United States Department of the Interior

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

August 16, 2013

Russell Morgan
State Conservationist
Natural Resources Conservation Service
Post Office Box 141510
Gainesville, Florida 32614-1510

Subject: U.S. Fish and Wildlife Service (Service) Biological Opinion on USDA Natural Resources Conservation Service (NRCS) Statewide Prescribed Fire Program and Related Activities

Dear Mr. Morgan:

The U.S. Fish and Wildlife Service is please to provide you with our Biological Opinion on NRCS' statewide prescribed burning program and related activities. Our two agencies recognize application of prescribed fire is one of the most important tools available to landowners and managers for restoring and maintaining wildlife habitat, not only in Florida, but throughout the Southeast. Prescribed fire is one of the top recovery actions for many of our State and federally listed species.

Because of the importance of prescribed fire, our two agencies decided to jointly review NRCS' conservation practice standards which facilitate the application of prescribed fire, and conduct a programmatic formal consultation under Section 7 of the Endangered Species Act of 1973, as amended (Act). This programmatic consultation on the NRCS' statewide prescribed fire program will help NRCS meet its Act obligations in a streamlined manner that balances the needs federally listed and imperiled species.

We would like to take this opportunity to thank your staff, especially Michael Bush and Chad George, for providing us with the information needed to complete this consultation, and for their thorough reviews of the draft portions of the Biological Opinion.

We look forward to continue working with NRCS to assist landowners in achieving their conservation objectives on their lands. Should you have any questions regarding our Opinion, or for further project coordination, please contact Delta Harris of our South Florida Office at 772-469-4247, Harold Mitchell of our Panama City Office at 850-799-0552 extension 246, or Stan Simpkins of our North Florida Office at 904-731-3096. Thank you for your conservation efforts in Florida.

Sincerely yours,

Larry Williams

Larry Williams
State Supervisor

cc: electronic only
FWC, Tallahassee, Florida (FWC-CPS)
Service, Jacksonville, Florida (Jay Herrington, Stan Simpkins, Mike Jennings)
Service, Panama City, Florida (Don Imm)
Service, Vero Beach, Florida (Delta Harris, Marilyn Knight)

U.S. Department of Agriculture
Natural Resources Conservation Service
Prescribed Fire
And
Related Activities

Biological and Conference Opinion

Prepared by:
U.S. Fish and Wildlife Service
Jacksonville, Florida
Panama City, Florida
Vero Beach Florida

August 16, 2013

Table of Contents

List of Tables and Figures viii
Consultation History 4
DESCRIPTION OF THE PROPOSED ACTION 5
Action Area Defined 5
Action Defined 6
Conservation Measures (NRCS Criteria) 11
Conservation Measures – General 11
Conservation Measures – General, Species Specific 12
Conservation Measures – Firebreaks 13
Conservation Measures – Firebreaks, Species Specific 13
Conservation Measures – Prescribed Fire, Species Specific 14
Conservation Measures – Fire Supportive Herbicide Application 17
Conservation Measures – Fire Supportive Herbicide Application Species Specific 17
Conservation Measures – Fire Supportive Mechanical Treatment 17
Conservation Measures – Fire Supportive Mechanical Treatment, Species Specific 18
STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE 18
Audubon’s Crested Caracara 19
Florida Grasshopper Sparrow 24
Florida Scrub-jay 28
Red-cockaded Woodpecker 36
Blue-tailed mole skink 37
Sand Skink 41
Eastern Indigo Snake 46
Gopher Tortoise 49
Frosted Flatwoods salamander 60
Reticulated Flatwoods slalamnder 60
Highlands Tiger Beetle 60
Bartram’s Hairstreak Butterfly 61
Florida Leafwing Butterfly 62
Florida Bonnected Bat 63
Striped Newt 70
American Chaffseed 79
Beautiful Pawpaw 87
Britton’s Beargrass 89
Brooksville Bellflower 92
Carter’s Mustard 96
Carter’s Small-flowered Flax 99
Chapman’s Rhododendron 104
Clasping Warea (Wide Leaf Warea) 105
Cooley’s Meadowrue 107
Cooley’s Water Willow 110
Crenulate Lead-Plant 112
Deltoid Spurge 114
Etonia Rosemary 117

Everglades Bully 119
Florida Bonamia 122
Florida Brickell-bush 125
Florida Golden Aster 130
Florida Skullcap 135
Four-petal Pawpaw 136
Fringed Campion 139
Gentian Pinkroot 140
Godfrey's Butterwort 140
Harper's Beauty 141
Highlands Scrub Hypericum 141
Lewton's Polygala 144
Longspurred Mint 147
Okeechobee Gourd 152
Papery Whitlow-wort 156
Pigeon Wings 159
Pygmy Fringe Tree 161
Sandlace 164
Scrub Blazingstar 167
Scrub Buckwheat 171
Scrub Lupine 174
Scrub Plum 176
Short-leaved Rosemary 179
Small's Milkpea 181
Snakeroot 184
Telephus Spurge 186
Tiny Polygala 187
White Birds-in-a-nest 190
Wireweed 190
ENVIRONMENTAL BASELINE 194
Status of the Species/Critical Habitat Within the Action Area 194
Audubon's Crested Caracara 194
Florida Grasshopper Sparrow 194
Florida Scrub-jay 195
Red-cockaded Woodpecker 195
Blue-tailed Mole Skink 196
Sand Skink 198
Eastern Indigo Snake 199
Frosted Flatwoods Salamander 199
Reticulated Flatwoods Salamander 199
Striped Newt 199
Gopher Tortoise 200
Highlands Tiger Beetle 201
Florida Bonneted Bat 201
Bartram's Hairstreak Butterfly 206
Florida Leafwing Butterfly 206

American Chaffseed....206
Beautiful Pawpaw....207
Britton's Beargrass....207
Brooksville Bellflower....208
Carter's Mustard....208
Carter's Small-flowered Flax....208
Chapman's Rhododendron....208
Clasping Warea (Wide-Leaf Warea)....209
Cooley'Meadowrue....209
Cooley's Waterwillow....209
Crennulate Lead-plant....209
Deltoid Spurge....210
Etonia Rosemary....210
Everglades Bully....211
Florida Bonamia....211
Florida Brickell-bush....211
Florida Golden Aster....211
Florida Skullcap....212
Four-petal Pawpaw....212
Fringed Campion....212
Gentian Pnkroot....212
Godfrey's Butterwort....212
Harper's Beauty....212
Highlands Scrub Hypericum....212
Lewton's Polygala....213
Longspurred Mint....213
Okeechobee Gourd....214
Papery Whitlow-wort....215
Pigeon Wings....215
Pygmy Fringe Tree....216
Sandlace....216
Scrub Blazingstar....217
Scrub Buckwheat....217
Scrub Lupine....217
Scrub Plum....218
Short-leaved Rosemary....218
Smalls Milkpea....218
Snakeroot....219
Telephus Spurge....219
Tiny Polygala....219
White Birds-in-a- nest....220
Wireweed....220
Factors affecting species habitat within the action area....220
EFECTS OF THE ACTION....223
Factors to be considerd....223
Species response to the proposed actions....225

Audubon’s Crested Caracara 225
Florida Grasshopper Sparrow 225
Florida Scrub-jay 225
Red-cockaded Woodpecker 226
Blue-tailed Mole Skink 227
Sand Skink 227
Eastern Indigo Snake 227
Gopher Tortoise 228
Frosted Flatwoods Salamander 229
Reticulated Flatwoods Salamander 229
Striped Newt 230
Highlands Tiger Beetle 230
Florida Bonneted Bat 230
Florida Leafwing Butterfly 231
Bartram’s Hairstreak Butterfly 231
American Chaffseed 231
Beautiful Pawpaw 233
Britton’s Beargrass 233
Brooksville Bellflower 234
Carter’s Mustard 234
Carter’s Small-flowered Flax 235
Clasping warea (Wide-leaf warea) 235
Chapman’s Rhododendron 236
Cooley’s Meadowrue 236
Cooley’s waterwillow 236
Crenulate Lead-plant 237
Deltoid Spurge 237
Etonia Rosemary 237
Everglades Bully 238
Florida Bonamia 238
Florida Brickell-bush 239
Florida Golden Aster 239
Florida Skullcap 239
Four–petal Pawpaw 240
Fragrant Prickly-apple 240
Fringed Campion 240
Gentain Pinkroot 241
Godfreys Butterwort 241
Harper’s Beauty 242
Highlands Scrub Hypericum 242
Lewton’s Polygala 243
Longspurred Mint 243
Okeechobee Gourd 244
Papery Whitlow-wort 244
Pigeon Wings 244
Pygmy Fringe Tree 245

Sandlace 245
Scrub Blazingstar 245
Scrub Buckwheat 246
Scrub Lupine 246
Scrub Mint 246
Scrub Plum 247
Short-leaved Rosemary 247
Small's Milkpea 248
Snakeroot 248
Telephus Spurge 248
Tiny Polygala 249
White Birds-in-a-nest 249
Wireweed 249
SUMMARY OF EFFECTS 250
CUMULATIVE EFFECTS 251
CONCLUSION 252
Listed species/critical habitat 252
Proposed and Candidate Species 252
INCIDENTAL TAKE STATEMENT 252
AMOUNT OR EXTENT OF TAKE ANTICIPATED 253
Listed Species 253
Audubon's Crested Caracara 253
Florida Grasshopper Sparrow 254
Florida Scrub-jay 255
Red-cockaded Woodpecker 255
Blue-tailed Mole Skink 256
Sand Skink 256
Eastern Indigo Snake 257
Frosted Flatwoods Salamander 257
Reticulated Flatwoods Salamander 258
Other Species (Proposed and Candidate Species) 258
Florida Bonneted Bat 258
Gopher Tortoise 259
Striped Newt 259
Highlands Tiger Beetle 260
Florida leafwing Butterfly 260
Bartram's Hairstreak Butterfly 261
COORDINATION OF INCIDENTAL TAKE STATEMENTS WITH OTHER LAWS, REGULATIONS, AND POLICIES 261
EFFECT OF THE TAKE 261
TERMS AND CONDITIONS 262
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS 262
Introduction 262
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS 263
General 263
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS 263

General –Species Specific ... 263
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 263
Firebreak ... 263
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 264
Prescribed Fire ... 264
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 264
Prescribed Fire-Species Specific ... 264
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 266
Pre-Fire Herbicide Application ... 266
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 266
Pre-Fire Herbicide Application Species Specific ... 266
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 266
Pre-Fire Mechanical Treatment ... 266
CONSERVATION RECOMMENDATIONS/CONSIDERATIONS ... 267
Pre-Fire Mechanical Treatment- Species ... 267
REINITIATION NOTICE ... 267
LITERATURE CITED ... 269
APPENDIX A – Conservation Practice Standards ... 1
APPENDIX B - Florida Ecological Services Offices Contact Info ... 13

List of Tables and Figures

Table 1. Affected Species (C=Candidate; E=Endangered; T=Threatened; P(E)=Proposed Endangered). 2
Table 2. Vegetative Natural Communities Acres* 6
Table 3. Conservation Practices Evaluated. 7
Table 4. Extant and historical populations of Carter's small-flowered flax. 103
Table 5**.** Extant and recent (presence still possible) occurences of Florida brickell-bush. 128
Table 6. Locations & habitat types recorded/observed for Florida bonneted bats (2003-2012). 205

Figure 1. Stiped newt Historic and Current Range 77

Table of Abbreviations/Acronyms

ABS – Archbold Biological Station

Act – Endangered Species Act

AFB – Air Force Base

AOU – American Ornithologists' Union

ANF – Apalachicola National Forest

APAFR – Avon Park Air Force Range

BCNP – Big Cypress National Preserve

BMP – Best Management Practices

BTG – Bok Tower Gardens

CARL – Conservation and Recreation Lands

CCSP – U.S. Climate Change Science Program

CFG – Cross Florida Greenway

CH – Chasmogamous

CL – Cleistogamous

cm – centimeters

DCSP – Dunns Creek State Park

DERM – Department of Environmental Resource Management

District – South Florida Water Management District

DOF – Division of Forestry

ECSF – Etonia Creek State Forest

EE – Environmental Evaluations

EEL – Environmentally Endangered Lands

ELAPP – Environmental Lands Acquisition and Protection Program

ENP – Everglades National Park

F - Fahrenheit

ft – feet

FTBG – Fairchild Tropical Botanic Garden

FDEP – Florida Department of Environmental Protection

FDOF – Florida Division of Forestry

FDOT – Florida Department of Transportation

FGSP – Florida Grasshopper Sparrow

FNAI – Florida Natural Areas Inventory

FSPSP – Fakahatchee Strand Preserve State Park

FWC – Florida Fish and Wildlife Conservation Commission

GDNR – Georgia Department Natural Resources

GIS – Geographic Information System

HARB – Homestead Air Reserve Base

HBS – Historic Bok Sanctuary

ha – hectares

HTB – Highlands Tiger Beetle

IPCC – Intergovernmental Panel on Climate Change Report

IPM – Integrated Pest Management

IRC – Institute for Regional Conservation

JDSP – Jonathan Dickinson State Park

JJERC – Joseph W. Jones Ecological Research Center

km – kilograms

km – kilometers

KPPSP – Kissimmee Prairie Preserve State Park

LCWA – Lake County Water Authority

LWR – Lake Wales Ridge

LWRNWR – Lake Wales Ridge National Wildlife Refuge

LWRWEA – Lake Wales Ridge Wildlife and Environmental Area

MDCCCTF – Miami-Dade County Climate Change Task Force

MDR – Mount Dora Ridge

mm – millimeters

MSRP – Multi-species Recovery Plan

NCNHP – North Carolina Natural Heritage Program

NEPA – National Environmental Policy Act

NFC – Natural Forest Communities

NOAA – National Oceanographic and Atmospheric Administration

NRCS – Natural Resources Conservation Service

NWR – National Wildlife Refuge

ONF – Ocala National Forest

ONWR – Okefenokee National Wildlife Refuge

Opinion – Biological and Conference Opinion

PCFO – Panama City Field Office

PSSF – Picayune Strand State Forest

RCW – Red-cockaded woodpecker

Service – U.S. Fish and Wildlife Service

SCS – Soil Conservation Service

SFESO – South Florida Ecological Services Office

SR – State Road

SWFWMD – Southwest Florida Water Management District

TLWMA – Three Lakes Wildlife Management Area

TNC – The Nature Conservancy

USDA – U.S. Department of Agriculture

USFS – U.S. Forest Service

WHR – Winter Haven Ridge

WMA – Wildlife Management Area

This transmits the U.S. Fish and Wildlife Service's (Service) combined Biological and Conference Opinion (Opinion) for effects of certain identified Conservation Practice Standards in support of habitat management and landowner conservation actions using prescribed fire for technical and financial assistance programs by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). Specifically, NRCS has requested a Service review of its Conservation Practice Standards that facilitate the application of prescribed fire and supporting habitat management and landowner conservation techniques on non-Federal lands in the State of Florida. NRCS cost share and technical assistance planning in support of prescribed fire may include firebreak construction and maintenance, prescribed fire, and mechanical and chemical treatment as pre-fire applications, as well as the other Conservation Practice Standards listed in the Opinion.

For the purposes of this Opinion, the action area consists of all pyrogenic vegetative communities in the state of Florida under NRCS easement programs or lands eligible to receive NRCS financial or technical assistance to undergo prescribed burning, or practices that will facilitate prescribed burning. Included within the action area would be vegetative communities that depend on periodic fires to restore and maintain habitat conditions. Many of these communities support some of the most endemic-rich vegetative types in Florida and represent some of America's most endangered ecosystems, to name just a few, Florida scrub, longleaf pine sandhill, and pine rocklands. Many rare and federally-listed plants and animals occur in these vegetative communities. The lack of fire in recent decades has left these habitats as overgrown and undesirable for many species (The Nature Conservancy [TNC] 2010a, 2010b). Prescribed fire is recognized as one of the top recovery actions for many of the covered species addressed in this Opinion.

The Opinion provides an evaluation of the proposed action and its effects on the following species in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 153 1 et seq.). Based on the review of the detailed components of the action, the Service has determined that the proposed action "may affect 79 listed, proposed and candidate species, with adverse effects to 69 listed, proposed, and candidate species (hereafter referred to as "covered species"). Please refer to Table 1 below. Those species with a LAA designation in Table 1 will be evaluated in detail in the Opinion and are hereafter referred to as the "covered species".

The Service and NRCS have agreed that because of their extreme endemism and rarity, or unknown or negative responses to fire, it is not appropriate to include the Atlantic salt marsh snake, Florida perforate cladonia, Florida ziziphus, Avon Park harebells, Scrub mint, Garrett's mint, Lakela's mint, fragrant prickly apple, sand flax, Florida prairie clover, Blodgett's silverbush, and Pineland sandmat in a programmatic opinion. NRCS projects occurring where these species are known to occur will require individual project review by the Service and section 7 consultation. These species requiring individual project review have been given an LAA NA (Likely to be Adversely Affected, but Not Addressed) designation in Table 1.

Table 1. Affected Species (C=Candidate; E=Endangered; T=Threatened; P(E)=Proposed Endangered).

Common Name	Federal Status	Critical Habitat	Affects	Lead Service Office For Contact Info
Eastern Indigo snake (*Drymarchon corais couperi*)	T		LAA**	North Florida
Atlantic Salt Marsh snake (*Nerodia clarkii taeniata*)	T		LAA**NA	North Florida
Gopher tortoise (*Gopherus polyphemus*)	C		LAA**	North Florida
Frosted flatwoods salamander (*Ambystoma cingulate*)	T	X	LAA**	Panama City
Reticulated flatwoods salamander (*Ambystoma bishop*)	E	X	LAA**	Panama City
Striped newt (*Notophthalmas perstriatus*)	C		LAA**	North Florida
Sand skink (*Neoseps reynoldsi*)	T		LAA**	South Florida
Blue-tailed mole skink (*Eumeces egregius lividus*)	T		LAA**	South Florida
Audubon's Crested caracara (*Polyborus plancus audubonii*)	T		LAA**	South Florida
Everglade Snail kite (*Rostrhamus sociabilis plumbeus*)	E	X	NLAA[*2]	South Florida
Florida Grasshopper sparrow (*Ammodramus savannarum floridanus*)	E		LAA**	South Florida
Florida scrub-jay (*Aphelocoma coerulescens*)	T		LAA**	North Florida
Red-cockaded woodpecker (*Picoides borealis*)	E		LAA**	North Florida
Red knot (*Calidris canutus*)	C		NLAA[*1]	Panama City
Wood stork (*Mycteria americana*)	E		NLAA [*1,*2]	North Florida
Florida panther (*Puma* (=*Felis*) *concolor coryi*)	E		NLAA*[1,2]	South Florida
Indiana bat (*Myotis sodalist*)	E		NLAA[*3]	Panama City
Florida Bonneted bat (*Eumops floridanus*)	P(E)		LAA**	South Florida
Highlands tiger beetle (*Cicindela highlandensis*)	C		LAA**	South Florida
Bartram's Hairstreak Butterfly (*Strymonacis bartrami*)	C		LAA**	South Florida
Florida Leafwing Butterfly (*Anaea troglodyta floridalis*)	C		LAA**	South Florida
American chaffseed (*Schwalbea americana*)	E		LAA**	Panama City
Apalachicola rosemary (*Conradina glabra*)	E		NLAA[*3]	Panama City
Avon Park harebells (*Crotalaria avonensis*)	E		LAA**NA	South Florida
Beautiful pawpaw (*Deeringothamnus pulchellus*)	E		LAA**	South Florida
Blodgett's silverbush (*Argythamnia blodgettii*)	C		LAA**NA	South Florida
Britton's beargrass (*Nolina brittoniana*)	E		LAA**	North Florida
Brooksville bellflower (*Campanula robinsiae*)	E		LAA**	North Florida
Carter's Small-Flowered flax (*Linum carteri* ssp. c*arteri*)	C		LAA**	South Florida
Carter's mustard (*Warea carteri*)	E		LAA**	South Florida
Chapman rhododendron (*Rhododendron chapmanii*)	E		LAA**	Panama City
Cooley's meadowrue (*Thalictrum cooleyi*)	E		LAA**	Panama City
Cooley's waterwillow (*Justicia cooleyi*)	E		LAA**	North Florida
Crenulate lead-plant (*Amorpha crenulata*)	E		LAA**	South Florida
Deltoid spurge (*Chamaesyce deltoidea* ssp. *deltoidea*)	E		LAA**	South Florida

Etonia rosemary (*Conradina etonia*)	E		LAA**	North Florida
Everglades bully (*Sideroxylon reclinatum* ssp. *austrofloridense*)	C		LAA**	South Florida
Florida Golden aster (*Chrysopsis floridana*)	E		LAA**	North Florida
Florida bonamia (*Bonamia grandiflora*)	T		LAA**	North Florida
Florida brickell-bush (*Brickellia mosieri*)	C		LAA**	South Florida
Florida Bristle fern (*Trichomanes punctatum* ssp. *floridanum*)	C		NLAA*3	South Florida
Florida prairie-clover (*Dalea carthagenensis* var. *floridana*)	C		LAA**NA	South Florida
Florida perforate cladonia (*Cladonia perforata*)	E		LAA**NA	South Florida
Florida pineland crabgrass (*Digitaria pauciflora*)	C		NLAA*3	South Florida
Florida skullcap (*Scutellaria floridana*)	T		LAA**	Panama City
Florida torreya (*Torreya taxifolia*)	E		NLAA*2,*3	Panama City
Florida ziziphus (*Ziziphus celata*)	E		LAA**NA	South Florida
Four-Petal pawpaw (*Asimina tetramera*)	E		LAA**	South Florida
Fragrant prickly-apple (*Cereus eriophorus* var. *fragrans*)	E		LAA**NA	South Florida
Fringed campion (*Silene polypetala*)	E		LAA**	Panama City
Garrett's mint (*Dicerandra christmanii*)	E		LAA**NA	South Florida
Gentian pinkroot (*Spigelia gentianoides*)	E		LAA**	Panama City
Godfrey's butterwort (*Pinguicula ionantha*)	T		LAA**	Panama City
Harper's beauty (*Harperocallis flava*)	E		LAA**	Panama City
Highlands Scrub hypericum (*Hypericum cumulicola*)	E		LAA**	South Florida
Lakela's mint (*Dicerandra immaculate*)	E		LAA**NA	South Florida
Lewton's polygala (*Polygala lewtonii*)	E		LAA**	South Florida
Longspurred mint (*Dicerandra cornutissima*)	E		LAA**	North Florida
Miccosukee gooseberry (*Ribes echinellum*)	T		NLAA*3	South Florida
Okeechobee gourd (*Cucubita okeechobeensis* ssp. *Okeechobeensis*)	E		LAA**	South Florida
Papery whitlow-wort (*Paronychia chartacea minima*)	T		LAA**	South Florida
Pigeon wings (*Clitoria fragrans*)	T		LAA**	South Florida
Pineland sandmat (*Chamaesyce deltoidea* ssp. *pinetorum*)	C		LAA**NA	South Florida
Pygmy fringe-tree (*Chionanthus pygmaeus*)	E		LAA**	South Florida
Sand flax (*Linum arenicola*)	C		LAA**	South Florida
Sandlace (*Polygonella myriophylla*)	E		LAA**NA	South Florida
Scrub blazingstar (*Liatris ohlingerea*)	E		LAA**	South Florida
Scrub buckwheat (*Erogonum longifolium* var. *gnaphalifolium*)	T		LAA**	North Florida
Scrub lupine (*Lupinus aridorum*)	E		LAA**	North Florida
Scrub mint (*Dicerandra frutescens*)	E		LAA**NA	South Florida
Scrub plum (*Prunus geniculata*)	E		LAA**	North Florida
Short-Leaved rosemary (*Conradina brevifolia*)	E		LAA**	South Florida
Small's milkpea (*Galactia smallii*)	E		LAA**	South Florida
Snakeroot (*Eryngium cuneifolium*)	E		LAA**	South Florida

Telephus spurge (*Euphorbia telephioides*)	T		LAA**	Panama City
Tiny polygala (*Polygala smallii*)	E		LAA**	South Florida
White birds-in-a-nest (*Macbridea alba*)	T		LAA**	South Florida
Wide-Leaf warea (Clasping warea) (*Warea amplexifolia*)	E		LAA**	North Florida
Wireweed (*Polygonella basiramia*)	E		LAA**	South Florida

* NLAA = "Not Likely to Adversely Affect"

Rationale for NLAA

*[1] Highly mobile species that can avoid fire and other activities. No indirect impacts.

*[2] Implementation of avoidance and minimization measure will avoid adverse impacts such that incidental take will never occur.

*[3] Species occurs in pyrogenic vegetative community types but due to its narrow range, it is believed that NRCS will not be implementing actions where the species occurs *e.g.*, species only occurs on lands not eligible for NRCS funding or technical assistance.

** LAA = "Likely to Adversely Affect"

**LAA NA = "Likely to Adversely Affect but Not Addressed"

The following Opinion is based on information provided to the Service in the form of a biological evaluation and through telephone conversations, e-mails, field investigations, and other sources of information. A complete administrative record of this consultation is on file in Jacksonville Ecological Services Office.

Consultation History

February 28, 2011-March 1, 2011: The Service participated in an annual coordination meeting with NRCS and the Florida Fish and Wildlife Conservation Commission (FWC). Because of the need for formal consultations related to prescribed burning on central Florida ridges habitats, our agencies agreed to pursue a programmatic consultation on the NRCS burning program being implemented on the central Florida ridges.

March 20, 2012: During the 2012 annual coordination meeting, the Service provided a summary of progress made in the process of NRCS initiating formal consultation on NRCS central Florida ridges prescribed burning program. Our agencies discussed what information was needed in order to proceed with the consultation.

May 24, 2012: NRCS requested via email that the scope of the consultation be expanded so that the action area would include NRCS burning program for the entire State of Florida.

July 2, 2012: The Service and NRCS participated in a conference call to discuss the habitats within the action area that would be addressed in the consultation and the management activities (Conservation Practice Standards) that would be evaluated.

July13, 2012: The Service provided NRCS for review and comment the section of the Opinion pertaining to the summary of the Conservation Practice Standards and their effects.

August 21, 2012: NRCS provided the Service an estimate on the number of acres to be treated on an annual basis.

October 30, 2012: The Service provided draft Conservation Measures and Recommendations to NRCS for review and comment.

January 18, 2013: NRCS provided comments on the draft Conservation Measures and Recommendations.

April 2, 2013: The Service provided the revised draft Conservation Measures and Recommendations to NRCS for final review and comment.

April 4, 2013: NRCS provided comments on the revised draft Conservation Measures and Recommendations.

April 11, 2013: The Service and NRCS met to discuss NRCS comments on the revised Draft Conservation Measures and Recommendations.

May 16, 2013: The Service provided NRCS a draft Opinion, with revised Conservation Measures and Recommendations based on the April 11, 2013 meeting, for review and comment via email.

June 3, 2013: NRCS provided additional comments on the Conservation Measures in the draft Opinion.

July 19, 2013: The Service and NRCS participated in a conference call to discuss NRCS comments on the Conservation Measures in the draft Opinion.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Action Area Defined

For the purposes of this Opinion, the Action Area consists of all pyrogenic vegetative communities in the State of Florida under NRCS easement programs or lands eligible to receive NRCS financial or technical assistance to undergo prescribed burning, or practices that will facilitate prescribed burning. The major focus of NRCS technical assistance and financial aid programs that would be related to prescribed burns and supporting practices is private and Tribal lands. Additionally approximately 25,000 acres of publicly owned Water Management District lands (Allapatah, Turkey Creek, Orange Creek, and Ocklawaha tracts) is part of the action area. Included within the action area are vegetative communities that depend on periodic fires to restore and maintain habitat conditions. NRCS has indicated they rarely, if ever, conduct activities in the Florida Keys. Therefore, the Florida Keys is excluded from the action area.

Table 2 lists the vegetative communities, as described by the Florida Natural Areas Inventory (FNAI), where NRCS could implement burning and associated practices.

It should be noted NRCS also implements prescribed burning and related actions in highly disturbed anthropogenic communities such as agricultural fields (*e.g.*, sugar cane fields) and improved pastures for reasons other than ecological restoration/enhancement. These types of actions are not addressed in this Opinion and may be subject to further section 7 consultation under the Act. On the other hand, prescribed burning actions may be implemented to restore an agricultural field to a natural vegetative community identified in Table 2. In such cases, acres to be restored are identified in Table 2 under the appropriate vegetative natural community type to be restored.

It is not known what specific landowners NRCS will be enrolling into their programs to conduct these practices. Furthermore, it is not known where in the State of Florida these landowners occur. Therefore, it is not possible to identify individual tracts where actions may be implemented for the purposes of this Opinion. However, NRCS has estimated actions may occur within the acres identified for each vegetative community in Table 2 on an annual basis. The NRCS estimates are based on; (1) acres NRCS is currently treating; (2) projection of percentage of increased acres NRCS expects to treat over the next 5 years; (3) acres currently enrolled in easement programs that would be treated over the next 5 years; and (4) acres projected to be enrolled into easement programs and treated the next 5 years.

Table 2. Vegetative Natural Communities Acres*

Pinelands (including Wet, Mesic, Scrubby, and Cutthroat grass Longleaf pine sandhill, Upland Pine, and Upland mixed woodland (also includes pine plantations and sivipastures in any of the pinelands types)	26,000
Pine Rocklands/Everglades Flatwoods	500
Sand Scrub	2,000
Wet Prairies and Bogs (including Wet prairies, Marl prairie, Seepage slopes including Cutthroat seeps, and Shrub bogs, and pitcher plant and other herbaceous bogs)	16,000
Dry Prairie	7,000
Scrub/Dwarf Cypress	500
Freshwater Marshes (including Depression, Basin, Floodplain, Slough, and Glades Marshes)	10,000
Saltwater Marshes	1,000

*Vegetative Natural Communites as defined by FNAI 2010, Guide to the Natural Communities of Florida.

Action Defined

The action for this Opinion includes the application of certain conservation practices incorporated into NRCS conservation plans and implemented by NRCS clients in the action area that follow the NRCS conservation planning process and meet NRCS conservation practice standards and specifications and associated Conservation Measures as described herein. Twelve Conservation Practice Standards will be implemented by NRCS that directly or indirectly support the use of prescribed fire for the purpose of restoring, enhancing, or maintaining wildlife habitat. These conservation practices are listed in Table 3 below.

Table 3. Conservation Practices Evaluated.

Conservation Practice Name	Conservation Practice Number	Conservation Practice Type
Upland Wildlife Habitat Management	645	Core Management
Wetland Wildlife Habitat Management	644	Core Management
Restoration and Management of Rare and Declining Habitats	643	Core Management
Early Successional Habitat Development/Mgmt	647	Core Management
Forest Stand Improvement	666	Facilitating Management
Prescribed Burning	338	Facilitating Management
Brush Management	314	Facilitating Vegetative
Firebreak	394	Facilitating Vegetative
Fuel Break	383	Facilitating Vegetative
Forest Slash treatment	384	Facilitating Vegetative
Herbaceous Weed Control	315	Facilitating Vegetative
Integrated Pest Management	595	Facilitating Management

Practices Implemented

1. The core conservation management practices which are specifically planned and designed to produce an overall benefit to the covered species and their habitat requirements;
2. Practices that facilitate the application of the core conservation management practices that, in themselves, may or may not be beneficial to the covered species and their habitat requirements; and
3. Additional practice-specific Conservation Measures that can minimize or eliminate detrimental effects of conservation practices to the covered species and their habitat requirements.

The Conservation Practice Standards covered as part of this Opinion are integrated within a larger planning framework conducted by NRCS to implement its authorities under the Farm Bill. A brief synopsis of this supporting conservation planning process appears below.

General Discussion of NRCS Conservation Planning Process

Local NRCS Field Office conservation planners develop conservation plans for clients that address natural resource concerns on non-Federal, or Tribal lands. NRCS conservationists help individuals and local communities take a comprehensive approach to planning the sustainable use and protection of natural resources on these lands through a nine-step conservation planning process described in the NRCS "National Planning Procedures Handbook."

As part of this conservation planning effort, individual environmental reviews called Environmental Evaluations (EE) are completed which inform the conservation planning effort and assist the Agency's compliance with NRCS regulations that implement the National Environmental Policy Act (NEPA) and the Act. The EE is a concurrent part of the conservation planning process in which the potential long-term and short-term impacts of an action on people, their physical surroundings, and the natural environment are evaluated and alternative actions explored. The EEs and conservation plans are developed to assist the client in making decisions and implementing the conservation practices identified in the conservation plan. A conservation plan is a record of the client's decision to implement one or more conservation practices, which prescribe the actions necessary to address the identified natural resource concerns in need of treatment.

Conservation Practices

NRCS provides technical and financial assistance through the Farm Bill to implement conservation plans based on standard Conservation Practice Standards and specifications. These conservation practices are developed through a multi-disciplinary science-based process to maximize the success and minimize the risk of failure of the Conservation Practice and its intended result. NRCS Conservation Practice Standards are established at the national level, and identify the minimum level of planning, designing, installation, operation, and maintenance required. Each Conservation Practice Standard includes a definition and purpose, identifies conditions in which the Conservation Practice applies, and includes criteria to support each purpose. A brief description of the Conservation Practices in Table 3 are in Appendix A. The actual conservation practices in their entirety along with other information can be found in Section IV of the Florida NRCS Field Office Technical Guide at http://efotg.sc.egov.usda.gov/treemenuFS.aspx.

Conservation Standards are listed in Section IV of the Field Office Technical Guide and are used and implemented by States, as needed, and may be modified to include additional requirements to meet State or local needs because of wide variations in soils, climate, and topography. Conservation Practice Standards are routinely reviewed and approved by State Technical Committees to ensure that appropriate criteria are included to cover State-specific interests. State laws and local ordinances or regulations may also dictate criteria that are more stringent; however in no case are the requirements of the National Conservation Practice Standard to be reduced.

Using the above Conservation Practice Standards and the identified Conservation Measures and Conservation Recommendations/Considerations, NRCS proposes to implement habitat restoration, creation, and management using prescribed fire and associated management activities on eligible lands. Habitat management prescriptions may include firebreak construction and maintenance, mechanical and chemical land treatments, pre-control burns, and controlled burns. The purpose of the prescriptions are to reduce fire fuel loads, manage invasive species, and promote and enhance management of various habitats throughout the region, primarily with fire. The Service acknowledges that many of the Conservation Practices identified in Table 2 are often implemented for reasons other than directly related to prescribed burning or to support prescribed burning. This Opinion addresses only actions that are related to prescribe burning and activities that are implemented so that prescribed fire can be applied at a later point in time.

The Opinon provides an evaluation of the proposed action and its effects on those species listed in Table 1 with a “LAA” desigination in accordance with section 7 of the Act of 1973, as amended (1 6 U.S.C. 153 1 et seq.).

In 2007, NRCS consulted informally with the Service on all conservation practices employed in Florida, including those practices evaluated in this Opinion. The “USFWS-NRCS Interagency Consultation Matrix documents the Service’s concurrence with NRCS determination of ‘not likely to adversely affect” when avoidance and minimization measures identified are implemented. However, the matrix also identifies actions that require further coordination with the Service that could adversely affect listed species. Furthermore, NRCS and the Service acknowledge that there may be instances where the avoidance and minimization measures cannot be implemented and short term adverse impacts during prescribed burning and related activities may occur. Examples of the above would include secretive species or species not known to occur in an area, which may not be able to be avoided during activities. To achieve long-term benefits of habitat restoration, burning may need to be implemented during an avian species’ nesting season that may interfere with a year’s reproduction. When these (and other) situations described above occur, actions are considered to be outside of the scope of the Consultation Matrix.

When prescribed burning and associated actions occur outside of the scope of the Consultation Matrix, the Service has determined the proposed actions may affect 79 listed, proposed and candidate species with a determination of adverse effects to 69 listed, proposed and candidate species; it is and not likely to adversely affect 10 species as identified in Table 1. Of the 69 species that may be adversely affected, the Service and NRCS have agreed that because of their extreme endemism and rarity, or unknown or negative responses to fire, it is not appropriate to include 12 of the species with a likely to adversely affect determination in a programmatic opinion (Atlantic salt marsh snake, Florida perforate cladonia, Florida ziziphus, Avon Park harebells, scrub mint, Garrett’s mint, Lakela’s mint, fragrant prickly apple, sand flax, Florida prairie clover, Blodgett’s silverbush, and pineland sandmat). NRCS projects occurring where these species are known to occur will require individual project review by the Service and section 7 consultation.

In this Opinion, the Service evaluated 57 proposed, listed and candidate species which are likely to be adversely affected by proposed activites, referred to as covered species. Covered species include 41 species of plants, 4 avian species (Florida scrub-jay, red-cockaded woodpecker, Florida grasshopper sparrow, and Audubon’s crested caracara), 2 skinks (sand skink and blue-tailed mole skink), 1 snake (eastern indigo snake), 1 bat (Florida bonneted bat), 2 butterflies (Bartram’s hairstreak and Florida leafwing), and 1 beetle (Highlands tiger beetle [HTB]).
The Service has determined the proposed action is not likely to jeopardize the continued existence of any of the covered species evaluated, and no destruction or adverse modification of the critical habitat for these species is expected. It is important to note that while we have identified adverse effects, these affects are believed to be short term. Long term effects of prescribed burning will result in restored and enhanced habitat for listed species and will result is a net conservation benefit for these species.

For the purpose of this Opinion, the conservation practices evaluated include various prescribed fire management activities. These prescribed fire management activities include pre-treatment, establishment and maintenance of fire lines, and actual ignition of fire-maintained ecosystems. Pre-treatment includes manual treatments (hardwood reduction using chainsaws or hand tools), mechanical treatments (mowing, roller chopping, gyro-track chopping, tree-cutting, logging, and disking), and application of herbicide for control of invasive species and other problematic vegetation (backpack sprayers, spot treatment, cut-stump treatment, and hack and squirt treatment).

Mechanical treatments such as roller-chopping, mowing, chain-sawing, and logging, and herbicide application, are used to manage fire-maintained Florida ecosystems. Goals include achieving or restoring desired vegetation structure and composition, providing habitat for listed species, and allowing the reintroduction of fire. Menges and Gordon (2010) reviewed studies evaluating mechanical treatments and herbicide effects on Florida's plant and animal communities. Mechanical treatments and herbicide often accelerated vegetation structure changes, but ecological benefits were generally greatest when they were combined with fire. Soil disturbances, weedy species increases, and rapid hardwood resprouting were sometimes problems with mechanical treatments. Fire itself was crucial for maintenance of individual species and species diversity (Menges and Gordon, 2010; Weekley et al. 2008a). Therefore, the Service believes that, when feasible, mechanical and herbicide treatments should be used only as pre-treatments for fire rather than as fire surrogates, and managers should segue to fire-only approaches as soon as possible. Mechanical and herbicide treatments should be followed in a timely manner with prescribed fire (within 3 to 6 months).

In addition to the actions described above for prescribed fire management activities, individual land managers or owners may also conduct invasive species control as a pre- or post-treatment for fire, which also promotes a more complete and comprehensive resource management approach. Invasive plant species pose tangible threats of their own, often-altering fire behavior within upland habitats. Plant species to be treated include, but are not limited to: cogon grass (*Imperata cylindrica*), natal grass (*Rhynchelytrum repen*), guinea grass (*Panicum maximum*), Johnson grass (*Sorghum halepense*), Japanese climbing fern (*Lygodium japonicum*), Old World climbing fern (*Lygodium microphyllum*), rosary pea (*Abrus precatorius),* Chinese tallow (*Triadica sebifera*), Brazilian pepper (*Schinus terebinthifolius*), chinaberry (*Melia azedarach*), and other woody tree species. Herbicides will be selected based upon university recommendations and applied in accordance to label instructions using foliar application with pump sprayers, frill and girdle application with pump sprayers, and cut stump application.

<u>Participation Requirements</u>

In order to participate in the technical and financial assistance programs available from NRCS, participating landowners, Tribal members, and NRCS utilize a variety of supporting decision and planning tools as described previously. NRCS clients will commit to implement the requirements of each Conservation Practice Standard as conditioned by the client's conservation plan.

Conservation Measures (NRCS Criteria)

Introduction

As part of the scope of the action, NRCS and the Service developed a set of requirements that when incorporated with the Conservation Practice Standards, will guide the implementation of each conservation plan developed for NRCS clients. These requirements are collectively identified as "Conservation Measures". Conservation Measures consist of criteria in addition to those specified in Conservation Practice Standards that avoid or minimize the amount or magnitude of adverse effects on species because of practice implementation. Each site specific Conservation Practice with the associated Conservation Measures must meet NRCS standards and specifications as planned and applied. The Service recognizes that emergency situations to control fire may supersede these Conservation Measures.

The majority of ecological communities in Florida depend upon periodic fires to maintain habitat conditions. The lack of fire in recent decades has left these habitats overgrown and undesirable for many native plant and animal species, particularly imperiled species. The application of NRCS Conservation Practices and Conservation Measures within the context of implementation of the client's Conservation Plan recognizes the current deficiencies in desired conditions of the habitat because of historical cultural and economic factors and seeks to reverse the trend. Furthermore, the use of the Conservation Measures acknowledges that, despite the expected positive conservation outcome on the covered species' persistence and habitat distribution resulting from the use of prescribed fire and the other conservation practices, some level of adverse effects are likely to occur.

In the rare circumstances that application of the Conservation Measures cannot be met, then consult with the appropriate Service office (See Appendix B).

Conservation Measures – General

1. Stipulations in the NRCS ECS form will be provided that vehicle and equipment operators will be notified to avoid adverse impacts to all covered species. All on-site personnel will be educated to recognize covered species and where such species occur on the burn unit to the extent practicable. Information will be made available on listed, proposed, and candidate species habitats and reproductive seasons. If any covered species is encountered, it will be avoided to the extent practicable. Covered animal species will be allowed to leave the immediate area of disturbance on their own before vehicle or equipment use is resumed.
2. If a dead, injured, or sick covered animal species is found in the project area, contact the appropriate Service's Ecological Services Office species lead as provided in Table 1.
3. Submit an annual report at the time of our annual coordination meeting that includes the following information: (a) list of areas burned and date of burn; total acreage burned by vegetative community in Table 2; (b) identify projects where activities were implemented where covered species were known to occur; and (c) all observed take of covered animal species.

4. In pine rocklands, conduct prescribed burns in small burn units using a mosaic pattern over time. Since many pine rockland habitats are fragmented and isolated from one another, partial / smaller burns will provide some on-site refugia for imperiled species and facilitate recolonization.
5. Reduce sediment or erosion into isolated wetland habitats.

Conservation Measures – General, Species Specific

1. Crested caracara: If a known caracara nest is within project area and is active (*i.e.*, nest building, incubation, and early nestling stages 3 to 4 weeks), keep fire, heavy equipment, vehicles, and personnel outside of an 850-foot radius buffer of the nest tree.
2. Florida grasshopper sparrow and crested caracara nest tree coordination: If a caracara nest tree is known to occur within the NRCS Florida grasshopper sparrow (FGSP) consultation area and is found in FGSP habitat as defined by the consultation matrix, contact the South Florida Ecological Services Office (SFESO) for further guidance.
3. Wood stork: If there is a known wood stork colony within the project area, prevent disturbance of the colony by deferring activities (including actual burning) in the following buffer zones until after the nesting season (a) 700 feet (ft) for colonies surrounded by protective vegetative cover or for colonies where no birds are observed and (b) 1,300 ft for exposed colonies (*i.e.*, lack of a vegetative cover that would serve to buffer or screen disturbance from human activities). The nesting season constraints may be shortened during years when the colony is not active or after nesting activities have concluded.
4. Eastern indigo snake: On tracts where eastern indigo snakes are known to occur or could potentially occur, contractors / fire crew members will be furnished the following information:
   a. If a snake barring a resemblance to an eastern indigo snake is encountered, cease any operations that might potentially harm the snake and allow it to move away on its own before resuming operations.
   b. Instructions to contact the appropriate Service Field Office if a dead eastern indigo snake is discovered.
5. Gopher tortoise: Keep equipment and activities that could potentially collapse gopher tortoise burrows, 25 ft away from known gopher tortoise burrows.
6. Flatwoods salamander: In areas where flatwoods salamanders could potentially occur, restrict heavy equipment use to dry periods to prevent soil compaction.
7. Florida bonneted bat: In areas where Florida bonneted bats are known to occur (see Table 6 when implementing activities within the residential, urban area identified in the table, contact the SFESO for site specific information), retain old trees and snags with hollows or cavities. If dead or old trees must be removed, examine them first to make sure they are not being used by roosting bats before removal.

Conservation Measures – Firebreaks

1. When constructing , new, boundary firebreaks, limit width to up to 30 ft maximum width (mineral soil). Scatter debris from firebreak construction, but avoid scattering it on covered species or on their nests, dens, or cover. Mowing or other mechanical treatment may be employed when necessary to create wider fire breaks.
2. Interior firebreaks may be constructed up to 20 ft maximum width (mineral soil) except as identified in species specific guidance..
3. For temporary fuel breaks , use mowing instead of other clearing practices that are more soil disturbing.
4. In pine rocklands, retain pineland croton.
5. Avoid altering the natural hydrology of an area.

Conservation Measures – Firebreaks, Species Specific

1. Red-cockaded woodpecker: Do not put firebreaks in a red-cockaded woodpecker (RCW) cluster except when property boundaries dictate the placement of firebreaks.
2. Florida scrub-jay: Avoid putting new firebreaks in occupied scrub jay habitat during the nesting season (March 1-June 30). When in occupied scrub jay habitats, limit soil disturbance by disking firebreaks at the minimum frequency necessary to maintain mineral soil (*i.e.*, recommended once a year or less).
3. Listed skinks: When in skink habitats (within the appropriate counties, soils and elevation) limit soil disturbance by disking firebreaks at the minimum frequency necessary to maintain mineral soil (*i.e.*, recommended once a year or less).
4. Covered plants: Do not place firebreaks or staging areas through known covered plant populations*, except in the following cases: (a). When property boundaries dictate the placement of firebreaks and there is a known population of covered plants in a proposed new firebreak, put a temporary firebreak next to the population to allow refuge during the first burn. The plant should then be allowed to seed into adjacent burned habitat. In the next burn cycle, you may construct a firebreak in the originally proposed location if the plant population has successfully moved into the temporary firebreak and (b) The other exception is if the plant distribution on the site is such that disruption of a few individuals is unavoidable.
5. Flatwoods salamander: Do not plow, or construct control firebreaks with ground-disturbing equipment through known Flatwoods salamander breeding ponds.
6. Florida leafwing and Bartram's hairstreak: In pine rocklands, avoid pineland croton when installing firebreaks.
7. Florida bonneted bat: In areas where Florida bonneted bats are known to occur See Table 6 (when implementing activities within the residential, urban area identified in the table, contact the SFESO for site specific information), retain cavity trees, old or large trees and snags. If these trees must be removed, because of firebreak integrity or for human safety concerns, examine them first to make sure they are not being used by roosting bats before removal.

8. Florida bonneted bat: Mark and avoid any known or suspected Florida bonneted bat roosts. No natural roost sites are currently known for this species. However, potential roost sites may be located based on one or more of the following: bonneted bats are observed emerging from a tree cavity, bat vocalizations (chattering) have been heard from a tree/snag cavity, large bats (> 5 inches in length) have been seen flying or bats have been heard vocalizing in the vicinity, echolocation calls have been recorded in the vicinity using acoustical recording devices, the tree/snag exudes an "ammonia"-like smell, or bat guano has been seen around the base of a tree/snag. Where one or more of these conditions exist, protect the tree or snag from damage.

Conservation Measures – Prescribed Fire, Species Specific

1. RCW: Protect active RCW cavity trees per guidance in the RCW Recovery Plan. If an active RCW cavity is accidentally burned or damaged, replace with an artificial cavity within 72 hours after loss. Ensure that all personnel contractors installing RCW artificial cavities are properly trained and permitted as described in the Service's November 13, 2003 *Biological Opinion For All Section 10(a)(1)(A) Management,Monitoring and Research permits Involved with Management Conservation and Recovery of the RCW.* Check active RCW tree(s) with artificial cavities that have been scorched after a burn to ensure that plastic entrance tubes have not been melted to exclude birds. If they have been melted, then the artificial cavity should be replaced.
2. Florida scrub jay: When possible, manage scrub jay habitat using methods that ensure suitable, unoccupied habitat remains adjacent to the burn unit or using methods that leave patches of unburned oak shrubs (ideally approximately 1 acre per 25 acres burned) that can provide nest sites, escape cover, and acorns within the burn unit.
    a. Avoid complete burns (*i.e.*, all black, with no unburned patches) over extensive acreages (*i.e.*, hundreds of acres) of occupied habitat, which can displace multiple scrub jay families.
    b. On properties with many scrub jay families and large amounts of habitat, use methods that minimize the number of displaced families; in this case, temporary loss of suitable habitat from prescribed fire for one or two families is less cause for concern.
    c. On small properties or properties with few remaining scrub jay families (*e.g.*, estimated number of groups < 10), avoid burning entire territories at once.
3. Crested caracara: Protect known caracara nest trees from fire. If a known caracara nest is within project area and is active (*i.e.*, nest building, incubation, and early nestling stages 3 to 4 weeks), keep fire outside of an 850-foot radius buffer of the nest tree.
4. Florida grasshopper sparrow: When burning areas containing FGSP habitat as defined by the Consultation Matrix, use low intensity fire to produce a mosaic of burned and unburned areas within the burn unit. Similarly, when planning for burning in adjacent units, allow habitat to recover at least 3 weeks prior to burning the adjacent units to produce a mosaic pattern across the larger landscape. Strive for a less than 2-year fire return interval to maintain the habitat and promote low-intensity fires by burning the same unit during different times of the year (e.g., avoid always burning the same area in April) and encouraging patchiness (*i.e.*, avoiding entire burns of a unit, block, or area).

When burning areas containing FGSP habitat as defined by the Consultation Matrix, the majority of burns in this habitat should be conducted between April 1 and June 15 to maintain habitat and allow enough time for FGSP to re-nest. To restore and maintain FGSP habitat, burning during other times of the year is not preferred. However, prescribed fire may also occur between June 15 to August 15 provided that prairie habitat is not currently ponded (*i.e.,* no standing water) and a major rain event such as a tropical storm or tropical depression is not forecast within one week after the burn is completed. Burning may occur from February 1 to April 1, provided that a cold snap or freeze resulting in a one day low temperature of 28 degrees Fahrenheit (F), or a low of 32 degrees F for 3 consecutive days within a week after the burn is not forecast.

Do not burn from August 15 to January 31 unless, due to weather, permitting, and other issues, a burn has not been completed on a unit for 3 consecutive years. To avoid further degradation of FGSP habitat, burning may be conducted during this time period of August 15 to January 31. Subsequent burning will be conducted during other times of the years as identified above.

A summary of burning dates in FGSP habitat is provided in the table below:

FGSP Burning Periods

Time Period	Provisions	Conservation Notes
April 1-June 15	Refer to all other Conservation measures for FGSP	Preferred & Encouraged
June 15-August 15	Burn only when: prairie habitat is not ponded & no major rain even is forecast one week after the burn.	Ponding after burning may discourage regrowth of grasses & herbaceous vegetation preferred by the FGSP.
August 15-January 31	Do NOT burn unless burning has not occurred within the unit for the last 3 consecutive years. For subsequent burning, aim to burn during other times.	Repeated burning during this time frame will not restore or maintain FGSP habitat on many tracts.
February 1-April 1	Burn only when:a cold snap or freeze resulting in a one day low of 28 degrees F or a low of 32 degrees F for 3 consecutive days within one week after burning is NOT forecast.	Freezing temperatures immediately following a burn may discourage regrowth of grasses and herbaceous vegetation preferred by the FGSP.

If it is not feasible to burn within these parameters additional coordination and concurrence with the Service will be necessary to evaluate or avoid impacts.

5. Everglades snail kite: If prescribed burning is planned within January 15 to August 30, within 2,000 ft of a lake or wetland that supports Everglade Snail Kite nesting, contact the Service's snail kite biologist (772-562-3909) for current nesting information. If there are active nests within 2,000 ft of the planned activity, a 1,640-foot minimum no-entry buffer may be established around nests.
6. Pine rockland species: Implement prescribed burns in small burn units using a mosaic pattern over time. That is, allow habitat to recover prior to burning adjacent pine rockland habitat in any year, and strive for a 3 to 5-year fire rotation.
7. Florida leafwing and Bartram's hairstreak: NRCS will coordinate with the SFESO regarding any pine rockland burns planned within or adjacent to Navy Wells Pineland Preserve or the Richmond Pine Rocklands in Miami-Dade County.
8. Florida leafwing and Bartram's hairstreak: When burning pine rockland habitat, do so in a mosaic pattern over time. That is, allow habitat to recover prior to burning adjacent pine rockland habitat in any year, and strive for a 3 to 5-year fire rotation for all habitat. Fore rotation and mosaic burn patterns will ease dispersal of the Florida leafwing and

Bartram's hairstreak butterflies from treatment areas during burns as well as aid in re-colonization post-burn.

9. Florida bonneted bat: Where bonneted bats are known to occur See Table 6 (when implementing activities within the residential, urban area identified in the table, contact the SFESO for site specific information), protect old trees and snags with hollows or cavities from fire. Rake and/or clear vegetation around the base of known or suspected roost sites to remove fuel load before conducting prescribed burns (Use similar guidance as provided for protection of RCW cavity trees in the RCW Recovery Plan). Potential roost sites may be located based on one or more of the following: bonneted bats are observed emerging from a tree cavity, bat vocalizations (chattering) have been heard from a tree/snag cavity, large bats (> 5 inches in length) have been seen flying or bats have been heard vocalizing in the vicinity, the tree/snag exudes an "ammonia"-like smell, or bat guano has been seen around the base of a tree/snag

Conservation Measures – Fire Supportive Herbicide Application

1. Use herbicide as a treatment to support prescribed fire when its use enhances the application of prescribed fire and does not impact covered plants species.
2. Where covered species are known to occur, suitable application methods include spot treatments using backpack sprayers, cut-stump application, and targeted boom spraying, and do not include aerial spraying.
3. Herbicide application must follow all label requirements.
4. Do not apply herbicide to covered plant species.
5. NRCS pesticide screening tool (WIN-PST) will be used to evaluate and avoid impacts of application of specific formulations to non-target species http://www.wsi.nrcs.usda.gov/products/W2Q/pest/winpst31.html

Conservation Measures – Fire Supportive Herbicide Application Species Specific

1. Florida Leafwing and Bartram's hairstreak: Do not apply herbicide to pineland croton.
2. Crested caracara: If a known caracara nest is within project area and is active (*i.e.*, nest building, incubation, and early nestling stages 3 to 4 weeks), do not apply herbicide using mechanical equipment within an 850-foot radius buffer of the nest tree.

Conservation Measures – Fire Supportive Mechanical Treatment

1. It is acceptable to use mechanical treatment (*e.g.*, roller chopping) to support prescribed fire. Carefully consider and plan the timing of mechanical treatments that are intended to complement prescribed fire. Avoid delays between treatments that reduce the beneficial effects achieved by combining fire and mechanical treatments. A window of 2 weeks to no more than 2 months between treatments and fire is recommended.
2. When using mechanical treatment to treat areas of habitat occupied by covered species, attempt to leave patches of untreated habitat throughout the burn unit in order to leave a refuge for these species.

3. If the goal of mechanical treatment is to create safe burning conditions or to more effectively introduce fire, mechanically treat only the perimeter of the unit or the least amount necessary to introduce fire.
4. Choose mechanical treatment methods and conduct tree harvesting in ways that minimize soil disturbance and compaction in habitat occupied by ground-dwelling covered plants or animals.
5. Select methods that minimize production of fine mulch, which can be difficult to burn or can lead to smoldering fires.
6. Minimize impacts resulting from activities that would permanently alter the natural hydrology.

Conservation Measures – Fire Supportive Mechanical Treatment, Species Specific

1. Florida scrub-jay: When scrub jays occur on a tract do not mechanically treat all scrub-jay habitat on the property all at once. Vary the treatments by season and by year so that only portions of the habitat are treated at a time.
2. Florida scrub-jay: When performing mechanical treatment buffer known active nests by 25 ft.
3. Crested caracara: If a known caracara nest is within project area and is active (*i.e.*, nest building, incubation, and early nestling stages 3 to 4 weeks), keep mechanical treatments outside of an 850-foot radius buffer of the nest tree
4. Florida grasshopper sparrow: In FGSP habitat as defined by the consultation Matrix, schedule mechanical treatment outside of FGSP nesting (April 1 and September 1).
5. Florida leafwing and Bartram' hairstreak: In pine rocklands, avoid impacts to pineland croton.
6. Florida leafwing and Bartram's hairstreak: Use a mosaic pattern and/or leave refugia when treating pine rocklands with known Florida leafwing and Bartram's hairstreak populations.
7. Florida bonneted bat Mark and avoid any known or suspected Florida bonneted bat roosts. No natural roost sites are currently known for this species. However, potential roost sites may be located based on one or more of the following: bonneted bats are observed emerging from a tree cavity, bat vocalizations (chattering) have been heard from a tree/snag cavity, large bats (> 5 inches in length) have been seen flying or bats have been heard vocalizing in the vicinity, echolocation calls have been recorded in the vicinity using acoustical recording devices, the tree/snag exudes an "ammonia"-like smell, or bat guano has been seen around the base of a tree/snag. Where one or more of these conditions exist, protect the tree or snag from damage.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

The following are summaries of the species ecology as well as information regarding the status and trends of these species within the action area. A complete discussion of the status of the species that occur in south Florida and throughout their range can be found in the Service's

South Florida Multi-species Recovery Plan (MSRP) (Service 1999a) located at http://www.fws.gov/verobeach/index.cfm?method=programs&NavProgramCategoryID=3&programID=109&ProgramCategoryID=3

Audubon's Crested Caracara

In addition to the assessment below, a 5-year review was completed in 2009 resulting in no change to the species designation (Service 2009a). The 5-year review builds upon the detailed information in the MSRP for this species and is located at http://www.fws.gov/ecos/ajax/docs/five_year_review/doc2507.pdf

Species/critical habitat description

The caracara is a large raptor with a crest, naked face, heavy bill, elongated neck, and unusually long legs. It is about 50 to 64 centimeters (cm) long and has a wingspan of 120 cm. The adult is dark brownish black on the crown, wings, back, and lower abdomen. The lower part of the head, throat, upper abdomen, and under tail coverts are white, the breast and upper back are whitish, heavily barred with black. The tail is white with narrow, dark crossbars and a broad, dark terminal band. Prominent white patches are visible near the tips of the wings in flight. The large, white patches in the primaries and the white tail, broadly tipped with black, are both very conspicuous in flight and can be recognized at a long distance (Bent 1961).

Juveniles have a similar color pattern but are brownish and buffy, with the breast and upper back streaked instead of barred. Subadults resemble adults but are more brownish in color. Adults have yellow-orange facial skin and yellow legs. Facial skin of juveniles is pinkish in color, and the legs are gray (Layne 1978). Full adult plumage is obtained sometime after 3 years of age (Morrison 1997). There is no evidence of sexual dimorphism, the sexes being similar in color and size; however, gender can be determined surgically or through genetic analysis (Morrison and Maltbie 1999).

A caracara's feet and flight behavior are also notable. Their feet are clearly those of a raptor; however, their talons are flatter, enabling caracaras to run and walk more easily than other raptors. Caracaras are terrestrial and often forage by walking for extended periods on the ground (Morrison and Humphrey 2001). Bent (1938) noted the caracara's flight pattern resembles that of a northern harrier (*Circus cyaneus*), but caracaras fly faster and more gracefully. Caracaras are strong fliers and may reach speeds of 40 miles per hour. They have also been observed soaring in large circles at great heights (Howell 1932).

No critical habitat has been designated for the Audubon's crested caracara.

Life history

Caracaras are resident, diurnal, and non-migratory. Adult caracaras may be found in their territory year-round. Territories average approximately 3,000 acres (approximately 1,200 hectares [ha]), corresponding to a radius of 1.2 to 1.5 miles (2.0 to 2.5 kilometers [km]) surrounding the nest site (Morrison and Humphrey 2001). Foraging typically occurs throughout the territory during nesting and non-nesting seasons.

The Florida caracara population historically inhabited native dry or wet prairie areas containing scattered cabbage palms, their preferred nesting tree. Scattered saw palmetto, and low-growing oaks (*Quercus minima, Q. pumila*), and cypress also occur within these native communities. Over the last century, many of the native prairie vegetation communities in central and south Florida have been converted to agricultural land uses, and frequently replaced by improved and unimproved pasture dominated by short-stature, non-native, sod-forming grasses. Morrison and Humphrey (2001) hypothesize that the vegetation structure of open grasslands (short-stature vegetation, scattered shrub cover, and nest trees) may be preferred by the caracara, due to its tendency to walk on the ground during foraging activities. The short vegetation stature and relatively simple vegetation structure may directly facilitate foraging by caracaras and provide less cover for predators. Consequently, caracaras appear to benefit from management actions such as prescribed burning that maintain habitat in a low stature and structurally simple condition. These activities reduce vegetation cover and may facilitate the observation and capture of prey. Within agricultural lands, regular mowing, burning, and high-density grazing may maintain low vegetative structure, an important habitat characteristic of the caracara's nest stand area (Morrison and Humphrey 2001). Regular prescribed burning maintains habitat in a favorable condition in native dry prairies. These field observations are consistent with the territory compositional analyses that indicate non-random selection of improved and semi-improved pasture land use.

Morrison and Humphrey (2001) characterized caracara distribution, reproductive activity, and land use patterns within a 21,000 km^2 area in south-central Florida. Comparisons of caracara territories to randomly selected areas and available habitat within the study area revealed caracara home ranges contained higher proportions of improved pasture and lower proportions of forest, woodland, oak scrub, and marsh. Territory size was inversely related to the proportion of improved pasture within the territory. In addition, breeding-area occupancy rate, breeding rates, and nesting success were consistently higher on private ranch lands during the study. Although it is unclear exactly which management activities best promote habitat utilization by caracaras, the mowing, burning, and grazing activities associated with improved pastures serve to maintain the short vegetation structure they appear to favor. The scattered cabbage palms that are often present within improved pastures to serve as shade for cattle provide nesting substrate for caracaras.

Additional investigations into habitat suitability for caracara (Morrison et al. 2006) indicate that maintaining heterogeneity which includes specific land cover types as well as small (less than 1 hectare or 2.47 acres) of freshwater wetlands, is critical in maintaining suitable habitat for the crested caracara in Florida. The proportion of six vegetation and land cover types (*i.e.*, cabbage palm-live oak hammock, grassland, improved pasture, unimproved pasture, hardwood hammocks and forest, and cypress/pine/cabbage palm) and 2 types of water (*i.e.*, lentic and lotic) were determined to be the most important criteria for predicting habitat suitability for caracara. Most known nest locations (72.9 percent) in the study were present on improved pasture although that habitat type only comprised 12.5 percent of the entire study area. Caracara appear to be exploiting pastures, ditches, and impounded wetlands that have replaced the historic land cover as shown by the high occurrence of improved and unimproved pastures and lotic waters in caracara home ranges (Morrison et al. 2006).

Caracaras are highly opportunistic in their feeding habits, eating carrion and capturing live prey. Their diets include insects and other invertebrates, fish, snakes, turtles, birds, and mammals (Layne 1978). Live prey also include rabbits, young opossums (*Didelphis marsupialis*), rats (*Rattus* spp.), mice, squirrels, frogs, lizards, young alligators, crabs, crayfish, fish, young birds, cattle egrets (*Bubulcus ibis*), beetles, grasshoppers, maggots, and worms (Bent 1961; Layne et al. 1977; Morrison 2001). Scavenging at urban dumps has also been observed (Morrison 2001).

More recent information from Morrison (Personal communication 2005) indicates wetland-dependent prey items comprise about 64 percent of the total diet (Service 2004a). Mammals make up about 31 percent of the diet, with the majority of this being carrion.

The birds also closely follow mowers in pastures and tractors plowing fields, in order to capitalize on prey that may be exposed. Agricultural drainage ditches, cattle ponds, roadside ditches and other shallow water features also provide good foraging conditions for caracaras (Morrison 2001). Within native habitats, caracaras regularly scavenge in recently burned areas, and forage along the margins of wetlands within dry prairie communities.

These raptors hunt on the wing, from perches, and on the ground (Service 1989). They will also regularly patrol sections of highway in search of carrion (Palmer 1988). They may be seen feeding on road kills with vultures. However, caracaras are dominant over vultures and may occasionally chase the larger vultures from the road kill (Howell 1932).

Although adult caracaras are generally territorial, and therefore, primarily occupy their territories, large groups of individual caracaras are occasionally encountered (Layne 1978). Oberholser (1974) attributes this to the birds' carrion-feeding habit, although Morrison (2005) has noted that juvenile caracaras are nomadic. Caracaras are capable of moving long distances. Between the time when young birds leave the natal territory, and when subadults establish a territory, each individual may traverse a large portion of the species' range in Florida. Adults will also occasionally leave their territory and travel great distances, primarily outside of the breeding season. The caracara's movement capability and nomadic character during subadult years may be the cause of occasional observations of caracaras far outside their breeding range. Caracaras have been observed in the Florida Keys and into the panhandle of Florida (Bay County), as well as in other states, though some of these may have been escaped individuals (Layne 1996). There appears to be no migration or genetic exchange between the Florida population and other populations of the northern caracara.

Routine observation and radio-telemetry monitoring suggest there are several "gathering areas" in south-central Florida that may be important to caracaras during the first 3 years after leaving their natal territory, before first breeding (Morrison 2001). Relatively large numbers of caracaras (up to 50) have been observed along the Kissimmee River north of State Road (SR) 98; south of Old Eagle Island Road in northern Okeechobee County; south of SR 70, west of Fort Pierce; and south of SR 70 in Highlands County, and on the Buck Island Ranch, for example. These gathering areas are regularly but not continually used by subadult and non-breeding caracaras and generally consist of large expanses of improved pasture; however, the particular habitat values of these areas have not yet been evaluated.

Morrison (1999) reported breeding pairs of caracaras seem to be monogamous, highly territorial, and exhibit fidelity to both their mate and the site. The age at first breeding has been documented as 3 years (Nemeth and Morrison 2002). Details of breeding behavior in the caracara have been documented by Morrison (1997, 1999). The initiation of breeding is marked by several behavioral changes, including the pair perching together near the nesting site, preening and allopreening, and sharing food. Caracaras are one of the first of Florida's raptors to begin nesting. Although breeding activity can occur from September through June, the primary breeding season is considered to be November through April. Nest initiation and egg-laying peak from December through February.

Caracaras construct new nests each nesting season, often in the same tree as the previous year. Both males and females participate in nest building. Nests are well concealed and most often found in the tops of cabbage palms (Morrison and Humphrey 2001) although nests have been found in live oaks (*Q. virginiana*), cypress (first record, Morrison et al. 1997), Australian pine (*Casuarina* spp.), saw palmetto, and black gum (*Nyssa sylvatica*). Caracaras usually construct their nests 4 to 18 meters above the ground; their nests primarily consist of haphazardly woven vines trampled to form a depression (Bent 1938, Sprunt 1954, Humphrey and Morrison 1997). Caracaras vigorously defend their nesting territory during the breeding season (Morrison 2001).

Clutch size is two or three eggs, but most often two. Incubation lasts for about 31 to 33 days (Morrison 1999) and is shared by both sexes. Ordinarily only one brood is raised in a season, but around 10 percent of the population (annually) may raise a second brood. The young fledge at about 7 to 8 weeks of age, and post-fledgling dependency lasts approximately 8 weeks.

Population dynamics

The great majority of caracara breeding territories occur on private lands in Florida, primarily within the ranchlands of central Florida. This fact makes monitoring the population and determining territory occupancy and nesting effort or success very difficult. Consequently, estimates of the caracara population in Florida have been based on counts of caracaras along roadsides (Heinzman 1970; Layne 1995). These roadside counts also have the potential be strongly affected by the presence of non-territorial juvenile and sub-adult birds during the period when they are nomadic. Because the occurrence and density of caracaras is not evenly distributed within the region they occupy (due to congregation and nomadic individuals), these roadside surveys are probably unreliable for estimating the overall population.

Status and distribution

The caracara's perceived decline, as described in historic literature, is attributed primarily to habitat loss (Layne 1996). This perceived decline and the geographic isolation of the Florida population eventually resulted in the caracara's listing as threatened in 1987 (52 FR 25232). In particular, the caracara was listed as threatened because its primary habitat, dry prairie, had been greatly eliminated or modified for agriculture and residential development. It was also listed because existing regulatory mechanisms did not adequately prevent the destruction or modification of the caracara's habitat, which is mainly located on private land.

Morrison and Humphrey (2001) stated that no data are available on historic abundance, habitat use, or nest distribution by caracaras in Florida. The size of Florida's caracara population remains in question. Accurate counts become difficult because of limited access to areas of suitable habitat and because of the bird's behavior and limited detectability (Humphrey and Morrison 1997). Heinzman (1970) published the results of a 4-year road survey (1967 to 1970), which suggested fewer than 100 individual caracaras at 58 localities remained in Florida. Stevenson (1976) concurred with this estimate in 1974. Layne (1995) monitored caracara distribution and population status in Florida from 1972 to 1989. Based on roadside surveys, he estimated that the adult portion of the population was stable with a minimum of about 300 birds in 150 territories. The immature portion of the population was estimated to be between 100 and 200 individuals, bringing the total statewide population to between 400 and 500 birds. However, given continued landscape change in areas where caracaras have been known to occur, and the fact that not all the probable breeding range has been adequately surveyed for breeding pairs, estimating this population's size remains difficult.

In addition to presumed population declines related to habitat loss, direct human-caused mortality may also be a factor to be considered in the recovery of the species. In the past, large numbers of caracaras were killed in vulture traps (Service 1989). Individuals may also be caught in leg-hold traps used to control mammalian predators (Morrison 1996). Road mortalities are a significant cause of caracara decline. Morrison (2003) identifies highway mortalities as a major cause of juvenile mortalities with young birds especially vulnerable within the first 6 months after fledging.

The Florida population of caracaras is isolated and habitat-specific. Therefore, it may be susceptible to environmental catastrophes and potentially reduced reproductive rates because of demographic accidents such as skewed sex ratios or disproportionate age-related mortality. Low numbers may also reduce the genetic viability through loss of heterozygosity, thereby increasing vulnerability to environmental stresses. The location of many of the occupied territories on private land, and the inaccessibility of these territories to surveyors, makes it difficult to census the caracara and detect changes in its population size and distribution. This difficulty increases the possibility of not detecting a population decline that could result in extinction.

The major threat to this population remains habitat loss. Large areas of native prairie and pasture lands in south-central Florida have been converted to citrus operations, tree farms, other forms of agriculture, and real estate development and this loss has accelerated in the past few decades (Morrison and Humphrey 2001). However, historical conversion of forested habitats to pasture has not been adequately documented as partially offsetting losses to caracara habitat, so a full accounting of historic habitat changes is lacking. The current threat of habitat loss persists as changes in land use continue. Florida's burgeoning human population has also increased the number of motor vehicles and the need for roads. The increase in traffic as well as the caracara's predisposition for feeding on road-killed animals has probably increased the number of caracaras killed or injured as a result of vehicle strikes.

Cattle ranching and extensive pastures appear to be compatible with caracara survival. Inadequate information is available to assess current caracara use of native wet and dry prairie communities, but these communities are likely the primary communities that caracaras occupied in the historic Florida landscape. The number of territories occurring in improved or unimproved pasture can be expected to increase if sufficiently large overgrown pastures are reclaimed and/or new pastures or restored native prairies are created from other agricultural land uses. The conversion of pasture to citrus (Cox et al. 1994), sugarcane, and residential development is also cause for concern. Recognizing the conservation value of cattle ranches and enlisting landowner cooperation in the preservation and management of these lands are critical elements in recovery of the caracara.

Lack of habitat management is also a potential threat to caracaras in some areas, and can result in habitat degradation to the point where it is no longer suitable for occupancy. In particular, encroachment of woody shrubs and trees into open dry prairies, pastures and similar habitats will result in some reduction in habitat suitability. Complete clearing of large areas that includes removal of cabbage palms and other trees may also reduce the suitability of habitat, but generally only when very large areas are completely cleared.

While there is inadequate evidence available to conclude that the caracara population in Florida has declined significantly, loss of habitat is threatening remaining caracara territories at an increasing rate. The limited distribution of caracaras and a lack of opportunities for expansion of the distribution make this species vulnerable to reductions in habitat quality and other increasing threats within its range.

Florida Grasshopper Sparrow

A complete discussion of the status of the species in south Florida and throughout its range can be found in the Service's South Florida MSRP (Service 1999). In addition, a 5-year review was completed in 2008 resulting in no change to the status of the species (Service 2008). The 5-year review builds upon the detailed information in the MSRP for this species and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/20080930FLGrasshopperSparrow.pdf These documents are incorporated here by reference. The following is a summary of the FGSP biology.

Species/critical habitat description

The FGSP is one of four North American subspecies of the grasshopper sparrow, and is endemic to the dry prairie region of central and southern Florida. The FGSP is a small, short-tailed, flat-headed sparrow averaging 13 cm in total length (Vickery 1996). The top of its head is mostly blackish with a light median stripe. The remainder of its dorsum is mainly black, edged with gray, and streaked with brown on the nape and upper back. Adult FGSPs are whitish underneath, unstreaked, with a buff throat and breast. Juvenile FGSPs have streaked breasts. The ventral color pattern resembles that of the Bachman's sparrow (*Aimophila aestivalis*). The rectrices of the FGSP are pointed, the lores are light gray to reddish-yellow, and the bend of the wing is yellow. Its bill is thick at the base, and its feet are flesh-colored (Vickery 1996).

During the breeding season, male and female FGSPs can be distinguished in the hand by the presence of a cloacal protuberance in the male or a brood patch in the female. The FGSP is most easily located and identified by its song, which is among the weakest of any North American bird (Stevenson 1978). Nicholson (1936) described it as being indistinct and as having a definite insect-like quality, which gave rise to the bird's common name (Sprunt 1954). The song starts as three low-pitched notes followed by a longer, higher-pitched "buzz" (Vickery 1996).

No critical habitat has been designated for the Florida Grasshopper Sparrow.

Life history

FGSPs are endemic to dry prairie habitats within central and southern Florida, and are strongly habitat-specific, occupying only the native, fire-maintained dry prairie vegetation community and a few unimproved or "overgrown" pasture sites that resemble the dry prairie community and were presumably dry prairie prior to conversion to pasture. Barriers to movement include forested edges and even sparsely stocked pine flatwoods. Habitat characteristics that are important for FGSPs include a high percentage of bare ground cover and low vegetation height (30-70 cm) (Delany et al. 1985). Both of these characteristics are maintained by frequent fire. Large areas of prairie habitat, possibly greater than 4,000 ha) (9,884 acres), are needed to maintain self-sustaining populations of FGSPs (Perkins 1999; Perkins and Vickery 2001).

FGSPs form pair bonds during the breeding season, but remain solitary for the remainder of the season, and rarely interact with other FGSPs outside of the breeding season. During the breeding season, FGSPs form breeding aggregations within suitable habitat (Delany 1996), and individual male sparrows set up territories within the breeding aggregations. Delany et al. (1995) found mean breeding territory size for FGSPs at Avon Park Air Force Range (APAFR) to be 1.8 ha (4.5 acres), with a maximum size of 4.8 ha (12 acres). As the time since last fire increases, territories are reported to be established less frequently (Walsh et al. 1995), and FGSP home ranges become larger (Delany et al. 1992). Male FGSPs defend their territory boundaries from the time territories are established through incubation (Delany et al. 1995). After the young hatch, territory defense becomes less rigorous (Smith 1968). Adult FGSPs exhibit strong site-fidelity to nesting territories, although individuals have been observed traveling as far as 4 kilometer (km) (0.62 mile) from the nesting territories during winter months. The great majority of males (86 percent [Delany et al. 1995]; 100 percent [Dean 2001]) remain on the same territory in consecutive years.

Male FGSPs generally begin singing in mid-March. Their singing usually diminishes by late June, although they continue to sing through August (T. Dean, Service, personal communication 2002). FGSPs begin nest-building activities approximately 4 weeks after the onset of territorial singing (Vickery 1996). Nests are located on the ground in shallow (<3.2 cm deep) excavations in the sand substrate (Delany and Linda 1998a; Delany and Linda 1998b); the rims are level or slightly above the ground. The nests are dome-shaped and constructed of narrow-leaved grasses and grass-like monocots, such as wiregrass, bluestems (*Andropogon* spp.), and yellow-eyed grass (*Xyris* spp.). Egg-laying is reported to begin as early as late March (McNair 1986) and breeding activities may extend into September (Vickery and Shriver 1995; Perkins 1999). Most nests contain 3-5 eggs with a mean of 3.71 (Smith 1968; McNair 1986). Perkins et al. (2003) report mean clutch sizes of 3.47 (n = 17) at APAFR, 3.56 (n = 9) at Three Lakes Wildlife Management Area (TLWMA), and 3.75 (n = 4) at Kissimmee Prairie Preserve State Park (KPPSP).

Female FGSPs incubate their eggs for 11-12 days (Nicholson 1936). Perkins et al. (1998) reported that it takes an average of 13.5 days between the fledging of a successful nest and the first egg of a new attempt. If a nest is destroyed, the female may make a new one in approximately 10 to 12 days (T. Dean, Service, personal communication 2003). Considering the duration necessary to complete a single reproductive cycle, three to four successful clutches are possible within a single breeding season (Vickery 1996; Perkins 1999) and multiple clutches are common (Vickery 1996).

During the non-breeding season, FGSPs appear to expand their scope of movements. As determined through radio telemetry, the average home range size during the non-breeding season was 29 ha (72 acres), with individual home ranges varying from 1 to 174 ha (3 to 429 acres) (Dean 2001). In addition, nearly 40 percent of individuals used more than one spatially distinct home range during the course of the non-breeding season. These home ranges were not mutually exclusive, however, and home ranges of many different individuals overlapped (Dean 2001).

FGSPs forage on the ground or just above it. An examination of the contents of 10 stomachs of FGSPs from the Kissimmee prairie region found 69 percent "animal matter" (insects) and 31 percent vegetation (Howell 1932). Identified insects included grasshoppers, crickets, beetles, weevils, and moths and their larvae, with a few flies and bugs. Sedge seeds, as well as some star grass (*Hypoxis* spp.) seeds, composed most of the vegetation found in the diet (Service 1988). FGSPs switch to a seed-dominated diet during the non-nesting season, but still consume some animal matter (Vickery and Dean 1997).

Population dynamics

FGSPs are capable of breeding during the first spring after hatching and are assumed to breed every year. Several studies (Shriver 1996; Perkins 1999) have suggested not all singing males are paired, with as many as 15 to 23 percent of males identified as unpaired (Vickery and Perkins 2001). The difficulty of observing female sparrows makes accurate determination of sex ratios, pairing, or the lack of pairing, difficult.

Considering the number of potential nesting attempts and the productivity per nest, the maximum productivity per pair could reasonably be expected to exceed 13 young per pair each year, though this level of productivity is likely uncommon. Nest success (defined as fledging at least one young) rates are generally low, and nest success rates range between 11 and 38 percent. Accounting for the number of nesting attempts and observed nest success, Vickery and Perkins (2001) report an average annual productivity per pair of 2.8 to 3.5 young per year. Nest predation is the most common cause of nest failures, with snakes and mammals accounting for the majority of observed depredations (Perkins 1999). The large reproductive potential combined with variability in depredation and nest failure rates may result in widely varying reproductive success among years.

Estimates of annual adult male survival rates range between 0.24 and 0.83 for different populations and different years (Delany et al. 1993; Perkins and Vickery 2001). Average adult annual survival rates are 0.48-0.53 at APAFR and TLWMA, respectively. Delany et al. (1993) estimated a pooled annual survival rate of 0.59 at APAFR. These results suggest annual adult survival rates are variable, with an average slightly above 50 percent. Juvenile survival rates have never been directly estimated, but Perkins and Vickery (2001) estimated the average juvenile survival rate to be 0.35 through indirect calculations. Results of a 3-year banding study indicate a mean life expectancy of 1.95 years for male birds that are at least 1 year old (n = 48) (Delany et al. 1993). The longevity record for FGSPs is 7 years (Dean et al. 1998; Miller 2005). Because there is no information on the survival and life expectancy of females, it can only be assumed female survival rates approximate those of males.

The main cause of adult mortality appears to be predation, primarily by wintering raptors (T. Dean, Service, personal communication 2002). Other predators known to take eggs or nestlings include the striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale putorius*), raccoon (*Procyon lotor*), longtailed weasel (*Mustela frenata*), foxes (*Urocyon* sp. and *Vulpes* sp.), cats (*Felis* spp.), feral hogs (*Sus scrofa*), snakes, and possibly armadillos (Vickery 1996).

Status and distribution

Based on declines in suitable habitat and population size, the National Audubon Society placed the FGSP on its blue list in 1974. The FGSP was listed as endangered by the State of Florida in 1977. The Service listed the FGSP as endangered on July 31, 1986, due to habitat degradation and loss, primarily as a result of conversion of native dry prairie vegetation to improved pasture (51 FR 27495). Critical habitat has not been designated for this species.

The current known range of the species is limited to Highlands, Okeechobee, Osceola, and Polk Counties. The historic distribution of the FGSP is not known with certainty, but there are records from Collier, Miami-Dade, DeSoto, Glades, Hendry, Highlands, Polk, Okeechobee, and Osceola Counties (Delany and Cox 1985; see also Pranty and Tucker 2006). Because the FGSP is closely associated with dry prairie habitats, trends in the amount and condition of dry prairie habitat within central Florida probably mirror the trends in the rangewide FGSP population.

Aerial surveys of dry prairie habitat indicated that only 156,000 ha (385,483 acres) of dry prairie habitat existed in 1995 (Shriver and Vickery 1999), an 81 percent decrease from the 0.83 million ha estimated from 1967 (Davis 1967). FGSP habitat loss is due to conversion of dry prairie to improved pasture (Layne et al. 1977) and agricultural uses such as citrus groves (Davis 1967; Mealor 1972; DeSelm and Murdock 1993), pine plantations, exotic sod-forming grasses, row-crops, and, historically, eucalyptus (*Eucalyptus* spp.) plantations. Conversion of dry prairie to citrus groves may represent the single greatest threat to existing prairie remnants. Lack of burning may have degraded additional prairie habitat.

Since Delany's first efforts to assess FGSP populations rangewide in the early 1980s (Delany et al. 1985), surveys have recorded a general decline in the distribution and occurrence of FGSPs. Of the 14 sites where FGSPs have been documented to occur, only 4 remain occupied, and 3 of these are on public lands. In addition, one of the public land sites is nearly extirpated (APAFR; see below). Despite several survey efforts, there have been no records of FGSPs outside of the upper Kissimmee River basin since the early 1990s, and this represents a large reduction in the species' distribution. Additional surveys are needed to confirm this change in distribution.

Today, three large tracts of publicly-owned land contain the largest and most-studied populations of FGSPs. There is one population at KPPSP, which now includes the Ordway-Whittell Kissimmee Prairie Sanctuary (formerly managed by the National Audubon Society until ownership was transferred in 2001). This preserve, acquired in 1996, has the largest contiguous block of dry prairie in public ownership (more than 12,000 ha [29,653 acres]) and had the largest known population of FGSPs. It also provides a corridor between other protected sites. There is another population of FGSPs at TLWMA, which has approximately 2,500 ha (6,178 acres) of suitable, occupied habitat, and another disjunct patch of suitable habitat (861 ha [2,128 acres]) where FGSPs did not occur, but to which FGSPs were translocated in 2001 and 2002 (Dean and Glass 2001a) but did not persist. There were three populations at APAFR, which has approximately 2,400 ha (6,178 acres) of suitable FGSP habitat.

Surveys for FGSPs have been conducted regularly at KPPSP since 1999 (Mulholland and Small 2001) at TLWMA since 1991 (Dean and Glass 2001b) and at APAFR since 1982 (Delany et al. 2001). Monitoring efforts from 1999 to 2004 indicate that the total population size at these three primary sites ranged from approximately 340 to 640 individuals, though the population sizes are variable among years. In 2003, surveys estimated the population size at these three sites at under 350 individuals, largely due to declines at APAFR and KPPSP. The APAFR subpopulations have declined sharply since 1997, and these once large subpopulations are now extirpated (two subpopulations) or functionally extirpated (one population) (Pranty and Tucker 2006; Delany et al. 2007; FGSP Working Group, personal communication, 2012). The TLWMA has maintained relatively stable numbers of FGSP until the decline in began to decline sharply in 2009 (Delany et al. 2007; Tucker and Bowman 2007; FGSP Working Group, unpublished data, 2012). The subpopulations at KPPSP vary widely, and have generally declined in the since 2002 (Miller 2007).

Despite unprecedented habitat restoration efforts in the last 5 years, recent surveys in 2012 recorded the lowest number of males ever (N = 75; all public land sites combined). If trends continue, the sparrow faces extinction on public lands within the decade. The sparrows' status on private lands is unknown, but populations on these lands are presumed to be small. The cause of the recent sharp decline is unknown, but may be due to predation from the red fire ant (*Solenopsis invicta*), prescribed burning regimes, disease, genetics, or a male-biased gender ratio

Florida Scrub-jay

In addition to the assessment below, a 5-year review was completed in 2007 resulting in no change to the species designation (Service 2007a). The 5-year review builds upon the detailed information in the MSRP for this species and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/Florida-scrub-jay.pdf

Species/critical habitat description

Florida scrub-jays are about 25 to 30 cm (10 to 12 inches) long and weigh about 85 grams (3 ounces). They are similar in size and shape to blue jays (*Cyanocitta cristata*), but differ significantly in coloration (Woolfenden and Fitzpatrick 1996a; Service 1990a). Unlike the blue jay, the Florida scrub-jay lacks a crest. It also lacks the conspicuous white-tipped wing and tail feathers, black barring, and bridle of the blue jay. The Florida scrub-jay's head, nape, wings, and tail are pale blue, and its body is pale gray on its back and belly. Its throat and upper breast are lightly striped and bordered by a pale blue-gray "bib" (Woolfenden and Fitzpatrick 1996a). Florida scrub-jay sexes are not distinguishable by plumage (Woolfenden and Fitzpatrick 1984), and males, on the average are only slightly larger than females (Woolfenden 1978). The sexes may be identified by a distinct "hiccup" call made only by females (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1986). Florida scrub-jays that are less than about 5 months of age are easily distinguishable from adults; their plumage is smoky gray on the head and back, and they lack the blue crown and nape of adults. Molting occurs between early June and late November and peaks between mid-July and late September (Bancroft and Woolfenden 1982). During late summer and early fall, when the first basic molt is nearly done, fledgling Florida scrub-jays may be indistinguishable from adults in the field (Woolfenden and Fitzpatrick 1984). The wide variety of vocalizations of Florida scrub-jays is described in Woolfenden and Fitzpatrick (1996b).

Scrub-jays are in the order Passeriformes and the family Corvidae. They have been called a "superspecies complex" and described in four groups that differ in geographic distribution within the United States and Mexico: *Aphelocoma californica*, from southwestern Washington through Baja California; *A. insularis*, on Santa Cruz in the Channel Islands, California; *A. woodhousii*, from southeastern Oregon and the Rocky Mountains and Great Plains to Oaxaca, Mexico; and *A. coerulescens* in peninsular Florida (American Ornithologists' Union [AOU] 1983). Other jays of the same genus include the Mexican jay or gray-breasted jay (*A. ultramarina*) and the unicolored jay (*A. unicolor*) of Central America and southwest North America (Woolfenden and Fitzpatrick 1996b).

The Florida scrub-jay, which was originally named *Corvus coerulescens* by Bosc in 1795, was transferred to the genus *Aphelocoma* in 1851 by Cabanis. In 1858, Baird made *coerulescens* the type species for the genus, and it has been considered a subspecies (*A. c. coerulescens*) for the past several decades (AOU 1957). It recently regained recognition as a full species (Florida scrub-jay, *Aphelocoma coerulescens*) from the AOU (AOU 1995) because of genetic, morphological, and behavioral differences from other members of this group: the western scrub-jay (*A. californica*) and the island scrub-jay (*A. insularis*). This species account references the full species name, *A. coerulescens,* as listed in the Federal Register (Service 1987a). The group name is retained for species in this complex; however, it is now hyphenated to "scrub-jay" (AOU 1995). Critical habitat has not been designated for the Florida scrub-jay.

No critical habitat has been designated for the Florida scrub-jay.

Life history

The Florida scrub-jay has specific habitat needs. It is endemic to peninsular Florida's ancient dune ecosystems or scrubs, which occur on well-drained to excessively well-drained sandy soils (Laessle 1958; Laessle 1968; Myers 1990). This relict oak-dominated scrub, or xeric oak scrub, is essential habitat to the Florida scrub-jay. This community type is adapted to nutrient-poor soils, periodic drought, and frequent fires (Abrahamson 1984a and 1984b). Xeric oak scrub on the Lake Wales Ridge (LWR) is predominantly made up of four species of stunted, low-growing oaks: sand live oak (*Quercus geminata*), Chapman oak (*Q. chapmanii*), myrtle oak (*Q. myrtifolia*), and scrub oak (*Q. inopina*) (Myers 1990). In optimal habitat for Florida scrub-jays on the LWR, these oaks are 1 to 3 meters (3 to 10 ft) high, interspersed with 10 to 50 percent unvegetated, sandy openings, and a sand pine (*Pinus clausa*) canopy of less than 20 percent (Woolfenden and Fitzpatrick 1991). Other trees and dense herbaceous vegetation is rare. Vegetation noted along with the oaks includes saw palmetto (*Serenoa repens*) and scrub palmetto (*Sabal etonia*), as well as woody shrubs such as Florida rosemary (*Ceratiola ericoides*) and rusty lyonia (*Lyonia ferruginea*).

Florida scrub-jays occupy areas with less scrub oak cover and fewer openings on the Merritt Island/Cape Canaveral Complex and in southwest Florida than typical of xeric oak scrub habitat on the LWR (Schmalzer and Hinkle 1992; Breininger et al. 1995; Thaxton and Hingtgen 1996). The predominant communities here are oak scrub and scrubby flatwoods. Scrubby flatwoods differ from scrub by having a sparse canopy of slash pine (*Pinus elliotii*); sand pines are rare. Shrub species mentioned above are common, except for scrub oak and scrub palmetto, which are restricted to the LWR. Runner oak (*Q. minima*), turkey oak (*Q. laevis*), bluejack oak (*Q. incana*), and longleaf pine (*Pinus palustris*) also have been reported. Kennedy Space Center, in Brevard County, supports one of the largest contiguous populations of Florida scrub-jays. Studies conducted there give good descriptions of this habitat type (Schmalzer and Hinkle 1992).

Optimal Florida scrub-jay habitat occurs as patches with the following attributes: (1) 10 to 50 percent of the oak scrub made up of bare sand or sparse herbaceous vegetation; (2) greater than 50 percent of the shrub layer made up of scrub oaks; (3) a mosaic of oak scrubs that occur in optimal height (1 to 3 meters) and shorter; (4) less than 15 percent canopy cover; and (5) greater than 300 meters (984 feet) from a forest (Breininger et al. 1998). Much potential Florida scrub-jay habitat occurs as patches of oak scrub within a matrix of little-used habitat of saw palmetto and herbaceous swale marshes (Breininger et al. 1991; Breininger et al.1995). These native matrix habitats supply prey for Florida scrub-jays and habitat for other species of conservation concern. The flammability of native matrix habitats is important for spreading fires into oak scrub (Breininger et al. 1995, Breininger et al. 2002). Degradation or replacement of native matrix habitats with habitat fragments and industrial areas attract predators of Florida scrub-jays, such as fish crows (*Corvus ossifragus*), that are rare in most regularly burned native matrix habitats (Breininger and Schmalzer 1990; Woolfenden and Fitzpatrick 1991). Matrix habitats often develop into woodlands and forests when there is a disruption of fire regimes. These woodlands and forests are not suitable for Florida scrub-jays, decrease the habitat suitability of nearby scrub, attract predators, and further disrupt fire patterns.

Florida scrub-jays have a social structure that involves cooperative breeding, a trait that the other North American species of scrub-jays do not show (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1990). Florida scrub-jays live in families ranging from two birds (a single mated pair) to extended families of eight adults (Woolfenden and Fitzpatrick 1984) and one to four juveniles. Fledgling Florida scrub-jays stay with the breeding pair in their natal territory as "helpers," forming a closely-knit, cooperative family group. Pre-breeding numbers are generally reduced to either a pair with no helpers or families of three or four individuals (a pair plus one or two helpers) (Woolfenden and Fitzpatrick 1996a).

Florida scrub-jays have a well-developed intrafamilial dominance hierarchy with breeder males most dominant, followed by helper males, breeder females, and, finally, female helpers (Woolfenden and Fitzpatrick 1977; Woolfenden and Fitzpatrick 1984). Helpers take part in sentinel duties (Woolfenden and Fitzpatrick 1984; McGowan and Woolfenden 1989), territorial defense (Woolfenden and Fitzpatrick 1984), predator-mobbing, and the feeding of both nestlings (Stallcup and Woolfenden 1978) and fledglings (Woolfenden and Fitzpatrick 1984; McGowan and Woolfenden 1990). The well-developed sentinel system involves having one individual occupying an exposed perch watching for predators or territory intruders. When a predator is seen, the sentinel Florida scrub-jay gives a distinctive warning call (McGowan and Woolfenden 1989; McGowan and Woolfenden 1990), and all family members seek cover in dense shrub vegetation (Fitzpatrick et al. 1991).

Florida scrub-jay pairs occupy year-round, multipurpose territories (Woolfenden and Fitzpatrick 1978; Woolfenden and Fitzpatrick 1984; Fitzpatrick et al. 1991). Territory size averages 22 to 25 acres (Woolfenden and Fitzpatrick 1990; Fitzpatrick et al. 1991), with a minimum size of about 12 acres (Woolfenden and Fitzpatrick 1984; Fitzpatrick et al. 1991). The availability of territories is a limiting factor for Florida scrub-jay populations (Woolfenden and Fitzpatrick 1984). Because of this limitation, nonbreeding adult males may stay at the natal territory as helpers for up to 6 years, waiting for either a mate or territory to become available (Woolfenden and Fitzpatrick 1984). Florida scrub-jays may become breeders in several ways: (1) by replacing a lost breeder on a non-natal territory (Woolfenden and Fitzpatrick 1984); (2) through "territorial budding," where a helper male becomes a breeder in a segment of its natal territory (Woolfenden and Fitzpatrick 1978); (3) by inheriting a natal territory following the death of a breeder; (4) by establishing a new territory between existing territories (Woolfenden and Fitzpatrick 1984); or (5) through "adoption" of an unrelated helper by a neighboring family followed by resident mate replacement (Woolfenden and Fitzpatrick 1984). Territories also can be created by restoring habitat through effective habitat management efforts in areas that are overgrown (Thaxton and Hingtgen 1994).

To become a breeder, a Florida scrub-jay must find a territory and a mate. Evidence presented by Woolfenden and Fitzpatrick (1984) suggests that Florida scrub-jays are monogamous. The pair retains ownership and sole breeding privileges in its particular territory year after year. Courtship to form the pair is lengthy and ritualized and involves posturing and vocalizations made by the male to the female (Woolfenden and Fitzpatrick 1996b). Copulation between the pair is generally out of sight of other Florida scrub-jays (Woolfenden and Fitzpatrick 1984). These authors also reported never observing copulation between unpaired scrub-jays or courtship behavior between a female and a scrub-jay other than her mate. Age at first breeding in the scrub-jay varies from 1 to 7 years, although most individuals become breeders between 2 and 4 years of age (Fitzpatrick and Woolfenden 1988). Persistent breeding populations of Florida scrub-jays exist only where there are scrub oaks in sufficient quantity and form to provide an ample winter acorn supply, cover from predators, and nest sites during the spring (Woolfenden and Fitzpatrick 1996b).

Florida scrub-jay nests are typically constructed in shrubby oaks, at a height of 1 to 2 meters (1.6 to 8.2 ft) (Woolfenden 1974). Sand live oak and scrub oak are the preferred shrubs on the LWR (Woolfenden and Fitzpatrick 1996b), and myrtle oak is favored on the Atlantic Coastal

Ridge (Toland 1991) and southern Gulf coast. In suburban areas, Florida scrub-jays nest in the same evergreen oak species as well as in introduced or exotic trees; however, they build their nests in a significantly higher position in these oaks than when in natural scrub habitat (Bowman et al. 1996). Florida scrub-jay nests are an open cup, about 7 to 8 inches outside diameter and 3 to 4 inches inside diameter. The outer basket is bulky and built of course twigs from oaks and other vegetation, and the inside is lined with tightly wound palmetto or cabbage palm (*Sabal palmetto*) fibers. There is no foreign material as may be present in a blue jay nest (Woolfenden and Fitzpatrick 1996b).

Nesting is synchronous, normally occurring from 1 March through 30 June (Woolfenden and Fitzpatrick 1984). On the Atlantic Coastal Ridge and southern Gulf coast, nesting may be protracted through the end of July. In suburban habitats, nesting is consistently started earlier (March) than in natural scrub habitat (Fleischer 1996), although the reason for this is unknown.

Clutch size ranges from one to five eggs, but is typically three or four eggs (Woolfenden and Fitzpatrick 1990). Clutch size is generally larger in suburban habitats, and the birds try to rear more broods per year (Fleischer 1996). Double brooding by as much as 20 percent has been documented on the Atlantic Coastal Ridge and in suburban habitat within the southern Gulf coast, compared to about 2 percent on the LWR. Florida scrub-jay eggs measure 1.1 x 0.8 inches (length x breadth) (Woolfenden and Fitzpatrick 1996b), and coloration "varies from pea green to pale glaucous green… blotched and spotted with irregularly shaped markings of cinnamon rufous and vinaceous cinnamon, these being generally heaviest about the larger end" (Bendire 1895). Eggs are incubated for 17 to 19 days (Woolfenden 1974), and fledging occurs 15 to 21 days after hatching (Woolfenden 1978). Only the breeding female incubates and broods eggs and nestlings (Woolfenden and Fitzpatrick 1984). Average production of young is two fledglings per pair, per year (Woolfenden and Fitzpatrick 1990; Fitzpatrick et al. 1991), and the presence of helpers improves fledging success (Woolfenden and Fitzpatrick 1990; Mumme 1992). Annual productivity must average at least two young fledged per pair for a population of Florida scrub-jays to support long-term stability (Fitzpatrick et al. 1991).

Fledglings depend upon adults for food for about 10 weeks, during which time they are fed by both breeders and helpers (Woolfenden 1975; McGowan and Woolfenden 1990). Survival of Florida scrub-jay fledglings to yearling age class averages about 35 percent in optimal scrub, while annual survival of both adult males and females averages around 80 percent (Woolfenden and Fitzpatrick 1996b). Data from Archbold Biological Station (ABS), however, suggest survival and reproductive success of Florida scrub-jays in suboptimal habitat is lower (Woolfenden and Fitzpatrick 1991). These data help explain why local populations inhabiting unburned, late successional habitats become extirpated. Similarly, data from Indian River County show mean annual productivity declines significantly in suburban areas where Toland (1991) reported productivity averaged 2.2 young fledged per pair in contiguous optimal scrub, 1.8 young fledged per pair in fragmented moderately-developed scrub, and 1.2 young per pair fledged in very fragmented suboptimal scrub. The longest observed lifespan of a Florida scrub-jay is 15.5 years at ABS in Highlands County (Woolfenden and Fitzpatrick 1996b).

Florida scrub-jays are nonmigratory and permanently territorial. Juveniles stay in their natal territory for up to 6 years before dispersing to become breeders (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1986). Once Florida scrub-jays pair and become breeders, generally within two territories of their natal area, they stay on their breeding territory until death. In suitable habitat, fewer than 5 percent of Florida scrub-jays disperse more than 5 miles (Stith et al. 1996). All documented long-distance dispersals have been in unsuitable habitat such as woodland, pasture, or suburban plantations. Florida scrub-jay dispersal behavior is affected by the intervening land uses. Protected scrub habitats will most effectively sustain Florida scrub-jay populations if they are located within surrounding habitat types that can be used and traversed by Florida scrub-jays. Brushy pastures, scrubby corridors along railway and road rights-of-way, and open burned flatwoods offer links for colonization among scrub-jay populations. Stith et al. (1996) believe a dispersal distance of 5 miles is close to the biological maximum for Florida scrub-jays.

Florida scrub-jays forage mostly on or near the ground, often along the edges of natural or man-made openings. They visually search for food by hopping or running along the ground beneath the scrub or by jumping from shrub to shrub. Insects, particularly orthopterans (*e.g.*, locusts, crickets, grasshoppers, beetles) and lepidopteran (*e.g.*, butterfly and moth) larvae, form most of the animal diet throughout most of the year (Woolfenden and Fitzpatrick 1984). Small vertebrates are eaten when encountered, including frogs and toads (*Hyla femoralis*, *H. squirella,* rarely *Bufo quercicus,* and unidentified tadpoles, lizards (*Anolis carolinensis*, *Chemidophorus sexlineatus*, *Sceloporus woodi*, *Eumeces inexpectatus*, *Neoseps reynoldsi*, *Ophisaurus compressus*, *O. ventralis*), small snakes (*Thamnophus sauritus*, *Opheodrys aestivus*, *Diadophis punctatus*), small rodents (cotton rat [*Sigmodon hispidus*], *Peromyscus polionotus*, black rat [*Rattus rattus*] young), downy chicks of the bobwhite (*Colinus virginianus*), and fledgling common yellowthroat (*Geothlypis trichas*). In suburban areas, Florida scrub-jays will accept supplemental foods once the scrub-jays have learned about them (Woolfenden and Fitzpatrick 1984).

Acorns are the principal plant food (Woolfenden and Fitzpatrick 1984; Fitzpatrick et al. 1991). From August to November each year, Florida scrub-jays may harvest and cache 6,500 to 8,000 oak (*Quercus* spp.) acorns throughout their territory. Acorns are typically buried beneath the surface of bare sand patches in the scrub during fall, and retrieved and consumed year-round, though most are consumed in fall and winter (DeGange et al. 1989). On the Atlantic Coastal Ridge, acorns are often cached in pine trees, either in forks of branches, in distal pine boughs, under bark, or on epiphytic plants, between 1 to 30 ft in height. Other small nuts, fruits, and seeds also are eaten (Woolfenden and Fitzpatrick 1984).

Many Florida scrub-jays occur in habitat conditions where their long-term persistence is doubtful, although their persistence in these areas can occur for many years (Swain et al. 1995; Stith et al. 1996; Root 1998; Breininger et al. 2002). A primary cause for Florida scrub-jay decline is poor demographic success associated with reductions in fire frequency (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1991; Schaub et al. 1992; Stith et al. 1996; Breininger et al. 1999). The reduction in fire frequency is associated with increases in shrub height, decreases in open space, increases in tree densities, and the replacement of scrub and marshes by forests (Duncan and Breininger 1998; Schmalzer and Boyle 1998; Duncan et al. 1999). These habitat trajectories result in declines in habitat use and demographic success (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1991). As a result, mean family size declines, and eventually the number of breeding pairs can decline by 50 percent every 5 to 10 years (Woolfenden and Fitzpatrick 1991; Breininger et al. 1999; Breininger et al. 2002).

Population dynamics

Stith (1999) utilized a spatially explicit individual-based population model developed specifically for the Florida scrub-jay to complete a metapopulation viability analysis of the species. The species' range was divided into 21 metapopulations demographically isolated from each other. Metapopulations are defined as collections of relatively discrete demographic populations distributed over the landscape; these populations are connected within the metapopulations through dispersal or migration (Hanski and Gilpin 1991). A series of simulations were run for each of the 21 metapopulations based on different scenarios of reserve design ranging from the minimal configuration consisting of only currently protected patches of scrub (no acquisition option) to the maximum configuration, where all remaining significant scrub patches were acquired for protection (complete acquisition option) (Stith 1999). The assumption was made that all areas that were protected were also restored and properly managed.

Results from Stith's (1999) simulation model included estimates of extinction, quasi-extinction (the probability of a Florida scrub-jay metapopulation falling below 10 pairs), and percent population decline. These were then used to rank the different statewide metapopulations by vulnerability. The model predicted five metapopulations (Northeast Lake, Martin, Merritt Island, Ocala National Forest [ONF], and LWR) have low risk of quasi-extinction. Two of the five (Martin and Northeast Lake), however, experienced significant population declines under the "no acquisition" option; the probability for survival of both of these metapopulations could be improved with more acquisitions.

Eleven of the remaining 21 metapopulations were shown to be highly vulnerable to quasi-extinction if no more habitats were acquired (Central Brevard, North Brevard, Central Charlotte, Northwest Charlotte, Citrus, Lee, Levy, Manatee, Pasco, St. Lucie, and West Volusia). The model predicted the risk of quasi-extinction would be greatly reduced for 7 of the 11 metapopulations (Central Brevard, North Brevard, Central Charlotte, Northwest Charlotte, Levy, St. Lucie, and West Volusia) by acquiring all or most of the remaining scrub habitat. The model predicted the remaining four metapopulations (Citrus, Lee, Manatee, and Pasco) would moderately benefit if more acquisitions were made.

Stith (1999) classified two metapopulations (South Brevard and Sarasota) as moderately vulnerable with a moderate potential for improvement; they both had one or more fairly stable populations of Florida scrub-jays under protection, but the model predicted population declines. The rest of the metapopulations could collapse without further acquisitions, making the protected populations there vulnerable to epidemics or other catastrophes.

Three of the metapopulations evaluated by Stith (1999) (Flagler, Central Lake, and South Palm Beach) were classified as highly vulnerable to quasi-extinction and had low potential for improvement, since little or no habitat is available to acquire or restore.

Status and distribution

The Florida scrub-jay was federally listed as threatened in 1987 primarily because of habitat fragmentation, degradation, and loss (Service 1987a). Historically, oak scrub occurred as numerous isolated patches in peninsular Florida. These patches were concentrated along both the Atlantic and Gulf coasts and on the central ridges of the peninsula (Davis 1967). Probably until as recently as the 1950s, Florida scrub-jay populations occurred in the scrub habitats of 39 of the 40 counties south of, and including Levy, Gilchrist, Alachua, Clay, and Duval Counties. Historically, most of these counties would have contained hundreds or even thousands of breeding pairs (Fitzpatrick et al. 1994a 1994b). Only the southernmost county, Monroe, lacked Florida scrub-jays (Woolfenden and Fitzpatrick 1996a). Although Florida scrub-jay numbers probably began to decline when European settlement began in Florida (Cox 1987), the decline was first noted in the literature by Byrd (1928). After 40 years of personal observation of the Etonia scrub (now known as Ocala National Forest), Webber (1935) observed many changes to the previously-undisturbed scrub habitat found there, noting that “The advent of man has created a new environmental complex.”

A State-wide Florida scrub-jay census was last conducted in 1992 and 1993, at which time there were an estimated 4,000 pairs of Florida scrub-jays left in Florida (Fitzpatrick et al. 1994). At that time, the Florida scrub-jay was considered extirpated in 10 counties (Alachua, Broward, Clay, Duval, Gilchrist, Hernando, Hendry, Pinellas, and St. Johns), and were considered functionally extinct in an additional 5 counties (Flagler, Hardee, Levy, Orange, and Putnam), where 10 or fewer pairs remained. Recent information indicates there are at least 12 to 14 breeding pairs of Florida scrub-jays located within Levy County, higher than previously thought, and there is at least one breeding pair of Florida scrub-jays remaining in Clay County. A Florida scrub-jay has been documented in St. Johns County as recently as 2003. Populations are close to becoming extirpated in Gulf coast counties (from Levy south to Collier) (Woolfenden and Fitzpatrick 1996a). In 1992-1993, population numbers in 21 of the counties were below 30 or fewer breeding pairs (Fitzpatrick et al. 1994). Based on the amount of destroyed scrub habitat, Florida scrub-jay population loss along the LWR is 80 percent or more since pre-European settlement (Fitzpatrick et al. 1991). Since the early 1980s, Fitzpatrick et al. (1994) estimated in the northern third of the species’ range, the Florida scrub-jay has declined somewhere between 25 and 50 percent. The species may have declined by as much as 25 to 50 percent in the last decade alone (Stith et al. 1996).

On protected lands, Florida scrub-jays have continued to decline due to inadequate habitat management (Stith 1999). However, over the last several years, steps to reverse this decline have occurred, and management of scrub habitat is continuing in many areas of Florida (Hastie and Eckl 1999; Stith 1999; TNC 2001; Turner et al. 2006). Fitzpatrick et al. (1994) indicated that fire suppression at Cape Canaveral and Cape Canaveral Naval Air Station threatens the viability of this core population of scrub-jays. Furthermore, they stated that current forestry practices on ONF are likely to contribute to the continued decline of scrub-jays in this core area. Scrub-jays occurring on private land also face continued threats due to habitat degradation, fragmentation, and loss

Red-cockaded Woodpecker

In addition to the assessment below, a 5-year review was completed in 2006. The MSRP builds upon the detailed information in the 5-year review for this species (Service 2006a). The 5-year review is located at http://www.fws.gov/ecos/ajax/docs/five_year_review/doc787.pdf

Species/critical habitat description

The RCW measures approximately 7 to 8 in (18 to 20 cm) in length with a wing span of 14 to 15 in (35 to 38 cm). The RCW is distinguished by its conspicuous white cheek patches, black cap and neck, and black-and-white barred back and wings. The current distribution of this non-migratory, territorial species (endemic to open, mature and old growth pine ecosystems) is restricted to the remaining fragmented parcels of suitable pine forest in 11 southeastern States; it has been extirpated in New Jersey, Maryland, Missouri, Tennessee, and Kentucky (Costa 2004). As of April 2003, there were an estimated 14,500 RCWs living in 5,800 known active clusters across 11 states (Service 2003a). This is less than 3 percent of the estimated abundance at the time of European settlement.

No critical habitat has been designated for the RCW.

Life history

The RCW is a territorial, non-migratory, cooperative breeding species (Lennartz et al. 1987). It is unique in that it is the only North American woodpecker that exclusively excavates its roost and nest cavities in living pines. Each group member has its own cavity, although there may be multiple cavities in a cavity tree. The aggregate of cavity trees, surrounded by a 200-foot (61-meter) forested buffer, is called a cluster (Walters 1990). Cavities within a cluster may be complete or under construction and either active, inactive, or abandoned.

RCWs live in social units called groups. This family unit usually consists of a breeding pair, the current year's offspring and zero to four helpers (adults, normally male offspring of the breeding pair from previous years) (Walters 1990).

RCWs forage almost exclusively on live pine trees, although they will forage on recently killed pines (Franzreb 2004). Their prey consists of wood cockroaches, caterpillars, spiders, woodborer larvae, centipedes, and ants (Hanula and Horn 2004). Although (most notably Central and South Florida) they will use smaller pine trees as foraging substrate RCWs prefer pines greater than 10 inches in diameter at breast height (Hooper and Harlow 1986; Engstrom and Sanders 1997). However, in southwest Florida, RCW cavity trees can be found in slash pine as small as 6 inches and 8 to 9 inches diameter-at-breast-height is a common cavity tree size (Beever and Dryden 1992).

Population dynamics

Reproductive rates, population density, and re-colonization rates may influence RCW population variability more than mortality rates, sex ratios, and genetic variability. RCWs exhibit relatively low adult mortality rates; annual survivorship of breeding male and female RCW is high, ranging from 72 to 84 percent and 51 to 81 percent, respectively (Lennartz and Heckel 1987; Walters et al. 1988; Delotelle and Epting 1992).

Regarding sex ratios, only two studies (Francis Marion National Forest and central Florida populations) report significantly different fledgling sex ratios than 50:50 (Gowaty and Lennartz 1985); however, other populations report an unbiased sex ratio (LaBranche 1992; Hardesty et al. 1997).

The average number of young fledged from successful nests is about two in northern populations. Productivity in Florida populations typically is somewhat less (averaging 0.9 to 1.6 young per group) due largely to greater partial brood loss.

RCW populations can be increased dramatically because of their ability to re-colonize unoccupied habitat made suitable by providing the limiting resource of cavity trees, via artificial cavities (Copeyon 1990; Allen 1991). Significant population expansions have been documented where artificial cavity provisioning has been employed (Gaines et al. 1995; Franzreb 1999; Carlile et al. 2004; Doresky et al. 2004; Hagan et al. 2004; Hedman et al. 2004; Marston and Morrow 2004; Stober and Jack 2005).

Status and distribution

The precipitous decline of RCWs was caused by an almost complete loss of habitat. Approximately 920,000 (Costa 2001) to 1.5 million (Conner et al. 2001) groups of RCWs inhabited southeastern forests prior to European settlement. Fire-maintained old growth pine savannahs and woodlands that once dominated the southeast (92 million acres [37 million ha]) pre-European settlement; Frost 1993), on which the woodpeckers depend, no longer exist except in a few small patches (<3.0 million acres [1,214,000 ha] today; Frost 1993). Longleaf pine ecosystems, of primary importance to RCWs, are now among the most endangered systems on earth (Simberloff 1993; Ware et al. 1993).

<u>Blue-tailed mole skink</u>

The following discussion is summarized from the MSRP (Service 1999) and the 5-year status review (Service 2007b), as well as from recent research publications and monitoring reports. A complete blue-tailed mole skink life history discussion may be found in the MSRP.

Species/critical habitat description

The mole skink (*Eumeces egregius*) is a small, fossorial lizard that occupies xeric upland habitats of Florida, Alabama, and Georgia (Mount 1963). Five subspecies have been described (Mount 1965), but only the blue-tailed mole skink (*Eumeces egregius lividus*) is federally listed. It requires open, sandy patches interspersed with sclerophyllous vegetation (Service 1999). The historic and anticipated future modification and destruction of xeric upland communities in central Florida were primary considerations in listing the blue-tailed mole skink as threatened under the Act in 1987 (52 FR 42662). No critical habitat has been designated for the blue-tailed mole skink.

Mount (1965) described the blue-tailed mole skink largely on the basis of a bright blue tail in juveniles and restricted this subspecies to the southern LWR in Polk and Highlands Counties. Christman (1978b) limited the range of blue-tailed mole skinks to these two counties, but later added Osceola County to the range, based on the collection of a single juvenile of the subspecies just north of the Polk County line on the LWR (Christman 1992, FNAI records). Analysis of mtDNA (Branch et al. 2003) supports Mount's (1965) hypotheses that blue-tailed mole skinks from the lower LWR represent the ancestral stock with radiation from there. Genetic analysis also indicates high population structure with limited dispersal in mole skinks among sandy habitats (Branch et al. 2003).

The blue-tailed mole skink reaches a maximum length of about 5 inches, and the tail makes up about half the body length. The body is shiny, and brownish to pink in color, with lighter paired dorsolateral stripes diverging posteriorly (Christman 1978b). Males develop a colorful orange pattern on the sides of the body during breeding season. Juveniles usually have a blue tail (Christman 1992; P. Moler, FWC, personal communication 1998). Regenerated tails and the tails of older individuals are typically pinkish. The legs are somewhat reduced in size and used only for surface locomotion and not for "swimming" through the sand (Christman 1992).

A variety of xeric upland communities provide habitat for the blue-tailed mole skink, including rosemary and oak-dominated scrub, turkey oak barrens, high pine, and xeric hammocks. Areas with few plant roots, open canopies, scattered shrub vegetation, and patches of bare, loose sand provide optimal habitats (Christman 1988, 1992). Within these habitat types, blue-tailed mole skinks are typically found under leaves, logs, palmetto fronds, and other ground debris. Shaded areas presumably provide suitable microhabitat conditions for thermoregulation, egg incubation, and foraging (Mount 1963). Blue-tailed mole skinks tend to be clumped in distribution with variable densities that may approach 25 adults per acre (Christman 1992). The distribution of blue-tailed mole skinks appears to be closely linked to the distribution of surface litter and, in turn, suitable microhabitat sites.

Specific physical structures of habitat that sustain sand skink populations, and likely blue-tailed mole skink populations as well, include a well-defined leaf litter layer on the ground surface and shade from either a tree canopy or a shrub layer, but not both. Leaf litter likely provides important skink foraging opportunities. Shade provided by a tree canopy or a shrub layer likely helps skinks regulate body temperature to prevent overheating. However, having both a tree canopy and a shrub layer appears to be detrimental to skinks (McCoy 2011, University of South Florida, personal communication).

Either natural fires started by lightning or prescribed burns are necessary to maintain habitat in natural scrub ecosystems. However, if fire occurs too frequently, leaf litter might not build up sufficiently to support skink populations. At ABS, sand skinks appear to be most abundant after 10 years of leaf litter development. The ideal fire frequency to maintain optimal leaf litter development for skinks likely varies by site and other environmental conditions (Mushinsky 2011, University of South Florida, personal communication).

No critical habitat has been designated for the blue-tailed mole skink.

Life history

Sand skinks and blue-tailed mole skinks generally partition rather than compete with one another for resources. Sand skinks are primarily fossorial; they move or “swim” below the surface of the ground in sandy soils and take prey below the surface. Blue-tailed mole skinks are semi-fossorial; they hunt primarily at the soil surface or at shallow depths to 2 inches and consume mostly terrestrial arthropods (Smith 1977, Service 1993b). Foraging activities usually occur during the morning or evening. Roaches, crickets, and spiders make up the bulk of the diet (Mount 1963). Their diet is more generalized than that of the fossorial sand skink, which probably reflects their tendency to feed at the surface (Smith 1982). Like sand skinks, mole skinks show an activity peak in spring (Mount 1963, Smith 1982). The reproductive biology of the blue-tailed mole skink is poorly known. Reproduction is presumably very much like that of the peninsula mole skink, *E. e. onocrepis*, where mating occurs in the fall or winter. In the peninsula mole skink, two to nine eggs are laid in a shallow nest cavity less than 12 inches below the surface. The eggs incubate for 31 to 51 days, during which time the female tends the nest. Individuals probably become reproductively active at 1 year of age (Mount 1963; Christman 1978b). No data are available on blue-tailed mole skink home ranges or dispersal.

Population dynamics

The Service has little information on the population dynamics of blue-tailed mole skinks within their extant ranges. The skinks’ diminutive size and secretive habits make their study difficult. Blue-tailed mole skinks often seem absent or rare on the same LWR study sites where sand skinks are common, and when present, are patchily distributed (Christman 1988, 1992; Mushinsky and McCoy 1995). Mount (1963) noted peninsula mole skinks also are patchily distributed and mostly occurred on xeric sites greater than 100 acres (40 ha) in size. Early maturity (1 year in laboratory) and a large clutch size (maximum = nine eggs) of relatively small eggs (Mount 1963) suggest the population dynamics of mole skinks are different from sand skinks.

Status and distribution

The historic and anticipated future modification and destruction of xeric upland communities in central Florida were primary considerations in listing the blue-tailed mole skink as threatened under the Act in 1987 (52 FR 42662). Almost 90 percent of the xeric upland communities on the LWR have already been lost because of habitat destruction and degradation due to residential development and conversion to agriculture, primarily citrus groves (Turner et al. 2006). Remaining xeric habitat on private lands is especially vulnerable because projections of future human population growth suggest additional demands for residential development within the range of the blue-tailed mole skink. Campbell and Christman (1982) characterized blue-tailed mole skinks as colonizers of a patchy, early successional, or disturbed habitat type, which occurs throughout the sandhill, sand pine scrub, and xeric hammock vegetative associations as a result of biological or catastrophic factors. Susceptibility of mature sand pine to windthrow may be an important factor in maintaining bare, sandy microhabitats required by blue-tailed mole skinks and other scrub endemics (Myers 1990).

At the time of Federal listing, there were 20 locality records for the blue-tailed mole skink. Currently, 43 sites are known. The increase in locality records is largely the result of more intensive sampling of scrub habitats in recent years and does not imply that this species is more widespread than originally supposed. Of the known locations, only 13 occur on public land or on private land protected under conservation easement. Turner et al. (2006) suggested blue-tailed mole skinks may be under-represented in the reserve network of protected public lands, but could not determine if their absence is a result of exclusion or sampling effort. It is likely continued residential and agricultural development of xeric upland habitat in central Florida has destroyed or degraded extensive tracts of habitat containing the blue-tailed mole skink. Estimates of habitat loss range from 60 to 90 percent, depending on the xeric community type (Christman 1988; Christman and Judd 1990; Kautz 1993; Center for Plant Conservation 1995). Blue-tailed mole skinks are known to be present on sites which total 52.4 percent of the 21,597 acres (8,740 ha) of Florida scrub and high pine that is currently protected (Turner et al. 2006). However, the extent of potential habitat that is actually occupied is unknown, as is their total population size. As noted above, this species appears to be patchily distributed, even in occupied habitat (Mount 1963; Christman 1992). Unlike sand skinks, their tracks cannot be easily detected in the sand, and most of the extant scrub sites on the LWR have not been adequately surveyed for blue-tailed mole skinks, including protected sites.

A density study of blue-tailed mole and sand skinks was conducted in 2004-2005 by Christman (2005). Only two blue-tailed mole skinks were observed in the enclosures (mean density = 3.3 per ha, 1.3 per acre) relative to at least 84 sand skinks (ratio = 1:41). Christman (1992) suggested only 1 blue-tailed mole skink is encountered for every 20 sand skinks. Other range-wide pitfall trap data on the LWR revealed a blue-tailed mole skink to sand skink ratio of 1:1.89 based on 54 total skinks captured in six trap arrays (Christman 1988), 1:4.3 based on 332 total skinks in 58 trap arrays (Mushinsky and McCoy 1991), and 1:2.7 based on 49 total skinks in 31,640 pitfall trap-days (Meshaka and Lane 2002). Mushinsky and McCoy (1991) confirmed that detection rates for blue-tailed mole skinks increased with sampling effort.

The protection and recovery of blue-tailed mole skinks will require habitat loss be stopped and unoccupied but potentially suitable habitat be restored. The existing protection of the blue-tailed mole skink includes a number of private and public preserves within the LWR. Current efforts to expand the system of protected xeric upland habitats on the LWR, in concert with implementation of aggressive land management practices, represent the most likely opportunity for securing the future of this species. Comprehensive land acquisitions that protect areas occupied by the blue-tailed mole skink include the Service's Lake Wales Ridge National Wildlife Refuge, (LWRNWR) and the State of Florida's Conservation and Recreation Lands (CARL) LWR Ecosystem Project (Service 1993d).

In summary, little information is available to adequately assess the status and population dynamics of the blue-tailed mole skink. This subspecies is endemic to central Florida and is a habitat specialist that relies on early successional xeric scrub habitat for its continuing existence. Estimates of habitat loss range from 60 to 90 percent, depending on the xeric community type (Christman 1988, Christman and Judd 1990, Kautz 1993, Center for Plant Conservation 1995). Furthermore, the implementation of favorable management practices can create and maintain suitable habitat conditions for both sand and blue-tailed mole skinks, as well as other xeric upland-dependent species. A number of actions over the last 20 years have resulted in conservation benefits to xeric uplands within the extant range of both species. The State of Florida has acquired xeric upland habitat through the CARL, Save Our Rivers, and other P-2000 acquisition programs. Combined, these land acquisition programs have protected 10,000 acres of xeric uplands (Florida Department of Environmental Protection [FDEP] 1998; South Florida Water Management District [District] 1998). The Service has also acquired portions of several small tracts totaling 800 acres as a component of the LWRNWR. Finally, private organizations, such as TNC and ABS have bought and currently manage xeric uplands within the LWR.

Sand Skink

The following discussion is summarized from the MSRP (Service 1999a) and the 5-year status review (Service 2007b), as well as from recent research publications and monitoring reports. A complete sand skink life history discussion may be found in the MSRP.

Species/critical habitat description

The sand skink is a small, fossorial lizard that occurs on the sandy ridges of interior central Florida from Putnam County south to Highlands County. The extant range of the sand skink includes Highlands, Lake, Marion, Orange, Osceola, Polk, and Putnam Counties (Christman 1988; Telford 1992; Service 1999a). Principal populations occur on the LWR and Winter Haven Ridge (WHR) in Highlands, Lake, and Polk Counties (Christman 1992a; Mushinsky and McCoy 1999; P. Moler, FWC, personal communication 1998). The sand skink is also found on the Mount Dora Ridge (MDR), including sites within the ONF (Christman 1970, 1992a). Despite intensive sampling efforts in scrub habitat with similar herpetofauna, the sand skink has not been recorded at APAFR on the Bombing Range Ridge (Branch and Hokit 2000). According to the FNAI database (updated as of September 2006) there were 132 locality records for the sand skink, including 115 localities on the LWR, 4 on the WHR, and 7 on the MDR. FNAI also reports four localities for this species west of the MDR in Lake County and two localities between the LWR and the Lake Hendry Ridge. The modification and destruction of xeric upland communities in central Florida were primary considerations in listing the sand skink as threatened under the Act in 1987 (52 FR 42662). No critical habitat has been designated for the sand skink.

Recent morphological (Griffith et al. 2000) and molecular studies (Schmitz et al. 2004, Brandley et al. 2005) have demonstrated that the scincid lizard genus *Eumeces*, Weigmann (1834) is paraphyletic and that *Plestiodon*, Dumeril and Bibron (1839) has nomenclatural priority for the American species formally referred to as *Eumeces*, except for those now placed in the genus

Mesoscincus (Smith 2005). Molecular analysis of ribosomal RNA gene sequences also show "*Eumeces*" *egregius* and *Neoseps reynoldsi* are closely related sister species (Schmitz et al. 2004; Brandley et al. 2005). Schmitz et al. (2004) suggested the amount of genetic differentiation between the two species (5 percent) is similar to other species of North American skinks and *Neoseps* (Stejneger 1910) should be synonymized. They argue sand skinks are a striking example of morphological adaptation for burrowing, where the rate of morpho-ecological change exceeds phylogenetic change.

The sand skink is believed to have evolved on the central LWR and radiated from there (Branch et al. 2003). Analysis of mitochondrial DNA (mtDNA) indicates populations of the sand skink are highly structured with most of the genetic variation partitioned among four lineages: three subpopulations on the LWR characterized by high haplotype diversity and a single, unique haplotype detected only on the MDR (Branch et al. 2003). Under the conventional molecular clock, the 4.5 percent divergence in sand skinks between these two ridges would represent about a 2-million-year separation; the absence of haplotype diversity on the MDR would suggest that this population was founded by only a few individuals or severely reduced by genetic drift of a small population (Branch et al. 2003).

The sand skink reaches a maximum length of about 5 inches. The tail makes up about half the total body length. The body is shiny and usually gray to grayish-white in color, although the body color may occasionally be light tan. Hatchlings have a wide black band located along each side from the tip of the tail to the snout. This band is reduced in adults and may only occur from the eye to snout on some individuals (Telford 1959). Sand skinks contain a variety of morphological adaptations for a fossorial lifestyle. The legs are vestigial and practically nonfunctional, the eyes are greatly reduced, the external ear openings are reduced or absent (Greer 2002), the snout is wedge-shaped, and the lower jaw is countersunk.

The sand skink is widespread in native xeric uplands with excessively well-drained soils (Telford 1996), principally on the ridges listed above at elevations greater than 25 meters above mean sea level. Various authors have attempted to characterize optimal sand skink habitat (Telford 1959; Campbell and Christman 1982; Christman 1978a, 1992a, Service 1993d), but McCoy et al. (1999) have argued these notions are "educated guesswork" (Burgman et al. 1993) with little empirical basis. Commonly occupied native habitats include Florida scrub, variously described as sand pine scrub, xeric oak scrub, rosemary scrub and scrubby flatwoods, as well as high pine communities that include sandhill, longleaf pine/turkey oak, turkey oak barrens and xeric hammock (see habitat descriptions in Myers 1990 and Service 1999). Coverboard transects extended from scrub or high pine (sandhill) through scrubby flatwoods to pine flatwoods revealed sand skinks left more tracks in scrub than the other three habitats and did not penetrate further than 40 meters into scrubby flatwoods or 20 meters into pine flatwoods (Sutton et al. 1999).

McCoy et al. (1999) used trap-out enclosures to measure sand skink densities at seven scrub sites and attempted to rank each area individually based on eight visual characteristics used in the literature (Telford 1959, 1962; Christman 1992a; Service 1993a) to identify good habitat: root-free, grass-free, patchy bare areas, bare areas with lichens, bare areas with litter, scattered scrubs, open canopy, and sunny exposure. None of the individual literature descriptions of optimal habitat (or any combination thereof) accurately predicted the rank order of actual sand skink abundance at these sites, which ranged in density from 125 individuals/ha to 650/ha (Sutton 1996). However, knowledgeable researchers, especially as a group, appear to be able to visually sort out the environmental variables important to sand skinks, but had difficulty translating their perceptions into a set of rules that others could use to identify optimal sand skink habitat (McCoy et al. 1999). Collazos (1998), Hill (1999), and Mushinsky et al. (2001) used grids of pitfall traps and coverboards to quantify the relationship between sand skink density and a suite of environmental variables. These authors found that sand skink relative density was positively correlated with low canopy cover, percent bare ground, amount of loose sand, and large sand particle size, but negatively correlated with understory vegetation height, litter cover, small sand particle size, soil moisture, soil temperature, and soil composition. In an unburned sandhill site at ABS, Meshaka and Layne (2002) captured significantly more sand skinks in pitfall traps set in openings without shrubs than at sites with moderate to heavy shrub density. Telford (1959) suggested scattered debris and litter provided moisture that was important to support an abundant food supply and nesting sites for sand skinks. Cooper (1965) noted the species was most commonly collected under rotting logs, and Christman (1992a) suggested they nest in these locations.

The trap-out enclosure surveys of Sutton et al. (1999) and Christman (2005) provide evidence that hot fires may negatively affect sand skink densities and the species continues to occupy scrub with a closed canopy and thick humus layer, although at lower densities. Also, recent coverboard surveys conducted by permit applicants have shown sand skinks may occupy both actively managed lands, such as citrus groves, pine plantations, and old field communities (Service data), particularly if these sites are adjacent to patches of native habitat that can serve as a source population for recolonization.

Specific physical structures of habitat that sustain sand skink populations, and likely blue-tailed mole skink populations as well, include a well-defined leaf litter layer on the ground surface and shade from either a tree canopy or a shrub layer, but not both. Leaf litter likely provides important skink foraging opportunities. Shade provided by a tree canopy or a shrub layer likely helps skinks regulate body temperature to prevent overheating. However, having both a tree canopy and a shrub layer appears to be detrimental to skinks (McCoy 2011, University of South Florida, personal communication).

Either natural fires started by lightning or prescribed burns are necessary to maintain habitat in natural scrub ecosystems. However, if fire occurs too frequently, leaf litter might not build up sufficiently to support skink populations. At ABS, sand skinks appear to be most abundant after 10 years of leaf litter development. The ideal fire frequency to maintain optimal leaf litter development for skinks likely varies by site and other environmental conditions (Mushinsky 2011, University of South Florida, personal communication).

No critical habitat has been designated for the sand skink.

Life history

The sand skink is highly adapted for life in the sand. It spends the majority of its time below the surface where it burrows through loose sand in search of food, shelter, and mates. Sand skinks feed on a variety of hard and soft-bodied arthropods that occur below the ground surface. The diet consists largely of beetle larvae and termites (*Prorhinotermes* spp.). Spiders, larval ant lions, lepidopteran larvae, roaches, and adult beetles are also eaten (Myers and Telford 1965; Smith 1982).

Sand skinks are most active during the morning and evening in spring and at mid-day in winter, the times when body temperatures can easily be maintained between 28°C and 31°C in open sand (Andrews 1994). During the hottest parts of the day, sand skinks move under shrubs to maintain their preferred body temperatures in order to remain active near the surface (Andrews 1994). With respect to season, Telford (1959) reported skinks were most active from early March through early May, whereas Sutton (1996) found skinks were most active from mid-February to late April. Based on monthly sampling of pitfall traps, Ashton and Telford (2006) found captures peaked in March at ABS, but in May at ONF. All of these authors suggested the spring activity peak was associated with mating. At ABS, Ashton and Telford (2006) noted a secondary peak in August that corresponded with the emergence of hatchling sand skinks. The literature states sand skinks lay two eggs typically in May or early June (Ashton 2005) under logs or debris, approximately 55 days after mating (Telford 1959). However, there have been observations of three to four eggs per clutch at times (Mushinsky, personal communication, 2007). The eggs hatch from June through July. Sand skinks first reproduce at 2 years of age and females produce a single clutch in a season, although some individuals reproduce biennially or less frequently (Ashton 2005). Sand skinks can live to at least 10 years of age (Meneken et al. 2005).

Information on sand skink dispersal and movement patterns is limited. Sand skink studies in the early 2000s documented dispersal distances of more than 140 meters (Mushinsky et al. 2001, Penney 2001, Penney et al. 2001) to more than 240 meters (Penney 2001). Evidence suggested smaller sand skinks might move greater distances than larger individuals. Researchers believed these documented sand skink dispersal distances likely underestimated dispersal capability. Information suggests that sand skinks can move more than 1 km at appropriate elevations where suitable soils are contiguous and there are no natural or manmade barriers to movement (Mushinsky et al. 2011a). More recent studies documented the longest sand skink movement at 8 km and an average movement of 1.6 km in naturally fragmented scrubby flatwoods at the ABS (Mushinsky et al. 2011a).

Sand skink dispersal distances documented in field studies are supported by sand skink genetic research. Genetic relatedness of sand skinks was similar between individuals captured as far as 1 to 2 km from one another (Schrey et al. 2010). Sand skink genetic relatedness tended to decline beyond the 1 km distance, although it appeared to be influenced by the time since fire (Schrey et al. 2010; Mushinsky et al. 2011b). Fires that occur too frequently could negatively decrease sand skink genetic diversity.

Population dynamics

The Service has little information on the population dynamics of sand skinks within their extant ranges. The skinks' diminutive size and secretive habits make their study difficult. As noted above, sand skinks can reach densities of up to 650 individuals/ha (263/acres) in high quality habitat, particularly on the LWR. Delayed maturity (2 years), a small clutch size (two eggs) of relatively large eggs, low frequency of reproduction, and a long lifespan in sand skinks are life-history traits that also characterize a number of other fossorial lizards that occur in high densities (Ashton 2005). Such character traits may reflect high intra-specific competition and/or predation (Ashton 2005). In contrast, blue-tailed mole skinks often seem absent or rare on the same LWR study sites where sand skinks are common, and when present, are patchily distributed (Christman 1988, 1992b; Mushinsky and McCoy 1995). Mount (1963) noted peninsula mole skinks also are patchily distributed and mostly occurred on xeric sites greater than 100 acres (40 ha) in size. Early maturity (1 year in laboratory) and a large clutch size (maximum = nine eggs) of relatively small eggs (Mount 1963) suggest the population dynamics of mole skinks are different from sand skinks.

Status and distribution

The modification and destruction of xeric upland communities in central Florida were primary considerations in listing the sand skink as threatened under the Act in 1987 (52 FR 42662). By some estimates, as much as 90 percent of the scrub ecosystem has already been lost to residential development and conversion to agriculture, primarily citrus groves (Florida Department of Natural Resources 1991; Kautz 1993). Xeric uplands remaining on private lands are especially vulnerable to destruction because of increasing residential and agricultural pressures.

Except for a few locations where intensive research has been conducted, limited information about the presence or abundance of sand skinks exists. An extensive 1992 survey in ONF failed to capture any sand skinks, despite placement of traps near historical locations and the capture of a number of other fossorial reptiles. Telford (1992) cited the ephemeral nature of early successional scrub habitats due to dynamic successional changes as an important confounding factor in the evaluation of the sand skink's status in the ONF. However, 24 sand skinks were collected later from ONF for genetic analysis (Branch et al. 2003) and population studies (Ashton and Telford 2006). Additional studies have provided presence/absence information that has been used to determine the extant range of the species (Mushinsky and McCoy 1991, Stout and Corey 1995). However, few long-term monitoring efforts have been undertaken to evaluate the status or trends of sand skinks at these or other sites.

At the time of Federal listing in 1987, FNAI had recorded 31 known sites for the sand skink. By September 2006, 132 localities were known by FNAI. This increase is largely the result of more intensive sampling of scrub habitats in recent years and does not imply that this species is more widespread than originally thought. Of the known locations, 50 (38 percent) occur on public lands or private lands placed under conservation easement, and offer habitat protection. It is likely continued residential and agricultural development of xeric upland habitat in central Florida has destroyed or degraded habitat containing sand skinks. Approximately 60 to 90 percent of xeric upland communities historically used by sand skinks on the LWR are estimated to have been lost due to development (Christman 1988; Christman and Judd 1990; Kautz 1993; Center for Plant Conservation 1995). More recently, Turner et al. (2006) calculated 12.9 percent of this habitat remains.

Protection of the sand skink from further habitat loss and degradation provides the most important means of ensuring its continued existence. Existing protection of occupied skink habitat consists primarily of private preserves such as ABS, Hendry Ranch, Tiger Creek Preserve, and Saddle Blanket Lakes Scrub Preserve, coupled with publicly owned lands such as Lake Arbuckle State Park and State Forest, Lake Louisa State Park, and Highlands Hammock State Park (Service 1993a). Current efforts to expand the system of protected xeric upland communities on the LWR, coupled with implementation of effective land management practices, represent the most likely opportunity for assuring the sand skink's survival (Turner et al. 2006). It will also be important to preserve the genetic diversity of sand skinks by protecting sites in each of the four genetically distinct populations, from the MDR, the northern LWR, the central LWR, and the southern LWR.

It is likely a substantial sand skink population is present on existing private and public conservation lands on the LWR. As of 2003, about 21,597 acres (8,740 ha) of Florida scrub and high pine on the LWR have been protected, which represents almost half of the remaining xeric habitat on this ancient ridge, but only 6.3 percent of its estimated historic extent (Turner et al. 2006). Sand skinks are present on sites that total 87.4 percent of the currently protected xeric acreage (Turner et al. 2006), but many of the other conserved sites have not been surveyed adequately. Fourteen trap-out enclosures at seven protected sites with a known burn history on the LWR in Polk and Highlands Counties contained a minimum of 84 sand skinks for a mean density of 152 individuals/ha (61per acre), and one enclosure set in dry flatwoods yielded none (Christman 2005). Fourteen of these sites had burned in the last 8 years, and the one "rosemary bald" that has not burned for 37 years had 275 sand skinks/ha (110 per acre). Five similar enclosures set on unburned xeric sites in Orange and Osceola Counties averaged 385 sand skinks/ha (155 per acre) (Sutton 1996). Meshaka and Lane (2002) found both species persisted on a sandhill at ABS that remained unburned for 67 years (1927-1994). The relative abundance of sand skinks decreased over time, but blue-tailed mole skinks did not.

Recovery of the sand skink also may require rehabilitation of suitable but unoccupied habitat or restoration of potentially suitable habitat. Because sand skinks do not readily disperse, introductions into restored or created unoccupied habitat may be necessary. Sand skinks relocated to two former citrus groves in Orange County have persisted for at least 5 years (Hill 1999; Mushinsky et al. 2001).

Eastern Indigo Snake

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008b). The 5-year review builds upon the detailed information in the MSRP for this species and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/easternindigofinal.pdf

Species/critical habitat description

The eastern indigo snake is the largest non-venomous snake in North America, obtaining lengths of up to 8.5 ft (2.6 meters) (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 the cheeks. Its scales are large and smooth (the central 3 to 5 scale rows are lightly keeled in adult males) in 17 scale rows at mid-body. Its anal plate is undivided. In the Florida Keys, adult indigo snakes seem to have less red on their faces or throats compared to most mainland specimens (Lazell 1989). Several researchers have informally suggested that Lower Keys indigo snakes may differ from mainland snakes in ways other than color. Critical habitat has not been designated for this species.

No critical habitat has been designated for the eastern indigo snake.

Life history

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

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

Population dynamics

Eastern indigo snakes need a mosaic of habitats to complete their annual life cycle. Over most of its range, the eastern indigo snake frequents several habitat types, including pine flatwoods, scrubby flatwoods, high pine, dry prairie, tropical hardwood hammocks, edges of freshwater marshes, agricultural fields, coastal dunes, and human-altered habitats. Eastern indigo snakes also use some agricultural lands (such as citrus) and various types of wetlands (Service 1999a). A study in southern Georgia found that interspersion of tortoise-inhabited sandhills and wetlands improve habitat quality for the eastern indigo snake (Landers and Speake 1980; Service 2004c). Eastern indigo snakes shelter in gopher tortoise burrows, hollowed root channels, hollow logs, or the burrows of rodents, armadillos, or land crabs (Lawler 1977; Moler 1985a; Layne and Steiner

1996). Throughout peninsular Florida, this species may be found in all terrestrial habitats which have not experienced high density urban development. They are especially common in the hydric hammocks throughout this region (Service 1999a). In central and coastal Florida, eastern indigo snakes are mainly found within many of the State's high, sandy ridges. In extreme south Florida (*i.e.*, the Everglades and Florida Keys), eastern indigo snakes are found in tropical hardwood hammocks, pine rocklands, freshwater marshes, abandoned agricultural land, coastal prairie, mangrove swamps, and human-altered habitats (Steiner et al. 1983; Service 1999a). Underground refugia used by this species include natural ground holes; hollows at the base of trees or shrubs; ground litter; trash piles; and in the crevices of rock-lined ditch walls (Layne and Steiner 1996). It is thought that they prefer hammocks and pine forests since most observations occur there and use of these areas is disproportionate compared to the relatively small total area of these habitats (Steiner et al. 1983). Observations over the last 50 years made by maintenance workers in citrus groves in east-central Florida indicate that eastern indigo snakes are occasionally observed on the ground in the tree rows and more frequently near the canals, roads, and wet ditches (Zeigler 2006). In the sugar cane fields at the A-1 Reservoir Project site in the Everglades Agriculture Area, eastern indigo snakes have been observed (including one mortality) during earthmoving and other construction-related activities.

Eastern indigo snakes range over large areas and use various habitats throughout the year, with most activity occurring in the summer and fall (Smith 1987; Moler 1985a). Adult males have larger home ranges than adult females and juveniles; their ranges average 554 acres, decreasing to 390 acres in the summer (Moler 1985b). In contrast, a gravid female may use from 3.5 to 106 acres (Smith 1987). In Florida, home ranges for females and males range from 5 to 371 acres and 4 to 805 acres, respectively (Smith 2003). At ABS, average home range size for females was determined to be 47 acres and overlapping male home ranges to be 185 acres (Layne and Steiner 1996).

Status and distribution

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

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

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

Gopher Tortoise

The following discussion is summarized from the 12-month finding (Service 2011), as well as from recent research publications and monitoring reports.

Species/Critical Habitat Description

The gopher tortoise is the only tortoise (family Testudinidae) east of the Mississippi River. It is larger than any of the other terrestrial turtles in this region, with a domed, dark-brown to grayish-black shell (carapace) up to 14.6 inches long, weighing up to 13 pounds (6 kilograms [kg]). The lower shell (plastron) is yellowish and hingeless. Tortoises cannot completely withdraw their limbs, which remain visible when folded and retracted. The hind feet are elephantine or stumpy, and the forelimbs are shovel-like, with claws used for digging. In comparison to females, males are smaller; usually have a larger gland under the chin, a longer gular projection, and more concave plastron. Hatchlings are up to 2 inches in length, with a somewhat soft, yellow-orange shell. As with other chelonians, gopher tortoises possess a keratinized beak, and lack teeth. Critical habitat has not been designated.

No critical habitat has been designated for the gopher tortoise.

Life history

The gopher tortoise is a long-lived, native burrowing species of the open, fire-maintained longleaf pine ecosystem. Historically, typical gopher tortoise habitat consisted of open, frequently burned longleaf pine or longleaf pine/scrub oak uplands and flatwoods on moderately well drained to xeric soils. Such habitat provided adequate sunlight reaching the forest floor to stimulate the growth and development of the herbaceous plant stratum for forage, with sufficient warmth for basking and the incubation of eggs.

The burrows of a gopher tortoise are the habitat and center of normal feeding, breeding, and sheltering activity. Gopher tortoises excavate and use more than one burrow for shelter beneath the ground surface. Burrows, which may extend for more than 30 ft, provide shelter from canid predators, fire, winter cold, and summer heat. Dogs and large canids are the most common predator of adult tortoises (Causey and Cude 1978).

In stable populations with fire-maintained, open longleaf pine habitat, females may use an average of five burrows each while males occupy an average of 10 burrows (Eubanks et al. 2003). In poor habitat due to encroaching, fire intolerant shrubs and hardwoods, gopher tortoises tend to excavate and use fewer burrows, probably because of limited sites that are sufficiently open. Males tend to use more burrows and move more frequently among their different burrows than females as they seek breeding opportunities with females (McRae et al. 1981; Diemer 1992a, 1992b; Smith 1995; Tuma 1996; Boglioli et al. 2000; Eubanks et al. 2003). The term “active burrow” is applied to burrows exhibiting indications it is likely inhabited by a gopher tortoise. Characteristics of active burrows include fresh soil excavated from the interior of the burrow, deposited on the apron at the burrow entrance; tortoise feces on the apron or near the burrow entrance; and eggshells and tracks. Inactive burrows, which display conditions of recent use and occupancy by a tortoise, are considered to be used as part of the annual home range of one or more tortoises, but are not currently occupied by a tortoise. Indicators of inactive burrows include suitable size and shape of the burrow entrance; a recognizable apron of bare soil without encroachment of grasses or shrubs; and small amounts of leaf litter in the entrance that have not been moved by a tortoise. Abandoned burrows are unlikely to be used by a tortoise and, normally exhibit indications of erosion, a loss of shape and structure, vegetative overgrowth, and no apron.

Tortoises spend most of their time within burrows and emerge during the day to bask in sunlight, to feed, and reproduce. Tortoises are active above ground during the growing season when daytime temperatures range from 75 to 87 °F (McRae et al. 1981; Butler et al. 1995). Daily active periods usually are unimodal in spring, followed by bimodal periods (early to mid-morning, middle to late afternoon) during the hotter temperatures of summer (McRae et al. 1981). Daily activity above ground becomes significantly reduced by the end of the growing season during October with cooler temperatures. Tortoises take shelter within their burrows during the dormant season, become torpid, do not eat, and rarely emerge except during periods of warm days to bask in sunlight at the burrow entrance. Except for those tortoises in southern peninsular Florida that do not have an overwintering period, most tortoises become active again during early spring.

Tortoises mostly forage on foliage, seeds, and fruits of grasses and forbs, generally in an area of about 150 ft surrounding each burrow (McRae et al. 1981; Diemer 1992b). The diet of adults resembles that of a generalist herbivore, with at least some preference for some plants over others, and may also include insects and carrion (MacDonald and Mushinsky 1988; Birkhead 2001). Juvenile tortoises tend to forage on fewer plant species, eat fewer grasses, and select more forbs, including legumes, than adults (Mushinsky et al. 2003).

Burrows are not randomly located in the environment. Tortoises select and prefer burrow sites in open sunny areas (Boglioli et al. 2000; Rostal and Jones 2002). Such sites reflect areas where herbaceous plants for food are more abundant on the forest floor and, for females, sunlight and soil temperatures for egg incubation are more suitable. Also, males select sites and burrows that increase their proximity to females and breeding opportunities (Boglioli et al. 2000; Eubanks et al. 2003). The repeated use and travel to the same burrows by individual tortoises in stable habitat reveal that tortoises know the geography of their home range, burrows, and the location of neighboring tortoises (Eubanks et al. 2003).

Tortoises breed from May through October (*e.g.*, Landers et al. 1980; McRae et al. 1981; Taylor 1982; Wright 1982; Service 1987f; Diemer 1992a; Eubanks et al. 2003). Females ovulate during spring, but likely store sperm so that active breeding during ovulation may not be always be required for fertilization. Males travel to female burrows and copulation occurs above ground at the burrow entrance, more frequently during July to September, a period of peak sex and adrenal steroid hormones (Ott et al. 2000; Eubanks et al. 2003). In earlier work by Douglass (1986), he described gopher tortoise “colonial” tendencies with aggregations of burrows in which dominant males competitively and behaviorally exclude other males at female burrows to maintain a loose female harem as a mating system. These more recent studies do not indicate the clear existence of an exclusive dominance hierarchy. Also, aggregations of burrows in some habitat and study sites probably is an artifact of fragmentation and the concentration of burrows in the available remaining suitable habitat (Mushinsky and McCoy 1994; Boglioli et al. 2003).

Females do not reproduce every year. In the listed range, about 80 percent of the females at Marion County Wildlife Management Area (WMA) in Mississippi and 85 percent of the females at Ben’s Creek WMA in Louisiana were gravid each year (Smith et al. 1997). Females excavate a shallow nest to lay and bury eggs, usually in the apron of soil at the mouth of the burrow, but they may lay elsewhere if the apron is excessively shaded (Landers and Buckner 1981). Range-wide, average clutch size varies from about 4 to 12 eggs/clutch. Average clutch size in the listed range, from 4.8 to 5.6 eggs/clutch, is comparably low (Seigel and Hurley 1993; Seigel and Smith 1995; Tuma 1996; Epperson 2003). Clutch size generally is positively correlated with adult female size (Diemer and Moore 1994; Smith 1995; Rostal and Jones 2002).

Females usually lay about five to seven eggs from mid-May through mid-July in the soil of the apron at the burrow entrance (Butler and Hull 1996; Smith et al. 1997) and egg incubation lasts 80 - 110 days (Diemer 1986; Smith et al. 1997). Incubation at temperatures from 27°C to 32°C is required for successful development and hatching (*e.g.*, Spotila et al. 1994; Burke et al. 1996; DeMuth 2001; Rostal and Jones 2002; Noel and Qualls 2004). As in other species, sex determination is temperature dependent (Burke et al. 1996; DeMuth 2001).

Nest depredation by vertebrates typically has been considered substantial, although little quantitative data is available. From studies in southern Georgia, Landers et al. (1980) estimated about 90 percent of nests were destroyed by predators. In a much smaller study from southern Alabama, about 46 percent of nests (n = 11) were destroyed by raccoons, opossums, and armadillos (Marshall 1986). Egg hatching success at experimentally protected nests has ranged from 28 to 97 percent in Florida and Georgia (92 percent, Arata 1958; 86 percent, Landers et al. 1980; 28 percent, Linely 1986; 67 to 97 percent, Smith 1995; 80.6 percent, Butler and Hull 1996). In the listed range in Mississippi, mean hatching success from protected nests in the field has ranged from 28.8 - 56 percent (Epperson and Heise 2003; Noel and Qualls 2004).

Hatchlings excavate themselves from the nest and emerge from the middle of August through October (Ashton and Ashton 2008). Hatchlings and yearlings (0 to 1 year old) may temporarily use the adult burrow, bury under sand or leaf litter, or excavate a small burrow nearby (Douglass 1978; Wilson et al. 1994; Butler et al. 1995; Pike 2006). Growth is most rapid during the juvenile stage, becoming slower at the onset of adulthood and reproductive maturity, followed by little or no adult growth (Mushinsky et al. 1994; Aresco and Guyer 1998, 1999). Generally, tortoises become adults at about 20 years of age, although the minimal stage to reach reproductive maturity is determined by size rather than age. Growth rates and sizes at sexual maturity can vary among populations and habitat types (Landers et al. 1982; Mushinsky et al. 1994; Aresco and Guyer 1998, 1999).

Hatchlings/yearlings initially move up to about 50 ft (15 meters) from their nest to establish their first burrow, from which they will subsequently excavate and use about five burrows in a home range as small as about 0.5 acres (0.2 ha), to as large as 11.8 acres (4.8 ha) (Mushinsky et al. 1994; Butler et al. 1995; Epperson and Heise 2003; Pike 2006). Yearlings move, on average, relatively short distances to establish new burrows, although they are known to have traveled up to 1,485 ft (450 meters) to new burrows (Butler et al. 1995; Epperson and Heise 2003). Hatchlings and yearlings may take shelter beneath litter and woody debris during longer distances or times encountered to move to a new burrow (Diemer 1992b; Butler et al. 1995). Yearlings and juveniles usually forage within about 23 ft (7 meters) from their burrow (McRae et al. 1981; Wilson et al. 1994; Butler et al. 1995; Epperson and Heise 2003).

Home range size and movements increase with age and body size. The burrows of a gopher tortoise represent the general boundaries of a home range, which is the area used for feeding, breeding, and sheltering. 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 outside the federally listed area have varied from 1.3 to 5.2 acres (3.2 to 2.2 ha) for males and 0.2 to 2.5 acres (0.09 to 1.0 ha) for females (McRae et al. 1981; Auffenberg and Franz 1982; Diemer 1992b; Tuma 1996; Ott 1999; Eubanks et al. 2003; Guyer 2003). In comparison to females, male tortoises use more burrows, and during breeding season, move among burrows more frequently over longer distances (McRae et al. 1981; Auffenberg and Franz 1982; Diemer 1992b; Smith 1995; Tuma 1996; Ott 1999; Eubanks et al. 2003; Guyer 2003).

A burrow may or may not be exclusively used by just one gopher tortoise. Two or more tortoises may share the same burrow, although the burrow is used at different times of the year by different individuals. Home ranges overlap when a burrow is used by more than one tortoise. About 50 percent of the area occupied by 123 tortoises was shared by 2 or more tortoises in relatively pristine, stable habitat in southwestern Georgia (Eubanks et al. 2002). At Camp

Shelby, Mississippi, average home range varied from 7.3 to 10.4 acres for males and 12.1 to 32.9 acres for females (Tuma 1996; Guyer 2003). At another population on timber industry land in Alabama, average home range was 10.4 acres (4.2 ha) for males and 32.9 acres (13.3 ha) for females. These home ranges are larger than those typically determined for tortoises at populations in Alabama, Georgia, and Florida outside the listed range. Since gopher tortoise movements and distance increase as herbaceous biomass and habitat quality decrease (Auffenberg and Iverson 1979; Auffenberg and Franz 1982), larger home ranges at these two study sites in the listed range probably reflect differences in habitat quality. Habitat conditions on the timber industry study site were highly heterogeneous, with patches and stands of suitable habitat mixed among patches of unsuitable habitat. These tortoises moved among relatively long distances to different burrows located in suitable habitat patches within a matrix of poor and unsuitable habitat.

As distances increase between gopher tortoise burrows, isolation among tortoises also increases due to the decreasing rate of visitation and breeding (Boglioli et al. 2003; Guyer 2003). Using extensive data from individual tortoise interburrow movements and home range size, Eubanks et al. (2003) found that most colonies or breeding population segments would consist of burrows no greater than about 558 ft (170 meters) apart. Guyer (2003) found that males only rarely will move from their burrows up to 1,640 ft (500 meters) to a female burrow for mating opportunities, and females typically experience a visitation rate of near zero when their burrows are 460 to 623 ft (140 to 190 meters) from nearest neighbors. Demographically, tortoises located at distances of about 600 ft (200 meters) from other tortoises are functionally isolated and subdivided as separate breeding populations. Thus, breeding populations or colonies likely consist of tortoises and burrows in suitable, unfragmented habitat within 600 ft or less from each other.

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, sand pine and oak ridges (beach 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. In the western range, soils contain more silt, and xeric (dry) conditions are less common west of the Florida panhandle (Craul et al. 2005). Ground cover in this Coastal Plains area can be separated into two general regions with the division in the central part of southern Alabama and northwest Florida. To the west, bluestem (*Andropogon* spp.) and panicum (*Panicum* spp.) grasses predominate; to the east, wiregrass (*Aristida stricta*) is most common (Boyer 1990). However, gopher tortoises do not necessarily respond to specific plants but rather the physical characteristics of habitat (Diemer 1986). Historic gopher tortoise habitats were open pine forests, savannahs, and xeric grasslands that covered the coastal plain from Mexico and Texas to Florida. Historic habitats might have had wetter soils at times and been somewhat cooler but were generally xeric, open, and diverse (Ashton and Ashton 2008).

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 obligate 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; Stewart et al. 1993) 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; Wright 1982; Macdonald and Mushinsky 1988; Mushinsky et al. 2006). A lack of vegetative diversity may negatively impact the long-term sustainability of gopher tortoise populations (Ashton and Ashton 2008).

Gopher tortoises require a sparse canopy and litter-free ground not only for feeding, but also for nesting (Landers and Speake 1980). In Florida, McCoy and Mushinsky (1995) found the number of active burrows per tortoise was lower where canopy cover was high. Females require almost full sunlight for nesting (Landers and Buckner 1981) because eggs are often laid in the burrow apron or other sunny spot and require the warmth of the sun for appropriate incubation (Landers and Speake 1980). At one site in southwest Georgia, Boglioli (et al. 2000) found most tortoises in areas with 30 percent or less canopy cover. Diemer (1992a) found ecotones created by clearing were also favored by tortoises in north Florida. When canopies become too dense, usually due to fire suppression, tortoises tend to move into ruderal habitats such as roadsides with more herbaceous ground cover, lower tree cover, and significant sun exposure (Garner and Landers 1981; McCoy et al. 1993; Baskaran et al. 2006). In Georgia, Hermann et al. (2002) found that open pine areas (*e.g.*, pine forests with canopies that allow light to penetrate to the forest floor) were more likely to have burrows, support higher burrow densities, and have more burrows used by large, adult tortoises than closed-canopy forests. Historically, open-canopied pine forests were maintained by frequent, lightning-generated fires.

Population dynamics

As long-lived animals, gopher tortoises naturally experience delayed sexual maturity, low reproductive rates, high mortality at young ages and small size-classes, and relatively low adult mortality. The growth and dynamics of populations are stochastically affected by natural variation due to demographic rates, the environment, catastrophes, and genetic drift (Shaffer 1981). Factors affecting population growth, decline, and dynamics include the number or proportion of annually breeding and egg-laying females (breeding population size), clutch size, nest depredation rates, egg hatching success, mortality (hatchling/yearling, juvenile-subadult, adult), the age or size at first reproduction, age- or stage-class population structure, maximum age of reproduction, and immigration/emigration rates.

These factors and data have been evaluated in several investigations of population viability to estimate the probabilities of gopher tortoise population extinction over time and the important factors affecting persistence. In the absence of field surveys and long-term monitoring, models may be used to project the status of populations in the future based on a specific set of assumptions and assignment of demographic parameters. There have been four substantive modeling efforts evaluating the long-term persistence of gopher tortoises (Tuberville et al. 2009). Two early modeling efforts focused on estimating the minimum number of tortoises needed for a population to persist for 200 years (Cox et al. 1987). Although relatively small population sizes (40 to 50 adults) were modeled to persist over the model duration, all populations declined and were projected to go extinct at some point in the future depending on model parameters.

Miller (2001) assessed the likelihood of tortoises being extirpated from Florida over a 100-year period when evaluating all known tortoise populations or only those on public lands considering a variety of assumptions regarding survivorship, carrying capacity constraints, disease, etc. (Miller 2001). The model results suggest that gopher tortoises have greater than 80 percent chance of persisting in Florida over the next 100 years whether looking at all known populations or only those on public lands (Miller 2001). Furthermore, they concluded that populations as small as 50 individuals can have conservation value under favorable conditions, but under less favorable habitat conditions populations larger than 250 individuals would be necessary to protect against extinction due to stochastic factors that increase hatchling and adult mortality (Miller 2001).

The most recent modeling effort recognized the need to evaluate the viability of individual populations, rank populations most appropriate for in-situ protection, and determine if nonviable populations are more likely to contribute to conservation through augmentation or translocation (Tuberville et al. 2009). All model scenarios resulted in a population decline of 1 to 3 percent per year, which varied as a function of habitat quality and location within the range (Tuberville et al. 2009). Only modeled populations with at least 250 tortoises were able to persist for 200 years, which is substantially different than earlier model results. Population dynamics of turtles, as long lived animals, have commonly been considered sensitive to demographic changes in adult survival and, in some cases, juvenile survival (Gibbons 1987; Congdon et al. 1993; Heppell and Crowder 1996). Likewise, models and simulations of gopher tortoise populations are most sensitive to adult, hatchling, and juvenile survival rates (Miller 2001; Epperson 2003; Wester 2004). For example, the small but positive population growth rates modeled for a stable base population became negative when mortality of the 3 to 4+ year age class increased from 3.0 to 5.0 percent, or the yearling (0 to 1 year age class) mortality increased from 95 to 97 percent (Miller 2001; McDearman 2006).

Recently, segmented regression models were developed to evaluate the relationship between area of habitat occupied by gopher tortoises and abundance of gopher tortoises to define how many individuals constitute a population and how much area is required for such a population. Data synthesized from 21 study sites in Alabama, Georgia, and Mississippi with varying tortoise population numbers indicated that an average gopher tortoise population consists of 444 burrows, covers 755 ha (1,865 acres), and contains 240 tortoises (Styrsky et al. 2010). This average population contained a density of 0.3 tortoises per ha (0.1 per acre), which is below the threshold identified by Guyer (personal communication) for maintaining a persistent population. The authors noted that this average tortoise population was calculated based on a variety of existing landscapes that differed in their current management and past land use history and, therefore, did not represent what a population of tortoises might be in areas that were all managed with frequent fire and contained the uneven-aged trees of old-growth longleaf pine forests. Thus, it is likely tortoises could persist on smaller parcels, but only if habitat were aggressively managed

(Styrsky et al. 2010). Lack of prescribed fire or ineffective use of prescribed fire is known to be a substantial impediment to the restoration and maintenance of gopher tortoise habitat throughout much of its range. The model results depict a typical tortoise population as one occupying a large area. This seems congruent with existing habitat conditions that are reported throughout much of the tortoise's range. Therefore, the model results show most existing conservation lands contain too few tortoises and too little suitable habitat to support persistent tortoise populations.

Status and distribution

Effectively assessing the status (*i.e.*, whether it is increasing, decreasing, or stable) of the gopher tortoise throughout its range requires evaluation of the distribution of tortoises, number of tortoises and populations, number of individuals in populations, and trends in population growth. As we indicated above, we do not have specific distribution data for most of the tortoise's range, but we estimated where potential habitat existed and where tortoises may still be present. Below, we provide summaries of survey data about the sizes and, in some cases, trends of gopher tortoise populations. There is a noticeable disparity between the apparently large area (expressed in hectares or acres) of potential gopher tortoise habitat reported above and actual numbers of individual tortoises known from populations that have been surveyed, as summarized below. Upon cursory examination, there seem to be few tortoises where there are millions of hectares of potential habitat. Many Federal and State agencies, non-governmental organizations, and timber owners have only recently begun to assess where and how many gopher tortoises are present on lands they own or manage.

Our review of the literature indicates that the status of an individual gopher tortoise population is dependent on the size of the population and its demographic performance. For comparative purposes, and as described in greater detail below, we considered tortoise populations to be large enough to persist in the future (*i.e.*, viable) if they contained 250 or more reproductively active individuals. Ideally, recruitment should exceed mortality, but few long-term studies provide this demographic information. In the absence of these data, burrow surveys that report hatchling and juvenile-sized burrows indicate that recent recruitment occurred, but we still often lack information about whether the observed level of recruitment is sufficient to offset mortality. The amount of habitat necessary to support a population of at least 250 breeding individuals likely varies depending on habitat quality. Populations in poor-quality habitat, such as those in atypical vegetative communities and in areas not aggressively managed, will likely require more area than populations in high-quality soils where there would be sparse canopy cover, multi-aged pine forests with abundant ground cover, and where prescribed fire is used periodically to maintain habitat conditions. Because of these variations, the density of gopher tortoises in a population that is large and demographically viable will vary.

A wide variety of information is available on the number and density of gopher tortoises and their burrows from many areas throughout their range. These data resulted from numerous surveys/censuses using a variety of methodologies ranging from one-time censuses to repeated surveys over several decades. The diversity of data poses a challenge when trying to evaluate the status of a species from a landscape perspective. For example, in some areas we have more data (*e.g.*, Florida and in portions of the listed range), and we have higher confidence in drawing conclusions about status of tortoises in these areas. In other areas, where there is little or no data, our confidence in assessing the status of tortoises is lower. Because of disparities in the type of data collected, methodologies in collecting data, and differences in the scope of studies, it is not possible to simply combine datasets to evaluate the status of the gopher tortoise throughout its range. Instead, we considered each individual dataset in the context of all other best available science to form general conclusions about the status of the gopher tortoise.

In the western portion of their range, gopher tortoise populations are small and occur in fragmented habitat. The largest and most substantial gopher tortoise populations in the western portion of its range occur on the De Soto National Forest in southern Mississippi. Long-term monitoring here indicates a decline in population sizes, a tendency towards adult-dominated populations, and a lack of, or very low, recruitment. Results of smaller-scale surveys of forest lands in Mississippi and public and private lands in Louisiana are largely consistent with findings on the De Soto National Forest. There are no known populations large enough (*e.g.*, > 250 individuals) to persist long-term based on projections resulting from recent modeling efforts.

The gopher tortoise is more widespread and abundant in parts of the eastern portion of its range, particularly southern Georgia and central and northern Florida. Long-term monitoring data indicate that many populations have declined and most are relatively small and fragmented. Smaller-scale, short-term or one-time surveys throughout the unlisted portion of the range indicate that tortoise populations typically occur in fragmented and degraded habitat, are small, and densities of individuals are low within populations. Unlike the western portion of the range, there are several known populations of tortoises in the eastern portion of the range that appear to be sufficiently large to persist long-term (*e.g.*, Camp Blanding Joint Training Center, Florida; Chassahowitzka WMA, Florida; Fort White Wildlife and Environmental Area, Florida; Jennings Forest WMA, Florida; TLWMA, Florida; Fort Benning, Georgia; Fort Stewart, Georgia; River Creek WMA, Georgia; Townsend WMA, Georgia). There are about 80 other public parcels in Florida that contain a substantial amount of potential gopher tortoise habitat but surveys or censuses of these areas have not been conducted to estimate the number of tortoises present (FWC 2011b).

The decline of the gopher tortoise has been linked to the decline of the open, fire maintained longleaf pine forest and ecosystem (Service 1990b). About 80 percent of the original habitat for the gopher tortoise within its listed range has been lost due to urbanization and agriculture (McDearman 2005). In remaining forests, management practices involving dense pine stands for pulpwood production, the silvicultural conversion from longleaf to other pines, and fire exclusion or infrequently prescribed fire have further reduced habitat for the species. These practices eliminate the open, sunny forest with a well developed groundcover of grasses and forbs needed by tortoises for burrowing, nesting, and feeding (Landers and Buckner 1981; Auffenberg and Franz 1982). Other threats and causes for decline include habitat fragmentation, fire ants, predation, and human-caused mortality as a result of roads and heavy equipment operations during forest site preparation and timber harvest (Service 1990b).

The gopher tortoise is federally listed 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 (Service 1987f). The listed range of the gopher tortoise includes three counties in southeastern Alabama, 14 counties in southern Mississippi, and three parishes in Louisiana. Most gopher tortoise habitat is privately owned (70 percent), while about 20 percent is owned by the Forest Service, and 10 percent by other public agencies (Noss 1988). No critical habitat has been designated for this species.

The Service's recovery plan (Service 1990b) for the gopher tortoise establishes short-term and long-term criteria involving public and private lands to delist the species (U.S. Forest Service [USFS] 1990b). The DeSoto National Forest represents a core area where management actions are required to prevent this threatened species from becoming endangered. This is the first and most immediate objective of the recovery plan. The long-term objective, delisting, involves substantial voluntary commitments from private landowners.

The short-term objective is to establish and maintain populations on the DeSoto National Forest, including Camp Shelby, on 18,144 acres (7,343 ha) at densities of 1.2 to 2.8 burrows per acre (3 to 7 burrows per ha). This is the acreage estimated to consist of deep sandy soils, designated as priority soils, and at burrow densities indicative of large, stable populations on such soils in Florida. By these criteria and using a 0.61 burrow occupancy rate, the Service's recovery plan estimates the total recovery population on DeSoto National Forest would consist of 13,437 to 31,354 tortoises. More recent data on the average percentage of active and inactive burrows inhabited by tortoises in the listed range reveals that the 0.61 burrow conversion factor is too large (*e.g.*, Mann 1995; Wester 1995). Using Mann's (1995) correction factor of 0.414, then 9,120 to 21,280 tortoises would occur on DeSoto National Forest by this acreage with burrow density criteria at 0.5 to 12 tortoises per acre. For a minimally viable population of at least 75 tortoises, the lower range of the recovery criterion of about 9,120 tortoises would represent up to 122 viable populations, or less with larger individual populations.

On July 26, 1990, the Forest Service and Service completed formal section 7 consultation on the effect of a proposed management plan for the gopher tortoise on DeSoto National Forest. The objective of the Forest Service's plan is to promote recovery by maintaining and improving gopher tortoise habitat. Management measures to attain these objectives included prescribed fire, timber thinning, and regeneration to longleaf pine. Because of recent surveys documenting a declining gopher tortoise population, primarily due to poor habitat associated with encroaching shrubs and hardwoods in response to infrequent fire, the Service and Forest Service have reinitiated an informal section 7 consultation phase to remedy management problems that have impaired successful habitat restoration and maintenance. The successful implementation of a modified gopher tortoise habitat management plan is crucial to stabilize declining populations and to prevent the species from becoming endangered. This will require an increase in the frequency of growing season prescribed fire, with thinning and selective herbicide treatment in some areas with inadequate ground fuels to restore and maintain habitat. Also, management needs to be prioritized and designated on core patches of priority soils as well as adjoining areas of suitable soils to establish and maintain habitat areas of sufficient size for future viable populations. Depending on burrow density and home range overlap, the minimal reserve size for a single minimally viable population may range from 50 to 200 acres (19 to 81 ha) (Eubanks et al. 2002).

On private lands, the long-term objective for recovery is the establishment of 1.2 gopher tortoise burrows per acre (3 burrows per ha) on 45,945 acres (18,594 ha) of sandhill communities, where such burrow densities are most likely (USFS 1990b). This acreage represents the area of privately-owned upland forests on sandy soils estimated by Lohoefener and Lohmeier (1984) at about the time of listing, although recovery objectives for private lands are not necessarily restricted to priority soil types. Using the 0.414 burrow conversion factor, recovery on private lands would represent about 23,094 tortoises by these criteria, or about 300 or fewer individual populations, each with 75 or more tortoises with good, long-term habitat management commitments.

Most of the timberland in the listed range of gopher tortoise is privately owned. In south Mississippi, for example, only about 14 percent of upland pine forests are publicly-owned and managed (Kelly and Sims 1987). Recovery for the gopher tortoise on private lands will require substantial voluntary commitments. Private landowners are not required by the Act to implement voluntary management to restore or maintain habitat by preventing or controlling forest succession that leads to habitat degradation in the absence of frequently occurring natural fire. A primary limiting factor for the recovery of the gopher tortoise is the absence of habitat restoration, which includes frequent prescribed fire and other active management measures to control and eliminate encroaching hardwoods and shrubs.

About 400,500 acres of longleaf pine stands remained within the listed range of the gopher tortoise by the 1990s. Gopher tortoises are not restricted to longleaf pine stands, but the best opportunity for recovery on both public and private lands will be in managed longleaf stands. The normal silviculture for the production of longleaf pine timber for poles and sawlogs, with frequent prescribed fire, is highly compatible with gopher tortoise habitat. In the listed range, voluntary landowner programs and technical assistance to private landowners by the Service, state, and private organizations recently have been initiated or are being planned as further incentives to the economic and ecological benefits for longleaf pine habitat restoration. These programs include Partners for Wildlife, Mississippi Partners for Fish and Wildlife, the Healthy Forest Reserve Program, the Emergency Conservation Reserve Program, and the Safe Harbor Program. Currently, about 2,000 acres of longleaf pine and potential gopher tortoise habitat has been treated by some form of habitat restoration management. These and other efforts will have to increase substantially to achieve recovery on private lands.

Recovery for the gopher tortoise on private lands will require substantial voluntary commitments. Private landowners are not required by the Act to implement voluntary management to restore habitat. Likewise, the Act does not require private landowners to implement active management that would prevent the natural processes of forest succession, leading to a further decline of habitat in the absence of a frequently occurring natural fire. A primary limiting factor for the recovery of the gopher tortoise is the absence of habitat restoration, with frequent prescribed fire and other active management measures to control and eliminate encroaching hardwoods and shrubs. The gopher tortoise will not be recovered simply by landowners complying with the prohibitions of section 9 of the Act to avoid incidental take. Active management to restore habitat is required, as well as active fire management to sustain existing suitable habitat.

Frosted Flatwoods salamander

The frosted flatwoods salamander is currently listed as threatened by the Service. While very similar in life history, behavior, and appearance to the reticulated flatwoods salamander, they are genetically distinct. A. cingulatum's range is to the east of the Apalachicola River drainage. Changes in land use, hydrology, rainfall, temperature, and timing of seasonal rains appears to be having negative effects on the habitat of this species. Approximately 43 extant populations are known to exist, although the survey information is not current.

Reticulated Flatwoods slalamnder

The reticulated flatwoods salamander (A. Bishopi) is listed as endangered under the Act of 1973 (as amended). There is currently some uncertainty regarding the precise number of extant populations. Efforts are ongoing to update the inventory of extant populations. There are 16 designated critical habitat breeding ponds for A. bishop. All were known to have larvae present in the last comprehensive survey (1993). Since then some have been shown to still have larvae, others have not had any detections since 1993. Plans are being developed to get fully updated information on these ponds and their occupancy in the next few years.

Highlands Tiger Beetle

The HTB is a candidate listed species. A complete discussion on this species may be found at http://www.fws.gov/ecos/ajax/docs/candforms_pdf/r4/I0MR_I01.pdf

Species/Critical Habitat Description

Adult tiger beetles are medium-sized, elongate beetles, mostly with brilliant metallic green, blue, red, and yellow coloration highlighted by stripes and spots (Knisley and Hill 1992; Deyrup 1994). The HTB is 0.4 to 0.5 inches (Knisley and Hill 1992; Deyrup 1994). The HTB is restricted to open, sandy, well-drained, Florida scrub habitat on the LWR in central Florida (Knisley and Hill 1992, 1996; Deyrup 1994).

Because the HTB is a candidate for listing, critical habitat has not been designated for this species.

Life history

HTB larvae are predatory. They live in small burrows from which they lunge and seize passing invertebrate prey (Eissig 1926, 1942; Pearson 1988). When a prey item passes near a burrow, the larva grasps it with its strong mandibles (mouthparts), pulls it into the burrow, and feeds (Eissig 1942; Pearson 1988). Adult tiger beetles are ferocious, swift, and agile predators that seize small prey with powerful sickle-shaped jaws (Essig 1942, p. 530; Nagano 1982, p. 34; Pearson 1988, pp. 124, 126-127, 132). Tiger beetle larvae are also predatory. Larvae live in singular, small burrows from which they lunge and seize passing invertebrate prey (Essig 1926, p. 372; Essig 1942, p. 532; Pearson 1988, pp. 131-132). When a prey item passes near a burrow, the larva grasps it with its strong mandibles (mouthparts), pulls it into the burrow, and feeds (Essig 1942, p. 531-532; Pearson 1988, p. 132). In Florida, their prey is typically ants (Choate 1996, p. 2).

Population dynamics

This species' narrow distribution may be in part due to its lack of dispersal. Among tiger beetles there is a general trend of decreasing flight distance with decreasing body size (Knisley 2005). HTB is one of the smallest tiger beetles and an extremely weak flier (usually moving only 1 to 5 meters in a flight). Species in woodland, scrub, or dune habitats seem to disperse less than water edge species, and this could further explain the apparent limited dispersal of HTB (Knisley and Hill 1996).

Status and distribution

The range of the HTB does not extend to the south end of the LWR, but it does extend northward to the north side of Lake Marion, east of Haines City. In recent years, a number of tiger beetle collectors have sought but not found this species in other areas in this vicinity. The primary threats to the HTB have been loss and inadequate management of scrub vegetation, and collection (Service 2012). An additional threat is fire suppression, which changes the nature and composition of the scrub communities. Land managers in the area are implementing fire management for scrub vegetation that will benefit the HTB.

<u>Bartram's Hairstreak Butterfly</u>

Species/critical habitat description

The Bartram's hairstreak, endemic to southern Florida, is a small butterfly approximately 25 millimeters (mm) (1 inch) in length with a forewing length of 10.0 to 12.5 mm (0.4 to 0.5 inches) (Opler and Krizek 1984, pp. 107-108; Minno and Emmel 1993, p. 129). Despite its rapid flight, this hairstreak is easily observed if present at any density as it alights often, and the brilliance of its grey underside marked with bold, white postdiscal lines beneath both wings provides an instant flash of color against the foliage of its host plant, pineland croton (*Croton linearis*) (Euphorbiaceae) (Smith et al. 1994, p. 118; Salvato 1999, p. 124). The Bartram's hairstreak does not exhibit sexual or seasonal dimorphism, but does show some sexual differences. The abdomen of the male is bright white, while females are gray (Service 2011).

Because the Bartram's hairstreak is a candidate for listing, critical habitat has not been designated for this subspecies.

Life history

The Bartram's hairstreak is rarely encountered more than 5 meters (16.4 ft) from its host plant (Schwartz 1987, p. 16; Worth et al. 1996, p. 65; Salvato and Salvato 2008, p. 324). Females oviposit on the flowering racemes of pineland croton (Worth et al. 1996, p. 62; Salvato and Hennessey 2004, p. 225). Eggs are laid singly on the developing flowers.

Population dynamics

The Bartram's hairstreak has been observed during every month on Big Pine Key and Everglades National Park (ENP); however the exact number of broods appears to be sporadic from year to year (Salvato and Hennessey 2004, p. 226; Salvato and Salvato 2010b, p. 156). Baggett (1982, p. 81) indicated the Bartram's hairstreak seemed most abundant in October-December. Salvato and Salvato (2010b, p. 156) encountered the subspecies most often during March to June within ENP. Land (personal communication 2012) has noted the subspecies to be most abundant in the spring and summer months. One of the earliest reports of *S. a. bartrami* phenology from Big Pine Key was provided by Schwartz (1987) who encountered the subspecies only during April, November and December, despite an extensive annual survey. Subsequent research by Hennessey and Habeck (1991), Emmel et al. (1995), and Minno and Minno (2009) reported occurrences *S. a. bartrami* on Big Pine throughout the year with varying peaks in seasonal abundance. Salvato (1999, p. 47) recorded 92 and 36 adult Bartram's hairstreak on Big Pine Key during 1-week periods in July 1997 and January 1998, respectively, suggesting the species can occur in high numbers during any season if suitable habitat and conditions are present. Since 2010 on Big Pine Key, Anderson has found them most active when the average temperature is consistently near 80ºF which can occur at any time of year (Anderson, personal communication 2012).

Status and distribution

The Bartram's hairstreak is currently known to occur on Big Pine Key, in the lower Florida Keys (Monroe County), Long Pine Key within ENP (Miami-Dade County), as well as Navy Wells Pineland Preserve and the various parcels that compose the Richmond Pine Rocklands in Miami-Dade County (Salvato and Hennessey 2004; Service 2011). The Bartram's hairstreak is extirpated from the majority of its' historic range in southern Florida, extant populations are threatened by loss or inconsistent fire management of pine rockland habitat, small population size, poaching, and pesticide applications.

<u>Florida Leafwing Butterfly</u>

Species/critical habitat description

The Florida leafwing butterfly is a medium-sized butterfly approximately 2.75 to 3.00 inches (76 to 78 mm) in length with a forewing length of 1.3 to 1.5 inches (34 to 38 mm) and has an appearance characteristic of its genus (Opler and Krizek 1984, p. 172; Minno and Emmel 1993, p. 153). The upper-wing surface color is red to red-brown, the underside is gray to tan, with a tapered outline, cryptically looking like a dead leaf when the butterfly is at rest. The Florida leafwing exhibits sexual dimorphism, with females being slightly larger and with darker coloring along the wing margins than the males.

Because the Florida leafwing is a candidate for listing, critical habitat has not been designated for this subspecies.

Life history

Adults are rapid, wary fliers. The subspecies is extremely territorial, with both sexes flying out to pursue other butterflies (Baggett 1982, p. 78; Worth et al. 1996, p. 65; Salvato and Hennessey 2003, p. 246; Salvato and Salvato 2010a, p. 96). Minno (personal communication 2009) and Salvato and Salvato (2010a, p. 96) note that males are generally more territorial. The Florida leafwing is multivoltine (*i.e.*, produces multiple generations per year), with an entire life cycle of about 60 days (Hennessey and Habeck 1991, p. 17) and maintains continuous broods throughout the year (Salvato 1999, p. 121). Females lay eggs singly on both the upper and lower surface of the host leaves, normally on developing racemes (Baggett 1982, p. 78; Hennessey and Habeck 1991, p. 16; Worth et al. 1996, p. 64; Salvato 1999, p. 120).

Population dynamics

The Florida leafwing has been observed during every month within the Everglades and formerly on Big Pine Key; however the exact number of broods appears to be sporadic from year to year (Baggett 1982, p. 78; Opler and Krizek 1984, p. 172; Minno and Emmel 1993, p. 153; Salvato and Hennessey 2003, p. 247; Salvato and Salvato 2010a, p. 96; 2010b, p. 140). Salvato and Salvato (2010a, p. 93) and Land (personal communication 2012) encountered the subspecies throughout the year, but the majority of observations occurred from late fall to spring in ENP. By contrast, when extant on Big Pine Key, Salvato and Salvato (2010c, p. 139) reported finding the subspecies abundantly throughout the year, particularly during the summer months.

Status and distribution

The Florida leafwing is currently known to occur only within the Long Pine Key within ENP (Miami-Dade County). Recent populations on Big Pine Key, in the lower Florida Keys (Monroe County), as well as Navy Wells Pineland Preserve and the various parcels that compose the Richmond Pine Rocklands in Miami-Dade County are no longer extant (Salvato and Salvato 2010, p. 91). The extant population within the Everglades remains threatened by inconsistent fire management of pine rockland habitat, small population size, and illegal poaching.

<u>Florida Bonnected Bat</u>

The Florida bonneted bat (*Eumops floridanus*) is proposed endangered federally and listed as threatened by the State. A complete discussion of the status of this species, including the most current available scientific and commercial data, may be found at http://www.regulations.gov/#!documentDetail;D=FWS-R4-ES-2012-0078-0001

Species/critical habitat description

The Florida bonneted bat is a memberof the Molossidae (free-tailed bats) family within the order Chiroptera. The species is approximately 130 to 165 mm (5.1 to 6.5 inches in length (Timm and Genoways 2004) and the largest bat in Florida (Owre 1978; Belwood 1992; Florida Bat Conservancy [FBC] 2005). The length of the tail ranges from 46 to 57 mm (1.8 to 2.2 inches), hind foot 11to 15 mm (0.4 to 0.6 inches), ear 20 to 30 mm (0.8 to 1.2 inches), and forearm 60.8 to 66.0 mm (2.39 to 2.60 inches) (Timm and Genoways 2004). Masses average 39.7 grams

(1.4 ounces) and range from 30.2 to 46.6 grams (1.1 to 1.6 ounces) (Owre 1978; Belwood 1981; Belwood 1992; Timm and Genoways 2004). A pregnant female with a single fetus weighed 55.4 grams (2.0 ounces) (Belwood 1981). Males and females are not significantly different in size (Timm and Genoways 2004). Timm and Genoways (2004) found no pattern of sizerelated geographic variation in this species.

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). The common name of ‘‘bonneted bat’’ originates from characteristic large broad ears, which project forward over the eyes (FBC 2005). Ears are joined at the midline of the head. This feature, along with its large size, distinguish the Florida bonneted bat from the smaller Brazilian (=Mexican) free-tailed bat (*Tadarida brasiliensis*) (Belwood 1992).

Wings of the members of the genus *Eumops* are among the narrowest of all molossids (Freeman 1981, as cited in Best et al. 1997) and are well-adapted for rapid, prolonged flight (Vaughan 1959 as cited in Best et al. 1997). This wing structure is conducive to high-speed flight in open areas (Findley et al. 1972 as cited in Best et al. 1997).

The Florida bonneted bat’s fur is short and glossy, with hairs sharply bicolored with a white base (Belwood 1992; Timm and Genoways 2004). Like other molossids, 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). The basisphenoid pits (paired depressions in the basisphenoid bone) of the skull are ovoid (egg-shaped) and moderately deep (Timm and Genoways 2004). The tail projects beyond the interfemoral membrane (skin that stretches between the legs) (Owre 1978; Belwood 1992).

Because the Florida bonneted bat is proposed for listing, critical habitat has not been designated for this species.

Life history

Relatively little is known about the Florida bonneted bat’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 Florida bonneted bat, with an average generation time of 5 to 10 years.

The Florida bonneted bat has a fairly extensive breeding season during summer months (Timm and Genoways 2004). The maternity season for most bat species in Florida occurs from mid-April through mid-August (Marks and Marks 2008a). During the early portion of this period, females give birth and leave young in the roost while they make multiple foraging excursions to support lactation (Marks and Marks 2008a). During the latter portion of the season, young and females forage together until the young become sufficiently skilled to forage and survive on their own (Marks and Marks 2008a). The Florida bonneted bat is a subtropical species, and pregnant females have been found in June through September (FBC 2005; Marks and Marks 2008a). Examination of limited data suggests this species may be polyestrous (having more than one period of estrous in a year), with a second birthing season possibly in January–February (Timm and Genoways 2004; FBC 2005).

Information on reproduction and demography is sparse. The Florida bonneted bat has low fecundity; litter size is one (FBC 2005; Timm and Arroyo-Cabrales 2008).

Based upon limited information, the species roosts singly or in colonies consisting of a male and several females (Belwood 1992). G.T. Hubbell believed that individuals in Miami roosted singly (Belwood 1992). However, Belwood (1981) suggested that a colony, consisting of seven females and one male using a longleaf pine cavity as a roost site in Punta Gorda, was a harem group, based on its sex ratio. Belwood (1981; 1992) suggested that this behavior has been recorded in a few bat species and such social groupings may be facilitated by roosting in tree cavities, which can be defended from other males (Morrison 1979).

Information on roosting habits from artificial structures is also limited. The Florida bonneted bat colony using bat houses on private property in Lee County consisted of 8 to 25 individuals, including one albino (S. Trokey, personal communication 2006a, 2006b; 2008a, 2008b, 2012). Sex ratio is not known. Some movement between the houses has been observed (S. Trokey, personal communication 2006a).

At the Fred C. Babcock/Cecil M. Webb WMA (Babcock-Webb WMA), 42 individuals are using 4 separate roosts, consisting of 7 bat houses among 4 sites (J. Myers, personal communication 2012a, 2012b; Marks and Marks 2012). It is not known if there is movement between houses or among roost locations or between artificial and unknown natural roosts within Babcock-Webb WMA.

The Florida bonneted bat is active year-round and does not have periods of hibernation or torpor. The species is not migratory, but there might have been seasonal shifts in roosting sites (Timm and Genoways 2004). Belwood (1992) reported that, prior to 1967, G.T. Hubbell routinely obtained several individuals per year collected during the winter from people's houses.

Precise foraging and roosting habits and long-term requirements are unknown (Belwood 1992). Active year-round, the species is likely dependent upon a constant and sufficient food supply, consisting of insects, to maintain its generally high metabolism. Based upon limited information, Florida bonneted bats feed on flying insects of the following orders: Coleoptera (beetles), Diptera (true flies), and Hemiptera (true bugs) (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).

Molossids, in general, seem adapted to fast flight in open areas (Vaughan 1966). Various morphological characteristics (*e.g.*, narrow wings, high wing-aspect ratios (ratio of wing length to its breadth) make *Eumops* well-adapted for efficient, rapid, and prolonged flight in open areas (Findley et al. 1972; Freeman 1981; Norberg and Rayner 1987; Vaughan, 1959 as cited in Best et al. 1997). Barbour and Davis (1969) noted that the species flies faster than smaller bats, but cannot maneuver as well in small spaces. Belwood (1992) stated *E. glaucinus* is ''capable of long, straight, and sustained flight,'' which should allow individuals to travel large distances. Norberg and Rayner (1987) attributed long distance flights of Brazilian free-tailed bats to their high wing-aspect ratios, with that species capable of traveling 65 km (40 miles) from its roosting site to its foraging areas (Barbour and Davis 1969). Nonetheless, average foraging distances for the Florida bonneted bat are not known (G. Marks, personal communication 2012). Although the species can fly long distances, it likely does not travel farther than necessary to acquire food needed for survival (G. Marks, personal communication 2012).

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). Foraging in open spaces, these bats use echolocation to detect prey at relatively long range, roughly 3 to 5 meters (10 to 16 ft) (Belwood 1992). Based upon information from G.T. Hubbell, Belwood (1992) indicated that individuals leave roosts to forage after dark, seldom occur below 10 meters (33 ft) in the air, and produce loud, audible calls when flying; calls are easily recognized by some humans (Belwood 1992; Best et al. 1997; Marks and Marks 2008a).

Relatively little is known of the ecology of the Florida bonneted bat, and long-term habitat requirements are poorly understood (Robson 1989; Robson et al. 1989; Belwood 1992; Timm and Genoways 2004). Habitat for the Florida bonneted bat mainly consists of foraging areas and roosting sites, including artificial structures. At present, no active, natural roost sites are known, and only limited information on historical sites is available.

Recent information on foraging habitat has been obtained largely through acoustical surveys, designed to detect and record bat echolocation calls (Marks and Marks 2008a). Acoustical methods have generally been selected over mist netting as the primary survey methodology because this species flies and primarily forages at heights of 9 meters (30 ft) or more (Marks and Marks 2008a). The Florida bonneted bat has a unique and easily identifiable call. While most North American bats vocalize echolocation calls in the ultrasonic range that are inaudible to humans, the Florida bonneted bat echolocates at the higher end of the audible range, which can be heard by some humans as high-pitched calls (Marks and Marks 2008a). Most surveys conducted using acoustical equipment can detect echolocation calls within a range of 30 meters (100 ft); call sequences are analyzed using software that compares calls to a library of signature calls (Marks and Marks 2008a). Florida bonneted bat calls are relatively easy to identify because calls are issued at frequencies well below that of other Florida bat species (Marks and Marks 2008a).

In general, open, fresh water and wetlands provide prime foraging areas for bats (Marks and Marks 2008c). Bats will forage over ponds, streams, and wetlands and drink when flying over open water (Marks and Marks 2008c). During dry seasons, bats become more dependent on remaining ponds, streams, and wetland areas for foraging purposes (Marks and Marks 2008c). The presence of roosting habitat is critical for day roosts, protection from predators, and the rearing of young (Marks and Marks 2008c). For most bats, the availability of suitable roosts is an important, limiting factor (Humphrey 1975). Bats in south Florida roost primarily in trees and manmade structures (Marks and Marks 2008a).

Available information on roosting sites for the Florida bonneted bat is extremely limited. Roosting and foraging areas appear varied, with the species occurring in forested, suburban, and urban areas (Timm and Arroyo-Cabrales 2008). Data from acoustical surveys and other methods suggests the species uses a wide variety of habitats (see Table 1) (Marks and Marks 2008a; 2008b; 2008c; 2012; R. Arwood, Inside-Out Photography, Incorporated, personal communication 2008a, 2008b, 2012; Smith 2010; S. Snow, personal communication 2011, 2012).

Population estimates and status

Little information exists on historical population levels. The Florida bonneted bat was considered common in the Miami-Coral Gables area because of regular collection of specimens from 1951 to 1965 (Robson 1989; Belwood 1992). Jennings (1958) indicated the species was not abundant, noting a total of 20 individuals had been taken from 1936 to 1958. Prior to 1967, G.T. Hubbell regularly heard loud, distinctive calls at night as the bats foraged above buildings in the Miami area, and he routinely obtained several individuals per year that were collected from people's houses (Belwood 1992). Barbour and Davis (1969) indicated that, on average, about two individuals per year are brought to the Crandon Park Zoo in Miami, due to injuries, but no time period was specified.

Unpublished data from a survey of 100 pest control companies in 1982 on the southeastern coast of Florida showed that requests to remove ''nuisance'' bats from this area all but ceased beginning in the 1960s (Belwood 1992), indicating a sharp decline in bats in general. Timm and Genoways (2004) found only three records of Florida bonneted bats in the greater Miami area after 1965. The colony found near Punta Gorda in 1979 appeared to be the only recorded occurrence since 1967 (Belwood 1981). A 6-week field trip in 1980 to locate other occurrences was unsuccessful and led to the belief that this species was ''probably extinct in Florida'' (Belwood 1992). No new evidence of this species was found from 1979 until 1988 when Robson et al. (1989) found a pregnant female in Coral Gables (Robson 1989).

Timm and Genoways (2004) surmised that the Florida bonneted bat may have been uncommon for several decades, based upon the work of previous researchers (Barbour 1945 as cited in Timm and Genoways 2004; Jennings 1958; Layne 1974), who noted the scarcity of bats in southern Florida. Owre (1978) observed fewer than a dozen individuals in roughly 25 years and noted that few mammalogists had success in finding the species. Robson (1989) indicated that the decline of specimens and sightings in the mid-1960s is reflected in the museum record and noted that the 1950s and 1960s was a period of rapid growth in the Miami area. Robson (1989) suggested that the resulting disturbance and destruction of native habitat may have flushed a large number of specimens out of established roosts, resulting in a high collection rate. 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).

Based upon available data and information, the Florida bonneted bat occurs within a restricted range and in low abundance (Marks and Marks 2008a; 2012; Timm and Arroyo-Cabrales 2008; FWC 2011a,b; R. Timm, personal communication 2012). Actual population size is not known, and no population viability analyses are available (FWC 2011a). However, population size is thought to be less than that needed for optimum viability (Timm and Arroyo-Cabrales 2008). As part of their evaluation of listing criteria for the species, Gore et al. (2010) found the extent of occurrence appears to have declined on the east coast, but trends on the west coast could not be inferred due to limited information.

In his independent review of the FWC's Biological Status Report, Ted Fleming, Emeritus Professor of biology at University of Miami, noted anecdotal evidence from the 1950s and 1960s suggests this species was more common along Florida's southeast coast compared with the present (FWC 2011b). Fleming stated, ''There can be no doubt that *E. floridanus* is an uncommon bat throughout its very small range. Its audible echolocation calls are distinctive and easily recognized, making it relatively easy to survey in the field'' (FWC 2011b). He also stated he does not doubt the total State population numbers ''in the hundreds or low thousands'' (FWC 2011b).

Similarly, in response to a request for information as part of the Service's annual Candidate Notice of Review, Robert Timm (personal communication 2012), Curator of Mammals at Department of Ecology and Evolutionary Biology and Biodiversity Institute at the University of Kansas, indicated that numbers are low, in his view, as documented by survey attempts. ''*Eumops* are very obvious bats where they occur because of their large size and distinctive calls. Given the efforts to locate them throughout southern Florida, if they were there in any significant numbers, they would have been located'' (R. Timm, personal communication 2012).

Results of the 2006-2007 range-wide survey suggested that the Florida bonneted bat 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 number 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 it is possible that the entire population of Florida bonneted bats 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 Miami area, areas of ENP and Big Cypress National Preserve [BCNP]) (S. Snow, personal communication 2011, 2012; R. Arwood, personal communication 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 Florida bonneted bat work. Based upon an average colony size of 11and an estimated 26 colonies within the species' range, researchers estimated the total Florida bonneted bat population at 286 bats (Marks and Marks 2012).

Status and distribution

The taxon was originally listed as endangered in the State of Florida as the Florida mastiff bat (*Eumops glaucinus floridanus*) (Florida Administrative Code, Chapter 68). As such, it is afforded protective provisions specified in Chapter 68A-27 rules (68A-27.0011 and 68A-27.003). As a consequence of the revision of the FWC's listing classification system, the Florida bonneted bat's status (and the status of other imperiled species) in Florida was changed to ''threatened'' on November 8, 2010. However, the species' original protective measures remained in place (68A-27.003, amended). As part of the FWC's revision of its classification system, biological status review reports were prepared for numerous imperiled species in Florida, including the Florida bonneted bat. Based upon a literature review and the biological review group's findings, FWC staff recommended that the Florida bonneted bat remain listed as a threatened species (FWC 2011a, p. 5). The biological status review recognized the taxon as the Florida bonneted bat, and the State's current threatened and endangered list uses both names, Florida bonneted (mastiff) bat, *Eumops (=glaucinus) floridanus*.

On October 4, 2012, the Service proposed endangered species status for the Florida bonneted bat, publishing a proposed rule in the Federal Register (77 FR 60750). Prior to publishing that proposed rule, the Service had recognized the Florida bonneted bat as a Federal candidate species in our annual Candidate Notice of Review (74 FR 57804) with a Listing Priority Number of 2 (threats high in magnitude and imminent).

The 2011 International Union for Conservation of Nature Red List of Threatened Species lists the species as ''critically endangered'' because ''its population size is estimated to number fewer than 250 mature individuals, with no subpopulation greater than 50 individuals, and it is experiencing a continuing decline'' (Timm and Arroyo-Cabrales 2008). The FNAI (2012) also considers the global element rank of the Florida bonneted bat to be G1, meaning it is critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1,000 individuals) or because of extreme vulnerability to extinction due to some natural or manmade factor.

Records indicating historical range are limited. Morgan (1991) indicated that *E. glaucinus* had been identified from four late Pleistocene (approximately 11,700 years ago) and Holocene (time period beginning 10,000 years ago) fossil sites in the southern half of the Florida peninsula. 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 1981and 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 (Morgan1991). 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 andArroyo-Cabrales 2008). G.T. Hubbell also reported a female with young from Fort Lauderdale in Broward County; all of his sightings of Florida bonneted bats were near human dwellings (Belwood 1992). Prior to 1967, G.T. Hubbell regularly heard loud, distinctive calls at night as the bats foraged above buildings and he routinely obtained several individuals per year that were collected during the winter months from people's houses (Belwood 1992). Other early literature also mentioned Fort Lauderdale as an area where the species occurred (Barbour and Davis1969; Belwood 1992). However, in their comprehensive review, none of the specimens examined by Timm and Genoways (2004) were from Broward County. Belwood (1981) found a colony in Punta Gorda; however, the longleaf pine in which the bats roosted was felled during highway construction. Recent specimens are only known 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).

Endemic to Florida, the Florida bonneted bat 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 Florida bonneted bat 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).

Based upon available information, the Florida bonneted bat appears to be restricted to south and southwest Florida. The core range may primarily consist of habitat within Charlotte, Lee, Collier, Monroe, and Miami-Dade Counties. Recent data also suggest use of portions of Okeechobee and Polk Counties and possible use of areas within Glades County. However, given available data, it is not clear to what extent areas outside of the core range may be used. It is possible that areas outside of the south and southwest Florida are used only seasonally or sporadically. Alternatively, these areas may be used consistently, but the species was not regularly detected due to the limitations of available data, survey methods, and search efforts.

<u>Striped Newt</u>

The following discussion is summarized from the 12-month finding (Service 2011), as well as from recent research publications and monitoring reports.

Species description

There are three species of *Notophthalmus* found in North America. These include the eastern red spotted newt (*N. viridescens*), the black-spotted newt (*N. meridionalis*), and the striped newt (*N. perstriatus*). The three species are found in different areas throughout the United States and Mexico (Reilly 1990, p. 51). Reilly (1990, p. 53), in his study of *Notophthalmus spp.*, found *N. perstriatus* and *N. meridionalis* are distinct species that are more similar and phylogenetically more closely related than either is to *N. viridescens*. In 2008, Zhang et al. (2008, pp. 586 and 592) looked at the phylogenetic relationship (*i.e*., evolutionary history of an organism) of the family Salamandridae and found the clade (*i.e*., group of species that includes all descendents of a common ancestor) containing newts was separate from the clade containing "true" salamanders. The branching order of the clades for newts are: primitive newts (*Echinotriton, Pleurodeles,* and *Tylototriton*), New World newts (*Notophthalmus* and *Taricha*), Corisca-Sardinia newts (*Euproctus*), modern European newts (*Calotriton, Lissotriton, Mesotriton, Neurergus, Ommatotriton,* and *Triturus*), and modern Asian newts (*Cynops, Pachytriton,* and *Paramesotriton*). New World newts, which include *Notophthalmus*, originally evolved from salamandrids migrating from Europe to North America via the Atlantic land bridge during the Mid-Late Eocene (Zhang et al. 2008, p. 595).

Another genetic study, conducted in 2010, looked at whether populations of *Notophthalmus perstriatus* that occur in two regions separated by 125 km (78 miles exhibit genetic and ecological differentiation showing that these two regions are separate conservation units (Dodd et al. 2005, p. 887; Dodd and LaClaire 1995, p. 42; Franz and Smith 1999, p. 12;

Johnson 2001, pp. 115-116; May et al. undated, unpublished report). One region consists of populations located in peninsular Florida and southeastern Georgia, and the other region consists of populations located in northwestern Florida and southwestern Georgia (Dodd and LaClaire 1995, p. 42; Franz and Smith 1999, p. 13). May et al. (2010, undated, unpublished report) found that there is gene flow between localities within each region, but none were shared between regions. Johnson (2001, pp. 107,113–115) found genetic exchange between populations is minimal or nonexistent due to upland habitat fragmentation that has limited long-distance dispersals and restricted gene flow. In 2001, Johnson (2001, p. 115) found there was enough genetic divergence to show that the western region is different than the eastern regions. However, May et al. (2010, unpublished report) did not find that there was sufficient genetic divergence to support splitting eastern and western regions into separate species.

May et al. (2010, unpublished report) ran niche-based distribution models that showed that there were significant climatic and environmental differences between the two regions when considering temperature and precipitation. The western region is characterized by lower mean temperatures and more extreme winter cold, coupled with higher variation in temperature and precipitation. These differences in temperatures and precipitation between the regions should be considered if translocation between regions is to be used for conservation of this species. Understanding genetic structure and species ecology will ensure that genetically similar individuals are moved between areas with similar environmental conditions.

No critical habitat has been designated for the striped newt.

Life history

Life-history stages of the striped newt are complex, and include the use of both aquatic and terrestrial habitats throughout their life cycle. Striped newts are opportunistic feeders that prey on frog eggs, worms, snails, fairy shrimp, spiders, and insects (adult and larvae) that are of appropriate size (Dodd et al. 2005, p. 889; Christman and Franz 1973, pp. 134-135; Christman and Means 1992, pp. 62-63). Christman and Franz (1973, p. 135) found that newts were attracted to frog eggs by smell. Feeding behavior of newts has only been documented with aquatic adults; little is known of the feeding habits in the terrestrial stage (Dodd et al. 2005, p. 889).

Aquatic and breeding adults occur in isolated, temporary ponds associated with well-drained sands. Sexually mature adults migrate to these breeding ponds, which lack predatory fish, and courtship, copulation, and egg-laying take place there. Females lay eggs one at a time and attach them to aquatic vegetation or other objects in the water. It may take one female several months to lay all of her eggs (Johnson 2005, p. 94). Eggs hatch and develop into externally-gilled larvae in the temporary pond environment.

Once larvae reach a size suitable for metamorphosis, they may either undergo metamorphosis and exit the pond as immature, terrestrial efts, or remain in the pond and eventually mature into gilled, aquatic adults (paedomorphs) (Petranka 1998, pp. 449-450; Johnson 2005, p. 94). The immature, terrestrial efts migrate into the uplands where they mature into terrestrial adults. Efts will remain in the uplands until conditions are appropriate (adequate rainfall) to return to the ponds to reproduce. Johnson (2005, p. 94) found that 25 percent of larvae became paedomorphs at his study pond. Paedomorphs will postpone metamorphosis until after they have matured and reproduced. At about a year old, they will reproduce, metamorphose, and migrate into the uplands adjacent to the pond (Johnson 2005, pp. 94-95). Once there are proper conditions (*e.g*., adequate rainfall) at the ponds, the terrestrial adults will move back to the ponds to court and reproduce. Once they return to the ponds, they are referred to as aquatic adults.

Striped newts as well as other *Notophthalmus* spp. have long lifespans (approximately 12 to 15 years) in order to cope with unfavorable stochastic environmental events (*e.g*., drought) that can adversely affect reproduction (Dodd 1993b, p. 612; Dodd et al. 2005, p. 889; Wallace et al. 2009, p. 139).

Movement of striped newts by both emigration and immigration occurs between ponds and surrounding uplands. Adult newts immigrate into ponds from uplands during the fall and winter months, but some newts also immigrate during the spring and summer months as well, when environmental conditions (*e.g*., adequate rainfall) are conducive to breeding (Johnson 2005, p. 95). Extended breeding periods allow striped newts to adapt to temporary breeding habitats whose conditions fluctuate within seasons (Johnson 2002, p. 395). Even with suitable water levels in ponds, adults emigrate back into uplands after breeding. There is a staggered pattern of adult immigration into ponds and eft emigration into uplands due to the required 6 months for larvae to undergo metamorphosis into efts (Johnson 2002, p. 397).

Suitability of upland habitat around breeding ponds influences the pattern of immigration and emigration of newts and directional movements (Dodd 1996, p. 46; Dodd and Cade 1998, p. 337; Johnson 2003, p. 16). Dodd and Cade (1998, p. 337) found that striped newts migrated in a direction that favored high pine sandhill habitats. Newts migrate into terrestrial habitats at significant distances from their breeding ponds. Dodd (1996, p. 46) found that 82.9 percent of 12 wetland breeding amphibians (including striped newts) were captured 600 meters (1,969 ft) from the nearest wetland, and only 28 percent of amphibians were captured less than 400 meters (1,300 ft) from the wetland. Johnson (2003, p. 18) found that 16 percent of striped newts in his study migrated more than 500 meters (1,600 ft) from ponds. Dodd and Cade (1998, p. 337) showed that striped newts travelled up to 709 meters (2,330 ft) from ponds. These long-distance movements of striped newts from breeding ponds to terrestrial habitats suggest that buffer zones around ponds should be established to protect upland habitats, as well as breeding ponds (Dodd 1996, p. 49; Dodd and Cade 1998, p. 337; Johnson 2003, p. 19; Kirkman et al. 1999, p. 557; Semlitsch and Bodie 2003, p. 1219). Trenham and Shaffer (2005, p. 1166) found that protecting at least 600 meters (2,000 ft) of upland habitat would maintain a population with only a 10 percent reduction in mean population size in the California tiger salamander (*Ambystoma californiense*). Dodd and Cade (1998, p. 337) suggested that terrestrial buffer zones need to consider both distance and direction (migratory patterns) when created. Johnson (2003, p. 19) recommended a protected area extending 1,000 meters (3,300 ft) from a breeding site as upland "core habitat" surrounding breeding ponds.

Optimal pond hydrology is important for maintaining the complex life-history pathways of striped newts. If there is not enough water in ephemeral ponds, then larvae will not have enough time to reach the minimum size needed for metamorphosis and will die as ponds dry up

(Johnson 2002, p. 398). However, permanent ponds could support predatory fish that feed on aquatic-breeding amphibians (Johnson 2005, p. 94; Moler and Franz 1987, p. 235). Variable hydroperiods in breeding ponds over a long time period could result in varying reproductive success. Dodd (1993, p. 610) found a decline in striped newts due to persistent drought conditions. Johnson (2002, p. 399) found that heavy rainfall in the winter of 1997 to spring of 1998 filled ponds to their maximum depth and contributed to the reproductive success at these ponds. At one breeding pond, a minimum hydro-period of 139 days (Dodd 1993, pp. 609-610) was needed for larvae to reach complete metamorphosis. Larvae undergo metamorphosis into efts after a period of 6 months, and in order for larvae to mature into paedomorphs, a breeding pond must hold water for at least a year (Johnson 2005, p. 94). For a paedormorph to successfully reproduce, ponds must hold water for an additional 6 months to allow sufficient time for its larvae to undergo metamorphosis.

Striped newts form metapopulations that persist in isolated fragments of longleaf pine-wiregrass ecosystems (Johnson 2001, p. 114; Johnson 2005, p. 95). Within metapopulations, ponds function as focal points for local breeding populations that experience periods of extirpation and recolonization through time (*e.g.*, “ponds as patches”) (Johnson 2005, p. 95; Marsh and Trenham 2001, p. 41). Striped newts typically have limited dispersal, which can lead to pond isolation when stochastic events (*e.g.*, drought) affect rates of colonization and extinction (Marsh and Trenham 2001, p. 41). In order for striped newts to recolonize local breeding ponds within the metapopulation, newts must disperse through contiguous upland habitat (Dodd and Johnson 2007, p. 150). Protecting the connectivity between uplands and breeding ponds of diverse hydroperiods is crucial for maintaining metapopulations (Dodd and Johnson 2007, pp. 150–151; Gibbs 1993, p. 25; Johnson 2005, p. 95). Only a few “stronghold” locations exist, where there are multiple breeding ponds with appropriate upland habitat that allow dispersal to occur among the ponds (Johnson 2005, p. 95). These “stronghold” locations represent different metapopulations across the range of the striped newt (Johnson 2005, p. 95). These sites need to be protected and managed to provide long-term protection for newts. In Florida, these include Apalachicola National Forest (ANF), ONF, Jennings State Forest, Katherine Ordway-Swisher Biological Station, and Camp Blanding Training Site. In Georgia, they are found at Joseph W. Jones Ecological Research Center (JJERC) and Fort Stewart Military Installation (Johnson 2005, p. 95; Stevenson 2000, p. 4).

Ephemeral ponds are important components of upland habitat in the southeastern United States (LaClaire and Franz 1990, p. 9). Ephemeral ponds tend to be described as small (typically less than 5 ha (12.4 acres), isolated wetlands with a cyclic nature of drying and refilling known as hydroperiods. Ephemeral ponds can hold water at various times throughout a year to allow for reproduction. Precipitation is the most important water source for ephemeral ponds (LaClaire and Franz 1990, p. 12). The cyclical nature of ephemeral ponds prevents predatory fish from inhabiting breeding ponds (Dodd and Charest 1988, pp. 87, 94; LaClaire and Franz 1990, p. 12; Moler and Franz 1987, p. 237). Ephemeral ponds are biologically unique, because they support diverse species that are different than species found in larger, more permanent wetlands or ponds (Moler and Franz 1987, pp. 234, 236; Kirkman et al. 1999, p. 553).

The frequency and duration of water in ephemeral ponds creates different zones of vegetation within ponds. One species, maidencane (*Panicum hemitomon*), has been found at ephemeral ponds where striped newts have been found, and seems be a good indicator of the extent of previous flooding in ponds (LaClaire 1995, p. 88; LaClaire and Franz 1990, p. 10). Persistence of maidencane helps to reduce the rate of oxidation of organic matter, reduce soil moisture loss, and inhibit growth and establishment of upland plant species (LaClaire 1995, p. 94). The center of flooded ponds may contain floating-leaved plants, and is surrounded by vegetation with submerged roots growing along the wet edges. Surrounding the wet areas are tall and short emergents, such as sedges, grasses, and rushes such as sandweed (*Hypericum fasciculatum*), followed by other grasses such as bluestem grass (*Andropogon virginicus*) found in the drier margins of ponds. Water-tolerant shrubs or trees are found in some transitional zones between pond and uplands (LaClaire 1995, p. 74; LaClaire and Franz 1990, p. 10).

Ephemeral ponds are surrounded by upland habitats of high pine, scrubby flatwoods, and scrub (Christman and Means, 1992, p. 62). Longleaf pine-turkey oak stands with intact ground cover containing wiregrass (*Aristida beyrichiana*) are the preferred upland habitat for striped newts, followed by scrub, then flatwoods (K. Enge, FWC, personal communication, May 24, 2010).

Striped newt habitat is fire-dependent, and naturally ignited fires and prescribed burning maintain an open canopy and reduce forest floor litter. An open canopy provides sunlight necessary for ground cover growth needed by newts for foraging and sheltering. Fire is also an important factor for wetland vegetation (LaClaire and Franz 1990, p. 10; Means 2008, p. 4). Historically, fire would be naturally ignited in the uplands during the late spring and early summer, and would sweep through the dry pond basins, reducing organic matter and killing encroaching upland plant species (Means 2008, p. 4; Myer 1990, p. 189). Lack of fire in uplands that buffer breeding ponds allows fire-intolerant hardwoods to shade out herbaceous understory needed by striped newts for foraging and sheltering. As a result, fire shadows may form along the upslope wetland and upland boundary. The vegetation in this area contains fire-intolerant evergreen shrubs (*Ilex* spp., *Vaccinium* spp., *Myrica* spp., and *Ceratiola* spp.) and sometimes xeric oak hammock zones (LaClaire and Franz 1990, p. 11). Ponds that are completely burned from the upland margin to the opposite margin lack this vegetation; however, if the ponds are filled with water, fire will burn out at the pond, and allow the invasion of fire-intolerant hardwoods (LaClaire and Franz 1990, p. 11). The impacts of fire on these temporary ponds promote species richness of grasses and sedges, especially during droughts (Means 2006, p. 196). To eliminate hardwood encroachment, a prescribed fire regime should be used every 1 to 3 years during May to June, in order to protect striped newt habitat (Means 2006, p. 196).

Striped newts use upland habitats that surround breeding ponds to complete their life cycle. Efts move from ponds to uplands where they mature into terrestrial adults. The uplands also provide habitat for the striped newt to forage and burrow during the non-breeding season (Dodd and Charest 1988, p. 95). Striped newts also use uplands to access alternative ponds that are needed if the original breeding pond is destroyed or the hydroperiod is altered (Means 2006, p. 197). This shows the interdependence between upland and aquatic habitats in the persistence of populations (Semlitsch and Bodie 2003, p. 1219). Semi-aquatic species (such as the striped newt) depend on both aquatic and upland habitats for various parts of their life cycle in order to maintain viable populations (Dodd and Cade 1998, pp. 336-337; Johnson 2001, p. 47; Semlitsch 1998, p. 1116; Semlitsch and Bodie 2003, p. 1219).

Population dynamics

Surveys have been conducted for striped newts at many sites within Florida and Georgia. These surveys have found that the number of known occupied sites has declined and occupied sites are limited to just a few counties. However, historical information on the location of striped newts is difficult to confirm, as most of these sites underwent substantial land use changes since newts were first collected (Dodd et al. 2005, p. 887).

Franz and Smith (1999, p. 8) reviewed 100 records from 20 counties in Florida between 1922 and 1995, and conducted surveys between 1989 and 1995. They found that 4 historical ponds had newts, but also found 34 new ponds containing newts were that were not part of the historical records. All 38 breeding ponds were found on 7 public lands that included ANF, Camp Blanding Military Reservation, Favor-Dykes State Park, Jennings State Forest, Katharine Ordway Preserve-Swisher Memorial Sanctuary, ONF, and Rock Springs State Preserve (Franz and Smith, 1999, pp. 8-9).

Johnson and Owen (2005, p. 7) visited 51 sites in 11 counties in Florida from 2000 to 2003 that overlapped with the sites visited by Franz and Smith. They found that of 51 sites visited (totaling 64 ponds), only 26 ponds and adjacent upland habitat had excellent habitat quality (*e.g.*, multiple ephemeral ponds surrounded by fire-maintained native uplands) capable of supporting striped newts. Only 4 of these 26 sites had multiple breeding ponds needed to comprise metapopulations. They were found in Clay, Marion, and Putnam Counties in Camp Blanding Military Reservation (Clay), Jennings State Forest (Clay), ONF (Marion), and Katherine Ordway Preserve-Swisher Memorial Sanctuary (Putnam) (Johnson and Owen 2005, p. 7).

From 2005 to 2010, Enge (FWC, personal communication, 2010) surveyed ponds in suitable habitat on 32 conservation lands in Florida. He found breeding ponds with newts in 58 ponds on 11 of the 32 conservation lands. He also found that although newts had a wider range in Florida than Georgia, they remained abundant only on public lands in Clay, Marion, and Putnam Counties. This is consistent with the surveys conducted by Franz and Smith (1999, pp. 8-9) and Johnson and Owen (2005, p. 7). He found that there were a total of 49 extant populations known from the peninsula of Florida and 7 populations from the panhandle. An isolated breeding pond farther than 1,000 meters (3,300 ft) from the closest other breeding pond represents a separate population (Enge, FWC, personal communication, 2010). The striped newt metapopulations (*i.e.*, multiple breeding ponds with enough upland to allow for dispersal) are now only found on public lands in Clay, Putnam, and Marion Counties. Populations still exist in 10 other counties in Florida, but these counties have fewer than 3 breeding ponds and these populations are considered vulnerable to extirpation (Enge, FWC, personal communication, 2010).

The status of the striped newt is unknown on private lands due to the difficulty in accessing these lands; however, Enge (FWC, personal communication, 2010) was able to survey 8 ponds on 2 private lands, and found newts on at least one site.

Striped newt breeding ponds at ANF and other areas within the Munson Sandhills region in Leon County, Florida, have seen a decline. ANF was once considered a metapopulation for striped newt (Johnson 2005, p. 95; Johnson and Owen 2005, p. 7; Enge, FWC, personal communication, 2010). However, the western Munson Sandhills in ANF was surveyed from 1995-2007, and researchers were only able to locate 18 breeding ponds (containing larvae or breeding adults) in 265 ephemeral ponds surveyed (Means and Means 1998a, p. 5). Means et al. (2008, p. 6) found only five adult striped newts and no larvae in the past 10 years. Since 2000, severe drought conditions were experienced at these ponds, and newts were shown to be declining. Recent surveys conducted in the Munson Sandhills in 2010 were not able to locate any striped newts at any of the breeding ponds (Means, Coastal Plains Institute, personal communication, 2010). The precipitous apparent declines now being seen at ANF could occur elsewhere on protected lands within the striped newt's range, despite the protection of habitat. This indicates perhaps other threats (*e.g.*, disease and drought) may continue to act on the species at these sites.

As mentioned above, striped newts have only been found at five locations in Georgia, and these sites are highly fragmented and isolated (Stevenson 2000, p. 4). An amphibian survey on 196 ephemeral ponds in 17 counties on timber company lands in the Coastal Plain of southeastern Georgia did not locate any striped newts in Georgia; however, striped newts were found in four ponds in Florida (Wigley 1999, pp. 5-10). Stevenson (2000, p. 3) looked at 25 historic striped newt localities in Georgia and was only able to find 2 sites (8 percent) that had multiple breeding ponds and upland habitat that would support striped newt populations. As of 2010, only two properties in the State are known to support viable populations: JJERC and Fort Stewart Army Base (Jensen, Georgia Department of Natural Resources [GDNR], personal communication, 2010; Stevenson et al. 2009a, p. 2). The Fort Stewart population lies within the range of the eastern genetic group on the Atlantic Coastal Plain and was represented by approximately 10 known wetlands. Since 2002, striped newts have been found at only one wetland at Fort Stewart (Stevenson et al. 2009, p. 2). The JJERC population lies within the range of the western genetic group on the Gulf Coastal Plain, and is represented by five known wetlands. In annual surveys from 2002 to 2010, researchers confirmed striped newts from only three of these five known wetlands (Smith, JJERC, personal communication, 2010). Evidence suggests that both the eastern and western striped newt populations in Georgia are rare and declining. Most suitable striped newt habitat in Georgia has been lost to development or converted to pine plantations and silviculture (Dodd and LaClaire 1995, p. 43).

Statue and distribution

The range of the striped newt extends from the Atlantic Coastal Plain of southeastern Georgia to the north-central peninsula of Florida and through the Florida panhandle into portions of southwest Georgia (Dodd et al. 2005, p. 887). There is a 125-km (78-miles) separation between the western and eastern portions of the striped newt's range (Dodd et al. 2005, p. 887; Dodd and LaClaire 1995, p. 42; Franz and Smith 1999, p. 12; Johnson 2001, pp. 115-116). The historical range of the striped newt was likely similar to the current range (Dodd et al. 2005, p. 887). However, loss of native longleaf habitat, fire suppression, and the natural patchy distribution of upland habitats used by striped newts have resulted in fragmentation of existing populations (Johnson and Owen 2005, p. 2).

The map belowshows the current and historical ranges of the striped newt on public lands. The dark-shaded areas represent the currently occupied sites documented from 2005 to 2010 surveys of public lands (Enge, FWC, personal communication, 2010; Jensen, GDNR, personal communication, 2010). The light-shaded areas represent the historical range where striped newts are now extirpated. There are from 1 to 30 breeding ponds documented within dark shaded areas. However, due to the scale of the map, the specific ponds are not identified. This map represents the best available information used to establish the Striped newt historic and current range.

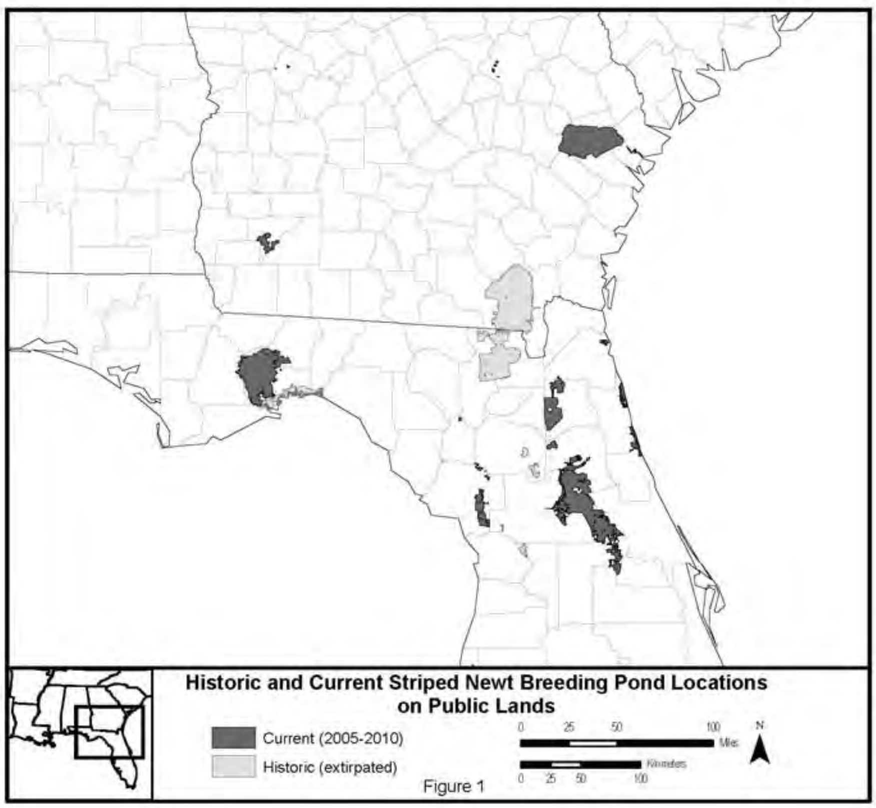

Figure 1. Stiped Newt Historic and Current Range**.**

To determine where there may be additional unsurveyed suitable habitat for striped newts in Florida, Endries et al. (2009, pp. 45-46) developed a striped newt habitat model. The model was developed using FWC 2003 landcover classes. Three classes were identified: (1) Breeding (bay, cypress swamp, freshwater marsh, wet prairie); (2) primary upland (sandhill, xeric oak scrub, sand pine scrub); and (3) secondary upland (hardwood hammocks and forests, pinelands, and shrub and brushlands). Then potential habitat was evaluated for each class. Breeding habitat was limited to patches that were less than 9 ha (22 acres) in size and which were contiguous with upland habitats. The primary upland habitats included in the model were those areas contiguous and within 1,000 meters (3,300 ft) of breeding habitat. Secondary upland habitat was included for areas that were contiguous and within 500 meters (1,600 ft) of primary uplands and 1,000 meters (3,300 ft) of breeding habitat.

The Geographic Information System (GIS) analysis found a total of 244,576 ha (604,360 acres) of potential habitat (Endries et al. 2009, p. 45). Of the potential habitat, 122,724 ha (303,257 acres) occurred on 124 sites within public lands, but only 64 of these sites had greater than 40 ha (100 acres) of potential habitat. The remaining habitat was found on privately owned lands in patches that were greater than 79 ha (195 acres) (Endries et al. 2008, pp. 45-46). Of the potential habitat found on public lands, 55 percent occurred on ONF, 8 percent on Camp Blanding Military Installation, 6 percent on Withlacoochee State Forest, 5.3 percent on ANF, and 2.9 percent on Jennings State Forest (Enge, FWC, personal communication, 2010). However, no records of striped newt occurrences have been found at Withlacoochee State Forest, even though this appears to be suitable habitat. ONF has 67,514 ha (166,831 acres) of potential habitat and 39 occupied ponds, making it the largest "stronghold" for metapopulations for striped newts in Florida (Enge, FWC, personal communication, 2010). Striped newts are also found in ponds throughout Peninsular Florida at Ordway-Swisher Biological Station, Camp Blanding Joint Training Center, Jennings State Forest, Goethe State Forest, Rock Springs State Park, Fort White Mitigation Park, Faver-Dykes State Park, and Pumpkin Hill Creek Preserve State Park.

Within the panhandle of Florida, striped newts have been found within the Munson Sandhills. This site represents a small physiographic ren within the Gulf Coastal Plains in Florida (Means and Means 1998a, p. 3). Striped newts have only been located in the western portion of the Munson Sandhills within the ANF. No newts have been found in the eastern portion of the sandhills since the 1980s, when the area was converted to a dense sand pine (*Pinus clausa)* plantation (Means and Means 1998a, p. 6). Striped newt distribution continues north of this site to the Tallahassee Red Hills and Tifton Uplands, and finally to the Dougherty Plain in southwestern Georgia. However, the Tallahassee Red Hills no longer support the newt. Striped newts were documented once in a breeding pond found in the Red Hills, but this site was dredged, deepened, and stocked with game fish in the 1980s, and no longer supports newts (Means and Means 1998b, pp. 6, 15).

The striped newt is currently known to occur in five separate locations in Georgia, including Fort Stewart, Lentile Property, JJERC, Fall Line Sandhills Natural Area, and Ohoopee Dunes Natural Area (J. Jensen, GDNR, personal communication, September 14, 2010; L. Smith, JJERC, personal communication, September 11, 2010; Stevenson 2000, p. 4; Stevenson and Cash 2008, p. 252; Stevenson et al. 2009a, pp. 2-3). Most of these locations are within the Dougherty Plain (Baker County), Tifton Uplands (Irwin, Lanier, and Lowndes Counties), and the Barrier Island Sequence (Bryan, Camden, Charlton, Evans, and Long Counties) (Dodd and LaClaire 1995, pp. 40-42). From 1993 to 1994, Dodd and LaClaire (1995, p. 40) found striped newts in one pond each at five sites in Irwin, Baker, and Charlton Counties, and a series of ponds at Fort Stewart in Bryan and Evans Counties. A pond in Baker County at JJERC was found to be a new location, and extends the known range west of the Flint River approximately 115 km (71 miles) farther from the nearest recorded site (LaClaire et al. 1995, pp. 103-104; Franz and Smith 1999, p. 13). Striped newts were first found on Trail Ridge in 1924 near Okefenokee National Wildlife Refuge (ONWR), but this area has been highly modified since the 1940s (Dodd 1995, p. 44; Dodd and LaClaire 1995, pp. 39-40), and newts are no longer found in this area, except for possibly in the ONWR. In 2008, a new striped newt site was found in Georgia in Camden County, which is the first record for this county since 1953 (Stevenson et al. 2009b, p. 248).

American Chaffseed

Species/critical habitat description

Schwalbea is an erect herb with unbranched stems or stems branched only at the base, growing to a height of 3.0 to 6.0 decimeters (12 to 24 inches). The plant is densely albeit minutely hairy throughout, including the flowers. The leaves are alternate, lance-shaped to elliptic, stalkless, *2.5* to 5.0 cm (0.8 to 2 inches) long, and entire; the upper leaves are reduced to narrow bracts. The large, purplish-yellow, tubular flowers, 3.0 to 3.5 cm long (1.2 to 1.4 inches) are borne singly on short stalks in the axils of the uppermost, reduced leaves (bracts) and form a many flowered, spike-like raceme. The showy flowers have a high degree of bilateral symmetry elaborated for pollination by bees (Pennell 1935*).* The fruit is a narrow capsule approximately 10 to 12 mm (0.4 to 0.5 inches) long, with a septicidal dehiscence. The numerous seeds are pale greenish brown or yellowish-tan, narrowly linear, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting, sac-like structure that provides the basis for the common name, chaffseed (Musselman and Mann 1978). Flowering occurs from April to June in the southern part of the species' range, and from June to mid-July in the northern part of its range. Fruits mature from early summer in the South to October in the North (Johnson 1988).

No critical habitat has been designated for the American chaffseed.

Life history

Parasitism: The root parasitic behavior of *Schwalbea* has been known since 1856 (Musselman and Mann 1977). As with many Scrophulariaceae, *Schwalbea* exhibits hemiparasitic behavior. Hemiparasites (also called semiparasites) contain chlorophyll and can produce all or part of their own food, as opposed to holoparasites, which lack chlorophyll and are entirely dependent on host plants for food and water. Haustoria developing from *Schwalbea* roots are unique among Scrophulariaceae parasites in that "a well-developed neck, interrupted zone, a sclerotic layer, and very broad endophyte are present. Tyloses, which arise from neighboring parenchyma cells and grow through pits in the vessels, are abundant in the neck region" (Musselman and Mann 1977). *Schis~.zIbea* is considered the rarest root parasitic plant in the South, and, like most parasitic Scrophulariacese, it is not host-specific. Musselman and Mann (1977) reported potgrown *Schwxalbea* had haustorial connections on tuliptree *(Liriodendron tulip~fera),* white pine *(Pinus strobus),* sweetgum *(Liquidambar styraciflua),* blackgum *(Nyssa sylvatica),* and tupelo *(Nyssa aquatica).* In the field, haustoria of *Schw~zlbea* were found attached to and penetrating inkberry *(hex glabra),* dwarf huckleberry *(Gaylussacia dumosa),* and St. John's-wort *Hypericum* sp.) (Musselman and Mann 1977). More recently, Kirkman (1993) obtained *Sch'wilbea* samples from the field and by clipping the roots of *Schnk~Jlbea* from the stems, observed haustorial connections to colicroot.

Reproduction/Pollinators: Schwalbea produces showy, insect-pollinated flowers with a high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). On Fort Bragg, bumblebees were observed visiting *Schwalbea* flowers exclusively (TNC 1993), and observations of insect visitation suggest that probable pollinators of *Schl4xzlbea* are worker bumblebees (*Bombus impatiens* and *Bombuspennsylvanicus*) Kirkman (1993). These bees were the most commonly observed insects on floral structures and the only species that entered the flowers. Kirkman (1993) covered *Schwabea* flowers with bags to control insect pollination. On the covered flowers, fruit production remained high, suggesting pollination does not appear to be a requirement for fruit and viable seed production. The flowers are unusual in their color and morphology and deserve more study (L. Musselman, Old Dominion University, *in litt.* 1994).

Germination: The germination rates of collected *Schwalbea* seeds are high. Kirkman (1993) reported that the germination rate of seeds placed in petri dishes, with and without cold stratification, was approximately 90 percent. Similar high germination rates on several types of media were obtained at the Atlanta Botanical Garden (Kirkman 1993). On the Francis Marion National Forest, similar high germination rates have been observed in greenhouse studies; however, to date, the plants have not grown beyond a small initial stage of approximately 2.0 cm (0. Buckles, USFS, Francis Marion National Forest, Moncks Corner, South Carolina, personal communication comm. 1994).

Germination of New Jersey seeds in petri dishes on germination paper was close to 100 percent after a 5-month wet cold treatment. Seedlings were transplanted to soil substrates and maintained in a greenhouse under a mist spray to keep the soil continually moist. Seedlings were sown into a series of five soil mixtures differing in soil moisture and water retention capacity. Some seedlings were sown with seeds of little bluestem *(Schizachyrium scoparium),* a potential host species. Seedlings survived for over a month but never grew appreciably larger than 1.0 cm, with 2 to 4 minute leaves. No differences in growth or survival were seen between any of the treatments (T. Hampton in *Iitt. 1995).*

During field observations, Kirkman and Drew (1995) found that recruitment appears to be associated with microsite soil disturbances such as earthworm casting, pocket gopher activity, and other minor disturbances that expose bare soil. Significant germination has also been observed under thick wiregrass that has fallen over and eliminated other vegetation (L.K. Kirkman, JJERC, *in list.* 1994). Examination of *Schwalbea* roots revealed that, although individual plants are multi-stemmed, they do not vegetatively propagate by rhizomes (Kirkman 1993). Additional information is needed regarding the exact time of year when germination occurs (L.K. Kirkman *in litt.* 1994).

Seed banking: Kirkman (1993) collected soil samples adjacent to *Schwalbea* plants prior to seed release. Various treatments, including cold treatment and exposure to various soil moisture regimes were used to encourage germination. No individuals of *Schwalbea* germinated in any of the soil samples. The absence of *Schwalbea* in the seed bank was unexpected, particularly considering the generalized germination requirements. It is possible the seeds were too deeply buried in the soil following mixing of the samples for germination, or the sampling technique was not adequate to obtain seeds in the soil sample (Kirkman 1993). Additional seed banking studies are being considered (L.K. Kirkman, personal communication 1995).

Seed dispersal: The structure of the *Schwalbea* seed, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting sac-like structure, suggests wind dispersal; however, no information is available to support this hypothesis. Information is lacking on both the mechanism and distance ofseed dispersal. Initial observations in New Jersey determined ants ignored *Schwalbea* seeds; therefore, ants may be unlikely to function as seed dispersers for this species (T. Hampton *in litt.* 1995).

Population dynamics

Kirkman and Drew (1995) report three life stages in the vegetative condition of *Schwalbea* based on leaf length: small leaves (~ 0.5 cm length), medium leaves (0.5-1 cm), and large leaves (>1.0 cm). First-year seedlings usually have small leaves, and all reproductive plants (plants with fruits and/or flowers) have large leaves. Reproductive individuals are primarily from the previous-year reproductive stage or large-leaf-vegetative stage. Kirkman and Drew (1995) report that more than a third of the reproductive plants in their study remained reproductive the following year and most of those that did not flower remained in the large-leaf vegetative class. Few individuals in the small-leaf-vegetative class became reproductive the next year. Recruits were mostly in the small-leaf-vegetative class; however, a large number of individuals recruited were in the reproductive or the large-leaf-vegetative class, suggesting that plants may have dormant years. Additional demographic analysis of *Schwalbea* subpopulations regarding spatial patterns of reproduction, recruitment, mortality, survivorship, seed banking, and transitions among age classes is needed to understand critical life stages for management of the species and to estimate the minimum viable population size.

Effects of fire: As with many pine flatwood and savanna species, *Schwalbea* may be adapted to a regular fire regime. Historically, lighting-strike fires that occurred throughout *Schwalbea's* range, as well as frequent burning as practiced by indigenous, pre-European human populations, maintained the open woodland/savanna conditions. These fires may have occurred frequently enough that fuel did not accumulate, and the fires were generally of low intensity. Herbaceous species would have been favored over tree and shrub species and would thrive in these conditions.

With the general suppression of natural fires in the twentieth century, the ecosystems that *Schwalbea* inhabits are declining. Without fire, open grass-sedge communities proceed through seral stages and become dominated by trees, shrubs, and dense herbaceous growth that overtop *Schwalbea*, which appears to be shade intolerant. If fire is suppressed for more than 3 years, the *Schwalbea* population declines as other species shade *Schwalbea* and compete with it for sunlight (D. Rayner, Wofford College, Spartenburg, South Carolina, personal communication 1991). Musselman and Mann (1977) reported vigorous growth of *Schwt7zlbea* and abundant seed production was evident after early spring fires at sites in South Carolina. Preliminary results from studies at the JJERC indicate *Schwalbea* has a strong flowering response to dormant- and growing-season burns (Kirkman 1993, Kirkman and Drew 1995). Preliminary analyses of the 1993 population data strongly indicate fire is a requirement for flower production (Kirkman 1993). In general, dormant-season (March) burns result in May flowering, and growing-season (June) burns result in July or August flowering. The proportion of reproductive individuals is greater in both dormant season and growing season burn treatments compared with that of the control plots (Kirkman and Drew 1995). No differences in mean flower or fruit production per stem were detectable between the dormant season and growing season burns. The highest number of recruits was in dormant season burn treatments.

Observations on the Francis Marion National Forest indicate *Schwalbea* plants burned during the growing season will reflower. Porcher (1994) reports mature *Schwalbea* plants in flower will immediately resprout after being burned, resulting in seeds falling on a bare, mineral soil in full sunlight, which may be a key factor in the plant's reproductive biology. Observations on Fort Bragg reveal that, following burns (regardless of season), there is an increase in *Schwalbea* plants the following season. Even on sites where only low herbaceous species occur, *Schwalbea* occurrences on Fort Bragg decline in the absence of frequent fires, which indicates competition may not be influencing *Schwalbea* populations as much as does fire (TNC 1993). Field observations and experimental studies in North Carolina (Porcher 1994) indicate fire is essential for maintaining *Schwalbea.* Overall, it appears *Schwalbea* responds favorably to dormant season and growing season burns. Additional experimentation is necessary to determine if there are substantial advantages to either of these fire regimes.

The current stronghold for *Schwalbea* is in the southeastern States where pinelands and savannas on private plantations are managed for bobwhite quail and on Fort Bragg around the artillery impact zone. Quail management on the private plantations consists of burning, usually in the dormant season before March, to increase and maintain the open, grassy conditions that provide habitat for quail. This management simulates the natural fire frequency of the past and effectively maintains a fire-dependent ecosystem in the Southeast. Similarly, the impact zones on Fort Bragg experience frequent burning due to fires ignited by military shelling exercises; as a result, a fire-dependent ecosystem that supports *Schwalbea* is maintained.

Kirkman (1993) reports relatively little flower production in the control and mowed treatments (mowed in June). Similarly, observations from the New Jersey *Schwulbea* population indicate that when mowing inadvertently took place during the growing season, flowering diminished considerably. In contrast, however, when a single late-season mowing (October - November) was conducted on the New Jersey site, flowering was relatively abundant during the following year. These observations indicate that while fire may be the ideal management tool, mowing (in the dormant season) could be an alternative to fire in instances where burning might not be possible or feasible (T. Gordon *in litt.* 1995). Mowing has certainly been responsible for sustaining the remaining population in New Jersey for the last three or more decades.

Status and distribution

Schwalbea is primarily a coastal plain species ofthe Atlantic and Gulf coasts. Exceptions to its coastal distribution, all of which are historical records, include: an occurrence in the sandplains near Albany, New York, which Pennell *(*1935*)* considered a possible remnant population of glacial migration along the shores of the Hudson River; occurrences from Tennessee and Kentucky on sandstone knobs and ridges of the Cumberland Plateau and Highland Rim; an inland site on the Montague sandplain near the Connecticut River; and a sandplain in Hubbardston, Massachusetts (TNC 1993).

Extant populations of *Schwalbea* are currently known from 72 locations in New Jersey, North Carolina, South Carolina, Georgia, and Florida (an occurrence reported from Mississippi at the time of Federal listing has since been determined not to be *Schwalbea).* States with historic records only are Massachusetts, Connecticut, New York, Delaware, Maryland, Virginia, Alabama, Mississippi, Louisiana, Texas, Tennessee, and Kentucky. A description of State-by-State historical and current distribution as well as the current level of protection of extant occurrences follows.

Alabama

Three historic occurrences are known from Baldwin, Geneva, and Mobile Counties (TNC 1993).

Connecticut

Two historic occurrences are known from Middlesex County (TNC 1993) and New London County (Crow 1982).

Delaware

One historic occurrence is known from New Castle County, where it was last observed in 1875. This site was destroyed by the dredging and widening of the Chesapeake and Delaware Canal (TNC 1993).

Florida

A total of 10 occurrences is known from Brevard (Pennell 1935), Duval, Highlands, Hillsborough, Levy, Putnam, Volusia (E.D. Hardin, FNAI, *in litt.* 1985*),* Gadsden (L. Peterson, FNAI, *in list.* 1994) and Leon Counties (W. Baker, TNC, Tallahassee, Florida, personal communication 1994). All occurrences except two, one in Gadsden County and one in Leon County are extirpated. A recent survey of the Gadsden County site revealed that a residential development is now in place there. This occurrence may thus also be extirpated (L. Peterson *in list.* 1994), although additional habitat near the site may be suitable for *Schwalbea* and should be searched (W. Baker personal communication 1994). The extant occurrence in Leon County is on private property managed for bobwhite quail *(Colinus virginianus)* (W. Baker personal communication 1994); current habitat management practices for quail (*e.g.*, prescribed burning) contribute to maintenance of suitable habitat for *Schwalbea.* Note: *In litt.* references refer to information received through correspondence, following style guidelines in the *Endangered Species Listing Handbook, Fourth Edition, U.S. Fish andWildlife Service, Division of Endangered Species*, March 1994.

Georgia

A total of 14 occurrences are known from Baker, Baldwin, Dougherty, Early, Miller, Pike, and Worth Counties. Four occurrences in Baldwin, Early, Miller, and Pike Counties are considered extirpated (T. Patrick, Georgia Department of Natural Resources, *in litt.* 1990). Of the 10 extant occurrences, 6 are located on the Ichauway Plantation, a 28,000-acre private ecological reserve in Baker County (W. Baker, personal communication 1994). Ichauway is predominantly vegetated with a natural stand of longleaf pine *(Pinus palustris).* All the *Schwalbea* populations on Ichauway are protected, and four of the populations are being included in a 5-year research study on the life history, seed banks, and experimental management of the species (Kirkman 1993). Two extant occurrences are located on another private quail plantation in Dougherty County (T. Patrick *in litt.* 1990), one of which is also included in the Kirkman study. The remaining two extant occurrences are located on private lands managed for quail in Baker and Worth Counties (W. Baker, personal communication 1994). Similarly to quail plantations in Florida and South Carolina, management practices for quail on the private plantations in Georgia maintain suitable habitat for *Schwalbea.*

Kentucky

Two historic occurrences are known from McCreary County near the Tennessee border. *Schwalbea* was last observed in Kentucky in 1935 (Kentucky State Nature Preserves Commission 1991).

Louisiana

Two historic occurrences are reported from Rapides Parish (Vincent 1982 as reported in TNC 1993) and Calcasieu Parish (MacRoberts 1989 as reported in TNC 1993). However, it is likely the record from Rapides Parish is due not to an occurrence of the species in or near Rapides Parish, but to a label on a specimen distributed by Josiah Hale around 1850. Hale put his hometown ("Alexandria"), which is found in Rapides Parish, on his labels but did not cite localities. Thus, the record from Rapides Parish cannot be considered valid (L. Morse, TNC, *in list.* 1986).

Maryland

Two historic occurrences are reported, one from Worcester County near Ocean City, where it was last observed in 1893, and one from Anne Arundel County. Both locales were searched in 1979, but *Sch4albea* was not found (Broome et al. 1979).

Massachusetts

Ten historic occurrences are recorded from Barnstable, Bristol, Dukes, Franklin, Nantucket, Norfolk, Plymouth, and Worcester Counties (TNC 1993). The species was last observed in Massachusetts in Nantucket County in 1963. Extensive areas of suitable habitat in the State have been searched for *Schwalbea*, without relocating the species. Lack of fire, coupled with intense development pressure, indicates minimal prospects for finding *Schwalbea* in Massachusetts (B. Some, Massachusetts Division of Fisheries and Wildlife, *in litt.* 1990).

Mississippi

Two historic occurrences are known from Covington and Jackson Counties (Rawinski and Cassin 1986). The occurrence reported as extant at the time of listing, in Noxubee County on the Noxubee NWR (Service 1992), is now considered invalid. The plants previously identified as *Schwalbea* at the Noxubee National Wildlife Refuge (NWR) have been verified as being *Parenucellia viscosa,* a European native closely related to *Schwalbea* (C. Norquist, Service, *in list.* 1993). No extant populations of *Schwalbea* are known to occur in Mississippi.

New Jersey

A total of 19 occurrences, only one of which is extant, is known from Atlantic, Burlington, Camden, Cape May, Cumberland, and Ocean Counties (New Jersey Department of Environmental Protection 1994). By the early 1970s there were still four extant occurrences in New Jersey: one in Cape May County, one in Camden County, and two in Burlington County.

The Camden County occurrence and one of the Burlington County occurrences were lost, apparently to succession of their habitat resulting, perhaps, from fire suppression. By 1980, only two occurrences of *Schwalbea* remained in New Jersey. In 1986, the Cape May population was destroyed by the construction of a new road, leaving one extant occurrence in Burlington County (G.A. Marshall, New Jersey Division of Parks and Forestry, in *litt.* 1991).

The Burlington County occurrence is located at the northernmost extent of the current range of *Schwalbea*, and is the only known occurrence north of North Carolina. The site is within Lebanon State Forest, although portions of the road shoulder along the highway remain under the jurisdiction of Burlington County. Additionally, part of the occurrence is on land the State leases to a cranberry grower under a 25-year lease. The lease was initiated in 1983 and amended in 1984 (New Jersey Department of Environmental Protection and Energy 1993). The Burlington County site is easily accessible and well known, making it particularly vulnerable to human disturbance. Trampling and removal of plants at the site and mowing at inopportune times for the species have been problems in the past. Throughout the 1980s, the number of plants at this occurrence seemed to be declining (G.A. Marshall *in list.* 1991). In 1993, the Lebanon State Forest, Burlington County, the cranberry grower, and the New Jersey Office of Natural Lands Management signed a management agreement to provide increased site protection and to implement a coordinated on-site management program for *Schwalbea.* As a result of this agreement, barriers to vehicles have been built in the area to prevent inadvertent disturbance, and coordination has increased to ensure that mowing occurs in the dormant season (*i.e*., October-November). Although mowing and hand-thinning of shrubby vegetation are conducted on the site, it is suspected a fire is needed to reinvigorate conditions suitable for *Sclwalbea* (R. Cartica, New Jersey Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey, personal communication 1994). Nonetheless,due to the increased management of the site in the past few years, the population does not appear to be declining at this time (T. Hampton, New Jersey Office of Natural Lands Management, *in litt.* 1995).

New York

One historic occurrence is recorded from Albany County in the sandplains, where *Schwalbea* was last observed in 1865 (TNC 1993).

North Carolina

A total of 24 occurrences is known from Bladen, Cumberland, Hoke, Moore, Pender, and Scotland Counties (TNC 1993), 6 of which are considered extirpated and 18 extant. At the time of listing, only one occurrence was reported as extant in North Carolina; the increase is attributed to additional searching and the recognition of separate occurrences on Fort Bragg. Of the 18 extant occurrences, 17 are located on Fort Bragg on or near live-ammunition impact zones in Cumberland and Hoke Counties. The other extant occurrence is located next to a roadside in Moore County.

The extent of *Schwalbea* on Fort Bragg appears to be related to military shelling activities on the base, which result in frequent fires in and around the live-ammunition impact zones. The frequent fires (in what were once fire-maintained communities) maintain a strong dominance and high diversity of herbs under widely scattered longleaf pine and pond pine *(Pinus serotina).* Without the frequent fires, most of the areas occupied by *Schwalbea* would be dense, shrub dominated pocosins or dominated by dense stands of turkey oak *(Quercus laevis)* as is the case under the artificial, fire-suppressed conditions prevailing in the sandhill coastal plain of North Carolina (A.S. Weakley, North Carolina Natural Heritage Program, *in lift.* 1990). The occurrences on Fort Bragg are afforded some protection under the Act as well as Army regulation AR 420-74 (Chapter 11 draft), Fort Bragg's range regulation No. 350-6, and Fort Bragg's Draft Endangered Species Management Plan (J. Shipley, Department of Defense, Fort Bragg, *in litt.* 1995*).*

South Carolina

A total of 53 occurrences are known from Berkeley, Charleston, Clarendon, Florence, Horry, Jasper, Lee, Sumter, and Williamsburg Counties (Porcher 1994). According to Porcher (1994), the current status of these 53 occurrences is as follows: one occurrence is considered extirpated, 5 occurrences are considered suppressed but possibly still extant, 4 occurrences have not been relocated and are possibly extirpated, one occurrence is undetermined due to inability to gain access to the sites, and 42 occurrences are considered extant (Porcher 1994). At the time of listing, 11 South Carolina occurrences were considered extant. The increase in known occurrences is attributed to extensive searching for the species, primarily in Clarendon and Williamsburg Counties and on the Francis Marion National Forest in Berkeley and Charleston Counties.

Of the 42 known extant populations, 10 are on the Francis Marion National Forest, 17 are on private property, one is on South Carolina Heritage property, and 8 are of unknown ownership. All management activities on the National Forest are carefully planned by the USFS to protect the *Schwalbea* populations (D.G. Unger, USFS, *in list.* 1992).

Most of the South Carolina occurrences known to be in private ownership are on plantations managed for bobwhite quail. Quail management in South Carolina includes prescribed burning to maintain the open pine flatwoods and savannas favorable for quail in the Southeast. Since *Schwalbea* also seems to require open pine flatwoods and savannas in South Carolina, quail management is compatible with, and in some areas responsible for, maintaining suitable habitat for *Schwalbea.* In other areas that were once suitable for *Schwalbea*, land use has changed to commercial and residential sites, agriculture fields, or pine plantations, all of which tend to eliminate the open pine flatwood and savanna ecosystems where *Schwalbea* flourishes. Porcher (1994) has recommended that additional searches for *Schwalbea* be conducted in suitable habitats in Georgetown, Lee, Sumter, Florence, and Hampton Counties. Tennessee

Two historic occurrences are known: one from Coffee County, which was last observed in 1879, and one in Fentress County, which was last observed in 1842 (P. Somers, Tennessee Department of Conservation, *in litt.* 1990).

Texas

One possible specimen record is reported from east Texas (Correll and Johnston 1970 as cited in TNC 1993).

Virginia

One historic occurrence is recorded from an area between Sussex and Greensville Counties, where it was last observed in 1937. The species' persistence in this region, which has been heavily affected by agriculture, pine plantations, and highways, is highly doubtful (J.C. Ludwig, Virginia Natural Heritage Program, *in litt.* 1990).

Beautiful Pawpaw

The following discussion is summarized from the MSRP (Service 1999), as well as from recent research publications and monitoring reports. A complete beautiful pawpaw life history discussion may be found in the MSRP. In addition, a 5-year review was completed in 2008 resulting in no change to the listing status of the species (Service 2008k.).

Species/critical habitat description

The beautiful pawpaw is a low-growing, diminutive shrub of the Annonaceae family rarely exceeding 0.5 meter in height. The stems may be annual or perennial and arise from a stout taproot that averages 32.5 cm long and is about 2.5 cm wide at its widest point. The leaves are alternate, leathery, deciduous, and 4.0 to 7.0 cm long with slightly revolute (curving under) margins. The leaf shape is oblong to oblong-ovate or spatulate, with a rounded or notched end. The base of the leaf is rounded or tapering to a 2.0 to 4.0 mm long petiole. Young leaves have sparse, short, red hairs on both sides. Maturing leaves become dark green to glossy green above and paler green below. The flowers of this species occur singly in leaf axils and have between 6 and 10 creamy-white petals that are about 2.0 to 3.0 cm long. The fruits are fleshy, smooth and yellow-green when ripe and are 4.0-7.0 cm long. The seeds are dark brown and from 1.0 to 1.5 cm long.

No critical habitat has been designated for beautiful pawpaw.

Life history

Research on the beautiful pawpaw has been conducted in the areas of phenology, pollination, reproductive structures, breeding system, germination, and hybridization (Norman 2003). Available information suggests that this species has poor fertilization, seed-setting, germination, and recruitment rates. Pollinators for this species are few, but those noted are a tumbling beetle (*Mordella atrata*) and two species of thrips (*Frankliniella bispinosa* and *Thrips hawaiiensis*) (Norman 2003). The reproductive biology of the species is not thoroughly understood, but the plant is thought to reproduce entirely by seed. Gopher tortoises may be an important seed disperser. Although not investigated in detail, ingestion of the seeds by gopher tortoises or other herbivores may be important for seed germination. However, seeds have been germinated without this type of treatment. On Pine Island, Lee County, plants begin flowering by mid-March and are at the peak of flowering the last week of April. Likewise, flowering was observed in Orange County in mid-March and lasted for 6 weeks (Norman 2003). Fruit is likely produced and dispersed during the summer.

Because the species is thought to be long-lived, reproductive success is not critical every year (Service 1999). Other than follow-up monitoring during the first year after transplant of three transplanted populations, no long-term estimates of survival have been obtained for the species (Service 1998; Preston et al. 2004). No follow-up data have been collected. Additionally, no information has been reported on survival of individuals in natural occurrences, and life history stage and population structure data have not been collected. Norman (2009) conducted limited experiments with seed collected from Orange County and reported very low seedling survival. She suggested that the species may rely on a mycorrhizal fungal association to promote seedling survival (Norman 2009).

Population dynamics

The beautiful pawpaw occurs in two disjunct locations in central and southwest Florida. It grows in xeric, mesic, and hydric pine flatwoods in western Charlotte and Lee Counties and eastern Orange County. Soils in these habitats are poorly drained, although slight elevations provide better drainage than surrounding soils that are wetter. In Lee County, the pawpaw exists on Pine Island, where it occurs in pristine and modified flatwoods, on road edges, and on mowed lots. In Charlotte County it is found in an area broadly known as the Charlotte Harbor flatwoods and includes sites along SR 765 and FWC's Cecil M. Webb WMA.

This small shrub rarely exceeds 0.5 meter in height and does not persist where it must compete for light with tall grasses and larger shrubs. Habitat management is typically needed to reduce competition, especially from exotic plant species (Service 1999). Fire suppression and lack of management has led to the overgrowth and degradation of habitat. The pine flatwoods are adapted to frequent ground fires that seldom kill or harm mature pine trees, but are usually hot enough to thin or clear understory vegetation. Beautiful pawpaw depends on such fires to limit competition with larger grasses and shrubs. It takes advantage of fire-created openings by flowering and setting fruit the first growing season after a fire.

If sites are not regularly maintained through fire or mechanical treatment, the overall health of the ecosystem may be compromised. Research on the effects of fire on congener Rugel's pawpaw (*Deeringothamnus rugelii*) indicated that vegetative growth, flowering, and fruit set are stimulated by fire, and the author suggested that the same is true for beautiful pawpaw (Helkowski and Johnson 2000). Norman (2003) verified fire enhances flowering of the beautiful pawpaw. Pawpaws respond well to frequent (every 1 to 3 years), low-intensity winter burns or mechanical disturbance, but this regime does not seem to favor associated species (Johnson 1999; Service 1999). It is thought pawpaw response to spring and summer burns should be similar and associated species may be favored (Johnson 1999; Helkowski and Johnson 2000).

On many privately owned sites, fire has historically been suppressed, and habitat has not received regular maintenance. Where this species occurs on fragmented landscapes interspersed with development, burning may be unlikely due to proximity to neighbors. In areas that cannot be readily burned, mowing is sometimes used as a management strategy. In mowed habitat, the growth habit of this species is more prostrate with woody stems lying on the ground, while in fire-maintained habitat, it grows more erect with arching stems (Service 1999).

Status and distribution

Surveys have indicated the beautiful pawpaw occurs throughout its historic range, but the population is fragmented and occurs primarily in two disjunct areas in Lee and Charlotte Counties and in Orange County (FNAI 2008). It occurs in the vicinity of Charlotte Harbor and the Caloosahatchee River from Punta Gorda to Fort Myers in southwestern Florida (Wunderlin and Richardson 1981d.) and in the suburbs of Orlando in eastern Orange County (Hilsenbeck 1992).

Surveys have been conducted intermittently in the past, but trend data are difficult to assess because surveys have generally only assessed a few occurrences at any one time and new occurrences have been discovered. Based upon the most comprehensive data available, there are currently thought to be approximately 5,000 pawpaw plants (FNAI 2008b.). The number of plants ranges from 1 to 2 plants on some sites to over 1,000 individuals on 3 sites (FNAI 2008b). Nearly one-third of the occurrences were comprised of 15 or fewer pawpaws (FNAI 2008b). Small occurrences tend to lack genetic diversity and may not be self-sustaining over time (Ellstrand and Elam 1993). They may also be more vulnerable to stochastic events but are very important to the recovery of the species. Currently, there are 43 occurrences of the species reported in Charlotte, Lee, and Orange Counties (FNAI 2011). Approximately 65 percent of the occurrences are on public or managed lands and 35 percent are on private lands (FNAI 2011). However, degradation to habitat on public land has occurred as the result of lack of management. Resources for management actions may not always be available, and habitat needed to support pawpaws will degrade in the absence of regular management. Some sites with beautiful pawpaw are being managed well, while others, even on public lands, may not be receiving management to meet the species' needs.

The beautiful pawpaw is threatened with extinction because of habitat loss due to agricultural, residential, and commercial conversion of land. The exclusion of fire is also responsible for habitat degradation throughout much of the species range.

Britton's Beargrass

The following discussion is summarized from the MSRP (Service 1999), as well as from recent research publications and monitoring reports. A complete Britton's beargrass life history discussion may be found in the MSRP.

Species/critical habitat description

The genus *Nolina* is placed in the agave family in the Flora of North America (Hess 2002), or alternatively in the butcher's broom family, Ruscaceae (Wunderlin and Hansen 2005). *Nolina* constitutes some 30 species of north and central Mexico and the United States, which has

14 species. Two are in Florida: *Nolina atopocarpa*, which is rare but scattered around the state and Britton's beargrass, which is restricted to the central peninsula (Hess 2002).

The identification key provided by Hess is probably not as useful as Wunderlin and Hansen's (2003), which points out that *N. brittoniana* has larger dry fruits (capsules), which are symmetrical, unlike the smaller, highly asymmetric fruits of *N. atopocarpa*. *N. brittoniana* has wider leaves whose surfaces appear flat, while the leaves of *N. atopocarpa* have an "accordionlike wrinkled appearance." The leaves of *N. brittoniana* are grasslike, 70 to 100 cm by 5 to 9 mm (occasionally 11 mm) (27 to 40 inches by 0.19 by 0.35 inches [occasionally 0.43 inch]) and those of *N. atopocarpa* are wiry, 45 to 85 cm by 1.5 to 4.5 mm (18 to 33 inches by 0.006 to 0.018 inches) (Hess 2002). The flowers of *N. brittoniana* are white, while those of *N. atopocarpa* are said to be greenish (Service 1996).

Britton's beargrass is a clump-forming perennial with no above-ground stem (except for the flowering stem) that grows from a short, thick, fleshy, bulblike rootstock. The grassy leaves form a rosette with the youngest leaves upright and the oldest lying nearly flat on the ground. Flowering is from early March to mid-May. The flowering stem, usually solitary, grows 1 to 1.5 meters (3 to 5 ft) tall from the rosette in April. The inflorescence is a panicle with about 6 to 20 branches. When in bloom, the branches are covered with small, white flowers, making the plant very conspicuous (Wunderlin et al. 1980b; Kral 1983). The flowers are moderately fragrant when open (TNC 1995). The fruits are symmetrical, triangular in cross-section. The species is generally dioecious (*i.e.*, male and female flowers on separate plants), but a few exceptions have been documented.

No critical habitat has been designated for Britton's beargrass.

Life history

Britton's beargrass produces seeds only through pollination, not apomictically. The male plants shed their pollen in the early morning (TNC 1995). The female flowers exude nectar about 24 hours after opening during the evening or before sunrise (TNC 1995). Britton's beargrass exhibits a generalist pollination syndrome, being pollinated throughout the day by a variety of visitors. At ABS and Lake Apthorpe Preserve, 34 pollinators from six different families were observed visiting Britton's beargrass plants (Menges et al. 1996).

Dolan et al. (2001) examined genetic variation in 48 populations of Britton's beargrass from throughout its range, using isozymes. These researchers expected, based on the species' life history and ecology, that Britton's beargrass would not be genetically impoverished, even though it has a narrow range. They found "values for percentage of polymorphic loci, average numbers of alleles per locus and expected heterozygosity" that were lower "than those generally reported for endemic plants. Populations were fairly well differentiated. Inbreeding rates were low and allele number and frequency did not indicate recent bottlenecks." They detected clines in allele frequency were along the species' distribution, from north to south. This pattern of genetic variation supports the need to conserve populations from throughout its range (Dolan et al. 2001; Menges et al. 1996).

Britton's beargrass occurs both as scattered individuals and in large groups of as many as 500 plants. It responds well to fire. Almost all of the plants reappear after a fire (Weekley and Menges 2003a, 2003b). Flowering of Britton's beargrass peaks 1 year after burning, then declines. At the Lake Apthorpe Preserve (now part of the Lake Wales Ridge Wildlife Environmental Area [LWRWEA]), 75 percent of the population flowered the year after burning, dropping to 13 percent the next year (Menges et al. 1996). Although Britton's beargrass responds to fire with increased flowering, seedlings have rarely been seen (Doria Gordon, TNC, personal communication, 1997).

It is found in a wide range of xeric upland communities ranging from xeric open oak scrub to closed hammocks and sandhill at one recently-discovered site in ONF.

Population dynamics

This long-lived species resprouts after fire, so there is apparently very little turnover of individuals. Britton's beargrass can remain vigorous in fire-suppressed habitat, but the trends of populations under these conditions are unknown (Reese and Orzell 1995).

Britton's beargrass responds to fire with increased flowering the year after the fire (Menges et al. 1996). This is important in that it represents a pulse of reproduction and, potentially, recruitment of new individuals to the population. Britton's beargrass can persist in areas where fire has been suppressed for many years, but under these conditions, it may only exist in a vegetative state without flowering.

Status and distribution

The original reasons for listing this species were habitat loss by land conversion for agricultural and residential expansion. As human population growth and development continues throughout its range, these problems are ongoing.

Britton's beargrass is typically associated with evergreen oaks such as sand live oak, myrtle oak, Chapman oak, and scrub oak. Other species occurring with Britton's beargrass include saw palmetto, and shrubs including wild olive (*Osmanthus*), staggerbush (*Lyonia*), garberia (*Garberia heterophylla*), hollies (*Ilex*), wireweed, and sandlace.

Where this species occurs in sandhill (high pineland) vegetation, the herbaceous layer is usually dominated by wiregrass, bottlebrush threeawn (*Aristida spiciformis*), Florida scrub frostweed (*Helianthemum nashii*), sandyfield beakrush (*Rhynchospora megalocarpa*), queensdelight (*Stillingia sylvatica*), and jeweled blue-eyed grass (*Sisyrinchium solstitiale*) (Wunderlin et al. 1980b).

Britton's beargrass occurs in association with several federally listed species, including Lewton's polygala, sandlace, wireweed, papery whitlow-wort, scrub blazing star, Highlands scrub hypericum, short-leaved rosemary, and Florida bonamia. It occurs with the endemic Ashe's calamint (*Calamintha ashei*), silk bay (*Persea borbonia* var. *humilis*), and sand holly (*Ilex opaca* var. *arenicola*) (Wunderlin et al. 1980b).

Nolina brittoniana is found on the MDR in the ONF (eastern Marion County), Orlando Ridge (western Orange and east Lake Counties), WHR (eastern Polk County), and on the LWR (Highlands, eastern Polk, and northwestern Osceola Counties). It was also recently found in northeastern Pasco County and northern Manatee County, and was historically reported from one location in eastern Hernando County (Turner et al. 2006; FNAI 2009; E. Gandy, FDEP, personal communication 2009). Its northern range limit is on the ONF, where it was discovered recently after an herbicide treatment and prescribed fire were applied to restore a long-unburned tract of sandhill in the western portion of the Forest, south of SR 40.

In Polk and Highlands Counties, Britton's beargrass is found mostly on the LWR, but also on smaller nearby ridges (Service 1996). It is present at most of the conservation lands and areas considered for State land acquisition on the LWR, in Polk and Highlands Counties. Tiger Creek Preserve has numerous individuals of Britton's beargrass throughout its sandhills and xeric hammocks. The demographics of five populations were monitored from 1991 to 2000. Individuals showed extremely low mortality both in fire-maintained and long-unburned areas. Because its populations are stable, TNC no longer monitors this species, except that patches of individuals are mapped during 5-year surveys of the entire Preserve.

Brooksville Bellflower

The following discussion is summarized from the 5-year review (Service 2010d), as well as from recent research publications and monitoring reports.

Species/critical habitat description

Brooksville bellflower is an annual herb, with stems 1-15 cm2 (0.5-6 inches) tall, very slender, simple or branched, faintly winged or 4-angled. The stems are glabrous except for a few trichomes in the angles (Morn 1987). The plant may be submerged for part of its life, which may affect its growth. Some stems root at the nodes (Morn 1987). The leaves are alternate, the blades varying in size and shape on different parts of the plant and from plant to plant (Morn 1987). Open flowers are solitary, 3 to 10 mm long, bell-shaped, "deep purple" (Morn 1987). Steven Leonard (under contract to TNC; report at FNAI) discovered in 1983 that the plant has cleistogamous (CL) (closed, self-pollinating) flowers, which are quite small. This is the only North American *Campanula* with CL flowers (Morn 1987). The fruit is a subglobose capsule about 2 mm in diameter (Wunderlin et al. 1980a). The seeds are about 1 mm long, the smallest of any North American member of the genus (Shetler and Morn 1986; description adapted from Wunderlin et al. [1980a] and other sources as noted). Leonard observed only CL flowers on February 8 and 11, 1983, and did not see a chasmogamous (CH) flower until February 23 (letters from Leonard to Morn *in* Morn 1987). Flowering specimens have also been collected March 11, 1983; April 13, 1983; and April 26, 1958. Seed production proceeds while flowering continues. Brooksville bellflower may be confused with *Campanula floridana*, but the latter species has very different seeds and leaves that are "much firmer than those of Brooksville bellflower" (Morn 1987).

No critical habitat has been designated for Brooksville bellflower.

Life history

Brooksville bellflower was originally found in a seepage area on the north facing slope of Chinsegut Hill surrounded by pasture used for animal husbandry. It has since been found within an oak/palm hydric hammock along the edge of an elongated maidencane (*Panicum hemitomom*) marsh at Burns Prairie (Laundry 1996). Typically this species is found along the margins of ponds and marshes with fluctuating water levels and moist seepage areas, both surrounded by pastures. Brooksville bellflower is associated with other wetland plants, such as mosquito fern (*Azolla carolinaiana*), hair sedge (*Bulbostylis* spp.), coinwort (*Centella asiatica*), button snakeroot (*Eryngium* spp.), pennywort (*Hydrocotyle* spp.), rush (*Juncus* spp.), pimpernel (*Anagallis minima*), pearlwort (*Sagina decumbens*), and maidencane (*Panicum hemitomom*) (Service 1994).

The Brooksville bellflower found at the north slope of Chinsegut Hill were near a dying live oak (*Quercus virginiana*) and a young China berry. The understory was consistent with the wetland plants mentioned above. However, surveys conducted in 1996 and 1997 found since the live oak has died, the proper soil conditions are no longer present for germination, which has resulted in grasses and other ground cover encroaching and outcompeting Brooksville bellflower (Landry 1997).

At Burns Prairie, this species was found near cabbage palm (*Sabal palmetto*), live oak, black gum (*Nyssa sylvatica*), and water oak (*Quercus nigra*). The understory was composed of similar wetland species with the exception of water hyacinth (*Eichhornis crassipes*). Several years of drought (2007-2009) resulted in low to no water present in the pond, which appeared to be succeeding into a dry prairie with small oak trees and cactuses (Campbell, Bok Tower Gardens [BTG], personal communication, 2009). However, following heavy rainfall during the 2009 and 2010 winter period, suitable habitat has returned and water is present in the pond (Peterson, BTG, personal communication, 2010).

On the privately owned Young site the habitat was also documented in the margins of a small pond located within a cattle pasture. The margins of the pond and pasture had widely scattered live oaks and were not very forested (Landry 1996). Although drought had affected conditions at other sites, surveys conducted in 2008 and 2009 found the proper soil conditions for optimal germination resulting in a significant number of plants (Campbell, BTG, personal communication, 2009). Surveys conducted in March 2010 documented high grasses, very thick leaf/grass litter, and slash pine growing in the areas where seedlings were found. The rest of the pond margin was heavily mowed (Peterson, BTG, personal communication, 2010).

Two of the three sites of Brooksville bellflower found at Hillsborough River State Park are along the edges of an enhanced wetland that was historically a cattle pasture. The plants appear to occupy the zone just below the seasonal high water line of the wetland edges. Both wetlands were herbaceous with woody edges. Other species found at these two sites were dwarf St. Johns-wart (*Hypericum mutilum*), stiff marsh bedstraw (*Galium tinctorium*),day-flower (*Commelina diffusa*), erect day-flower (*Commelina erecta*), Carolina cranesbill (*Geranium carolinianum*), false hop sedge (*Carex lupuliformis*), Florida pellitory-of-the-wall (*Parientaria floridana*), creeping woodsorrel (*Oxalis corniculata*), bald cypress (*Taxodium distichum*), soft rush (*Juncus effuses*), and prairie iris (*Iris hexagona*) (Gandy, FDEP, personal communication, 2009). A third site was found along a mowed firebreak that bisects a dome. This firebreak holds water most of the year. Other species found in this area were similar to the other two sites but also included common buttonbush (*Cephalanthes occidental*), *Eupatorium* sp., Long's sedge (*Carex longii*), *Polygonum* sp., and *Pseudognaphalium* sp.

It is unknown if there are any management activities that will benefit this species. However, invasive nonnative species such as skunk vine (*Paedena foetida*) and air potato (*Dioscorea bulbifera*) form dense ground cover that excludes native plants such as Brooksville bellflower (Landry 1996). Bermuda grass (*Cynodon dactylon*) also has been found to be a problem at the original Brooksville bellflower site at Hillsborough River State Park. The presence of the grass at the wetland edge is ephemeral relative to the water levels, but the cover of the grass in the dry months has increased every year that monitoring has been conducted (Gandy, FDEP, personal communication, 2009). Control of these invasive nonnative species is needed before they spread into areas occupied by Brooksville bellflower. Also, providing an overstory canopy will create shading that will reduce the light intensity and allow the soils to remain moist, which may provide suitable conditions for germination.

Population dynamics

Brooksville bellflower was originally found in 1924 at Chinsegut Hill in Hernando County. It was not until 1983 that this species was found at Burns Prairie and on privately owned land (Young site) in Hernando County. The 1983 surveys documented plants at all three sites, although habitat conditions at Chinsegut Hill were poor and extreme trampling by cattle resulted in a low number of plants. Additional surveys of the Young and Burns Prairie sites has occurred over the years (1995 to 1998 and again from 2007 to 2010). In 2006, a biologist with the FDEP at Hillsborough River State Park in Hillsborough County found two sites with Brooksville bellflower (Gandy, FDEP, personal communication, 2009). A third site was found at Hillsborough River State Park in 2009.

Since Brooksville bellflower was originally found in 1924, the abundance of this species has fluctuated greatly due to many factors including an increase in water levels and drought (Wunderlin et al. 1980). Germination appears to be affected by the changes in water levels. At Burns Prairie, Williams (1998) found after a period of high rainfall that caused water levels to rise in the ponds, a large number of flowering plants were present the following growing season when waters had receded. It was determined water levels from rainfall rather than time of year may be a critical factor controlling germination (Williams 1998). Seeds may remain dormant for long periods until high levels of cumulative rainfall could affect germination and the annual life cycle (Landry 1996). From 2001 to 2009, a decrease in the number of plants was documented by BTG at the Burns Prairie site, which is likely the result of drought conditions that have caused water levels to drop and habitat conditions to change (Historic Bok Sanctuary [HBS] 2007). In 2010, surveys found an increase in the number of seedlings at the Burns Prairie site, likely the result of heavy winter rainfall.

During the 1983 survey at the Chinsegut Hill site, only a few plants were found. Surveys were conducted from 1996 to 1998, but no plants were located. A large live oak that had provided shade and kept the soils most, which is needed for germination, had died. This also allowed grasses and other groundcover to encroach and possibly outcompete Brooksville bellflower (Laundry 1997).

Burns Prairie also saw fluctuations in numbers between 2002 and 2007 due to the changing water levels and rainfall amounts (HBS 2007). During a very high rainfall period in 2002 and 2003, only 265 plants were located during the entire growing season (February through May). In 2004 and 2005, lower than normal rainfall resulted in thousands (2,556 and 2,403, respectively) of Brooksville bellflower being found. However the drought conditions in 2007 resulted in a significant drop in numbers to 47. By 2008 and 2009, no plants were found. Three years (2007 to 2009) of drought conditions has resulted in the pond succeeding into a dry prairie and the area where Brooksville bellflower occurred is now covered in grasses, small oaks, and cactuses (Campbell, BTG, personal communication, 2009). Future rainfall could recreate proper habitat conditions needed for germination. In March 2010, BTG surveyed Burns Prairie and found 2,300 seedlings after heavy winter rainfall reestablished suitable habitat following 2 years of drought.

Brooksville bellflower was first located at two sites in Hillsborough River State Park in 2006 on the edge of an enhanced wetland, which was historically a cattle pasture (Gandy, FDEP, personal communication, 2009). Surveys conducted in 2007 found 92 plants at the first site and 264 plants at the second site. The plants were found along the zone just below the seasonal high water line. In 2008, 189 and 858 plants were found at the two sites. However, in 2009, as a result of drought conditions, no plants were found at the first site and 57 plants were found at the second site. It is likely the water levels were too low for germination. An additional site was found in 2009 along a mowed firebreak that holds water most of the year. Since this species was located at Hillsborough River State Park, plants at all three sites have produced flowers. BTG has been able to collect seed for future germination and population studies. Surveys were attempted in March 2010 but water levels at the pond margins were too high to find any plants. Additional surveys are scheduled for 2010 once water levels recede.

This species has also been documented on privately owned land north of Chinsegut Hill. This site has had several owners and is currently referred to as the Young site which is planned for a housing development. In 2008, BTG was given permission to survey and collect seed to protect the genetic diversity of this site. BTG has collected thousands of Brooksville bellflower seeds from 2008 to 2010. In 2008 and 2009, BTG surveyed the Young site. The proper conditions required for germination were present in both years, and approximately 499,800 plants were found in 2008 and 95,616 plants were found in 2009 (Campbell, BTG, personal communication, 2009). A site visit in March 2010 found thousands of seedlings; however, the habitat has become unsuitable due to the lack of mowing along the pond margin where high grasses are growing. The rest of the pond margin is being heavily mowed and few seedlings were found under the heavy grass clippings. BTG is performing transplantation trials at the BTG greenhouses this year in hopes of having some Young site plants mature to reproductive stage for seed production. These seeds or plants may be used for reintroduction at another location in Hillsborough or Hernando Counties.

Status and distribution

This species was first collected on the north slope of Chinsegut Hill in 1924 and documented again in 1958 in the same area (Wunderlin et al. 1980). All historically known sites of Brooksville bellflower occurred within approximately 2 to 3 square miles centered on Chinsegut Hill, which is located 5 miles north of Brooksville, in Hernando County, Florida (Laundry 1997). Additional surveys in 1983 found this species at two additional sites in Hernando County, Burns Prairie and on private property known as the Young site both within the Chinsegut Hill area. Only the Burns Prairie site is on conservation lands. The Young site has been sold and there are plans for a housing development with homes already being built. In 2006, Brooksville bellflower was found outside the known historic range at two sites in Hillsborough River State Park in Hillsborough County. Another site was found at the State Park in 2009 (Peterson 2007; Gandy, FDEP, personal communication, 2009). Additional surveys are needed throughout Hernando and Hillsborough Counties in areas where suitable habitat may be present.

Carter's Mustard

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008c). The 5-year review builds upon the detailed information in the MSRP for this species and is located at
http://www.fws.gov/southeast/5yearReviews/5yearreviews/CartersMustard.pdf

Species/critical habitat description

Carter's mustard is an annual herb, 0.2 to 1.5 meters (0.8 to 2.5 ft) tall with erect green stems. The plants usually have many slender, ascending branches forming an open, rounded crown. The leaves lack stipules and are arranged alternately on the stem. Lower leaves are lost by the time the plant flowers. Leaf size and shape varies with age and position on the plant. At the time of flowering, leaf petioles range from 0.8 to 3.9 mm (0.03 to 0.15 inches) with blades 1 to 3 cm (0.4 to 1.2 inches) long. Towards the tips of stems, the leaves are smaller and narrowly elliptical to almost linear, while closer to the bases of stems and branches, the leaves are larger and oblanceolate or spatulate. All leaves are rounded at the tip, their margins entire, and their bases attenuate to cuneate. The lower leaves may have undulated margins or lobes.

Carter's mustard plants have several to many inflorescences, which are dense, rounded racemes with 60 or more flowers. They are about the size of table tennis balls (ABS 2003). The inflorescences and flowers resemble the common garden spiderflower or cleome (*Cleome hassleriana*) but the garden cleome has much larger flowers (FNAI 2000a).

The flowers are open and radially symmetric, with four white petals, about 4.5 mm long, and curved toward the center of the flower at the tip. The four petals are white, about 6.0 mm (0.24 inch) long, with more than half their length in the form of a slender claw. The blade portion of the petal is nearly round with irregular margins. The six spreading stamens are irregularly subequal in length and arise from a nectar-producing floral disc. The ovary is superior, cylindric, about 2.3 mm (0.09 inch) long, and raised on a slender stalk (gynophore) about 2 mm (0.08 inch) long. The flowers are protandrous, with the anthers opening before the stigmas are receptive (Evans et al. 2000). Anthers begin to open within an hour or 2 after the flower has opened. The sessile stigma, which has two lobes, is receptive until 2 to 4 days after the flower opens, by which time the stamens on that flower have already dropped.

The fruit of Carter's mustard is a long, slender pod (silique) divided lengthwise by a partition (septum). The pod is flattened, cylindrical in cross-section and gently curved along its length, which is 4 to 6 cm long and 1.5 mm wide (1.6 to 2.4 inches long and 0.06 inch long). The pod is borne on a gynophore, which is a stalk-bearing pistil 5 to 6 mm (0.19 to 0.26 inches) long, above a spreading pedicel, which is around 8.5 mm (0.34 inch) long. The pod carries numerous oblong seeds, each 1.5 mm long (Kral 1983). Fruits split apart passively to shed the seeds. Flowering occurs in September and October. Fruiting occurs in October to November and dispersal follows in November and early December.

No critical habitat has been designated for Carter's mustard.

Life history

Carter's mustard is self-compatible, although experiments by ABS ecologists show that fruit set from self-fertilizing (autogamous) crosses is lower than experimental hand-pollinated self-crosses and outcrosses, and seed set is lower than with hand pollinations or open-pollinated controls. The morphology of Carter's mustard flowers indicates generalist (rather than specialized) insect pollination. Flowers are visited by bees, flies and wasps. Nonetheless, since hand pollinations result in greater fruit and seed set than open pollinated controls, it appears that Carter's mustard is pollinator-limited (ABS 2003). Autogamy is presumably valuable to this annual species because it assures that seeds are produced, even if no other plants are nearby, or if pollinators do not visit.

ABS ecologists report that seedlings may remain as rosettes until the end of the dry season from fall through spring. They report seedling mortality is generally highest in April and May, at the end of the dry season. Once the summer rains arrive, surviving plants typically bolt, "often doubling in height from month to month." There appears to be considerable variation in growth rates both in terms of time and the location of the plants, "perhaps having to do with differences in annual rainfall or in microhabitat. For example, seedlings recruiting in shadier microsites seem to elongate sooner than those in sunnier microsites" (ABS 2003).

In the first year after a fire, "aboveground populations experience dramatic booms" as seeds germinate. The second year after a fire brings equally dramatic crashes in population size. Small, fluctuating populations may persist in mechanically disturbed sites like firelanes or trails. The sudden (re)appearance of large aboveground populations following fire suggests the presence of a long-lived seedbank" (ABS 2003) and also suggests the apparent absence of this plant from an unburned area should not be interpreted to mean the species is absent.

Population dynamics

Aboveground populations fluctuate wildly. Autogamy helps ensure fecundity and may be a key life history trait with respect to population recovery (Evans et al. 2000). "Annual surveys of scores of sites have been conducted at TNC's Tiger Creek Preserve, ABS, and Lake Placid Scrub since 1988 and at LWR State Forest since 1995. Monthly seedling survival surveys have been conducted monthly at the State Forest since 1996 and at ABS since 1999. Numerous lab and field germination experiments have also been conducted over the last several years" (ABS 2003). Monitoring at Tiger Creek Preserve ended in 2003 because populations were stable (B. Pace-Aldana, TNC, letter correspondence, 2005). Annual census data are available online (ABS 2005a).

At the Arbuckle tract of LWR State Forest, Cox (2004) notes Carter's mustard is only found in three burn units, and these populations "appear to fluctuate considerably depending on local climate and rainfall." Populations increased in 2002 after several years of drought were broken.

Archbold ecologists report that "genetic diversity is lower in Carter's mustard than in other species with similar ecological and life history traits. A relatively large proportion of the detected diversity (30.4 percent) occurs among rather than within populations. Genetic diversity is spatially organized, with a significant north-south cline in allele frequencies at one locus." (Evans et al. 2003; ABS 2003).

Status and distribution

The largest known populations are at the ABS and the TNC's Tiger Creek Preserve. It is present at the Lake Placid tract of LWRWEA, the Carter Creek tract of LWRNWR, LWR State Forest. In northern Polk County, its distribution is apparently less well worked-out. It is present on the Snell Creek tract of LWRNWR, probably on adjoining land belonging to the Upper Lake Marion Creek Watershed, managed by the District. It is also probably present slightly farther north on another tract of the Upper Lake Marion Creek Watershed, located near Horse Creek. Evans et al. (2000) provide a distribution map.

Off the LWR, a single herbarium specimen was collected from Spessard Holland Park in Melbourne Beach, Brevard County, but there have been no further sightings from that county, including from a recent plant survey conducted during the growing season (Schmalzer and Foster 2003). Carter's mustard was last collected in Miami-Dade County in 1942. The highly reliable Roy Woodbury reported seeing it at the DuPuis Preserve in Palm Beach County, but his sighting is not supported by a herbarium specimen (Gann et al. 2002). Carter's mustard is conspicuous only during its brief, 1-month flowering period, and its remaining habitat on the LWR outside of conservation lands has not been completely surveyed.

While habitat has been conserved since it was listed (notably at Horse Creek Scrub owned by District, the Lake Walk-in-the-Water and Arbuckle tracts of LWR State Forest, and the Carter Creek tract of LWRNWR), habitat for Carter's mustard is still presumably being lost. No new localities seem to have been found since 1996, except on conservation lands. Distributional records may be incomplete because Carter's mustard typically exists as seeds in the soil except when germination is stimulated by fire or disturbance, and the plants are inconspicuous except during their flowering period lasting about a month (Service 1996).

This plant occurs within a research project at the Carter Creek tract of the LWRNWR where Florida ziziphus was introduced and the demography of Lewton's polygala studied (Menges and Weekley 2003). Carter's mustard responded positively to a prescribed fire that was part of the project, indicating prescribed burning elsewhere (such as at Lake Walk-in-the-Water) will prove highly beneficial.

<u>Carter's Small-flowered Flax</u>

Carter's small-flowered flax first became a candidate on October 25, 1999. The following discussion is summarized from the most recent species assessments (Service 2011g and 2012) and from recent research publications and monitoring reports.

Species/critical habitat description

Carter's small-flowered flax is an annual or short-lived perennial herb that is endemic to Miami-Dade County, where it grows in pine rockland, particularly disturbed pine rocklands (Bradley and Gann 1999). 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 to 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 5 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."

At this time, no critical habitat has been designated for Carter's small-flowered flax. If the species is listed as federally threatened or endangered in the future, critical habitat may be designated at that time.

Life history

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 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).

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 2002).

Maschinski and Walters (2008) studied in situ germination and growth-to-maturity of plants growing in the wild at two sites, measuring height, number of branches, number of buds, flowers, and fruit of 32 seedlings. Of the total 32 seedlings tracked, only 6 set fruit (Maschinski and Walters 2008). The mean time to set first bud was 197 ± 2.4 days, while mean time to first fruit set was 226 ± 2.3 days (Maschinski and Walters 2008). The 226-day growth- to-maturity enables Carter's small-flowered flax to contribute seeds to a next generation in a relatively short period (Maschinski and Walters 2008). Once mature, individuals may live one to several years producing multiple fruits (Maschinski and Walters 2008). Growth-to maturity may be influenced by season of germination; seeds germinating in the summer may grow to maturity more rapidly than seedlings that germinate in the fall or winter (Maschinski and Walters 2008). Carter's small-flowered flax is capable of flowering throughout the year, but tends to have most abundant flowering and fruiting following rain (Maschinski and Walters 2008).

Carter's small-flowered flax has typical behavior for an early successional species (Maschinski 2006). In a recent study to examine population viability in response to disturbance, long-term demography studies were initiated at disturbed and undisturbed sites in Miami-Dade County (Maschinski 2006, Maschinski and Walters 2007). These studies indicated Carter's small-flowered flax occurred in higher densities at a mowed site where competition with other plants was decreased. However, mowing can also eliminate reproduction entirely in very young plants or delay reproductive maturation (Maschinski and Walters 2007). Disturbance from mowing was found to result in higher mortality, but greater fruit production (Maschinski 2006). Because mowing had been a repeated pressure on one population for more than 50 years, it is possible mowing is also selecting for plants that can grow and reproduce more rapidly than the disturbed site plants (Maschinski 2006). This work confirms, to a degree, the recommendation by Bradley and Gann (1999) that "periodic mowing in these areas may partially replace fires, maintaining an open, shrub free understory."

Preliminary models indicated population viability was greatly affected by reproduction and whether there is a persistent seed bank (Maschinski 2006, Maschinski and Walters 2007). Fruiting was variable across years and sites, such that there was no clear effect of mowing on fruit production (Maschinski 2006, Maschinski and Walters 2007). Seedlings and juveniles (non-reproductive) had a higher probability of survival to adult stage at the undisturbed site than at the mown site; however, the mown site had higher reproduction than the undisturbed site (Maschinski 2006). Models indicate that transitions from seedling to adult and adult reproduction greatly influence population trajectories (Maschinski and Walters 2007). Increasing these vital rates is critical to improving population persistence (Maschinski and Walters 2007). Year-to-year variation was found to be extremely high across populations and subject to the unpredictability of weather (Maschinski and Walters 2007). Continued monitoring is needed to determine whether disturbance regime has a persistent impact on life history (Maschinski 2006).

Population dynamics

Bradley and Gann (1999) estimated the total population size was 101 to 1,000 plants (based on a $\log_{10}$ scale) and the population may be declining. Based on the latest available data (Table B), 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 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 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 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 Institute for Regional Conservation (IRC) and Fairchild Tropical Botanic Garden (FTBG) indicate 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) (K. Bradley, personal communication 2007; J. Possley, personal communication 2012a). However, populations at the Rockdale Pineland Preserve and the USDA Subtropical Horticulture Research Station were found to have more individuals than previously estimated (K. Bradley, personal communication 2007; J. Possley, personal communication 2012a), and a new occurrence was discovered (Montgomery Foundation) (J. Maschinski, personal communication 2006).

Status and distribution

John Kunkel Small and Joel J. Carter first collected this species in 1903 between Coconut Grove and Cutler; Small described it as a new species in 1905 (Gann et al. 2002). Bradley and Gann (1999) indicated it has been found at many widespread locations, from the Coconut Grove area of Miami (latitude 25° 43.8') to southern Miami-Dade County, terminating near SW 280 Street (latitude 25° 30.4'), a range of about 24 miles (39 km) (Bradley and Gann 1999). Since 1903, Carter's small-flowered flax has been found in pine rocklands from as far north as the Brickell Hammock area to as far south as the Naranja area (Gann et al. 2002).

Austin et al. (1980) mapped 17 stations for Carter's small-flowered flax. Most of those stations are likely to be historic (the report's format did not allow the authors to clearly note where plants had been found during field work). Bradley and Gann (1999) believe several occurrences represented misidentifications—that the plants were either *L. arenicola* (sand flax) or *L. carteri* var. *smallii*. For example, a previous report of the plant occurring at Homestead Air Reserve Base (HARB) site is now considered to be erroneous (K. Bradley, IRC, personal communication 2008). Based upon data from IRC, Carter's small-flowered flax is extirpated from Brickell Hammock (owner unknown) due to development, Charles Deering Estate (owned by Miami-Dade County) for unknown reasons, and the Red Road and 114 Terrace locations (private land) due to development (K. Bradley, personal communication 2007). Austin et al. (1980) noted that there were four historical sites for this species in a study of southern Florida, including National Key Deer Refuge and Great White Heron NWR. However, in 1980, Austin et al. (1980) found only one site remaining, representing a 75 percent reduction in number of sites, and attributed the reduction to urbanization. Gann et al. (2002) indicated most of its habitat has been destroyed.

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 miles) between the farthest locations. The apparent reduction in its historic range (11.2 km (7.2 miles); 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, p. 463). 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 2007, personal communication; IRC 2013, pp. 14-16). Bradley and Gann (1999, p. 71) 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, p. 94) 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 Miami-Dade County (Gordon et al. 2007, pp. 1, 36).

In 2012, IRC (2013) conducted a status survey for Carter's small-flowered flax to include extant occurrences, historic locations, and new survey stations. Because they had previously conducted a comprehensive survey of all pine rockland habitat in 2004 and 2005 (during which, Carter's small-flowered flax was not found on any new sites), this habitat was excluded from new surveys. Canals within urban Miami-Dade County that intersected with the pine rockland soils of the Miami Rock Ridge were surveyed, as were additional disturbed sites with remnant native vegetation in close proximity to existing sites. Carter's small-flowered flax was 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 (Table 4; IRC 2013, p. 6). One occurrence (at Gifford Arboretum Pineland), which had not been observed since the 1990s but whose habitat was still extant, was deemed "Historical" and may reappear there (IRC 2013, p. 14). Of the seven extant occurrences, five populations are on publicly owned lands but only three of these are managed for the conservation of natural resources (Table 4). 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 miles) gap between the closest populations of these groups. Within each grouping, populations are approximately 1.3 to 4.3 km (0.8 to 2.7 miles) apart.

Because this variety is known to be a short-lived perennial with widely fluctuating numbers of individuals (Maschinski et al.2003, p. v; 2004, p. iv), as well as being difficult to find when not in flower, we include an estimate of population range using the logarithmic scale (Table 4) to account for these characteristics and to provide a comparison to the previous total population estimates. Using the logarithmic scale, the total population estimate is 337 to 3,310 plants. However, it should be noted that most 2012 observations were at the low end of the corresponding logarithmic range such that the resulting high end for the total population estimate may be a gross overestimate of the actual population. Based strictly on 2012 observations, the total population estimate may be closer to 1,300 individuals. Comparing these estimates to the 1999 and 2003 population estimates generally supports the boom-and-bust nature of *Linum carteri* var. *carteri*, although the decline since 2004 could also potentially indicate a declining trend for the largest occurrence. The species was not found during a 2-year project intended to survey and map exotic and rare plants along FDOT right-of-ways within Miami-Dade and Monroe Counties (Gordon et al. 2007).

Table 4. Extant and historical populations of Carter's small-flowered flax.

POPULATION Natural Forest Communities (NFC) # if applicable (P-#)	**OWNERSHIP (*denotes lands managed for conservation)**	**POPULATION RANGE (Est. No. of plants in 2012)** [1]
Extant: Population status confirmed in 2012 surveys conducted by IRC		
C-103 Canal	State of Florida –District	1-10 (1)
Camp Owaissa Bauer Addition (P-255.4)	State of Florida – Managed by Miami-Dade County*	11-100 (13)
Chapman Field, USDA Subtropical Horticultural Research Station (portions are P-63)	Federal – USDA	101-1000 (700)
Montgomery Botanical Center	Private – Montgomery Botanical Center	11-100 (12)
Old Dixie Pineland	Private	11-100 (18)
R. Hardy Matheson Preserve (H-634)	State of Florida – Managed by Miami-Dade County*	101-1000 (374)
Rockdale Pineland (P-52)	Miami-Dade County*	101-1000 (195)
Historical: Population not observed for > 10 years, but habitat extant		
Gifford Arboretum Pineland	Private	0

[1] Source for number of plants is IRC (2013, p. 12-16)

The number of known populations of Carter's small-flowered flax has decreased by nearly 50 percent in recent years, and extant populations are small and isolated. Of the remaining species' occurrences, four are on conservation lands; three of these have approximately 100 individuals or fewer. Another site is owned by the United States government, but the site is not managed for conservation. On private lands, this species is threatened by on-going urban development (NatureServe 2012), and habitat destruction is a major threat (Gann et al. 2002) as demonstrated by the recent probable extirpations of at least three populations on private lands (see Table 4). The Service has determined the threats to Carter's small-flowered flax consist primarily of habitat loss and modification through urban and agricultural development, fire suppression, proliferation of nonnative invasive plants, and sea level rise. Threats described under habitat loss, fragmentation, and degradation resulting from development, fire suppression, and competition from nonnative invasive plants are believed to be the primary drivers in the historic and recent declines of Carter's small-flowered flax and has also been threatened by anthropogenic disturbances which threaten populations in disturbed habitats such as firebreaks and road rights-of-way, and both taxa are suspected to be negatively affected by threats related to small, isolated populations. All of these threats are expected to continue to impact populations of these taxa in the future. Current local, State, and Federal regulatory mechanisms are inadequate to protect these taxa from taking and habitat loss. Despite the existing regulatory mechanisms, Carter's small-flowered flax continue to decline.

Remaining habitats are fragmented. Climatic changes, including sea-level rise, are long-term threats that will further reduce the extent of habitat. Most occurrences are in low-lying areas and will likely be affected by rising sea level. Carter's small-flowered flax is vulnerable to natural disturbances, such as hurricanes, tropical storms, and storm surges. Due to the few remaining occurrences within a restricted range and the small and isolated populations, this species is vulnerable to environmental (catastrophic hurricanes), demographic (potential episodes of poor reproduction), and genetic (potential inbreeding depression) threats. This species exists in such small numbers at so few sites, that it may be difficult to develop and maintain viable occurrences on the available conservation lands. Viable plant populations for small, short-lived herbs may consist of tens of thousands of plants. Although no population viability analysis has been conducted for this plant, indications are that existing occurrences are at best marginal, and it is possible that none are truly viable. Lack of dispersal between occurrences may also be a threat (Fellows et al. 2004).

Chapman's Rhododendron

The following discussion is summarizied from information taken from the 5-year review (Service 2010c) authored by Dr. Vivian Negron-Ortiz of the Panama City Field Office (PCFO). This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews.

Chapman's rhododendron is restricted to Florida, where it is known from onlythree populations: coastal Gulf County; Liberty and Gadsden Counties in thevicinity of Hosford; and in Clay County on Camp Blanding Military Installation. The population near Hosford is the largest; the land is privately owned and used for tree farming. The smallest and most geographically isolated of these populations is within the Florida National Guard post at Camp Blanding, about 165 miles east of the Hosford population. (Negrón-Ortiz, V.2008).

Clasping Warea (Wide Leaf Warea)

The following discussion is summarized from the MSRP (Service 1999a), as well as from research publications and monitoring reports. A complete clasping warea (*Warea amplexifolia*) life history discussion may be found in the MSRP.

Species/critical habitat description

Clasping warea is an annual herb in the mustard family (Brassicaceae or Cruciferae). Plants may be 30 to 100 cm (1 to 3 ft) tall and the stalk may be unbranched or, more often, branching midway up the stem. Leaves are alternate, from 2 to 5 cm (0.8 to 2.0 inches) long, and 1 to 3 cm (0.4 to 1.2 inches) wide, smaller as they ascend the stalk, with a rounded apex and entire margin. On young plants, the leaves are slightly folded along the midrib, tipped upward, and the lobes at the base of leaves reach around the stem. This characteristic has led to several common names for the species, clasping or wide-leaf warea. The heart-shaped clasping leaf bases and its pale green, slightly glaucous leaves readily distinguish clasping warea from the three other species in its genus in Florida. The characteristic leaves provide reliable field identification even if the plants are not flowering. The pale lavender flowers of clasping warea vary in individuals from almost white to almost purple. Flowers appear at the ends of the branches in spherical clusters about 5 to 6 cm across. The inflorescences are dainty, and in the field the flowering plants look almost fluffy. Individual flowers are about 1.5 cm (0.6 inch) across, with four paddle-shaped petals and six long stamens. Clasping warea is also readily identifiable even as the stalk turns brown and the leaves wither, by the clusters of narrow down-curving seed pods, from 5 to 7 cm long. The pods split longitudinally, with small black seeds on either side of the center membrane (Judd 1980b; Kral 1983; Service 1999).

Slenderleaf clammyweed (*Polanisia tenuifolia*), an annual in the family Capparaceae, might be mistaken for clasping warea when the plants are brown and dry at the end of the season; it is about as tall as clasping warea and its seed pods are about the same size as those of *Warea*. However, the seed pods of *Polanisia* appear singly in the leaf axils rather than in groups at the ends of the stems, and are erect and straight (Service 1993c).

No critical habitat has been designated for clasping warea.

Life history

Clasping warea seedlings may be seen from April onward (FNAI 2000c). The plants flower from mid-August to early October. The showy flowers are pollinated by various Hymenoptera (bees) and Lepidoptera (butterflies). Reproduction is exclusively sexual. The small seeds generally fall near the parent plant (Service 1987e), probably by wind action. Senescence of the plants occurs just before the fruit matures, from late September to mid-November. The population overwinters as seeds.

Like many herbaceous plants that grow in open, sandy patches, clasping warea does not tolerate shading by dense shrubs or trees. The habitat structure of the surrounding forest around the open patches is controlled under natural conditions by fire. Mechanical treatments as preparation for fire, or as a substitute, have been investigated by Menges et al. (2005).

Four species of ants (*Camponotus socius*, *Pogonomyrmex badius*, *Formica pallidafulva*, and *F. archboldi*) occur around clasping warea at Lake Griffin State Park and these ants are believed to help disperse its seeds (Bard 1996).

Population dynamics

Clasping warea occurs in sandhill vegetation constituting well-drained, open longleaf pine woods, longleaf pine/turkey oak woods, or sand live oak/bluejack oak. Clasping warea seems unable to tolerate shading or competition from other plants; it may be favored by slight disturbance, but does not generally occur in weedy sites (roadsides, cleared fields, citrus groves, or pastures) (Judd 1980b). Sandhills historically had frequent low-intensity fires that were supported by (and maintained) the grassy understory.

Because the number of plants at a given site varies greatly from year to year (T. Race, BTG, personal communication, 1997), it is difficult to document trends in population numbers. Clasping warea occupies a habitat which historically burned during the summer growing season. There are anecdotal reports of plants appearing at sites where they had not been seen for several years, suggesting that the species banks seeds in the soil (Service 1993c; BTG 1994). Fire has been documented to stimulate germination of stored seeds of another species of *Warea*, Carter's mustard, resulting in boom-and-crash population dynamics with the fire cycle (ABS 2003, 2005).

Experimental propagation to field plots at the HBS suggests the number of flowering plants is related to the amount of rainfall during the December prior to the growing season. They also found plants grew from seeds that had been sown into the experimental plots 2 to 4 years earlier, which indicates seed banking in the soil is important in this species (BTG 1994). Although propagation from seed in a greenhouse resulted in a high rate of germination and early survival, all of the seedlings planted outside in native yellow sand died before flowering from the action of leaf miners, lepidopteran larvae, fungus, and unknown causes (BTG 1994). Direct sowing of clasping warea seeds in the field was more effective. In 1990, 2,000 seeds were sown, resulting in 30 percent germination and 16 flowering plants (0.80 percent). In 1991, 5,000 seeds produced 280 seedlings (5.60 percent), and 46 flowered (0.92 percent of total seed) (BTG 1994).

Status and distribution

Judd (1980b) documented the former range of clasping warea to include Lake County, western Orange County, extreme northwestern Osceola County, and northern Polk County. Since his survey, additional sites have been discovered in Lake, Polk, and Osceola Counties and several of the previously documented sites have been destroyed.

When the recovery plan for this plant was prepared (Service 1993c), 10 populations had been identified in Lake and Polk Counties, including a population at the HBS, near Lake Wales in Polk County (Hall 1985). Clasping warea is also present in remnant sandhill vegetation within Mountain Lake Estates, near the HBS (T. Race, BTG, personal communication, 1997). Judd's (1980b) Haines City site, located west of U.S. Highway 27 and east of Lake St. Charles, about 7 km (4.3 miles) north of Haines City, appears to have been eliminated by a residential housing development (N. Bissett, The Natives, personal communication, 1997). Clasping warea was found on the site of a proposed nursery along Champagne Road, northeast of Haines City and southeast of Davenport, Polk County (N. Bissett, The Natives, personal communication, 1997). This species is protected in a restored sandhill at Lake Griffin State Park in Lake County. In 1999, TNC acquired the Warea Tract (formally Flat Lake Tract) near Flat Lake, southeast of Clermont in Lake County. This tract, surrounded by orange groves, has sandhill and scrub vegetation with clasping warea. It is now managed as part of Seminole State Forest (FNAI 2005).

At Lake Griffin State Park, clasping warea was present on about 0.08 ha (0.2 acre) on the 8.00 ha (20.0 acres) parcel in May 1994. Park employees cleared oaks (except bluejack oak [*Quercus incana*]) and treated the cut surfaces with Garlon 3A (triclopyr) or Roundup (glyphosate). After removal of the oaks, centipede grass (*Eremochloa ophiuroides*) increased around the colony of clasping warea. This exotic grass was treated with Poast (sethoxydim). Other exotic plants were hand-pulled or treated with herbicide, including rosary pea, Chinese tallow tree (*Sapium sebiferum*), mimosa *(Albizia julibrissin*), and Sprenger's asparagus (*Asparagus sprengeri*). By 1997, about 2.0 ha (5.0 acres) had been cleared and the area covered by warea had increased to about 0.2 ha (0.5 acre). The number of individual clasping warea plants increased from 57 in 1994 to 118 in 1996. Approximately 26,000 wiregrass plants were planted in the restored area to restore the original understory (Bard 1996; A. Bard, FDEP, personal communication, 1997). Since then, techniques for directly seeding wiregrass have improved, and this method would probably be used in a similar situation. The Lake Griffin project was one of the first to demonstrate the feasibility of sandhill restoration, at least on a small scale.

The severe loss of habitat for this plant was carefully documented by the FNAI, which produced a land acquisition proposal, entitled the Warea Archipelago, for the Florida CARLs acquisition program, based on surveys conducted in 1991 and 1992 (R. Hilsenbeck, TNC, personal communication, 1997). The FNAI identified six tracts of land containing clasping warea: Sugarloaf Mountain, Ferndale Ridge, Castle Hill, Warea Tract, Schofield Sandhill, and Lake Davenport. Five of these are in Lake County and one is in Osceola County. The FNAI conducted another survey for clasping warea in 1994 and 1995 in Lake County on behalf of the Lake County Water Authority (LCWA) and the St. Johns Water Management District. This survey located a total of 17 sites (G. Race, LCWA, personal communication, 1997). Unfortunately, none of these sites appear to have been acquired as of 2005 (FNAI 2005).

Cooley's Meadowrue

The following discussion is summarized from the 5-year status review (Service 2009), as well as from recent research publications and monitoring reports.

Species/critical habitat description

Cooley's meadowrue (*Thalictrum cooleyi*, Ahles. Ranunculaceae) is a rare perennial herb endemic to the Southeastern coastal plain; 11 populations occur in southeastern North Carolina and one occurs in the Florida panhandle. The herb grows in circumneutral soil in moist to wet savannas and savannalike areas kept open by frequent fire or other disturbance. *Thalictrum cooleyi* is particularly notable for its extremely high chromosome count and ploidy level. Due to its rarity and its vulnerability to habitat destruction and loss, the species was federally listed as endangered on March 9, 1989 (Service 1989). Cooley's meadowrue is listed as endangered in North Carolina (Sutter 1990) and in Florida (FNAI 1991). The Center for Plant Conservation ranks the species as a priority A taxon, one which '~could become extinct within the next 5 years if no conservation efforts are implemented" (Peggy Olwell, Center for Plant Conservation, personal communication to Brian P. Cole [Service], 1992).

Cooley's meadowrue is a tall herb (1 meter or more in flower), with the slender stems erect in sunny locations to lax or sprawling in shade, leaves ternately divided (lower leaves usually subdivided). Leaflets are about 2 cm long, mostly narrow (four or more times as long as wide), with entire (untoothed) margins or rarely with two to three lobes near the tip. All parts of the plant are glabrous (smooth) and have virtually no hairs or glands. Male and female flowers are on separate plants, in loose few-flowered clusters, appearing at the top of the plants in late June to early July. The flowers lack petals, and the sepals are small and fall early. The male flowers are conspicuous for their numerous pale lavender stamens, while the female flowers have several separate spindle-shaped carpels which develop into narrowly ellipsoid, ribbed, one-seeded fruits (achenes) 6 mn long, each tipped with a persistent linear style.

All of the known *Thalictrum cooleyi* populations occur in the Coastal Plain Province. The recovery plan states the species grows in circumneutral soils (pH near 7) in wet pine savannas, grass-sedge bogs and savanna-like areas, often at the border of intermittent drainages or swamp forests. It is found on fine sandy loam soils that are at least seasonally (winter) moist or saturated and are only slightly acidic (pH 5.8-6.6).

No critical habitat has been designated for Cooley's meadowrue.

Life history

Cooley's meadowrue flowers from mid-June to early July, with males flowering somewhat earlier than females and shade plants later than sun plants. Plants mowed or burned during the growing season have been observed to resprout and flower later in the same season (Park 1992; Leonard, personal communication, 1992; White 1992). Populations are easiest to locate at flowering time by watching for male plants, which have showier flowers and tend to be taller than females. Fruits mature in August and September and remain on the plant at least into October (Rome 1987).

Little genetics research has been done on this species. Park (1992) found that *Thalictrum cooleyi* has the highest chromosome number in the genus, 2n = 210, a ploidy level of 30x compared to the base chromosome level of 7 in *Thalictrum*.

The Georgia Natural Heritage Program recognizes seven element occurrences of *Thalictrum cooleyi* in Georgia. Six occurrences are in Worth County and one is in Doughtery County. These occurrences or subpopulations likely only represent two metapopulations. Research by Dr. Wayne Parrott and his graduate students (University of Georgia) indicates that the Georgia populations of *Thalictrum* applied to the species *cooleyi*, might actually be part of a hybrid swarm (Tom Patrick, Botanist, Georgia Natural Heritage Program, 2003, personal communication). LeBlond (Retired Botanist, North Carolina Natural Heritage Program [NCNHP], 2008, personal communication) visited this site in the 1990s with Bruce Sorrie and Jim Allison and he does not believe the plants are strictly *Thalictrum cooleyi*, but may be more closely related to *Thalictrum revolutum*. The Service agrees further genetics research, including anatomical, morphological, determination of chromosome number, etc., will be necessary to compare plants from Florida, Georgia and North Carolina before a final determination can be made. In the meantime, State and Federal agencies in Georgia are taking a conservative approach and treating the plants as if they are the endangered *Thalictrum cooleyi*.

Population dynamics

This species was discovered new to science in 1957 and named a distinct species in 1959. Aside from presence/absence surveys to update Natural Heritage Program records, little work has been done on this species since then. Its growth habit as a weak upright or leaning perennial typically found in areas that are completely covered with grasses and other herbaceous vegetation makes quantitative surveys very difficult.

Between 2005 and 2007, NCNHP staff or other knowledgeable botanists have visited 12 of 25 North Carolina subpopulations (representing 10 populations) of *Thalictrum cooleyi*. Of the 25 subpopulations known from North Carolina, one is believed to be extirpated and no *Thalictrum cooleyi* plants were observed at four other subpopulations during the last visit to the site (by a competent botanist during the appropriate season; NCNHP denotes these populations as F – Failed to Find). We have little population data from the known sites in Georgia with the exception of TNC's Dry Creek Swamp Preserve a 20-acre preserve which is monitored annually. According to Dr. Matthew Aresco, director of Nokuse Plantation, Bruce, Walton County, Florida (personal communication), the single known Florida population was burned on April 24, 2008. He reported seeing several plants before the prescribed fire and will monitor the site through the growing season. With the exception of the Dry Creek Swamp Preserve in Georgia, there is no regular monitoring program in place for this species at any of the other known sites.

Despite recent visits to approximately half of the known subpopulations, they have not been monitored in enough detail or with sufficient frequency nor has enough detailed data been collected to predict long term population trends. Due to the growth habit, appearance and general nature of this species, stem counts are rarely conducted in the field. Reports of stem counts should be considered with great uncertainty unless detailed methodology are described since it would be very easy to overlook many individual plants during a cursory, low intensity count. It is doubtful we have a clear understanding of how many individual plants occur at any one subpopulation or population. Therefore, it would be more appropriate to record the species status as unknown at this time.

Status and Distribution

When the recovery plan was written in 1994, Cooley's meadowrue was known from 12 sites (these sites are now considered subpopulations) in the coastal plain of North Carolina and one population in the Florida panhandle. Since that time, additional occurrences have been found in North Carolina, and several sites of uncertain taxonomy (described above) have been found in Georgia. Our records currently indicate a total of 9 extant populations including 24 extant subpopulations in North Carolina. Of the 25 subpopulations once known from North Carolina, 1 is believed to be extinct and no Cooley's meadowrue plants were observed at 4 other subpopulations during the last visit to those sites (by a competent botanist during the appropriate season); however, those four sites have not been labeled extirpated yet by the NCNHP. Two populations (consisting of seven subpopulations) are known in Georgia. The one population consisting of one subpopulation is still extant in Florida.

Cooley's Water Willow

The following discussion is summarized from the 5-year review (Service 2010), as well as from recent research publications and monitoring reports.

Species/critical habitat description

Cooley's water willow is a rhizomatous perennial herb usually no more than 40 cm (about 1.3 ft.) tall, with erect stems. The stems are slender, somewhat squared in cross section, hairy, somewhat zig-zag, with few branches. Leaf blades are ovate or lanceolate, up to 5 cm (2 inches) long, the surfaces bristly-hairy. The flowers are sessile on paired, zigzag spikes. The flowers somewhat resemble miniature snapdragons. The corolla consists of a tube and two lips totaling 7 to 8 mm long. The corolla is bright lavender-rose; the lower lip is longer than the upper and has a strip of mottled lavender and white down its middle. All flower parts except the stamens are hairy. The capsule is finely hairy, about 1.2 cm (0.47 inch) long (Kral 1983; Perkins 1978). Flowering occurs at least from August through December and probably continues sporadically through March (Kral 1983; Wunderlin et al. 1980b). Cooley's water willow is distinguished from the only other *Justicia* in this area, *J. ovata*, "by its thinner leaves, its generally piose-pubescent surfaces . . . its much smaller, much brighter colored corollas" and by unique hairs on its seeds (Kral 1983).

No critical habitat has been designated for Cooley's water willow.

Life history

Cooley's water willow has mainly been found in the hardwood or hardwood pine forests in north central Hernando County (including Chinsegut Hill) and one known hardwood forest in Sumter County (Service 1994; Landry 1995). Soils range from moist to seasonally wet fine sandy loam to silty clay loam, usually underlain by limestone, occasionally with limestone outcroppings (Landry 1995).

The overstory where this species is found is mainly hardwood species, including southern magnolias (*Magnolia grandiflora*), black gum (*Nyssa sylvatica*), cabbage palm (*Sabal palmetto*), pignut hickory (*Carya glabra*), laurel oak (*Quercus laurifolia*), live oak, water oak (*Quercus nigra*), winged elm (*Ulmus alata*), sweetgum (*Liquidambar styraciflua*), and sugarberry (*Celtis laevigata*) (Wunderlin et al. 1980). The understory is made up of American hornbeam (*Carpinus caroliniana*), eastern hophornbeam (*Ostrya virginica*), dwarf palmetto (*Sabal minor*), beautybush (*Callicarpa americana*), and yaupon holly (*Ilex vomitoria*) (Landry 1995). There are also many herbaceous species of plants including ferns, grasses, and sedges that occur in these areas. This species is also found along roadways among various species of grasses and herbs (Service 1994).

Invasive nonnative species such as skunk vine (*Paederia foetida*), air-potato (*Dioscorea bulbifera*), cogon grass, and coral ardisia (*Ardisia crenata*) form dense ground cover that excludes native plants such as *Cooley's water willow* (Landry 1995). Control of these invasive nonnative species is needed before they spread into areas occupied by Cooley's water willow.

Population dynamics

Cooley's water willow has not been consistently monitored since it was originally found near Mascotte in Sumter County in 1925 (Service 1994). Additional surveys were conducted in the 1980s and confirmed the presence of this species at several of the historical locations (Wunderlin et al. 1980). The most recent rangewide surveys were conducted in 1992, which also confirmed the presence of this species at several of the historic locations (Chichardi 1992). Landry (1995) did conduct additional surveys on the USDA sites in 1995. Current surveys are needed throughout Hernando and Sumter Counties to determine the abundance of this species.

Cooley's water willow is found at two sites on two properties owned and operated by the USDA (*i.e.*, Plant Materials Center and STARS), both in Hernando County. Surveys conducted in 1995 found three sites at the Plant Materials Center with a total of approximately 1,500 plants (Landry 1995). During his research at these sites, Landry (1995) determined this species is rhizomatous with two to three above ground stems per plant. This made it difficult to determine if the observed above ground stems were from one or more plants.

In the 2001 Withlacoochee State Forest Management Plan (Florida Division of Forestry [FDOF] 2001), this species was documented at two sites within the forest boundaries: McKethan Lake Recreation Area at the Headquarters Tract and the Baird Tract. The 2001 surveys at the Baird Tract found a larger population than originally thought. At the Headquarters site, Cooley's water willow has been removed out of an area planned for a parking lot and transplanted elsewhere on the property. These plants have done well with the relocation at the new site. Both of these sites have invasive species such as skunk vine (*Paederia foetida*) and air-potato (*Dioscorea bulbifera*) that are in competition with *Cooley's water willow.* Invasive control is in place to manage this threat and had shown to be effective.

Cooley's water willow has also been at two sites found along Highway 50 in Sumter County and Highway 98 in Hernando County, and on private lands bordering both roadways in both counties. The FDOT has maintained both of these sites by mowing and herbicide treatments to control invasive species in areas occupied by Cooley's water willow.

Seed collection and cuttings have been made at several locations throughout the years in Hernando County. Seeds were collected in 1991 and then stored at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. The germination rate was 92 percent when checked in 1991. The seeds were placed into liquid nitrogen cryogenic storage (Campbell, BTG, personal communication 2009). Recently BTG has been working on the development of a germination protocol for this species and has found a high germination rate, in which the fresh seed germinated in a short period of time (Campbell, BTG, personal communication 2009). The results of the germination research being conducted by BTG may provide justification for exploring the potential for future reintroductions of this species at protected sites within its historic range.

Status and distribution

Cooley's water willow was first collected off Highway 50 near Mascotte in Sumter County in 1925 and documented again in the 1950s around Chinsegut Hill area in Hernando County (Wunderlin et al. 1980). Wunderlin et al. (1980) confirmed the historical occurrences in his report for the Service. Surveys conducted in 1992 and 1995 confirmed the presence of this species at most of the historical locations along roadways and at both the USDA Plant Materials Center and USDA STARS in Hernando County (Chicardi 1992; Landry 1995). Most of these sites are found in the Annutiliga Hammock northwest of Brooksville.

Withlacoochee State Forest has also reported Cooley's water willow at two sites: McKethan Lake Recreation Area at the Headquarters Tract and Baird Tract (FDOF 2001). The plants at the Headquarters Tract were relocated to another area within the same Tract for the construction of a parking lot.

This species has also been located along Highway 98 and Highway 50 in Hernando and Sumter Counties, and on private lands bordering this road.

<u>Crenulate Lead-Plant</u>

The following discussion is summarized from the Service's South Florida MSRP (Service 1999a), the 5-year status review (Service 2006c), as well as from recent research publications and monitoring reports. A complete crenulate lead-plant life history discussion may be found in the MSRP.

Species/critical habitat description

The crenulate lead-plant is a rhizomatous, perennial, deciduous shrub that inhabits marl prairies and wet pine rocklands in a small area of Miami-Dade County. This pine rockland community is maintained by periodic fires. Also known as the Miami lead-plant, crenulate lead-plant grows to 1.5 meters in height and is endemic to Miami-Dade County, Florida (FDOT 1997). The branches of this plant are red/purple, and contain 25 to 33 leaflets borne on leaves that are 0 to 15 centimeter (cm) long, with petioles 1 cm long or less. The crenulate leaflets are gray and green above, paler and glandular dotted below, and 5 to 11 cm long. The racemes are terminal, 15 to 20 cm long, solitary, or in clusters of two to three. The 8 mm long flowers are held in loose clusters. The calyx is dark green or purplish, 3.2 to 4.0 mm long with the upper half glandular dotted. The showy white standard flower is 5.2 mm long and 4.2 mm wide with long exerted stamens. The fruit is 6 to11 mm long, laterally compressed, and glandular dotted on the upper two-thirds. The seeds produced in the fruit are 5 mm long and compressed.

No critical habitat has been designated for the crenulate lead-plant.

Life history

Not much is known of the life history of crenulate lead-plant. The plants are long-lived, but little to no recruitment occurs in populations in a typical year (Fisher 2000). Plants show little to no growth and flower primarily following human disturbance. Several species of native solitary bees, such as *Dianthidium curvatum floridens* and non-native honeybees, *Apis mellifora*, pollinate the flowers (Koptur 2006). Crenulate lead-plant seems to be a Shoots of these woody plants die back to the root stock following fire or other disturbance, and, therefore, age of the plant may not be strongly correlated with size (Fisher 2000). Crenulate lead-plant is semi-deciduous, with about 70 percent of plants losing most or all leaves between December and February. New sprouts, when observed, have been identified as primarily adventitious roots (FDOT 1997). In addition, the viability of germplasm is not known (FDOT 1997). Fisher (2000) reported this species is relatively easy to cultivate, indicating the lack of reproduction in the wild may not be due to a lack of viable seeds. Maschinski et al. (2005) reported low recruitment rates may be due to the depth of the duff layer and to hydrologic influences. A propagation protocol has recently been developed for conservation purposes (Roncal et al. 2006).

Population dynamics

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. The type specimen (Small and Wilson #1898) describes the primary habitat type for crenulate lead-plant as hammock (Miami-Dade County Department of Environmental Resource Management [DERM] 1993). No recent collections have been seen from within hardwood hammocks. Many of Small's specimen labels were pre-printed with habitat data and some species were collected and labeled as occurring in hammocks that were actually collected in habitat types outside of hammocks. It is possible crenulate lead-plant was never collected in hammocks.

The pine rocklands where the crenulate lead-plant occurs are characterized by a canopy of slash pine (*Pinus elliottii* var. *densa*), a shrub canopy of saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), poison wood (*Metopium toxiferum*), and willow bustic (*Sideroxylon salicifolium*). Common herbaceous associates include crimson bluestem (*Schizachyrium sanguineum* var. *sanguineum),* wire bluestem (*S. gracile),* scaleleaf aster (*Aster adnatus),* and bastard copperleaf (*Acalypha chamaedrifolia).* Other typical species associates of crenulate lead-plant include cabbage palm (*Sabal palmetto*), southern sumac (*Rhus copallina* var. *leucantha*), bluestem (*Schizachyrium rhizomatum*), wild-petunia (*Ruellia succulenta*), gulfdune paspalum (*Paspalum monostachyum),* and blueheart (*Buchnera americana*).

Status and distribution

Crenulate lead-plant was listed as endangered on July 18, 1985, because of the loss of pine rockland habitat from residential and commercial development. Vegetative communities within the historic range of crenulate lead-plant have been almost entirely eliminated by agricultural, urban, and commercial development. The transverse glades where crenulate lead-plant occurs were among the first areas in Miami-Dade County to be farmed, because their marl soils were better suited to conversion to farmland than the limestone rock of the adjacent pinelands. By 1984, 98 to 99 percent of Miami-Dade County pine rocklands had been destroyed, and development continues today. In addition, fire suppression, invasion by exotic plant species, and drainage threaten the survival of the crenulate lead-plant. Flowering and seed production may not occur as a result of these disruptions. A newly recognized potential threat to trees and shrubs in south Florida is lobate lac scale (*Paratachardina lobata lobata*), an invasive scale insect. It was discovered on some of the crenulate lead-plants at one of the sites in November 2004 (Maschinski et al. 2005). Since that time, it has not appeared to be a threat to crenulate lead-plant.

The crenulate lead-plant was known from a 20-square-mile area from Coral Gables to Kendall, Miami-Dade County (DERM 1993). Its historic 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 Miami-Dade County. This range encompasses an area 5 miles east to west and 12 miles north to south. The crenulate lead-plant is currently known from six sites, four of which contain natural populations and two contain re-introduced populations (Roncal et al. 2006). The two largest natural populations showed a slight increase in numbers of individuals in 2012, of which one site had particularly high seedling recruitment (Maschinski et al. 2012). However, within the last 10 years, 4 additional natural populations were lost to urban development, leaving the total population size at less than 2,000 individuals (Roncal et al. 2006).

<u>Deltoid Spurge</u>

The following discussion is summarized from the final listing rule (50 FR 29345), the South Florida MSRP (Service 1999a), the 5-year status review (Service 2006d), and from recent research publications and monitoring reports.

Species/critical habitat description

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 inch) 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 inches) wide; seeds measure about 1 mm (0.04 inch) 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.

No critical habitat has been designated for the deltoid spurge.

Life history

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.

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).

Population dynamics

Current estimates of the number of individuals have not been obtained for the entire population, and population trends are not well understood. The Natural Areas Management staff of Miami-Dade County 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 litt*.). 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.

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.

Although these demographic studies have provided a catalyst for recovery of this subspecies, these data are only sufficient to run short-term population models. Additional information is needed on the plant's life history, especially data on age-specific mortality and drought-related mortality. Additional censuses and studies on seed production and germination must be initiated to refine recruitment data for modeling population trends to determine the appropriate numbers of self-sustaining populations required to ensure a high probability of persistence.

Status and distribution

Deltoid spurge is a Miami-Dade County 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 and 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 Miami-Dade County, and eight others were proposed for acquisition. According to recent updates, five sites located on private lands have been developed (Maschinski 2005 *in litt*.).

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, 1 Federal) and an undetermined number of private lands from southern Miami to Homestead (K. Bradley, IRC, personal communication 2010). 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 will be necessary to develop accurate population models.

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 2006d).

Etonia Rosemary

In addition to the assessment below, a 5-year review was completed in 2007 resulting in no change to the species designation (Service 2007e). The 5-year review builds upon the detailed information in the 1994 Recovery Plan for this species and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/etonia_rosemary5yr.pdf

Species/critical habitat description

Kral and McCartney (1991) described *Etonia conradina* and compared the species to *Conradina grandiflora* (large-flowered rosemary). The flowers of both species are very similar in their dimensions, shapes, and pollination guide markings. The leaves of *C. etonia* are distinctly broader and have lateral veins clearly visible on the ventral surface. The *C. grandiflora* leaves are dark green and lustrous in contrast to the dull green of *C. etonia.* The two plants differ in the pubescence on the leaves, young shoot, inflorescence branches, sepals, and anthers. One specimen of *C. grandiflora* from south Dayton Beach had new shoots with downiness similar to that of *C. etonia*, but the closest known population of *C. grandiflora* to the Etonia Creek site is approximately 70 air miles to the southeast in Volusia County, Florida.

Conradina etonia is a long, straight, slender shrub that grows up to 1.5 meters and has numerous, frequently arching primary branches. The reddish-brown new shoots, about 1 mm thick, have square stems covered with very short, fine, downy hairs and scattered glands. Older growth thickens and has circular stems. The outer bark peels off in long, narrow gray strips, exposing red-brown or orange-brown smooth inner bark (Service 1994).

The leaves are 15 to 30 mm long and 3 to 9 mm wide. The tips are rounded to broadly acute the margins are tightly rolled to the underside. The blade tapers to a short (less than 1 mm) petiole. Short Leafy shoots develop at each node with auxiliary buds giving the foliage a clustered, whorled appearance. The dull green dorsal side of the leaf is covered with short, downy hairs, and numerous minute glands. The ventral side is slightly paler and concave with tiny hairs that are very dense even on the midrib. The midrib, seen at the base of a strong median groove on the dorsal surface, is strongly raised on the ventral surface and has two to four strong branch nerves on each side, a characteristic unique to this species of *Conradina* (Service 1994).

Clusters (cymes) of three to seven flowers are produced from all or most nodes from the midstem up. The flower’s corolla tube is sharply bent above the middle, a characteristic of this genus. The sepals form two lips. The upper lip is three-toothed and upswept, the lower lip with two teeth is split almost to the base. The corolla is 20 to 25 mm long to the tip of the lower lip. It is also strongly tow-lipped with a lavender-blue to lavender-rose corolla tube and throat. The upper lip is uniformly lavender and the lower lip and throat have a broad longitudinal zone of white or cream mottled with spots and streaks of deep purple. The four stamens consist of a shorter pair extending almost to the tip of the upper lip and a longer pair, extending slightly beyond, arching outward and downward. The pollen sacs on the anthers are dark purple with white hairs. The S-shaped style extends beyond the anthers. Generally, four brown, egg-shaped nutlets are produced. Flowering occurs from early spring to late fall (Service 1994).

No critical habitat has been designated for Etonia rosemary.

Life history

Although there are many natural communities that occur at Etonia Creek State Forest (ECSF) and Dunns Creek State Park (DCSP), *C. etonia* tends to occur in the scrub communities dominated by sand pine with various levels of understory thickness (Herring 2004). At ECSF, most of the plants are found in scrub with a low 8 to 12-foot tall canopy of sand live oaks (*Quercus geminata*) and scattered low sand pines (*Pinus clausa*) with a shrubby understory of scrub palmetto (*Sabal etonia*), myrtle oak (*Q. myrtifolia*), and blueberries (*Vaccinium stamineum, V. myrsintes*) (Johnson 1998).

The lack of fire at both sites has resulted in dense sand pine forests. More research is needed to determine if *C. etonia* is fire dependent. As described earlier, in 2004 a prescribed burn at one site in ECSF (Quail Road) destroyed two mature plants; however, during the 2005 survey, two new seedlings were found along Quail Road in a burned area adjacent to where the mature plants had occurred (C. Pederson, ECSF, personal communications, 2005). ECSF has plans to harvest timber and implement prescribed burns in the 500 to 600 acres adjacent to the one of the largest *C. etonia* populations. No *C. etonia* are currently found in this area but this area will be monitored to see if any plants are located after the fire.

Within ECSF, the Garden Drive/Blossom Street population is found mostly on private land. These plants are found along the roadside and within individual 1-acre lots. ECSF has acquired some of these lots adjacent to existing state lands and plans to acquire additional lots occupied by *C. etonia* as money becomes available. The state owned lots have been timbered and mechanically treated adjacent to privately owned lands to help control the vegetation. There are several existing homes within this area, which would make prescribed burning very difficult. Most of the populations of *C. etonia* are located along open dirt roads/trails throughout both the ECSF and DCSP. Crooked wood harvesting takes place at both ECSF and DCSP. During the harvest, small trails are cut to access the crooked wood. During the 2005 surveys of these trails at ECSF, several new *C. etonia* sites were discovered. Thus, it would appear that *C. etonia* favors open disturbed sites, such as those occurring along these trails and roadways.

Population dynamics

Results from recent surveys indicate that the total number of individual wild populations on the ECSF has increased since the species was listed (2000, 2001, 2002, 2003, 2004, 2005, and 2006). It appears that there has been a 22 percent and 7 percent increase in the number of individual plants in 2005 and 2006, respectively. There are several reasons to account for the increase in plants. The wet season in 2005 accounted for a good year for seedlings (C. Pederson, ECSF, personal communications, 2005). Also, more plants were discovered along trails cleared during crooked wood (*Lyonia* spp.) harvesting activities. It is possible that these plants previously existed in these areas but were not discovered until after the areas became more easily accessible. There are plans to timber and then prescribe burn 500 to 600 acres adjacent to a large *C. etonia* population at ECSF later this year. There is uncertainty as to how *C. etonia* will respond to this kind of disturbance. However, based on a clear cut and burn that took place in 2004 on the Quail

Road site at ECSF, it is believed that the plants will respond favorably. Although two mature plants were destroyed by the fire, a year later two seedlings were found in an adjacent area that had burned as well (C. Pederson, ECSF, personal communication, 2005).

The recently discovered DCSP populations have also shown signs of an increase over the past few years (J. DePue, DCSP, personal communication). *C. etonia* was found at six sites during floristic surveys of DCSP that were conducted by the FNAI in 2002 and 2003 (Herring 2004). During a 2004 survey, the first full inventory of *C. etonia* at DCSP, FNAI surveyed 10 sites, including the 6 sites found during the 2002 and 2003 surveys and four new or previously undiscovered sites. The 2004 survey found the number of plants had increased from 500 to 600 to 800 to 1,000 individuals (Herring 2004).

Status and distribution

When listed in 1993, *C. etonia* was thought to occur only on two sites, both on what were then private lands, in Putnam County, Florida. The 2006 surveys at ECSF in Putnam County, Florida, located 5 populations (10 or more plants) at seven sites (Etoniah Trail population, Long Leaf Pine Hiking Trail population, Quail Road population, Woods Road population, and Garden Drive/Blossom Street population). The Garden Drive/Blossom Street population occurs on private land located within ECSF and is not protected. Since 2000, there has always been less than 10 plants found at Quail Road even after the prescribed burn in 2004. Over the past several years, new locations have been found along the crooked wood trails in the ECSF. These new locations are in close proximity to Etoniah Trail, where the largest population (800 plants) of *C. etonia* occurs, and are considered to be part of that population. Longleaf Pine Hiking Trail has the second largest population with 414 plants.

C. etonia was first discovered within the recently acquired DCSP in Putnam County, Florida, in 2001 by a State biologist (J.B. Miller, St. Johns Water Management District, personal communication 2001). In 2002 to 2003, six *C. etonia* populations were documented by FNAI during floristic surveys of DCSP (Herring 2004). A full inventory of *C. etonia* took place at DCSP in 2004. A total of 10 potential *C. etonia* sites were surveyed, including the 6 sites where the species was originally recorded in 2002 and 2003 and 4 new sites. Plants were only located at 6 of the 10 sites, and of these, 4 of the 6 sites have populations of 10 or more plants (Sites 1, 2, 3, and Historic Site 6). Two of the largest populations were found during the 2004 surveys, Site 3 with 190-200 plants and Site 1 with 126 to 150 plants. At Site 4 and Historic Site 6, only one plant was found so these are not considered viable populations. Four of the historic sites were impacted by the 2004 hurricane season and no plants were found. Recent annual surveys (2005 and 2006) have shown an increase in the number of plants in the three new (Sites 1, 2, and 3) and one historic population (Historic Site 6) (J. DePue, DCSP, personal communication).

<u>Everglades Bully</u>

The following discussion is summarized from the South Florida MSRP (Service 1999a), the 5-year status review (Service 2006c), as well as from recent research publications and monitoring reports. A complete crenulate lead-plant life history discussion may be found in the MSRP.

Species/critical habitat description

Everglades bully is a decumbent or upright shrub, 3 to 6 ft (1 to 2 meters) tall. The branches are smooth, slightly geniculate, and somewhat spiny. Leaves are thin, obovate or ovate, 0.8 to 2 inches (2 to 5 cm) long, evergreen, oblanceolate, and fuzzy on their undersides. The flowers are in axillary cymes (Long and Lakela 1971, p. 679). 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, p. 603).

The genus Sideroxylon is represented by eight species in Florida. All of these plants were previously assigned to the genus Bumelia. Sideroxylon reclinatum, the Florida bully, is represented by three subspecies that range nearly throughout Florida and into neighboring states. The Everglades subspecies was first recognized by David Whetstone (1985, pp. 544-547) as Bumelia reclinata var. austrofloridense. The Everglades bully was transferred to the genus Sideroxylon by Kartesz and Gandhi (1990, pp. 421-427). The transfer of Everglades bully from Bumelia to Sideroxylon is presumably in accordance with Pennington's (1990, 1991) revision of the genera of the family Sapotaceae and constitutes a nomenclatural formality.

Kartesz and Gandhi (1990, pp. 421-427) made Sideroxylon reclinatum ssp. austrofloridense a subspecies rather than a variety; in plant nomenclature, the ranks of variety and subspecies are interchangeable, except in the situation where two or more varieties constitute a subspecies. This name is used in the current treatment of the Florida flora (Wunderlin and Hansen 2008, p. 1). The Integrated Taxonomic Information System (2011, p. 1) indicates that the taxonomic standing for Sideroxylon reclinatum ssp. austrofloridense (Whetstone) Kartesz & Gandhi is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name S. reclinatum ssp. Austrofloridense (Whetstone), as does NatureServe (2010, p. 1). In summary, there is general agreement that S. reclinatum ssp. austrofloridense is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the subspecies is a valid taxon.

Because the Everglades bully is a candidate for listing, critical habitat has not been designated for this species.

Life history

Everglades bully is restricted to pinelands with tropical understory vegetation on limestone rock (pine rocklands), mostly in the Long Pine Key area of ENP, which is an area of pine rockland surrounded by wetlands. In ENP, Everglades bully is found in pinelands, pineland/prairie ecotones, and prairies (Gann et al. 2006, p. 12). Plants are found in low elevation pinelands and pineland/marl prairie ecotones that flood each summer (Gann et al. 2006, p. 13). Plants are also present in BCNP, south of Loop Road, but the habitat has not been described and surveys have not been conducted (K. Bradley, personal communication 2007). The species was locally common at the edges of pine rockland and prairie when plants were collected at the very southern end of Lostman's Pines, close to the ENP boundary, in 2003 (J. Sadle, ENP, personal communication 2008). Occurrences in Miami-Dade County are within remnant pine rocklands.

Population dynamics

In 2005, IRC reported more than 10,000 plants were found in surveys of Long Pine Key (K. Bradley, personal communication 2005). The baseline abundance estimate at Long Pine Key based on a log10 abundance estimate is 10,000 to 100,000 plants (Gann et al. 2006, p. 11). Gann et al. (2006, p. 11) found 14 occurrences of this species recorded at 149 stations. There is not a good estimate of the population size in BCNP. Bradley (personal communication 2007) indicates that this species was discovered within BCNP in 2003, and that 50 to 100 plants were observed, but the population has not been surveyed. Funding became available for a full survey in 2009, and a full survey within BCNP was initiated in 2011 (see Conservation Measures Planned or Implemented) (Bradley 2009, pp. 1-4).

FTBG tagged 41 groups of plants, each group consisting of 1 to 6 individuals, for a total of approximately 73 individuals at Larry and Penny Thompson Park (Possley and McSweeney 2005, p. 1). This is probably the largest population outside of Long Pine Key. Estimated population sizes for the other occurrences are noted in Table 1 (Hodges and Bradley 2006, p. 42; Gann et al. 2006, pp. 9-11; K. Bradley, personal communication 2007; J. Possley, personal communication 2011a;2011b).

The rounded global status of Everglades bully is T1, critically imperiled (NatureServe 2010, p. 1). NatureServe (2010, p. 1) indicates this taxon is a narrow, endemic subspecies occurring in sensitive and highly fragmented pine rocklands of southern Florida. FNAI considers Everglades bully to have a global rank of G4G5T1, meaning the species as a whole is “apparently” or “demonstrably secure globally,” but the subspecies is “critically imperiled globally” (FNAI 2011, p. 9).

Everglades bully was considered to be critically imperiled by IRC; however, based upon data collected in the first year of their study, IRC down-ranked this species to imperiled (Gann et al. 2006, p. 13; Gann et al. 2001-2010, p. 1). Everglades bully is not listed by the State.

Status and distribution

Everglades bully was long considered to be restricted to the tropical pinelands of Miami-Dade County. Gann et al. (2002, p. 526) provided a history of collections: Everglades bully was first documented at Camp Jackson near what is now the main entrance to ENP. It has been collected several times (starting in 1852) at Long Pine Key. The species has been observed in pinelands east of ENP, the Nixon-Lewis Hammock (where the pinelands have since been destroyed), privately-owned Grant Hammock, and privately-owned Pine Ridge Sanctuary.

In Monroe County, this species is found only on the mainland (Hodges and Bradley 2006, p. 42). Hodges and Bradley (2006, p. 42) stated if it had occurred in the Florida Keys, the most likely locations would have been pine rocklands on Key Largo, Big Pine Key, Cudjoe Key or Lower Sugarloaf Key, all of which were surveyed for this species. Hodges and Bradley (2006, p. 42) indicated most of the sites on Key Largo have been developed. There have been no records of this taxon ever being collected there.

Everglades bully is extant at eleven sites (Table 1). One population occurs at BCNP south of Loop Road, the extent of which is not known, on the mainland portion of Monroe County (K. Bradley, personal communication 2007). The largest population is at Long Pine Key within ENP in Miami-Dade County (Hodges and Bradley 2006, p. 42; Gann et al. 2006, p. 11). New occurrences within ENP are expected to be found as work continues to establish the limits of this species' habitat requirements. Everglades bully appears to have a much wider range than previously thought (Gann et al. 2006, p. 9).

One occurrence is located at Larry and Penny Thompson Park in the Richmond Pinelands adjacent to the Metrozoo in Miami-Dade County (Gann et al. 2002, p. 527; Possley and McSweeney 2005, p. 1). This plant occurs at the privately-owned Pine Ridge Sanctuary in Miami-Dade County and possibly at a few non-protected pinelands, such as Grant Hammock (Gann et al. 2002, p. 526). In 2007, Bradley (personal communication 2007) reported small occurrences in Miami-Dade County at the following locations: Lucille Hammock, South Dade Wetlands, NFC #P-300, and NFC #P-310. More recently, Possley (J. Possley, FTBG, personal communication 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 (personal communication 2011b) reported populations from Navy Well Pineland Preserve (four plants) and Sunny Palms Pinelands (two plants), both areas are Miami-Dade County conservation lands. Table 1: Extant occurrences of Everglades bully (Hodges and Bradley 2006, p. 42; Gann et al. 2006, p. 11; K. Bradley, personal communication 2007; J. Possley, personal communication 2011a; 2011b; J. Sadle, ENP, personal communication 2011).

Florida Bonamia

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008d). The 5-year review builds upon the detailed information in the MSRP and the 1996 Recovery Plan for this species and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/FLBonamia.pdf

Species/critical habitat description

Florida bonamia is a perennial vine with long prostrate stems a meter or more (at least 3 ft) in length. It has a long, relatively slender tap root. The leathery sessile or subsessile leaves are up to 4 cm (1.6 inch) in length and ovate in shape. The flowers are solitary and sessile in the leaf axils. The funnel-shaped corolla is 7 to 10 cm (3 to 4 inches) long and 7 to 8 cm (2.7 to 3.2 inches) across. It has a deep blue or bluish-purple color with a white throat. The flowers open in the morning and are wilted by early afternoon (Romano 1999). The fruits are capsules, normally containing four seeds. The seeds are smoothish, pale brown or greenish-brown, 5 to 8 mm long, and oblong (Romano 1999). The outer face is convex and the inner two faces are flat, forming an angle (Wunderlin et al. 1980a). Florida bonamia is the only morning glory vine found in scrub areas with a large blue flower (Wunderlin et al. 1980a), but could be confused with hairy dawnflower (*Stylisma villosa*).

Life history and population dynamics

Florida bonamia grows for 3 or more years (50 FR 42068; Wunderlin et al. 1980a), flowering from spring to summer (Wunderlin 1998). It has a mixed mating system; it is highly self-compatible, it can self-pollinate, and it can produce seeds without fertilization (Romano 1999). Pollinators are essential, however, to ensure substantial seed production by self-, as well as cross-, fertilization. Florida bonamia shows some inbreeding depression in selfed fruits and seeds but it does not appear to be enough to hinder the present populations (Romano 1999). The seeds of Florida bonamia become dormant, but may do not require dormancy to germinate, particularly if the seeds are planted immediately. Hartnett and Richardson (1989) observed that populations of this species have large seed banks of dormant seeds, mostly within 1 cm (0.4 inch) of the surface, distributed rather homogeneously, with no relation to the distribution of mature plants. The seedlings germinate throughout the summer until September. This germination pattern is somewhat unusual among scrub plants, many of which germinate during the fall or winter. Germination occurs on sites with sparse vegetation that have not burned recently (Romano 1999).

Seedling survival was investigated by Romano (1999), but results from this unpublished dissertation have not yet been obtained. Hartnett and Richardson (1989) excavated several plants. They found that clumps of prostrate stems seen at the surface are connected to a large central and somewhat woody rootstock. They had no difficulty distinguishing such clump-forming, well-established older individuals from young single-stem plants that had grown from seed. According to Hartnett and Richardson (1989), fire stimulates seed production and germination as well as regrowth from clonal stems. Stem production is greatest during the first season after a fire, while seed production peaks the second year. The lag is probably due to the increased energy needed for regrowth following fire. Seed production is postponed to conserve energy. New seed production replaces the seed banks that are often destroyed by fire.

Status and distribution

The known populations of Florida bonamia occur within, on the edge of, or near scrub habitat on the white sands associated with the ancient Pleistocene dune systems of the central ridge system (Ward 1979). Scrub vegetation, particularly on the ONF, consists of myrtle oak and sand live oak with sand pine, with openings between the trees and shrubs occupied by lichens and herbs. The LWR has additional shrub species and many endemic herbs and small shrubs. Scrub is renewed by infrequent fires or mechanical disturbances, including logging on the ONF. Florida bonamia grows in a variety of growth stages of sand pine, but flowers profusely only in the open, sunny conditions of regeneration stands, and sparsely if at all in older stands.

Florida bonamia also occupies disturbed areas near roadways and clearings caused by logging operations (50 FR 42068). This species is not found on altered soils such as the clay applied to logging roads on the ONF (Miller 1989). As the scrub community reaches maturity, encroachment and shading from overstory pines and oaks cause this and other smaller species to decline (Wunderlin et al. 1980a).

Florida bonamia has been collected in Hardee, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Polk, Sarasota, and Volusia Counties in peninsular Florida. Many of these records are historic: Manatee (1878, 1916), Sarasota (1878) and Volusia (1900) (Wunderlin et al. 1980a). The plant has been collected in Hardee County in 1995 and in Orange County in 1989 and 1995 (University of Florida herbarium collections catalog, accessed June 28, 2005). Florida bonamia is relatively abundant and widespread on the ONF, especially along road edges, in Marion and Lake Counties. South of the ONF, Florida bonamia was once collected near Mt. Dora or Tavares, but has probably been extirpated. It is present at the 120-acre Flat Lake tract of Seminole State Forest in Lake County southeast of Clermont (Schultz et al. 1999; FNAI 2005), which was purchased by TNC in 1999 (Finkelstein 1999).

In south Florida, Florida bonamia is present at most sites with scrub vegetation on the LWR, as shown by a survey of 26 sites being considered for State land acquisition (Schultz et al. 1999). Here is a summary of the south Florida distribution, based in part on Service (1996):

- Charlotte County. Seen by I.J. Stout of the University of Central Florida. No collections have been reported from this county.
- Hardee County. Reported from one site by Johnson (1981). The University of Florida Herbarium catalog includes a specimen collected by S.L. Orzell (23688, June 4, 1995), from rosemary scrub.
- Polk County. Protected at the Arbuckle tract of LWR State Forest. Reported by Schultz et al. (1999) from the following CARL acquisition areas: Horse Creek Scrub (District), Lake Blue, Lake McLeod (part of the LWRNWR), Mountain Lake Cutoff, Hesperides, the Arbuckle, Boy Scout (Cox 2004), and Lake Walk-in-the-Water tracts of LWR State Forest, Sunray/Hickory Lake South, and Trout Lake. It is not present at TNC’s Tiger Creek Preserve (B. Pace-Aldana, TNC, letter correspondence, 2005), contrary to label information on herbarium specimen S.P. Christman 1935 (with D.K. Dorman), collected in 1987 (University of Florida herbarium catalog).
- Osceola County. Present immediately north of the county line, north of SR 532, southeast of Interstate 4.
- Highlands County. Protected at the Flamingo Villas tract of LWRNWR. It is not on the plant list for ABS (Menges et al. 2000). Schultz et al. (1999) report it from Avon Park Lakes, Carter Creek (LWRWEA and LWRNWR), and Lake Apthorpe and Holmes Avenue (LWRWEA).

DeLaney (1988) found 500 plants in the Arbuckle tract of LWR State Forest. Monitoring at the Arbuckle tract found 66 in 2002 and 36 in 2003. Walk-the-Water had 14 in 2001 and 53 in 2002. Boy Scout had 150 in 2003 (Cox 2004). Cox expressed concern over these apparently declining numbers on the LWR State Forest.

Florida bonamia depends on the sunny cleared areas left by periodic fires or physical disturbance (52 FR 42068). Historically, lightning fires swept through the scrub and surrounding communities, burning large tracts of land. Today, habitat fragmentation and fire suppression have interrupted the natural burn regime. Reduced fire frequency has left many of the scrub sites overgrown and unsuitable for highly specialized scrub endemics that require open sunny patches. Florida bonamia, like other herbs of the scrub, can be found growing along roadsides that are often the only available openings. However, these areas cannot be considered a safe refuge for rare species. Roadsides are often filled with invasive exotics that compete with scrub endemics. In addition, road maintenance activities such as mowing, herbicide spraying, and soil disturbance can adversely affect native species.

Florida Brickell-bush

Florida brickell-bush first became a candidate on October 25, 1999. The following discussion is summarized from the most recent species assessments (Service 2011 and 2012) and from recent research publications and monitoring reports.

Species/critical habitat description

Florida brickell-bush is a perennial herb 1 to 3.5 ft (0.3 to 1.1 meters) tall, slender, erect, and branching (Chafin 2000). Leaves are 0.4 to 1.2 inches (1 to 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 to October), but individuals may be found in flower during most of the year (Bradley and Gann 1999).

At this time, no critical habitat has been designated for Florida brickell-bush. If the species is listed as federally threatened or endangered in the future, critical habitat may be designated at that time.

Life history

Bradley and Gann (1999) stated Florida brickell-bush is "found exclusively in pine rocklands. It tolerates only minor amounts of disturbance. The pine rockland habitat where it occurs in Miami-Dade County 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 to 4 meters), one occurrence is in a low elevation pine rockland very close to a marl prairie (2 to 3 meters). 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 to 7 years, with most fires occurring at the beginning of the wet season in spring and early summer. These periodic fires keep the shrub canopy low and reduce litter accumulation."

Population dynamics

Larry and Penny Thompson Park has the only large population. Based upon data from IRC, Keith Bradley (personal communication 2007) had estimated 1,001 to 10,000 individuals at this location. More recently, based upon data from FTBG, Jennifer Possley (personal communication 2008) had estimated the population size at 1,000 to 1,500 individuals, noting 200 plants were found in a survey covering approximately 10 percent of the Park. Bradley and Gann (1999) indicated this species rarely occurs in great abundance; most populations are very sparse, containing a low density of plants.

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 to 10,000 plants, with the exact number probably between 5,000 and 7,000 plants (Bradley and Gann 1999). Based on the latest available data (Table A), 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."

Status and distribution

Florida brickell-bush is "endemic to Miami-Dade County on the Miami Rock Ridge. It was historically distributed from central and southern Miami-Dade County from South Miami (latitude ca. 25º 42.5') to Florida City (latitude 25º 26.0'). This is a range of approximately 22.5 miles along the Miami Rock Ridge." Herbarium specimens have not been studied from the New York Botanical Garden, so the full extent of its historic 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 Miami-Dade County. 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 (personal communication 2007) also confirmed the more recent extirpation of another population at a privately owned site (Turnpike Extension and 93rd Terrace) due to development.

Brickellia mosieri is currently distributed from central and southern Miami-Dade County from SW 120 Street (latitude ca. 25" 39.4) to Florida City (latitude ca. 25" 26.0), suggesting its historic range has contracted at least 4.8 km (3 miles; more than 13 percent) (Bradley and Gann 1999, p. 11). At least 9 known populations on private lands have been extirpated including: Sunset Drive and 71 Court (site developed; last observation in 1968); Palms Woodlawn Cemetery (site developed; last observation in 1992); Turnpike Extension and 93rd Terrace (site destroyed; confirmed extirpated in 2007); plus at least 6 of 18 undated occurrences reported by Alan Herndon (Bradley and Gann 1999, p. 12; Bradley 2007, personal communication). In addition, several of Herndon's 18 sites experienced impacts to habitat through disturbance or invasion by nonnative plants or dense hardwoods, and *B. mosieri* may no longer occur at these sites (Bradley and Gann 1999, p. 12).

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, *Brickellia mosieri* 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 and 2005 mapping by IRC of NFCs; pinelands and hardwoods) in Miami-Dade County 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 *B. mosieri* on six privately owned parcels, including on the University of Miami 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. *B. mosieri* was not found during a 2-year project intended to survey and map nonnative and rare plants along FDOT right-of-ways within Miami-Dade County (Gordon et al. 2007, pp. 1, 36).

Based on the best available data, we classified those occurrences of *Brickellia mosieri* which have not been confirmed extirpated as either extant (status confirmed within the last 10 years), possibly extant (reliable data are greater than 10 years but less than 15 years old, habitat is still extant), or unknown/historical (observation does not include sufficient detail and/or data are more than 15 years old, habitat is still extant) (Table 1). Using this classification, populations of *B. mosieri* are believed to occur on at least 17 (extant or presumed extant) sites, and may possibly occur on up to another 5 (possibly extant) sites although most of these latter sites have been searched in recent years without the species being found. *B. mosieri* may also occur at three historical sites, but additional information would be needed to confirm at this time. Of the 17 extant occurrences, 9 occur on public conservation lands, 3 occur on private lands managed for conservation, and five occur on private lands with unknown management (Table 1). Four of the populations on public conservation lands, including two of the three large (>100 plants) monitored populations, occur adjacent to one another in the Richmond Pineland Complex.

Bradley and Gann (1999, p. 12) estimated population size using a logarithmic scale. On that scale, the total population of the species in 1999 was estimated at 1,001 to 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, p. 12). Since that time, the estimate for the largest population (Larry and Penny Thompson Park, 1,001 to 10,000 plants in 1999) has decreased to 101 to 1,000 plants, with adjacent areas (University of Miami, Metrozoo, Martinez Pineland) estimated to hold another 112 to 1,100 plants combined (Possley 2013, personal communication). Additional plants are suspected to occur on adjacent privately owned parcels in the Richmond Pineland Complex (Possley 2013, personal communication). 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 miles) southwest at the southern end of species current range. Another large population was observed on a private parcel situated between Navy Wells 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 miles) from their nearest neighboring population – the major exception to this is a 7.2 km (4.5 miles) 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 and 3,700 (Table 5). Based on current estimates, the total population of *B. mosieri* has apparently declined by approximately 50 percent since 1999.

Table 5. Extant and recent (presence still possible) occurences of Florida brickell-bush.

POPULATION (NFC # if applicable (P-#)	**OWNERSHIP** (*denotes lands managed for conservation)	**POPULATION RANGE** (No. plants and year if available)
Extant: Regularly monitored populations – Status confirmed within last 5 years		
Navy Wells Pineland Preserve (P-415)	Miami-Dade County*	101-1,000 (272 in 2009) [1]
Pine Shore Pineland Preserve (P-48)	Miami-Dade County*	11-100 (77-118 in 2009) [1]
Quail Roost Pineland (P-144)	State of Florida – managed by Miami-Dade County*	11-100 (23 in 2011) [1]
Richmond Pinelands Complex – Larry and Penny Thompson Park (P-391)	Miami-Dade County*	101-1,000 (815 in 2008) [1]
Richmond Pinelands Complex – Miami MetroZoo (P-391)	Miami-Dade County*	101-1,000 (742 in 2009) [1]
Rockdale Pineland (P-52)	State of Florida – managed by Miami-Dade County*	1-10 (5 in 2010) [1]
Ron Ehman Park	Miami-Dade County*	11-100 (31-45 in 2011) [1]
West Biscayne Pineland (P-295)	State of Florida – managed by Miami-Dade County*	11-100 (15-150 in 2008) [1]
Presumed Extant: Populations not regularly monitored – Status confirmed within last 10 years		
P-132	Private	1-10 [2]
P-295	Private	101-1000 [2]
P-297	Private	11-100 [2]
P-316	Private	11-100 [2]
P-365	Private	11-100 [2]
Pine Ridge Sanctuary (P-310)	Private*	11-100 [3]
Porter Russell Pineland Preserve (P-160)	Private – Tropical Audubon Society*	10-15 [4]
Richmond Pinelands Complex – Martinez Pineland (P-391)	Miami-Dade County*	Unknown (previously grouped with Larry and Penny Thompson Park)
Richmond Pinelands Complex – University of Miami, Richmond Campus (P-391)	Private – University of Miami*	11-100 [2]

Possibly Extant: Habitat extant but status last confirmed 10-15 years ago		
Camp Choee (P-397)	Private*	11-100 [5]
Camp Owaissa Bauer (H-681)	Miami-Dade County*	11-100 [5]
Panther Pineland (P-338)	Private	11-100 [5]
Seminole Wayside Park (P-365)	Miami-Dade County*	11-100 [5]
Tamiami Pinelands Complex Addition (P-6.00)	State of Florida – managed by Miami-Dade County*	10-100 [5]
Unknown/Historical: Habitat extant but records regarding occurrence are limited and/or >15 years old		
Ingram Pineland (P-360)	State of Florida – managed by Miami-Dade County*	Unknown [6]
Navy Wells #2 (P-329)	Miami-Dade County – School Board	Unknown [7]
Nixon Smiley Pineland Preserve (P-370)	Miami-Dade County*	Unknown [8]

Table 1. Extant and historical populations of *Brickellia mosieri*
[1] Possley 2013, personal communication
[2] Bradley and Gann 2005, page numbers not applicable
[3] Glancy 2013, personal communication
[4] Bradley 2008, personal communication
[5] Bradley and Gann 1999, p. 15
[6] Included in a 2005 plant list by IRC, but no estimate provided
[7] FNAI Element Occurrence #7, dated 9/5/1995
[8] Included in a 1999 letter by IRC but no estimate provided; also included in a 2004 IRC list of *B. mosieri* occurrences

Alan Herndon had reported 18 occurrences in an undated report (Bradley and Gann 1999). Six of Herndon's occurrences have been developed and several additional sites have been disturbed or, because of lack of management, the sites are now dominated by exotic plants and/or dense hardwoods (Bradley and Gann 1999). Florida brickell-bush may no longer occur at some of these sites (Bradley and Gann 1999). IRC mapped all of the public and many private pinelands in Miami-Dade County outside of ENP in 2004. They found no new sites for this plant, other than at the Porter Russell Preserve. Data from IRC from 2007 indicates 21 other locations have an undetermined status (*i.e.*, the area was surveyed, but the plant was not observed by IRC) (K. Bradley, personal communication 2007). Additional survey work at these locations (all private land) would be needed to determine presence. The species was not found during a 2-year project intended to survey and map exotic and rare plants along FDOT right-of-ways within Miami-Dade County (Gordon et al. 2007).

Nearly all of the pine rockland habitat within the narrow range of Florida brickell-bush has been urbanized, converted to agricultural use, or degraded, so that the original low understory has been replaced by hardwoods or exotic plants. Based upon available data, there are 16 extant occurrences of Florida brickell-bush in remnants of its former pine rockland habitat in Miami-Dade County (Table A) (Bradley and Gann 1999; K. Bradley, personal communication 2007). Only one occurrence of more than 100 individuals is known to exist. Essentially all remaining occurrences are small and isolated. The Service has determined that the threats to Florida brickell-bush consist primarily of habitat loss and modification through urban and agricultural development, fire suppression, proliferation of nonnative invasive plants, and sea level rise. Threats described under habitat loss, fragmentation, and degradation resulting from development, fire suppression, and competition from nonnative invasive plants – are believed to be the primary drivers in the historic and recent declines of Florida brickell-bush and has also been threatened by anthropogenic disturbances which threaten populations in disturbed habitats such as firebreaks and road rights-of-way, and both taxa are suspected to be negatively affected by threats related to small, isolated populations. All of these threats are expected to continue to impact populations of these taxa in the future. Current local, State, and Federal regulatory mechanisms are inadequate to protect these taxa from taking and habitat loss. Despite the existing regulatory mechanisms, Florida brickell-bush continue to decline.

This species is threatened by habitat loss, which is exacerbated by habitat degradation due to fire suppression, modification of fire regime, the difficulty of applying prescribed fire to pine rocklands, and threats from exotic plants (Bradley and Gann 1999; NatureServe 2012). Remaining habitats are fragmented, and populations which occur on private lands are threatened by development and further fragmentation. Climatic changes, including sea-level rise, are long-term threats that will further reduce the extent of habitat. Florida brickell-bush is vulnerable to natural disturbances, such as hurricanes, tropical storms, and storm surges. Due to its restricted range and the small sizes of most isolated occurrences, this species is vulnerable to environmental (catastrophic hurricanes), demographic (potential episodes of poor reproduction), and genetic (potential inbreeding depression) threats.

Florida Golden Aster

The following discussion is summarized from the 5-year review (Service 2009), as well as from recent research publications and monitoring reports.

Species/critical habitat description

Florida golden aster, commonly referred to as the Florida golden aster, is a member of the Aster Family (Asteraceae). Currently, the genus consists of 11 species and 3 subspecies native to Florida. Florida golden aster was first described as a species in 1903 within the Chrysopsis genus. Over the years, the nomenclature of its species status and genus were disputed until it was finally returned to the current genus in the early 1980s. Most authors agree to its current nomenclature and it is recognized as a distinct species (Wunderlin 1979, p. 21; Wunderlin 1982, p. 369).

This species is a perennial (living 3 or more years) herb with stems that are woody toward the base and non-woody above. The plants have basal rosettes (a dense radiating cluster of leaves at the base of a stem) with leaves 4 to 10 cm (1.5 to 4.0 inches) long, 1.5 to 2.0 cm (0.6 to 0.8 inches) wide; the leaves of the rosette are densely short-wooly pubescent (covered with short, soft hairs). The stem leaves are nearly the same size from the top to the bottom of the stem; they are obovate-elliptic (inversely ovate, attachment at narrower end; narrow oval, broadest at the middle), slightly clasping the stem, entire (continuous margins of leaf edge), and densely short-wooly pubescent. The flower heads are grouped into a more or less flat-topped cluster of 1 to 25 heads at the top of the stem. Each head is slightly over 2.5 cm (1 inch) in diameter. Both the central disc and the rays of the flower are golden yellow. Florida golden aster is distinguished from other members of its genus by its perennial habit, the woodiness of its stems, the wooliness and the shape of the stem and the leaves, and the flower heads arrangement in a flat-topped cluster (Wunderlin et al. 1981, p. 6).

No critical habitat has been designated for Florida golden aster.

Life history

Florida golden aster flowers in late November and December and sheds seed from December onward. This plant can spread vegetatively by forming new basal rosettes at the ends of rhizomes, but reproduction is primarily by seed (Service 1988, p. 1). The entire genus has an out-crossing breeding system (transfer of pollen from the male anthers of the flowers of one plant to the female stigma of the flower of another plant). Lambert and Menges (1996, p. 132) found that seedling emergence was increased by disturbed soil, by the absence of a litter layer, and by their combination. However, seedling survival was not affected by those experimentally controlled factors. The response to fire on the landscape did not affect seed germination or seedling survival, but did increase flowering (Lambert and Menges 1996, p. 133).

Florida golden aster prefers open, sandy areas within the sand pine scrub community (Service 1999, p. 877). It has been found growing in the ecotone between scrub and other communities. This species does not compete well with other plants such as saw palmetto (*Serenoa repens*), scrub oaks (*Quercus spp*.), and invasive exotic grasses, such as natal grass, and bahia grass (Paspalum notatum) (Cox et al. 2004, p. 4). Species frequently found growing in association with Florida golden aster that could be considered indicators of appropriate habitat include narrowleaf silkgrass (*Pityopsis graminifolia*), coastal plain honeycomb (*Balduina angustifolia*), cup lichen (*Cladonia leporina*), and wiregrass (*Aristida stricta*) (Johnson et al. 2006, p. 3).

Little information is available on the relationship of Florida golden aster to other species. Shading by overly dense canopy species will result in reduced population size, and will ultimately eliminate Florida golden aster from the understory. No information is available on pollinators. Lambert and Menges (1996, p. 122) reported that the disturbance of soil by an ant mound (species not reported) favored germination of Florida golden aster, as did rooting by armadillos (*Dasypus novemcinctus*). Gopher tortoise burrows are also known to provide areas of disturbed soil suitable for germination of many scrub species.

Prescribed fire is important for Florida golden aster because plants that occupy open sandy areas in scrub habitat rely on periodic fire to prevent canopy closure. Fire should mimic the natural cycle of the cover type being managed, with frequent burns (1 to 10 years) in transitional or sandhill areas and burns every 10 or more years in scrub areas (Lambert and Menges 1996, p. 133). Lambert and Menges (1996, p. 133) also recommended burning in late spring and summer, when lightning-generated fires tended to occur naturally, and when Florida golden aster would have set seed.

Population dynamics

Florida golden aster was first documented in Manatee County in 1901, and additional sites were found in Pinellas County in 1921 and Hillsborough County in 1924 (Wunderlin et al. 1981). Historically, there are no estimates as to the abundance of this species since most of the sites were impacted by extensive urbanization. Surveys conducted by Wunderlin in 1981 found plants along Bradenton Beach in Manatee County and at several sites in Hillsborough County. Most of these areas were on private land. In the 1988 recovery plan, the Service determined Florida golden aster was extirpated at sites in Manatee and Pinellas Counties, but in the late 1980s, Florida golden aster was introduced at several sites in Pinellas County. Additional surveys by Wunderlin in 1987 found plants further inland in both Manatee and Hardee Counties (Service 1988).

In 2000, there were 20 known sites throughout Hillsborough County where the plant occurred. FNAI conducted surveys in 2004 in Hillsborough County on Environmental Lands Acquisition and Protection Program (ELAPP) lands. During the 2004 surveys, FNAI was able to survey 13 of the 20 sites (Cox et al. 2004). Of the 13 sites, 7 had Florida golden aster, 1 had suitable habitat but no plants, and habitat was either cleared or destroyed at the remaining 5 sites. Of the seven occupied sites, there was an estimated 850 plants. Since the surveys took place in November when the species would be flowering, most of the plants appeared to be reproducing with seedlings and flowering adults.

In 2006, FNAI resurveyed most of the previous sites on ELAPP lands as well as additional sites in Hardee and Manatee Counties. FNAI had received reports of plants occurring on 30 sites in 2006, but was only able to survey 25 of these sites (Johnson et al. 2006). The estimated number of plants at all these sites was approximately 7,900 individuals. The sites surveyed in Hardee County were all located on private lands with an estimated 200 to 300 plants found at two of these sites. Two sites (Lake Manatee State Park and Moody Branch Mitigation Park) in Manatee County, both on public lands, had an estimated 300 plants.

Follow-up surveys in 2007 and 2008 by Bok Towers Garden (BTG), Hillsborough County staff, and FNAI found that many of the managed and protected lands in Hillsborough County have ±1,000 plants. Sites surveyed included Rhodine Scrub, Balm-Boyette Scrub, Alafia Scrub, Goldenaster Scrub (all ELAPP lands), and The FWC’s Bullfrog Creek Mitigation Park. Additional sites in Hillsborough County (Little Manatee State Park), Manatee County (Moody Branch Mitigation Park and Lake Manatee State Park), and Pinellas County (Boyd Hill Nature Preserve and Fort Desoto County Park) all have ±100 plants (Campbell 2008).

In 1986 and 1987, projects to reintroduce Florida golden aster at several sites in Hillsborough and Pinellas Counties took place using seeds collected from Summertime Lake Estates (now ELAPP Bell Creek Scrub) and Shadow Run Subdivision in Hillsborough County. Reintroduction took place at two sites in Hillsborough County (Lithia Springs and Alderman’s Ford Park); however, plants have not been found subsequently at either site (Campbell 2008). There were seven sites (Clearwater Nature Center, Boyd Hill Nature Preserve, Fort Desoto County Park, Taylor Lake Park, Anderson Park, Magnolia Falls, and Joe’s Creek) in Pinellas

County where Florida golden aster was reintroduced. Plants were reintroduced at Boyd Hill Nature Preserve in 1989 with plants cultivated at BTG. Plants were successfully reintroduced at Fort Desoto County Park from wild-collected seeds from Shadow Run Subdivision (Service 1999). In November 2008, a Service biologist conducted site visits to several of these sites in Pinellas County and determined that only three sites (Boyd Hill Nature Preserve, Fort Desoto County Park, and Magnolia Falls) supported plants. The habitat at Magnolia Falls was severely degraded and only two plants were found (Campbell 2008).

The Service funded BTG in 2007 to collect Florida golden aster seed from existing donor sites, propagate, and eventually reintroduce the plants to suitable recipient sites. Although several reintroduction sites were considered, the first planting occurred at Southwest Florida Water Management District's (SWFWMD) Cordell Site in June 2008. The donor sites for the seed collection were on protected lands (Rhodine Scrub, Alafia Scrub, Bell Creek, and Goldenaster Scrub) all owned and managed by Hillsborough County. Two additional sites owned and managed by the FWC (Bullfrog Creek Mitigation Park in Hillsborough County and Moody Branch Mitigation Park in Manatee County) were used as donor sites for seeds (Campbell 2008).

BTG undertook an analysis of seeds that were harvested in 2001, 2003, and 2005 from various sites in Hillsborough and Manatee Counties and stored at BTG with those collected in 2007 (Campbell 2008). Two hundred seeds from each site were tested to see if they were "empty" (soft, gave when lightly squeezed) or "full" (hard, did not give when lightly squeezed). All of the seed sets were found to have 50 to 55 percent full seeds (Campbell 2008). Additional seeds where collected in December 2008 at several sites in Hardee, Hillsborough, and Manatee Counties. Additional germination trials conducted in 2008 found that seeds older than 2 years are more prone to fungal outbreaks than younger seed and are less likely to germinate.

The full seeds were germinated in a warm and cold growth chamber as well as in the greenhouse. Total germination rates for the growth chambers averaged 50 percent while rates in the greenhouse were 21 percent. The total germination mortality in the warm chamber was 9 percent compared to 2 percent in the cool chamber; however, the greenhouse had the highest rate of mortality at 19 percent. Overall, the cool chamber resulted in rapid germination rates, and the highest seedling survivorship, both in trays and after being moved to larger pots and/or moved to the greenhouse environment. The warm chamber had the quickest germination rates but suffered the greatest loss once moved to larger pots and/or moved to the greenhouse (Campbell 2008).

In June and August 2008, 410 seedlings were planted at two sites at SWFWMD Cordell East. Both sites had been hydro axed and burned in July of 2006. The first site was planted with 297 seedlings and the second site was planted with 113 seedlings (Campbell 2008). An additional 86 plants will be introduced in 2009 for a total of 496 plants for Cordell East. Five hundred more plants will be introduced at the Cordell West site in 2009 for a total of 996 plants introduced at the Cordell property by the end of 2009.

On November 4, 2008, BTG, Service, and SWFWMD completed the first demographic monitoring of the newly introduced plants at Cordell East. All plants were located and data was collected on plant survival, life stage, and reproductive status. Total mortality at both sites was a low 4 percent (1 percent from the first planting and 3 percent from the second planting). Over

59 percent of the total number of plants had reproductive stalks (buds, flowers, and seedlings) (Campbell 2008). Budding and flowering percentages seem to be consistent with other sites including Balm-Boyette Scrub and the Hardee County sites. Seeds have been collected from these sites and are now being propagated at BTG for future reintroductions (C. Campbell, BTG, personal communication, 2009).

BTG also worked with three private landowners in Hardee County at sites where Florida golden aster is found, and seeds were successfully collected at these sites in December 2008 (C. Campbell, BTG, personal communication, 2009). Seeds were also collected from plants at additional sites in Hillsborough County at Balm-Boyette Scrub. These seed collections will provide additional genetic variability for reintroduction at other sites.

Reintroduction of 500 Florida golden aster at a Pinellas County park is scheduled to take place in the summer of 2009. The Service's Partners for Fish and Wildlife program is working with Pinellas County Parks and Recreation to restore the habitat prior to the reintroduction. Monitoring of this site and the Cordell sites will take place in November or December 2009.

Additional reintroduction at sites within the historic range of Florida golden aster is possible at several additional sites in Manatee and Pinellas Counties. These include Duette Park (Manatee County Park and Recreation) and Gilley Creek (SWFWMD) in Manatee County and several sites on Pinellas County lands.

Status and distribution

Historically, Florida golden aster was considered an endemic to the Tampa Bay region of central Florida, which includes Hillsborough, Hardee, Manatee, and Pinellas Counties. The historic distribution of this species could not be determined accurately since most of the suitable habitat in this region had been lost to development by the late 1980s (Service 1988, 1999). When the species was listed in 1988, it was thought to occur only in Hillsborough County and extirpated throughout the rest of its range. However, in the past 20 years, conservation lands have been acquired in Hillsborough, Manatee, and Pinellas Counties, and the Florida golden aster sites on these lands are now protected.

Past surveys conducted in 2000, 2004, and 2006 found Florida golden aster on many of the Hillsborough County conservation lands purchased through ELAPP since the program began in 1987. There are five sites acquired through ELAPP that have large populations (± 1000 plants). These include Rhodine Scrub, Balm-Boyette Scrub, Alafia Scrub, Goldenaster Scrub, and Bell Creek. Management plans for the county properties have incorporated Best Management Practices (BMP) for Florida golden aster including prescribed fire, ground disturbance, and eradication of invasive non-native vegetation. Hillsborough County continues to apply prescribed burning or mechanical treatments at most of these sites and the plants have responded extremely well. Only Alafia Scrub has not been actively managed with prescribed fire since it is located within close proximity to a major road (Interstate 75) and several homes.

Two other sites found in Hillsborough County that contain large populations are Bullfrog Creek Mitigation Park managed by FWC and Little Manatee River State Park managed by the FDEP. Bullfrog Creek Mitigation Park has had a prescribed burn in the past 5 years. Little Manatee River State Park has a 2004 management plan that recommends prescribed burning to benefit this species.

Several sites in Manatee County that support Florida golden aster are currently being actively managed. These include the SWFWMD's Cordell site, FWC's Moody Branch site, and Lake Manatee State Park. In 2006, Cordell was hydro-axed and prescribed burned to reduce the oak canopy and minimize the competition from other ground cover. In 2008, plants were reintroduced at the Cordell site, and further reintroductions will take place at additional areas at this site in 2009. Reintroduction has also been considered at Manatee County's Duette Park and SWFWMD's Gilley Creek. Both of these sites are being actively managed and provide suitable habitat for this species.

Historically Florida golden aster was found in Pinellas County prior to urbanization. Plants currently exist at two sites (Fort Desoto County Park and Boyd Hill Nature Preserve) as a result of a reintroduction in the late 1980s. Both of these sites have been managed with prescribed fire and mechanical treatments. Future reintroductions will take place at a Pinellas County park. Management of this site is slated to take place in early 2009 with reintroduction possible by the summer of 2009.

The sites with Florida golden aster in Hardee County are all found on private lands. Most of these sites are agricultural lands used to graze cattle. BTG has been working with several of these landowners to collect seed and monitor these sites. The Service's Partner for Fish and Wildlife program may be able to assist these landowners with protection of these sites.

Florida Skullcap

The following discussion is summarizied from information taken from the 5-year review (Service 2010) authored by Dr. Vivian Negron-Ortiz of the PCFO. This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews. The Florida skullcap is a perennial herb with quadrangular stemsand opposite leaves. The flowers are solitary, with a bell shaped calyx and brightlavender-blue corolla. The corolla has two lips, the lower one being white in the middle. The stigma sticks out from under the flower hood with the anthersresiding inside. Bumblebees, megachilids and halictids are probably importantpollinators. Plants flower from mid-April through early July and are most prolific after a fire.

The primary habitat of Florida skullcap is wet longleaf pine flatwoods and wetprairie, within the grassy seepage bog communities at the edge of forested orshrubby wetlands, a habitat defined as a fire-dependent community. It is alsofound in the ecotones between mesic flatwoods and swamps sites or grassymargins of wetland habitats, and somewhat disturbed wetland savanna. Florida skullcap can be found growing in full sun or light shade, and in low nutrient, acid,or sandy soil (Service 1994; Jenkins et al. 2007).

It is locally abundant in the ANF and the St. Joseph Bay State Buffer Preserve , where fire management ismaintained. This species has a strong flowering response to recent burns (Negron-Ortiz, 2009, personal observation) blooming most abundantly the spring or summer following a fire. (Negrón-Ortiz, V.2008).

Four-petal Pawpaw

Species/critical habitat description

Asimina tetramera is a 1 to 3 meters tall aromatic shrub that has one to several stems arising from a deep taproot. Leaves are oblong to oblanceolate, 5 to 10 cm long, arranged alternately on the stem, and are yellow-green to deep green. The leaves are narrow at the base (A. Cox, Florida International University, personal communication 1995), have broadly acute or blunt tips, and lack stipules. The flowers are maroon and fetid. They occur singly in the leaf axil; however, if the plant is burned or damaged, two or three flowers may develop. Perianth parts are typically in whorls of three, but may vary. The petals usually form whorls. The stamens are spirally arranged on an elevated torus or ballshaped receptacle, surrounding one to many separate carpels. After fertilization, the receptacle expands as fruit develops. The fruit is an aggregate of developing carpels, or monocarps, on the expanding receptacle. The monocarps are indehiscent and berry-like. An individual flower may produce from one to eight monocarps with one to nine seeds each (A. Cox, Florida International University, personal communication 1995). The fruit are oblong and greenish-yellow, emitting a banana-like aroma when ripe (A. Cox, Florida International University, personal communication 1995). The laterally flattened seeds are dark brown and shiny (Austin and Tatje 1979, Kral 1983).

Many flowers of *A. tetramera* are four-merous, with sepals, inner petals and outer petals arranged in groups of four (Kral 1960). Some flowers may have a combination of three and four-merous parts. Four-merous flowers are more common on *A. tetramera* than on the other *Asimina*.

No critical habitat has been designated for the four-petal pawpaw.

Life history

The species was first named and described by John K. Small and separated from other species partly on the basis of being tetramerous, or having flower parts in sets of four (Small 1933). Subsequent treatments of taxonomy have been consistent with that of Small (Kral 1960; Wilbur 1970). The Integrated Taxonomic Information System (2008) was also checked while conducting this review and did not indicate any formal changes to the name *Asimina tetramera*.

Reproduction in *A. tetramera* is sexual. The perfect flowers open before all the parts are fully developed, and mature from the base of the stem toward the developing tip. They are rotogynous, meaning that the stigmatic surface becomes receptive before anther maturation and pollen release. The petals fall from the flowers within 1 day of pollen release, and carpel development and receptacle enlargement follow successful pollination and fertilization. Flowers that are not pollinated fall soon after pollen release (A. Cox, Florida International University, personal communication 1995). Beetles are the most likely pollinators, although Dipterans (flies), Hymenopterans (wasps), and other insects have been observed visiting flowers. Gopher tortoises, and small mammals such as the Florida mouse (*Podomys floridanus*) (Jones 1989) eat the fleshy fruit and may disperse seeds. Ingestion by animals is not necessary for seed germination (A. Cox, Florida International University, personal communication 1998). *Asimina tetramera* seeds germinate from September to March. Old, stored, or dried seeds will not germinate (Service 1988, A. Cox, Florida International University, personal communication 1995). Germination may take from 1 to 8 months after the seed is planted. The root system establishes several months before shoot emergence, and two to seven leaves are produced the first year (A. Cox, Florida International University, personal communication 1996b).

Asimina tetramera plants are deciduous, or partly so, with new leaves emerging in April and continuing to develop into summer. Buds are borne in the axils of the leaves as shoots develop. Flowers occur on new growth, and flower maturation proceeds from the base of the shoot toward the tip. Damaged stems sprout, producing new growth and may flower as late as September (A. Cox, Florida International University, personal communication 1995). Flowering peaks in April and May, and continues throughout the summer, with fruit ripening in 2 to 3 months (A. Cox, Florida International University, personal communication 1995).

The four-petal pawpaw is found in scrub habitat along ancient coastal dunes only in southeast Florida (Kral 1960). Habitat management is needed to sustain this species and varies by site (Cox 2003). For example, one site is covered with exotic plant species and has experienced a severe decline in plant numbers (Cox 2003). Another site is being maintained, but park development may impact it (Cox 2003). Pawpaw plants on public sites that are being burned regularly are doing quite well (Cox 2006). Habitat restoration projects have improved approximately 373 acres of scrub and sandhill habitat with plans for improving more on Jonathan Dickinson State Park (JDSP) (Rossmanith and Nelson 2008).

Another project undertaken recently at JDSP assessed the four-petal pawpaw plants and their habitat following the 2004 and 2005 hurricane seasons (Cox and Shropshire 2007). Many mature sand pines were broken and blown down by high winds during these storms and few survived more than a year following the storms, but the shrub and ground layers were not greatly impacted (Cox and Shropshire 2007). Over half of the known pawpaw plants at this site were found during this study and most (81 percent) received very little damage (Cox and Shropshire 2007). Less than 6 percent of the plants were crushed by fallen trees (Cox and Shropshire 2007). The low number of adult plants and seedlings found following the storms did not indicate a decrease in plant numbers, but rather was the result of low detection among storm debris (Cox and Shropshire 2007). Other sites with dense pine canopies containing pawpaws in the area received similar damage, while those occurring further to the south were less impacted (Cox and Shropshire 2007).

Population dynamics

Based upon data compiled by FNAI and other sources, Peterson (2008) reported approximately 26 historically known sites where four-petal pawpaw occurred. Because 1 of these sites is in both public and private ownership, we are treating it as 2 separate locations for the purposes of this review and, therefore, presuming the total number of sites was 27.

Of these 27 sites, 6 are presumed extirpated (Peterson 2008). Of the 21 remaining, 13 are on public lands and 8 are on private lands. Three of the sites on private lands are currently being beneficially managed (Cox 2004). Of the 5 sites on private lands not being managed, at least 1 has not been surveyed since 2006 and is believed to have been developed (Cox 2006, Peterson 2008). Four of the 21 sites are introduced populations (2 of the 4 were introduced on private land), 3 in Martin County and 1 in Palm Beach County (Peterson 2008).

Previously, Cox (1998) reported the total population estimate was 1,000 individuals, which included approximately 300 plants on 6 sites in Martin County and 700 plants on 10 sites in Palm Beach County. Loring et al. (2003) did not provide an estimate of the total population size at the time of their study but indicated that pawpaws occurred on 17 sites in 3 disjunct locations with more than half of the total population located on 2 sites. Cox (2004) reported over 1,200 plants on 19 sites in July 2003. In 2006, the population was estimated to be from 1,800 to just over 2,000 individuals (Cox 2006, Cox and Shropshire 2006).

There are approximately 1,800 extant pawpaw plants in the 21 sites (Peterson 2008). Introduced sites are comprised of approximately 76 individuals (Peterson 2008). Numbers of plants per site range from 1 to 2 on some sites to over 400 on one of the public sites (Peterson 2008). The apparent overall increase in sites and population sizes over the last 10 years is thought to be due primarily to better survey techniques and discoveries of previously unknown sites rather than an actual population increase. At least three sites have been developed (Cox 2004, 2006).

Efforts have been made to augment the total population through pilot seed planting studies at several sites (Cox 2004, 2005, 2006; Cox and Shropshire 2006). Plants propagated from seed in greenhouse conditions have also been introduced to suitable habitat in both Palm Beach and Martin Counties (Cox 2005). Additionally, 134 plants propagated from seeds collected in Palm Beach County and from plants at HBS were used to genetically supplement an existing site with four plants on Federal property at the Jupiter Inlet Lighthouse Outstanding Natural Area in northern Palm Beach County in December 2008 (Cox *in litt*. 2009). Further augmentation and reintroductions are needed to support the recovery efforts for the species.

Some demographic information has been obtained. Cox and Shropshire (2007) noticed slow seedling growth between 1997 and 2006 at JDSP, which may suggest that the four-petal pawpaw is a long-lived species. Six distinct life history stages have been delineated for the species, from seedlings to senescing adults (Cox and Shropshire 2006). The population structure of pawpaws loc ted at JDSP after the 2004 and 2005 hurricane seasons was determined to be 19.4 percent seedlings, 36.0 percent juveniles, 14.4 percent adults with buds and flowers but no fruit, 23.0 percent reproductive adults with flowers and fruit, and 7.2 percent senescent adults with small flowers but no fruit (Cox and Shropshire 2007). However, this sample represented only about 51 percent of that population because pawpaws were difficult to locate beneath hurricane debris and more are expected to be found after the next prescribed burn (Cox and Shropshire 2007).

Status and distribution

Historically, four-petal pawpaw occurred in sand pine scrub habitat on the coastal dune system in Martin and northern Palm Beach Counties in southeastern Florida (Kral 1960). Although the species occurs in disjunct locations within its historic range, most of the suitable habitat has been destroyed or converted for residential housing and commercial activities (Service 1999). Trends in spatial distribution show increasing fragmentation of four-petal pawpaw habitat as the coastal ridge has become developed and fire has been suppressed. Plants remain on sites in Martin and northern Palm Beach Counties along a 30-mile stretch of coastal sand pine scrub, but are highly fragmented on the landscape (Peterson et al. 2007). Loring et al. (2003) reported plants occur in three disjunct locations, northern Martin County near Jenson Beach, southern Martin County in JDSP, and northern Palm Beach County north of PGA Boulevard. A 13-mile gap separates the sites on the northern and southern ends of the range (Peterson et al. 2007).

The remaining 21 sites are not equally distributed between the 2 counties; 9 occur in Martin County and 12 in Palm Beach County (Peterson 2008). Of the six historical sites presumed extirpated, three were in Martin County and three were in Palm Beach County (Peterson 2008).

<u>Fringed Campion</u>

Species/critical habitat description

Basic Description: A perennial which grows to 25 (or more) cm tall. Some stems are erect, but most are decumbent and rooting. The basal rosette and lower stem leaves are spatula-shaped and 3 to 9 cm long. Leaves are progressively shorter up the stem. Inflorescence is a three to five flowered terminal cluster. Petals, five, are pinkish or white in color. (Based on Kral 1983; Clewell 1985.)

No critical habitat has been designated for the fringed campion.

Life history

Reproduction Comments: This species spreads vegetatively and the number of genotypes is far fewer than the number of clusters of plants at a site (Service 1991). Terrestrial Habitat(s): Forest - Mixed, Forest/Woodland Habitat Comments: Well-drained, sandy-loam soils of deciduous woods, usually hillsides. Further, this species is usually found in mature hardwood or hardwood pine forests on river-bluffs, small stream terraces, moist slopes and well shaded ridge crest (Patrick et al. 1995).

Silene polypetala produces nectiferous flowers that suggest it is pollinated by insects and possibly by hummingbirds too. It is unknown how often sexual reproductions takes place, and it is also known that this species reproduces asexually too by producing runners (Service 1996). Since this species is clonal in nature it is difficult, if not impossible, to know how many genotypes exist in each population without molecular studies. If the numbers of genetically diverse individuals are few, this species could be vulnerable to changes that not all individuals could adapt to.

Status and distribution

This species has a very narrow range, from the Florida panhandle near the Apalachicola River (Chafin 2000) and in westcentral Georgia in the Flint and Ocmulgee River drainages (Patrick et al. 1995). It is known in Bibb, Crawford, Decatur, Talbot, Taylor and Upson Counties in Georgia, and Gadsden and Jackson Counties in Florida (Service 1996c)

Gentian Pinkroot

The following discussion is summarizied from information taken from the 5-year review (Service 2009h) authored by Dr. Vivian Negron-Ortiz of the PCFO. This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews.

At the time the species was listed, only three populations from Florida were known. Since then, additional populations have been found in Florida, two sites are considered to be extirpated, and new findings have extended the species range into Alabama. In addition, two varieties have been recognized (Gould 1996). Liberty and Levy Counties were included as part of *S. gentianoides* distribution (Wunderlin 1980), but the collection was subsequently determined to be *S. loganioides* (Wunderlin, 2005, personal communication).

Fire management practices (*i.e.*, winter burns), implemented by TNC on their property (Calhoun County) and reduced soil disturbance practices, have resulted in a slight increase of var. *gentianoides*. In Geneva State Forest, var. *gentianoides* responded well to growing season prescribed fire with plants flowering about 7 to 8 weeks after the burn. Similarly, growing season prescribed burns have been implemented at the State Recreation Area for several years and the population remains large and is increasing in numbers.

Godfrey's Butterwort

The following discussion is summarizied from information taken from the 5-year review (Service 2009i) authored by Dr. Vivian Negron-Ortiz of the PCFO. This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews. Pinguicula ionantha grows in the Florida panhandle between Tallahassee and Panama City (Godfrey and Wooten 1981; FNAI 2008). Originally the Recovery Plan (1994) only reported the species in Bay, Franklin, Gulf, and Liberty Counties, however, herbarium specimens confirm the species was also found in Wakulla County. In addition, the geographical distribution has been extended to Calhoun County based on an observation by A. Johnson (FNAI) in 2004 of 20 plants.

Based on information provided by FNAI (2008) and recent surveys, there were 83 historically documented occurrences. Subsequent surveys in 2008 were unable to locate plants at 43 percent of those sites.

This species appears to be declining in population. It is worth noting the area has been under severe drought in the 4 years prior to 2008, which could have contributed to the decline. (T. Miller, Florida State University, 2009, personal communication). It is locally abundant in the ANF, where fire management is maintained. (Service 2009i).

Harper's Beauty

The following discussion is summarizied from information taken from the 5-year review (Service 2009j) authored by Dr. Vivian Negron-Ortiz of the PCFO. This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews. Originally, the Recovery Plan (1983) reported the species for Liberty County. Since then, the geographic distribution has extended to Franklin and Bay Counties (FNAI 2008; Keppner and Anderson 2008). In addition to the geographic distribution, the number of populations has increased from 3 to 16 (Service 1983; FNAI 2008, L. Kirn, unpublished data) due to better surveys. Most populations occur inside ANF. Harper's beauty has an extremely narrow distribution. The FDEP ranks this species as FACW, indicating Harper's beauty is a facultative wetland species (*i.e.*, usually occurs in wetlands but may be found occasionally in uplands). Soils in these habitats are hydric, generally high in sand and peat, and strongly acidic. About 85 to 98 percent of herb bog habitat has been estimated to be lost(Folkerts 1982); consequently, the rarity of this species' habitat is a limiting factor.

Harper's beauty occurs in fire-prone habitats. Walker and Silletti (2005) suggested fire might be important for promoting growth and fecundity by increasing availability of nutrients and light. Lack of fire, or reduced fire frequency, and subsequent growth of shrubs and saplings in the understory, reduces *H. flava* abundance in areas where it was previously at high density (Negron-Ortiz, 2007, personal observation).

Seed germination and seedling establishment are not understood. If matured ovules lack dormancy (Wagner and Spira 1996), perhaps a persistent seed bank is not present, and if the established individuals are eliminated, a population cannot re-establish itself. Suppression of fire continues to threaten the pineland and savanna's flora as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson andHartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Lack of fire, and subsequent growth of shrubs (particularly encroachment of *Cyrilla racemiflora* L., commonly known as swamp titi) and saplings in the understory, inhibits this species emergence (Negrón-Ortiz, 2008, personal observation; FNAI 2008), reducing its abundance in areas where it was previously observed in great quantities (FNAI 2008). Therefore, frequent prescribed burnings are needed to maintain optimal habitat for *H. flava* populations.

Highlands Scrub Hypericum

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008e). The 5-year review builds upon the detailed information in the MSRP and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/HighlandsScrubHypericum.pdf

Species/critical habitat description

Highlands scrub hypericum is a small, short-lived perennial herb reaching 20 to 70 cm (8 to 30 inches) in height. It is branched from the base and has a woody, fibrous root system. The stems are shorter and more numerous in winter and spring before reproductive stalks develop. Usually there are three stems, but there can be as many as 17 stems on a healthy plant (Quintana-Ascencio and Morales Hernández 1997). During the reproductive season, all stems of mature individuals bear flowers and fruits. The leaves of Highlands scrub hypericum are opposite, simple, entire, and needle-like. Flowers are small, bisexual, and arranged in cymes. The calyx consists of five distinct sepals, while the corolla consists of five bright yellow petals that are asymmetrically shaped like the blades of a propeller. There are approximately 27 anthers. The gynoecium has 3, sometimes 4 locules, and the ovary is superior with approximately 22 ovules aligned around the walls of the ovary (parietally). The style has three, sometimes four, white lobes. Fruits are small capsules, red when immature and dark purple at the time of dehiscence. Mature seeds are small and dark brown.

No critical habitat has been designated for the Highlands scrub hypericum.

Life history

Because Highlands scrub hypericum has many-flowered stems, a single large plant can have as many as 1,600 reproductive structures (fruits, flowers, or buds) by the end of the reproductive season (Quintana-Ascencio and Morales Hernández 1997). Flowers are exposed one at a time or in small numbers (up to eight per branch) each day. The new flowers open early in the morning and the petals curl up by noon depending on the weather. This species is self-compatible, but the flowers must be visited by pollinators to set seed (ABS 2003). The mature purple capsules remain attached to the stem after releasing seeds. Seeds do not show any obvious primary dispersal mechanism and probably are dispersed passively by gravity.

"Native solitary bees (*Dialictus* spp. and *Augochloropsis* spp.) appear to be the primary pollinators. Other visitors include *Geron* sp., *Copestilium nigrum*, and *Bombus* sp. Pollinator visitation occurs at similar rates regardless of flower or plant density" (ABS 2003, citing Boyle and Menges 2001; M. Evans, personal communication *in* Quintana-Ascencio et al. 1998). Most flowering and fruiting occurs between June and September, coinciding with the rainy season and daily thunderstorms typical of the region. Stems dry at the end of the reproductive season and new ones sprout from the base in late winter and early spring. Germination occurs from November through June, but most seedlings germinate between December and February. Plants reach maturity in as little as a year.

Highlands scrub hypericum inhabits Florida scrub vegetation on upland areas with excessively-drained white sand soil (Judd 1980a). It is almost exclusively found in rosemary balds - patches of bare sand surrounding Florida rosemary within scrub vegetation. It shares these bare patches with a number of other small scrub endemic herbs, grasses, and even a few small shrubs (Christman and Judd 1990). Rosemary balds have a fire frequency from 10 to 100 years

(Myers 1990) while the surrounding scrubs have higher fire return intervals. Occasionally, Highlands scrub hypericum occurs in openings in well-drained scrubby flatwoods or with turkey oak on yellow sand soil (P. Quintana-Ascencio, ABS, personal communication, 1995). Where found, it is locally common and can occur in large groups of several thousand individuals (Judd 1980a).

Highlands scrub hypericum is one of a suite of herbs (and a few grasses) that inhabit sunny, sandy gaps between the shrubs that dominate scrub vegetation. Many of these gap-inhabiting species are endemic to the LWR. The gap size requirements of Highlands scrub hypericum appear to be intermediate between those of two other co-occurring rosemary scrub plants: snakeroot, which is restricted to large openings (Menges and Kimmich 1996); and wireweed, which is found in large and small gaps between shrubs (Hawkes and Menges 1995). Highlands scrub populations have a high degree of genetic differentiation among populations (Menges et al. 2001).

Population dynamics

Most populations of Highlands scrub hypericum are relatively small. The median size for 34 populations was 539 individuals, and most populations were smaller than 1,000 plants (Menges et al. 1998). A population viability model (Quintana-Ascencio et al. 2003) concluded that "fire kills aboveground individuals, but seeds in the soil survive fire and form long-lived seed banks. Fire suppression and alteration of fire regimes constitute a threat for this species because of its dependence on fire to release local populations from competitive exclusion" (ABS 2003). "After fire in Florida rosemary scrub, *Hypericum cumulicola* [Highlands scrub hypericum] had higher fecundity, survival, establishment, and population growth rates than in unburned populations" (Quintana-Ascencio et al. 2003). This may be due to a number of mechanisms, including killing back of shrubs, removal of lichens, destruction of allelopathic agents that affect seed germination, and the creation of open gaps that may have higher levels of soil water (Quintana-Ascencio et al. 2003). The seed germination rate for this species is extremely low except at recently-burned sites (Quintana-Ascencio et al. 2003).

The most critical life-history stage influencing Highlands scrub hypericum's population growth rate and fitness is seed survival in the soil seed bank. The next-most-important life-history stage is seedling recruitment (Quintana-Ascencio et al. 2003). Massive recruitment of plants in favorable patches and in favorable years allows Highlands scrub hypericum populations to "increase rapidly and/or replenish the soil seed bank. Similar population explosions are documented in other short-lived perennials (Picó et al. 2002) and annual plants with a seed bank (Kalisz and McPeek 1992), which are able to cope with high or unpredictable environmental variation" (Quintana-Ascencio et al. 2003). The survival of Highlands scrub hypericum populations in fire-dependent habitats thus depends on the seed bank, while seedling recruitment is highly variable and depends on environmental cues (Picó et al. 2003).

A population viability assessment model (Quintana-Ascencio et al. 2003) strongly also affirms that fire is essential for Highlands scrub hypericum to persist over the long term. Even the largest populations may be imperiled by fire intervals greater than 50 years. Smaller populations are more vulnerable to lack of fire. These authors consider fire suppression and alteration of fire regimes to constitute threats to this species "because of its dependence on fire to release local populations from competitive exclusion" (Quintana-Ascencio et al. 2003; Quintana-Ascencio and Morales Hernández 1997; Quintana-Ascencio and Menges 2000). In planning fire regimes for scrub, it is important to take into consideration the needs of multiple plant and animal species. Management that alternates short and long fire intervals may allow species to coexist, while invariant fire return intervals may harm some species (Quintana-Ascencio et al. 2003).

Researchers at ABS have developed spatially explicit disturbance-demographic models of Highlands scrub hypericum. "This spatially explicit, individual-based model improves the precision of prior matrix projections that did not include Florida rosemary or spatial structure. It allows prediction of ranges of Florida rosemary densities that will allow scrub hypericum populations to persist under various fire regimes." The model's predictions agreed with "observed differences in scrub hypericum disappearance among gaps with contrasting rosemary densities but similar times-since-fire," so this modeling approach is likely to prove useful in predicting the effects of fires and other disturbances, including mechanical treatments of overgrown scrub, such as roller-chopping (Quintana-Ascencio et al. 2004).

Status and distribution

Highlands scrub hypericum has a narrow distribution at the southern end of the LWR in Highlands County. Early inventories of LWR endemic plants found this species at few sites – only 69 of 254 scrub sites surveyed by Christman (1988) (ABS 2003). This severely restricted range, combined with continuing habitat loss, led to its listing.

Highlands scrub hypericum is locally abundant, with populations larger than a thousand plants and presumably large seed banks in the soil at ABS, the properties of the LWRWEA (including Lake Placid, Holmes Avenue, Lake Apthorpe, and Carter Creek), Lake June-in-Winter Scrub State Park, TNC's Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWR State Forest. On these lands, Highlands scrub hypericum has benefited from fire-oriented land management practices and insights provided by the intensive demographic research program at ABS.

<u>Lewton's Polygala</u>

Lewton's polygala was federally listed as an endangered species on April 27, 1993 (58 FR 25746; Service 1993). Critical habitat has not been designated. The species is listed as endangered by the State of Florida. In addition to the assessment below, a 5-year review was completed in 2010 resulting in no change to the species designation as endangered (Service 2010e). The 5-year review builds upon the detailed information in the MSRP and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/20100806%20Lewton's%20polygala%20Five-Year%20Status%20Review.pdf

Species/critical habitat description

Lewton's polygala, a member of the milkwort family (Polygalaceae), is an herb reaching a height of 20 cm (8 inches). It produces one to several annual stems, which are spreading, upward curving or erect, and are often branched. The leaves are small, sessile, and tend to overlap along the stem. Three types of flowers are produced – aboveground open-pollinated (CH) flowers, aboveground self-pollinated flowers that do not open (aboveground CL), and belowground closed self-pollinated flowers that do not open (belowground CL) (Weekley 1996). CH flowers are in erect, loosely five flowered racemes about 1.5 cm to 3.3 cm (0.6 to 1.2 inches) long. Each flower is about 0.5 cm (0.2 inches) long and bright pink to purplish-red. Two of the five sepals are enlarged and wing-like, between which the largest of the three petals forms a keel that ends in a tuft of finger-like projections. This species is closely related to the widespread *P. polygama*, which forms larger clumps and has a longer root, narrower leaves, and differently shaped wing sepals (Wunderlin et al. 1981).

Lewton's polygala occurs almost exclusively on yellow sands in sandhill (high pine) and oak-hickory scrub (Menges and Weekley 2003), and transition zones between these two communities. In the ONF, Lewton's polygala but also in scrub in areas that probably were former sandhill sites prior to logging and fire suppression (C. Weekley personal communication 2010a).

No critical habitat has been designated for the Lewton's polygala.

Life history

Lewton's polygala is a relatively short-lived (5 to 10 years) perennial (TNC 2008, Weekley and Menges, submitted). Lewton's polygala is amphicarpic, producing flowers and fruits above and below ground (Menges and Weekley 2002). It produces three kinds of flowers: aboveground open-pollinated CH flowers, belowground self-pollinated CL (CL) flowers, and aboveground self-pollinated CL flowers (Menges and Weekley 2003). CH flowers are usually produced in the spring; CL are usually produced in the summer or fall. However, observations suggest that flowering periods for both CH and CL flowers are variable, and that sexual reproduction is not confined to a specific season (Menges et al. 2008).

While self-fertilization occurs in Lewton's polygala, it appears to be a less-reliable mechanism for seed production than insect pollination. Insect pollination increases the fruit set of CH flowers (Weekley and Brothers 2006). Prominent pollinators include bee-flies (Bombyliidae), flower flies (Syrphidae) and leaf-cutter bees (Megachilidae) (Menges et al. 2006).

Lewton's polygala seeds have a fleshy appendage called an elaiosome which is a protein- and lipid-rich body common among ant-dispersed seeds. The elaiosome attracts ants, which presumably benefit the plant by distributing the seeds to appropriate microsites. At least eight species of ants collect seeds of Lewton's polygala, the most frequent being *Pheidole morrissii* (Menges and Weekley 2002, 2003).

Lewton's polygala is one of only a few dozen amphicarpic angiosperms known worldwide, among them several species of *Polygala* (James 1957). Amphicarpy is viewed as an adaptation for reproduction in uncertain habitats, for example, producing seeds underground where they have better chances of surviving fire (Cheplick and Quinn 1982) and are protected from herbivory (Menges and Weekley 2003).

Population dynamics

Fire is the predominant natural disturbance in Florida and a primary driver in the demography of all Florida scrub and sandhill plants that have been studied (Menges 2007). Plants of Lewton's polygala are consumed by fire and post-fire resprouting is extremely rare (Weekley and Menges 2003). The beneficial effects of fire on Lewton's polygala include removal of litter, competing vegetation, and ground lichens (Menges and Weekley 2004). Usually, Lewton's polygala responds to fire with abundant seedling recruitment (Menges and Weekley 2003), which often results in populations increases of at least one order of magnitude (Menges and Weekley 2005). For example, Menges and Weekley (2003) documented an 800 percent increase following the 2001 prescribed fire at the Carter Creek unit of the LWRNWR.

Demographic monitoring indicates that: (1) seedling recruitment is markedly higher in burned than unburned areas for the first 6 months post fire; (2) survival was higher for plants that recruited in burned plots; (3) plants in burned areas reach reproductive age more quickly; (4) burned microsites have greater plant density than unburned ones; and (5) any increase in density-dependent mortality is outweighed by the first three benefits. Menges et al. (2006) recommend that fire frequencies for Lewton's polygala be at least every 4 years, due to the rapid decline in population size as time-since-fire increases.

The response of Lewton's polygala may vary from one fire to another depending on post-fire precipitation patterns, with lower seedling recruitment when fire occurs during drier seasons (Menges et al. 2009). Higher rates of recruitment are observed in El Niño winters, when rainfall is greater and temperatures are lower than average (Weekley and Menges, submitted). Major seedling recruitment events are linked to winter rainfall (Menges and Weekley 2003) and about 75 percent of all seedling recruitment occurs between October and March (Menges et al. 2007).

Evidence suggests a persistent seed bank is important to post-fire recovery of Lewton's polygala populations (Weekley and Menges, submitted). Seeds can remain intact within the soil and retain viability for at least 2 years (Menges and Weekley 2004). They are capable of surviving short-term heat pulses lethal to living cells, which underground seeds might be subjected to during fire (Menges and Weekley 2004). The chemical compounds in smoke may also cue or improve seed germination (Lindon and Menges 2008). Populations occurring at sites with a long period of fire suppression may retain the potential for dramatic increase. For example, Menges and Weekley (2002) reported a dramatic increase in seedling recruitment following a fire on a sandhill site that had not burned in 60 years. Data from long-unburned populations suggest that even small (fewer than 50 plants) populations can persist without fire through occasional small-scale seedling recruitment events (Menges et al. 2007).

Status and distribution

Lewton's polygala occurs in sandhill (high pine) vegetation and Florida scrub of the Lake Wales and MDRs in Highlands, Polk, Osceola, Orange, Lake, and Marion Counties of central Florida.

The 5-Year Status Review for Lewton's polygala identified 49 extant occurrences and 6 that are presumed extirpated (Service 2010e). Of the 49 extant occurrences, 32 (65 percent) are protected on publicly owned land (23 occurrences) or private conservation land (9 occurrences). Protected occurrences span 13 different managed areas. Seventeen of 49 extant occurrences (35 percent) are located on private property (excluding those on private conservation lands) where they have no protection from development and are threatened by lack of fire and other management. The status of 14 of the 17 unprotected occurrences on private property is uncertain. See the Lewton's polygala 5-year Status Review (Service 2010e) for descriptions of known occurrences on private land.

Lewton's polygala occurs within the following managed areas : ONF (USFS), Scrub Point Preserve (LCWA), Warea Tract of the Seminole State Forest (FDOF), Allen D. Broussard Memorial Catfish Creek Preserve (FDEP), Horse Creek Scrub (District), Pine Ridge Preserve (BTG), Tiger Creek Preserve (TNC), Crooked Lake Sandhill (Polk County), LWR State Forest - Arbuckle, Walk-In-Water, and Hesperides tracts (FDOF), Carter Creek unit of LWRWEA (FWC), and the Carter Creek unit of LWRNWR (Service).

The distribution of Lewton's polygala has decreased over the past 100 years as the central Florida has been transformed by commercial and residential development. Large-scale destruction of upland habitat on the LWR began in the 1880s. Citrus growers favored yellow sands and many sites potentially supporting Lewton's polygala were converted to citrus production in the early decades of the 20th century. Weekley et al. (2008) estimated 78 percent of the xeric upland habitat on the LWR was destroyed by1990, and greater than 85 percent by 2006, mainly due to agriculture, ranching, and commercial and residential development.

Habitat loss has played a large role in the current abundance and distribution of Lewton's polygala. The loss and fragmentation of habitat has resulted in scattered, mostly small, populations. All known occurrences are protected in the northernmost portion of the species range in Marion County, but a gap in protection exists in Lake, Orange, and Osceola Counties (approximately one-fourth of the range of Lewton's polygala), where only 2 of 14 occurrences are protected.

Longspurred Mint

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008f). The 5-year review builds upon the detailed information in the Recovery Plan for Three Florida Mints (1987) and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/LongspurredMint.pdf

Species/critical habitat description

Dicerandra is a genus of seven species in the mint family (Lamiacea or Labiatae). Four species are annuals and three are shrubby, with woody bases and non-woody flowering shoots. Each has a strong minty odor. The three shrubby species are endangered. *D. cornutissima* grow to 1.6 ft tall and have sharply bent corollas with dark reddish- purple spots. This species has purple-rose flowers with geniculate floral tube in whorls on elongated flowering stems (Wunderlin 1980). Although this species has been confused with the related *D. fructescens*, this species is easily distinguished by its narrow leaves, purple-rose corolla, style with few hairs or naked, and anther appendage usually over 1mm long. Flowering occurs in September and October.

No critical habitat has been designated for Longspurred mint.

Life history

D. cornutissima is endemic to sand pine scrub habitat that can best be described as scrub composed of overstory of older mature sand pine (*Pinus clausa*), with an open to thick understory of sand live oak (*Quercus geminate)*, Chapman's oak (*Q. chapmanii)*, myrtle oak (*Q. myrtifolia)*, saw palmetto (*Serenoa repens)*, scrub palmetto (*Sabal etonia)*, Florida rosemary (*Ceratiola ericoides)*, and the state listed *Garberia heterophylla* (Herring 2005). The ground cover component of this habitat is composed of patchy occurrences of lichens (*Cladina evansii, Cladina subtenuis,* and *Cladonia leporine)*, as well as grasses such as wiregrass (*Aristida stricta)*, arrowfeather threeawn (*Aristida purpurescens*), and sandy field beaksedge (*Rhynchospora megalocarpa)*. *D. cornutissima* grows well in open, sandy patches usually along roadside edges. Although *D. cornutissima* occurs in a fire-adapted habitat, the timing of fires related to the plants survivorship and reproduction is not known (Herring 2005).

At the Cross Florida Greenway (CFG), *D. cornutissima* mostly occurs within sand pine-dominated scrub that has a mosaic of sandhill throughout the site (Herring 2005). The overstory is open, consisting of mostly sand pine, but longleaf pines are occasionally found. Fire suppression in the sandhill has led to an invasion of sand pine, but prescribed burning of this area needs to be conducted carefully, since response of *D. cornutissima* is unknown (Herring 2005). Menges (1992) found that a similar species, *D. frutescens,* a short-lived perennial is killed by fire and re-establishes vigorously from seed. Weekley (2006) notes its close relative *D. christmanii* is also killed by fire and re-establishes from seed. There has recently been research (K. Holsinger, University of Connecticut, unpublished data, 2008) to show that longer intervals of fire (more than 12 years) may be optimum for these species. Therefore, research on the similar *D. frutescens,* which grows in yellow sand scrub at ABS on the LWR, should be considered to elucidate the effects of fire on *Dicerandra* species and help refine prescribed burning activities (A. Johnson, FNAI, personal communication, 2008).

Further east on the CFG, along the Interstate 75 right-of-way, and Marion Oaks and Ocala Waterway Estates subdivisions, *D. cornutissima* occurs along roadside edges, its preferred habitat (Herring 2005). Care must be taken along these edges to not move dirt, mow, and establish fire lines with heavy equipment (Herring 2005). There are plans at CFG to manage the scrub habitat using mechanical means to open the habitat and reduce the sand pine. Due to the close proximity of Interstate 75 to this site, prescribed burning is extremely difficult. The Office of Greenways and Trails recently completed a management plan for CFG that has goals and objectives to protect, enhance, and increase *D. cornutissima* found on the site (FDEP 2007).

Population dynamics

D. cornutissima was originally found in Marion and Sumter Counties. Currently *D. cornutissima* is only known to occur at four sites in Marion County: CFG, along the Interstate 75 right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision. A survey of the historic locations of *D. cornutissima* in Sumter County was conducted in 1984 and no plants were found (Wunderlin 1984). FNAI has a record of *D. cornutissima* south of Marion Oaks along a powerline in Sumter County in 1988. The site along the powerline was discovered after the recovery plan was written in 1987. The recovery plan states there was no suitable habitat left at the sites surveyed in 1984 in Sumter County, although suitable habitat may still exist between Sumter County and southern Marion County. (Service 1987d; Wunderlin 1984). Other FNAI records include plants on private lands in Marion County near Rainbow Lakes Estates in 1993 and along SR 200 (Bahia Oaks development) in 1991 (FNAI 1996a). No surveys of these sites have occurred since the early 1990s. Adjacent protected lands (Ross Prairie State Forest, Halpata Tastanaki Preserve, and Potts Preserve) have been surveyed the past 5 years but no *D. cornutissima* have been located in suitable habitat at these locations (A. Johnson, FNAI, personnel communication, 2008).

Monitoring of *D. cornutissima* has occurred as recently as 2008 at the CFG and the Interstate 75 right-of-way. At CFG over 14,000 plants were found and along the Interstate 75 right-of-way 731 plants have been documented. The two sites on private lands in Marion County (Marion Oaks and Ocala Waterway Estates subdivisions) have had periodic surveys but no long-term monitoring has occurred.

In 1975, *D. cornutissima* was first documented along the Cross Florida Barge Canal (now CFG) in sand pine scrub (Florida Game and Fresh Water Fish Commission 1976). This area at CFG was thought to have been extirpated in 1981; however, surveys in 1988 on the CFG Canal lands found six additional areas of *D. cornutissima* including the one area previously recorded in 1975 (Johnson 1988). In 1991, the Canal Authority transferred the land to the CFG. FNAI was then contracted to conduct a biological inventory in which they found four areas with this species where it had previously been found during the 1975 and 1988 surveys (Knight et al. 1991).

From 2001 to 2005, CFG again funded FNAI to conduct exotic and rare plant surveys at on their properties mentioned above, which included looking for areas with *D. cornutissima*. Five areas were located; three were historic areas already recorded with FNAI (Herring 2005).

Most recently (2007 to 2008), FNAI was contracted by CFG to perform a natural community mapping survey of the CFG. Also included in the mapping survey of natural communities were rare and exotic species surveys. Since the 2001-2005 surveys, the CFG had acquired additional land and *D. cornutissima* was found to occur at some of those new acquisitions. In particular, additional *D. cornutissima* were documented within Marion County, north and west of the Interstate 75 CFG Landbridge within a tract called “the triangle.” *D. cornutissima* follows the western boundary of the CFG triangle along both sides of a firebreak that serves as an ecotone between the CFG scrub and what was (or currently is) the Ocala Waterway Estates subdivision. *D. cornutissima* also follows an east/west southern boundary of the triangle scattered along an open and deep, white, sandy road that borders sandhill. The eastern edge of the triangle borders the western side of Interstate 75 where additional *D. cornutissima* occur.

Since the first *D. cornutissima* survey of the CFG Canal (1975) to the present survey of the CFG (FDEP 2008b), many *D. cornutissima* have been documented on this site. The majority of *D. cornutissima* at the CFG occurs west of Interstate 75 in the canal diggings along an east/west road within sandhill and scrub habitats. As described in the preceding paragraphs, *D. cornutissima* was also recently documented occurring along a north/south and southern boundary road of the triangle tract in primarily scrub habitat. East of Interstate 75, *D. cornutissima* has only been located in a few localities. Historically, before the habitat centering around what is now Interstate 75 in Marion County was urbanized (pre-interstate, Barge Canal, and housing subdivisions), the land was unfragmented and *D. cornutissima* probably occurred naturally throughout the scrub and sandhill in openings. Perhaps there was only one area of *D. cornutissima,* a huge and unfragmented occurrence. Today, it might be correct to consider *D. cornutissima* occurs in Marion County as a single area that has been fragmented from the Barge Canal diggings and associated roads, housing subdivisions, and Interstate 75. An estimate of the current number of *D. cornutissima* individuals on the CFG is approximately 14,222 plants (Herring, FNAI, personal communication, 2008).

In 1995, *D. cornutissima* was inadvertently impacted by construction of stormwater swales associated with road widening along Interstate 75 in Marion County. To mitigate these impacts, the FDOT agreed to leave sod off the new swale backslopes and investigate techniques to restore this species in suitable areas along Interstate 75. FDOT conducted a small study with three test plots in one of the excavated backslopes. One plot was sown with collected *D. cornutissima* seeds, one plot was planted with nursery-grown seedlings, and one plot was left unplanted. Both of the planted plots achieved high seedling survival (although germination rates were low), and more *D. cornutissima* grew in these plots than in the unplanted plot. However, because of the small numbers of plants and the lack of replicates to test the variables among the plots, it was not possible to determine if active planting is superior to passive recruitment. Many new plants were informally observed growing in the un-sodded backslopes outside the test plots, and in 2005, surveys located additional plants outside the test plots along both the west and east sides of Interstate 75 in Marion County (Herring 2005). The successful seedling survival in the planted plots holds promise for re-establishing extirpated populations in areas where habitat has been restored.

During the 2005 FNAI survey, a total of 731 *D. cornutissima* plants were documented on the Marion County, FDOT Interstate 75 right-of-way with 344 plants occurring along the west side and 387 plants recorded on the east side of the interstate. Some of the *D. cornutissima* along the west side of Interstate 75 have spread under the CFG boundary fence where there are openings in the thick scrub there.

Dicerandra cornutissima was also historically located north and south of the CFG in the Marion Oaks subdivision and Ocala Waterway Estates subdivisions. Although the 1987 recovery plan documented several thousand plants at both sites (Service 1987d), no recent surveys have been conducted. There were two general areas within Marion Oaks where *D. cornutissima* were found, the northern end along County Road 484 and the southern end near the Sumter County line. Habitat loss from an increase in development has occurred at these sites in recent years, so additional surveys should be conducted to determine if these areas are still occupied and to what extent. Historic records show that *D. cornutissima* also was found at Rainbow Lakes Estates (1993) and along SR 200 near the Bahia Oaks development (1991) in Marion County, as well as, south of Marion Oaks along a powerline in Sumter County (1988). Surveys are needed to determine if these areas are still occupied by *D. cornutissima.*

Status and distribution

When listed in 1985, *D. cornutissima* was only found at four locations, along Interstate Interstate 75, CFG Canal, and two residential subdivisions (Ocala Waterway Estates and Marion Oaks). *D. cornutissima* still occurs at these sites. Within Marion Oaks subdivision, this species was found along the northern end near County Road 484 and southern end (about 4 miles south) near the Sumter County line. In 1938 and 1946, *D. cornutissima* was found in northern Sumter County 7 miles south of the Marion Oaks Subdivision. In 1984, no suitable habitat was found at these sites when surveyed (Wunderlin 1984). Other historic locations include areas south of Marion Oaks along a powerline in Sumter County (1988), near Rainbow Lakes Estates (1993) in Marion County, and along SR 200 near the Bahia Oaks development (1991) in Marion County. Only the site near Rainbow Lakes Estates appears to still have suitable habitat (A. Johnson, FNAI, personal communication, 2008). However, surveys are needed to determine if these areas are still occupied by *D. cornutissima*.

Dicerandra cornutissima was originally found along the right-of-way of the CFB Canal in 1975 (FWC 1976). This population was thought to have been extirpated in 1981; however, Johnson located it in 1988 at several other locations along the CFB Canal. In 1991, after the CFB Canal Project was abandoned, the property was acquired by the State of Florida and leased to the FDEP and is now managed by the Office of Greenways and Trails. A biological inventory of CFG was conducted in 1991, which located the same areas with *D. cornutissima* during the 1975 and 1988 surveys of CFG (Knight et al. 1991). Surveys conducted by FNAI from 2001 to present have located this species along additional roads and the old barge canal right-of-way (Herring 2005).

Along the Interstate 75 right-of-way, *D. cornutissima* is currently being managed by FDOT. FDOT has managed these sites by avoiding mowing in areas occupied by this species as well as eradicating invasive cogon grass at many of the sites where *D. cornutissima* occurs along Interstate 75. The densest populations of *D. cornutissima* appeared in the viewsheds of several billboards and along the fence lines after the impacts from the roadside construction occurred. The vegetation in the billboard viewsheds appeared to be maintained at a few feet in height, possibly by bush-hogging every few years, and the fence lines were disked by FDOT every few years. Shortly thereafter, the billboards were removed and the viewsheds are no longer maintained, and disking along the fence line was discontinued. The density of *D. cornutissima* appears to have decreased in both the former viewsheds and along the fence lines (Stephen Tonjes, FDOT, personal communication, 2008).

In 1987, two large tracts of privately owned land that make up the Marion Oaks and Ocala Waterway Estates subdivisions contained the largest populations of several thousand plants each (Service 1987d). During the late 1980s and early 1990s, both subdivisions were more or less abandoned; however, development has begun to increase in both of these areas. *D. cornutissima* was found historically along the road rights-of-way in the sand pine scrub in these subdivisions. The current distribution of this species is unknown at these sites.

Okeechobee Gourd

The following discussion is summarized from the final listing rule (50 FR 29345), the MSRP (Service 1999a), the 5-year status review (Service 2009g), and from recent research publications and monitoring reports.

Species/critical habitat description

The Okeechobee gourd is an annual or perennial, fibrous-rooted, high-climbing vine with tendrils, belonging to the gourd family (Cucurbitaceae). It possesses heart- to kidney-shaped leaf blades, with 5 to 7 angular, shallow lobes, and irregularly serrated margins (Walters and Decker-Walters 1993). Young leaves are covered with soft hairs. The stems produce adventitious roots at the nodes and will separate from the parent plant if they contact soil or water (Minno and Minno 1995). The cream-colored flowers are bell-shaped, with the corolla (petals) 2.25 to 2.75 inches long. They can be distinguished from flowers of *C. martinezii* (Martinez gourd) by the presence of dense pubescence on the hypanthium of the male flower and on the ovary of the female flower. The light green gourd is globular or slightly oblong, with 10 indistinct stripes, and hard shelled with bitter flesh. The seeds are gray-green and flat (Small 1930; Tatje 1980; Walters and Decker-Walters 1991). Morphological differences in fruits have been noted between the Lake Okeechobee and St. Johns River populations (Minno and Minno 2006c). Results indicated that fruits from the St. Johns River population are longer than they are wide while those of the Lake Okeechobee population are wider than they are long with some overlap between populations (Minno and Minno 2006c). There are also some other differences (*e.g.*, fruit coloration; peduncle width, length, and hair coverage) (Minno and Minno 2006c).

Small (1922, 1930) originally described the gourds he found in the pond apple (*Annona glabra*) forest surrounding Lake Okeechobee as *Pepo okeechobeensis*. Bailey (1930) transferred the Okeechobee gourd to the genus *Cucurbita*, which includes pumpkins and squashes. Bailey (1943) subsequently described two new gourd species, *C. martinezii* and *C. lundelliana*. These two gourds were proven to be closely related to the Okeechobee gourd. Closely related gourds with cream-colored corollas (all others in the genus *Cucurbita* are bright yellow) are found in Florida and in Mexico, near the Gulf Coast. The Florida plants were described as the Okeechobee gourd (Bailey 1930), and the Mexican plants were designated (Bailey 1943) as the Martinez gourd (*C. martinezii*). However, Robinson and Puchalski (1980) showed through isozyme analysis that there was only a single allelic difference between the two varieties.

A later study by Walters and Decker-Walters (1991), also using isozyme analysis, showed a difference of just one allele. However, they calculated an estimated time since divergence of about 450,000 years between the Martinez and Okeechobee gourds, and concluded that they should be considered distinct at the subspecies level. Walters and Decker-Walters (1993) rearranged the nomenclature, designating the Florida gourds as *Cucurbita okeechobeensis* (Small) Bailey ssp. *okeechobeensis*, and assigning the Mexican gourds to the subspecies *C. okeechobeensis* ssp. *Martinezii* (Bailey) Andres and Nabhan ex T. Walters and Decker Walters. The Service concurred with this finding, and because the Act allows protection of distinct subspecies, the Okeechobee gourd was subsequently listed as endangered.

No critical habitat has been designated for the Okeechobee gourd.

Life history

The flowers of Okeechobee gourds open at dawn and, although specific pollinators have not been identified, a variety of insects are likely to be available including bees, flies, and squash beetles. Preliminary information indicates that pollination may be a problem for this species, especially in small colonies. Typically, male flowers outnumber female flowers, and where pollinators are rare, decreased fruit set may be observed (Minno and Minno 1998). In at least one collection of Okeechobee gourd, flowers must be pollinated by hand to insure fruit set (T. Race, BTG, personal communication 1998).

The two populations of Okeechobee gourd appear to exhibit some different demographic features. Plants from the Lake Okeechobee population that grow on the spoil islands appear to be annuals, lasting just one season, whereas plants from the natural islands of Lake Okeechobee and along the St. Johns River are perennials and tend to grow for several years before dying back (Minno and Minno 2006c). The reason for this difference is not known.

Although the mechanism for seed dispersal of the Okeechobee gourd is not fully understood, Walters et al. (1992) suggested that Okeechobee gourds disperse by floating in water bodies (in canals and along the shore of islands in Lake Okeechobee); however, no information is available on the distances seeds may disperse. Walters et al. (1992) also indicate marsh rabbits are the main terrestrial disperser of gourd seeds, but others suggest rabbits are only a predator of these seeds and are unlikely to be major seed dispersers (Decker-Walters 2002c). The seeds germinate in early spring during the dry season. Seedlings do not tolerate water-soaked soil for extended time periods, which would account for Nabhan's (1989) discovery of a stand of Okeechobee gourds apparently in decline, inundated in 7.75 to 11.75 inches of water. By the rainy season, the vines will have climbed shrubs, avoiding complete inundation as water levels rise. The vines and fruit become most visible by early to mid-summer.

Experimental studies were conducted in 2002 to determine seed properties of the Okeechobee gourd associated with possible adaptations to water (*e.g.*, seed flotation, germination, and viability) (Decker-Walters 2002b). The author found that seeds from fruits of varying ages and from different populations varied greatly in buoyancy and that seeds from older, drier fruits were less buoyant (Decker-Walters 2002b). This is important in nature because older seeds are most frequently released from the fruit through predation (Decker-Walters 2002b). Low germination rates indicated that seeds exhibit some dormancy properties that may respond to both environmental and physiological cues, and germination is affected by age of the seed (Decker-Walters 2002b). Approximately 73 percent of seeds remained viable after immersion in water for 70 days, and seed viability was not dependent upon whether the seed sank or remained at the surface (Decker-Walters 2002b). This subspecies employs a strategy of growing on open organic soils exposed by low water levels with little to no competition, producing numerous seeds with somewhat long viability, and experiencing vegetative decline when competition increases or water levels rise (Moyroud 2009).

Population dynamics

The Okeechobee gourd is a vine that was locally common in the pond apple forest that once grew south of Lake Okeechobee (Small 1922). As early as 1930, at least 95 percent of the pond apple forests had been destroyed (Small 1930), and pond apple now persists as scattered trees or small stands around Lake Okeechobee and in the Everglades. The conversion of these swamps and marshes for agriculture and water-level regulation in Lake Okeechobee have been the principal causes of the reduction in range and number of Okeechobee gourds. The documented population of Okeechobee gourd around the southeastern shore of Lake Okeechobee is strongly associated with Torry muck, a soil formed in the pond apple forests that once surrounded Lake Okeechobee (Service 1999a). However, successful growth and reproduction of the gourd under cultivation suggests that the species can grow in a wider range of soils. The gourd is now restricted in the wild to two small disjunct populations, one along the St. Johns River which separates Volusia, Seminole, and Lake Counties in north Florida and a second around the shoreline and on natural and man-made islands of Lake Okeechobee in south Florida. Currently, the survival of the gourd in south Florida is threatened by the water-regulation practices in Lake Okeechobee and the continued expansion of non-native vegetation in the lake. Careful use of herbicides to control non-native woody vegetation (primarily *Melaleuca)* and dense growths of aquatic vegetation can be compatible with recovery of the gourd.

Status and distribution

The gourd was historically found on the southern shore of Lake Okeechobee, in Palm Beach County, and formerly in the Everglades. The relative abundance of the gourd in the Everglades region south of the original pond apple forest along the southern rim of Lake Okeechobee is not known. In 1965, it was seen north of Homestead in an agricultural area of Dade County (FNAI 1992). A population on a disturbed roadside north of Andytown, Broward County, was discovered in 1978 and was destroyed by road construction the following year (Tatje 1980). The FWC reported finding the gourd in 1985 on a spoil island just west of the outlet of Harney Pond Canal along the northwestern shore of Lake Okeechobee in Glades County (Don Fox, FWC, personal communication 1996), suggesting that the species may be more widespread around the shores of the lake.

A new population of the gourd was found along the shore of the middle St. Johns River in September 1993. Gourds had not been noted in this area for more than 200 years (Bartram 1791). Surveys conducted from 1995 to 1997 documented 12 locations along the St. Johns River, but only 3 of these localities contained gourds during a 1998 survey (Minno and Minno 1998). Surveys along the St. Johns River were later conducted in 2002 and indicated that 8 of the 12 sites where they had been documented (Minno and Minno 1998) were occupied (Decker-Walters 2002a). It was estimated that the entire St. Johns River population consisted of no more than 100 plants (Ward and Minno 2002). The Okeechobee gourd was found later at an additional site along the river, and surveys indicated that plants were present at only 2 of the 13 previously known sites in 2005 (Minno and Minno 2005). During this census, a fourteenth site was discovered and one of the previously known sites appeared to no longer be suitable due to habitat degradation and herbicide spraying (Minno and Minno 2005). In 2006, surveys indicated that plants were occupying a total of 10 sites, including 3 new sites that were discovered (Minno and Minno 2006b). In 2007, plants were observed at eight of the previous sites, plus four new locations (Minno 2007). Plants from the St. Johns River population were reported to occur on both sides of the river along the Lake and Volusia County line from Lake Beresford south to Goat Island, a distance of approximately 4.9 miles (Ward and Minno 2002). This population is now known to occur from Lake Beresford further south than Goat Island into Lake Monroe and along the western side of Lake Jessup in Seminole County (Minno 2009).

In surveys conducted around Lake Okeechobee, the species was found at 11 sites along the southeastern shore of Lake Okeechobee, including Torry Island, Ritta Island, Kreamer Island, Bay Bottom Dynamite Hole Island, South Shore Dynamite Hole Island, and the southern shore of the Lake Okeechobee Rim Canal (Walters et al. 1992; Walters and Decker-Walters 1993).

In 2002, surveys were conducted for the first time in 10 years for the Lake Okeechobee population (Decker-Walters 2002a). Plants were observed on Torry and Kreamer Islands and on FWC spoil islands, but not on Ritta Island where plants were inundated with water (Decker-Walters 2002a, 2002c). There were hundreds of mature vines and thousands of fruits estimated to occupy Kreamer Island, which was the largest observation recorded (Decker-Walters 2002a).

In 2005, an assessment was made of the gourd populations to determine the effects of the hurricanes (Minno and Minno 2005). No live plants were located in the previously colonized northwestern and southern portions of Lake Okeechobee. Only dried fruits were located in Lake Okeechobee. There does not appear to have been any reproduction in 2005 on this island, despite an incidental report of live plants prior to the surveys in 2005, because fruits typically take over a year to dry out (Minno and Minno 2005). Therefore, gourd reproduction most likely occurred in 2004 (Minno and Minno 2005). The Florida peninsula, including the Lake Okeechobee region, experienced a relatively dry year in 2006, and water levels in the lake were lower than normal (Minno and Minno 2006a). With more favorable growing conditions, gourd plants were found on the natural islands (Kreamer, Ritta, and Torry Islands) and one of the spoil islands (Minno and Minno 2006a). During this survey, gourd plants were growing only along the perimeter of the spoil island, unlike in 2002 when plants covered most of the island (Minno and Minno 2006a). Plants were previously reported from the northern and western edges of Ritta Island, but occupied only the eastern side of the island in 2006 (Minno and Minno 2006a).

Drought conditions persisted into 2007, and we expected to see the Lake Okeechobee population expand. However, Minno (2007) reported the population appeared to have been reduced based on observations of extensive moonflower vines in areas where gourds were known. Plants and fruits were confirmed from the wildlife island where they occurred in 2006, as well as on Ritta, Kreamer, and Torry Islands (Minno 2007). However, plants on Ritta Island were not observed on the eastern part of the island, possibly due to inability to see vines under the coverage of moonflower, but returned to the northern end (Minno 2007).

Surveys in 2007 indicated that the subspecies was present on 4 of the islands in Lake Okeechobee and on 12 sites along the St. Johns River (Minno 2007). There are also two introduced populations of gourds that are persisting on private property in Putnam County and west of Lantana in Palm Beach County (Minno 2009, Moyroud 2009). Gourds are ephemeral (short-lived) by nature; they appear at a site for one or many years and then disappear. They tend to grow well under good conditions (appropriate hydrology and reduced competition) and subside when conditions become unfavorable. Therefore, searches should not be limited to previously documented sites. Because of the rambling growth habit of the gourd, and because plants can root at the nodes, it is difficult to count numbers of individual plants. Counting the number of fruits on the vines in the fall may provide a good index of the reproductive health of the population, rather than attempting to count individual plants.

Papery Whitlow-wort

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008g). The 5-year review builds upon the detailed information in the MSRP and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/PaperyWhitlowWort.pdf

Species/critical habitat description

Papery whitlow-wort is a small mat-forming herb with many bright yellowish-green branches radiating flatly from a taproot (Kral 1983; Small 1933). The stems are 5 to 20 cm (2 to 8 inches) long and are wiry. The leaf blades are sessile, 1.5 to 3.0 mm (0.06 to 0.12 inches) long, ovate to triangular-ovate in shape, and strongly revolute. The plant has numerous small cream-colored to greenish flowers (Small 1933; Service 1996) that produce a very thin-walled one-seeded dry fruit that remains intact, functioning as a seed (Kral 1983).

This species consists of two geographically isolated subspecies, with papery whitlow-wort (*Paronychia chartacea* ssp. *chartacea*) in the Florida peninsula (Anderson 1991; Hartman et al. 2005) and a distinct subspecies, Crystal Lake nailwort (*P. chartacea* ssp. *minima*) in the Florida panhandle. This discussion is limited to the peninsula subspecies. Papery whitlow-wort is easily identified, especially where it forms large populations in the scrub. However, another species, American nailwort (*Paronychia americana*) is present throughout its range, and has been confused with it.

No critical habitat has been designated for the Papery whitlow-wort.

Life history

Flowering and fruiting occur in late summer or fall (Anderson 1991) and the seeds mature in September or October (T. Race, BTG, personal communication, 1996). This species is a short-lived perennial (Anderson 1991 and observations by staff at the HBS). Seed germination is not affected by the allelopathic effects of Florida rosemary (Hunter and Menges 2002). Seed germination is during the winter as is typical for scrub plants, and can be very low during droughts. Biological soil crusts provide the most favorable germination conditions during drought conditions. These crusts develop in the years between fires (Hawkes 2004). Loose sand may also affect germination (Petrů and Menges 2004), as discussed in the next section.

Population dynamics

Papery whitlow-wort is most frequently seen in open, sunny gaps in rosemary balds within scrub vegetation (Abrahamson et al. 1984; Christman 1988; Menges and Kohfeldt 1995). At ABS, rosemary scrubs are found only on the higher ridges and knolls surrounded by scrubby flatwoods with dense oaks. The main soil types are St. Lucie and Archbold (Abrahamson et al. 1984), which are both well-drained white sands (USDA-Soil Conservation Service [SCS] 1989). The fire return interval in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982; Myers 1990). Rosemary scrub has rosemary and scrub oaks including Chapman oak, sand live oak, Archbold oak, and occasional sand pine. The open sandy areas of rosemary scrub contain small herbs and lichens (Abrahamson et al. 1984; Hawkes and Menges 1996). These gaps in the dense vegetation are more persistent in rosemary scrubs than in scrubby flatwoods (Hawkes and Menges 1996).

Papery whitlow-wort has also has been reported from sandhill (high pineland) vegetation in the Walk-in-the-Water tract of LWR State Forest (A. Cox, Division of Foresty [DOF], personal communication, 2002) and at TNC's Crooked Lake Sandhill Preserve (B. Pace-Aldana, TNC, letter correspondence, 2002) as well as at the Tiger Creek Preserve, where it is confined to disturbed areas and pond margins (B. Pace-Aldana, TNC, letter correspondence, 2005).

Weekley and Menges (2003a, 2003b; Menges and Weekley 2004) confirmed the earlier findings Johnson and Abrahamson (1990) and Ostertag and Menges (1994) that this plant is killed by fire and returns to the vegetation from seed. Johnson and Abrahamson (1990) had found that papery whitlow-wort appeared in rosemary balds after fires, even though it had been rare or absent prior to the burn. This strongly indicates papery whitlow-wort maintains seed banks in the soil, waiting for suitable germination conditions. Within about 9 to 12 years after a fire, papery whitlow-wort was displaced by Florida rosemary and reindeer lichens (*Cladonia* and *Cladina*). Quintana-Ascencio and Menges (2000) showed some gap plants such as snakeroot and Highlands scrub hypericum disappear relatively quickly after fires. To persist, these plants require large populations consisting of tens of thousands of individuals. Papery whitlow-wort persists longer after fire, which could reduce the population sizes needed for population viability. It also has many large populations over a relatively large geographic range, compared to other LWR endemic plants.

The density of papery whitlow-wort increases in relation to available open space (Hawkes and Menges 1996; Menges and Kohfeldt 1995), so the species is most abundant in disturbed, sandy areas such as road rights-of-way and recently cleared high pine (Abrahamson et al. 1984; Christman 1988; Service 1996). Papery whitlow-wort can become very abundant after a fire or on disturbed sites such as along fire lanes or trails (Service 1996; Johnson and Abrahamson 1990) and is the last of the federally-listed herbaceous scrub plants that are restricted to open areas to suffer local extirpations as open areas become covered by shrubs.

Loose sand affects papery whitlow-wort. According to research by Petrů and Menges (2004) comparing natural bare areas within scrub vegetation to artificially disturbed roadsides, "the demographic responses of the species to sand movements indicate that mobile sands create constantly shifting arrays of microsites that can influence post-dispersal seed germination, survival, and growth of Florida scrub herbs. Roadside habitats have more dynamic patterns of sand movement than natural gaps and may alter selection regimes important for demographic variation of endemic Florida scrub plants." This research supports other evidence that roadsides and other artificially disturbed areas may not constitute desirable substitutes for open areas in fire-maintained vegetation. Management for papery whitlow-wort requires burning regimes that mimic the natural fire cycles of rosemary scrub.

Status and distribution

Papery whitlow-wort occurs in Highlands, Polk, Osceola, Orange, and Lake Counties (Anderson 1991). It is present on the LWR (Kral 1983) and at least one smaller nearby ridge at the Lake McLeod tract of LWRNWR. It is not present on the Bombing Range Ridge (APAFR). It is present on essentially all of the LWR scrub conservation lands. Since the last comprehensive survey (Schultz et al. 1999), it has been found in sandhills (high pineland) vegetation at the Walk-in-the-Water tract of LWR State Forest (A. Cox, DOF, personal communication, 2002). It is also present at pond edges and in disturbed areas in sandhills on the Tiger Creek Preserve, owned by TNC (B. Pace-Aldana, TNC, letter correspondence, 2005).

The northern range limit of papery whitlow-wort is in Lake County, where it occurs on the north side of Lake Louisa at Crooked River Preserve, owned by the LCWA. It was possibly present at a nearby site, Schofield Sandhill. The only site on conservation lands in Orange County (also at the northern range limit) is the small Shadow Bay Park (formerly Lake Cane-Marsha Park) near where the Florida Turnpike crosses Interstate 4. The species was reported from localities in western Orange County, but the area has since become urbanized, and there are few if any opportunities for setting aside conservation lands in this area. The only papery whitlow-wort site in Osceola is Lake Davenport, in the northwestern corner of the County (FNAI 2005). The southernmost sites on conservation lands are Gould Road (part of the LWRWEA operated by FWC) and ABS, both in Highlands County south of Lake Placid (Schultz et al. 1999).

During 2003, the State and ABS purchased portions of the McJunkin ranch that bordered the Biological Station's preserve to the west. The recently-acquired land adds more scrub to the LWRWEA and provides a buffer for Archbold.

While FNAI data provide an overall view of the distribution of this species, intensive local inventories add important detail. The LWR State Forest is represented in the FNAI database by nine element occurrences, yet the Forest's Arbuckle tract has 188 records of this plant in its GIS database, mostly from a 1988 inventory. Of the 188 records, 23 represented more than 100 individuals (data collected by K. DeLaney, provided by A. Cox, LWR State Forest).

ABS has not monitored this plant because it thrives in fire lanes that usually are not threatened by invasive exotic plants (E. Menges and M. Deyrup, ABS, personal communication, 1995; *in* Service 1996). However, the propensity of this species to occupy fire lanes, roadsides, and other artificially disturbed areas is a conservation concern for the papery whitlow-wort, because it tends to be far more abundant in such disturbed areas than within the vegetation itself, and these disturbed areas have different physical characteristics than natural ones, including more sand movement, as noted above (Petrů and Menges 2004).

Pigeon Wings

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008h). The 5-year review builds upon the detailed information in the MSRP and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/PigeonWngs.pdf

Species/critical habitat description

Pigeon wings is a 0.2 to 1 meters (0.5 to 3.5 ft) tall, long-lived perennial herb with erect stems. The thick horizontal root, which may grow to more than 2 meters (6 ft) long, bears one to several purplish, glaucous, wiry, very straight stems. The somewhat leathery leaves consist of three leaflets. Leaflets of the upper leaves are obtuse at the tip and narrower than those of lower leaves. Pigeon wings has CH (insect-pollinated) and CL flowers (small self-pollinating flowers that remain closed). The CH flowers are usually in pairs, each corolla consisting of one standard petal that is 3.5 to 4.5 cm (1.4 to 1.8 inches) long (Fantz 1977). Isley's (1990) treatment of the pea family in the Southeast gives the standard petal length as 4.5 to 5 cm (1.8 to 2 inches) long. The flower has a small white keel. The common name of this species refers to the petals of the CH flowers, which resemble wings (Fantz 1979).

Flowers of the pigeon-wings genus *Clitoria* are easily recognizable because their pale purple flowers are inverted–upside down, compared to other members of the pea family (Fantz 1979). The inverted position of the flowers allows the anthers and stigma to touch the backs of visiting insects. The only other legume genus with inverted flowers is butterfly pea (*Centrosema*), with two species in central Florida.

The seedpod (legume) is 5 to 8 cm (2.0 to 3.1 inches) long and extends from the calyx (Fantz 1979). Pigeon wings can be confused with the other Florida species in the genus, *C. mariana*, but pigeon wings is distinguished by having purplish, glaucous stems, non-twining habit, narrow leaflets, smaller flowers, and long-stipitate fruits (Fantz 1977). Technical descriptions are also available in Isley (1990) and Kral (1983). Dr. Paul Fantz of North Carolina State University is preparing the treatment of this genus for the Flora of North America.

No critical habitat has been designated for Pigeon wings.

Life history

Pigeon wings has two distinct kinds of flowers, insect-pollinated and self-pollinated. The former hosts insects in May to June while the latter initiates seeds in summer through late September.

Though this species may exist in a continuum of scrub to sandhill (high pineland) vegetation, it is most prevalent in intermediate vegetation called turkey oak barrens by Christman (1988). Christman and Judd (1990) reported the species from scrub, turkey oak barrens, and the edges of high pines. Others report pigeon wings from scrubby sandhills, more like hickory-dominated scrub (which could also be called the hickory phase of high pineland) (E. Menges, ABS, personal communication, 1997). Bea Pace-Aldana (TNC, letter correspondence, 2005) reports that a few plants are even present in small gaps in long-unburned xeric hammock. Apparent disagreements about this plant's habitat may demonstrate limits to developing and applying consistent terminology to describe a complex mosaic of vegetation, especially in a part of Florida where most of the sandhill vegetation was destroyed early in the twentieth century, making way for citrus groves. TNC at Tiger Creek Preserve and the Service at the Carter Creek tract of LWRNWR are restoring prescribed fire to turkey oak barrens, and are finding, especially at Tiger Creek, that wiregrass is increasing and the vegetation is becoming more like a classic sandhills.

There has been some disagreement about the plant's preference for white sand soils versus yellow sand soils. As mentioned above, the species has been found in turkey oak barrens and scrub hickory, both of which occur on yellow sand soils. At Tiger Creek Preserve, it is on yellow sand (B. Pace-Aldana, TNC, letter correspondence, 2005). However, Fantz (1979) regarded pigeon wings as a species of white sand soils. The species has been seen in white sand scrub at Carter Creek in Highlands County, and has been noted in the LWR State Forest on both white (Archbold) and yellow (Tavares) sands (C. Weekley, DOF, personal communication, 1998).

Population dynamics

Pigeon wings has been monitored on the LWR State Forest (Weekley 1996c). It is an intermediate resprouter after fire. About 48 percent of the plants in study plots reappeared after fire (Weekley and Menges 2003a, 2003b; Menges and Weekley 2004). In this vegetation, plant species range from being strong resprouters, invariably reappearing after fires, to non-resprouting species that are invariably killed. Individual plants of pigeon wings appear to be relatively long-lived, based on their responses to fire.

Status and distribution

Pigeon wings has apparently never been abundant in its central Florida range, possibly because intermediate pine/scrub habitat was not a widespread type of vegetation. This species has never been observed in large numbers. Typically, groups of 20 to 30 are found per site. The species is known from about 40 occurrences on private and protected lands. Among them are:

- The 120-acre Flat Lake tract of Seminole State Forest in Lake County, southeast of Clermont (Schultz et al. 1999; FNAI 2005), which was purchased by TNC in 1999 (Finkelstein 1999);
- TNC's Tiger Creek Preserve, where it is locally abundant in sandhill vegetation;
- APAFR;
- Walk-in-the-Water and Lake Arbuckle tracts of LWR State Forest. Few plants were noted in areas of the Arbuckle tract in 2002-2004 that needed fire, raising concern over possible population decline (Cox 2004);
- Horse Creek scrub, owned by District;
- Saddle Blanket Lakes Preserve (TNC);
- Carter Creek, Lake Placid, and Lake Apthorpe tracts of LWRWEA;
- Carter Creek and Flamingo Villas units of LWRNWR; and
- ABS.

Pigeon wings is threatened by conversion of its habitat to agricultural, residential and commercial uses. Other threats are fragmentation of existing populations and habitat degradation by off-road vehicle use, trash dumping, and trampling.

Conservation of this plant depends largely on conservation lands that have been acquired to protect distinctive scrub and sandhill vegetation on the LWR. Acquisition of a neighboring ranch by the private ABS in 2003 may have benefited pigeon wings. Hurricane Charley brought at least category 2 winds to Polk County in the vicinity of Lake Wales, but the storm did minimal damage to upland native vegetation in the range of pigeon wings (broken branches, snapped sand pines, and a few snapped longleaf pines; shrubs and herbs were generally unaffected).

According to information presented at recent meetings of the LWR Ecosystem Working Group in 2003and 2004, Old World climbing fern is not yet a severe problem in uplands, but it is appearing in wetlands, including some severe infestations. There is concern the hurricanes of 2004 may have spread its spores. Natal grass is spreading, and Carl Weekley of ABS (personal communication, 2004) suggests its spread appears to be facilitated by the construction of fire lines and operation of mechanical equipment in fire management.

Pygmy Fringe Tree

The following discussion is summarized from the MSRP (Service 1999a), as well as from recent research publications and monitoring reports. A complete pygmy fringe-tree life history discussion may be found in the MSRP.

Species/critical habitat description

Pygmy fringe tree is a shrub or small tree that is often less than 1 meter (3 ft) tall, but can reach 4 meters (12 ft). The twigs are opposite or sub-opposite and stiff, while the leaf scars and leaves are mostly opposite but sometimes alternate. The leaves are simple, mostly 3 to 10 cm (1 to 4 inches) long, and lacking stipules. They have short petioles and the somewhat leathery blades are ovate to elliptic or obovate in shape, with the tips acute to rounded. The base of the blade is attenuated to the petiole. The upper surface of the blade is dark yellow-green and smooth, but the lower surface is paler and reticulate. The inflorescence is a leafy-bracted panicle that appears with the new shoots from the axils of most leaf scars from the previous season. The axis (main stem) of the inflorescence is rather short with numerous opposite branches that are spreading, slender and dropping, terminating in clusters of three to six flowers. Bracts toward the base of the inflorescence are similar to, but smaller than, the leaves. The flowers are regular, perfect and pleasingly fragrant. The four sepals are green, united at the base, and 1.5 to 2.0 mm long. The four petals are white, united at the base to a short, campanulate throat, with narrowly linear lobes, 1.0 to 1.5 cm long and somewhat spreading. The two stamens are fused (adnate) to the corolla base. The ovary is superior with a single style. The fruit is a drupe 2.0 to 2.5 cm long, oval, and green, becoming purplish-brown when ripe.

The pygmy fringe tree is deciduous (*i.e.*, leafless during the winter). Leafing occurs mid-March, budding occurs in March, and anthesis is from late March to early April. When it is in leaf, pygmy fringe tree may be confused with scrub wild olive (*Osmanthus megacarpus*).

This species was named by Small (1933). Hardin (1974) continued to recognize it as distinct from the much more widespread white fringe tree (*Chionanthus virginicus*), and Elfers (1989) reaffirmed its distinctness in an unpublished masters thesis. The species is recognized by Wunderlin and Hansen (2003, 2005).

No critical habitat has been designated for the pygmy fringe-tree.

Life history

Pygmy fringe tree inhabits excessively drained sandy soils on central Florida's LWR (and historically on the MDR, Orange County). This species is found on low-nutrient St. Lucie fine sand soil which is subject to rapid drying (Wunderlin et al. 1981a), as well as other dry sand soils. Pygmy fringe tree occurs primarily in scrub as well as high pine, dry hammocks, and transitional habitats. It is abundant at a few sites, where it may form thickets along with evergreen oaks and other shrubs such as tallow wood, silk bay, and scrub hickory. In some locations, it may be the dominant plant while in others it may be codominant or subdominant (Wunderlin et al. 1981a). At Carter Creek, where it is relatively abundant, it is scattered among turkey oaks.

Although the reproductive biology of this species has not been thoroughly investigated, it is known to spread by root sprouts and occasionally by seed (Stout 2000a). The plants appear to be functionally dioecious (Gill and Pogge 1974), and the female flowers have stunted anthers that usually do not open (Goodrum and Halls 1961). The four plants in the endangered species display garden at the HBS (2 males, 2 females) flowered and set seed in 1997 (Center for Plant Conservation 2003). After spring flowering, fruiting probably occurs in June, with seed dispersal in September (Gill and Pogge 1974; Ward and Godfrey 1979b). Seeds (drupes) may remain on the plants well into winter (Stout 2000a).

Little is known about seed dissemination of pygmy fringe tree, and seed production is variable from year to year, with mixed reports for success of germination. In nursery conditions the best results are obtained with cleaned, air-dried seed, but whole fruits have also germinated. BTG has achieved 60 to 70 percent germination rates under greenhouse conditions (T. Race, BTG, personal communication, 1996).

Germination dates for pygmy fringe tree are unknown. Leafing occurs mid-March, budding occurs in March, and anthesis is from late March to early April. Recruitment is exceedingly slow in this species. At TNC's Tiger Creek Preserve (Possum Creek Trail Scrub), over 100 pygmy fringe trees have been tagged and monitored (I.J. Stout, University of Central Florida, personal communication, 1997). In more than 10 years of monitoring, hundreds of root sprouts were found, but only one seedling was located. Despite this extremely low seedling recruitment, the number of individuals at the site appears to be stable. Due to population stability and this species' reliable resprouting after fires, TNC no longer conducts detailed monitoring on this species (B. Pace-Aldana, TNC, letter correspondence, 2005).

Pygmy fringe tree is long-lived and persists in scrub that is burned on a frequency between 20 and 70 years. Monitoring at LWR State Forest shows that it is a long-lived resprouting species, resprouting after fire events (Weekley 1996d, 1999). Its above-ground stems grow from rootstocks or buried stems that survive the fires that are characteristic of the habitat (Kral 1983; Ward and Godfrey 1979b). It has been observed to resprout from rootstocks following a spring burn (Stout 2000a). Fires may have an important indirect effect on pygmy fringe tree by regulating the numbers and sizes of plants that might shade or otherwise compete with it (Kral 1983).

In the spring and summer of 1997, TNC burned sandhill vegetation containing pygmy fringe tree at Tiger Creek Preserve and the effects of fire on these individuals were monitored (I.J. Stout, University of Central Florida, personal communication, 1997). Burning to restore the sandhill vegetation's original grassy appearance continues and Bea Pace has monitored the results (Center for Plant Conservation 2003).

Pygmy fringe tree is also present at the Carter Creek tract of LWRNWR, where restoration of sandhill is being studied by ABS (Menges et al. 2005). Their results to date "suggest that burning is beneficial for sandhill community structure and the populations of several key species. Chainsawing as a pre-treatment has mixed results depending on the species. The saw and burn treatment promotes more complete and intense fires" (Menges et al. 2005) and more open post-treatment subcanopies, which may have a number of benefits for restoration of sandhill vegetation and its biota. Subsequent fires may be more effective in areas impacted once with this mechanical pre-treatment to fire."

Status and distribution

This species is protected on a substantial number of conservation lands, most of them purchased after it was listed. The Service does not have current information on threats because this shrub is considered relatively abundant and secure by managers of the conservation lands of the LWR, so limited funds for monitoring have been devoted to other species. After this plant was listed, an extensive network of state conservation lands and the LWRNWR came into existence, providing habitat and management supported by extensive ecological research and monitoring programs.

Pygmy fringe tree occurs in Seminole, Lake, northwestern Osceola, Polk, and Highlands Counties in central Florida. Wunderlin and Hansen (2005) have recently added the east side of Tampa Bay (Hillsborough, Manatee, and Sarasota Counties) to its distribution. Detailed information on localities and habitats is not yet available.

In central Florida, pygmy fringe tree is known from west of Lake Apopka in Lake County, northwestern Osceola County, and the LWR in Polk and Highlands Counties. It is no longer found in its historic habitat on the MDR. One of the largest known populations is at the Carter Creek tract of LWRNWR in Highlands County, where it occurs with turkey oak and scattered longleaf pine with an understory with abundant scrub palmetto. Experimental prescribed fires and reintroductions of Florida ziziphus have been conducted here by ABS in a project like the one underway at TNC's Tiger Creek Preserve. Pygmy fringe tree is represented at Tiger Creek

Preserve by 13 populations with few to numerous individuals, which have been mapped. Approximately 75 percent of the individuals occur in yellow sand scrub at the extreme northwestern edge of the preserve. The remaining individuals are scattered throughout xeric hammocks. Because of the stability of this plant's populations with and without fire, monitoring consists only of mapping of individuals during complete surveys, which are conducted throughout the preserve every 5 years Bea Pace-Aldana of TNC (letter correspondence, March 2005).

Pygmy fringe tree is protected in Polk County at Horse Creek Scrub (District and SWFWMD), Snell Creek (LWRNWR), Allen David Broussard Catfish Creek Preserve State Park, Saddle Blanket Lakes and Tiger Creek Preserves (TNC), Arbuckle and Walk-in-the-Water tracts of LWR State Forest; and in Highlands County at Flamingo Villas (LWRNWR) and Lake Apthorpe (LWRWEA). It is maintained as part of the National Collection of Endangered Plant Species at BTG.

Pygmy fringe-tree was searched for on the LWR State Forest in 1988 (DeLaney 1988). Weekley (1996a) found only 12 plants on the Arbuckle Tract west of School Bus Road and 10 plants east of the road. In surveys conducted by Anne Cox in 2002 and 2003, many of Weekley's 22 tagged plants were relocated and others were found in burn units (numbered LA02, RC01, and SH04). In surveys conducted at flowering time in March and April 2003, 279 seedlings and saplings were observed in the RC09 burn unit. This was probably the first confirmation of seedlings occurring in the wild. At the Arbuckle tract of the State Forest, most pygmy fringe trees are at the edges of scrub adjoining a wet habitat, while in the Walk-in-the-Water tract, fringe trees are in hickory scrub, as they are at the Tiger Creek Preserve (Cox 2004).

Information is being gathered on the effects of hurricane Charley in August 2004. The LWR State Forest near Avon Park, Florida suffered only minor wind damage to the vegetation and facilities were undamaged. Scrub at Hickory Lake County Park and Saddle Blanket Lakes Preserve suffered minor wind damage, including fallen oak limbs and snapped sand pines. In general, the shrub layer was unaffected. Plants in cultivation at the HBS survived, although nearby buildings were heavily damaged.

<u>Sandlace</u>

The following discussion is summarized from the MSRP (Service 1999a), as well as from recent research publications and monitoring reports. A complete sandlace life history discussion may be found in the MSRP.

Species/critical habitat description

Sandlace is a sprawling shrub with zigzag branches that tend to hug the ground, rooting at the nodes (Wunderlin et al. 1980d) and forming low mats. The lower parts of the creeping branches have bark that cracks and partly separates in long, flat, interlacing strips. The short lateral branches end in flowering racemes. Sandlace has the sheathing leaf stipules (ocreae and ocreolae) typical of the jointweed family. The leaves are needle-like and are from 0.3 to 10.0 mm (0.1 to 0.4 inches) long. The small, white or cream colored flowers have white petal-like sepals up to 3.4 mm (0.1 inch) long (Kral 1983). It flowers and fruits all year.

Sandlace, a member of the jointweed family (Polygonaceae), is one of three species of *Polygonella* that occur in Florida scrub in Highlands and Polk Counties of south central Florida (Lewis and Crawford 1995). While the species have rather similar inflorescences and flowers, the shrubby habit of sandlace is extremely distinctive.

No critical habitat has been designated for sandlace.

Life history

Sandlace occupies open, sandy areas within the scrub vegetation and appears to require fire or other disturbances that create or maintain these sandy gaps. This species is killed by fire and reoccupies burned sites from seed (P. Quintana-Ascencio, ABS, personal communication, 2004). Surveys at TNC's Saddle Blanket Lakes Preserve in fire-suppressed scrub revealed that this species occurred less frequently on long-unburned areas with few open sand "gaps" in the vegetation.

Weekley and Menges (2003a) confirmed that sandlace does not resprout after fire, but recolonizes burned areas from seed arriving from unburned areas, and perhaps by spreading from unburned areas. Pollinators of sandlace are genus-specific bees and likely a few varieties of wasps. Little is known about seed production and germination for this species, but seedlings do not survive in the vicinity of the mature plants, which are allelopathic, meaning they produce chemicals that inhibit the growth and survival of other nearby plants (Weidenhamer et al. 1989). The major allelochemicals are gallic acid and hydroquinone (Weidenhamer and Romeo 2004). Most of the available information on the life history of this plant comes from a study of cutting and burning of scrub (Quintana-Ascencio et al. 2004). The study has emphasized the value of disturbance (fire or mechanical) in this ecosystem. Although fire kills individual plants, sandlace benefits from fires or other disturbances that create sandy gaps that can be occupied by new plants that grow from seed. Like most other LWR endemics, sandlace is threatened by fire suppression and habitat loss resulting from agricultural and residential development (Service 1999a).

Population dynamics

Because sandlace is a sprawling clonal shrub, with plants taking root where their stems touch the ground (Wunderlin et al. 1980d), individuals may spread significant distances by vegetative means. For this reason, it is difficult to identify genetically-distinct individuals (P. Quintana-Ascencio, ABS, personal communication, 2004). Despite being a narrow endemic, it has the highest within-population genetic diversity of any species in the genus *Polygonella*, which includes several very widespread species (Lewis and Crawford 1995). Its abundance can easily be overestimated, because it tends to colonize disturbed areas along easily accessible road cuts and rights-of-way.

Little is known of the population biology of this species. Based on work on other scrub species, such as wireweed (Boyle et al. 2003), it is clear that the bare sand areas (gaps) occupied by sandlace fluctuate dramatically in size, expanding after a fire and contracting until the next fire. As a result, sandlace probably has metapopulation dynamics, with local populations in gaps expanding after fire and potentially going extinct, either as a result of a long interval between fires or the fires themselves.

Status and distribution

Sandlace's range is from Orange County south through Highlands County in scrub vegetation. It occurs near Interstate 4 in Orange County and at one site in northwestern Osceola County. In Polk County, sandlace is found on the LWR from the Davenport-Poinciana area. It is also found well west of the LWR in a highly altered area just southeast of Bartow. In Highlands County, sandlace is found on the LWR as far south as the ABS. Because it is so easily recognized, the early status surveys of scrub (Christman 1988) provided very accurate coverage of its distribution.

Sandlace is present on the following scrub properties acquired, or under acquisition, for conservation purposes. Areas of tracts (in acres) were obtained from the FNAI database 2001 and then updated through the FNAI website in November 2004:

- The Allen David Broussard Catfish Creek Preserve State Park comprises 3,268 ha (8,077 acres) operated by FDEP. It has a management plan, active fire management with annual requests for prescribed burning, and rare plant monitoring;
- Hickory Lake Scrub County Park is a 23 ha (57 acres) tract owned by Polk County. It has a management plan, prescribed fire management, and rare plant monitoring;
- Saddle Blanket Lakes Preserve comprises 335 ha (829 acres) and is owned by TNC;
- Sun Ray Scrub is 109 ha (270 acres) and is a component of the LWRWEA;
- LWR State Forest, operated by DOF, consists of several tracts – Arbuckle, Walk-in-the-Water, Babson/Hesperides, and Boy Scout. Collectively, they cover 10,719 ha (26,488 acres). Weekley (1996e) reported monitoring of sandlace from this site. DeLaney found 380 individuals at Arbuckle in 1988. Cox (2004) found 484 plants at 42 sites at Arbuckle in 2003 and 20 at 2 sites at Boy Scout;
- The LWRNWR, owned by the Service, consists of the Lake McLeod and Snell Creek units in Polk County and the Carter Creek and Flamingo Villas units in Highlands County. They comprise 744 ha (1,839 acres);
- The LWRWEA, administered by FWC, consists of 12 tracts, totaling over 6,543 ha (16,167 acres). The tracts include Blue Lake, Silver Lake, Carter Creek, Henscratch, Highlands, Royce, Lake Apthorpe, Lake Placid, and McJunkin;
- The Preserve, operated by Highlands County, comprises 559 ha (1,380 acres), in part, longleaf pine vegetation. Sandlace is probably present, but not confirmed;
- Highlands Hammock State Park comprises 3,743 ha (9,251 acres). It has been expanded to include scrub;
- Jack Creek, comprising 520 ha (1,285 acres), is owned by the SWFWMD. It adjoins the Henscratch Road/Jack Creek tract of the LWRWEA;
- Lake June-in-Winter Scrub State Park, located on the lake, comprises 342 ha (846 acres); and
- The private ABS comprises over 3,592 ha (8,877 acres). Sandlace is present, but rare.

Sandlace has benefited from the extensive State and private land acquisition programs on the LWR since it was listed and it appears to be benefiting from prescribed fire programs on these lands. A range-wide survey is being conducted in winter 2004-2005.

Scrub Blazingstar

The following discussion is summarized from the MSRP (Service 1999a), as well as from recent research publications and monitoring reports. A complete scrub blazingstar life history discussion may be found in the MSRP.

Species/critical habitat description

Scrub blazingstar is a member of the aster family. Blazingstars are native to much of the eastern United States and some species are popular garden perennials and cut flowers. Scrub blazingstar is attractive enough to have been tested for use as a cut flower.

Scrub blazingstar is a long-lived perennial herb with a thickened, cylindric root (corm). Its stems are erect, usually unbranched, and it can grow up to 1 meter (3 ft) tall. Its leaves are fleshy and narrow, 1.0 to 2.5 mm (0.04 to 0.10 inches) wide, and generally 3 to 8 cm (1 to 3 inches) long (Wunderlin et al. 1980b). Flower heads are well separated on the stem and are up to 3 cm across. They consist entirely of disc flowers, without the ray flowers that provide the petals for daisy-like flower heads. The corollas of the disc flowers are bright purplish-pink in color. The broad, separated flower heads and narrow leaves distinguish scrub blazingstar from the eight other *Liatris* species in central Florida.

No critical habitat has been designated for scrub blazingstar.

Life history

Peak flowering of scrub blazingstar is from June through August. Seed heads mature from late July through October (Dolan et al. 1999). Flowering stems die after seed dispersal and "production of flowering stems does not seem to occur in plants younger than 2 years old." (ABS 2003).

Scrub blazingstar flowers produce nectar and are purple, so they were expected to be butterfly-pollinated. Observation of flowers showed that insect visits were infrequent and were mostly between 11 a.m. and 3 p.m. The most common visitors were butterflies: skippers (Family Hesperiidae), sulfurs (Pieridae), and swallowtails (Papilionidae). At the observation site, which had a high density of scrub blazingstar, butterflies were seen with pollen on their bodies and were observed moving among plants of scrub blazingstar, rather than going to flowers of other species (Evans et al. 2003). Scrub blazingstar requires cross-pollination to reproduce (Dolan et al. 1999), and it may be pollinator-limited. Seedling germination is "temporally and spatially patchy" and seedlings grow slowly (Dolan et al. 1999).

Scrub blazingstar is found in sunny openings, usually fire-maintained Florida rosemary bald habitats and adjoining scrubby flatwoods, but it is notable among LWR endemic plants for not being restricted to open, sunny areas. Herndon (1996, 1999) found that scrub blazingstar has specific microhabitat requirements, notably a preference for shade. Unlike most other scrub endemics, scrub blazingstar appears to thrive in lightly shaded areas. Twenty-five percent of scrub blazingstar plants are found in open areas in direct sun, 25 percent along the edges of canopies in partial shade, and 50 percent under canopies of other rosemary bald vegetation.

Scrub blazingstar occupies scrub "with both relatively short (scrubby flatwoods < 10 years) and relatively long (rosemary scrub > 20 years) fire return intervals" (ABS 2003). Generally, scrub blazingstar is found in relatively high densities on the lower slopes of rosemary balds especially where low, thin-canopied scrub oaks (Chapman oak, sand live oak, and scrub oak) or patches of scrub palmetto and saw palmetto dominate the vegetation and where patches of open sand exist. These habitat conditions are also frequently found under individual sand pine crowns, but never in dense groves of sand pines. Over periods of years, however, shady microhabitats are not fixed within rosemary balds. Large-scale disturbance such as intense fire may decrease the amount of shade, at least temporarily until larger shrubs regrow.

Experiments indicate scrub blazingstar seed germination did not differ with distance to Florida rosemary plants (which are known to inhibit seed germination of other species), but that germination is lower in full shade or in the presence of rosemary litter (Hunter and Menges 2002). Germination also appears unaffected by the presence of ground lichens (*Cladina evansii*). A clip-and-burn experiment has been initiated. Most of the plants resprouted within a month of the treatments, and the plants are continuing to be monitored to see whether fire benefits scrub blazingstar (Menges and Weekley 2004). This research is crucial for guiding the management of conservation lands and it also recognizes the future of this species lies primarily on conservation lands and the single most important management issue on such lands is the use of prescribed fire to mimic the historic fire regimes.

Population dynamics

Experiments indicate scrub blazingstar seed germination did not differ with distance to Florida rosemary plants (which are known to inhibit seed germination of other species), but that germination is lower in full shade or in the presence of rosemary litter (Hunter and Menges 2002). An experiment begun in 2003 is investigating post-germination establishment and survival. Within six rosemary sites, 1,260 seeds were planted along transects between November 18 and 20, 2003. The first germinants were seen on December 10 and by December 29 (about 5 weeks after planting), 245 germinants had appeared. By July 2004, 277 had germinated. Germination peaked between 33 and 41 days post-planting. Overall, percent germination differed only slightly between recently-burned sites (less than 12 years since fire) and long-unburned (more than 30 years) (51 percent versus 46 percent, respectively). Inhibition of scrub blazingstar seedlings by rosemary appears to be weak and is present mainly near the rosemary plants at long-unburned sites and especially on the south side of a rosemary plant. A significantly lower percentage of seed germinated in full shade than in partial shade or full sun. Germination was also lower at test sites with rosemary litter (Menges and Weekley 2004). Germination also appears unaffected by the presence of ground lichens (*Cladina evansii*).

Overall, germination experiments show that scrub blazingstar germination is high under a variety of conditions and is inhibited little if at all by chemicals from Florida rosemary or lichens. Germination may be physically inhibited by deep litter or lichens (based on the results of experiments using sponges as substitutes for lichens) (Menges and Weekley 2004).

Studies of population dynamics began in 1996, when Herndon (1999) tagged individual plants. More plants were tagged at LWR State Forest in 1997. In 2002, almost a quarter (42 of 179) of Herndon's tagged plants were still alive for a longevity of at least 7 years. At another site, at least one third (41 of 124) survived at least 6 years (Menges and Weekley 2003). However, it is not always possible to distinguish seedlings from plants "young vegetative plants and from individuals resprouting from herbivory" (Menges and Weekley 2004). A clip-and-burn experiment has been initiated. Most of the plants resprouted within a month of the treatments, and the plants are continuing to be monitored to see whether fire benefits scrub blazingstar (Menges and Weekley 2004). This research is crucial for guiding the management of conservation lands, and it also recognizes the future of this species lies primarily on conservation lands, and that the single most important management issue on such lands is the use of prescribed fire to mimic the historic fire regimes.

Most study populations are dominated by plants that produce flowering stems. Only 3 of 10 study populations had seedlings (Menges and Weekley 2003). Demographic monitoring in 2003 suggested populations located on a roadside had "more flowering stems, more topped flowering stems, lower total flowering stem height, and fewer flowering heads than scrub populations."

"This species is unusual among LWR endemics in having low population densities and relatively high genetic variation" (Menges and Weekley 2002, citing Menges 1998). Herndon (1999) found that populations were stable due to low rates of mortality and seedling recruitment. Menges and Weekley (2002) note monitoring of this plant is complicated by dormancy: corms may remain dormant for at least an entire year before producing new aboveground stems. This trait may help populations survive fires. Dormancy does create a problem for assuring projects will not harm this species because the presence of dormant plants makes it difficult to ensure plants will not be destroyed or disturbed. Evans et al. (2003) showed this species is self-incompatible, which in small populations results in low overall seed production. Should populations become too small, self-compatibility alleles could be lost, causing a collapse of seed production.

Vertebrate (Kettenring 1999) and invertebrate herbivores (Weekley 1998; Menges and Weekley 2002) reduce reproductive output. Browsing by deer and rabbits "tops" bud-bearing or flowering stems by "removing or damaging flowering stems, inflorescences or developing achenes," while invertebrates destroy developing flowers and fruits (Menges and Weekley 2003). In 2003, about 80 percent of aboveground individuals had flowering stems, but about a third of these plants lacked flower heads due to topping by vertebrates. The proportion of topped individuals varied significantly among 10 populations (Menges and Weekley 2003).

Unlike other endemic plants of scrub, which have metapopulation dynamics of local extinction and recolonization, there is no evidence for metapopulation dynamics in scrub blazingstar. As a result, Evans et al. (2003) suggest that threats to scrub blazingstar are different from threats to two other plants of the same habitat: snakeroot and Highlands scrub hypericum. Scrub blazingstar's slow population declines between fires may, over the long term, be important, as are pollinator limitations. Factors influencing recruitment should be a focus of further investigation. Arranging prescribed fire regimes to accommodate a number of plant and animal species with different population (or extinction-recolonization) dynamics is inherently difficult, and they suggest that "further investigation should focus on whether [common conservation] strategies based on multiple aspects of population biology can be successful." Menges and Weekley (2002) caution that "we have only begun to accumulate information on population dynamics and responses to fire." ABS began collecting demographic data on this species in 2000 (ABS 2003).

A reciprocal transplant experiment, begun in 2001, compared seed germination from scrub and roadside populations, as well as the germination of seed reciprocally sown into the contrasting habitat. As of September 2003, overall seedling survival was highest at a roadside site and lowest in long-unburned scrub. Two-year-old plants had not yet produced flowering stems, indicating that plants take more than two growing seasons to reach sexual maturity (Menges and Weekley 2003, 2004).

The extensive (19 study populations with 892 plants in 20 study plots for 2004) and long-term (up to 7 years as of 2004) demographic studies are demonstrating the value of such longer-term work. Additional information is needed about the effects of fire management and how to best manage fire regimes on conservation lands. The longevity of this plant (ABS 2003) renders it relatively insensitive to reduced fire frequency.

Status and distribution

The distribution of scrub blazingstar is on the southern LWR of Polk and Highlands Counties, Florida, plus a single known site on the WHR in Polk County, at Lake Blue (Schultz et al. 1999). This perennial herb is known from about 115 extant populations (Dolan et al. 1999) and it is present on most of the network of conservation lands with scrub vegetation in this area. A distribution map is available in Dolan et al. (1999).

From north to south, it occurs at:

- Camp Flaming Arrow (a privately owned site east of Lake Wales);
- Allen David Broussard Catfish Creek Preserve State Park;
- Boy Scout (Cox 2004) and Lake Arbuckle tracts of LWR State Forest;
- Saddle Blanket Lakes Preserve (TNC);
- LWRWEA (all, or nearly all, of the 12 units, including Placid Lakes, Carter Creek, Lake Apthorpe, Holmes Avenue, Hendrie Ranch, Gould Road, and McJunkin);
- Lake June-in-Winter Scrub State Park;
- Flamingo Villas tract of LWRNWR; and
- ABS (Schultz et al. 1999; Service 1996).

Historic and prospective loss of habitat due to commercial, residential, and agricultural uses qualified this species for endangered status. Overall, habitat is still being lost, but State, Federal, and private acquisition of conservation lands on the LWR has clearly benefited this plant, as has active land management by DOF, FDEP, and FWC. Incomplete land acquisition remains a problem at some sites, such as the Carter Creek unit of LWRWEA. Habitat loss and small population sizes could result in inbreeding, which could be detrimental to this outcrossing species (Dolan et al. 1999).

Scrub Buckwheat

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008i). The 5-year review builds upon the detailed information in the MSRP and is located at
http://www.fws.gov/southeast/5yearReviews/5yearreviews/ScrubBuckwheat2008.pdf

Species/critical habitat description

Scrub buckwheat belongs to the buckwheat family (*Polygonaceae*). It constitutes a variety of *Eriogonum longifolium*, a widespread species of the Great Plains that is represented east of the Mississippi by var. *harperi* in northern Alabama, Tennessee, and Kentucky (Kral 1983), and by var. *gnaphalifolium* in Florida (Reveal 1968).

Scrub buckwheat is a long-lived perennial herb with a substantial taproot that probably provides ample food reserves for resprouting (McConnell and Menges 2002), basal rosettes, and one to three or more leafless, upright above-ground flowering stems (scapes) up to 1 meter (3 ft) tall, but upwards of 10 stems have been observed in vigorous specimens, especially post-fire. It has a basal rosette of leaves that are 15 to 20 cm (5.9 to 7.9 inches) long, narrow, and white-woolly on the underside. The stem leaves are smaller than the rosette leaves. The stem terminates in a corymb, with each branch of the corymb ending in a cup-shaped involucre that holds a cluster of 15 to 20 small flowers, with each flower hanging on its stalk down below the involucre. The involucre is silvery and silky-pubescent, while the flowers are green with pink anthers (Rickett 1967; ABS 2005b).

This species is easiest to recognize when it is in flower or fruit. In Highlands County, ABS (2003) reports that plants produce flowering stalks mainly during summer (May through July), but scrub buckwheat can flower at other times of year following burns. Plants on the ONF have been observed with immature flower stalks between April and mid-July and bloom from May to mid-October. Seedlings have been observed in a variety of substrates within a few feet of the parent plant (Clutts 1998).

No critical habitat has been designated for the scrub buckwheat.

Life history

Scrub buckwheat is a perennial herb distributed widely in sandhill (high pineland) and Florida scrub in north central and central Florida from ONF through the LWR. Its growing season is between April and mid-July and it flowers from May to mid-October. This species probably does not have a long-lived seed bank (ABS 2003).

Individual scrub buckwheat plants produce only one or a few flowers at any one time, but continues flowering for months. "Flowers have an easily accessible, generous drop of nectar. Flowers are visited by a variety of insects, including solitary digger and twig-nesting wasps (*Parancistrocerus* spp. and *Stenodynerus* spp.), flies (*Geron* spp.), small solitary bees, and occasional social wasps. Visiting wasps learn the location of each plant and use trap-line strategies. The small number of flowers per plant induces them to visit several plants and probably promotes outcrossing. Individual flowers avoid self-pollination. The anthers open and shed their pollen first, then the pistils, which have kept their stigmas tucked into a tuft of hairs at the base of the flower, straighten up and offer their receptive surfaces to incoming insects. An extremely low number of seeds and fruits developed by experimentally bagged flowers (compared to open pollinated flowers) indicates the need of pollinator services to set seed" (ABS 2003).

Population dynamics

Scrub buckwheat resprouts repeatedly after fire, which is the primary agent of disturbance in its sandhill and Florida scrub habitats (McConnell and Menges 2002). Fire benefits this plant by stimulating resprouting, which is followed by "quick and heavy flowering and seed production" (McConnell and Menges 2002). New seedlings appear promptly after seed drop. McConnell and Menges (2002) observed seedling numbers peaked during July, 2 months after an experimental fire (and a month after another experimental treatment – litter removal). Scrub buckwheat is unlike most other scrub species in that seedlings will appear in summer, not just winter. This may allow the species to take advantage of summer rains, but seedlings are likely to desiccate during hot weather.

The seedlings that appear after a fire are unlikely to originate from a seed bank. McConnell and Menges (2002) observed that the seeds are very small, and those buried deeply enough to survive heat from a Florida scrub fire (about 2 cm) would be unlikely to reach the surface. Satterthwaite et al. (2002) placed fresh seeds at the soil surface and saw high germination rates.

This species occupies both sandhill and scrub vegetation, which have very different fire regimes. Sandhill vegetation, under historic natural conditions, burned roughly every 1 to 10 years, while scrub may burn at intervals of 5 to as much as 100 years (McConnell and Menges 2002; citing Menges 1999). Over the long term, a population viability analysis by Satterthwaite et al. (2002) shows scrub buckwheat populations require fire at intervals of 5 to 20 years to remain viable.

Prescribed burning is the "most appropriate treatment for enhancing both seed production and seedling recruitment, and linking the two in time" (McConnell and Menges 2002). Because this species tolerates a wide variety of fire intervals, prescribed fire regimes do not have to be tailored to its specific needs. At the Carter Creek tract of the LWRNWR, biologists from ABS have carried out experimental fires that show promise of restoring the vegetation by suppressing evergreen oaks, reducing the sizes of turkey oaks, and improving conditions for reproduction by longleaf pines and wiregrass. This conclusion fits with monitoring and experimental work on scrub buckwheat and three other species, going back to Menges (1995), Menges and Yahr (1996, 1998), and Menges and Weekley (1999).

McConnell and Menges (2002) experimentally applied alternative treatments to promote a "demographic response" in scrub buckwheat. They applied top-clipping, litter canopy removal, shrub canopy removal, and ash addition in a replicated, factorial experiment. None of these treatments was as productive as fire. These and continuing work by Menges et al. (2005) suggest that for a long-unburned tract like the Carter Creek tract of LWRNWR, "pre-treatments to facilitate the application of fire management may be important to this and other species." In the Carter Creek experiments, a saw-and-burn treatment "created a hotter, more complete fire and more open post-treatment canopies. This had generally favorable effects on scrub buckwheat. The saw & burn treatment enhanced seedling recruitment, plant dormancy, flowering (both percentages and amount per plant) and reduced herbivory." The burn-only treatment was left with large unburned patches. These researchers are planning to analyze the effects of fire intensity on scrub buckwheat demography.

Status and distribution

This was once a relatively widespread species. Its decline is due almost entirely to loss of sandhill habitat and to habitat degradation due to lack of prescribed fire. Its long-term prospects are favorable due to habitat acquisition after it was listed, as well as efforts by conservation land managers to restore natural fire regimes. It is now the most abundant of the "rare" species at the Tiger Creek Preserve and populations are stable, so it does not receive intensive monitoring (B. Pace-Aldana, TNC, letter correspondence, 2005). There is still some degree of threat from ongoing conversion of the remaining small fragments of sandhill (high pineland) and turkey oak scrub for agricultural, commercial, and residential purposes. Recreational motorized off-road vehicles have the potential to severely impact scrub buckwheat, but conservation lands on the LWR with scrub buckwheat generally do not have vehicle management problems. Several other endangered or threatened plants occur in turkey oak scrub with scrub buckwheat, notably pygmy fringe tree, pigeon wings, Carter's mustard, and Lewton's polygala (Christman 1988).

Scrub buckwheat occurs in the following counties:

- Putnam (Wunderlin and Hansen 2005) – no specific information is available, but the county has extensive sandhill vegetation, including some on conservation lands;
- Marion – relatively abundant in parts of the ONF, with up to 71 localities reported (Service 1996);
- Pasco – sandhill area within the Green Swamp property of the SWFWMD (Service 1996). The report by a SWFWMD employee, has not been confirmed with a herbarium specimen;
- Hillsborough – reported by the 1996 recovery plan, apparently in error (not attributed to this county by Wunderlin and Hansen [2005]);
- Lake – probably still present in sandhill vegetation remnants near Clermont (Service 1996), formerly near Lake Eustis (Herbarium specimen G.V. Nash 704, May 1, 1894, Gray Herbarium, Harvard University). It is present on the 120-acre Flat Lake tract of Seminole State Forest in Lake County southeast of Clermont (Schultz et al. 1999; FNAI 2005), which was purchased by TNC in 1999 (Finkelstein 1999);

- Seminole (Wunderlin and Hansen 2005) – no further information is available on this urban county;
- Orange – southwest corner of county. Collected by S. Christman in 1987 University of Florida herbarium catalog);
- Osceola – northwest corner of county. Collected in 1991 by Angus K. Gholsen in a "planted slash pine area with a native sandhill understory with *Prunus geniculata* (scrub plum) and *Nolina brittoniana* (Britton's beargrass) (University of Florida herbarium specimen catalog);
- Polk – on conservation lands at the Arbuckle, Lake Walk-in-the-Water, and Babson-Hesperides tracts of LWR State Forest, Allen David Broussard Catfish Creek Preserve State Park, the TNC Tiger Creek Preserve, the Carter Creek tract of LWRNWR, Pine Ridge nature preserve at the HBS, Lake Davenport, and Horse Creek Scrub (District); and
- Highlands – on conservation lands at the Lake Apthorpe tract of the LWRWEA, Flamingo Villas tract of LWRNWR, and ABS, which represents its southern range limit. Also present in the Avon Park Lakes area (Schultz et al. 1999).

Scrub Lupine

In addition to the assessment below, a 5-year review was completed in 2007 resulting in no change to the species designation (Service 2007g). The 5-year review builds upon the detailed information in the Recovery Plan for Ninteen Florida Scrub and High Pineland Plant Species (1996) and is located at http://www.fws.gov/ecos/ajax/docs/five_year_review/doc1607.pdf

Species/critical habitat description

Scrub lupine is a member of the pea family. It is unique among central Florida scrub plants because it is absent from the LWR proper, but is restricted to smaller nearby ridges. It is an herb that lives more than 1 year. The plants are usually in open areas and form large, silvery clumps. The sprawling stems with woody bases are up to 1 meter long. The leaves do not have visible stipules at their bases, which distinguishes this species from the much more abundant *Lupinus diffusus*, which has obvious stipules. The leaves appear to be simple (lupines have compound leaves, but some, including scrub lupine, have just one leaflet per leaf) (Wunderlin 1998). The leaf blades are obovate-elliptic, 4 to 7 cm (1.6 to 2.8 inches) long and 2 to 4 cm (0.8 to 1.6 inches) wide. The base and end of the leaf are rounded with a sharp point at the leaf's tip. The petioles are 2.0 to 4.5 cm (0.8 to 1.8 inches) long and the stipules are very small or absent. A silvery pubescence covers the leaves and stems. The flowers are a pale flesh-colored pink and are 4 to 5 cm long. The upper petal (standard) has a black center surrounded by a maroon area. They are arranged in racemes with stalks 4 to 13 cm long. Each raceme has 5 to 14 flowers, but up to 25 on occasion (Stout 2000b). Scrub lupine seed pods are long, woody, and elliptical with a pointed end. It is distinguishable from *Lupinus villosus*, the only other pink-flowered lupine in central Florida, by not being prostrate and having hairs on the leaves and stem. When it is not flowering, scrub lupine must be distinguished from the abundant *L. diffusus* by the absence of stipules at the bases of the leaves.

While the Service continues to recognize scrub lupine's scientific name as *Lupinus aridorum* in the List of Endangered and Threatened plants, it is worth noting that Isley's (1986, 1990) regional treatment of the pea family in the Southeast assigned the scrub lupine the name *L. westianus* var. *aridorum*. Wunderlin (1998) and Wunderlin and Hansen (2003) follow Isley's treatment.

No critical habitat has been designated for the Scrub lupine.

Life history

Scrub lupine grows on well-drained sandy soils of the Lakewood or St. Lucie series (Wunderlin 1984). These soils are extremely well drained and have very little organic accumulation. The sands are white or occasionally yellow and generally support sand pine scrub (Wunderlin 1984). They are also quite acidic with a pH from 4.0 to 4.5 (I.J. Stout, University of Central Florida, personal communication, 1996).

Scrub lupine is a plant of sand pine and rosemary scrub (I.J. Stout, University of Central Florida, personal communication, 1996). Scrub lupine probably exists in sunny gaps until the growth of shrubs and sand pines causes shading. After long periods without disturbance, "gap specialist" plants of sunny sites usually become less common in scrub. After fire or other disturbances, scrub lupine seed stored in the sand germinates. Most of the sites where scrub lupine is now found have been disturbed, moderately to severely, by soil scraping, road construction, land clearing, or offroad vehicles (Stout 2000b). With these disturbances and associated vegetative responses, it is difficult to determine what the "natural" vegetative cover may have been, but Kordek (2005) has assembled historic aerial photographs for the Lake McLeod tract of LWRNWR from 1941 onward. It is very clear that the tract, in its more or less undisturbed condition of 1941, was very open, with a great deal of bare sand separating clusters of shrubs. Despite disturbances in the intervening years (including heavy all terrain vehicle traffic for a number of years) the present structure of the vegetation may not be much different from what it was. Wunderlin (1984) found the predominant overstory in vegetation with scrub lupine to be sand pine, longleaf pine, and occasionally turkey oak. The shrub layer tends to be sparse at scrub lupine sites. Wunderlin suggested this might be a result of human disturbances. Shrubs most frequently found in association with scrub lupine include Florida rosemary, although scrub lupine will not grow in the immediate vicinity of this shrub due to Florida rosemary's allelopathic effects (I.J. Stout, University of Central Florida, personal communication, 1996). Scrub lupine also occurs with sand live oak, rusty lyonia, Feay's palafox (*Palafoxia feayi*), tallowwood (*Ximenia americana*), and occasional cabbage palms (*Sabal palmetto*). The herbaceous layer is mostly wiregrass. Wunderlin's 1984 survey is important in part because many of the sites that existed at that time have been destroyed. Status surveys found scrub lupine growing in association with several other listed plants, including Florida bonamia, papery whitlow-wort, sandlace, and scrub plum (Service 1987c).

Flowering by the scrub lupine is from February or March to May. The seed pods mature by June and the seeds fall off the plant and germinate nearby or remain in a long-lived soil seedbank (T. Race, BTG, personal communication, 1996; I.J. Stout, University of Central Florida, personal communication, 1996). The plant may flower from one to three times throughout its life, though few seeds are produced the first year (I.J. Stout, University of Central Florida, personal communication, 1996).

The scrub lupine is short-lived and declines after flowering (Beckner 1982; I.J. Stout, University of Central Florida, personal communication, 1996). This reproductive cycle, combined with the susceptibility of the plant to root rot both in the wild and when cultivated, limits conservation options (Service 1996). Furthermore, the species does not transplant well, even when very young (Service 1996), but it can be propagated from seed sown *in situ*.

Status and distribution

Scrub lupine was known from two distinct areas. In western Orange County (Orlando area) it was found on the southern MDR from the Apopka-Plymouth area south, past Lake Buena Vista. A population has persisted in an open, sandy area that is used for passive recreation at Shadow Bay County Park (formerly Lakes Cane and Marsha Park). It has been monitored by Dr. I.J. Stout of the University of Central Florida for over a decade. Turkey Lake Park, a short distance north of Shadow Bay Park, has scrub vegetation, but scrub lupine has not been seen there. During construction of a new interchange connecting the Florida Turnpike to the East-West Expressway, scrub lupine plants appeared from seed at the disturbed edges of sand pine scrub vegetation. Attempts to transplant some of these individuals met with failure. As of 2003, the FDOT maintains marked non-mowing areas along the Turnpike at the interchange. The Service does not have recent monitoring information on the site, which is capable of supporting several dozen plants. Dr. Stout has shown that scrub lupine may be present at some heavily-vegetated scrub sites in Orange County only in the form of long-lived seed in the soil, which may germinate when the site is disturbed (I.J. Stout, University of Central Florida, personal communication, 1996). This is certainly what happened at the Turnpike construction site. No protected sites are known to exist in the county other than these two. It is reported to be present along the shoulder of the Turnpike near its junction with Interstate 4 (Christman 2001). It was found in at six sites in north-central Polk County on the WHR near Auburndale and Winter Haven (Service 1999a). The sites near Auburndale were threatened by land clearing for residential development. Only small tracts of scrub remained among expanses of residential development. Polk County sites totaled only about 380 ha (940 acres) (Christman 1988). The species has been conserved on the Lake McLeod unit of LWRNWR, where it is thriving on the small tract. A tract near Lake Blue, south of Auburndale, has been acquired as part of the LWRWEA. It has the potential to serve as a reintroduction site. No other conservation lands with suitable habitat exist in this area, and none are being acquired.

A great deal of practical experience in managing scrub lupine has been obtained at the Lake McLeod tract of LWRNWR, where trash has been cleared, exotic pest plants removed, and prescribed fires have been planned but not yet conducted. Dr. Stout has monitored and mapped the species with technical assistance from Ryan Kordek.

<u>Scrub Plum</u>

In addition to the assessment below, a 5-year review was completed in 2009 resulting in no change to the species designation (Service 2009f). The 5-year review builds upon the

detailed information in the MSRP and is located at
http://www.fws.gov/southeast/5yearReviews/5yearreviews/ScrubPlum05192009.pdf

Species/critical habitat description

Scrub plum is a much-branched shrub that can reach 2 meters (6 ft) in height, although 0.5 meters (1.5 ft) is more typical at sites with frequent fires. It grows from gnarled, half-buried trunks. Its twigs are strongly geniculate (zigzag shaped), while its lateral branches are either short, stubby spur shoots bearing leaves and flowers, or are strongly tapering and spine-like. The bark of old stems is thin, gray, usually lichen-encrusted, and forms small rectangular or square plates. The bark of new shoots is lustrous reddish-brown or purplish and smooth.

The scrub plum's leaves are crowded on the spur shoots (an arrangement typical of the Rosaceae family) and are widely spaced on the normal shoots. The fragrant white flowers of scrub plum are distinctive in being sessile, without flower stalks. They are fragrant, five-petaled, and 11 to 13 mm (0.43 to 0.51 inches) across when open. The flowers have "numerous stamens with conspicuous yellow anthers that are exerted well above the floral cup. Some flowers have a well-developed pistil equal in height to the stamens, while in other flower the pistil is vestigial and nonfunctional" (ABS 2003). The fruit of the scrub plum is an ovoid or ellipsoidal drupe, 12 to 25 mm (0.47 to 0.98 inches) long, and dull reddish or "vaguely peachy" (ABS 2003) in color. It has a thin, bitter flesh and a slightly flattened seed.

Although it is distinctive as the only plum with crooked twigs, scrub plum can be casually mistaken for other scrub and sandhill plants. Several have a similar geniculate, thorny habit of growth, including tough bumelia, hog plum (*Ximenia americana*), Florida ziziphus, and a local hawthorn, a variant of *Crataegus lepida* (Judd and Hall 1984). Hog plum has yellow fruit, straight twigs, and thorns only in the angles of leaf and stem. Florida ziziphus has entire leaf margins and yellow fruit and is exceedingly rare. Buckthorns have thorns and clustered leaves, but the leaves or twigs are very hairy (FNAI 2000b).

Flowering occurs in January to February, leafing occurs from late February to March, fruit begins to develop in late February and may continue to early May, and seed dispersal is in early May, but germination dates are unknown (Harper 1911; Ward 1979; C. W. Weekley, DOF, personal communication, 1998). ABS's plant ecology lab reports that flowering occurs in February to March when the plants are largely leafless. Individuals drop most of their leaves in the winter dry season.

No critical habitat has been designated for the scrub plum.

Life history

Scrub plum has a very unusual breeding system called andromonoecy, in which male and bisexual flowers are present on the same individual (Weekley and Menges 2001).
Scrub plum is believed to be self-incompatible, which would make the services of pollinators essential for fruit set (Weekley 1997). The flowers attract insect visitors. Insects may disseminate the pollen of the scrub plum and birds and possibly mammals disperse the seeds.

The plants add new stems every year, especially after fire (ABS 2003). Fire stimulates growth and flowering; flowering and fruit production gradually declines until the next fire (Menges et al. 2005). Seedlings have not yet been observed in the wild.

Scrub plum prefers dry, sunny, nutrient-poor sites of acidic, entisols (deep, nearly featureless, sand soils). It is most typically associated with oak-dominated scrub and high pine communities. Scrub plum is native to sandhill (high pineland) vegetation and Florida scrub. Sandhill vegetation is usually thought of as having a grassy understory, although the abundance of scrub palmetto and shrubs like scrub plum and pygmy fringe tree at areas like the LWRNWR tract at Carter Creek indicate that sandhill on the Ridge may not historically have had the lawn-like appearance of many sandhill sites farther north. Sandhill is subject to low-intensity, frequent fires (every 1 to 5 years). Scrub has shrubby vegetation and is subject to high-intensity, infrequent fires. Fires maintain both habitats. In the absence of frequent fires, high pine vegetation is typically invaded by sand pines and evergreen oaks, eventually becoming upland hardwood forest (Myers 1985). Similarly, scrub may become upland hardwood forest if fire is absent (Myers 1985).

Sandhills plants that can be found in the vicinity of scrub plum include Chickasaw plum (*Prunus angustifolia*), tallowwood (*Ximenia americana*), wiregrasses (*Aristida stricta* var. *beyrichiana* and other species), broomsedges (*Andropogon* spp.), slenderleaf clammyweed (*Polanisia tenuifolia*), and largeflower wireweed (*Polygonella robusta*). The dominant tree is turkey oak, with longleaf pine. Listed species that co-occur with scrub plum in sandhills include pygmy fringe tree, pigeon wings, scrub buckwheat, Britton's beargrass, wide-leaf warea, Carter's mustard, and Florida ziziphus.

Population dynamics

Although scrub plum's historic range was rather extensive compared to other narrowly endemic plants of Florida's central ridges, this species has declined with destruction and fragmentation of its scrub habitat.

Scrub plum plants nearly always resprout after fire (Menges and Kohfeldt 1995; Menges et al. 2005; Weekley and Menges 2001, 2003a, 2003b). Three years after a fire, more than 98 percent of burned plants had survived, though they had lesser height and crown diameter than unburned control plants (Menges et al. 2005). During 10 years of monitoring of 65 scrub plum individuals at TNC's Tiger Creek Preserve, more than 95 percent of the plants resprouted post-fire and regained their pre-burn height and width within 2 years post-fire (TNC 2004). Populations at the Arbuckle and Walk-in-the-Water tracts of LWR State Forest appear stable, but Cox (2004) did not find any seedlings or juveniles.

In 3 years of conducting experimental burning and cutting treatments at Carter Creek and collecting demographic data, 903 plants were tagged. Of these, 565 were in burn treatments, of which 454 were burned to some extent in an August 2001 burn; 99.7 percent survived or resprouted. Only three plants "with total consumption of the aboveground parts died"

(Menges et al. 2005). As of February 2005, four plants had been killed by prescribed fire and six had died from other causes (Menges et al. 2005). Twelve plants near the study area boundaries were inadvertently damaged during site maintenance in 2004, but are expected to recover (Menges et al. 2005). ABS has carried out germination experiments, but has not yet reported results (ABS 2003).

Status and distribution

Habitat loss due to conversion to agriculture and residential development continues to threaten this species. Removal by plant collectors has been an additional threat that land acquisitions and conservation areas are alleviating. Fire suppression has degraded the habitat required by this species. This species apparently requires periodic fire or other disturbances to maintain suitable habitat.

Scrub plum occurs in three general areas on Florida's central ridges: Lake County, west and southwest of Lake Apopka; the southwest and northwest corners of Orange and Osceola Counties, respectively; and Polk and Highlands Counties, from the City of Lake Wales south to the Highlands County/Glades County border (FNAI 1996b) on the LWR. It is absent from the Bombing Range Ridge of APAFR.

Scrub plum is present on nearly all conservation lands within its range that have scrub or sandhill vegetation (FNAI 1985; Stout 1982):

- In Lake County, the 120-acre Flat Lake tract of Seminole State Forest southeast of Clermont (Schultz et al. 1999; FNAI 2005), which was purchased by TNC in 1999 (Finkelstein 1999);
- In Polk County, protected sites containing scrub plum exist at the Arbuckle and the Lake Walk-in-the-Water tracts of LWR State Forest, at the Pine Ridge Nature Preserve of HBS, at the Allen David Broussard Catfish Creek Preserve State Park, at TNC's Tiger Creek Preserve, and probably at the Saddle Blanket Lakes Preserve; and
- In Highlands County, the scrub plum is protected on the Carter Creek tract and Apthorpe, Holmes Avenue, Lake Placid, and Gould Road areas of the LWRWEA; the Carter Creek and Flamingo Villas tracts of LWRNWR; ABS; and Lake June-in-Winter Scrub State Park.

The Florida Plant Conservation Program, operated by DOF, commissioned a status survey for scrub plum in late December 2003. FNAI conducted field surveys to relocate and document known populations in 2008. They found 83 populations throughout the range but only 45 populations have more than 10 plants.

Short-leaved Rosemary

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008j). The 5-year review builds upon the detailed information in the MSRP and is located at http://www.fws.gov/southeast/5yearReviews/5yearreviews/ShortLeavedRosemary.pdf

Species/critical habitat description

This "profusely branched mint-smelling shrub [up] to about 1 meter [3 ft] tall" (Kral 1983) has short, narrow leaves and lavender flowers about 1.3 cm (0.5 inch) long that are bilaterally symmetric (with upper and lower lips). Short-leaved rosemary is similar to false rosemary (*Conradina canescens*) of the Florida panhandle, but has, as its name implies, shorter leaves: the larger leaves on well-developed flowering branches are 6.0 to 8.2 mm (0.24 to 0.31 inches) long, mostly longer than the internodes, versus 7 to 20 mm (0.28 to 0.79 inches) long, mostly longer than the internodes for *C. canescens*. *Conradina brevifolia* also tends to have more flowers per axil than *C. canescens*: one to six per axil versus one to three in *C. canescens* (Shinners 1962; Kral 1983). Gray (1965) showed that *C. brevifolia*, like Apalachicola false rosemary (*C. glabra*) of the Florida panhandle, is morphologically not strongly differentiated from, and is less variable than, *C. canescens*. Kral and McCartney (1991) maintained *C. brevifolia* as a distinct species, while Wunderlin and Hansen (2005), without explanation, treat it as part of *C. canescens*.

Short-leaved rosemary is one of four shrubby mints in the interior central Florida scrub. The others are Ashe's calamint (*Calamintha ashei*), scrub mint, and Garrett's mint. Short-leaved rosemary can be distinguished from the scrub and Garrett's mints (*Dicerandra*) by its flowers not having sharply-bent corollas, and by its lack of the strong mint or camphor scents of the scrub mint or Garrett's mint leaves. Short-leaved rosemary and other members of *Conradina* are distinguished from *Calamintha* by differences in the branches of the flowers' stigmas and by short-leaved rosemary having appressed trichomes (hairs) on the lower sides of the leaves, while *Calamintha* has erect trichomes (Shinners 1962; Kral 1983). The other "rosemary" in central Florida scrub is Florida rosemary, a larger shrub that is not a member of the mint family, and is so distinctive it cannot be mistaken for any of the mints.

No critical habitat has been designated for short-leaved rosemany.

Life history

Short-leaved rosemary inhabits white sand scrub with evergreen scrub oaks and sometimes a scattered overstory of sand pine. Short-leaved rosemary is usually found interspersed in gaps between the shrubs on bare sand with other small shrubs and herbs (Service 1992). No specific information is available on the ecological requirements of short-leaved rosemary. However, existing information on the natural fire regimes of various scrub communities suggest that the white sand scrub inhabited by short-leaved rosemary requires periodic, patchy, high-intensity fires. Fire cycles of 15 to 20 years, or possibly less, reduce overstory competition and provide disturbed open sandy patches within which obligate seeding species may re-establish. Short-leaved rosemary, like other scrub mints, is probably killed by fire (Service 1996), or other disturbance, but readily germinates post-fire from seeds stored in the sand (Menges 1992). To conserve short-leaved rosemary, managers of conservation lands must restore and maintain scrub communities by mimicking the timing and intensity of natural fire regimes. Monitoring at TNC's Saddle Blanket Lakes Preserve has revealed that short-leaved rosemary readily re-establishes post-fire from seedlings (TNC 2004).

Status and distribution

Short-leaved rosemary has a very restricted distribution in the middle of the LWR. It occurs at only about 30 sites whose total area is less than 2,400 ha (6,000 acres) in the Sebring-Avon Park area of Highlands and Polk Counties (Christman 1988; Christman and Judd 1990). Wunderlin and Hansen (2005) also report it, or *Conradina canescens*, from Hernando County, on the Brooksville Ridge. A survey of sites under consideration for acquisition by the State (Schultz et al. 1999) found no significant new sites for this plant.

Short-leaved rosemary is present on conservation lands at:

- Carter Creek unit of the LWRWEA (FWC), Highlands County;
- Silver Lake unit of the LWRWEA (FWC), Highlands County (Schultz et al. 1999);
- Saddle Blanket Lakes Preserve (TNC), Polk County;
- Sun Ray unit of the LWRWEA (FWC), Polk County (Schultz et al. 1999);
- Hickory Lake Scrub County Park, Polk County (Schultz et al. 1999), adjacent to Sun Ray; and
- Arbuckle tract of LWR State Forest (FDOF), Polk County. At this site, it was surveyed by Kris DeLaney in 1988 and by Anne Cox in 2002 and 2003. Overall numbers appeared stable, with 1,496 plants at 11 sites in 2003 (plus several other unsurveyed sites with 30 to 50 plants each) and 1,525 plants in 1988. A suggestion was made that the species does not require monitoring, except after fires (Cox 2004).

It is present on non-conservation lands in the Avon Park Lakes area (two occurrences) and Silver Lake southwest of Avon Park (three occurrences) (Schultz et al. 1999).

Small's Milkpea

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

Species/critical habitat description

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 inches] long, standard and keel 1 to 1.5 cm [0.4 to 0.6 inches] long) (Herndon 1981). This species has compound leaves, usually with three elliptic leaflets 1.5 to 3 cm (0.6 to 1.2 inches) long. The stem pubescence is ascending or spreading-sericeous, and upper leaf surface is puberulent (hairs 0.1 to 0.2 mm [0.004 to 0.008 inches] long); hairs on stem less than 0.5 mm [0.02 inch] long) (Herndon 1981).

No critical habitat has been designated for Small's milkpea.

Life history

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). FTBG is conducting propagation trials in order to expand the ex situ collection of this species. 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.

Population dynamics

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-mile (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 Miami-Dade County for conservation purposes. The County is working to restore and manage these lands.

Status and distribution

When this species was listed, it was known from two sites near Homestead in Miami-Dade County. 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 meters) 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-mile (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 2010a). Miami-Dade County owns six of the public sites, purchased for conservation purposes, and is working to restore and manage these lands through their Environmentally Endangered Lands program. The remaining public site is owned by the County's Board of Education (Bradley, 2010b) and is, therefore, subject to future development. However, the Environmentally Endangered Lands program is currently attempting to acquire this site (Guerra 2010).

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 2009). 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 natural forested communities in Miami-Dade County recorded the species on eight public sites (IRC 2006; Bradley 2009, 2010a). Also in 2009, an additional small population was discovered on the private Palms Woodlawn Cemetery along Old Dixie Highway in Homestead (Bradley 2010b). Because this species has no apparent mechanism for long-distance dispersal of seeds, it is presumed 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 *in litt.*).

Less than 2 percent of the original acreage of pine rockland habitat remains (Bradley and Possley 2002). Most of that habitat 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. The known sites where Small's milkpea occurs on public lands are protected from development, but these sites must be managed to prevent habitat degradation and potential loss of plants. Privately-owned sites remain at risk of being developed and management remains a concern.

Limited distribution renders the species vulnerable to random natural or human induced events, such as hurricanes and encroachment of invasive exotic species. All of the populations require active management, including exotic plant control, thinning of overgrown vegetation, and/or prescribed fire. The current number of individuals in wild populations is not known, therefore, trend analysis is not available. Although some demographic information is available, additional long-term research will be necessary to develop accurate population models.

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. Continued habitat loss and fragmentation, fire suppression, and invasion by exotic plant species threaten the existence of Small's milkpea (Service 2007j).

Snakeroot

The following discussion is summarized from the MSRP (Service 1999a), as well as from recent research publications and monitoring reports. A complete snakeroot life history discussion may be found in the MSRP.

Species/critical habitat description

Snakeroot is a member of the carrot family (Apiaceae or Umbelliferae). It is a short-lived perennial herb with a very long taproot. The basal rosette, which may remain green during the winter or disappear briefly, is composed of wedge-shaped leaves that are thick but not succulent. The flowering stems are up to 0.5 meter (1.5 ft) tall. The inflorescence is diffusely branching, with each branch ending in a tight umbel (or small head) with bristly bracts. Each plant may have hundreds of umbels. The flowers are perfect (bisexual), but the anthers open before stigmas become active (*i.e.*, flowers are protandrous), but each plant has so many flowers that functionally male and female flowers are usually present at the same time. The 10 to 15 flowers in each umbel have white petals, filaments, styles, and stigmas, but the anthers are powdery blue. Plants flower for about a month in late summer to fall (August to October) (ABS 2003). After fruiting, reproductive stems soon wither and die. All other *Eryngium* species in south Florida have blue flowers (Service 1996; ABS 2003).

No critical habitat has been designated for the snakeroot.

Life history

The concise guide to snakeroot's life history by ABS (2003) summarizes intensive research on its breeding system, genetics, and population dynamics. Snakeroot requires insect pollinators to produce seed (ABS 2003). "Many species (at least 100) of generalist insects are frequent (0.3 visits per minute) visitors and likely pollinators. Most insects are apparently seeking nectar although some collect pollen. Pollinator visitation does not appear to limit seed production, and open pollinated seed set was very high (80 percent). Most insect movements are among flowers on the same plant or between nearby (< 5 meters apart) plants. Self and cross treatments produced similar numbers of seeds, suggesting that inbreeding depression is not acting at this life history stage" (ABS 2003).

Fruiting and seed dispersal is believed to occur between October and January (Wunderlin et al. 1981c; Kral 1983). Seeds are mature in November (T. Race, BTG, personal communication, 1996). There seems to be no special seed-dispersal mechanism (other than gravity) (Wunderlin et al. 1981c; Kral 1983). Germination is in winter and spring. "Although some seeds can germinate shortly after maturation, most seeds remain dormant for a year or more, germinating in subsequent winter seasons. … Seedling numbers are highest during wet spring weather and in recently burned areas" (ABS 2003). Few plants survive as long as 10 years. "Most plants start flowering at ages 2-3 years and many continue flowering year after year. However, regression from reproductive to vegetative stages is common and our historical analyses suggest that regression is often a predictor of mortality. Nearly every aspect of the demography of [snakeroot] is affected by fire. Plants in recently burned areas live longer, survive better, grow faster, and flower earlier than those that germinate in areas that have not been burned recently" (Menges and Quintana-Ascencio 2004). Demographic data have been collected for this plant since 1988, and this species has become an important subject for research into population dynamics and population viability in relation to fire. The population viability analysis published by Menges and Quintana-Ascencio (2004) takes full advantage of that data. They note that snakeroot "populations explode within the first decade after fire. Large plants with many flowering stems are common beginning the third year postfire. Many of these plants become rather static in size and fecundity" and mortality increases, so populations tend to decline after 9 years and aboveground plants disappear "between 25 and 35 [years] postfire." The exacting habitat requirements of snakeroot mean that, despite large populations at several sites (possibly millions of individual plants in its small range, plus dormant seeds), its habitats must be managed aggressively to maintain the open, sunny gaps that snakeroot needs.

Snakeroot is restricted to Florida scrub vegetation, usually with much Florida rosemary and scrub oak. It is restricted to open, sandy areas within the vegetation, with herbs such as scrub blazingstar, Highlands scrub hypericum and nodding pinweed. In the open areas between shrubs, reindeer moss (*Cladonia*) lichens cover more area than the herbs. The vegetation burns to the ground at intervals. Oaks resprout from the roots, sand pine recolonizes by seed, and rosemary and snakeroot return from seed stored in the soil (ABS 2003; Abrahamson et al. 1984; Abrahamson 1984a, 1984b). Shrubs and trees may affect snakeroot by shading it. Florida rosemary may affect snakeroot through allelopathy (Wunderlin et al. 1981c; Kral 1983; Richardson 1985; ABS 2003).

The open, sunny sand between shrubs (gaps) inhabited by snakeroot are created or enlarged by fire or other disturbance (Wunderlin et al. 1981c; Abrahamson et al. 1984). Of the endemic plant species that occur in white sand habitats in Florida scrub, it "has the greatest specialization for open microsites and recently burned areas, and seems particularly vulnerable to allelopathy [inhibition of growth caused by chemicals released by other plants] from Florida rosemary" (ABS 2003). Snakeroot populations boom after a fire, peaking about 6 to 10 years post-fire, then crash. Fire intervals of greater than 20 years may lead to local extinction (ABS 2003). Although its growth is suppressed by rosemary, at ABS the plant usually occurs in the vicinity of rosemary, mostly on Psamment (sand) soils of the Archbold Series which are moderately well drained, acid (pH 4.2), and with low soil nutrient levels (trace phosphorus; potassium, 5.6 kg/ha). Other soils in the area are also infertile. A small portion of the rosemary scrub at Archbold has soils of the St. Lucie Series, which are deep fine sands. This appears to be the major series in which snakeroot is found outside of ABS (Wunderlin et al. 1981c; Abrahamson et al. 1984).

"Population sizes of [snakeroot] fluctuate widely, with the largest populations found shortly after fire and in disturbed areas. Local population sizes and densities are larger than most other Florida scrub endemics. Population sizes peak 6 to 10 years postfire. Subsequent declines can be steep, and most populations disappear (aboveground) from sites 30 to 34 years postfire. [Snakeroot] populations may persist longer in disturbed areas and extremely xeric, open sites.

Seeds have persistent dormancy and most populations recover from fire from a persistent soil seed bank. Survival of seeds in the seed bank is probably high. Occasionally, some plants resprout in areas with very low fire intensity. Growth, survival, and fecundity are markedly higher shortly after fire and, over time, for seedling cohorts originating shortly after fire" (ABS 2003).

A 40-acre (6.2-ha) addition to ABS's property, on its west boundary had abundant snakeroot when it was purchased, apparently because snakeroot proliferated after the former owner had cleared and root-raked the area. This supports other observations that this plant requires burned or disturbed habitats.

Status and distribution

The distribution of snakeroot is in southern Highlands County, near the town of Lake Placid. It occurs only on the southern LWR. The northernmost sites were at several sites in and around the town of Sebring, especially on the sand dune along the south side of Lake Jackson (Wunderlin et al. 1981c); this area was developed by about 1990. All other sites are in an area about 39 km (24 miles) long from the southern side of Josephine Creek to the southern tip of the LWR. Christman (1988) reported only about 20 localities, but even this number is misleading since he divided several larger sites. A survey of properties under consideration for purchase by the State did not find any new localities (Schultz et al. 1999). It is present at these sites, from south to north:

- Hendrie Ranch, a private property some 24 km (15 miles) south of Lake Placid or east of Highway 27 (roughly 8 miles south of SR 60) (Service 1996; FNAI 2005);
- Gould Road, 212 acres, part of LWRWEA, 1 occurrence (Schulz et al. 1999);
- ABS (private preserve);
- Woolfenden (McJunkin) tract, 623 acres, part of LWRWEA;
- Lake Placid Scrub, 2,159 acres, part of LWRWEA (Service 1996);
- Holmes Avenue, 974 acres, part of LWRWEA, 1 occurrence (Schulz et al. 1999); and
- Lake Apthorpe, 810 acres, part of LWRWEA, 3 occurrences (Schulz et al. 1999).

The only large privately-owned tract with habitat with this species may be the Hendrie Ranch. The local distribution of snakeroot within ABS is quite limited. Archbold has about 90 rosemary balds, which are patches of open, dry scrub surrounded by scrubby flatwoods with dense scrub oak (Johnson 1981; Abrahamson et al. 1984). Only about 12 of the rosemary balds have snakeroot (E. Menges, ABS, personal communication, 1989). Snakeroot was reported to occur at Lake June-in-Winter Scrub State Park on the west side of Lake June in Winter (Service 1996), but it was not relocated after several intensive searches (Schultz et al. 1999).

<u>Telephus Spurge</u>

The following discussion is summarizied from information taken from the 5-year review (Service 2008l) authored by Dr. Vivian Negron-Ortiz of the PCFO. This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews Telephus spurge is endemic to the Florida panhandle and restricted to Bay, Gulf, and Franklin Counties. It is unknown whether *Euphorbia telephioides* was once continuously distributed throughout the three counties or populations were restricted to local habitat patches. The present remaining patches are separated by clear cuts, pine plantations or residential/commercial development.

In 1992 when the species was listed, it was known from 22 localities in the three counties, all within 4 miles of the Gulf coast (57 FR 19813). To date, the species is still constrained to the same three counties, but the number of occurrences within the counties, specifically Gulf County, has increased to 38. Development has resulted in (or potentially resulted in) extirpation of several of those populations and has left other sites highly fragmented. (Negrón-Ortiz, V.2008) Telephus spurge can be locally abundant along disturbed sandy, sunny roads, and in sites with bedding. It can be found sporadically abundant in dense grass of unburned scrubby flatwoods (Negrón-Ortiz, 2007, personal observation). It has also been noted in upland communities, which have been historically burned with a 2 to 3-year fire frequency (J. Huffman, 2007, personal communication). In general, the plants do well on sandy, acidic soil, with no litter, and low organic and moisture content (Peterson and Campbell 2007; (Service 2008l).

Tiny Polygala

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

Species/critical habitat description

Tiny polygala is 1 of 9 species of *Polygala* native to Miami-Dade County and 1 of 11 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 Hanson (2004) show the distribution of *P. nana* extending south to Broward County.

No critical habitat has been designated for tiny polygala.

Life history

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 to November, but a few seedlings emerge from May to 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 to 100 percent 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 *in litt.*). It is, therefore, important to manage not only for above-ground plants, but for the conservation of the seed bank.

Because seeds may remain dormant in the soil until fire disturbs the site, abundance and population trends for this species are difficult to assess. 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 (2002) 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).

Status and distribution

When tiny polygala was listed, it was known from sandy pine rockland and Florida scrub vegetation in Miami-Dade and Broward Counties (the Miami and Fort Lauderdale metro areas, respectively). A survey of 56 sites between Broward and Indian River Counties extended its known range into northern Palm Beach and south-central Martin Counties, but only at a few sites (Bradley and Gann 1995). Later, Bradley et al. (1999) conducted an endangered plant survey in Florida scrub vegetation in Martin, St. Lucie, and Indian River Counties, covering 25 properties. They found no new populations. Surveys for rare plants in Brevard County did not find tiny polygala (Kennedy 2003a, 2003b, 2004), although this was not a target species and may have been missed. 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).

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). 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.

During 2008, FTBG conducted surveys for the species at all known sites within Miami-Dade County (Maschinski et al. 2008; Maschinski 2010). The four known sites where it remains include the publicly owned Miami Metrozoo and adjacent U.S. Coast Guard property, both located within the 2,100-acre Richmond pinelands (Maschinski et al. 2008; Maschinski 2010). The Coast Guard site contains the largest population of plants, which was estimated at over 10,000 plants during a 2008 survey (Maschinski et al. 2008; Maschinski 2010). The species was also reported from the Deering Estate at Cutler (441 acres) and the Pine Shore Pineland Preserve (Pine Shore Park) (8 acres) (Maschinski 2005 *in litt.*; Maschinski et al. 2008; Maschinski 2010; FNAI 2010). This survey failed to locate the plant at two previously documented sites, the County owned Ludlam pineland and the adjoining Florida Power and Light Company easement (Maschinski 2005 *in litt.*; IRC 2006, Maschinski et al. 2008; Maschinski 2010; FNAI 2010), suggesting the species may be extirpated from these sites. The survey also did not report finding the species at former sites on University of Miami and Air Force lands, both occurring within the Richmond pinelands (Maschinski et al. 2008; Maschinski 2010). However, Woodmansee et al. (2007) indicate tiny polygala occurrences appear to be cyclic, suggesting historical occurrences, if given appropriate management, may reappear.

In Broward County, tiny polygala was known to occur only at one site, the 16.5-acre Gopher Tortoise Preserve at Fort Lauderdale Executive Airport, managed by the City of Fort Lauderdale (FNAI 2010; Maschinski 2010). This site was surveyed in 2002 and no plants were found (Possley 2006 *in litt.*), but it is presumed seeds remain in dormancy. However, Woodmansee et al. (2007) also failed to locate the plant at this site during 2006 surveys and suggested drought conditions, exotic plants, and lack of fire may have hindered this population. The nearly adjoining Cypress Creek Scrub Preserve (8 acres), also managed by the City (FNAI 2010), has not been surveyed for tiny polygala (Possley 2006 *in litt.*, Maschinski 2006 *in litt.*), but plants may occur there.

Palm Beach County's Department of Environmental Resources Management (Walesky 2005 *in litt.*) reports tiny polygala is found in two locations in the County. Walesky (2005 *in litt.*) indicates all of the locations are characterized by open patches of white sand with a ground water table that is relatively near the surface. At Jupiter Ridge Natural Area (269 acres), which had 100 plants when discovered by Gann in 1994, there were 12 plants in 2004 and 86 in August 2005. County biologists attribute the increased population in 2005 to the opening up of the site's dry hammock (hardwood forest) from hurricane activity and above-normal spring and summer rainfall (Walesky 2005 *in litt.*; Woodmansee et al. 2007). Further surveys by Woodmansee et al. (2007) found smaller densities in 2006 and noted the species abundance at the site fluctuates dramatically from year to year. Tiny polygala was also discovered at Limestone Creek Natural Area in 2002. A survey conducted in July 2003 recorded 13 plants (Walesky 2005 *in litt.*).

Since 2006, the number of plants recorded at this site has ranged from 3 to 60, with 26 encountered during April 2010 (Woodmansee et al. 2007; Shearer 2010). Walesky (2005 *in litt.*) indicated the County's oceanfront Diamondhead/Radnor Future Park Site (154 acres), discovered in 2001, maintained a population of about 50 plants. However, further surveys at this site determined that the plants reported from this site were candyroot (*Polygala nana*), the closest congener of tiny polygala (Woodmansee et al. 2007; Bradley 2010).

In southern Martin County, tiny polygala is known to occur in JDSP (17,314 acres). Surveys of the site conducted from 2000 to 2008 have recorded varying numbers of plants (Woodmansee et al. 2007; FNAI 2010). Woodmansee et al. (2007) indicated that while the species appears to be in decline at JDSP, it is expected that plant numbers will increase in the long run, provided fires are administered. In St. Lucie County, the species was determined to occur at the privately owned Lynn University, based on a specimen collected in 1984 (Bradley and Gann 1995). Woodmansee et al. (2007) located 14 plants at this site in 2006, further noting that the site had recently been burned and that exotics were being managed.

Bradley and Gann (1995) documented the species at the Lynngate portion of Savanna Preserve State Park, also in St. Lucie County. However, Woodmansee et al. (2007) reported no plants during a 2006 survey and indicated that fire suppression over time was the most likely cause for the plants' disappearance from this site.

White Birds-in-a-nest

The following discussion is summarizied from information taken from the 5-year review (Service 2009) authored by Dr. Vivian Negron-Ortiz of the PCFO. This information is also on the PCFO website at http://www.fws.gov/southeast/5yearReviews/5yearreviews, White birds-in-a-nest is endemic to the Florida panhandle and is still restricted to the same four counties: Bay, Gulf, Franklin, and Liberty. In 1992 when the species was listed, the majority of the populations (65 percent of the occurrences) were found or known to occur in the ANF, Liberty Company (Service 1992). Based on current survey information, only 40 percent of the current occurrences are within ANF (FNAI 2008). However, this number could be misleading because this species is quite abundant, almost continuously distributed throughout large sections of the forest (Negrón-Ortiz, Service 2008, personal observation), specifically in areas properly managed with prescribed burns.

Most locations in Bay, Gulf, and Franklin Counties are separated by clear cuts, pine plantations or residential/commercial development. Development has resulted in extirpation of populations, and has left other sites highly fragmented. Habitat destruction, fragmentation, and modification are the primary threats identified in the Recovery Plan for *M. alba*, and remains the main threats to date for this plant. Timbering, urban development, and fire management and suppression in this region have changed the ecosystems in the parts of the state where this plant is found.

Wireweed

The following discussion is summarized from the MSRP (Service 1999a), as well as from recent research publications and monitoring reports. A complete wireweed life history discussion may be found in the MSRP.

Species/critical habitat description

Wireweed is one of three species of *Polygonella* occurring in scrub in southern Florida (Lewis and Crawford 1995). The other endangered species, sandlace, inhabits the LWR and vicinity, and is extremely different in appearance. Where wireweed is an herb, sandlace is a creeping shrub (Horton 1960). Hairy jointweed (*Polygonella ciliata*) is very similar to wireweed, but its geographic range does not overlap with wireweed's (Wunderlin and Hansen 2005).

Wireweed plants consist, during the winter and spring months, of a basal rosette of leaves. During the summer rainy season, a cluster of upright stems appears. The stems have small, narrow, alternate leaves. The sheaths at the plant's stem nodes (ocreae) that are characteristic of the jointweed family are ciliate (fringed). Stems and leaves range in color from green to dark red. Red coloration appears to be associated with exposure to full sunlight and with older vegetative parts (although seedlings are often red). As the stems elongate, 1 to 46 slender spike-like clusters of flowers develop at the ends of the stems. The flowering stems are as tall as 0.8 meter (3 ft) (Hawkes and Menges 1995). Individual plants produce either pistillate (female) flowers or perfect (bisexual/hermaphroditic) flowers. Individual flowers are small, white to slightly pink with five sepals (covers for a flower before it opens), no petals, pink pistils, and black anthers. The gynoecium (seed-producing organ) consists of three united carpels (ovule-bearing units), each with a one-ovuled, superior ovary. The flowers are arranged in spikes, and flowering starts at the tops of the spikes and proceeds downward. The fruit is a three-sided, single-seeded dry fruit (achene), 1 to 3 mm (0.04 to 0.10 inches) in length (Horton 1963).

No critical habitat has been designated for wireweed.

Life history

Wireweed seeds germinate in winter or spring. Individual plants flower for at least 1 or 2 years, but often fail to live the third year (ABS 2003; Hawkes and Menges 1995; 1996). Flowering is from September through November. Plants overwinter as rosettes. In May or June (ABS 2003; Hawkes and Menges 1995) the plants tend to lose their leaves and can for a while be nearly invisible until stems begin to grow. Wireweed is gynodioecious – plants have either only female flowers or hermaphroditic flowers. Seed is produced in abundance and is highly viable. Seeds do not become dormant and the species does not have seed banks in the soil.

Population dynamics

Analysis of wireweed's population dynamics and population viability is based on the essential role that fire plays in maintaining this vegetation (Boyle et al. 2003) and the importance of recovery from fire for the vegetation itself and for its species (Abrahamson 1984a, 1984b).

Wireweed occupies open, sandy patches (or gaps) in the rosemary phase of Florida scrub, which itself is quite patchy, usually being surrounded by denser vegetation. The gaps are usually impermanent. Large areas of open sand may have especially dense populations that may be attractive to pollinators and may have high seed production. Because gaps are impermanent, wireweed suffers local extinctions. Because wireweed does not maintain seed banks in the soil and is killed by fire, it must colonize recently-burned areas from nearby populations (Boyle et al. 2003). Recolonization may be slow due to this species' small seeds, which have no obvious dispersal mechanisms.

Boyle (2004) prepared a metapopulation viability analysis of this plant, based on its colonization of newly-available gaps, and its subsequent local extinctions as gaps decrease in size. Boyle (2005) reports that "from 1999 to 2002, turnover among 1,210 gaps was 8 percent per year and dominated by local extinctions. Logistic regression shows that the incidence of

P. basiramia within gaps increases in larger, less isolated gaps. The probability of local extinction decreases with increasing gap area. The probability that a vacant gap is colonized rises with gap area and proximity to other occupied gaps. Extinction and colonization of populations within 83 rosemary patch populations occurred more slowly (1 percent per year, 1989-1999) and responded less to habitat characteristics, as expected if large scale patterns integrate over smaller-scale dynamics…" In brief, wireweed is more likely to be present in large gaps that are near other gaps, and large, vacant gaps are more likely to be colonized.

Boyle's innovative metapopulation population viability assessment compliments viability assessments that have been prepared for several other LWR scrub plants. Evans et al. (2003) emphasize the importance of understanding the reproductive biology of individual rare species and the hazards of simply assuming that plants from shared habitats and shared disturbance regimes share the same risks to population viability. They conclude that "prescribed fire programs tailored to the population dynamics of these plants and reserve systems designed to accommodate extinction-recolonization dynamics should address both the positive and negative effects of fire on these plants."

Wireweed, like other small herbs of scrub openings, opportunistically occupies road edges and other artificially disturbed areas. Roadside habitats are significantly different from the bare areas within the vegetation, and may be less suitable for conservation of the scrub species. Petrů and Menges (2004) found that "the demographic responses of the species to sand movements indicate that mobile sands create constantly shifting arrays of microsites that can influence post-dispersal seed germination, survival, and growth of Florida scrub herbs. Roadside habitats have more dynamic patterns of sand movement than natural gaps and may alter selection regimes important for demographic variation of endemic Florida scrub plants."

Boyle and collaborators examined the genetic diversity and structure of wireweed populations. They found low levels of population differentiation, and "opportunistic roadside populations harbor genetic diversity similar to scrub populations" (Boyle 2005; Boyle et al. 2000). This finding somewhat allays concerns that the artificial conditions at the edges of unpaved roads, trails, and fire lanes may become genetically differentiated from populations growing under natural conditions within the vegetation.

Status and distribution

Wireweed occurs on the LWR and the adjoining, much smaller, Bombing Range Ridge. It is present on most of the conservation lands with scrub within its range, and it is locally abundant. As of September 1999, the FNAI database had 142 element occurrence records for wireweed, of which 61 (43 percent) were on 12 different conservation lands. Another 42 Element Occurrence Records were on sites proposed for State acquisition (Schultz et al. 1999). Data from 1983 to 2000 showed that 10 of 144 localities had more than 100 individual plants and 4 of these 10 localities had greater than 500 plants (FNAI Unpublished Data). These sites are now on sites belonging to the LWRWEA, except for a site at Hickory Lake. The FNAI data do not include abundant wireweed at ABS and the Arbuckle tract of LWR State Forest. A new assessment of this species' distribution and abundance will be available in 2005.

Wireweed is reported from the following conservation lands. Information is provided where available:

- The Allen David Broussard Catfish Creek Preserve State Park comprises 4,218 acres operated by FDEP. It has active fire management and rare plant monitoring;
- Hickory Lake Scrub County Park, a 57-acre tract owned by Polk County. It has a management plan, prescribed fire management, and rare plant monitoring;
- Saddle Blanket Lakes Preserve comprises 829 acres owned by TNC. The tract has rare plant monitoring. TNC has conducted fires since the early 1990s, so this preserve has substantial open, sandy areas ideal for wireweed;
- Sun Ray (270 acres) is a scrub unit of the LWRWEA;
- LWR State Forest consists of three tracts. Wireweed is present on the Arbuckle and Babson/Hesperides tracts. The Forest has rare plant monitoring. The LWR State Forest is represented in the FNAI database by 13 element occurrences, but the Arbuckle tract has records for 184 records for this plant, based upon an inventory by K. DeLaney in 1988 (data provided by A. Cox). Of the 184 locations of wireweed on the Arbuckle tract, 30 of these represented more than 100 individuals. Although even today not all of this property has been searched for scrub plants, these data demonstrate that wireweed is abundant on the Arbuckle tract;
- Hickory Lake Park, operated by Polk County, south of Frostproof, comprises 57 acres. Wireweed is abundant (FNAI 2002);
- LWRNWR, Flamingo Villas tract;
- APAFR comprises 106,110 acres. The tract has a management plan, land and fire management, and rare plant monitoring for wireweed, which is present on the Bombing Range Ridge;
- The LWRWEA comprises 11 tracts, totaling 16,167 acres. Wireweed is present on the following tracts: Lake Apthorpe, Gould Road, Henscratch Road/Jack Creek, Holmes Avenue Scrub, Highlands Ridge, Carter Creek, Silver Lake, Gould Road, and Lake Placid. Royce Ranch and the Woolfenden Tract (McJunkin Ranch) have not been fully inventoried but both have suitable habitat and are within the species' range;
- The Preserve at Sun N' Lakes, operated by Highlands County, comprises 1,380 acres, in part longleaf pine vegetation. An overall management plan has been prepared, and the County planning department prepares annual stewardship reports (V. Pontius, Highlands County, personal communication, 2002). Wireweed is almost certainly present here, based on the tract's location adjacent to the Silver Lake tract of the LWRWEA, but we do not have confirmation;
- Highlands Hammock State Park, comprising 8,123 acres, was expanded during the 1990s to include scrub. The Park has a management plan, land and fire management, and rare plant monitoring;
- Jack Creek, comprising 1,285 acres, is owned by SWFWMD. It adjoins the Henscratch Road/Jack Creek tract of the LWRWEA;

- Lake June-in-Winter Scrub State Park, located on the lake, comprises 845 acres. It has a management plan, land and fire management, and monitoring of endangered and threatened plants; and
- ABS comprises 5,238 acres. The Station has a management plan, land and fire management, monitoring of endangered and threatened plants, and extensive research programs, including projects on wireweed, which is abundant here.

Habitat outside of conservation lands is still being lost by conversion to residential and agricultural development.

ENVIRONMENTAL BASELINE

The environmental baseline includes the effects of past and ongoing human and natural factors leading to current status of the species and their habitats.

Status of the Species/Critical Habitat Within the Action Area

<u>Audubon's Crested Caracara</u>

The Service has reviewed the most current GIS database (1992 to 2007 observations) for caracara observations. Although these data do not represent a systematic survey throughout the species' range, they do provide a general impression of its overall range and the area of concentration of observations in the Central Florida Sand Ridges Prescribed Fire action area. From these data, it is apparent that most observations of nests and individuals occur in suitable habitat in and around the LWR and Bombing Range Ridge, and suitable habitat in Okeechobee and Highlands Counties. Scattored occurrences were also noted in Osceola and Polk Counties on lands boarding the Kissimmee River and the Kissimmee River Chain of Lakes. This subset of the action area is estimated at about 1,738,000 acres and represents about 15 percent of the species' range. From the data we have examined, the Service believes that caracara nests could be present in nearly any given month of the year where suitable habitat exists, but nests are more likely to be present in the peak period from November through April.

Within the action area, based on review of consultation records for caracara, approximately 10 caracara territories and approximately 8 nests are occupied each year at MacArthur Agro-Ecology Research Center and ARC. About 19 individual caracaras have been known to roost at MacArthur Agro-Ecology Research Center at a given time. Consultations associated with training exercises on APAFR and proposed restoration actions associated with the the Kissimmee River Restoration Project have also documented approximately three caracara nests present in suitable habitat along the eastern boundary of the APAFR range overlapping territories in the adjacent KPPSP and TLWMA.

<u>Florida Grasshopper Sparrow</u>

The FGSP is currently limited to the prairie region of south-central Florida from Highlands, Okeechobee, Osceola, and Polk Counties. The majority of birds are known to occur in an undefined number of subpopulations at TLWMA, and at KPPSP. The status of FGSP on private lands is not known, but populations on these lands are presumed to be small.

Despite unprecedented habitat restoration efforts in the last 5 years, recent surveys in 2012 recorded the lowest number of males ever (60 males at TLWMA, 14 males at KPPSP, and 1 male at APAFR). Less than 15 percent of the Florida native prairie habitat remains; however, habitat is not believed to currently limit population growth, as large areas of seemingly high quality habitat are not currently occupied. The total FGSP population size is estimated at only a few hundred individuals, and the subspecies is nearing extinction.

Dry prairie habitat is maintained primarily through the application of prescribed fire. However, the best timing of prescribed burns is not certain. When prescribed fires are conducted in winter or early spring, the growth of trees and shrubs in patches within dry prairies and along the perimeter of the prairies may have increased. The result has been a potential reduction in suitability for FGSP (Bowman and Tucker 2006, Bowman and Tucker 2007). Late spring and summer burns may result in more appropriate habitat, but may limit population growth due to disturbance during the nesting season or direct harm to nests or young. These later burns may increase fire ant distribution across the prairie landscape. Despite this uncertainty in ideal timing of fires, frequent fire is necessary to maintain prairie habitat and will ultimately benefit the species when used appropriately

<u>Florida Scrub-jay</u>

Within in the action area both the Ocala and LWR metapopulations of this species are very important to its recovery. Results from Stith's (1999) simulation model included estimates of extinction, quasi-extinction (the probability of a scrub-jay metapopulation falling below 10 pairs), and percent population decline. These were then used to rank the different statewide metapopulations by vulnerability. The model predicted that five metapopulations (NE Lake, Martin, Merritt Island, ONF, and LWR) are at low risk of quasi-extinction. Two of the five (Martin and NE Lake), however, experienced significant populations declines under a "no acquisition" option (Stith 1999). This means that, as of now, that both the Ocala and LWR metapopulation are two of the remaining three best in existence.

While the LWR and ONF metapopulation extends into lands some distance away from themselves onto private lands within the action area, these metapopulation are of critical importance for the maintenance of metapopulations dynamics. The lands comprising the action area also include the largest and most intact units of habitat for the scrub-jay in the metapopulation. This project intends to enhance the continued existence of this species by improving habitat conditions of scrub and scrubby flatwoods through the use of prescribed fires

<u>Red-cockaded Woodpecker</u>

In Florida, the RCW is found in the panhandle and throughout the peninsula to northern Monroe County. Florida contains two of the largest RCW populations that occur on public lands within the species historic range; Apalachicola Ranger District—ANF and Eglin Air Force Base (AFB). Other public lands on which the RCW occurs include (but may not be limited to) other

National Forests and Department of Defense Lands, NWRs, State and National Preserves, State Forests, State WMAs, and Water Management District lands. However, the RCW is not known to occur within the approximately 25,000 acres of publicly owned Water Management District lands (Allapatah, Turkey Creek, Orange Creek, and Ocklawaha tracts) that were identified as part of the action area.

Florida has 3 populations that are identified as primary core populations (Central Florida Panhandle consisting of both State and Federal lands, Osceola/Okefenokee found on Federal lands, and Eglin AFB found on Federal lands.) One population is identified as a secondary core population (Conecuh/Blackwater consisting of State and Federal lands.) There are 13 essential support populations comprising the South/Central Florida Recovery Unit and several other important and significant support populations distributed throughout the State that occur on Federal, State, and private properties.

According to the best data available to the Service and FWC (which includes 2004 data for some properties and 2005 data for other properties), there are approximately 1,558 active RCW clusters within the State of Florida. Of these clusters, 1,125 active clusters are on Federal lands, 312 active clusters are on State lands, and 55-121 active clusters occur on private lands (Ralph Costa, personal communication, 2006). Using the "high end" estimate for the number of active clusters on private land, the Service estimates that 72 percent, 20 percent, and 8 percent of RCW active clusters present in Florida are located on Federal, State, and Private lands respectively. A range of active clusters is given for private lands as these numbers rely partly on the voluntary disclosure of landowners where RCW are believed to occur. Many private landowners are wary of disclosing the presence of RCWs on their land have restricted access to many parcels. Therefore, many occurrences on private land likely remain unknown and numerous reported occurrences might represent inactive clusters. Furthermore, it can be reasonably assumed that since the early 1990's RCWs have declined on private lands because habitat has been lost, fragmented and degraded as a result of lack of management (including prescribed fire management) and urban encroachment.

Blue-tailed Mole Skink

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem, within the action area. It includes the impact of State or private actions, which occur simultaneously with the consultation in progress.

Because the range of the blue-tailed mole skink is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for the species.

The action area includes scrub, sandhill, and limited areas of other vegetation on privately-owned lands found on the sandy ridges of the Crescent City Ridge, LWR, MDR, Orlando Ridge, Deland Ridge, Bombing Range Ridge, WHR, Lake Henry Ridge, Lakeland Ridge, Gordonville

Ridge, and any other ancient sand dunes in the center of peninsular of Florida located in Highlands, Lake, Marion, Okeechobee, Osceola, Orange Polk, Putnam, Seminole, and Volusia Counties where habitat is suitable for skinks. Blue-tailed mole skinks occur in Highlands, Polk, and Osceola Counties. The most important factor influencing the species is habitat destruction and degradation due to agricultural and residential development. In response, the State of Florida, the Service, and other parties including local governments, TNC, and ABS conducted carefully-designed land acquisition programs during the 1990s, resulting in a network of conservation lands. To date, four conservation banks encompassing over 1,000 acres have been established and certified for skinks (1 in Highlands County, 3 in Polk County). Another bank is in the process of being established for skinks in Highlands County.

One of the primary concerns for this habitat is fire and its management. At some sites, the proximity of housing or other land uses severely limits the use of prescribed fire, even as the presence of overgrown vegetation increases the threat of destructive wildfire. Prescription fire applications on privately-owned lands not under conservation programs is identified as an opportunity where additional benefits can be achieved for the species. The use of prescribed fire for habitat restoration and maintenance is strongly encouraged by recovery plans for many of the species covered by this plan, except that some require special attention due to extremely limited distribution and potential vulnerability to fire. Construction of firebreaks is essential for carrying out prescribed fire programs, and their creation and maintenance can both create opportunities for, and destroy skinks.

Blue-tailed mole skinks are vulnerable within the action area due to habitat loss resulting from the intense development pressures related to central Florida’s burgeoning human population. From 2000 to 2010, Florida's population increased 12.2 percent from 17.5 million to 19.7 million. Between 2005 and 2060, Florida’s population is projected to double to approximately 36 million people (Zwick and Carr 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). Accordingly, it is extremely likely remaining unprotected skink habitats in the project area will be targeted for conversion to residential subdivisions, golf courses, and shopping centers.

Remaining skink habitats are also threatened by degradation resulting from fire exclusion and lack of management. Xeric habitats favored by skinks require periodic fire to maintain optimal habitat values, such as patches of bare sand and low shrub architecture. The need to protect agricultural, residential, and commercial development has resulted in the suppression of wildfires. Furthermore, implementing prescribed burns in areas adjacent to residential areas is difficult due to safety concerns and objections of local residents. Xeric habitats lacking periodic fire or management become overgrown and less suitable to skinks. Over time, skinks will diminish in abundance and eventually may be extirpated. Mechanical treatments, such as roller chopping, are not the preferred method for management of skink habitat because the use of heavy equipment could potentially crush and kill skinks, adversely affect suitable skink habitat by depositing vegetative debris into bare areas, and compact soils over time. Habitat degradation also occurs from the introduction of non-native species.

Sand Skink

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem, within the action area. It includes the impact of State or private actions, which occur simultaneously with the consultation in progress.

Because the range of the sand skink is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for the species.

The action area includes scrub, sandhill, and limited areas of other vegetation on lands found on the sandy ridges of the Crescent City Ridge, LWR, MDR, Orlando Ridge, Deland Ridge, Bombing Range Ridge, WHR, Lake Henry Ridge, Lakeland Ridge, Gordonville Ridge, and any other ancient sand dunes in the center of peninsular of Florida located in Highlands, Lake, Marion, Okeechobee, Osceola, Orange Polk, Putnam, Seminole, and Volusia Counties where habitat is suitable for skinks. The most important factor influencing the species is habitat destruction and degradation due to agricultural and residential development. In response, the State of Florida, the Service, and other parties including local governments, TNC, and ABS conducted carefully-designed land acquisition programs during the 1990s, resulting in a network of conservation lands. To date, four conservation banks encompassing over 1,000 acres have been established and certified for skinks (one in Highlands County, three in Polk County). Another bank is in the process of being established for skinks in Highlands County.

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Sand skinks are vulnerable within the action area due to habitat loss resulting from the intense development pressures related to central Florida's burgeoning human population. From 2000 to 2010, Florida's population increased 12.2 percent from 17.5 million to 19.7 million. Between 2005 and 2060 Florida's population is projected to double to approximately 36 million people (Zwick and Carr 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). Accordingly, it is extremely likely remaining unprotected skink habitats in the project area will be targeted for conversion to residential subdivisions, golf courses, and shopping centers.

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Eastern Indigo Snake

This species is present in a wide variety of habitats including the scrub and sandhill vegetation within the action area. Although we do not have specific information on the eastern indigo snakes abundance within the action area, its home range size is large enough that most properties can be expected to have habitat occupied by indigo snakes. The relatively large range of this snake and its use of a wide variety of natural and modified habitats mean the action area comprises only a fraction of this species' range.

Frosted Flatwoods Salamander

There are many suitable ponds that appear to be usable by frosted flatwoods salamanders, but, many of these areas have not yet been surveyed for presence. The action area includes lands that are proposed to have prescribed fire applied where the NRCS has management input. Where exactly the fire will be applied is yet uncertain. However, much of the fire will occur in the range of this salamander, and the potential exists for fire to be applied in areas where this salamander currently is present. Everywhere within the action area exists the possibility of having fire impact breeding ponds or salamanders, but the likelihood is low.

Reticulated Flatwoods Salamander

Reticulated flatwoods slalmander status status in the action area is the same as it is throughout its range. There are 16 federally designated critical habitat ponds, all of which are located outside of Eglin AFB in the western and central Florida panhandle. This species is currently listed as endangered. The action area includes lands that are proposed to have prescribed fire applied where the NRCS has management input.

Striped Newt

There are many suitable ponds on private lands that appear to be usable by striped newts but many of these areas have not yet been surveyed for presence. The action area includes lands that are proposed to have prescribed fire applied where the NRCS has management input. Where exactly the fire will be applied is yet uncertain. However, much of the fire will occur in the range of this newt, and the potential exists for fire to be applied in areas where newts are present.

Within the action area there is the possibility of having fire impact breeding ponds or newts, but the likelihood is low.

Gopher Tortoise

The following is a summary of the status of the species in Florida from the FWC Gopher Tortoise Management Plan (FWC 2012):

The gopher tortoise occurs in the southeastern Coastal Plain from southeastern South Carolina to extreme southeastern Louisiana (Auffenberg and Franz 1982). The gopher tortoise is endemic to the United States, and Florida represents the largest portion of the total global range of the species. Gopher tortoises remain widely distributed in Florida, occurring in parts of all 67 counties; however, their current range in south Florida is limited because of unsuitable habitat and increased urbanization (Diemer 1987; Mushinsky et al. 2006). Tortoise populations occur as far south as Cape Sable and on islands off Florida's east and west coasts (Auffenberg and Franz 1982; Kushlan and Mazzotti 1984).

Population estimates for the gopher tortoise in Florida are based on 2003 GIS data indicating that the current extent of gopher tortoise habitat is approximately 3.3 million acres (Enge et al. 2006a). Using density information from McCoy et al. 2002 and population ratios of adult to immature tortoises from Diemer 1992a, the estimated number of adult tortoises approximately is 785,000 (see Enge et al. 2006a for more detailed explanations of acreage and population estimates).

Gopher tortoises could potentially occur in pinelands (up to 26,000 acres could be treated annually), scrub (up to 2,000 acres could be treated annually), and dry prairie (up to 7,000 acres could treated annually) vegetative communities where NRCS has identified proposed activities may occur. However, all acres treated may not be occupied. Many of the tracts where activities occur are in degraded condition and do not support the habitat for the species. Other tracts may not have suitable well drained soils that support tortoises, or the species may simply not be present due to past management practices, isolation, predation, or other factors. In the Gopher Tortoise Management Plan (FWC 2012), FWC includes regional priority habitat maps that identify public and private owned property that has suitable gopher tortoise habitat. When identifying gopher tortoise habitat the variables considered include: vegetation, canopy cover, and soils with a water table depth greater than 1.5 ft. Larger, contiguous habitat patches can provide the highest conservation value for gopher tortoises, therefore; the FWC identified all gopher tortoise habitat patches greater than 200 acres as potential habitat. The potential habitat patches that contained the specified habitat characteristics were then separated into primary (desirable) and secondary (acceptable) gopher tortoise habitat. Primary Habitat is defined as areas that contain appropriate habitat types that have a canopy closure of < 65 percent and are located on non-hydric soils are at least moderately well drained, flood occasionally or less, and have a water table depth greater than 6.5 ft deep or have a water table depth between 1.5 ft and 6.5ft. Secondary Habitat is defined as areas that contain appropriate habitat types that have canopy closure ≥ 65 percent and are located on non-hydric soils, are at least moderately well drained, flood occasionally or less, and have a water table depth greater than 6.5ft deep or have a water table depth between 1.5ft and 6.5ft. Maps of primary and secondary habitat patches can be found in Appendix Four of the Gopher Tortoise Management Plan at http://myfwc.com/media/2286685/GT-Management-Plan.pdf.

Highlands Tiger Beetle

This species was described in 1984, so there are no records of its past distribution and abundance. It seems quite likely that it was common in scrub and sandhill vegetation of the LWR in Highlands and Polk Counties prior to the widespread destruction of upland vegetation during the past 50 years (Knisley and Hill 1992) that eradicated most of the HTB's suitable habitat. Knisley and Hill (1992, 1996) found this species at 40 sites, 25 in Polk County and 15 in Highlands County, from the north side of Lake Marion, east of Haines City southward to the vicinity of Sebring. Subsequently, Knisley (2005, p. 2) surveyed all known and additional sites (n = 72) throughout the range of the HTB in Polk (45 sites) and Highlands (27 sites) Counties in 2004 and 2005 and found evidence for a significantly improved conservation status.

The HTB is present on several conservation lands, including the Allen David Broussard Catfish Creek Preserve State Park, Tiger Creek Preserve, LWR State Forest, Carter Creek and Henscratch units of the LWRWEA, and the Jack Creek tract. Many of these sites have been acquired since the first status survey was conducted in 1992. All of them are in the action area. Roughly 85 percent of the scrub and sandhills on LWR has been lost to development and agriculture (Turner et al. 2006, p. 3). Fortunately, much of the remaining known high quality habitat for the HTB has been acquired and placed in public or other conservation ownership (Service 2012). Knisley (2005) attributed the recent improvement of the HTB to the conservation management (specifically implementation of fire) at several high-quality sites known to support large beetle populations.

As with other beetles, the HTB inhabits bare sand and cannot persist in thickets or where the ground is covered with litter. Since remaining scrub and sandhill vegetation in the tiger beetle's range is disappearing, and is unlikely to receive prescribed fire, this beetle's conservation depends mostly on the conservation lands. A separate threat to this tiger beetle is collecting, because tiger beetles may be the subject of more intense collecting and study than any other single insect genus.

Florida Bonneted Bat

Within the action area, the Florida bonneted bat has been documented at Babcock / Webb WMA (Charlotte County), and Picayune Strand State Forest (PSSF) (Collier County) (Timm and Genoways 2004; NatureServe 2009; Marks and Marks 2008c).

The site is significant as one of the few documented roosting sites for the Florida bonneted bat. Major habitat types at Babcock-Webb WMA include dry prairie, freshwater marsh, wet prairie, and pine flatwoods; all calls were recorded in pinelands (Marks and Marks 2008a, pp. A7, B38-B39; 2012, pp. 8, A61, B43). The species was also recorded at an adjacent property, Babcock Ranch in 2007; calls were recorded at Telegraph Swamp, but not in the pinelands surveyed (Marks and Marks 2008a, pp. A9, B55-B57).

The species has been found within the Fakahatchee Strand Preserve State Park (FSPSP), using this area throughout the year (D. Giardina, FDEP, personal communication 2006; C. Marks, personal communication 2006a, 2006b; M. Owen, FSPSP, personal communication 2012a, 2012b). In 2006, this species was found at a small lake and at a canal adjacent to tropical hardwood hammocks (Ballard Pond and Prairie Canal Bridge) in the FSPSP (Marks and Marks 2008a, pp. 11, A7-A9, B50-B51). Available data and observations indicate that the species was regularly heard at FSPSP from 2000 through 2012 at various locations, primarily in the main strand swamp and near royal palms (M. Owen, personal communication 2012a, 2012b; R. Rau, personal communication 2012). In November 2007, the species was observed along U.S. Highway 41 at Collier-Seminole State Park in Collier County (S. Braem, FDEP, personal communication 2012). The FDEP also suggests that the species may occur at Charlotte Harbor Preserve State Park in Charlotte County and Delnor-Wiggins Pass State Park in Collier County (P. Small, FDEP, personal communication 2012).

The Florida bonneted bat has been found in various habitats within BCNP. During surveys conducted in a variety of habitats in 2006 and 2007, the majority consisting of cypress swamps and wetlands, only one call was recorded in 16 survey nights in 2007 (Marks and Marks 2008a, pp. 11, A12-A14). The call was recorded at Deep Lake along the western edge of BCNP and the eastern side of the FSPSP; the lake was surrounded by cypress and hardwood hammocks similar to the habitat around Ballard Pond in the FSPSP (see above) (R. Arwood, personal communication 2008b). The species was recorded again in February 2012 at another location (Cal Stone's camp) in an area of pine and palmetto with cypress domes in the surrounding area (R. Arwood, personal communication 2012; Marks and Marks 2012, p. 13). Data derived from recordings taken in 2003 and 2007 by a contractor and provided to the Service (S. Snow, personal communication 2012) and available land use covers derived from a geographic information system also suggest that the species uses a wide array of habitats within BCNP.

As noted earlier, FWC biologists and volunteers caught a free-flying juvenile male Florida bonneted bat in 2009 using a mist net in the PSSF in Collier County (Smith 2010, p. 1). Habitat composition of PSSF includes wet prairie, cypress stands, and pine flatwoods in the lowlands and subtropical hardwood hammocks in the uplands, and the individual was captured in the net above the Faka-Union Canal (Smith 2010, p. 1). This was particularly notable because it may have been the first capture of a Florida bonneted bat without a roost site being known (Smith 2010, p. 1).

In 2000, the species was found within mangroves at Dismal Key within the Ten Thousand Islands (Timm and Genoways 2004, p. 861; Marks and Marks 2008a, pp. 6, A9, B53; 2012, p. 14). Subsequent surveys in 2000, 2006, and 2007 did not document any calls at this location (Marks and Marks 2008a, pp. 6, 11, 14). In 2007, the species had been recorded at a backcountry campsite (Watson's Place) within ENP, comprised of mixed hardwoods (S. Snow, personal communication 2012). In 2012, the species was found within mangroves and mixed hardwoods at another backcountry campsite (Darwin's Place) along the Wilderness Waterway (Ten Thousand Island area), approximately 4.8 (km) (3 miles) east-southeast of Watson's Place within ENP (Marks and Marks 2012, pp. 8, 17, A53, B35, B38; C. Marks, personal communication 2012; S. Snow, personal communication 2012). However, the species was not located in similar habitats during 18 survey nights in 2012 (Marks and Marks 2012, p. 14).

In 2011 and 2012, the species was found in various natural habitats elsewhere in ENP and vicinity (S. Snow, personal communication 2011, 2012; Marks and Marks 2012, pp. 8, 14). It was found in wetlands and pinelands at the junction of the main park road and road to Long Pine Key (S. Snow, personal communication 2011, 2012; Marks and Marks 2012, p. 8, 14, 17), and also along the L-31N canal in a rural area, at the eastern boundary of ENP (S. Snow, personal communication 2012; Marks and Marks 2012, pp. 8, 14, 17, A59). In March 2012, one suspect (presumed, but not confirmed) call sequence was also recorded on SR 9336 in an area of rural residential and agricultural habitat in Miami-Dade County (S. Snow, personal communication 2012). In January 2012, another suspect call was recorded from the suburban streets of the village of Palmetto Bay in Miami-Dade (S. Snow, personal communication 2012).

In 2008, the Florida bonneted bat was found at two locations along the Kissimmee River during a survey of public areas contracted by FWC (J. Morse, personal communication 2008, 2010; Marks and Marks 2008b, pp. 2-5; 2008c, pp. 1-28). One location was at an oxbow along the Kissimmee River in a pasture in Kicco; the other was at Platt's Bluff boat ramp at a public park on the Kissimmee River (Marks and Marks 2008c, pp. 11, 17). However, despite numerous attempts, no additional calls were detected in the Lake Kissimmee areas or along the Kissimmee River during subsequent surveys designed to more completely define the northern part of its range (C. Marks, personal communication 2012a; Marks and Marks 2012, pp. 3, 5, 8, 10).

Use of Parks, Residential, and other Urban Areas

The Florida bonneted bat uses human structures and other nonnatural environments. In Coral Gables (Miami area), specimens have been found in the shafts of royal palm leaves (Belwood 1992, p. 219). Based upon observations from G.T Hubbell, past sightings in Miami suggest that preferred diurnal roosts may be the shingles under Spanish tile roofs (Belwood 1992, p. 219). The species also roosts in buildings (*e.g.*, in attics, rock or brick chimneys of fireplaces, and especially buildings dating from about 1920 to 1930) (Timm and Arroyo-Cabrales 2008, p. 1). One individual recently reported that a single Florida bonneted bat had come down the chimney and into his residence in Coral Gables in the fall about 5 years ago (D. Pearson, personal communication 2012). Belwood (1992, p. 220) suggested that urban bats would appear to benefit from using Spanish tile roofs on dwellings, since the human population in south Florida is growing, and such structures are more common now than in the past. However, it is important to recognize that bats using old or abandoned and new dwellings are at significant risk; bats are removed when structures are demolished or when they are no longer tolerated by humans and eradicated or excluded from dwellings.

This species may also roost in rocky crevices and outcrops on the ground, based on the discovery of an adult for which the specimen tag says "found under rocks when bull-dozing ground" (Timm and Genoways 2004, p. 860). A colony was found in a limestone outcropping on the north edge of the University of Miami campus in Coral Gables; the limestone contained a large number of flat, horizontal, eroded fissures in which the bats roosted (Timm and Genoways 2004, p. 860). It is not known to what extent such roost sites are suitable.

Recent acoustical surveys (2006, 2008, 2012) confirmed that the species continues to use a golf course in urban Coral Gables (Marks and Marks 2008a, pp. 6, 11, A4; 2008b, pp. 1-6; 2012, pp. 8, 14, 16, 19, A24, B16). Despite numerous efforts, attempts to locate the roost site have been unsuccessful.

Recordings taken continuously from a balcony from a fifth floor condominium also detected presence in Naples (R. Arwood, personal communication 2008a). Recordings taken from a house and at a boat dock along the Barron River in Everglades City also detected presence in this area (R. Arwood, personal communication 2008a).

The species has been documented at Zoo Miami within an urban public park in Miami-Dade County (C. Marks, personal communication 2011; Ridgley 2012, p. 1; Marks and Marks 2012, pp. 8, 14, 16, A26). A dead specimen was found on Zoo Miami (then known as Miami Metrozoo) grounds at the Asian Elephant barn in 2004 (Marks and Marks 2008a, p. 6). Miami-Dade County biologists observed seven bats similar in size to Florida bonneted bats and heard chatter at the correct frequency a few years ago, but were unable to obtain definitive recordings (S. Thompson, Miami-Dade Park and Recreation Department, personal communication 2010) until a single call was recorded by FBC outside the same enclosure in September 2011 (Ridgley 2012, p. 1; Marks and Marks 2012, pp. 8, 14, 16, A26). Surrounding habitats include natural areas and horticulturally altered landscape, with a variety of manmade structures (Ridgley 2012, p. 1).

In 2011 and 2012 the species was recorded within tropical gardens at FTBG in Miami-Dade County (S. Snow, personal communication 2011, 2012; Marks and Marks 2012, pp. 8, 13-14, 17, A35, A37).

Use of Artificial Structures

The Florida bonneted bat can use artificial structures (Marks and Marks 2008a, p. 8; Morse 2008, pp. 1-14; S. Trokey, personal communication 2012). In fact, all of the active known roosting sites for the species are bat houses (two at a private landowner's house; four at Babcock-Webb WMA).

The species occupies bat houses on private land in North Fort Myers, Lee County; until recently, this was the only known location of an active colony roost anywhere (S. Trokey, personal communication 2006a, 2008b; Marks and Marks 2008a, pp. 7, 15). The Florida bonneted bat has used this property for over 9 years (S. Trokey, personal communication 2012). The bat houses are located near a small pond, situated approximately 5 meters (17 ft) above the ground with a south by southwest orientation (S. Trokey, personal communication 2012). The relatively high height of the houses may allow the large bats to fall from the roosts before flying (S. Trokey, personal communication 2012).

The species also occupies bat houses within pinelands at Babcock-Webb WMA in Punta Gorda, Charlotte County (Marks and Marks 2012, pp. 8, A61). In winter 2008, two colonies were found using bat houses (Morse 2008, p. 8; N. Douglass, FWC, personal communication 2009). In 2010, approximately 25 individuals were found at two additional bat houses, bringing the potential total at Babcock-Webb WMA to 58 individuals, occupying four houses (J. Birchfield, FWC, personal communication 2010; Marks and Marks 2012, pp. 12, A61). In 2012, 42 individuals were found to use four roost sites, consisting of a total of seven bat houses, situated approximately 5 meters (17 ft) above the ground with north and south orientations (J. Myers, personal communication 2012a; Marks and Marks 2012, pp. 12, 19, A61). Roosts at Babcock-Webb WMA are mainly in hydric and mesic pine flatwoods with depression and basin marshes and other mixed habitat in the vicinity (J. Myers, personal communication 2012b).

In summary, relatively little is known of the species' habitat requirements. Based upon available data above, it appears that the species can use a wide array of habitat types. Available information on roosting sites is extremely limited and particularly problematic, since the availability of suitable roosts is an important, limiting factor for most bat species. Existing roost sites need to be identified so they can be preserved and protected (Marks and Marks 2008a, p. 15). Uncertainty regarding the location of natural and artificial roost sites may contribute to the species' vulnerability. Since the location of key roost sites is not known, inadvertent impacts to and losses of roosts may be more likely to occur, placing the species at greater risk. If key roost sites are located, actions could be taken to avoid or minimize losses.

A summary of known occurrence's for the Florida bonneted bat is provided in Table 6 below.

Table 6. Locations & habitat types recorded/observed for Florida bonneted bats (2003-2012).

Site	Ownership	Counties	Management	Habitat Type
ENP (2 backcountry sites along Wilderness Waterway [Darwin's Place, Watson Place])	public	Monroe	NPS	earth midden hammocks, mangroves
ENP (junction of Main Park Road and Long Pine Key)	public	Miami-Dade	NPS	pine rocklands, wetlands
L-31N FPL corridor, eastern boundary ENP	private	Miami-Dade	NPS and FPL	canal, mixed
Homestead, Florida	private	Miami-Dade	None	residential, urban
Fairchild Tropical Botanic Garden	private	Miami-Dade	FTBG	pine rockland, hardwood hammock, water, tropical garden, residential
Zoo Miami	private and public	Miami-Dade	Miami-Dade	urban, landscaped; pine rocklands
Coral Gables (2 sites, including Granada Golf Course)	private	Miami-Dade	None	residential, urban
Snapper Creek Park	public	Miami-Dade	Miami-Dade	residential, urban
Everglades City	private	Collier	None	residential, urban
Naples	private	Collier	None	residential, urban
FSPSP (2 sites, including Ballard Pond, Prairie Canal Bridge)	public	Collier	FDEP	lake and canal near hardwood hammock, and pine flatwoods
PSSF	public	Collier	FFS	canal (juvenile male caught above Faka-Union Canal)
BCNP (multiple sites)	public	Collier	NPS	pine flatwoods, palmetto, cypress, mixed and hardwood hammocks, mangroves, mixed shrubs, wet prairies, river
North Fort Myers (2 sites, including bat houses)	private	Lee	None;private landowner	residential, urban; bat houses

Babcock-Webb WMA (3 sites, Tucker Grade east end, B/W west area, and bat houses and near red-cockaded woodpecker clusters)	public	Charlotte	FWC	pinelands (and near red-cockaded woodpecker clusters); bat houses
Babcock Ranch (Telegraph Swamp)	public, private	Charlotte	Private entities, FWC, FFS, and Lee County	swamp
Kicco	public	Polk	FWC and District	oxbow along Kissimmee River
Kissimmee River Public Use Area (Platt's Bluff)	public	Okeechobee	FWC and District	boat ramp along Kissimmee River

Bartram's Hairstreak Butterfly

The Bartram's hairstreak is occurs on Big Pine Key, in the lower Florida Keys (Monroe County), Long Pine Key within ENP (Miami-Dade County), as well as Navy Wells Pineland Preserve and the various parcels that compose the Richmond Pine Rocklands in Miami-Dade County (Salvato and Hennessey 2004; Service 2011). All of them are in the action area. Although the majority of known Bartram's hairstreak populations occur on public lands, several parcels within the Richmond Pine Rocklands are privately-owned and receive only limited conservation management. The Bartram's hairstreak occurs entirely within pine rocklands, and specifically those that retain contiguous levels (at least 100 ha) of the subspecies' only known larval hostplant, pineland croton. Therefore, consistent fire management within pine rocklands is required to maintain adequate populations of both larval hostplant and the butterfly. Additional major threats to the butterfly include poaching from collectors and the influence of mosquito control pesticides.

Florida Leafwing Butterfly

The Florida leafwing is currently known to occur only within the Long Pine Key within Everglades National Park (Miami-Dade County), which is not in the action area. However, Navy Wells Pineland Preserve and the various parcels that compose the Richmond Pine Rocklands in Miami-Dade County are within the action area and retain re-colonization potential from the adjacent Everglades population. Several parcels within the Richmond Pine Rocklands and adjacent to Navy Wells Pineland Preserve are privately-owned and receive only limited conservation management. The Florida leafwing occurs entirely within pine rocklands, and specifically those that retain the subspecies' only known larval hostplant, pineland croton. Therefore, consistent fire management within pine rocklands is required to maintain adequate populations of both larval hostplant and the butterfly. Additional major threats to the butterfly include poaching from collectors and the influence of mosquito control pesticides.

American Chaffseed

In Florida a total of 10 occurrences is known from Brevard (Pennell 1935), Duval, Highlands, Hillsborough, Levy, Putnam, Volusia (E.D. Hardin, FNAI, *in litt.* 1985), Gadsden (L. Peterson, FNAI, *in list.* 1994) and Leon Counties (W. Baker, TNC, Tallahassee, Florida, personal communication 1994). All occurrences except two, one in Gadsden County and one in Leon County are extirpated. A survey of the Gadsden County site revealed that a residential development is now in place there. This occurrence may thus also be extirpated (L. Peterson *in list.* 1994), although additional habitat near the site may be suitable for *Schwalbea* and should be searched (W. Baker personal communication 1994). The extant occurrence in Leon County is on private property managed for bobwhite quail (*Colinus virginianus*) (W. Baker personal communication 1994); current habitat management practices for quail (*e.g.*, pescribed burning) contribute to maintenance of suitable habitat for *Schwalbea.*

Beautiful Pawpaw

Because the range of the beautiful pawpaw is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area. No critical habitat has been designated for the species. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Much of the action area consists of upland communities including sandhill and flatwoods on publicly-owned conservation lands and private land. The most important factor influencing the species covered by this biological opinion and their habitats was, until the 1990s, destruction and degradation due to agricultural and residential development. In response, the State of Florida, the Service, and other parties including local governments, and non-profit organizations carefully-designed land acquisition programs during the 1990s, resulting in a network of conservation lands. As a result, conservation concern has shifted to completing land acquisitions and to management of the conservation lands.

By far the largest management concern for these lands is fire and its management. Research and monitoring over the past 15 years, as explained in background information on individual species, has done a great deal to elucidate the benefit of fire to the species and their habitats. As a result, nearly all conservation lands in the action area have fire management plans for their listed species, and fire prescriptions can be made to benefit those species over a period of 2 to about 30 years. The MSRP (Service 1999) encourages the use of prescribed fire through its recovery criteria for species that require restoration of native vegetation.

Cumulatively, these efforts will enhance and restore upland habitats that have been degraded by long-term fire suppression. Construction of firebreaks is essential for carrying out prescribed fire programs, and their creation and maintenance can both present opportunities for, and destroy, listed and candidate species.

On conservation lands, exotic pest plant threats are mostly manageable (with serious concern for Old World climbing fern and somewhat less concern over several grasses, including cogon grass and Natal grass but need to be controlled on private lands, as well. Unauthorized use of all-terrain vehicles or dumping is a serious concern at several sites. Stochastic events, such as hurricanes, are of concern to listed and candidate species in the action area.

Britton's Beargrass

The largest remaining populations and largest tracts of occupied habitat for this species are in Polk and Highlands Counties, on conservation lands comprising the action area, in both scrub and sandhill vegetation. It is locally abundant and apparently secure, so much so that only minimal monitoring is done at the Tiger Creek Preserve, where sandhill is being restored by frequent prescribed fires. Populations of this plant are believed to be relatively stable, in large part because the individual plants are long-lived.

Brooksville Bellflower

Because the range of the Brookesville bellflower is wholly contained within the action area, the preceding rangewide status discussion includes the status of this species within the action area.

Carter's Mustard

The largest known populations of this species are at the ABS in Highlands County and the TNC's Tiger Creek Preserve in Polk County. In Highlands County, it is present at the Lake Placid tract of LWRWEA, the Carter Creek tract of LWRNWR, LWR State Forest. In northern Polk County, its distribution is apparently less well worked-out. It is present on the Snell Creek tract of LWRNWR and is probably present on adjoining land belonging to the Upper Lake Marion Creek Watershed, managed by the District. It is also probably present slightly farther north on another tract of the Upper Lake Marion Creek Watershed, located near Horse Creek. Carter's mustard responded positively to a prescribed fire at the Carter Creek tract of LWRNWR. Carter's mustard typically exists as seeds in the soil except when germination is stimulated by fire or disturbance, and the plants are inconspicuous except during their flowering period lasting about a month. As a result, the distributional records may be incomplete (Service 1996). The annual habit of Carter's mustard makes assessment of its status or planning its conservation more difficult than is the case for perennial herbs or shrubs. Because this plant is restricted on the LWR to sandhill vegetation with relatively frequent fires, this plant is essentially restricted to the sandhills that have come into public ownership as the result of State, local, Federal, and private conservation land acquisitions over the past 15 years. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Carter's Small-flowered Flax

Based upon data from IRC, Carter's small-flowered flax is extirpated from Brickell Hammock (owner unknown) due to development, Charles Deering Estate (owned by Miami-Dade County) for unknown reasons, and the Red Road and 114 Terrace locations (private land) due to development (K. Bradley, personal communication 2007). Austin et al. (1980, p. 3) noted there were four historical sites for this species in a study of southern Florida, including National Key Deer Refuge and Great White Heron NWR. However, in 1980, Austin et al. (1980, p. 3) found only one site remaining, representing a 75 percent reduction in number of sites, and attributed the reduction to urbanization. Gann et al. (2002, p. 463) indicated most of the species' habitat has been destroyed.

Chapman's Rhododendron

Because the range of the Chapman's rhododendron is wholly contained within the action area, the preceding rangewide status discussion includes the status of this species within the action area. In fact, as previously noted, there are only two known occurences for this speices, one on private lands near Hosford, so careful management of these lands are critical to its continued existence.

No critical habitat has been designated for the species

Clasping Warea (Wide-Leaf Warea)

There is almost no possibility that this plant will be conserved on private land, with the possible exception of the private Mountain Lake Estates, outside of the action area near the HBS. Clasping warea (wide-leaf warea) occupies sandhill habitat which historically burned during the summer growing season. There are anecdotal reports of plants appearing at sites where they had not been seen for several years, suggesting the species banks seeds in the soil. Fire is believed to stimulate germination of seeds. The species occurs within the action area at the HBS. It may also occur in the vicinity of Horse Creek or other areas near Haines City in northern Polk County. This sandhill annual is stimulated to germinate and grow by fire. Population sizes probably peak the first or second year after a fire, then decline. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Cooley'Meadowrue

Because the range of the Cooley's meadowrue is wholly contained within the action area, the preceding rangewide status discussion includes the status of this species within the action area. In fact, as previously noted, there is onlyone known occurences for this speices in Florida, so careful management of the tract is critical to its continued existence in the State.

No critical habitat has been designated for the species

Cooley's Waterwillow

Because the range of the Cooley's meadowrue is wholly contained within the action area, the preceding rangewide status discussion includes the status of this species within the action area.

No critical habitat has been designated for the species

Crennulate Lead-plant

Because the range of the crenulate lead-plant is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for the species.

The action area contains appropriate habitat for listed and candidate plants, among other taxa. However, the rapid urbanization of Miami-Dade County has resulted in the virtual elimination of extensive pine rocklands, the preferred habitat for several listed and candidate species. Based on IRC surveys, pine rockland habitat in urban Miami-Dade County has been reduced to about 1.8 percent of its natural extent. Of the original 127,000 acres, only 2,273 acres of largely fragmented pine rocklands remain throughout Miami-Dade County, outside of ENP. The primary factors affecting listed and candidate plants within pine rockland fragments are exotics and natural fire suppression. Altogether, 79 species of naturalized exotic plants have been recorded in pine rocklands, the most problematic being Burma reed and Brazilian pepper. Pine rocklands are dependant on natural fires to maintain their scrub and herb layers as well as to prevent succession. Without natural fires or adequate prescribed burns, pine rocklands can be replaced by hardwood hammock and invasive plant species.

Many of these remaining pine rocklands and pine rockland-containing disturbed areas, such as parks, pastures, and vacant lots, are geographically distinct and, therefore, do not provide contiguous habitat for listed plants. They are fragmented by highly urbanized and suburban areas making it difficult to manage these parcels. Other factors affecting the species within the action area include an ongoing federally-funded restoration project for privately-owned pine rocklands that will benefit the species.

Deltoid Spurge

Because the range of the deltoid spurge is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for the species.

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Etonia Rosemary

The only occurrences of Etonia rosemary are near Florahome in Putnam County, Florida. Etonia rosemary currently exists on 13 sites on public land and 6 sites on private land. The publicly owned sites are located within Etoniah Creek State Forest and DCSP. Etoniah Creek State Forest is an 8,622-acre forest originally acquired in 1996 as part of the Etoniah / CFG CARL Project and is managed by the FDOF. The privately-owned sites in ECSF containing Etonia rosemary consists of several sub-acre to acre lots platted for development. Plants are located along the unpaved, sandy roadsides within the undeveloped subdivision. The subdivision is surrounded by Etoniah Creek State Forest. The State is in the process of purchasing select lots owned by willing sellers.

DCSP has been in State ownership since 2001. The 2004 surveys for Etonia rosemary at Dunns Creek located eight populations, with a total number of plants from 850 to 1000. Several populations could not be located due to the hurricane damage caused from the 2004 hurricanes which caused downed sand pines and prevented access to historical sites.

A survey of Etonia rosemary at Etoniah Creek State Forest was conducted November 2004 and 1,767 plants were counted. This was down from the 2003 survey which documented 1,938 plants. The decrease in the number of plants was caused from hurricane damage to several sites that contained large Etonia rosemary populations. These mints respond positively to disturbance, which, historically, was probably fire. Etonia rosemary is apparently restricted to very limited areas of deep white-sand scrub with shrubby oaks and sand pines on dry soils. Habitat loss and fire suppression resulting in closure of overstory vegetation are important limiting factors. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Everglades Bully

Because the range of the Everglades bully is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Florida Bonamia

This species is present at most sites with scrub vegetation on the LWR (Schultz et al. 1999), and the conservation lands comprising the action area are very important for its conservation, representing an area with sufficient habitat to maintain populations in Polk and Highlands Counties. Land managers at the LWR State Forest, who have monitored this species, expressed concern over its apparently declining numbers on the Forest's three tracts (Cox 2004). This plant does not appear to be abundant anywhere on the LWR. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Florida Brickell-bush

Because the range of the Florida brickell-bush are wholly contained within the action area, the preceding rangewide status discussion includes the status of those species within the action area.

No critical habitat has been designated for this species.

Florida Golden Aster

Because the range of the Everglades bully is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Florida Skullcap

Because the range of the Florida skullcap is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Four-petal Pawpaw

Because the range of the four-petal pawpaw is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Fringed Campion

The fringed campion is known to be extant in seven locations in Florida in Jackson and Gadsden counties near the Apalachicola River.

No critical habitat has been designated for this species.

Gentian Pnkroot

The gentian pinkroot is restricted to four locations within two counties (*i.e.*, Jackson and Calhoun) in Florida. Two of the tracts where the plants are known to occur are publicly owned and managed. Of the other two tracts in private ownership, one is owned by TNC and is under a conservation easement. The last tract is owned by a private individual and has a very small population consisting of as few as three individual plants.

Godfrey's Butterwort

Because the range of the Godfrey's butterwort is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Harper's Beauty

Because the range of the Harper's beauty is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Highlands Scrub Hypericum

This species has a narrow distribution at the southern end of the LWR in Highlands County and southernmost Polk County. Inventories of LWR endemic plants found this species at few sites – only 69 of 254 scrub sites surveyed by Christman (1988). Highlands scrub hypericum is locally abundant, with populations larger than a thousand plants and presumably large seed banks in the soil at ABS, the properties of the LWRWEA, Lake June-in-Winter Scrub State Park, TNC's Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWR State Forest. No substantial privately-owned tracts of scrub remain in this area. Land acquisition projects by the State and ABS have brought remaining sites into conservation ownership. Conversely, the species' recovery depends on these conservation lands, all of which are in the action area. Research at ABS shows this species is fire-dependent, restricted to open areas that are created, and maintained by fires and slowly disappearing as shrubs encroach. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

No critical habitat has been designated for this species.

Lewton's Polygala

This species is restricted to sandhill vegetation, such as at Tiger Creek Preserve and the Carter Creek unit of LWRNWR. Recent research demonstrates that seed in the soil germinates after a fire, leading to a short-term population explosion. Population sizes decline with time after fire. Lewton's polygala occurs in sandhill vegetation and Florida scrub of the LWR. The largest occurrence is at the Carter Creek tract of LWRNWR. Within the action area, it also occurs on LWR State Forest (Arbuckle and Walk-in-the-Water), Allen David Broussard Catfish Creek Preserve State Park, TNC's Tiger Creek Preserve, Pine Ridge Preserve at the HBS, and Highlands Hammock State Park. Overall, the action area probably represents a majority of the populations and individuals of the species. It would be difficult to accurately compare population sizes because this species experiences population booms shortly after fires, and populations decline until after the next fire. Even with regular fire management, patches of Lewton's polygala often diminish or disappear within 5 years. TNC's Tiger Creek Preserve has numerous individuals of Lewton's polygala. Monitoring since 1991 has shown that fire is crucial for the maintenance of this species, and the 10-year trend for this species is stable. Demographic monitoring at the Carter Creek unit of LWRNWR also demonstrates boom-and-bust demography. The active prescribed fire and sandhill restoration program at Tiger Creek and the prospect of similar management at Carter Creek and other tracts is very favorable for this species. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

No critical habitat has been designated for this species.

Longspurred Mint

Longspurred mint is presently known from 15 occurences in Marion and Sumter Counties. Six of these populations are on the CFG State Recreation and Conservation Area in Marion County. The plant has been extirpated from several sites in these counties. Longspurred mint is found only in open areas in sand pine scrub or oak scrub, and in the ecotones between these and turkey oak communities. It can colonize the edges of road rights-of-way, and has spread vigorously along streets. Sites where the species once occurred in Sumter County and several of the sites where the species formerly occurred in Marion County are no longer suitable habitat because of development. Development continues to threaten other populations. The species has been taken sporadically for scientific purposes and is vulnerable to losses from the general public. The plants occur close to the highway and human habitation, and they can be easily identified by the strongly aromatic mint-like odor. The species' restricted range and limited numbers also increases its vulnerability to disturbance or natural disaster. The species should be preserved in the extant sites, and, to provide greater security, the possibility of establishing additional populations within the historic range should be evaluated. Mild disturbances appear to have little effect and probably stimulate the species by reducing competition. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

No critical habitat has been designated for this species.

Okeechobee Gourd

Because the range of the Okeechobee gourd is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

The subspecies' decline is largely attributed to two factors: (1) conversion of swamp forests to agriculture and (2) water level management in Lake Okeechobee. Agricultural conversion was the principal form of habitat destruction for the gourd prior to 1940. Today, water management practices appear to be the greatest threat in the action area. Permanent inundation of suitable soils is detrimental to the species. Water regulation practices can greatly influence the timing and duration of flooding and drying cycles across remnant areas of suitable elevation and soils around Lake Okeechobee.

Okeechobee gourd plants are not strong competitors and are often out-competed by more aggressive plant species (Decker-Walters 2002c). Weed competitors include moonflower, common reed (*Phragmites australis*), Virginia saltmarsh mallow (*Kosteletzkya virginica*), camphorweed (*Pluchea* sp.), melaleuca (*Melaleuca quinquenervia*), *Sesbania* sp., and *Polygonum* spp. (Decker-Walters 2002a; 2002c). Moonflower appears to be especially competitive (Minno 2007). Native trees and shrubs are often smothered by weeds and have been affected on Ritta Island in Lake Okeechobee (Decker-Walters 2002c). A stable overstory to support the growth of gourd vines is necessary for the long-term survival of the subspecies but is lacking on some of the islands of Lake Okeechobee (Decker-Walters 2002c). Interactions between competing species and the Okeechobee gourd are complex and not well understood, and individual responses to different stimuli are difficult to assess (Nee 2009).

Decker-Walters (2002c) stated factors that reduce the availability of habitat (*e.g.*, lack of fluctuation in water levels and aggressive weeds) pose a large threat to the subspecies. In addition, several factors related to human values (*e.g.*, water storage, flood control, navigation) and ecological values (*e.g.*, waterfowl, fisheries, littoral zone vegetation, water quality, snail kite recovery, and others) that affect management decisions can potentially conflict (Service 1999). At this time, the habitat seems stable along the St. Johns River; however, proposed water withdrawals for alternative public water supplies may affect suitability for the Okeechobee gourd (Minno 2009). Water management practices associated with Lake Okeechobee directly influence the fluctuation in water levels, and, as a result, impact habitat. Water levels have typically been held between 15 and 17.5 ft above mean sea level to store water for agricultural irrigation and municipal needs, which is higher than natural levels (Walters and Decker-Walters 1991). Permanent inundation of suitable soils prevents germination of gourd seeds, and changes in water level management that would reduce the likelihood of low water can threaten the subspecies. However, management changes that would result in more frequent low water-level events may be beneficial to the subspecies. Extended periods of low water levels generally result in increased growth and reproduction (Minno and Minno 2006a). Natural rainfall affects water levels for both populations, but especially for the St. Johns River population.

Although necessary for control of non-native plants, herbicide use also poses a threat to the Okeechobee gourd. The occurrences at one of the sites along the St. Johns River were destroyed in 2005 where herbicide was sprayed, and the site is no longer suitable (Minno and Minno 2005). Herbicides are routinely sprayed around Lake Okeechobee to keep waterways free of aquatic vegetation. If herbicides are used carefully to control non-native woody vegetation (primarily melaleuca trees) and dense coverage of aquatic vegetation, this management practice can be compatible with recovery of the Okeechobee gourd (Service 1999).

Within the range of Okeechobee gourd in the Lake Okeechobee region, the human population is predicted to grow from nearly 11,000 to over 17,000 in Glades County between 2005 and 2060 and from approximately 1,270,000 to over 2,700,000 in Palm Beach County (Zwick and Carr 2006). Population growth is expected to increase water demands and recreational pressure on the lake. Within the range of the St. Johns River gourd population, the number of residents in Volusia County is projected to increase over the same time period from nearly 500,000 to over 940,000 and nearly triple in Lake County.

Papery Whitlow-wort

The vast majority of existing populations of this species are in Highlands and Polk Counties, mainly on conservation lands constituting the action area. This plant forms locally large populations on most of the lands in the action area. For example, the LWR State Forest's Arbuckle tract has 188 records of this plant in its GIS database, mostly from a 1988 inventory. Of the 188 records, 23 represented more than 100 individuals (data collected by K. DeLaney, provided by A. Cox, LWR State Forest). Recent monitoring (Cox 2004) indicates populations remain large. ABS has not monitored this plant because it thrives in fire lanes. Overall, threats to this species have been greatly reduced by purchase of its best remaining habitats for conservation purposes since it was listed. However, the propensity of this species to occupy fire lanes, roadsides, and other artificially disturbed areas is a conservation concern, because the papery whitlow-wort tends to be far more abundant in such disturbed areas than within the vegetation itself. Prescribed fire appears appropriate to create or enlarge open, sandy areas in the scrub vegetation. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

No critical habitat has been designated for this species.

Pigeon Wings

This species is present in Polk County, where it is locally abundant at the Tiger Creek Preserve and present in extensive suitable habitat at APAFR, Arbuckle and Walk-in-the-Water tracts of

LWR State Forest, Horse Creek Scrub, and Saddle Blanket Lakes Preserve; and in Highlands County, including several tracts of the LWRWEA, two units of LWRNWR, and ABS. It inhabits sandhill, scrub, and dry hammock vegetation. Conservation of this plant depends largely on conservation lands that have been acquired to protect distinctive scrub and sandhill vegetation on the LWR, plus continued appropriate management of its habitat on the APAFR. Individual plants of pigeon wings resprout from large horizontal underground rootstocks and appear to be relatively long-lived, based on their responses to fire at sites like Tiger Creek Preserve, where they are thriving under a regime of frequent prescribed fires. Acquisition of conservation lands on the LWR since this species was listed has greatly reduced the threat of habitat loss, and vegetation restoration through prescribed fire on conservation lands appears to be yielding further benefits (more information will become available as a study at APAFR progresses). The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

No critical habitat has been designated for this species.

Pygmy Fringe Tree

The best-monitored population of this species within the action area is in Polk County, in sandhill vegetation at Tiger Creek Preserve, where it has been monitored since 1989. This population appears to be stable and responding well to frequent prescribed fires. Other populations are at LWR State Forest (Arbuckle and Walk-in-the-Water tracts), at the Saddle Blanket Lakes Preserve (also burned recently), and the Allen David Broussard Catfish Creek Preserve State Park. In Highlands County, the Carter Creek unit of LWRNWR may have the largest protected population. It has responded well to prescribed fire. It is also present at two units of the LWRWEA and ABS. These protected sites within the action area collectively represent the only prospect for conserving this species. Threats to the pygmy fringe tree have been reduced by acquisition of such conservation lands over the past 15 years, despite the loss of habitat outside of conservation lands. Available information shows that this species resprouts readily after fire, and seedlings and saplings can be found. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Sandlace

This species is found in Polk County on the Allen David Broussard Catfish Creek Preserve State Park, Hickory Lake Scrub County Park, Saddle Blanket Lakes Preserve, Sun Ray Scrub unit of the LWRWEA, and the Lake McLeod and Snell Creek units of LWRNWR. In Highlands County, it is present on the Flamingo Villas unit of LWRNWR, all or nearly all of the tracts of the LWRWEA, The Preserve (Highlands County government), Highlands Hammock and Lake June-in-Winter Scrub State Parks, Jack Creek (District), and ABS. All of these conservation lands are within the action area. Scrub vegetation is not expected to persist outside of the conservation lands, in part because conducting safe prescribed burns in this vegetation is difficult, and the vegetation becomes less suited to this and other scrub endemic species as time-since-fire increases. Collectively, they constitute the area available to this species for its recovery. Sandlace is locally reasonably abundant and appears to respond well to restoration of the scrub vegetation through the use of prescribed fire. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Scrub Blazingstar

This species is never abundant, but is present as scattered individuals in scrub throughout the action area. Overall, habitat is still being lost, but State, Federal, and private acquisition of conservation lands on the LWR has clearly benefited this plant, which is distributed on the southern LWR of Polk and Highlands Counties, plus a single known site on the WHR in Polk County, at Lake Blue (Schultz et al. 1999). This perennial herb is known from about 115 extant populations (Dolan et al. 1999) and it is present on most of the conservation lands with scrub vegetation within its range. They include Allen David Broussard Catfish Creek Preserve State Park, Boy Scout (Cox 2004) and Lake Arbuckle tracts of LWR State Forest, Saddle Blanket Lakes Preserve, all or nearly all of the 12 units of the LWRWEA, Lake June-in-Winter Scrub State Park, the Flamingo Villas tract of LWRNWR, and ABS (Schultz et al. 1999; Service 1996). Collectively, these conservation lands constitute the area available to scrub blazingstar for its recovery. Individual plants of this herb are relatively long-lived (with a life expectancy of at least 8 years, according to one report) and typically return after fire. This species is more shade-tolerant than most LWR scrub endemics, so it may be less sensitive than most to fire frequency. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Scrub Buckwheat

This species can be abundant in sandhills vegetation. Fire stimulates flowering, and seeds (unusually for plants of scrub or sandhills) germinate in summer, so a fresh crop of seedlings can emerge after a winter or spring fire. Failure to conduct prescribed fires is likely to result in population declines. Its decline is due almost entirely to loss of sandhill habitat and to habitat degradation due to lack of prescribed fire. Its long-term prospects are favorable due to habitat acquisition after it was listed, as well as efforts by conservation land managers to restore natural fire regimes. For example, it is now the most abundant of the “rare” species at the Tiger Creek Preserve and its populations are stable, so it does not receive intensive monitoring (B. Pace-Aldana, TNC, letter correspondence, 2005). Within Polk County, scrub buckwheat is present on conservation lands within the action area at Tiger Creek, the LWR State Forest, Allen David Broussard Catfish Creek Preserve State Park, Carter Creek tract of LWRNWR, HBS, and Horse Creek Scrub. In Highlands County, it is present at the Lake Apthorpe tract of the LWRWEA, Flamingo Villas tract of LWRNWR, and ABS, which represents its southern range limit. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Scrub Lupine

This species is very narrowly distributed and most of its former habitat has been destroyed. The only securely protected site within the action area is the 65 acre Lake McLeod unit of LWRNWR. Planning for Lake McLeod’s management is underway, but already monitoring indicates that cutting and burning selected patches of shrubs is appropriate to control patches of shrubs in this very open scrub. Lake McLeod is critically important for conservation of this herb, which has not been successfully propagated. The action area includes the entire range of this species, so careful management of these lands are critical to its continued existence.

Scrub Plum

This species, like most other plants of scrub and sandhill, faces very poor prospects outside of conservation lands. It is present in both scrub and sandhill vegetation on nearly all other conservation lands within the action area. In Polk County, it is present at LWR State Forest, at HBS, at the Allen David Broussard Catfish Creek Preserve State Park, and at Tiger Creek Preserve. In Highlands County, it is present on tracts of the LWRWEA; the Carter Creek and Flamingo Villas tracts of LWRNWR; ABS; and Lake June-in-Winter Scrub State Park. Nearly all plants survive fires, although a few plants burned to the ground may die (fewer than two percent after 3 years). Information on numbers of plants by site has not been available, probably because it is perceived by land managers as relatively abundant. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Short-leaved Rosemary

This species has a very restricted distribution in the Sebring-Avon Park area in Polk and Highlands Counties. It was found at only about 30 sites whose total area was less than 2,400 ha (6,000 acres) (Christman 1988; Christman and Judd 1990). All the conservation lands where this scrub species is protected are within the action area. In Polk County, they are the large Arbuckle tract of LWR State Forest, Saddle Blanket Lakes Preserve (335 ha/829 acres), Hickory Lake Scrub County Park (26 ha/65 acres), and the Sun Ray unit of LWRWEA (109 ha/270 acres). In Highlands County, it is on the Silver Lake unit of LWRWEA (157 ha/389 acres). It is also present on non-conservation lands in this county. Although it has not been studied in any detail, it is believed to respond positively to periodic fire, probably returning to burned areas from seed buried in the soil. Because this species only occurs in fire-maintained scrub vegetation and because development continues in its tiny range, its conservation depends essentially entirely on appropriate management of these conservation lands, which are all within the action area.

Smalls Milkpea

Because the range of the Small's milkpea is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

The action area contains appropriate habitat for listed and candidate plants, among other taxa. However, the rapid urbanization of Miami-Dade County has resulted in the virtual elimination of extensive pine rocklands, the preferred habitat for several listed and candidate species. Based on IRC surveys, pine rockland habitat in urban Miami-Dade County has been reduced to about 1.8 percent of its natural extent. Of the original 127,000 acres, only 2,273 acres of largely fragmented pine rocklands remain throughout Miami-Dade County, outside of ENP. The primary factors affecting listed and candidate plants within pine rockland fragments are exotics and natural fire suppression. Altogether, 79 species of naturalized exotic plants have been recorded in pine rocklands, the most problematic being Burma reed and Brazilian pepper. Pine rocklands are dependant on natural fires to maintain their scrub and herb layers as well as to prevent succession. Without natural fires or adequate prescribed burns, pine rocklands can be replaced by hardwood hammock and invasive plant species.

Many of these remaining pine rocklands and pine rockland-containing disturbed areas, such as parks, pastures, and vacant lots, are geographically distinct and, therefore, do not provide contiguous habitat for listed plants. They are fragmented by highly urbanized and suburban areas making it difficult to manage these parcels. Other factors affecting the species within the action area include an ongoing federally-funded restoration project for privately-owned pine rocklands that will benefit the species.

Snakeroot

This species formerly occurred in and near Sebring. All other sites are in an area about 39 km (24 miles) long in the vicinity of Lake Placid. Christman (1988) reported about 20 localities, but even this number is misleading since he divided several sites. It is present on the Hendrie Ranch (private) (Service 1996), Gould Road (212 acres), Woolfenden (McJunkin) tract (623 acres), Lake Placid (2,159 acres), Holmes Avenue (974 acres) and Lake Apthorpe (810 acres) tracts of LWRWEA, and ABS (5,200 acres). Acquisition of some of the LWRWEA tracts is not complete, and the presence of private inholdings inhibits fire management by FWC; only the DOF has authority to conduct fires including private properties. There are no significant prospects for conserving this plant on private land, unless there might be a conservation easement at Hendrie Ranch. The conservation lands, which are all within the action area, are crucial to the conservation of this species. Intensive demography research at ABS has shown that populations of this plant explode within the first decade after fire, with large flowering plants being common beginning with the third year after a fire. Populations begin decline 9 years after a fire and plants disappear entirely between 25 and 35 years after a fire. The exacting habitat requirements of snakeroot mean that, despite large populations at a number of sites, its habitat must be managed aggressively with fire or equivalent disturbances to maintain open, sunny gaps. ABS has a very effective fire management, and management on the LWRWEA tracts varies depending on the presence of inholdings. The action area includes the entire range of this species, so careful management of these lands is critical to its continued existence.

Telephus Spurge

Because the range of the telephus spurge is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Tiny Polygala

Because the range of the tiny polygala is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for the species.

The action area contains appropriate habitat for listed and candidate plants, among other taxa. However, the rapid urbanization of Miami-Dade County, where the highest density of populations are located, has resulted in the virtual elimination of extensive pine rocklands, the preferred habitat for several listed and candidate species. Based on IRC surveys, pine rockland habitat in urban Miami-Dade County has been reduced to about 1.8 percent of its natural extent.

Of the original 127,000 acres, only 2,273 acres of largely fragmented pine rocklands remain throughout Miami-Dade County, outside of ENP. The primary factors affecting listed and candidate plants within pine rockland fragments are exotics and natural fire suppression. Altogether, 79 species of naturalized exotic plants have been recorded in pine rocklands, the most problematic being Burma reed and Brazilian pepper. Pine rocklands are dependant on natural fires to maintain their scrub and herb layers as well as to prevent succession. Without natural fires or adequate prescribed burns, pine rocklands can be replaced by hardwood hammock and invasive plant species. Where the species exists outside of pine rockland habitat in scrub vegetation, similar concerns occur.

Many of the remaining pine rocklands and pine rockland-containing disturbed areas, such as parks, pastures, and vacant lots, are geographically distinct and, therefore, do not provide contiguous habitat for listed plants. Like scrub parcels, they are fragmented by highly urbanized and suburban areas making it difficult to manage these parcels. Other factors affecting the species within the action area include an ongoing federally-funded restoration project for privately-owned pine rocklands that will benefit the species.

White Birds-in-a- nest

Because the range of the white birds-in-a-nest is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for this species.

Wireweed

Because the range of the wireweed is wholly contained within the action area, the preceding rangewide status discussion includes the status of the species within the action area.

No critical habitat has been designated for the species.

Factors affecting species habitat within the action area

The action area consists of all pyrogenic vegetative communities in the State of Florida under NRCS easement programs or lands eligible to receive NRCS financial or technical assistance to undergo prescribed burning, or practices that will facilitate prescribed burning. Included within the action area would be vegetative communities previously identified in Table 2 that depend on periodic fires to restore and maintain habitat conditions. These vegetative communities contain habitat or potential habitat listed, proposed, and candidate plants and animals. The most important factor influencing the species covered by this Opinion and their habitats is destruction and degradation due to agricultural and residential development. From 2000 to 2010, Florida's population increased 12.2 percent from 17.5 million to 19.7 million. Between 2005 and 2060, Florida’s population is projected to double to approximately 36 million people (Zwick and Carr 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006).

By far the largest management concern for these lands is fire and its management. The lack of fire in recent decades has left these habitats as overgrown and undesirable for many species (TNC 2010a, 2010b). Many of the habitats within the action area are geographically distinct and, therefore do not provide contiguous habitat for imperiled species. Furthermore, fragmented habitats are difficult to manage for these species. For example, based on IRC surveys, pine rockland habitat in urban Miami-Dade County has been reduced to about 1.8 percent of its natural extent. Of the original 127,000 acres, only 2,273 acres of largely fragmented pine rocklands remain throughout Miami-Dade County, outside of ENP. The primary factors affecting listed and candidate plants within pine rockland fragments are exotics and natural fire suppression. Altogether, 79 species of naturalized exotic plants have been recorded in pine rocklands, the most problematic being Burma reed and Brazilian pepper.

At some sites, the proximity of housing or other land uses severely limits the use of prescribed fire even as the presence of overgrown vegetation increases the threat of destructive wildfire. In wildland urban interface areas, the likelihood of covered species such as the eastern indigo snake coming into contact with humans and being killed by property owners and domestic pets is increased.

Research and monitoring over the past 15 years, as explained in background information on individual species, has done a great deal to elucidate suitable fire return intervals and intensities the vegetative communities within the action area. Prescription fire applications on privately-owned lands not under conservation programs and lands under NRCS easements is identified as an opportunity where additional benefits can be achieved for the species. The use of prescribed fire for habitat restoration and maintenance is strongly encouraged by recovery plans for many of the species covered by this Opinion. However, some species require special attention due to extremely limited distribution and potential vulnerability to fire. Construction of firebreaks is essential for carrying out prescribed fire programs, and their creation and maintenance can both create opportunities for, and destroy listed, proposed, and candidate species.

Managing the pyrogenic vegetative communities through the use of ecologically based prescribed fire regimes mimicking the natural process that historically occurred when wildfires swept across the landscape is the preferred method of habitat restoration and maintenance. However, there are instances where habitats have become so overgrown that mechanical and chemical methods are needed before prescribed fire and be successfully and safely applied. These methods are considered more intrusive and as in the case of firebreaks, can create opportunities for and destroy listed, proposed and candidate species. When mechanical and chemical treatments are used, they should be followed up by prescribed fire.

Another factor affecting species within the Action Area includes habitat degradation from the introduction of non-native species. In the pine rocklands vegetative community alone, 79 species of naturalized exotic plants have been recorded. Exotic pest plant threats need to be controlled where they are identified. Although necessary for control of non-native plants, herbicide use also poses a threat to the listed proposed and candidate plant species. If herbicides are used carefully to control target vegetation this management practice can be compatible with recovery of listed, proposed, and candidate species.

Water management practices and human caused changes in hydrology are other factors affecting species with in the action area. Water regulation practices can greatly influence the timing and duration of flooding and drying cycles across remnant areas of suitable elevation and soils occurring within habitats for covered species. For example, permanent inundation of suitable soils in some areas around Lake Okeechobee is detrimental to the Okeechobee gourd.

Stochastic events, such as hurricanes and drought, are of concern to listed proposed, and candidate species in the action area. Both short and long-term drought events can negatively impact manager's ability to apply prescribed fire on lands within the action area.

Cumulatively, the conservation practices evaluated in the Opinion will enhance and restore pyrogenic habitats that have been degraded by long-term fire suppression. Without implementation of the proposed actions, suitable or waning habitats may degrade further and will become unsuitable for the covered species. Unsuitable habitats, if not restored by implementation of the conservation practices will remain in an unsuitable state.

Climate Change

According to the Intergovernmental Panel on Climate Change Report (IPCC)(2007), warming of the earth's climate is "unequivocal," as is now evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. The 2007 IPCC report describes changes in natural ecosystems with potential wide-spread effects on many organisms, including marine mammals and migratory birds. The potential for rapid climate change poses a significant challenge for fish and wildlife conservation. Species' abundance and distribution are dynamic, relative to a variety of factors, including climate. As climate changes, the abundance and distribution of fish and wildlife will also change. Highly specialized or endemic species are likely to be most susceptible to the stresses of changing climate. Based on these findings and other similar studies, the Department of the Interior requires agencies under its direction to consider potential climate change effects as part of their long-range planning activities (Service 2007i).

Climate change at the global level drives changes in weather at the regional level, although weather is also strongly affected by season and local effects (*e.g.*, elevation, topography, latitude, proximity to the ocean, etc). Temperatures are predicted to rise from 2^{o}C to 5^{o}C for North America by the end of this century (IPCC 2007). Other processes to be affected by this projected warming include rainfall (amount, seasonal timing and distribution), storms (frequency and intensity), and sea level rise. However, the exact magnitude, direction, and distribution of these changes at the regional level are not well understood or easy to predict. Seasonal change and local geography make prediction of the effects of climate change at any location variable. Current models offer a wide range of predicted changes.

Climatic changes in south Florida could amplify current land management challenges involving habitat fragmentation, urbanization, invasive species, disease, parasites, and water management (Pearlstine 2008). Global warming will be a particular challenge for endangered, threatened, and other "at risk" species. It is difficult to estimate, with any degree of precision, which species will be affected by climate change or exactly how they will be affected. The Service will use Strategic Habitat Conservation planning, an adaptive science-driven process that begins with explicit trust resource population objectives, as the framework for adjusting our management strategies in response to climate change (Service 2006b).

EFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on the species and/or critical habitat and its interrelated and interdependent activities. The Service has evaluated the identified Conservation Practice Standards in the context of how the individual standards have the potential to produce beneficial and adverse effects to the covered species – at the individual, population, and landscape scales. The Service worked in collaboration with the NRCS to develop specific Conservation Measures/criteria for the four core conservation management practices and the eight facilitating Conservation Practice Standards included in this Opinion. The Service believes that, as implemented, the Conservation Measures will result in ameliorating, minimizing, or eliminating potential adverse effects. The use of specific Conservation Measures focusing on design, timing, and method of operation of machinery, including the use of avoidance buffers is expected to significantly reduce the potential adverse effects of the Conservation Practice Standards. However, even with the implementation of the Conservation Measures, some remaining adverse effects will occur to the covered species as described below. Nevertheless, the Service believes implementation of prescribed burning and associated practices in concert with the Conservation Measures/criteria will collectively produce net conservation benefits to all covered species.

Factors to be considerd

Physical Disturbance (Including Noise)

All of the covered Conservation Practice Standards, either directly or indirectly, have the potential to produce some additional level of physical disturbance because they involve the physical presence of humans and/or associated equipment, vehicles or machinery. Further, future periodic disturbances have the potential to occur as maintenance actions for the implemented practices may be needed over their operational life. Although effects are not quantitatively known the literature suggests some form of physical effects from presence and/or associated noise will create a disturbance response to individuals of each of the covered species.

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

Temporary Soil Disturbance and Vegetation Removal

Temporary soil disturbance and vegetation removal are expected from the implementation of most of the Conservation Practice Standards. This disturbance may result in loss and/or temporary change in habitat conditions for the covered species. Sources of the disturbance would include use of equipment (tractors, and other machinery) as well as practices that involve manipulation of vegetation (e.g., brush management, forest slash treatement, and prescribed burning). The installation or application of many conservation practices could result in soil surface disturbance and/or compaction. The ground disturbance may involve minor surface disturbance such as tracked vehicles or tires. Common potential adverse effects identified by the Service include short term degradation of habitat conditions and the potential for increased habitat fragmentation if the scale of the disturbance is large enough and the potential to create opportunities for colonization of these disturbed sites by invasive plants.

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

Permanent Removal/loss of Suitable Habitat

This adverse effect is a result of permanent removal of habitat conditions and specific vegetative loss caused by the installation of Conservation Practice Standards or the expectation that, once implemented, permanent degradation of habitat conditions for any of the covered species will have resulted.

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

Increased Potential of Accidental Mortality to Individuals

Several Conservation Practice Standards were identified as potentially causing mortality or injury to individuals of listed species. These include accidental mortality from collisions with vehicles or, in the case of plants, loss of individual plants due to crushing or as a result of vegetative manipulation. Prescribed burning is identified as a Conservation Practice that could potentially cause mortality or injury to listed species. Accidental injury or mortality of individual members of the covered species may occur if the burn is conducted during the nesting or brood-rearing seasons. Fires that burn too fast or hot may not provide individuals seeking refuge/cover, time to escape, causing mortality. While fire may "top kill" covered plant species, these plants are fire adapted and have various strategies for responding to fire events, including vigorous resprouting from roots stock or seed banks. A temporary reduction of habitat may occur and persist until the habitat recovers. In almost all cases, recovery of habitat is rapid with improvement in habitat conditions resulting in a net conservation benefit for both plants and animals. Conversely, in the absence of fire, habitat will degrade and reach a point where conditions are no longer suitable for the covered species resulting in an overall loss of population numbers.

Increased Potential for Predation

Certain Conservation Practice Standards may increase the potential for predation on individuals through the installation of structures or modifying existing habitat conditions. The affected conservation practice standards include those that involve the creation or maintenance of infrastructure or habitat manipulations. For example, some practices may create habitat for raptor perching. In addition, some practices will temporarily reduce available cover and food sources, making the covered species more vulnerable to predation. Finally, the presence of humans during practice installation can temporarily create an artificial food source for predators (*i.e.*, trash attracts predators such as foxes, coyotes, badgers).

Species response to the proposed actions

Audubon's Crested Caracara

Fire preparation work carried out by land managers will include preparation of firebreaks by mechanical means and protection of nest trees. Firebreaks tend to be permanent and the open sand they provide is likely to be colonized by the short-lived herbs covered by this Biological Opinion and to be used by numerous insects that need bare sand. For crested caracara, this preparatory work appears to have few effects, apart from creating or maintaining bare areas in the mosaic of habitats present in the caracara's foraging area. With implementation of the Conservation Measures, including but not limited to providing buffers around nests during the nesting season, actual fire should have very little effects to known nests and individuals (see Conservation Measures).

Florida Grasshopper Sparrow

Prescribed fire and related activities could take place throughout the sparrow's current range and suitable habitat, and could affect all populations. Currently, this consists of two, sharply declining populations on public lands and one or more presumable small populations on private lands. To minimize effects, mechanical treatments should not occur from April 1 to September 1, and prescribed fire activities should not take place from August 15 to January 31 unless as provided in the Conservation Measures (see Conservation Measures).

Temporary disturbance to birds is likely due to fire line maintenance and construction and herbicide treatment, especially during the peak of nesting season. Birds may be injured or killed and nests may be lost as a result of fire or vehicle use associated with management activities. There will also be short-term impacts including temporary loss of habitat. Overall, as frequent fire is necessary to maintain prairie habitat, the long-term effects of the proposed action are expected to be beneficial.

Florida Scrub-jay

Fire preparation work carried out by land managers will include preparation of fire breaks by mechanical means. Firebreaks tend to be permanent and the open sand they provide is likely to be colonized by short-lived herbs and used by numerous insects that need bare sand. For scrub-jays, this preparatory work appears to have few effects, apart from creating or maintaining bare areas that will be useful for burying acorns and causing some minor disturbance to the birds. There is some risk of destroying nests and/or nestlings if located in the path of the equipment needed to install firebreaks.

Weather conditions necessary to provide burn conditions that produce optimal scrub-jay habitat occur primarily during the early growing season before the summer rains begin. Although the early growing season coincides with the scrub-jay nesting season, burning in the winter, fall, and late summer often produces inferior results and non-optimal scrub-jay habitat. Adult and juvenile scrub-jays can avoid flames and smoke. However, the prescribed burns and associated human activity will temporarily disrupt the birds' daily behavior patterns and ability to forage for a short period.

Overgrown scrub generally does not provide suitable nesting sites, so some burns will not contain nest sites. Although measures will be taken to avoid the loss of scrub-jay nests, it is possible nests might be lost in prescribed fires and during mechanical treatment. This species typically re-nests rapidly after fire. Scrub-jay data from ABS suggest the loss of individual nests as a result of fires does not have a significant negative effect on the local jay population if adequate habitat remains unburned. Habitat enhancement from ecologically-based prescribed burning outweighs the short-term detrimental impacts to scrub-jay nesting success that may occasionally occur.

Optimal scrub-jay habitat consists of evergreen oak scrub 1 to 3 meters (3 to 10 ft) tall interspersed with numerous patches of bare sand (Cox 1984). Sand pine scrub, scrubby flatwoods with slash pines, Florida rosemary scrub, sandhill, and the edges of mature sand pine scrub and xeric hammocks may also provide suitable habitat. Surveys have shown that overgrown scrub does not provide suitable habitat for scrub jays. Family groups are often observed on the periphery of overgrown scrub in adjacent flatwoods. Successful prescribed burns and mechanical treatments such as roller chopping, midstory removal, and timber removal on the project sites will restore marginally-usable or unusable, overgrown habitat to suitable habitat for foraging and nesting. The project is specifically intended to enhance the continued existence of this species by improving habitat conditions. Long-term negative impacts are expected to be minor.

Red-cockaded Woodpecker

This species occurs in open old growth pine habitats, which include sand hills and flatwoods. The pines must be of sufficient size to accommodate the nests that individuals excavate within inactive heartwood. In addition to suitable nest trees, RCW habitat consists of open pine canopies, little pine or hardwood mid-story, and abundant herbaceous groundcover for forage. Hardwood encroachment resulting from a long absence of fire typically results in abandonment of the areas by the woodpeckers. Thus, prescribed fire is critical for the creation and preservation of suitable habitat for this species.

Nesting season is April through June, which coincides with the growing season (*i.e.,* April through July), the optimal period recommended for prescribed fire. Growing season fires are most effective for hardwood reduction and establishment of herbaceous groundcover. Adult and juvenile RCWs can avoid flames and smoke by fleeing the area. Protection of nest trees can be provided by limiting fire intensities around the trees, by establishing firebreaks, or cutting down surrounding vegetation. However, there is the potential that birds may be injured or killed, and nests or cavity trees may be destroyed during prescribed burns as a result of the fire. Also, adults and juveniles can typically avoid the flames and smoke, but may leave the area temporarily due to disturbance from fire activities and herbicide treatment. Overall, some short-term negative impacts are anticipated from the proposed action. However, the long-term effects of the proposed action are expected to be beneficial.

Blue-tailed Mole Skink

The land manager's equipment operators will take care to avoid running over individuals during preparations. All vehicle use will be contained as much as possible to the burn unit perimeter roads. There is a risk of individuals being crushed by equipment. Fire crew members supported by this project will be trained in identification of the blue-tailed mole skink, in habitat needs that pertain to the health of the population, and in specific management practices that will avoid detrimental impacts to individuals. Equipment operators will take care to avoid running over individuals during burns, and vehicle use will be contained as much as possible to the burn unit perimeter roads. Blue-tailed mole skinks are unlikely to be seen, but if one is seen, it will be allowed to move out of harm's way on its own before equipment use is resumed. Individuals, if present, could be killed by overheating from fire or from crushing by equipment. Populations are vulnerable to habitat degradation due to overgrown vegetation caused by fire exclusion. Prescribed fire is essential to maintain and restore its habitat. After treatment, this species is likely to benefit from the availability of more open sand habitat over a term of 1 to perhaps 15 years.

Sand Skink

The land manager's equipment operators will take care to avoid running over individuals during preparations. All vehicle use will be contained as much as possible to the burn unit perimeter roads. There is a risk of individuals being crushed by equipment. Fire crew members supported by this project will be trained in identification of the sand skink, in habitat needs that pertain to the health of the population, and in specific management practices that will avoid detrimental impacts to individuals. Equipment operators will take care to avoid running over individuals during burns, and vehicle use will be contained as much as possible to the burn unit perimeter roads. Sand skinks are very unlikely to be seen (its fossorial behavior makes the chance of seeing one remote), but if one is seen, it will be allowed to move out of harm's way on its own before equipment use is resumed. Individuals, if present, could be killed by overheating from fire or from crushing by equipment. Sand skink populations are vulnerable to habitat degradation due to overgrown vegetation caused by fire exclusion. Prescribed fire is essential to maintain and restore its habitat. After treatment, this species is likely to benefit from the availability of more open sand habitat over a term of 1 to perhaps 15 years.

Eastern Indigo Snake

Fire crew members supported by this project will be trained to identify the species, learn about habitat needs that pertain to the health of the population, and learn about specific management practices that will avoid detrimental impacts to individuals. Personnel will use caution to avoid running over individuals when operating vehicles during preparations for prescribed burns.

Ring fires, which could trap indigo snakes inside the burn area, will not be used. If an indigo snake is observed inside the burn unit, ignition will cease and the snake will be allowed to leave the unit. If that is not successful, fire activities will be delayed to give the snake time to find refuge underground before burning is continued. If fire threatens to burn over an individual, crew members will attempt to extinguish the fire to avoid impacts to the snake. Any eastern indigo snakes in a burn project area may incur a brief period of disturbance to its patterns of feeding, breeding, or sheltering. Disturbance from prescribed burns will occur for only 1 to 2 days on each of the burn units, and the burns will be conducted in mosaic patterns, providing areas of refuge for indigo snakes. Fire treatments could conceivably kill or injure snakes, but the precautions to be taken make it very likely that snakes would successfully flee fires or escape into underground refugia. However, juvenile eastern indigo snakes use dense vegetation for cover rather than underground refugia and may be injured or killed during firebreak construction, mechanical treatment, and application of prescribed fire. Prescribed fires are expected to improve prey species abundance in the re-growing vegetation. The eastern indigo snake inhabits fire-adapted vegetation, so the proposed activities are expected, over a term of several years to a decade, to be beneficial to the eastern indigo snake.

Gopher Tortoise

Prescribed burning and other covered Conservation Practice Standards that require the use of heavy mechanized equipment were identified as potentially causing mortality or injury to individuals of gopher tortoises. These events can arise from: (1) fires that burn too fast and/or hot and/or catch a tortoise outside of its burrow; (2) direct collision between the equipment and adults, juveniles, eggs and/or nests; and (3) indirectly via burrow collapse and subsequent entombment.

The use of specific Conservation Measures (NRCS criteria) focusing on design, timing, and method of operation of machinery, including the use of avoidance buffers surrounding known gopher tortoise burrows, is expected to significantly reduce the potential adverse effects of these Conservation Practice Standards. This risk is primarily associated with the use of heavy machinery directly adjacent to or on top of the burrows, and should not restrict the use of hand tools within the buffer area. Since the majority of gopher tortoise nests are found directly outside the burrow entrance (*i.e.*, burrow "apron"), maintaining a heavy machinery buffer around each known burrow should greatly reduce the risk of either directly destroying a nest or compacting the soil to the extent that an emerging hatchlings cannot dig out. Although studies have shown most adult gopher tortoises are capable of self-excavation following burrow collapse, the long-term individual and population-level effects are unknown, as are the abilities of commensals to self-excavate. Beauman (2008) noted entombment periods might limit a tortoise's foraging opportunity at times when they should be enhancing their body condition before overwintering. In addition, tortoises could potentially miss mating and nesting opportunities if entombment occurs in the late summer and fall.

Prescribed burning will result in loss of gopher tortoise foraging habitat. However, loss of available foraging is temporary as recovery of grasses and herbaceous growth utilized by tortoises for forage is extremely rapid - if burning is conducted during the growing season, "green-up" of these grasses and herbs can occur within several days. Recovery of plants utilized for forage may be somewhat slower after dormant season fires, but this is a time when the species is less active.

Implementation of prescribed burning and associated covered conservation practices within the action area is expected to increase the amount and quality of suitable gopher tortoise habitat on private lands, thereby furthering recovery and conservation goals. Without management of the current and historic areas where these species occur, but are not afforded protection and conservation, declines in populations have occurred or are expected. Although longleaf pine stands exist in the project area, pine plantations also exist, creating isolation and fragmentation between populations.

Creation, restoration, and enhancement of additional habitat may facilitate some adults and/or juveniles to reoccupy previously abandoned lands/habitats, and new populations and associated habitat components will be created which will contribute to the recovery and conservation of the species. Implementation of the described management practices may have a temporary impact to the gopher tortoise and other covered species in the form of harm and/or harassment; however, benefits from the creation, restoration and maintenance of habitat, especially when coupled with established Conservation Measures, will outweigh any temporary impacts associated with those practices

Frosted Flatwoods Salamander

Fire is a necessary component of the habitat of the flatwoods salamander. While fire can potentially kill flatwoods salamanders, the overall effect of fire is beneficial as it maintains or helps restore good quality habitat. Eventually prescribed fire is expected to occur in the growing season, which will limit exposure of the salamanders to fire as they are frequently below ground during the daytime and in the warm season. Flatwoods salamanders are likely more vulnerable to fire in the dormant or winter season when movement to breeding ponds normally occurs.

The creation of firebreaks and use of fireplows to contain prescribed fire has the potential to directly impact the salamanders that could be just below the surface of the soil and dug up by plows. Firebreaks and fireplow areas also have the potential to drain water away from breeding ponds resulting in early drying of the breeding ponds or connection to other water bodies that could allow access to ponds from predatory fish. Overall, application of fire will result in a net benefit to the health of the habitats on which the salamander depends, even if some are directly killed by the fire.

Reticulated Flatwoods Salamander

Fire is a necessary component of the habitat of the flatwoods salamander. While fire can potentially kill flatwoods salamanders, the overall effect of fire is beneficial as it maintains or helps restore good quality habitat. Eventually prescribed fire is expected to occur in the growing season, which will limit exposure of the salamanders to fire as they are frequently below ground during the daytime and in the warm season. Flatwoods salamanders are likely more vulnerable to fire in the dormant or winter season when movement to breeding ponds normally occurs.

The creation of firebreaks and use of fireplows to contain prescribed fire has the potential to directly impact the salamanders that could be just below the surface of the soil and dug up by plows. Firebreaks and fireplow areas also have the potential to drain water away from breeding ponds resulting in early drying of the breeding ponds or connection to other water bodies that could allow access to ponds from predatory fish.

Striped Newt

Fire is a necessary component of the habitat of the striped newt. While fire can potentially kill newts, the overall effect of fire is beneficial as it maintains or helps restore good quality habitat. Eventually prescribed fire is expected to occur in the growing season, which will limit exposure of the newts to fire as they are frequently below ground during the daytime and in the warm season. Newts are likely more vulnerable to fire in the dormant or winter season when movement to breeding ponds normally occurs.

The creation of firebreaks and use of fireplows to contain prescribed fire has the potential to directly impact the newts that could be just below the surface of the soil and dug up by plows. Firebreaks and fireplow areas also have the potential to drain water away from breeding ponds resulting in early drying of the breeding ponds or connection to other water bodies that could allow access to ponds from predatory fish. Overall, application of fire will result in a net benefit to the health of the habitats on which the newts depends, even if some are directly killed by the fire.

Highlands Tiger Beetle

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Larval individuals could be crushed by equipment and/or be killed or injured through use of hand-held equipment. Prescribed fires are likely to kill adults and larvae, although because the larvae are restricted to bare sand, there are likely to be relatively few within areas selected for burning. Newly-created bare sand will constitute desirable habitat for this species.

Florida Bonneted Bat

This species occurs in Polk and Okeechobee Counties and is known to forage along wetlands and open water, and roost within pine flatwoods and other habitats. This species is now “proposed endangered”. Specific natural roost sites are unknown. Potential effects to Florida bonneted bats due to the proposed action include a number of direct and indirect effects on the bat and its habitat. Potential direct effects to the bat or its habitat include: (1) direct mortality from fire or other proposed activities; (2) harassment by proposed activities; and (3) destruction of roosting sites. Potential indirect effects include beneficial long-term improvements in habitat quality. Bats may be disturbed by fire pre-treatment and herbicide application. Because it is thought they roost in tree hollows and in dead palm fronds, bats may be injured or killed during prescribed fire or fire-related activities.

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

Florida Leafwing Butterfly

Prescribed burns could result in disturbance to the butterfly and/or its habitat and larval hostplant, pineland croton, but because pine rocklands will be burned in a mosaic pattern over time, thereby easing the butterfly's dispersal from and return to treatment area. Immature Florida leafwing will likely be killed by prescribed fires. However, the strong flight abilities of the adult Florida leafwing allow the subspecies to both escape fires, as well as to quickly re-colonize an area after treatment. Prescribed fires will restore and increase the distribution of pineland croton in treatments areas, providing more habitat for butterfly use. In addition, effort will be made to avoid the largest stands of pineland croton to provide refugia for the butterflies and their immature stages.

Bartram's Hairstreak Butterfly

Prescribed burns could result in disturbance to the butterfly and/or its habitat and larval hostplant, pineland croton, but because pine rocklands will be burned in a mosaic pattern over time, thereby easing the butterfly's dispersal from and return to treatment area. Immature Bartram's hairstreak will likely be killed by prescribed fires. Similarly, adult Bartram's hairstreaks are largely sedentary, rarely dispersing farther than 5 meters from their hostplant. As a result, only adult butterflies at the periphery of treatment areas are likely to escape prescribed burns. However, prescribed fires will restore and increase the distribution of pineland croton in treatments areas, providing more habitat for butterfly use. In addition, effort will be made to avoid the largest stands of pineland croton to provide refugia for the butterflies and their immature stages.

American Chaffseed

As with many pine flatwood and savanna species, *Schwalbea* may be adapted to a regular fire regime. Historically, lighting-strike fires that occurred throughout *Schwalbea's* range, as well as frequent burning as practiced by indigenous, pre-European human populations, maintained the open woodland/savanna conditions. These fires may have occurred frequently enough that fuel did not accumulate, and the fires were generally of low intensity. Herbaceous species would have been favored over tree and shrub species and would thrive in these conditions.

With the general suppression of natural fires in the twentieth century, the ecosystems that *Schwalbea* inhabits are declining. Without fire, open grass-sedge communities proceed through seral stages and become dominated by trees, shrubs, and dense herbaceous growth that overtop *Schwalbea*, which appears to be shade intolerant. If fire is suppressed for more than 3 years, the *Schwalbea* population declines as other species shade *Schwalbea* and compete with it for sunlight (D. Rayner, Wofford College, Spartenburg, South Carolina, personal communication 1991). Musselman and Mann (1977) reported that vigorous growth of *Schwt7zlbea* and abundant seed production was evident after early spring fires at sites in South Carolina. Preliminary results from studies at the JWJERC indicate that *Schwalbea* has a strong flowering response to dormant- and growing-season burns (Kirkman 1993, Kirkman and Drew 1995). Preliminary analyses of the 1993 population data strongly indicate that fire is a requirement for flower production (Kirkman 1993). In general, dormant-season (March) burns result in May flowering, and growing-season (June) burns result in July or August flowering.

The proportion of reproductive individuals is greater in both dormant season and growing season burn treatments compared with that of the control plots (Kirkman and Drew 1995). No differences in mean flower or fruit production per stem were detectable between the dormant season and growing season burns. The highest number of recruits was in dormant season burn treatments.

Observations on the Francis Marion National Forest indicate that *Schwalbea* plants burned during the growing season will reflower. Porcher (1994) reports that mature *Schwalbea* plants in flower will immediately resprout after being burned, resulting in seeds falling on a bare, mineral soil in full sunlight, which may be a key factor in the plant's reproductive biology. Observations on Fort Bragg reveal that, following burns (regardless of season), there is an increase in *Schwalbea* plants the following season. Even on sites where only low herbaceous species occur, *Schwalbea* occurrences on Fort Bragg decline in the absence of frequent fires, which indicates that competition may not be influencing *Schwalbea* populations as much as does fire (TNC 1993). Field observations and experimental studies in North Carolina (Porcher 1994) indicate that fire is essential for maintaining *Schwalbea.* Overall, it appears that *Schwalbea* responds favorably to dormant season and growing season burns. Additional experimentation is necessary to determine if there are substantial advantages to either of these fire regimes.

The current stronghold for *Schwalbea* is in the southeastern States where pinelands and savannas on private plantations are managed for bobwhite quail and on Fort Bragg around the artillery impact zone. Quail management on the private plantations consists of burning, usually in the dormant season before March, to increase and maintain the open, grassy conditions that provide habitat for quail. This management simulates the natural fire frequency of the past and effectively maintains a fire-dependent ecosystem in the Southeast. Similarly, the impact zones on Fort Bragg experience frequent burning due to fires ignited by military shelling exercises; as a result, a fire-dependent ecosystem that supports *Schwalbea* is maintained.

Kirkman (1993) reports relatively little flower production in the control and mowed treatments (mowed in June). Similarly, observations from the New Jersey *Schwulbea* population indicate that when mowing inadvertently took place during the growing season, flowering diminished considerably. In contrast, however, when a single late-season mowing (October- November) was conducted on the New Jersey site, flowering was relatively abundant during the following year. These observations indicate that while fire may be the ideal management tool, mowing (in the dormant season) could be an alternative to fire in instances where burning might not be possible or feasible (T. Gordon *in litt.* 1995). Mowing has certainly been responsible for sustaining the remaining population in New Jersey for the last three or more decades

Beautiful Pawpaw

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Beautiful pawpaw occurs on poorly drained flatwoods in Lee, Charlotte, and Orange Counties and occurs on Babcock / Webb WMA. Fire and fire break construction can have short-term adverse impacts. Mechanical treatments of vegetation will utilized mowing or chopping equipment. Fires stimulate reproduction because the species resprouts and flowers vigorously after fire. Although there will be immediate mortality of certain life history stages, these plants are dependent on fire for long-term survival, and could be extirpated without fire. Fire will kill the above-ground stems of this long-lived shrub. However, these plants will resprout from their roots and flower vigorously post-fire. Fire break construction mechanical treatments of vegetation will crush and injure individual plants, but most will resprout from their roots. Seedlings and young plants will be most vulnerable. Actual mortality of adult plants is expected to be minimal. The proposed action is expected to have long-term beneficial effects to the species because of the restoration and habitat-sustaining nature of the management activity.

Britton's Beargrass

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Occasional mowing may have short term adverse effects, including loss or reduction of fecundity, but is unlikely to seriously harm this perennial herb, which readily resprouts from its roots. However, if mowed annually, this and many other species will not have enough time to mature and reproduce between disturbances. The effects of being run over by trucks are unknown, but likely to be survivable. Plants will be subject to prescribed fire, which will destroy above-ground stems but spare underground rootstocks, which will resprout. Flowering of Britton's beargrass peaks 1 year after burning. Britton's beargrass benefits from reduction in shrub height because overgrown shrubs can shade this species, reducing sexual reproduction (Service 1999a). Long-term monitoring of this species at TNC's Tiger Creek Preserve has shown that numbers of Britton's beargrass are stable to increasing with regular fire management (TNC 2004). Therefore, prescribed fire should be beneficial to this plant over the long term due to its habitat-restoring effects.

Brooksville Bellflower

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. During any activities, mechanical equipment could kill plants. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. Individual plants are likely to survive mowing at 12 inches or greater.

It is unknown if there are any management activities that will benefit this species. However, invasive nonnative species such as skunk vine (*Paedena foetida*) and air potato (*Dioscorea bulbifera*) form dense ground cover that excludes native plants such as Brooksville bellflower (Landry 1996). Bermuda grass (*Cynodon dactylon*) also has been found to be a problem at the original Brooksville bellflower site at Hillsborough River State Park. The presence of the grass at the wetland edge is ephemeral relative to the water levels, but the cover of the grass in the dry months has increased every year that monitoring has been conducted (Gandy, FDEP, personal communication, 2009). Control of these invasive nonnative species is needed before they spread into areas occupied by Brooksville bellflower. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so mortality from herbicide use is unlikely.

Providing an overstory canopy will create shading that will reduce the light intensity and allow the soils to remain moist and also promote suitable conditions for germination.

Carter's Mustard

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Mowing would almost certainly kill this annual herb, as is the case with being run over by trucks. Prescribed fires or mechanized equipment will, except in late fall, kill growing plants and probably some seed at the surface of the soil. In late fall, mature plants will have shed seed and died, while seedlings will not yet have appeared. In the first year after a fire, aboveground populations increase dramatically as seeds germinate. The second year after a fire brings an equally dramatic decline in population size. Small, fluctuating populations may persist in mechanically disturbed sites like firebreaks or trails. The effects on this plant, over a period of 1 to 3 years, will be beneficial. Carter's mustard is a species of sandhill vegetation, where fire frequencies of less than 5 years are typical.

Carter's Small-flowered Flax

The action area contains appropriate habitat for listed and candidate plants, candidate butterflies and eastern indigo snakes. However, the rapid urbanization of Miami-Dade County has resulted in the virtual elimination of extensive pine rocklands the preferred habitat for several listed and candidate species. Based on IRC surveys, pine rockland habitat in urban Miami-Dade County has been reduced to about 1.8 percent of its natural extent. Of the original 127,000 acres, only 2,273 acres of largely fragmented pine rocklands remain throughout Miami-Dade County, outside of ENP. The primary factors affecting listed and candidate plants within pine rockland fragments are exotics and natural fire suppression. Altogether, 79 species of naturalized exotic plants have been recorded in pine rocklands, the most problematic being Burma reed and Brazilian pepper. Pine rocklands are dependant on natural fires to maintain its scrub and herb layers as well as to prevent succession. Without natural fires or adequate prescribed burns pine rocklands can be replaced by hardwood hammock and invasive plant species. Pineland croton, the plant on which both candidate butterflies depend for reproduction, is quickly out-competed by exotic plants or reduced in pine rocklands when fire is restricted.

Many of these remaining pine rocklands and pine rockland-containing disturbed areas such as parks, pastures, and vacant lots are geographically distinct and, therefore, do not provide contiguous habitat for the snake, listed plants, and candidate plants and butterflies. They are fragmented by highly urbanized and suburban areas making it difficult to manage these parcels and difficult for snakes or candidate butterflies to move from one area to another. Breeding and foraging opportunities may be limited. In wildland urban interface areas, residential housing is also a threat to eastern indigo snakes because it increases the likelihood of snakes being killed by property owners and domestic pets. Collecting pressure may affect the species on public lands for each species. Other factors affecting the species within the action area include another ongoing federally-funded IRC restoration project for privately-owned pine rocklands that will benefit the species.

Clasping warea (Wide-leaf warea)

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Because this annual herb invariably occupies open, sandy areas with little vegetation, sites with it are very unlikely to be mowed, so damage from mowing is unlikely. This annual species is expected to be killed by any fire conducted during its growing season (roughly late winter through early fall). Seedlings are expected to appear after fire. This species is currently known in the action area only from the HBS's Pine Ridge Preserve (sandhill vegetation surrounding the developed garden). More thorough surveys in existing and future land acquisitions may possibly reveal the presence of this species within other parts of the action area, most likely in northern Polk County. This plant is found only on open sandy patches within sandhill vegetation. It does not tolerate dense shrubs or trees, so prescribed fire is essential to maintain suitable habitat

Chapman's Rhododendron

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Mowing could destroy stems of this shrub. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems. Patchy fires may allow survival of individual plants. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Cooley's Meadowrue

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Cooley's waterwillow

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected.

When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 18 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Crenulate Lead-plant

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Site preparation and restoration activities could result in loss and disturbance to plants and/or their habitat. Some plants are expected to be lost during prescribed fires. However, prescribed fires will improve habitat in the long-term.

Deltoid Spurge

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Site preparation and restoration activities could result in loss and disturbance to plants and/or their habitat. Some plants are expected to be lost during prescribed fires. However, prescribed fires will improve habitat in the long-term.

Etonia Rosemary

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. This plant will be present at the edges of some fire breaks and might be subject to mowing or other fire break maintenance activities. Depending on the height of mowing of firebreaks, individual plants might survive high mowing. Low mowing would kill plants, assuming that this plant responds similarly to scrub mint. Fire probably kills all plants directly affected by high temperatures, but patchy fires may allow survival of individual plants. Seed at the soil surface may also be killed by excessive heat. Populations probably recover after a fire via dormant seeds in a soil seed bank at an interval of 15 to 20 years (typical for scrub) is likely to be beneficial to populations of this plant, by creating suitable open gaps among the large shrubs, and by encouraging reproduction.

Everglades Bully

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Mowing could destroy stems of this shrub but should encourage regrowth. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Florida Bonamia

Occasional mowing may have short term adverse effects, including loss or reduction of fecundity, but is unlikely to seriously harm this deeply-rooted, low-growing perennial herb, which readily resprouts from its roots. However, if mowed annually, this and many other species will not have enough time to mature and reproduce between disturbances. Effects of being run over by rubber-tired vehicles are uncertain, but the abundance of this species along the edges of sand roads on the ONF indicates this impact is survivable. Effects of from more soil disturbing equipment such as tracked vehicles are likely to be more severe. Fire will destroy above-ground stems but spare underground rootstocks, which will resprout. Plants resprout from substantial rootstocks post-fire and fire stimulates germination and growth of seeds buried deeply enough not to suffer from overheating. Over a term of 5 or more years, fire will benefit Florida bonamia by reducing shading and other competition from shrubs and encouraging seed germination and growth of young plants.

Florida Brickell-bush

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Site restoration could result in disturbance to plants and/or their habitat. Removal of seeds could result in a reduction in the number of plants produced the following year and/or minor impacts to an individual plant. Long-term effect will be to improve habitat.

Florida Golden Aster

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Florida Skullcap

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Four–petal Pawpaw

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Site preparation and restoration activities could result in loss and disturbance to plants and/or their habitat. Removal of seeds or cuttings could result in a reduction in the number of plants produced the following year and/or minor impacts to individual plants. Both mowing and fire can kill the above ground stems of this plant. However, prescribed fire, when applied at the appropriate interval, will benefit the Florida prairie clover by reducing shading and other competition from shrubs and encouraging seed germination.

Fragrant Prickly-apple

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants can be killed by activities involving equipment. Removal of seeds/fruit could result in a reduction in the number of plants produced the following year. The fragrant prickly apple is intolerant of fire. However, land management practices including invasive plant control and prescribed burning are important to maintaining the perimeter of scrub habitat in xeric hammocks in which this plant depends. Activities are expected to provide an overall net conservation benefit.

Fringed Campion

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Mowing could destroy stems of this plant but should encourage regrowth. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Gentain Pinkroot

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Mowing could destroy stems of this plant but should encourage regrowth. Alternate language depending upon if the plant in questions is a low growing herb or “higher” Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Godfreys Butterwort

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Harper's Beauty

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Highlands Scrub Hypericum

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Because this small herb invariably occupies open, sandy areas with little vegetation, sites with it are very unlikely to be mowed, so damage from mowing is unlikely. Vehicles could run over plants, killing them. Any plants present in burn areas are likely to be killed by fire or high heat. Because this plant is locally abundant within its narrow range, the fraction of the rangewide population of the species to be affected will be small. Prescribed fires are expected to immediately create suitable conditions for germination of seed buried in the soil in freshly opened, formerly overgrown areas where survival would have been impossible. Over a period of 1 or more years, the fire will benefit this species.

Lewton's Polygala

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. This small herb occupies relatively open, sandy areas with little vegetation that may include edges of firebreaks and roads. Occasional mowing may have short term adverse effects, including loss or reduction of fecundity. However, if mowed annually, this and many other species will not have enough time to mature and reproduce between disturbances. Hand-held equipment is unlikely to do long term harm, although some plants may be temporarily injured. Fires will kill adult plants and possibly seeds on the surface of the ground. The effects of prescribed fires in a sandhill at the Carter Creek tract of LWRNWR in 1996, July 2001, and May 2004 have been observed by Archbold researchers. The 2001 fire produced a spectacular population boom, with populations increasing "by at least two orders of magnitude," with high plant densities in some post-burn plots (Menges and Weekley 2004). Seedling cohorts at this site "continue to demonstrate greater survival of plants from burned than from unburned quadrats, although the beneficial effects of fire on seedling recruitment may be short-lived and fire may temporarily deplete the soil seed bank." (Menges and Weekley 2004) Monitoring by TNC at the Tiger Creek Preserve presents a similar picture. Even with regular fire management, patches of Lewton's polygala often diminish or disappear within 5 years. We expect the management activities will over a period of several years benefit this species, by improving its habitat and stimulating germination, growth, and seed production.

Longspurred Mint

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. This plant will be present at the edges of some of them, and might be subject to mowing. Depending on the height of mowing of firebreaks, individual plants might survive high mowing. Low mowing would kill plants, assuming that this plant responds similarly to scrub mint. Fire probably kills all plants directly affected by high temperatures, but patchy fires may allow survival of individual plants. Seed at the soil surface may also be killed by excessive heat. Populations probably recover after a fire via dormant seeds in a soil seed bank. Fire at an interval of 15 to 20 years (typical for scrub) is likely to be beneficial to populations of this plant, by creating suitable open gaps among the large shrubs, and by encouraging reproduction.

Okeechobee Gourd

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. The relationship of fire and the Okeechobee gourd is also not fully understood. Fire could be a threat in that it could destroy plants, yet it could also be a management tool because gourds sprout in areas cleared by disturbance.

Papery Whitlow-wort

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Because this small herb is very persistent in even small open areas provided by firebreaks or the edges sand roads, papery whitlow-wort plants could be mowed in a few cases. Occasional mowing may have short term adverse effects, including loss or reduction of fecundity, but is unlikely to seriously harm this perennial herb. However, if mowed annually, this and many other species will not have enough time to mature and reproduce between disturbances. Vehicles could run over plants, killing them. Individuals of this species will be killed by fire. However, overgrown scrub is unsuited to this plant. Prescribed fires are expected to immediately create suitable conditions for seeds in the soil seedbank to germinate and survive in overgrown areas where survival would previously have been impossible. Over a period of 6 months or greater, prescribed fire will benefit this species.

Pigeon Wings

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Mowing will harm this upright perennial herb, as will being run over by trucks. This species is likely to recovery quickly from such injury by resprouting from its rootstocks. Although the above-ground portions of pigeon wings plants are killed by fire, plants readily resprout from their substantial below-ground parts and quickly and profusely flower after fire (Service 1999a). We expect this plant, which is moderately abundant in areas such as the Tiger Creek Preserve, to benefit from prescribed fire starting as soon as it regrows, within 2 months of the fire, to as much as 10 years later.

Pygmy Fringe Tree

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Any pygmy fringe trees in mowing areas would be cut. Pygmy fringe trees are expected to readily resprout from their roots. Fire will kill the above-ground stems of this long-lived shrub or small tree. As is the case with mowing, this species will resprout and flower after fire. Loss of aboveground may casue temporary reduction oof fecundity while plants regrow. Pygmy fringe tree is restricted to fire-dependent scrub and sandhill vegetation, so it is presumed to be fire-dependent (Service 1999a) and to tolerate a very wide range of fire intervals, possibly ranging from as little as 2 or 3 years to as long as 50 years (in scrub).

Sandlace

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Mowing will injure this low shrub, as will being run over by trucks. Some individuals might recover from such mechanical disturbance. Sandlace will be killed by fire. Surveys at TNC's Saddle Blanket Lakes Preserve in fire-suppressed scrub revealed that this species occurred less frequently on long-unburned areas with few open sand "gaps" in the vegetation. Young plants have been seen in abundance at recently-burned areas of the Preserve. As a result, the the management activities are expected to benefit this species, on a scale of one to 15 to 20 years.

Scrub Blazingstar

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Mowing will injure this perennial, as will being run over by trucks, but individuals are likely to recover by resprouting from their substantial, long-lived root systems. The above-ground parts of this long-lived herb will be killed by fire. Scrub blazingstar resprouts postfire (Menges and Weekley 2003). Although adult mortality is rare in unburned populations, seedling recruitment is rare as well (Menges and Weekley 2003). Over a period of several years, prescribed fire is expected to benefit this species.

Scrub Buckwheat

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Mowing will injure this perennial, as will being run over by trucks, but individuals are likely to recover by resprouting from their substantial, long-lived root systems. Fire kills the above-ground parts of scrub buckwheat, which has been shown to readily resprout after fire, followed by quick and heavy flowering and seed production (McConnell and Menges 2002). New seedlings appear promptly after seed drop. McConnell and Menges (2002) observed seedling numbers peaked during July, 2 months after an experimental fire. Scrub buckwheat is unlike most other scrub species in that seedlings will appear in summer, not just winter. This means a spring burn may yield seedlings within just a few months. As a result, maintenance or restoration of the sandhill vegetation by prescribed fire may benefit scrub buckwheat as soon as a few months postfire. The sandhill habitat of this plant has a natural fire return interval of no more than about 5 years.

Scrub Lupine

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. There is a risk of crew members stepping on seedlings or plants, or of fire burning individual plants and almost certainly killing them. However, this lupine is believed to germinate after fire or other disturbance, even in areas where seeds may have been dormant for as much as 50 years. Fire maintains the open, sunny conditions that this herb requires.

Scrub Mint

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. This small shrub is present primarily at ABS and the nearby Lake Placid tract of LWRWEA. These properties have existing systems of firebreaks, some of which have this plant along their edges. Because both tracts have active prescribed fire programs, mowing of firebreak areas with this plant is likely to be minimal. The land manager's mechanical equipment is rubber-tired. Depending on the height of mowing of firebreaks, individual scrub mint plants might survive high mowing (at 12 inches or higher). Low mowing would kill plants, to judge from clipping experiments on this species. Fire will kill all plants directly affected by high temperatures, but patchy fires may allow survival of individual plants. Seed at the soil surface may also be killed by excessive heat. Populations probably recover after a fire via dormant seeds in a soil seed bank (ABS 2003). Because this plant reoccupies burned areas by germination of seed buried in the soil, and because it requires open, sunny areas or their edges, it is expected to benefit from burning of overgrown vegetation over a period of 1 to at least 10 years. This view appears to be upheld by historic aerial photographs of ABS, which show that it was quite open until fire suppression was instituted.

Scrub Plum

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Any scrub plums in mowing areas would be cut. Scrub plum is expected to readily resprout from its roots. Fire will kill the above-ground stems of this long-lived shrub. As is the case with mowing, this species will resprout and flower after fire. Scrub plum is restricted to fire-dependent scrub and sandhill vegetation. Post-fire monitoring indicates very low mortality rates after a fire – less than 5 percent in a small sample, less than 2 percent in a larger sample. While presumably fire may be roughly neutral in its effects on this shrub over the short term and scrub plum has persisted on sites that went unburned for many years, over the long term (perhaps 20 or more years), we believe fire is essential to maintain suitable habitat for this species.

Short-leaved Rosemary

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. This small shrub is present at relatively few sites, including Saddle Blanket Lakes and Carter Creek. All of the conservation lands where it occurs have existing systems of firebreaks or subdivision roads. This plant will be present at the edges of some of them, and might be subject to mowing. The land manager's mechanical equipment is rubber-tired. Depending on the height of mowing of firebreaks, individual short-leaved rosemary plants might survive high mowing (at 12 inches or higher). Low mowing would kill plants, assuming that this plant responds similarly to scrub mint. Fire probably kills all plants directly affected by high temperatures, but patchy fires may allow survival of individual plants. Seed at the soil surface may also be killed by excessive heat. Populations probably recover after a fire via dormant seeds in a soil seed bank.

Small's Milkpea

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Site preparation and restoration activities could result in loss and disturbance to plants and/or their habitat. Some plants are expected to be lost during prescribed fires. However, prescribed fires will improve habitat in the long-term.

Snakeroot

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Because this small herb invariably occupies open, sandy areas with little vegetation, sites with it are very unlikely to be mowed, so damage from mowing is unlikely. This small herb is killed by fire, and quickly populates sandy bare openings created by fire from its large soil seed bank. Ecologists at ABS have shown that this plant requires relatively frequent fires to maintain viable populations. The effects of the management activities are expected to benefit this species over a period of about 1 year to the period when postfire population sizes are at their largest, 6 to 10 years postfire.

Telephus Spurge

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant.

Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Tiny Polygala

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Site preparation and restoration activities could result in loss and disturbance to plants and/or their habitat. Some plants are expected to be lost during prescribed fires. However, prescribed fires will improve habitat in the long-term.

White Birds-in-a-nest

Prescribed fire and associated fire preparation work may include the creation and maintenance of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Individual plants are likely to survive mowing at 12 inches or greater. If herbicide is applied directly to the plant or if overspray or drift occurs, plants could be killed. However, known plants will be protected and buffers will be in place so that mortality from herbicide use is unlikely. During any activities, mechanical equipment could run over plants killing them. Fire will kill all above ground stems but this plant resprouts after fire and may require periodic disturbance (fire or mowing) to retain its vigor. Patchy fires may allow survival of individual plants. Populations will probably recover after a fire via dormant seeds in a soil seed bank. Unburned or unmowed plants lose vigor. In the absence of fire the habitat for the plant will degrade and populations could eventually be lost. Therefore, fire is expected to be highly beneficial to this plant. Individuals may be lost, but with potential for resprouting, recovery of plants from seed banks, and improved habitat, a net conservation benefit is expected to be attained from implementation of activities.

Wireweed

Fire preparation work will include preparation of fire breaks by mechanical means. Land managers and other personnel will maintain and construct where necessary fire breaks using mechanical measures such as chopping mulching, logging, mowing, disking, and plowing using rubber-tired or tracked equipment. Hand tools may also be used. Depending on need, the least disruptive method possible will be selected. When conducting prescribed fires, equipment may be rubber tired or tracked. In the event of a spot over, suppression equipment often includes the use of a tracked fire plow. Crew members may use hand-held equipment. Mowing would kill or injure this herb, which seldom lives longer than 3 years. Plants might be able to regrow after being run over by trucks. Prescribed fires will kill growing plants and any seed at the surface of the soil. Because this plant forms moderately large populations in a wide range, compared to the most narrowly-distributed LWR endemic plants, the fraction of the rangewide population of wireweed to be affected will be small and the land management approach of preferring relatively small, patchy fires will help create local sanctuaries for this species, which recolonizes burned areas by seed coming from plants in nearby unburned areas. Prescribed fires are expected to immediately create suitable conditions for seed germination from what had been overgrown, unsuitable habitat. Over 2 or more years (allowing time for seed from untreated areas to colonize newly-available habitat) prescribed fires will benefit this species.

SUMMARY OF EFFECTS

Implementation of the proposed action is intended to utilize the prescribed fire and related Conservation Practice Standards to conduct important habitat management, restoration, and enhancement actions. By improving habitat conditions, these actions will directly eliminate or reduce a primary threat to the covered species. The targeted benefit of proposed action is to create improvements to the status of the species on eligible lands receiving NRCS cost share and technical assistance. The proposed action in conjunction with the integrated use of the Conservation Measures (also known as NRCS criteria) is expected to benefit the covered species by maintaining, enhancing, and restoring populations and their habitats as well as by reducing the risk of adverse effects.

The agreed-upon Conservation Practices in conjunction with the Conservation Measures are designed to maintain and enhance habitat and decrease fragmentation, which is the primary limiting factor to most of the fire-dependent species covered by the Opinion. Further, the proposed action will encourage large expanses of private lands will be involved in habitat creation, restoration and/or management to provide a substantial conservation benefit for the covered species.

We expect the majority of incidental take will be in the form of death, injury, or temporary harassment (via displacement) during Conservation Practice implementation. For some Conservation Practice Standards, a portion of incidental take is expected over the life of the practice. The scale of the effect will be landscape specific, but will most likely involve mortality of some members of the species covered in this Opinion.

The overwhelming conservation benefits of implementation of the proposed action within the selected priority areas, maintenance of existing habitat, and enhancement of marginal habitat will outweigh short-term negative impacts to individual members of the covered species. The implementation of the proposed action will result in more of the threats that adversely affect populations being managed, and more habitat under the appropriate management prescriptions.

Cumulatively, the Service finds that effective implementation of Conservation Practice Standards and associated Conservations Measures (NRCS Criteria) are anticipated to result in a positive population response by the species. This positive response is expected as threats are reduced, notably in addressing habitat fragmentation and improvement of habitat conditions across Florida. Additionally, the proposed action is expected to limit unfavorable impacts to the species, and to maintain and enhance habitat at both the population and landscape level. In conclusion, the anticipated levels of adverse effects are more than offset by the implementation of the Proposed Action, combined with the Conservation Measures resulting in a net conservation benefit to the covered species.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Future management actions on conservation lands on the action area will include prescribed fires and alternative treatments such as cutting or mowing to supplement fire. On occasion, suppression of wildfires or escaped prescribed fires will be necessary. Activities associated with fire management include the maintenance of firebreaks, including access roads and fire lanes, as well as the creation of temporary firebreaks. On many properties, networks of access roads and firebreaks already exist. Land managers in the action area are very likely to use cutting, logging, mowing, and possibly roller chopping to prepare sites for fire, or in lieu of fire. If mechanical treatment is used in lieu of fire, a separate consultation will be necessary. Successful use of prescribed fire may decrease the need for mechanical treatments in the future, after vegetation restoration is initiated.

Because prescribed fire or equivalent mechanical treatments are essential to maintain suitable scrub habitat, temporary impacts to listed species from prescribed fires is inescapable. Prescribed fires are also crucial to the management of many wildlands due to the threat posed by wildfires in overgrown vegetation. By reducing fuel loads, prescribed fire programs can significantly reduce the threat of runaway wildfires threatening neighboring properties, in some cases, homes. Prescribed fires also serve to minimize the likelihood of damage to biological resources on conservation lands that can be caused by wildfires. When wildfires occur, damage to plants and animals from fire suppression is unavoidable.

Management of wildlands may also include control of invasive plant species, and conservation practices as identified in Table 2 on that may damage individuals of listed, candidate, and proposed species. Work of this sort has generally been carried out on conservation lands with little damage to biological resources. Research and monitoring continues on some conservation lands. Work conducted by ABS, TNC, Tall Timbers Research Station, LWRNWR and elsewhere, has been valuable for assessing the effects of prescribed fire. Many aspects of the ecology of LWR plants are of interest in the context of basic research, although to date such research has nearly always been useful to managers. Research and monitoring projects may require small-scale vegetation management, installation of traps, tagging of plants, and other manipulations. All research/monitoring projects, as well as prescribed fires and mechanical vegetation treatments, require that personnel enter areas inhabited by these species, so a degree of trampling is inevitable. Inasmuch as scrub and sandhills vegetation are maintained by regular disturbance, primarily from fire, carefully-planned, small-scale research disturbances for research purposes and larger disturbances for vegetation management are expected to be consistent with restoring and maintaining the vegetation and its biota.

CONCLUSION

Listed species/critical habitat

After reviewing the status of the Audubon's crested caracara, FGSP, Florida scrub-jay, RCW, blue-tailed mole skink, sand skink, eastern indigo snake, frosted and reticulated flatwoods salamanders, beautiful pawpaw, Broorksville bellflower, Britton's beargrass, Carter's mustard, Cooley's waterwillow, crenulate lead-plant, deltoid spurge, Etonia rosemary, Florida bonamia, Florida golden aster, Florida skullcap, four-petal pawpaw, fringed campion, gentain pinkroot, Godfrey's butterwort, Harper's beauty, highlands scrub hypericum, Lewton's polygala, Long-spurred mint, Okeechobee gourd, papery whitlow-wort, pigeon wings, pygmy fringe tree, sandlace, scrub blazingstar, scrub buckwheat, scrub lupine, scrub mint, scrub plum, short-leaved rosemary, Small's milkpea, snakeroot, telephus spurge, tiny polygala, White birds-in-a-nest, wide-leaf warea, and wireweed, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that application of the Conservation Practice Standards identified in Table 3 in support of habitat management and landowner conservation actions using prescribed fire for technical and financial assistance programs is not likely to jeopardize the continued existence of any of these species. Critical habitat has been designated for the frosted and reticulated flatwoods salamanders and everglades snail kite. However, no destruction or adverse modification of the critical habitat for these species is expected.

Proposed and Candidate Species

After reviewing the current status of the gopher tortoise, HTB, the Florida bonneted bat, striped newt, Bartram's hairstreak, Florida leafwing, Carter's small flowered flax, everglades bully, Florida brickell-bush, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's conference opinion that, application of the Conservation Practice Standards identified in Table 3 in support of habitat management and landowner conservation actions using prescribed fire for technical and financial assistance programs is not likely to jeopardize the continued existence of any of these candidate or proposed species.

INCIDENTAL TAKE STATEMENT

Sections 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

Section 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plants and candidate species. However, limited protection of listed plants from take is provided to the extent the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulations, or in the course of any violation of a State criminal trespass law. If this project is on private land and the landowner is not the project proponent, in addition to landowner permission, a Florida Department of Agriculture and Consumer Services permit for plants may be needed. To determine if such a permit is necessary or to apply for this permit, contact:

Florida Department of Agriculture and Consumer Services
Florida Division of Forestry
Plant Conservation
3125 Conner Boulevard
Tallahassee, Florida 32399-1650
Telephone: 850-414-8293
Fax: 850-921-6724

AMOUNT OR EXTENT OF TAKE ANTICIPATED

Listed Species

These take statements address the Audubon's crested caracara, FGSP, Florida scrub-jay, RCW, blue-tailed mole skink, sand skink, eastern indigo snake, and frosted and reticulated flatwoods salamanders.

Audubon's Crested Caracara

The Service anticipates that up to 40 adult crested caracaras and 20 juveniles may be harassed annually by mechanical and herbicide applications and prescribed fires, as a result of human activity associated with conducting burns, applying herbicides and conducting mechanical site preparations, and as a result of the fires themselves (smoke, noise, heat, etc.). An unknown number of juveniles may be lost to direct mortality or reproductive success. Prescribed fires proposed by Multiple Conservation Partners will be planned carefully to minimize the possibility of take of this species. In cases where habitat occupied by caracara's is burned, careful planning and BMP, such as identification of nests and roost trees and raking or burning around nest and roost trees prior to conducting the prescribed burn, will minimize the risk of losing nest and roost tree and birds. However, there remains a possibility that prescribed fire could accidentally destroy one or more nest or roost trees or injure or kill birds. As discussed in the environmental baseline, the most observations of nests and individuals occur in suitable habitat in and around the Lake Wales and Bombing Range Ridges, and suitable habitat in Okeechobee and Highlands Counties. Scattered occurrences were also noted in Osceola and Polk Counties on lands boarding the Kissimmee River and the Kissimmee River Chain of Lakes. This subset of the action area is estimated at about 1,738,000 acres and represents about 15 percent of the species' range. This subset of the action area also represents the most likely areas to receive prescribed fire applications that may adversely affect the caracara. Caracara territories average approximately 3,000 acres, corresponding to a radius of 1.2 to 1.5 miles surrounding the nest site (Morrison and Humphrey 2001). A total of 61,000 acres of vegetative community types listed in Table 2, (excluding Pine Rockland, Scrub Dwarf Cypress, and Saltmarshes) may receive prescribed fire management under this action and may affect 20 territories containing two adult birds per territory (61,000/3000 = 20 x 2 = 40). If spatially distributed equally across the landscape, then no more than 20 potential breeding groups might be affected per year with each group containing two adults and 20 juveniles. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Florida Grasshopper Sparrow

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

The Service estimates that as many as 7,000 acres per year of dry prairie habitat may be treated. However, the Service expects most, if not all, of this acreage will not be occupied by FGSPs. In the rare event previously undocumented FGSPs are present, the Service anticipates FGSPs may be harassed by herbicide application and prescribed fires, as a result of human activity associated with conducting the burns and applying herbicides and as a result of the fires themselves (smoke, noise, heat, etc.). All nests on occupied habitat are expected to be destroyed by growing season fires, with each nest containing three to five eggs or four chicks. However, the Service believes the loss of nests and the productivity associated with the nests will be compensated by the improved habitat conditions and by successful post-fire nesting by FGSP because adult reproductive sparrows are not expected to be injured or killed by these management actions.

Adult FGSPs will be displaced temporarily during the fire and will seek refuge in suitable habitat outside the burn unit. Prescribed fires will be planned carefully and in a mosaic fashion to minimize the possibility of take of this species. Some take would occur naturally with wildfires, and fire is necessary for the species. Without fire, habitat would become unsuitable to support FGSPs. Any burns conducted during the growing season can take nests, fledglings, and post-fledged young, but growing season burns are necessary to maintain habitat for the species. Therefore, there remains a possibility that prescribed fire or vehicle use could accidentally destroy nests. However, survival rates are naturally low for this species, and birds often re-nest after failed attempts. Take associated with prescribed burns may also be partially compensatory rather than fully additive. In other words, FGSP mortality may occur as a result of predation or some other cause in the absence of prescribed fire. Also, measures such as timing of prescribed burns and percent of habitat patches burned in a year will be taken to reduce impacts. The incidental take is expected to be in the form of harm, harassment, and direct mortality

Florida Scrub-jay

The Service anticipates that up to 160 Florida scrub-jays may be harassed by herbicide application and prescribed fires, from human activity associated with conducting the burns and applying herbicides and as a result of the fires themselves (smoke, noise, heat, etc.). Although this bird is relatively easy to census, it is possible that all nests will not be found during fire planning. In the unlikely event that nests are destroyed, finding nest remnants after the fire would be nearly impossible. Therefore, measuring take is inherently difficult. Prescribed fires will be carefully planned to minimize the possibility of take of this species, and most fires conducted in scrub will be in overgrown vegetation that will not have active scrub jay territories or nests. In cases where scrub inhabited by scrub-jays is burned, careful planning and BMP will minimize the risk of losing nests. However, there remains a possibility prescribed fire could accidentally destroy one or more nests, so the Service anticipates the possible destruction of as many as 20 occupied nests, with each nest containing up to 4 eggs or 2 chicks and 6 adults (a pair plus 4 helpers), for a total of 240 birds (2 chicks plus 2 breeders and 4 helpers times 20 nests = 160). The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Red-cockaded Woodpecker

NRCS burning on lands within the action area is expected to occur primarily on lands with degraded habitat or on lands that do not have trees old enough to support RCW foraging or nesting. Furthermore implementation of Conservation Measures (NRCS Criteria) such as protection of cavity trees from fire, replacing burned cavities with artificial ones, and limiting activities (with the exception of burning) during the non-nesting season will minimize the potential for take.

However, there is potential for NRCS to conduct activities on lands where RCWs groups occur and prescribed burning may occur during the RCW nesting season. In spite of implementation of the Conservation Measures there remains a possibility that prescribed fire could accidently destroy one or more cavity trees when burning occurs within an RCW cluster. Therefore incidental take in the form of harm or harass is anticipated for a maximum of eight active non-nesting cavity trees per year as a result of prescribed fire. This translates to a maximum of eight adult RCW woodpeckers harmed or harassed. In addition, two active nest trees with young, up to four chicks per tree, with one adult per tree, may be lost. The incidental take of nest trees is expected to be in the form of harm, harassment, and direct mortality. Any incidental taking is not expected to result in significant negative impacts to the population over time. Activities, by improving and maintaining habitat conditions are expected to result in a net conservation benefit.

Blue-tailed Mole Skink

The Service anticipates incidental take of the blue-tailed mole skink will be difficult to detect for the following reasons: (1) its fossorial behavior, with individuals usually just beneath the surface of loose sand; (2) low density within suitable scrub and similar habitats within its limited range; and (3) apparently suitable habitat may not be occupied. However, the Service anticipates incidental take of the blue-tailed mole skink associated with conducting prescribed fires. Burns will occur in scrub, scrubby flatwoods, yellow sand scrub, and sandhill. Blue-tailed mole skinks inhabit open sand within scrub, but also inhabit litter and shaded areas. Because skinks are patchily distributed across the landscape and prescribed fires do not burn all habitat, many skinks are likely to survive fires. Some of the habitat proposed for burning is low quality, containing dense scrub vegetation that may not be suitable for skinks. Therefore, it is likely that only a portion of the area to be treated is inhabited by skinks. Up to 4,000 acres of the 26,000 total pineland acres in the action area and 1,500 acres of the 2,000 total sand scrub acres in the action area may be burned annually. Thus 5,500 acres may be burned per year. Because most of the habitat is overgrown and skinks are patchily distributed, we anticipate only 20 percent, or 1,100 acres, may be occupied. Because of their biology, we do not have population estimates for skinks. Therefore, determining an estimate of the number of individuals that may be taken is difficult. We anticipate take associated with 100 percent of the blue-tailed mole skinks occupying the habitat on no more than 1,100 acres per year. The incidental take is expected to be in the form of harm, harassment, and direct mortality and is not expected to result in significant negative impacts to the population over time.

Sand Skink

The Service anticipates incidental take of the sand skink will be difficult to detect for the following reasons: (1) its fossorial behavior, with individuals usually just beneath the surface of loose sand; (2) low density within suitable scrub and similar habitats within its limited range; and (3) apparently suitable habitat may not be occupied. However, the Service anticipates incidental take of the blue-tailed mole skink associated with conducting prescribed fires. Burns will occur in scrub, scrubby flatwoods, yellow sand scrub, and sandhill. Blue-tailed mole skinks inhabit open sand within scrub, but also inhabit litter and shaded areas. Because skinks are patchily distributed across the landscape and prescribed fires do not burn all habitat, many skinks are likely to survive fires. Some of the habitat proposed for burning is low quality, containing dense scrub vegetation that may not be suitable for skinks. Therefore, it is likely that only a portion of the area to be treated is inhabited by skinks. Up to 4,000 acres of the 26,000 total pineland acres in the action area and 1,500 acres of the 2,000 total sand scrub acres in the action area may be burned annually. Thus 5,500 acres may be burned per year. Because most of the habitat is overgrown and skinks are patchily distributed, we anticipate only 20 percent, or 1,100 acres, may be occupied. Because of their biology, we do not have population estimates for skinks. Therefore, determining an estimate of the number of individuals that may be taken is difficult.

We anticipate take associated with 100 percent of the blue-tailed mole skinks occupying the habitat on no more than 1,100 acres per year. The incidental take is expected to be in the form of harm, harassment, and direct mortality and is not expected to result in significant negative impacts to the population over time.

Eastern Indigo Snake

The Service anticipates incidental take of the eastern indigo snake will be difficult to detect for the following reasons: (1) wide-ranging distribution, not restricted to specialized habitats; (2) patchy distribution within suitable habitats; and (3) suitable habitat may not be occupied. However, the Service anticipates incidental take of the indigo snake associated with conducting prescribed fires and mechanical and herbicide treatment on as much as 64,000 acres per year. Juvenile indigo snakes may be more vulnerable to management actions because they are less likely to use underground refugia and often rely on above-ground vegetation for cover. Due to the lack of surveys, in conjunction with the wide-ranging activity and use of a variety of habitat types by the indigo snake, it is difficult to determine the exact number of snakes that will be taken. Layne and Steiner (1996) determined the average home range for female indigo snakes to be 19 ha (47 acres) and overlapping male home ranges to be 75 ha (185 acres) on ABS. However, these home range estimates are derived from studies conducted in very good habitat, but much of the habitat to be treated in the proposed project is thick, overgrown, and in need of management. Furthermore, a portion of the action area encompasses northwest Florida where indigo snakes are rare, even in good habitat. If indigo snakes were present on all of the 64,000 acres that may be burned, then there could be up to 1,361 female and 346 male snakes present. However, because we do not think all of the 64,000 acres are occupied by the species and because adult indigo snakes are able to escape and find refugia during prescribed fires and preparation work for fires, we anticipate no more than 170 snakes will be harassed and no more than 17 snakes will be injured or killed. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Frosted Flatwoods Salamander

The Service anticipates incidental take of frosted flatwoods salamander (Ambystoma cingulatum) will be difficult to detect for the following reasons: (1) the fossorial nature of most of the salamanders life cycle, with individuals rarely encountered above ground except during the breeding season; (2) suitable habitat may not be occupied or occupation is unknown; and (3) finding evidence of take is nearly impossible except that the habitat catches fire. It is important to remember this is a species that has evolved in mostly fire dependent communities and is well suited for survival in such areas.

While it is possible for the application of prescribed fire to result in unintended take, the likelihood is quite low. Ground disturbing activities (such as fireplows) are more likely to cause take in the form of harm to habitat and possibility of direct take on salamanders. However, there is no reliable way to calculate the number of animals taken by the proposed action. This biological opinion requires several precautions and actions designed to minimize the impact on the salamanders. The use of fire is considered so intrinsically important to the maintenance of quality salamander habitat, that the overall beneficial effect of the fire far outweighs the potential for take of salamanders, particularly given the minimization measures specified in this Opinion. Therefore the take authorized for this action is any salamanders that may be killed as a result of performing prescribed fire (including firebreaks and plows) with the conditions and measures specified in this document. It is expected that take would be very few in number and unlikely to occur.

Reticulated Flatwoods Salamander

The Service anticipates incidental take of reticulated flatwoods salamanders will be difficult to detect for the following reasons: (1) the fossorial nature of most of the salamanders life cycle, with individuals rarely encountered above ground except during the breeding season; (2) suitable habitat may not be occupied or occupation is unknown; and (3) finding evidence of take is nearly impossible except that the habitat catches fire. It is important to remember this is a species that has evolved in mostly fire dependent communities and is well suited for survival in such areas.

While it is possible for the application of prescribed fire to result in unintended take, the likelihood is quite low. Ground disturbing activities (such as fireplows) are more likely to cause take in the form of harm to habitat and possibility of direct take on salamanders. However, there is no reliable way to calculate the number of animals taken by the proposed action. This biological opinion requires several precautions and actions designed to minimize the impact on the salamanders. The use of fire is considered so intrinsically important to the maintenance of quality salamander habitat, that the overall beneficial effect of the fire far outweighs the potential for take of salamanders, particularly given the Conservation Measures specified in this Opinion. Therefore the take authorized for this action is any salamanders that may be killed as a result of performing prescribed fire (including firebreaks and plows) with the conditions and measures specified in this document. It is expected take would be very few in number and unlikely to occur.

Other Species (Proposed and Candidate Species)

These incidental take statements address the Florida bonneted bat, gopher tortoise, striped newt, HTB, Florida leafwing, and Bartram's hairstreak. The incidental take statement provided in this conference opinion portion of this document does not become effective until the species is listed and the conference opinion is adopted as the Opinion issued through formal consultation. At that time, the project will be reviewed to determine whether any take of the species has occurred. Modifications of the Opinion and incidental take statement may be appropriate to reflect that take. No take of the species may occur between the listing of the HTB, Florida bonneted bat, striped newt, Bartram's hairstreak, Florida leafwing, or gopher tortoise, and the adoption of the conference opinion through formal consultation, or the completion of a subsequent formal consultation for the gopher tortoise, HTB, the Florida bonneted bat, and striped newt.

Florida Bonneted Bat

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

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

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

<u>Gopher Tortoise</u>

The Service anticipates up to 35,000 acres (taken from Table 2) of habitat annually could be temporarily disturbed as a result of this proposed action. However, as discussed in the "Status of the Species" section of the Opinion, not all of the above acres identified above are expected to be occupied. Additionally, an unknown number of individuals of the species may be injured or killed. However, we anticipate incidental take of individual gopher tortoises, will be difficult to detect for the following reasons: the gopher tortoise has a wide-ranging distribution, is not restricted to specialized habitats, occupies a patchy distribution within occupied habitats and may not occupy all suitable habitat. While the exact amount of incidental take of individual tortoises may be difficult to predict, this number is expected to be minimal with implementation of the proposed Conservation Measures (NRCS Criteria). Additionally, we anticipate both habitat and species benefits with implementation of the proposed action that exceed any incidental take. The incidental take is expected to be in the form of harm, harassment and direct mortality.

<u>Striped Newt</u>

Fire is a necessary component of the habitat of the striped newt. While fire can potentially kill newts, the overall effect of fire is beneficial as it maintains or helps restore good quality habitat. Eventually prescribed fire is expected to occur in the growing season, which will limit exposure of the newts to fire as they are frequently below ground during the daytime and in the warm season. Newts are likely more vulnerable to fire in the dormant or winter season when movement to breeding ponds normally occurs.

The creation of firebreaks and use of fireplows to contain prescribed fire has the potential to directly impact the newts that could be just below the surface of the soil and dug up by plows. Firebreaks and fireplow areas also have the potential to drain water away from breeding ponds resulting in early drying of the breeding ponds or connection to other water bodies that could allow access to ponds from predatory fish. Overall, application of fire will result in a net benefit to the health of the habitats on which the newts depends, even if some are directly killed by the fire.

Highlands Tiger Beetle

The Service anticipates incidental take of the HTB will be difficult to detect for the following reasons: (1) small body size of adults; (2) larva living below the surface; and (3) adults are not present year round. However, the Service anticipates incidental take of the tiger beetle associated with conducting prescribed fires. Much of the habitat proposed for burning is of low quality containing dense scrub where tiger beetles are not expected to occur. Because tiger beetles are patchily distributed across the landscape, adults are not present year round, and prescribed fires do not burn all habitat, many tiger beetles are likely to survive fires. It is difficult to determine the number of individuals that would be injured or killed during NRCS burn activities due to numerous factors. We do not have current population estimates or assessments of current habitat conditions for potential treatment areas; many areas that would be targeted for burns will likely consist of thick vegetation and may not be inhabited by beetles, which prefer open, scrub and sandhill conditions. Beetles, if present, may be patchily distributed. Also, factors associated with the burn (*e.g.,* seasonality of the burn, if site is burned in entirety, nature of the fire prescription, etc.) will affect the extent of injury or mortality. Burns conducted during the period of adult activity (mid-May through July) in areas with adults may cause some mortality (Knisley 2005). Due to the wide array of factors associated with beetle distribution, habitat conditions, and timing of prescribed fire, we estimate that up to 300 beetles may be taken during burns conducted throughout select sites within the sand ridge habitats of Polk and Highlands Counties. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Florida leafwing Butterfly

The Service anticipates incidental take of the Florida leafwing will be difficult to detect because the status of this butterfly on private lands is poorly known. Currently, outside of the Everglades, the Florida leafwing is only known to rarely stray to privately-owned pine rockland fragments within the Richmond Pine Rocklands and adjacent to Navy Wells Pineland Preserve. Breeding populations have not been documented on mainland Florida outside of the Everglades in several decades. Therefore, we do not believe any Florida leafwings currently occur within the project area. However, restoration efforts within these conservation areas may allow the Florida leafwing to ultimately re-colonize conservation lands outside of the Everglades. Prescribed fires will restore and increase the distribution of pineland croton in treatments areas, perhaps also increasing the distribution of the butterfly. Due to the wide array of factors associated with limited butterfly distribution, habitat conditions, and timing of prescribed fire, butterflies may be taken during burns conducted throughout select sites within the relict pine rockland fragments of central Miami-Dade County. Therefore, in order to minimize or avoid take NRCS will coordinate with the SFESO regarding any pine rockland burns planned within or adjacent to Navy Wells Pineland Preserve or the Richmond Pine Rocklands in Miami-Dade County. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

<u>Bartram's Hairstreak Butterfly</u>

The Service anticipates incidental take of the Bartram's hairstreak will be difficult to detect because the status of this butterfly on private lands is poorly known. Currently, outside of Federal, State, and Miami-Dade County-owned conservation lands, the Bartram's hairstreak is only known to occur sporadically on privately-owned pine rockland fragments within the Richmond Pine Rocklands and adjacent to Navy Wells Pineland Preserve.

We do not have a current population estimate of each site or assessment of current habitat conditions; however these sites are believed to have received only limited fire management, historically. Butterflies, if present, may be scarce and locally distributed. Factors associated with the burn (*e.g.*, seasonality of the burn, if site is burned in entirety, nature of the fire prescription, etc.) will affect the extent of injury or mortality. The Bartram's hairstreak occurs throughout the year with variable annual peaks in abundance, so there is no "preferred" window for treatments. However, prescribed fires will restore and increase the distribution of pineland croton in treatments areas, perhaps also increasing the distribution of the butterfly. Due to the wide array of factors associated with limited butterfly distribution, habitat conditions, and timing of prescribed fire, butterflies may be taken during burns conducted throughout select sites within the relict pine rockland fragments of central Miami-Dade County. Therefore, in order to minimize or avoid take NRCS will coordinate with the SFESO regarding any pine rockland burns planned within or adjacent to Navy Wells Pineland Preserve or the Richmond Pine Rocklands in Miami-Dade County. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

COORDINATION OF INCIDENTAL TAKE STATEMENTS WITH OTHER LAWS, REGULATIONS, AND POLICIES

The Service will not refer the incidental take of any migratory bird or the bald eagle (*Haliaeetus leucocephalus*) for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 7 03-712), or the Bald Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

EFFECT OF THE TAKE

In the accompanying Biological and Conference Opinion, the Service determined this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

The prohibitions against taking the species found in section 9 of the Act do not apply until the HTB, Florida bonneted bat, striped newt, Bartram's hairstreak, Florida leafwing, and gopher tortoise are listed. However, we are advising NRCS to consider implementing the reasonable and prudent measures that are already part of the proposed action. If this Conference Opinion is adopted as a biological opinion following a listing or designation, these measures, with their implementing terms and conditions, will be nondiscretionary.

REASONABLE AND PRUDENT MEASURES

The Service is not aware of any reasonable and prudent measures that can be implemented to minimize take of Audubon's crested caracara, FGSP, Florida scrub-jay, RCW, blue-tailed mole skink, sand skink, eastern indigo snake, Highlands tiger beetle, frosted and reticulated salamanders, striped newt, Bartram's hairstreak, Florida leafwing, gopher tortoise or Florida bonneted bat beyond those that are already part of the proposed action, which includes the Conservation measures provided in this Opinion.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, NRCS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline the required reporting and monitoring requirements. These terms and conditions are non-discretionary:

- NRCS shall implement the Conservation Measures jointly developed between the Service and NRCS as discussed on pages 23-30 of this Opinion.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

Introduction

Prescribed fire is recognized as one of the top recovery actions for many of the covered species addressed in this Opinion. Conversely, lack of fire and suppression of ecologically based fire regimes is considered to be a threat to many of these species. In addition to the above Conservation Measures, NRCS agrees to, where appropriate, and acceptable to the landowner, incorporate Conservation Recommendations/Considerations into the planning process. Conservation recommendations represent addition opportunities to avoid or minimize effects to the covered species listed in Table 1, but are not requirements within each covered Conservation Practice Standard. Further, the conservation recommendations will assist the Service in continually assessing the conservation status of the covered species, further reduce any adverse effects to the covered species, and otherwise promote recovery of the species on private lands through implementation of the proposed action. The Service recognizes that emergency situations to control fire may supersede these Conservation Recommendations.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

General

1. Survey for covered species identified in Table 1 and for their nests, dens or cover that could be affected by treatment when projects are proposed within their ranges.
2. Document the location of any covered species and nest/roost or potential roost/den/cover sites/skink tracks and provide information to the landowner.
3. Consider important seasonal vulnerabilities for all covered species occurring in the area to be burned and limit burn activity during those times.
4. Seek opportunities for collaborative research. This may include pre- and post-fire surveys for covered species followed by continued monitoring at pre-determined time intervals post fire. Findings may aid in developing adaptive management programs.
5. Provide refugia by retaining stumps, snags, large trees with hollows and cavities, and woody debris during activities to provide habitat and escape cover.
6. If it is deemed that fire alone will accomplish goals in the desired period of time without using mechanical or herbicide treatments, then fire applied in an ecologically based manner should be used without using any other treatment.
7. Minimize soil disturbance and compaction (when possible, limit use of heavy machinery) outside of firebreaks and limit vehicle travel to a specific footprint within the mineral soil portion of the firebreak.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

General –Species Specific

1. Crested caracara: Within the habitat and range of crested caracaras, remove road-killed animals daily from paved roads in the project site to avoid or minimize the likelihood that foraging caracaras will be hit by vehicles.
2. Florida grasshopper sparrow: During planning of projects, allow for FGSP surveys, site visits, and habitat recommendations.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Firebreak

1. Only create plowed lines if other, less disturbing methods are not available.
2. In cases where fire breaks are needed to tie into wetlands and streams to contain fires, use methods to prevent soil erosion and runoff such as (but not limited to) constructing hand lines or wet lines where practicable. When using wet lines, avoid the use of foam or other fire retardant that may affect water quality.
3. Rehabilitate plowed lines as soon as possible, but not before, the fire is completely out.

4. Use existing roads, previously constructed lines, or natural features instead of constructing new firebreaks
5. In forested habitat, minimize impacts to snags, old or large trees, and cavity trees.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Prescribed Fire

1. Consult FNAI guide for suitable fire-return intervals for each habitat type, however, some variance from these guidelines may occur based upon habitat conditions on individual sites.
2. Promote habitat diversity through mosaic burns.
3. Use prescribed fire at appropriate, but varying, intensities and intervals to encourage vegetative diversity and habitat heterogeneity. Adjust fire frequency, intensity, and spatial extent in individual landscapes by using vegetation height, openings, tree cover, and other structural features to aid in determining burning objectives (adaptive management).
4. Incorporate growing season burning into the planning process. However, fires conducted during the non-growing season are better than none at all.
5. Use firing patterns to provide escape routes for wildlife (*i.e.*, avoid ring fires and fast-moving headfires). Ideally, the rate of spread of the fire should be no more than 10 ft per minute.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Prescribed Fire-Species Specific

1. <u>RCW</u>
   - Burn old growth pine stands and foraging habitat used by RCWs every 2 to 3 years. However, old growth may be managed with low intensity burns as often as every 1.5 years if the habitat is in really good condition (*i.e.*, does not contain a large fuel load and RCW cavities are not too low to the ground). (Refer to Recovery Plan language).
   - During the RCW breeding season (mid-April to mid-June), conduct prescribed burns carefully, or even avoid if there are high fuel loads, to reduce the risk of losing nests during intense fires.
   - In the case of burned cavity trees that continue to be used by RCW, monitor the cavity trees (as well as the entire cluster) for a period of at least 2 years to determine indirect or long-term adverse effects.
   - If a burned cavity tree dies, place an artificial cavity in the nearest suitable tree.
2. <u>Florida scrub jay</u>
   - Do not burn known scrub jay nests during the nesting season (Mar. 1-June 30). This may require “soft” firebreaks, but care must be exercised not to disturb nesting. If habitat is occupied by scrub jays but nest sites are not known, it is preferable to burn outside of the peak nesting period (March 15 - May 30) as long as this does not restrict burning in a way that leads to overgrown, unsuitable habitat.

- Manage for connections between patches of suitable habitat to facilitate scrub-jay dispersal.
- Maintain optimal scrub-jay habitat by creating a mostly treeless open expanse of low shrubs interspersed with bare sandy patches. Oaks and other shrubs should be low enough that a person approximately 6 ft tall can see over most of the landscape.
  For more specific details on please refer to the Scrub Management Guidelines for Peninsular Florida at:
  http://share2.myfwc.com/scrubjay/Shared%20Documents/Scrub%20Mgmt%20Guidelines%20for%20Peninsular%20Florida%2003-10.pdf

3. Highlands tiger beetle

- Where HTBs are known to occur, limit burning during peak adult activity (mid-May through July). If burning cannot be avoided during this time, conducting burns later in this timeframe (late June or July) is preferable to allow for beetle reproduction.

4. Flatwoods salamander

- When known and potential breeding ponds occur within a burning block, consider allowing the prescribed fire to burn through the ponds to control and eradicate woody vegetation and promote a desirable herbaceous ground cover.

5. Florida panther

- The main considerations in using prescribed fire in panther habitat is to create as much "edge" as possible and leave some patches of thick cover in uplands for denning and feeding. Prescribe burning and other practices described keep the habitat in earlier successional stages, which is good for deer, the panther's primary prey. However, panthers are stalking predators and need stalking cover (usually forest edges) in order to catch their prey.

6. Crested caracara

- Where caracaras occur, strive to schedule prescribed fire on a 1- to 3-year rotation in native range areas to maintain the prairie community at an early successional vegetative stage dominated by grasses and small shrubs (palmetto, wax myrtle, gallberry, etc.).

7. Covered plant species

- Whenever possible, do not burn an entire population of a covered plant at each site. Allow for 30-50 percent of the (each) population to go unaffected by fire.
- Usually in overgrown scrub or sandhill areas where restoration burns are needed, the numbers of federally-listed plants are very low. When covered species are absent use high intensity fire when applicable.. Higher intensity fire is needed in some habitats to create gaps to restore habitat for covered species.

8. Florida bonneted bat

   - In known or suspected occupied areas, conduct prescribed burns carefully, especially during the Florida bonneted bat breeding season (Jan-Mar; June-Oct). Where prescribed fire is to be used near known active or suspected roosts, and there are high fuel loads, consider avoiding burning, to reduce the risk of losing roosts during intense fires.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Pre-Fire Herbicide Application

1. Prescribed fire should be applied within 6 months of herbicide treatment in order to achieve the best results.
2. Mixing of chemicals should occur off-site to the greatest extent practicable.
3. Cut-stump applications will not be conducted when intense rainfall events are predicted in the treatment area.
4. Imazapyr, Glyphosate, and Triclopyr should be the primary herbicides applied using foliar application with pump sprayers, frill and girdle application with pump sprayers, and cut-stump application.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Pre-Fire Herbicide Application Species Specific

1. Highlands tiger beetle
   - Do not apply herbicides (chemicals) to HTBs and burrows.
2. Covered plant species
   - Do not apply herbicide to any covered plant species.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Pre-Fire Mechanical Treatment

1. To minimize risk of spreading invasive plant species, wash equipment before and after each use and before moving equipment to other areas.
2. In scrub and pine rockland habitat, mechanical treatments other than ignition strips should be performed during the summer to early fall.
3. Adjust mowing height higher to provide protection for covered species.
4. Consider timing mechanical treatments to avoid sensitive periods in the life history of listed, proposed, and candidate species.
5. In forested habitat, minimize impacts to snags and cavity trees, wherever possible.

CONSERVATION RECOMMENDATIONS/CONSIDERATIONS

Pre-Fire Mechanical Treatment- Species

1. Gopher tortoise
   - Mark (as well as) avoid known gopher tortoise burrows.
2. Florida scrub-jay
   - Mark and avoid known Florida scrub-jay nests.
3. Eastern indigo snake
   - Consider protection of stumps in an area to provide for refugia for eastern indigo snakes.
4. Bartram's hairstreak
   - Survey and mark pineland croton.
5. Covered plant species:
   - If spatial considerations allow, when a listed, proposed, or candidate plant occurs on a tract, avoid mechanically treating the entire population on the property at once. Vary the treatments by season and by year so that only portions of the habitat are treated at a time.

REINITIATION NOTICE

This concludes formal consultation and conference on the action outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

You may ask the Service to confirm the Conference Opinion as a biological opinion issued through formal consultation if the HTB, Florida bonneted bat, striped newt, Bartram's hairstreak, Florida leafwing, gopher tortoise, Blodgett's silverbush, Carter's small flowered flax, Everglades bully, Florida prairie clover, sand flax, are listed. The request must be in writing. If the Service reviews the proposed action and finds there have been no significant changes in the action as planned or in the information used during the conference, the Service will confirm the Conference Opinion as the biological opinion on the project and no further section 7 consultation will be necessary.

After listing of the HTB, Florida bonneted bat, striped newt, Bartram's hairstreak, Florida leafwing, gopher tortoise, Blodgett's silverbush, Carter's small flowered flax, Everglades bully, Florida prairie clover, or sand flax as endangered or threatened and any subsequent adoption of this Conference Opinion, NRCS shall request reinitiation of consultation if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect the species or critical habitat in a manner or to an extent not considered in this conference opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this Conference Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

The incidental take statement provided in this Conference Opinion document does not become effective until the species is listed and the Conference Opinion is adopted as the biological opinion issued through formal consultation. At that time, the project will be reviewed to determine whether any take of the species has occurred. Modifications of the Opinion and incidental take statement may be appropriate to reflect that take. No take of the species may occur between the listing of the HTB, Florida bonneted bat, striped newt, Bartram's hairstreak, Florida leafwing, or gopher tortoise, and the adoption of the Conference Opinion through formal consultation, or the completion of a subsequent formal consultation.

If you have any questions, please contact Delta Harris of our South Florida Office at 772-469-4247, or Stan Simpkins of our North Florida office at 904-731-3096.

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APPENDIX A – Conservation Practice Standards

(Below is a summary of the Conservation Practices evaluated in the accompanying Biological Opinion. The conservation practices can be found in their entirety, along with other supporting information in Section IV of the NRCS Florida Field Office Technical Guide @ http://efotg.sc.egov.usda.gov/treemenuFS.aspx)

CORE PRACTICES

Conservation Practice Standard: Upland Wildlife Habitat Management (645) (Core Management Practice)

Definition: Provide and manage upland habitats and connectivity within the landscape for wildlife.

Purpose: Respond to upland wildlife habitat concerns identified during the conservation planning process that enable movement or provide shelter, cover and food in proper amounts, locations and times to sustain wild animals that inhabit uplands during a portion of their life cycle.

Practice Application: This practice is considered a core practice in which a system of supporting practices, such a prescribed burning and related practices will be applied to restore and manage rare and declining habitats and their associated wildlife species to conserve biodiversity.

Resource concern(s): Factors that reduce habitat quality or otherwise limit population growth of the targeted species.

Potential beneficial effect(s) to Covered Species: This core management practice will be used to restore, enhance or create, and manage for suitable habitat for the targeted species; to improve habitat conditions for all life cycles, including breeding, nesting, brood-rearing, and over-wintering and to provide adequate food, cover and shelter, and address the effects of habitat fragmentation by creating, maintaining, or restoring landscape connectivity for movement.

Potential adverse effect(s) to Covered Species: This core management practice was developed for the primary purpose of improving wildlife habitat. When applied and managed to the standards and specification of the practice, this practice should not result in adverse conditions to the covered species. Some of the supporting practices associated with this core practice have the potential for adverse effects. These supporting practice and their potential impacts (if any) are discussed below in the “Facilitating Practices” Section of this Appendix as well as the “Effects of the Action” section in the accompanying Biological Opinion.

Conservation Practice Standard: Restoration and Management of Rare and Declining Habitats (643) (CORE MANAGEMENT PRACTICE)

Definition: Restoring, conserving, and managing unique or diminishing native terrestrial and aquatic ecosystems.

Purpose: To provide habitat for rare and declining species. To return aquatic or terrestrial ecosystems to their original or usable and functioning condition and to improve biodiversity by providing and maintaining habitat for fish and wildlife species associated with the ecosystem

Practice Application: This practice is considered a core practice in which a system of supporting practices, such a prescribed burning and related practices will be applied to restore and manage rare and declining habitats and their associated wildlife species to conserve biodiversity. This practice will be used to improve the overall biodiversity within the action area. This practice may be used convert cropland and pastureland to native habitat.

Resource concerns: The loss or degradation of rare or declining native habitats. Also the fragmentation of these habitats.

Potential beneficial effect(s) to the Covered Species: Provides enhancement, creation and restoration of wildlife habitat including habitat for rare and declining species. Implementation of this practice will help to create and ensure a diversity of native habitat types. This practice may include restoration of vegetative components, such as native grasses, forbs, and shrubs and/or alterations to existing functioning vegetative structural groups through the use of facilitating practices.

Potential adverse effect(s) to the Covered Species: This core management practice was developed for the primary purpose of restoration and management of rare and declining habitats. When applied and managed to the practice standards and specifications, this practice should not result in adverse conditions to the covered species. Some of the supporting practices associated with this core practice have the potential for adverse effects. These supporting practice and their potential impacts (if any) are discussed below in the “Facilitating Practices” Section of this Appendix as well as the “Effects of the Action” section in the accompanying Biological Opinion

Conservation Practice Standard: Wetland Wildlife Habitat Management (644) (CORE MANAGEMENT PRACTICE)

Definition: Retaining, developing, or managing habitat for wetland wildlife.

Purpose: The purpose of this practice is to maintain, develop, or improve habitat for wildlife that depend on wetlands during some portion of their life cycle.

Practice Application: This practice is considered a core practice in which a system of supporting practices, such as prescribed burning and related practices will be applied to help achieve the goals of maintaining developing or managing wetland wildlife habitat. This practice will be applied on or adjacent to wetlands, rivers, lakes and other water bodies where wetland associated wildlife habitat can be managed. The practice can be applied to both natural wetlands and wetlands that may have been previously restored, enhanced or created.

Resource concern(s): The loss or degradation of wetlands, particularly wetlands associated with wildlife.

Potential beneficial effect(s) to the Covered Species: When used in combination of the facilitating practices this core practice will provide wetland habitat for wetland dependent species.

Potential Adverse Effects(s) to the Covered Species: Reduced habitat quality in wetlands may occur without implementing this core practice. When applied and managed to the standards and specification of the practice, this practice should not result in adverse conditions to the covered species. Some of the supporting practices associated with this core practice have the potential for adverse effects. These supporting practice and their potential impacts (if any) are discussed in the "Facilitating Practices" Section of this Appendix as well as the "Effects of the Action" section in the accompanying Biological Opinion.

Conservation Practice Standard: Early Successional Habitat Development/Management (647) (CORE MANAGEMENT PRACTICE)

Definition: Manage plant succession to develop and maintain early successional habitat to benefit desired wildlife and/or natural communities.

Purpose: To provide habitat for species requiring early successional habitat for all or part of their life cycle.

Practice Application: This practice will be a core practice in which a system of supporting practices such as prescribed burning and related practices will be applied to achieve its purpose of developing and maintaining early successional habitats. Implementation of this practice is intended to produce and manage vegetative conditions at early successional stages to support plant and animal species dependent upon these early successional stages.

Resource Concern(s): Lack of fire has allowed many early successional habitats to become overgrown and unsuitable for many endemic species that depend on early successional habitat conditions. Prescribed fire as a supporting practice mimics a natural process that maintains the successional stage than many common and rare species depend.

Potential beneficial effect(s) to the Covered Species: This core management practice will be used to restore, enhance or create, and manage suitable habitat for species dependent upon early successional habitat by improving habitat conditions for all life cycles, including breeding and nesting, providing adequate food, cover and shelter. It will also help to address the effects of habitat fragmentation by creating, maintaining, or restoring landscape connectivity.

Potential Adverse Effects to the Covered Species: When applied and managed to the standards and specification of the practice, this practice should not result in adverse conditions to the covered species. Some of the supporting practices associated with this core practice have the potential for adverse effects. These supporting practice and their potential impacts (if any) are discussed below in the “Facilitating Practices” Section of this Appendix as well as the “Effects of the Action” section in the accompanying Biological Opinion.

Conservation Practice Standard: Integrated Pest Management (595) (CORE) MANAGEMENT PRACTICE)

Definition: A site-specific combination of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies (*i.e.*, invasive/exotic and other undesirable species). Integrated Pest Management (IPM) is defined as an approach to pest control that combines biological, cultural and other alternatives to chemical control with the judicious use of pesticides.

Purpose: To prevent or mitigate risks to natural resources during control of invasive/exotic and other undesirable species.

Practice Application This practice is considered a core practice in which a combination of supporting practices is evaluated to determine the most efficient way to control pests (including invasive species) in a way that mitigates impacts to natural resources. For the purposes of the accompanying Biological Opinion, this practice is applied to control or suppress invasive/exotic species and other undesirable vegetation to facilitate prescribed burning.

Resource Concerns: The presence of invasive exotic species and other undesirable vegetation can create high fuel loads and create ladder fuels causing undesired mortality to non-target vegetation. Other invasive/exotic species are fire adapted, are encouraged, and can be spread by fire. Therefore, control is needed before burning can be implemented. The purpose of the practice is to address or mitigate:

- Off site pesticide risks to water quality from leaching, solution runoff, and absorbed runoff losses,
- Pesticide risks to soil water, covered species and other plants and animals, and humans from drift and volatilization losses,
- Pesticide risks to pollinators and other beneficial species through direct contact,
- Cultural, mechanical, and biological suppression risks to soil, water, air, plants, animals, and humans.

Potential beneficial effect(s) to the Covered Species: By implementing IPM, resource concerns and risks of controlling invasive/exotic and other undesirable species are mitigated to the extent practicable. Prescribed burning is facilitated by implementing IPM to reduce invasive/exotic plants and other undesirable vegetation

Potential Adverse Effects to the Covered Species: When applied and managed to the standards and specification of the practice, this practice should not result in adverse conditions to the covered species. Some of the supporting practices associated with this core practice have the potential for adverse effects. These supporting practice and their potential impacts (if any) are discussed below in the "Facilitating Practices" Section of this Appendix as well as the "Effects of the Action" section in the accompanying Biological Opinion.

FACILITATING PRACTICES

Conservation Practice Standard: Prescribed Burning (338) (FACILITATING MANAGEMENT PRACTICE)

Definition: Controlled fire applied to a predetermined area.

Purpose: Create the desired plant community phase consistent with the ecological site description that is desirable and suitable for the covered species. Control undesirable vegetation or to manipulate desired vegetation. Prepare sites for planting or seeding. Reduce wildfire hazards. Improve wildlife habitat to enhance and produce desirable or needed plant communities for all phases of the covered species life history requirements. Improve forage production quantity and/or quality. Restore and/or maintain pyrogenic vegetative ecological communities.

Practice Application: This practice will be applied to pyrogenic communities that depend on periodic fires to restore and maintain habitat conditions. For the purposes of the accompanying Biological Opinion, the Service expects that this practice will be applied as a "stand-alone" treatment or as a 'follow-up" treatment to the other facilitating practices as discussed below.

Resource Concerns: Suppression of naturally occurring wildfires and lack of prescribed burning activities has resulted in existing habitat conditions that are vastly different from historic plant communities for the covered species. Habitat productivity, health, and vigor have been reduced due to a lack of fire or inappropriate (*e.g.*, unnatural) fire regimes.

Potential beneficial effect(s) to the Covered Species: Prescribed burning is one of the most important management tools for naturally creating and maintaining habitat conditions for the covered species. Fire shapes vegetative community composition and structure and is an integral part of the community function. In fact, for some covered plant species, fire is needed to promote or enhance reproduction.

Potential Adverse Effect(s) to the Covered Species: Accidental injury or mortality of individual members of the covered species may occur if the burn is conducted during the nesting or brood-rearing seasons. Fires that burn to fast or hot, may not provide individuals seeking refuge/cover, time to escape, causing mortality. While fire may "top kill" covered plant species, these plants are fire adapted and have various strategies for responding to fire events, including vigorous resprouting from roots stock or seed banks. A temporary reduction of habitat may occur and persist until the habitat recovers. In almost all cases, recovery of habitat is rapid with improvement in habitat conditions resulting in a net conservation benefit for both plants and animals. Conversely, in the absence of fire, habitat will degrade and reach a point where conditions are no longer suitable for the covered species resulting in an overall loss of population numbers. More "species specific" discussion effects of this practice are provided in the "Effects Section" of the accompanying biological Opinion.

Conservation Practice Standard: Brush Management (314) (FACILITATING VEGETATIVE PRACTICE)

Definition: The management or removal of woody (non-herbaceous or succulent) plants including those that are invasive and noxious.

Purpose: To restore or enhance the desired native plant community and which provides the most suitable habitat for the covered species and other wildlife species. Specifically, it may be used for the purpose of:

- Restoring the appropriate vegetative seral stage optimal for persistence of the covered species.
- Improving the diversity of habitat to create a mosaic of age/seral stage habitats

This practice can be used to facilitate prescribed burning by reducing the fuel load, reducing the risk of fires burning too hot, causing mortality to non-target vegetation. By reducing brush, growth of desirable ground cover is encouraged which helps to carry fire.

Practice Application: The practice is implemented by:

- manual or mechanical means, such as: chainsaws, roller choppers, mowers, bush hogs, feller bunchers, hydrologic sheers, or masticators. Cut brush may be lopped-and-scattered, piled-and-burned, chipped, or hauled off.
- herbicide application. When herbicides are applied for suppression of oaks, wax myrtle, saw palmetto, etc, rates will be determined by desired ecological state for the targeted habitat conditions. Herbicides can also be used for control of invasive/exotic vegetation.

Resource concerns: Habitat fragmentation and loss of suitable habitat for the covered species. Heavy fuel loads may prevent prescribed fire from being introduced safely on the landscape. In other cases, the presence of non-pyrogenic vegetation (*e.g.*, species of oaks in the midstory) may prevent fire from burning through an area and achieving the purpose of ecological restoration. Heavy bush, in the absence of fire, can shade out covered plants species. Brush can also shade out native ground cover, which is a required component for foraging, nesting, and shelter of some covered animal species Other avian species (*e.g.*, red-cockaded woodpecker and Florida grasshopper sparrow) are very sensitive to the presence of brush in the midstory and will abandon an area if the brush component exceeds a certain percentage or height.

Potential beneficial effect(s) to the Covered Species: Removal of limiting habitat factors and creation of desired or targeted habitat conditions. Facilitates prescribed burning. The presence of invasive exotic species and other undesirable vegetation can create high fuel loads and create ladder fuels causing undesired mortality to non-target vegetation. Some invasive/exotic species are fire adapted, are encouraged, and can be spread by fire. Therefore, control is needed before burning can be implemented.

Potential adverse effect(s) to the Covered Species: Short-term effects may include visual and physical disturbance (including noise) during implementation. Temporary soil and vegetation disturbances resulting from implementation can increase the potential for introduction of invasive plants on disturbed areas. Implementation of this practice will likely cause a temporary loss of habitat, increased fire hazard from equipment, or if slash remains on-site. There may be an increased potential for soil erosion. Potential of accidental mortality to both covered plant and animal species during implementation. Recovery of habitat is expected to be rapid and loss of individuals due to mortality is expected to be offset by improved habitat conditions resulting in a net conservation benefit to covered species. More “species specific” discussion effects of this practice are provided in the “Effects Section” of the accompanying biological Opinion.

Conservation Practice Standard: Firebreak (394) (FACILITATING, VEGETATIVE PRACTICE)

Definition: A permanent or temporary strip of bare or vegetated land planned to retard fire.

Purpose: Reduce the spread of wildfire and contain prescribed burns to their targeted area.

Practice Application: Firebreaks will be applied on lands where prescribed burning will take place. Exterior firebreaks are typically placed around exterior property lines or the perimeter of the designated prescribed burn unit to confine fires to the areas in which they are intended. Interior firebreaks are used to aid in ignition and control the way in which fire is applied. Firebreak location and installation methods are an integral part of site-specific burn plans. Four types of firebreaks are used; 1) access roads, 2) vegetated firebreaks, 3) either plowed, disked or bladed firebreaks and, 4) natural barriers. In addition, hand lines may be constructed using hand tools. Vegetated firebreaks are constructed and maintained used a variety of mowers and mowing techniques. They may be disked and seeded to establish desired vegetation. Plowed or disked firebreaks are installed using rubber tired, or tracked equipment pulling disks or fire plows.

Resource Concerns: The primary concern that a firebreak addresses is the spread of fire beyond the targeted prescribed burn area and the spread of wildfires, resulting in large-scale, temporary alteration of the landscape. Firebreaks must be of sufficient width, length, and design to contain fire.

Potential beneficial effect(s) to the Covered Species: Practice can help reduce the spread of catastrophic wildfires thus reducing the risk of large-scale, habitat loss. Placement of fire breaks allow for control of the fire to meet site-specific objectives identified in the burn plan. Firebreaks create openings that provide habitat for some covered plants and animals.

Potential Adverse Effects(s) to the Covered Species: Short-term physical disturbances, such as disking or mowing, may cause mobile species to leave the area temporarily. Ground disturbance is a primary concern. Firebreaks may disturb soil and vegetation and result in a temporary reduction of cover over a small area. Soil disturbance may also allow invasive plants to grow and alter the community structure. Potential exists for accidental mortality or injury to covered species from direct impacts from equipment during firebreak installation. The less intrusive type of firebreak is selected and less intrusive method of installation is used to alleviate ground disturbance. More “species specific” discussion effects of this practice are provided in the “Effects Section” of the accompanying biological Opinion

Conservation Practice Standard: Fuelbreak (550) (FACILITATING VEGETATION PRACTICE)

Definition: A strip of land on which the vegetation, debris, and detritus (*i.e.*, fuel load) have been reduced and/or modified to control or diminish the risk of fire crossing the strip or block of land.

Purpose: Control and reduce the risk of fire by treating, removing, or modifying vegetation, debris and detritus.

Practice Application: This practice applies on all land where protection from wildfire is needed.

Resource concerns: The primary concern addressed by this practice is protection from wildfire.

Potential Beneficial Effect(s) to the Covered Species. Implementation of this practice helps provide protection from wildfire helps and helps to alleviate the risk of uncontrolled fire affecting non-target species and altering habitat on a scale that could have adverse effects. This practice reduces the risk of wildfires occurring during times of the year and in areas that would negatively impact covered species. By facilitating the use of prescribed burning, benefits to covered species can be taken into consideration and potential impacts avoided or minimized.

Potential Adverse Effect(s) to Covered Species: Installation of fuel breaks has the same potential for adverse effects as installation of firebreaks. Short-term physical disturbances, such as disking or mowing, may cause mobile species to leave the area temporarily. Fuelbreaks may disturb soil and vegetation and result in a temporary reduction of cover over a small area. Soil disturbance may also allow invasive plants to grow and alter the community structure. Potential exists for accidental mortality or injury to covered species form direct impacts from equipment during firebreak installation. More "species specific" discussion effects of this practice is provided in the "Effects Section" of the accompanying biological Opinion

Conservation Practice Standard: Herbaceous Weed Control (315) (FACILITATING VEGETATIVE PRACTICE)

Definition: The removal or control of herbaceous weeds including invasive, noxious and prohibited plants.

Purpose: This practice may be applied to control or remove invasive and noxious weeds through chemical, biological, or mechanical means in order to restore native or desired plant communities and habitat for the covered species consistent with the ecological site description. It secondarily protects soils, controls erosion, reduces fine-fuels fire hazards, and improves air quality.

Practice Application: Specifically, this practice may be applied to control or remove invasive and noxious weeds (and other undesirable herbaceous vegetation) through chemical, biological, or mechanical means in order to restore native or desired plant communities and habitat for the covered species. This practice is applied during the growing season which will vary depending on species and method of control. Typically for chemical applications, a tractor or ATV with a sprayer is used. Mechanical application normally requires using a tractor and mower or disk. In support of prescribed burning this practice may be needed to remove heavy fuel loads prior to implementing a prescribed fire. This practice will also be utilized to control/suppress invasive exotic species which have the potential to create high fuel loads and ladder fuels causing undesired mortality to non-target vegetation. Some invasive/exotic species are fire adapted, are encouraged, and can be spread by fire. Therefore, control is needed before burning can be implemented.

Resource concerns: Invasive and noxious weeds degrade ecological value of sites by increasing competition with native and desirable plant species. This results in decreased sustainability and resiliency of the vegetative communities and leads to reduced habitat quality and quantity for wildlife, including the covered species. Accidental treatment by either mechanical or chemical means to non-target species is a concern, therefore this practice is planned in conjunction with integrated pest management to avoid and minimize potential adverse effects.

Potential Beneficial Effect(s) to the Covered Species: Practice implementation removes or reduces invasive or other weed species that directly or indirectly limit habitat quality and productivity. Practice can beneficially influence the vigor and establishment of native or desirable vegetation required to provide optimal habitat conditions for the covered species. Practice facilitates prescribed burning.

Potential Adverse Effect(s) to Covered Species: Temporary physical disturbance (including noise), soil and vegetation disturbance and increased potential for invasive plants. Destruction of nesting habitat and loss of nests and/or young when mechanical treatment coincides with nesting season. Potential exists for accidental mortality or injury to covered species from direct impacts from equipment during mechanical treatment or during chemical application when equipment is used. Accidental treatment of non-target species (including covered species) during chemical application can result in mortality or harm, particularly (but not limited to) listed plants. Temporary reduction in habitat quality is expected to be offset by rapid recovery with improvement in habitat conditions resulting in a net conservation benefit. More "species specific" discussion effects of this practice is provided in the "Effects Section 'of the accompanying biological Opinion

Conservation Practice Standard: Forest Stand Improvement (666) (FACILITATING VEGETATIVE PRACTICE)

Definition: The manipulation of species composition, stand structure and stocking by cutting or killing selected trees and understory vegetation.

Purpose: For the purpose of the accompanying Biological Opinion, the primary purpose of the application of this practice is to reduce hazardous fuels to facilitate prescribed burning. This practice is also employed to (1) Increase the quantity and quality of forest products by manipulating stand density and structure. (2) Timely harvest of forest products; (3) Development of renewable energy systems; (4) Initiate forest stand regeneration; (5) Reduce wildfire hazard; (6) Improve forest health reducing the potential of damage from pests and moisture stress; (7) Restore natural plant communities; (8) Achieve or maintain a desired native understory plant community for special forest products, grazing, and browsing; (9) Improve aesthetic and recreation, values; (10) Improve wildlife habitat; (11) Alter water yield; (12) Increase carbon storage in selected trees.

Practice Application: This practice will create desired tree and mid-story conditions consistent with the restoration objectives and maintain, modify, or enhance wildlife habitat for covered species. For the purposes of the accompanying Biological Opinion, this practice is applied to reduce fuel loading so that prescribed burning can be applied to the site. Thinning of overstock stands may take place to reduce the risk of crown fire and promote more desirable ground cover conditions. Midstory control can also take place to reduce the fuel load in a stand.

Resource concerns: This practice addresses the issue of overstocked timber stands and closed canopy cover. Overstocked timber stands and closed canopy cover can influence implementation of prescribed burning in a variety of ways. Overstocked stands may result in heavy fuel loads causing prescribed fires to burn hotter than desired, resulting in mortality to non-target species. Conversely, in other situations, a closed canopy can negatively impact ground cover which "carries" fire through a stand. Heavy canopy cover can also shade out covered plant species. Another concern is the presence of off-site tree species, particulary on sites suitable for longleaf pine or (in its native range) south Florida slash pine.

Potential Beneficial Effect(s) to the Covered Species: By helping to restore the fuel, load of a stand to acceptable levels this practice facilitates prescribed burning. Thinning can beneficially influence the vigor and establishment of native or desirable vegetation required to provide and improve habitat conditions for the covered species. By thinning and/or removal of midstory, in conjunction with burning groundcover is encouraged. Native ground cover, is a required habitat component for foraging, nesting, and cover of some covered animal species Other avian species (*e.g.,* red-cockaded woodpecker) are very sensitive to the presence of brush in the midstory and will abandon an area if the brush component exceeds a certain percentage or height. Thinning also promotes the growth of the residual trees in a stand decreasing the amount of time before the trees reach an acceptable size to be used for foraging by the red-cockaded woodpecker.

Potential Adverse Effect(s) to Covered Species: Potential exists for accidental mortality or injury to covered species from direct impacts from equipment. Short-term effects may result from visual and physical disturbance (including noise) during operations. Soil disturbance and compaction can occur. Temporary reduction in habitat quality is expected to be offset by rapid recovery with improvement in habitat conditions resulting in a net conservation benefit. More "species specific" discussion effects of this practice is provided in the "Effects Section" of the accompanying biological Opinion

Conservation Practice Standard: Forest Slash Treatment (384) (FACILITATING VEGETATIVE PRACTICE)

Definition: Treating woody residues created during forestry, agroforestry, and horticultural activities to achieve management activities.

Purpose: For the purpose of this accompanying Biological Opinion, the primary purpose of the application of this practice is to reduce hazardous fuels to facilitate prescribed burning. This practice is also employed to: reduce the risk of harmful insects and disease, protect/maintain air quality by reducing the risk of wildfire, improve the organic soil matter, and improve the site for natural or artificial regeneration.

Practice Application: This practice would be used to treat quantities of woody slash and debris, which may or may not be the result of the implementation of other Conservation Practices such as Forest Stand Improvement and Brush Management. A combination of treatment methods may include (but is not limited to) burning, chipping, lop and scatter, crushing/chopping, and removing/transporting from the site.

Resource concerns: The presence of slash may create high level of hazardous fuels, which may need to be treated prior to implementing prescribed burning. Slash may bury or shade out plant species. Covered species (*e.g.*, the eastern indigo snake) and other wildlife may be found in the proximity of slash using the area for refuge.

Potential Beneficial Effect(s) to the Covered Species: In areas where covered plant species occur, treatment of slash improves habitat and prevent plants form being buried or shaded out. Treatment of slash in removing hazardous fuel loads reducing the risk of both wild fire and prescribed from being catastrophic.

Potential Adverse Effect(s) to Covered Species: Potential exists for accidental mortality or injury to covered species from direct impacts from equipment. Short-term effects may result from visual and physical disturbance (including noise) during operations. Soil disturbance and compaction can occur.

APPENDIX B - Florida Ecological Services Offices Contact Info