This document is scheduled to be published in the
Federal Register on 10/03/2013 and available online at
http://federalregister.gov/a/2013-24173, and on FDsys.gov

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R4–ES–2013-0033; 4500030113]

RIN 1018–AZ15

Endangered and Threatened Wildlife and Plants; Proposed Endangered Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax)

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Proposed rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), propose to list *Brickellia mosieri* (Florida brickell-bush) and *Linum carteri* var. *carteri* (Carter's small-flowered flax), as endangered species under the Endangered Species Act. If we finalize this rule as proposed, it would extend the Act's protections to these plants.

DATES: We will accept comments received or postmarked on or before [INSERT

DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]. Comments submitted electronically using the Federal eRulemaking Portal (see **ADDRESSES** section, below) must be received by 11:59 p.m. Eastern Time on the closing date. We must receive requests for public hearings, in writing, at the address shown in **FOR FURTHER INFORMATION CONTACT** by [INSERT DATE 45 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: You may submit comments by one of the following methods:

(1) *Electronically*: Go to the Federal eRulemaking Portal: *http://www.regulations.gov*. In the search box, enter FWS–R4–ES–2013–0033, which is the docket number for this rulemaking. You may submit a comment by clicking on "Comment Now!" If your comments will fit in the comment box provided, please use this feature of *http://www.regulations.gov*, as it is most compatible with our comment review procedures. If you attach your comments as a separate document, our preferred file format is Microsoft Word. If you attach multiple comments (such as form letters), our preferred format is a spreadsheet in Microsoft Excel.

(2) *By hard copy*: Submit by U.S. mail or hand-delivery to: Public Comments Processing, Attn: FWS–R4–ES–2013-0033; Division of Policy and Directives Management; U.S. Fish and Wildlife Service; 4401 N. Fairfax Drive, MS 2042–PDM; Arlington, VA 22203.

We request that you send comments **only** by the methods described above. We will post all information received on *http://www.regulations.gov*. This generally means that we will post any personal information you provide us (see the **Information Requested** section below for more information).

FOR FURTHER INFORMATION CONTACT: Larry Williams, Field Supervisor, U.S. Fish and Wildlife Service, South Florida Ecological Services Office, 1339 20th Street, Vero Beach, FL 32960, by telephone 772–562–3909, or by facsimile 772–562–4288. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. Under the Act, if we intend to list a species as endangered or threatened throughout all or a significant portion of its range, we are required to promptly publish a proposal in the **Federal Register** and make a final determination on our proposal within one year. Listing a species as an endangered or threatened species can only be completed by issuing a rule.

This document consists of a proposed rule to list *Brickellia mosieri* and *Linum carteri* var. *carteri* as endangered species. Elsewhere in today's **Federal Register**, we propose to designate critical habitat for *Brickellia mosieri* and *Linum carteri* var. *carteri* under the Act. Both plants are candidate taxa (i.e., species or varieties) for which we have on file sufficient information on biological vulnerability and threats to support preparation of a listing proposal, but for which development of a listing regulation has been precluded by other higher priority listing activities. This rule reassesses all available information regarding status of and threats to both plants.

The basis for our action. Under the Act, we may determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. We have determined that the threats to both *Brickellia mosieri* and *Linum carteri* var. *carteri* consist primarily of habitat loss and modification through urban and agricultural development, and lack of adequate fire management (Factor A); proliferation of nonnative invasive plants, and sea level rise (Factor E); and these threats are not reduced by existing regulatory mechanisms (Factor D).

We will seek peer review. We are seeking comments from knowledgeable individuals with scientific expertise to review our analysis of the best available science and application of that science and to provide any additional scientific information to improve this proposed rule. Because we will consider all comments and information received during the comment period, our final determinations may differ from this proposal.

Information Requested

We intend that any final action resulting from this proposed rule will be based on the best scientific and commercial data available and be as accurate and as effective as possible. Therefore, we request comments or information from the public, other concerned governmental agencies, Native American tribes, the scientific community, industry, or any other interested parties concerning this proposed rule. We particularly seek comments concerning:

(1) Both plants' biology, range, and population trends, including:

(a) Habitat requirements for feeding, breeding, and sheltering;

(b) Genetics and taxonomy;

(c) Historical and current range including distribution patterns;

(d) Historical and current population levels, and current and projected trends; and

(e) Past and ongoing conservation measures for the plants, their habitat, or both.

(2) The factors that are the basis for making a listing determination for a species under section 4(a) of the Act (16 U.S.C. 1531 *et seq*.), which are:

(a) The present or threatened destruction, modification, or curtailment of their habitat or range;

(b) Overutilization for commercial, recreational, scientific, or educational purposes;

(c) Disease or predation;

(d) The inadequacy of existing regulatory mechanisms; or

(e) Other natural or manmade factors affecting their continued existence.

(3) Biological, commercial trade, or other relevant data concerning any threats (or lack thereof) to these plants and regulations that may be addressing those threats.

(4) Additional information concerning the historical and current status, range, distribution, and population size of these plants, including the locations of any additional populations of these plants.

(5) Current or planned activities in the areas occupied by these plants and possible impacts of these activities on these plants.

(6) Additional information concerning the biological or ecological requirements of these plants, including pollination and pollinators.

Please note that submissions merely stating support for or opposition to the action under consideration without providing supporting information, although noted, will not be considered in making a determination, as section 4(b)(1)(A) of the Act directs that determinations as to whether any species is an endangered or threatened species must be made "solely on the basis of the best scientific and commercial data available."

You may submit your comments and materials concerning this proposed rule by one of the methods listed in **ADDRESSES**. We request that you send comments **only** by the methods described in **ADDRESSES**.

If you submit information via *http://www.regulations.gov*, your entire submission—including any personal identifying information—will be posted on the website. If your submission is made via a hardcopy that includes personal identifying information, you may request at the top of your document that we withhold this information from public review. However, we cannot guarantee that we will be able to do so. We will post all hardcopy submissions on *http://www.regulations.gov*. Please include sufficient information with your comments to allow us to verify any scientific or commercial information you include.

Comments and materials we receive, as well as supporting documentation we used in preparing this proposed rule, will be available for public inspection on *http://www.regulations.gov*, or by appointment, during normal business hours, at the U.S. Fish and Wildlife Service, South Florida Ecological Services Office (see **FOR FURTHER INFORMATION CONTACT**).

Previous Federal Actions

Brickellia mosieri was first recognized as a candidate for possible future listing on September 27, 1985 (50 FR 39526), and we assigned the species a listing priority number

(LPN) of 2. Candidate species are assigned LPNs based on immediacy and magnitude of threats, as well as taxonomic status. The lower the LPN, the higher priority that species is for us to determine appropriate action using our available resources (September 21, 1983; 48 FR 43100). Category 2 candidates were those taxa for which information contained in our files indicated that listing may be appropriate, but for which additional data were needed to support a listing proposal.

Linum carteri var. *carteri* was also first recognized as a candidate for possible future listing on September 27, 1985 (50 FR 39526), and assigned an LPN of 1. Category 1 candidates were those taxa for which the Service had substantial information on biological vulnerability and threats to support the appropriateness of proposing to list them as endangered or threatened species. On February 21, 1990, we downgraded this variety to a category 2 candidate (55 FR 6184).

Both *Brickellia mosieri* and *Linum carteri* var. *carteri* remained on the candidate list as published in what is now known as the Candidate Notice of Review (CNOR) until 1993 (55 FR 6184, February 21, 1990; 58 FR 51144, September 30, 1993). Both plants were removed from the candidate list from 1996 to 1998 because there was not sufficient information on their biological vulnerability and threats to support issuance of a proposed rule. Both plants were again placed on the candidate list in the 1999 CNOR (October 25, 1999, 64 FR 57534), in which we determined that listing was warranted, but was precluded due to workloads and priorities. *B. mosieri* was assigned an LPN of 5, meaning that the magnitude of threats for the species remained high but were not imminent. *L. c.* var. *carteri* was assigned an LPN of 3, meaning that the magnitude of threats remained both high and immediate and reflected its taxonomic status at the varietal level.

Both plants remained on the candidate list as published in the CNORs from 2001 to 2004 (66 FR 54808, October 30, 2001; 67 FR 40657, June 13, 2002; 69 FR 24876, May 4, 2004). On May 11, 2005, we published findings for both plants in the 2005 CNOR (70 FR 24869) in response to a petition received on May 11, 2004. *Brickellia mosieri* remained on the candidate list, but we changed the LPN from a 5 to an 8, meaning that the magnitude of threats to the species were moderate, but immediate (70 FR 24869). A primary factor noted in this downgrading was the occurrence of 13 of the 17 known populations on conservation lands, which were being managed appropriately with prescribed fire and control of invasive nonnative species. *Linum carteri* var. *carteri* also remained on the candidate list, with an unchanged LPN of 3 (70 FR 24869). *B. mosieri* and *L. c.* var. *carteri* remained on the candidate list as published in the CNORs from 2006 to 2012, with LPNs of 8 and 3, respectively (71 FR 53756, September 12, 2006; 72 FR 69034, December 6, 2007; 73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009; 75 FR 69222, November 10, 2010; 76 FR 66370, October 26, 2011; and 77 FR 69994, November 21, 2012).

On May 10, 2011, as part of an agreement with one of the agency's most frequent plaintiffs, the Service filed a workplan with the U.S. District Court for the District of Columbia. The workplan will enable the agency to, over a period of 6 years, systematically review and address the needs of more than 250 species listed within the 2010 CNOR, including *Brickellia mosieri* and *Linum carteri* var. *carteri*, to determine if these plants should be added to the Federal Lists of Endangered and Threatened Wildlife and Plants. This workplan will enable the Service to again prioritize its workload based on the needs of candidate species, while also providing state wildlife agencies, stakeholders, and other partners clarity and certainty about when listing determinations will be made. On July 12, 2011, the Service reached an agreement with another frequent plaintiff group and further strengthened the workplan, which will allow the agency to focus its resources on the species most in need of protection under the Act. These agreements were approved by the court on September 9, 2011.

Status Assessment for *Brickellia mosieri* and *Linum carteri* var. *carteri*

Background

It is our intent to discuss below only those topics directly relevant to the listing of *Brickellia mosieri* and *Linum carteri* var. *carteri* as endangered in this proposed rule.

Brickellia mosieri

Description

Brickellia mosieri (Family: Asteraceae) is a perennial herb. Mature plants are 0.3–1.1 meters (m) (1.0–3.5 feet (ft)) tall, slender, erect, and branching (Chafin 2000, page numbers not applicable). Leaves are 1–3 centimeters (cm) (0.4–1.2 inches (in)) long, alternate, narrow, linear, thick, usually spreading or curved downward, entire or slightly toothed, and resin-dotted (Chafin 2000, page numbers not applicable). The flower heads are in loose, open clusters at the ends of branches (Chafin 2000, page numbers not applicable). 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, page numbers not applicable).

Taxonomy

Brickellia mosieri was first described by Small in 1933 as *Kuhnia mosieri* (Bradley and Gann 1999, p. 11). In 1970, Long called the species *Kuhnia eupatorioides* var. *floridana*, reducing it to a variety of a more widespread species occurring in the eastern United States (Bradley and Gann 1999, p. 11). In 1971, Shinners included all members of the genus *Kuhnia* in *Brickellia* and restored the plant to species status, calling it *Brickellia mosieri* (Bradley and Gann 1999, p. 11). In a 1989 study of the *Brickellia eupatorioides* complex, Turner identified it as a variety of the more widespread *Brickellia eupatorioides*, and gave it the new name *Brickellia eupatorioides* var. *floridana*. Wunderlin and Hansen (2003, pp. 300–301) recognized *Brickellia mosieri*, thinking the plant to be specifically distinct from *Brickellia eupatorioides* (Bradley and

Gann 1999, p. 11) and differentiating the species by leaf width and margin (i.e., *B. mosieri* having 1–3 millimeter (mm) (0.04–0.12 in) wide, entire or obscurely toothed leaves versus *B. eupatorioides* having 5–40 mm (0.2–1.6 in) wide, coarsely toothed leaves).

While some sources (Integrated Taxonomic Information System (ITIS) 2013a, page numbers not applicable) indicate that *Brickellia eupatorioides* var. *floridana* is the accepted taxonomy, local sources including the online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, page numbers not applicable), the Florida Department of Agriculture and Consumer Services (FDACS; Coile and Garland 2003, p. 7), and the Institute for Regional Conservation (IRC) all use *Brickellia mosieri*. Although there is not complete agreement on whether this taxon is a variety or a species, there is consensus that it is a distinct taxon. Based upon the best available scientific information, *Brickellia mosieri* is a distinct taxon, endemic to Miami-Dade County in Florida. Synonyms include *Brickellia eupatorioides* var. *floridana, Kuhnia eupatorioides* var. *floridana*, and *Kuhnia mosieri* (Wunderlin and Hansen 2008, page numbers not applicable).

Climate

The climate of south Florida where *Brickellia mosieri* occurs is classified as tropical savanna and is characterized by distinct wet and dry seasons and a monthly mean temperature above 18 degrees Celsius (°C) (64.4 degrees Fahrenheit (°F)) in every month of the year (Gabler *et al.* 1994, p. 211). Freezes can occur in the winter months, but are infrequent at this latitude in south Florida. Rainfall in the pine rockland community where *B. mosieri* occurs exclusively, varies from an annual average of 153–165 cm (60–65 in) in the northern portion of the Miami Rock Ridge to an average of 140–153 cm (55–60 in) in the southern portion (Snyder *et al.* 1990, p. 238). Approximately 75 percent of yearly rainfall occurs during the wet season from June through September (Snyder *et al.* 1990, p. 238).

Habitat

Brickellia mosieri grows exclusively on the Miami Rock Ridge in Miami-Dade County outside the boundaries of Everglades National Park (ENP). This area extends from the ENP boundary, near the Park entrance road, northeast approximately 72 kilometers (km) (45 miles (mi)) to its end near North Miami. Habitat conditions more specific to this area are highlighted below. The pine rocklands are a unique ecosystem found on limestone substrates in three areas in Florida—the Miami Rock Ridge, in the Florida Keys, and in the Big Cypress Swamp. The pine rocklands differ to some degree between and within these areas with regard to substrate (*e.g.,* amount of exposed limestone, type of soil), elevation, hydrology, and species composition (both plant and animal).

Pine rockland occurs on relatively flat terrain, approximately 2–7 m (6.5–23.0 ft) above sea level with an average elevation of approximately 3 m (9.8 ft) (Service 1999, p. 3-167; Florida Natural Areas Inventory (FNAI) 2010, p. 62). On the Miami Rock Ridge, oolitic limestone is at or very near the surface, and solution holes occasionally form where the surface limestone is dissolved by organic acids. There is typically very little soil development, consisting primarily of accumulations of low-nutrient sand, marl, clayey loam, and organic debris found in solution holes, depressions, and crevices on the limestone surface (FNAI 2010, p. 62). However, extensive sandy pockets can be found at the northern end of the Miami Rock Ridge, beginning from approximately North Miami Beach and extending south to approximately S.W. 216 Street (which runs east-west approximately one-half mile south of Quail Roost Pineland) (Service 1999, p. 3-162). *Brickellia mosieri* tends to occur on exposed limestone with minimal organic litter and in areas with only minor amounts of substrate disturbance (Bradley and Gann 1999, p. 11).

Pine rocklands are generally moderately to well drained, depending on the porosity of the limestone substrate and landscape position, including nearby associated natural communities. In pine rocklands on the Miami Rock Ridge outside of ENP, the water table seldom reaches the surface (Service 1999, p. 3-167). Bradley and Gann (1999) found one occurrence of *Brickellia mosieri* in a low-elevation pine rockland (2–3 m above sea level) very close to a marl prairie. The pine rockland that contains this occurrence may have flooded periodically during the summer wet season. Known populations of *B. mosieri* are found at elevations ranging from approximately 1.7–4.8 m (5.5–15.8 ft). While species occurrences are distributed throughout this range, there are two elevational groupings in the landscape—one with average elevations of approximately 1.7–2.1 m (5.5–7.0 ft) and the other, larger grouping between approximately 2.7 and 4.0 m (9.0 and 13.0 ft).

Pine rockland is characterized by an open canopy of South Florida slash pine (*Pinus elliottii* var. *densa*). Subcanopy development is rare in well-maintained pine rocklands, with only occasional hardwoods such as *Lysiloma bahamensis* (wild tamarind) and *Quercus virginiana* (live oak) growing to tree size in Miami Rock Ridge pinelands (Snyder *et al.* 1990, p. 253). The shrub/understory layer is a diverse mix of species including both temperate and tropical shrubs and palms. Dominant plants in the shrub layer of pine rocklands vary based on elevation, soils, and location, including nearby associated natural communities. The pine rocklands where *Brickellia mosieri* occurs are characterized by an open shrub canopy of *Serenoa repens* (saw palmetto), *Myrica cerifera* (wax myrtle), *Metopium toxiferum* (poisonwood), and *Sideroxylon salicifolium* (willow bustic) as well as species with more restricted distribution within pine rocklands including *Sideroxylon reclinatum* (buckthorn), *Callicarpa americana* (beauty berry), *Dodonaea angustifolia* (varnish leaf), and *Ilex cassine* (dahoon holly) (Snyder *et al.* 1990, p. 254; Bradley and Gann 1999, p. 12). The shrub layer in pinelands occurring in the northern end of the Miami Rock Ridge more closely resembles pine flatwoods as a result of the amount of sandy soils in this area, with species such as *Lyonia fruticosa* (staggerbush), *Quercus minima* (dwarf live oak), *Quercus pumila* (running oak), and *Vaccinium myrsinites* (shiny blueberry) becoming more common (Snyder *et al.* 1990, p. 255). The height and density of the shrub layer vary based on fire frequency, with understory plants growing taller and more dense as time since fire increases.

Pine rocklands in all three areas of Florida also boast a richly diverse herbaceous layer, including a large number of rare and endemic species such as *Brickellia mosieri*. The diversity of the herbaceous layer decreases as the density of the shrub layer increases (i.e., as understory openness decreases), and pine rockland on the mainland has a more diverse herbaceous layer due to the presence of temperate species and some tropical species that do not occur in the Florida Keys (FNAI 2010, p. 63). The herbaceous layer can range from mostly continuous in areas with more soil development and little exposed limestone, to sparse where much of the limestone is at the surface. Most herbaceous species in pine rocklands are perennials (Snyder *et al*. 1990, p. 257). Common herbaceous associates of *B. mosieri* in the Miami Rock Ridge pine rocklands include *Schizachyrium sanguineum* (crimson bluestem), *Schizachyrium gracile* (wire bluestem), *Aster adnatus* (scaleleaf aster), and *Acalypha chamaedrifolia* (bastard copperleaf) (Bradley and Gann 1999, p. 12). *B. mosieri* may also be found in close association with several other rare plants, including *Chamaesyce deltoidea* ssp. *deltoidea* (deltoid spurge), *Chamaesyce deltoidea* ssp. *adhaerens* (wedge sandmat), *Chamaesyce deltoidea* ssp. *pinetorum* (pineland sandmat), *Galactia smallii* (Small's milkpea), *Polygala smallii* (tiny polygala), and *Argythamnia blodgettii* (Blodgett's silverbush) (Bradley and Gann 199, p. 12).

Pine rockland occurs in a mosaic with primarily two other natural community types—rockland hammock and marl prairie. Pine rockland grades into rockland hammock; pine rockland has an open pine canopy, and rockland hammock has a closed, hardwood canopy. Pine rockland is a fire-maintained ecosystem—a well-maintained pine rockland is a savanna-like forest, but, in the absence of fire, it will eventually succeed into rockland hammock. Historically, fires often started in the adjacent prairie wetlands and swept into the pinelands, which often have suitable fuel conditions to support surface fires that consume primarily leaf litter (pine needles and herbaceous fuel) and some understory vegetation (Snyder *et al.* 1990, p. 258). Pine rockland plants have adapted to frequent fires. Mature South Florida slash pine is a highly fire-resistant variety, and even its seedlings have thicker stems and are more fire-resistant than typical slash pine seedlings (Snyder *et al.* 1990, p. 259). Aboveground portions of hardwood shrubs are typically killed by fire, but often resprout below ground; palms typically produce new growth post-fire from their unaffected apical buds. Pine rockland herbs, including *Brickellia mosieri*, respond favorably to fire with rapid regrowth and increased flowering. On one private conservation area, *B. mosieri* has only been observed in flower immediately after prescribed burning has occurred (Pine Ridge Sanctuary; Glancy 2013, pers. comm.).

Fire is important for the removal of litter accumulation from the limestone substrate and stimulation of herbaceous growth as well as for maintaining an open shrub layer. Evaluation of herbaceous layers post-fire suggests that pine rocklands may have evolved under a wide range of fire frequency, and some degree of variation in burn season, suggesting that pine rockland habitat historically existed as a mosaic in the landscape. The natural fire regime of pine rockland is believed to be approximately 3–7 years, or twice per decade, on average, with fires primarily occurring in the summer (wet season) in association with lightning strikes. As time since fire increases, leaf litter deepens and the shrub layer becomes denser, eventually shading out understory species and preventing germination of new plants, which require exposed substrate and high light conditions. If fire is excluded for 20–30 years, hardwoods will come to dominate the community and hammock conditions will prevail, which further discourage fires from spreading except in drought conditions.

Pine rocklands are also susceptible to natural disturbances such as hurricanes and other severe storms, during which trees may be killed, thereby helping to maintain the open canopy that is essential to pine rockland plants such as *Brickellia mosieri*. This species was first observed in flower on Pine Ridge Sanctuary after Hurricane Andrew made landfall in south Florida in 1992 (Glancy 2013, pers. comm.). During such events, pine rocklands near the coast may be temporarily inundated by saltwater which can also kill or damage vegetation (Snyder *et al.* 1990, p. 251; URS Corporation Southern *et al.* 2007, p. 11). In addition, though rare, freeze events can kill tropical plants in the open understory, helping to reduce hardwood encroachment (Service 1999, p. 3-167; FNAI 2010, p. 63). These sporadic, but potentially major, disturbances along with burning, create the dynamic nature of the pine rockland habitat, in which some currently unsuitable areas may become open in the future, while areas currently open may develop more dense canopy over time, eventually rendering that portion of the pineland unsuitable for *B. mosieri* and other pine rockland endemic plants.

Pine rockland on the Miami Rock Ridge can also occur within lower, seasonally flooded marl prairies, which differ from pine rockland in having no pines, an understory dominated by grasses and sedges, and a minimal cover of shrubs (FNAI 2010, p. 63). Where pine rockland occurs close to the ocean, it may be bordered by mangrove swamp or salt marsh and can receive flooding by extremely high tides (FNAI 2010, p. 63). Pine rocklands on the northern Miami Rock Ridge grade into scrub and sandhill vegetation where the three communities intermix in areas with deep sands and rock outcrops (Snyder *et al.* 1990, p. 257).

Historical Range

Brickellia mosieri is endemic to the pine rocklands of the Miami Rock Ridge in Miami-Dade County. It was historically known from central and southern Miami-Dade County from South Miami to Florida City, a range of approximately 36.2 km (22.5 mi), along the Miami Rock Ridge (Bradley and Gann 1999, p. 11). However, Bradley and Gann (1999, p. 11) state that herbarium specimens have not been studied from the New York Botanical Garden, so the full extent of its historical range is unknown. Available herbarium specimens and other records for this plant (Bradley and Gann 1999, p. 16; Wunderlin and Hansen 2008, page numbers not applicable) do not give precise or accurate location information.

Current Range, Population Estimates, and Status

Brickellia mosieri is currently distributed from central and southern Miami-Dade County from SW 120 St. (latitude ca. 25" 39.4) to Florida City (latitude ca. 25" 26.0), suggesting its historical range has contracted at least 4.8 km (3 mi), or 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, pers. comm.). 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 that 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 that included the species was the 2004–2005 mapping by IRC of natural forest communities (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 Florida Department of Transportation (FDOT) rights-of-way within Miami-Dade County (Gordon *et al.* 2007, pp. 1, 36).

Based on the best available data, we classified those occurrences of *Brickellia mosieri* that 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, 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, although additional confirmation is needed. Of the 17 extant occurrences, 9 occur on public conservation lands, 4 occur on private lands managed for conservation, and 4 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 1,001–10,000 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, 1,001–10,000 plants in 1999) has decreased to 101–1,000 plants, with adjacent areas (University of Miami, Zoo Miami, Martinez Pineland) estimated to hold another 112–1,100 plants combined (Possley 2013b, pers. comm.). Additional plants are suspected to occur on adjacent privately owned parcels in the Richmond Pineland Complex (Possley 2013a, pers. comm.). The only other monitored population estimated to be composed of greater than 100 plants occurs on the Navy Wells Pineland Preserve, located approximately 20 km (12.5 mi) southwest at the southern end of the 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 mi) from their nearest neighboring population—the major exception to this is a 7.2-km (4.5-mi) gap between the populations on Quail Roost Pineland and Camp Owaissa Bauer. Based on the 17 populations considered to be extant, the current total population estimate is between 515 and 4,935 plants, although the actual number of individuals is probably closer to between 2,150 and 3,700 (Table 1). Based on current estimates, the total population of *B. mosieri* has apparently declined by approximately 50 percent since 1999.

Table 1. Extant and historical populations of *Brickellia mosieri*. For those populations occurring within a County-designated natural forest community (NFC) parcel, NFC number is provided if available. The NFC number format is a letter designating primary habitat type within the NFC ("P" for pine rockland, "H" for hammock), followed by a 1–3 digit number assigned by the county.

POPULATION (NFC # if applicable (P-#))	**OWNERSHIP (* denotes lands managed for conservation)**	**POPULATION RANGE (No. of plants and year if available)**
Extant: Regularly monitored populations—status confirmed within last 5 years.		
Navy Wells Pineland Preserve (P–415)	State of Florida (Florida Keys Aqueduct Authority) and 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—Zoo Miami (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 School Board—managed by 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	101–1,000 [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—Girls Scouts of Tropical Florida	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 School Board	Unknown [7]
Nixon Smiley Pineland Preserve (P–370)	Miami-Dade County*	Unknown [8]

[1] Possley 2013b, pers. comm.
[2] Bradley and Gann 2005, page numbers not applicable.
[3] Glancy 2013, pers. comm.
[4] Bradley 2008a, pers. comm.
[5] Bradley and Gann 1999, p. 15.
[6] IRC 2005, page numbers not applicable.
[7] FNAI 2011, page numbers not applicable.
[8] IRC 1999, p. 2; IRC 2013, page numbers not applicable.

Demographic, Reproductive Biology, and Population Genetics

Little research has been done into the demography, reproductive biology, or genetics of *Brickellia mosieri*. Field observations indicate that the species does not usually occur in great abundance—populations are typically sparse and contain a low density of plants even in well-maintained pine rockland habitat (Bradley and Gann 1999, p. 12). Reproduction is sexual (Bradley and Gann 1999, p. 12). While specific pollinators or dispersers are unknown, flower morphology suggests this species may be pollinated by butterflies, bees, or both (Koptur 2013, pers. comm.); wind is one likely dispersal vector (Gann 2013b, pers. comm.). Flowering takes place primarily in the fall (August–October), but individuals may be found in flower during most of the year (Bradley and Gann 1999, p. 12).

Linum carteri var. *carteri*

Description

Linum carteri var. *carteri* (Family: Linaceae) is an annual or short-lived perennial herb endemic to Miami-Dade County, where it grows in pine rocklands, particularly in disturbed pine rocklands (Bradley and Gann 1999, p. 70). Its stem is erect, 23–36 cm (9.0–14.2 in) tall, commonly branched near the base, and puberulent (covered with minute hairs). Its leaves are slender (18–26 mm (0.7–1.0 in) long and 0.8–1.2 mm (0.03–

0.05 in) wide), entire, alternate, and closely overlap at the base of the plant. This variety has stipules (pair of appendages at the base of the petiole, which is the stalk by which a leaf is attached to a stem) with paired dark glands. Its inflorescence (cluster of flowers arranged on a branching stem) is an ascending or spreading cyme (usually flat-topped or convex flower cluster in which the main axis and each branch end in a flower that opens before the flowers below or to the side of it), with yellow petals that are broadly obovate (egg-shaped), 9–17 mm (0.35–0.67 in) long, and quickly deciduous. The fruit is straw-colored, ovoid, 4.1–4.6 mm (0.16–0.18 in) long, 3.4–3.7 mm (0.13–0.15 in) in diameter, and dehisces (opens spontaneously at defined places) into five two-seeded segments; seeds are narrowly ovoid-elliptic, 2.3–2.8 mm (0.09–0.11 in) long, 1.0–1.3 mm (0.04–0.05 in) wide. In habit and flower, the plant closely resembles *Piriqueta caroliniana* (Pitted stripeseed) in the Turneraceae (Bradley and Gann 1999, p. 70).

Taxonomy

According to Bradley and Gann (1999, p. 70), *Linum carteri* was named by Small in 1905; in 1907, he put it in a segregate genus, calling it *Cathartolinum carteri*. His concept of the taxon included both pubescent and glabrous (smooth, without hairs) plants, with or without stipular (having stipules) glands. In 1963, Rogers renamed the plants as a variety of *Linum rigidum*, noting the close relationship of Florida plants to those in the Western United States. In 1968, he split the taxon into two varieties, calling pubescent plants *Linum carteri* var. *carteri*, and segregating the glabrous plants as *Linum carteri* var. *smallii*, basing the division on new genetic data from Mosquin and Hayley (1967, pp.

1278–1283) and his own morphological data (Bradley and Gann 1999, p. 70). *L. c.* var. *carteri* was treated as endemic to Miami-Dade County, while *L. c.* var. *smallii* was slightly more widespread in southern Florida (Bradley and Gann 1999, p. 70). Long and Lakela (1971), Robertson (1971), and Wunderlin (1998) have used this same taxonomy (Bradley and Gann 1999, p. 70). ITIS (2013, page numbers not applicable) uses the name *Linum carteri* var. *carteri* and indicates that this species' taxonomic standing is accepted. Based upon the best available scientific information, *Linum carteri* var. *carteri* is a distinct taxon, endemic to Miami-Dade County in Florida. Synonyms include *Cathartolinum carteri* and *Linum rigidum* var. *carteri* (ITIS 2013b, page numbers not applicable).

Climate

The climate of south Florida where *Linum carteri* var. *carteri* occurs is described above for *Brickellia mosieri*.

Habitat

Like *Brickellia mosieri, Linum carteri* var. *carteri* grows exclusively on the Miami Rock Ridge in Miami-Dade County outside the boundaries of ENP. Its known populations are found at elevations ranging from approximately 1.6–4.8 m (5.2–15.9 ft), with occurrences distributed fairly regularly throughout this range. Herbarium label data indicated that *L. c.* var. *carteri* once occurred in pine rocklands with sand or marl deposits

(Bradley and Gann 1999, p. 75). In addition, one specimen was taken from Brickell Hammock, but it is more likely that the plant was collected outside of the hammock or along the roadside (Bradley and Gann 1999, p. 75). Currently, this variety is associated with pine rocklands that have undergone some sort of substrate disturbance (*e.g.*, firebreaks, canal banks, edges of railway beds). All known occurrences are within either scarified pine rockland, disturbed areas adjacent to or within pine rocklands, or in completely disturbed areas having a limestone substrate (Bradley and Gann 1999, p. 71; Bradley 2013, pers. comm.). None of the known occurrences over the last 15 years have been from a completely undisturbed pine rockland. *L. c.* var. *carteri* responds positively to low competition and high light conditions, and responds negatively to shading or litter accumulation. Thus, it may have been excluded from much of its former habitat by inadequate fire management (Bradley and Gann 1999, p. 71). Alternatively, this variety may only proliferate on sites where exposed substrate occurs following disturbance; historically this may have occurred following hurricanes (*e.g.,* under tip-up mounds), animal disturbance, or fire (Gann 2013a, pers. comm.). More information is needed to understand how this variety behaved in intact habitat before modern human disturbance (Gann 2013a, pers. comm.).

The pine rockland community is described above for *Brickellia mosieri*. The scarified pine rocklands and disturbed areas where *Linum carteri* var. *carteri* occurs often supports a subset of the pine rockland flora, as well as a component of weedy native and nonnative plants, including *Bidens alba* var. *radiata* (beggarticks), *Eremochloa ophiuroides* (centipede grass), *Desmodium* spp. (ticktrefoil), and *Stenotaphrum* *secundatum* (St. Augustine grass) (Bradley and Gann 1999, p. 71). *L. c.* var. *carteri* may grow in association with several other rare species including *Linum arenicola* (sand flax), *Dalea carthagenensis* var. *floridana* (Florida prairie-clover), and *Argythamnia blodgettii* (Blodgett's silverbush) (Bradley and Gann 1999, p. 71).

The natural disturbance regime for pine rocklands is discussed above for *Brickellia mosieri* and also applies to *Linum carteri* var. *carteri*. Fellows *et al.* (2004, p. 95) suggested that fire could be beneficial as it creates openings in the habitat, but that the potential for adults to survive from rootstock is unknown (although population recovery may be supported by the seed bank). Because areas where the variety now exists support native pine rockland herbaceous and grass plant species, periodic mowing of these areas may partially replace the role of fire in maintaining an open understory.

Historical Range

Linum carteri var. *carteri* was first collected in 1903 between the Coconut Grove and Cutler areas of Miami, and since that time, it 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, p. 463). Bradley and Gann (1999, p. 70) indicated that it has been found at many widespread locations, from Coconut Grove (latitude 25° 43.8') to southern Miami-Dade County, terminating near SW 280 Street (latitude 25° 30.4'), a range of about 39 km (24 mi). However, they believe that several of these occurrences represented misidentifications, and that the plants actually were either *Linum arenicola* (sand flax) or

Linum carteri var. *smallii* (Bradley and Gann 1999, p. 72). For example, a previous report of the plant occurring at Homestead Air Reserve Base site is now considered to be erroneous (Bradley 2008b, pers. comm.). Austin *et al.* (1980, page number not applicable) noted that there were four historical sites for this variety in a study of southern Florida, although only one site remained in 1980; they attributed the 75 percent decline to urbanization.

Current Range, Population Estimates, and Status

Linum carteri var. *carteri* is currently found from R. Hardy Matheson Preserve (near Pinecrest) southwest to Naranja/Modello, with a distance of approximately 27.3 km (17 mi) between the farthest locations. The apparent reduction in its historical range (11.2 km (7.2 mi), or 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, pers. comm.; Bradley and van der Heiden 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.

Fellows *et al.* (2001, p. 2) estimated the total population to be 9,540–10,300 plants across six populations in 2001, with one population sustaining the vast majority (Chapman Field, U.S. Department of Agriculture (USDA) Subtropical Horticultural Research Station; 7,500 individuals). *L. c.* var. *carteri* was not found during a 2-year project intended to survey and map nonnative and rare plants along FDOT rights-of-way within Miami-Dade County (Gordon *et al.* 2007, pp. 1, 36).

In 2012, IRC (Bradley and van der Heiden 2013, entire) conducted a status survey for *Linum carteri* var. *carteri* to include extant occurrences, historical locations, and new survey stations. Because they had previously conducted a comprehensive survey of all pine rockland habitat in 2004–2005 (during which, *L. c.* var. *carteri* 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. *L. c.* var. *carteri* 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 2; Bradley and van der Heiden 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 (Bradley and van der Heiden 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 2). Four of the populations occur near the north end of the variety's range (near R. Hardy Matheson Preserve), and three occur near the south end (near Camp Owaissa Bauer), with an approximately 16-km (10-mi) gap between the closest populations of these groups. Within each grouping, populations are approximately 1.3–4.3 km (0.8–2.7 mi) 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 2) 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 337–3,310 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 significant decline since 2001 could also potentially indicate a declining trend in one or more populations (especially USDA Chapman Field and R. Hardy Matheson Preserve).

Table 2. Extant and historical populations of *Linum carteri* var. *carteri*. For those populations occurring within a County-designated natural forest community (NFC) parcel, NFC number is provided if available. The NFC number format is a letter designating primary habitat type within the NFC ("P" for pine rockland, "H" for hammock), followed by a 1–3 digit number assigned by the county.

POPULATION (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—South Florida Water Management 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—U.S. Department of Agriculture	101–1,000 (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*	101–1,000 (374)
Rockdale Pineland Addition (P–52)	Miami-Dade County*	101–1,000 (195)
Historical: Population not observed for > 10 years, but habitat extant.		
Gifford Arboretum Pineland	Private	0

[1] Source for number of plants is Bradley and van der Heiden (2013, pp. 12–16).

Demographics, Reproductive Biology and Population Genetics

The reproductive ecology and biology of *Linum carteri* var. *carteri* is not well understood, but reproduction is sexual (Bradley and Gann 1999, p. 71). *L. c.* var. *carteri* is capable of flowering throughout the year, but tends to have most abundant flowering and fruiting following rain (Maschinski and Walters 2008, p. 28). Tatje (1980, p. 2) indicated that the variety requires disturbance to bloom, although this theory was not supported by observations of Maschinski *et al.* (2003, pp. 37–39). While specific pollinators are unknown, flower morphology suggests this variety may be pollinated by butterflies, bees, or both (Koptur 2013, pers. comm.). Alternatively, Mosquin and Hayley (1967, p. 1278) suggested *L. c.* var. *carteri* may be self-pollinated. Dispersers are also unknown, although historically water may have played a role in dispersal when summer high-water conditions in adjacent wet prairies may have inundated portions of pine rocklands (Gann 2013b, pers. comm.). The maximum magnitude and frequency of seed production is unknown, although Maschinski and Walters (2007, p. 56) indicate plants can produce up to 62 fruits. Some fruits dehisce in a characteristic 5-parted star pattern, while others never dehisce (Fellows 2002, Appendix D2 p. 1).

Preliminary demographic monitoring of *Linum carteri* var. *carteri* showed that, for adult reproductive plants, average plant growth was fairly constant from July through October, flowering and fruit production were most abundant in July, and plant mortality increased during the fall months (Maschinski *et al.* 2002, p. iv). Maschinski and Walters (2008, p. 27) studied in situ germination and growth-to-maturity of plants growing in the wild at two sites (mown and undisturbed) from January 2006 until July 2007. Field germination varied across sites and season of seed production, with seed produced in winter (January) having low to no germination and longer germination times than seeds produced in summer (July). Of the 51 seeds that germinated across all trials, they followed the growth of 32 seedlings—of these, only 6 set fruit (Maschinski and Walters 2008, p. 27). 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, p. 27). The 226-day growth-to-maturity enables this variety to contribute seeds to a next generation in a relatively short period (Maschinski and Walters 2008, p. 28). Once mature, individuals may live one to several years producing multiple fruits (Maschinski and Walters 2008, p. 28). Growth-to-maturity may be influenced by season of germination, with summer-germinating seeds possibly reaching maturity more rapidly than seedlings that germinate in the fall or winter (Maschinski and Walters 2008, p. 28). Similarly, seeds produced during different seasons may differ in their germination rates, dormancy breaking requirements, and rates of growth (Maschinski and Walters 2008, p. 28).

To examine population viability in response to disturbance, long-term demographic studies were conducted from June 2003 through July 2007 at a disturbed (mown) site and an undisturbed site; in May 2006, a site having both disturbed and undisturbed sections was added (Maschinski 2006, p. 82; Maschinski and Walters 2007, p. 55). Results were mixed with regard to demographic responses between sites. Maschinski (2006, p. 83) reported that *Linum carteri* var. *carteri* has typical behavior for an early successional plant. Significantly higher densities of plants were found at the mown sites where competition with other plants is decreased, although changes in number of plants between sites and treatments were variable (Maschinski and Walters 2007, p. 56). Germination varied across sites and season of seed production as discussed above, although there was greater germination on the undisturbed site in both seasons. Fruiting was also variable across years and sites; while there was no clear effect of mowing, plants growing on mown sites were shorter, which may affect fruiting magnitude. While mowing does not usually kill adult plants, if mowing occurs prior to plants reaching reproductive status, it can also delay reproduction (Maschinski and Walters 2007 pp. 56–57). If such mowing occurs repeatedly, reproduction of those plants would be entirely eliminated. If, instead, mowing occurs at least three weeks after flowering, there would be a higher probability of adults setting fruit prior to mowing; mowing may then act as a positive disturbance by both scattering seeds and reducing competition (Maschinski and Walters 2007, p. 57). The exact impacts of mowing thus depend on the timing of the mowing event, rainfall prior to and following mowing, and the numbers of plants in the population that have reached a reproductive state.

Although population viability models projected declines in mown sites, and fairly stable population growth in undisturbed sites, high variation in the models suggest caution be used in interpreting results. One likely factor in the high year-to-year variation observed is variation in weather, which was most apparent in the model for undisturbed habitat. Preliminary models indicated that population viability was greatly affected by reproductive rates and whether there is a persistent seed bank (Maschinski 2006, p. 83; Maschinski and Walters 2007, p. 56). Models indicate that the transition from seedling to adult and adult reproduction greatly influence population trajectories (Maschinski and Walters 2007, p. 56). However, more frequent monitoring (with frequency partially dependent of mowing regime) is needed to determine threshold reproductive values for population growth and whether disturbance regime has a persistent impact on population demographics (Maschinski 2013, pers. comm.).

Summary of Factors Affecting the Species

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may determine a species to be endangered or threatened due to one or more of the following five factors: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors as applied to these two plants is discussed below.

A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Brickellia mosieri and *Linum carteri* var. *carteri* have experienced substantial destruction, modification, and curtailment of their habitat and range (see **Status Assessment**, above). Specific threats to these plants included in this factor include habitat loss, fragmentation, and modification caused by development (i.e., conversion to both urban and agricultural land uses) and inadequate fire management. Each of these threats and its specific effects on these plants are discussed in detail below.

Human Population Growth and Development

The pine rockland community of south Florida, to which both plants are endemic, is critically imperiled globally (FNAI 2012, p. 27). Since the 1800s, residential and commercial development and agriculture have drastically reduced the habitat for these plants throughout pine rocklands in south Florida. When the Florida East Coast (FEC) Railroad reached Miami in 1896, industrial logging began and pinelands were clearcut over the next 50 years (Snyder *et al.* 1990, p. 271). Groves of tropical trees were planted on well-drained (and previously cleared) pinelands; with the invention of the "rock plow" in 1954, large-scale clearing of pinelands for row crops began (Snyder *et al.* 1990, p. 272). Due to these impacts combined with increased residential development from the early 1900s, pine rockland habitat in Miami-Dade County, including ENP, was reduced to about 11 percent of its natural extent, from approximately 74,000 hectares (ha) (183,000 acres (ac)) to only 8,140 ha (20,100 ac) in 1996 (Kernan and Bradley 1996, p. 2). Outside of ENP, only about 1 percent of the Miami Rock Ridge pinelands have escaped clearing, and much of what is left is in small remnant blocks isolated from other natural areas (Herndon 1998, p. 1). Habitat loss continues to occur in these plants' ranges, and most remaining suitable habitat has been negatively altered by human activity.

While Miami-Dade County has developed a network of public conservation lands including some of these pine rocklands, much of the remaining habitat occurs on private lands as well as publically owned lands not managed for conservation. Species occurrences and suitable habitat remaining on these lands are threatened by habitat loss and degradation, and threats are expected to accelerate with increased development. The human population within Miami-Dade County, which comprises the historical and current ranges for these plants and, therefore, supports all of the remaining occurrences, is currently greater than 2.4 million people, and the population is expected to grow to more than 4 million by 2060, an annual increase of roughly 30,000 people (Zwick and Carr 2006, p. 20). Approximately 47 percent (8 sites) of extant *Brickellia mosieri* occurrences, and 28 percent (2 sites) of extant *Linum carteri* var. *carteri* occurrences, are located on private land within this County; however, it is likely that these plants will be lost from most of these sites, with increased development pressure.

Development, such as road construction, can also threaten these plants' habitat on public lands. This is especially true for *Linum carteri* var. *carteri*, whose association with disturbed areas is more likely to result in occurrences in firebreaks and other edge areas subject to increased development pressure and effects. For example, one colony of 11–100 *L. c.* var. *carteri* individuals located within the FEC Railway right-of-way at Old

Dixie Pineland was destroyed by the construction of the South Miami-Dade Busway in 2007 (Bradley and van der Heiden 2013, p. 15). In addition, one of the two colonies of *L. c.* var. *carteri* on Camp Owaissa Bauer Addition occurs along the edge of pine rockland along Krome Avenue, and is threatened by the proposed widening of that road.

Another human-related factor that can modify public and private lands alike is the potential for high levels of nutrients from agricultural and urban areas to enter into pine rockland systems. Such chemical alteration of pine rockland soil, which has naturally low amounts of phosphorus and nitrogen, can result in changes to vegetation composition and structure, at the expense of pine rockland endemics such as *Brickellia mosieri* and *Linum carteri* var. *carteri*. This is currently not considered a problem in most intact pine rockland systems, but could likely be an issue where restoration is required (Gann 2013a, pers. comm.).

Habitat Fragmentation

Habitat fragmentation reduces the size of plant populations, and increases spatial isolation of remnants. Barrios *et al.* (2011, p. 1062) investigated the effects of fragmentation on a threatened pine rockland plant, *Angadenia berteroi* (pineland golden trumpet), and found that abundance and fragment size were positively related. Possley *et al.* (2008, p. 385) studied the effects of fragment size on species composition in south Florida pine rocklands, and found that plant species richness and fragment size were positively correlated (although some small fragments supported nearly as many species as the largest fragment). Composition of fragmented habitat typically differs from that of intact forests, as isolation and edge effects increase leading to increased abundance of disturbance-adapted species (weedy species, nonnative invasive species) and lower rates of pollination and propagule dispersal (Laurence and Bierregaard 1997, pp. 347–350.; Noss and Csuti 1997, pp. 284–299). The degree to which fragmentation threatens the dispersal abilities of *Brickellia mosieri* and *Linum carteri* var. *carteri* is unknown. Because *B. mosieri* is thought to be dispersed, to some degree, by wind, dispersal-related impacts are probably less than those experienced by *L. c.* var. *carteri,* which has heavier seeds. In the historical landscape, where pine rockland occurred within a mosaic of wetlands, water may have acted as a dispersal vector for all pine rockland seeds, and especially for plants such as *L. c.* var. *carteri*. In the current, fragmented landscape, this type of dispersal would no longer be possible. While additional dispersal vectors for *L. c.* var. *carteri* may include animals and (in certain locations) mowing equipment, it is likely that fragmentation has effectively reduced this taxon's ability to disperse.

While pollination research has not been conducted for *Brickellia mosieri* or *Linum carteri* var. *carteri*, research regarding other species and ecosystems provides valuable information regarding potential effects of fragmentation to these plants. Effects of fragmentation on pollinators may include changes to the pollinator community as a result of limitation of pollinator-required resources (*e.g.*, reduced availability of rendezvous plants, nesting and roosting sites, and nectar/pollen); these changes may include changes to pollinator community composition, species abundance and diversity, and pollinator behavior (Rathcke and Jules 1993, pp. 273–275; Kremen and Ricketts 2000, p. 1227;

Harris and Johnson 2004, pp. 30–33). As a result, plants in fragmented habitats may experience lower visitation rates, which in turn may result in reduced seed production of the pollinated plant (which may lead to reduced seedling recruitment), reduced pollen dispersal, increased inbreeding, reduced genetic variability, and ultimately reduced population viability (Rathcke and Jules 1993, p. 275; Goverde *et al.* 2002, pp. 297–298; Harris and Johnson 2004, pp. 33–34).

In addition to effects on pollination, fragmentation of natural habitats often alters other ecosystems' functions and disturbance regimes. Fragmentation results in an increased proportion of "edge" habitat, which in turn has a variety of effects, including changes in microclimate and community structure at various distances from the edge (Margules and Pressey 2000, p. 248), altered spatial distribution of fire (greater fire frequency in areas nearer the edge) (Cochrane 2001, pp. 1518–1519), and increased pressure from nonnative invasive plants and animals that may out-compete or disturb native plant populations. The effects of fragmentation on fire go beyond edge effects and include reduced likelihood and extent of fires, and altered behavior and characteristics (*e.g.*, intensity) of those fires that do occur. Habitat fragmentation encourages the suppression of naturally occurring fires, and has prevented fire from moving across the landscape in a natural way, resulting in an increased amount of habitat suffering from these negative impacts. High fragmentation of small habitat patches within an urban matrix discourages the use of prescribed fire as well due to logistical difficulties (see Fire Management, below). Forest fragments in urban settings are also subject to increased likelihood of certain types of human-related disturbance, such as the dumping of trash

(Chavez and Tynon 2000, p. 405). The many effects of habitat fragmentation may work in concert to threaten the local persistence of a species; when a species' range of occurrence is limited, threats to local persistence increase extinction risk.

Fire Management

One of the primary threats to both of these plants is habitat modification and degradation through inadequate fire management, which includes both the lack of prescribed fire and suppression of natural fires. Where the term "fire-suppressed" is used below, it describes degraded pine rockland conditions resulting from a lack of adequate fire (natural or prescribed) in the landscape. Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands (see **Status Assessment**, above). A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010, p. 63). Exclusion of fire for approximately 25 years will likely result in gradual hammock development over that time period, leaving a system that is very fire resistant if additional pre-fire management (*e.g.,* mechanical hardwood removal) is not undertaken.

Now, natural fires are unlikely to occur or are likely to be suppressed in the remaining, highly fragmented pine rockland habitat. The suppression of natural fires has reduced the size of the areas that burn, and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Without fire, successional climax from pine rockland to rockland hammock is rapid, and displacement of native species by invasive nonnative plants often occurs. Understory plants such as *Brickellia mosieri* and *Linum carteri* var. *carteri* are shaded out by hardwoods and nonnatives alike. Shading may also be caused by a fire-suppressed (and, in some cases, planted) pine canopy that has evaded the natural thinning effects that fire has on seedlings and smaller trees. Gann (2013a, pers. comm.) indicates this is also a threat to pine rockland habitat on the Miami Rock Ridge. Whether the dense canopy is composed of pine, hardwoods, nonnatives, or a combination, seed germination and establishment are inhibited in fire-suppressed habitat due to accumulated leaf litter, which also changes soil moisture and nutrient availability (Hiers *et al.* 2007, pp. 811–812). This alteration to microhabitat can also inhibit seedling establishment as well as negatively influence flower and fruit production (Wendelberger and Maschinski 2009, pp. 849–851), thereby reducing sexual reproduction in fire-adapted species such as *B. mosieri* and *L. c.* var. *carteri* (Geiger 2002, pp. 78–79, 81–83).

After an extended period of inadequate fire management in pine rocklands, it becomes necessary to control invading native hardwoods mechanically, since excess growth of native hardwoods would result in a hot fire, which can be destructive. Mechanical treatments cannot entirely replace fire because pine trees, understory shrubs, grasses, and herbs all contribute to an ever-increasing layer of leaf litter, covering herbs and preventing germination, as discussed above. Leaf litter will continue to accumulate even if hardwoods are removed mechanically. In addition, the ashes left by fires provide important post-fire nutrient cycling, which is not provided via mechanical removal.

Brickellia mosieri—All occurrences of *Brickellia mosieri* are affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999, p. 15; Bradley and Gann 2005, page numbers not applicable). While management of some County conservation lands (*e.g.,* those in Richmond Pinelands complex and Navy Wells Pineland Preserve) includes regular burning, other such lands can be severely fire-suppressed. For example, the *B. mosieri* population at Pine Shore Pineland Preserve may be the most endangered (due to lack of adequate fire management), and is expected to be extirpated within 10 years if fires are not reintroduced (Possley 2013a, pers. comm.). Even in areas under active management, some portions are typically fire-suppressed, thereby threatening populations of this species.

Linum carteri var. *carteri*—Of the seven extant occurrences of *Linum carteri* var. *carteri*, six are threatened to some degree by inadequate fire management. Three of these populations (Camp Owaissa Bauer Addition, Montgomery Botanical Center, and Rockdale Pineland) occur adjacent to fire-suppressed pine rocklands (Bradley and van der Heiden 2013, pp. 13–16). One population (R. Hardy Matheson Preserve) occurs in previously cleared pine rockland habitat in areas of open canopy gaps and exposed bare rock substrate (Bradley and van der Heiden 2013, p. 16). Pine rocklands at Chapman Field, USDA Subtropical Horticultural Research Station are severely fire-suppressed, and the plant now occurs only adjacent to the pine rocklands or in nearby open fields (Bradley and van der Heiden 2013, p. 13). In addition, one historical population (at Gifford Arboretum Pineland) may have been extirpated due to the effects of inadequate fire management (Bradley and van der Heiden 2013, p. 14). Bradley and Gann (1999, pp. 71–72) suggested that the lack of fires in most forest fragments in Miami-Dade County during the last century may be one of the reasons why this taxon occurs primarily in disturbed areas.

Implementation of a prescribed fire program in Miami-Dade County has been hampered by a shortage of resources, and by logistical difficulties and public concern related to burning next to residential areas. Many homes have been built in a mosaic of pine rockland, so the use of prescribed fire in many places has become complicated because of potential danger to structures and smoke generated from the burns. Nonprofit organizations such as IRC have similar difficulties in conducting prescribed burns due to difficulties with permitting and obtaining the necessary permissions as well as hazard insurance limitations (Gann 2013a, pers. comm.). Few private landowners have the means and/or desire to implement prescribed fire on their property, and doing so in a fragmented urban environment is logistically difficult and may be costly. One of the few privately owned pine rocklands that is successfully managed with prescribed burning is Pine Ridge Sanctuary, located in a more agricultural (less urban) matrix in the southwestern portion of *Brickellia mosieri*'s current range, which was last burned in November 2010 (Glancy 2013, pers. comm.).

Conservation Efforts To Reduce the Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

In 1979, Miami-Dade County enacted the Environmentally Endangered Lands (EEL) Covenant Program, which reduces taxes for private landowners of natural forest communities (NFCs; pine rocklands and tropical hardwood hammocks) who agree not to develop their property and manage it for a period of 10 years, with the option to renew for additional 10-year periods (Service 1999, p. 3-177). Although these temporary conservation easements provide valuable protection for their duration, they are not considered under Factor D, below, because they are voluntary agreements and not regulatory in nature. Miami-Dade County currently has approximately 59 pine rockland properties enrolled in this program, preserving 69.4 ha (172 ac) of pine rockland habitat (Johnson 2012, pers. comm.). The vast majority of these properties are small—only three are larger than 2 ha (5 ac)—and many are in need of habitat management such as prescribed fire and removal of nonnative invasive plants. Of the 59 pine rockland properties, three have known populations of *Brickellia mosieri*. Two of these, a 1.3-ha (3.3-ac) parcel and a 5.7-ha (14-ac) parcel, are in good overall condition. The other, a 5.75-ha (14.2-ac) parcel, has heavy cover by exotics, and illegal clearing of NFC vegetation was observed during a 2013 site inspection. Thus, while EEL covenant lands have the potential to provide valuable habitat for these plants and reduce threats in the near term, the actual effect of these conservation lands is largely determined by whether individual land owners follow prescribed EEL management plans and NFC regulations (see Local under Factor D).

Since 2005, the Service has funded IRC to facilitate restoration and management of privately owned pine rockland habitats in Miami-Dade County. These programs included prescribed burns, nonnative plant control, light debris removal, hardwood management, reintroduction of pines where needed, and development of management plans. One of these programs, called the Pine Rockland Initiative, includes 10-year cooperative agreements between participating landowners and the Service/IRC to ensure restored areas will be managed appropriately during that time. Although most of these objectives have been achieved, IRC has not been able to conduct the desired prescribed burns, due to logistical difficulties as discussed above (see Fire Management).

Fairchild Tropical Botanic Garden (FTBG), with the support of various Federal, State, local, and nonprofit organizations, has established the "Connect to Protect Network." The objective of this program is to encourage widespread participation of citizens to create corridors of healthy pine rocklands by planting stepping stone gardens and rights-of-way with native pine rockland species, and restoring isolated pine rockland fragments. By doing this, FTBG hopes to increase the probability that pollination and seed dispersal vectors can find and transport seeds and pollen across developed areas that separate pine rockland fragments to improve gene flow between fragmented plant populations and increase the likelihood that these plants will persist over the long term. Although these projects may serve as valuable components toward the conservation of pine rockland species and habitat, they are dependent on continual funding, as well as participation from private landowners, both of which may vary through time.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

We have no evidence suggesting that overutilization for commercial, recreational, scientific, or educational purposes is a threat to *Brickellia mosieri*. Except for its rarity, the species does not possess any attributes that would make it desirable to collectors, such as showy foliage or flowers, and there are no known medicinal, culinary, or religious uses for this species. We also have no evidence that overutilization is a threat for *Linum carteri* var. *carteri*. However, FTBG states that the species is a member of the *Linum rigidum* complex and, therefore, may contain the α-carotenoids leutin and 5,6-monoepoxide (Robertson 1971, p. 658), both of which are hypothesized to reduce the risk of certain cancers (Fellows *et al.* 2004, p. 96). At this time, we have no evidence indicating that *L. c.* var. *carteri* is being used for this purpose. Therefore, we believe that collection for medicinal purposes is not a threat at this time. Based on our analysis of the best available scientific and commercial information, we find that collecting for commercial or scientific reasons or recreational activities is not a threat to *B. mosieri* or *L. c.* var. *carteri* in any portion of their ranges at this time and is not likely to become so in the future. Threats to these plants related to other aspects of recreation and similar human activities (i.e., not related to overutilization) are discussed in Factor E.

C. Disease or Predation

No diseases or incidences of predation have been reported for *Brickellia mosieri* and *Linum carteri* var. *carteri*.

D. The Inadequacy of Existing Regulatory Mechanisms

Under this factor, we examine whether existing regulatory mechanisms are inadequate to address the threats to the species discussed under the other factors. Section 4(b)(1)(A) of the Act requires the Service to take into account "those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species…." In relation to Factor D, we interpret this language to require the Service to consider relevant Federal, State, and tribal laws, plans, regulations, and other such mechanisms that may minimize any of the threats we describe in threat analyses under the other four factors, or otherwise enhance conservation of the species. We give strongest weight to statutes and their implementing regulations and to management direction that stems from those laws and regulations. An example would be State governmental actions enforced under a State statute or constitution, or Federal action under statute.

Federal

These plants have no Federal regulatory protection in their known occupied and suitable habitat. Neither taxon occurs on National Wildlife Refuge or National Park land. *Brickellia mosieri* is known to occur on Federal lands within the Richmond Pinelands

Complex, including lands owned by the U.S. Coast Guard and the National Oceanic and Atmospheric Association (NOAA; small portion of Martinez Pineland). The only known Federal occurrence of *Linum carteri* var. *carteri* is on Chapman Field USDA Subtropical Horticultural Research Station. There are no Federal protections for candidate species on these properties. These plants primarily occur on State- or County-owned and private land (Tables 1 and 2), and development of these areas will likely require no Federal permit or other authorization. Therefore, projects that affect them are usually not analyzed under the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et seq.*).

State

Brickellia mosieri and *Linum carteri* var. *carteri* are listed on the Regulated Plant Index as endangered under Chapter 5B-40, Florida Administrative Code. The Regulated Plant Index also includes all federally listed endangered and threatened plant species. This listing provides little or no habitat protection beyond the State's Development of Regional Impact process, which discloses impacts from projects, but provides no regulatory protection for State-listed plants on private lands.

Florida Statutes 581.185 sections (3)(a) and (b) prohibit any person from willfully destroying or harvesting any species listed as endangered or threatened on the Index, or growing such a plant on the private land of another, or on any public land, without first obtaining the written permission of the landowner and a permit from the Florida Department of Plant Industry. The statute further provides that any person willfully destroying or harvesting; transporting, carrying, or conveying on any public road or highway; or selling or offering for sale any plant listed in the Index as endangered must have a permit from the State at all times when engaged in any such activities.

In addition, subsections (8)(a) and (b) of the statute waive State regulation for certain classes of activities for all species on the Regulated Plant Index, including the clearing or removal of regulated plants for agricultural, forestry, mining, construction (residential, commercial, or infrastructure), and fire-control activities by a private landowner or his or her agent. However, section (10) of the statute provides for consultation similar to section 7 of the Federal Act for listed species by requiring the Department of Transportation to notify the FDACS and the Endangered Plant Advisory Council of planned highway construction at the time bids are first advertised, to facilitate evaluation of the project for listed plant populations, and to "provide for the appropriate disposal of such plants" (i.e., transplanting).

Local

In 1984, Section 24–49 of the Code of Miami-Dade County established regulation of County-designated NFCs, which include both pine rocklands and tropical hardwood hammocks. These regulations were placed on specific properties throughout the county by an act of the Board of County Commissioners in an effort to protect environmentally sensitive forest lands. The Miami-Dade County Department of Regulatory and Economic Resources (RER) has regulatory authority over NFCs and is charged with enforcing regulations that provide partial protection on the Miami Rock Ridge. Miami-Dade Code typically allows up to 20 percent of a pine rockland designated as NFC to be developed, and requires that the remaining 80 percent be placed under a perpetual covenant. In certain circumstances, where the landowner can demonstrate that limiting development to 20 percent does not allow for "reasonable use" of the property, additional development may be approved. NFC landowners are also required to obtain an NFC permit for any work, including removal of nonnatives within the boundaries of the NFC on their property. The NFC program is responsible for ensuring that NFC permits are issued in accordance with the limitations and requirements of the code and that appropriate NFC preserves are established and maintained in conjunction with the issuance of an NFC permit. The NFC program currently regulates approximately 600 pine rockland or pine rockland/hammock properties, comprising approximately 1,200 ha (3,000 ac) of habitat (Joyner 2013, pers. comm.). NFC regulations are designed to prevent clearing or destruction of native vegetation within preserved areas; however, illegal development and destruction of pine rockland continues to occur, despite these regulations. When discovered, RER pursues unpermitted work through appropriate enforcement action and seeks restoration when possible.

Fee Title Properties

In 1990, Miami-Dade County voters approved a 2-year property tax to fund the acquisition, protection, and maintenance of environmentally endangered lands. The EEL Program identifies and secures these lands for preservation. Under this program to date, Miami-Dade County has acquired a total of approximately 255 ha (630 ac) of pine rockland. In addition, approximately 445 ha (1,100 ac) of pine rockland are owned by the Miami-Dade County Parks and Recreation Department and managed by the EEL Program, including some of the largest remaining areas of pine rockland habitat on the Miami Rock Ridge outside of ENP (*e.g.,* Larry and Penny Thompson Park, Zoo Miami pinelands, and Navy Wells Pineland Preserve).

While State and local regulations, and fee title properties, do provide for protection of these plants specifically, and pine rockland habitat in general, they are either not effective or not implemented sufficiently to alleviate the threats to these plants or their habitat.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

Brickellia mosieri and *Linum carteri* var. *carteri* are both threatened by other natural or manmade factors that affect each taxon to varying degrees. Specific threats to these plants included in this factor consist of the spread of nonnative invasive plants, potentially incompatible management practices (such as mowing and herbicide use), direct impacts to plants from recreation and other human activities, small population size and isolation, climate change, and the related risks from environmental stochasticity (extreme weather) on these small populations. Each of these threats and its specific effect on these plants are discussed in detail below.

Nonnative Plant Species

Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of *Brickellia mosieri* and *Linum carteri* var. *carteri* to some degree (Bradley and Gann 1999, pp. 15, 72; Bradley and Gann 2005, page numbers not applicable; Bradley 2007, pers. comm.; Bradley and van der Heiden 2013, pp. 12–16). As a result of human activities, at least 277 taxa of nonnative plants have invaded pine rocklands throughout south Florida (Service 1999, p. 3-175). *Neyraudia neyraudiana* (Burma reed) and *Schinus terebinthifolius* (Brazilian pepper) threaten both plants (Bradley and Gann 1999, pp. 13, 72). *S. terebinthifolius*, a nonnative tree, is the most widespread and one of the most invasive species. It forms dense thickets of tangled, woody stems that completely shade out and displace native vegetation (Loflin 1991, p. 19; Langeland and Craddock Burks 1998, p. 54). *Acacia auriculiformis* (earleaf acacia), *Rhynchelytrum repens* (natal grass), *Lantana camara* (shrub verbena), and *Albizia lebbeck* (tongue tree) are some of the other nonnative species in pine rocklands. More species of nonnative plants could become problems in the future, such as *Lygodium microphyllum* (Old World climbing fern), which is a serious threat throughout south Florida.

Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for both *Brickellia mosieri* and *Linum carteri* var. *carteri,* which respond positively to open conditions. They also affect the characteristics of a fire when it does occur. Historically, pine rocklands had an open, low understory where natural fires remained patchy with low temperature intensity, thus sparing many native plants such as *B. mosieri* and *L. c.* var. *carteri*. Dense infestations of

Neyraudia neyraudiana and *Schinus terebinthifolius* cause higher fire temperatures and longer burning periods. With the presence of invasive nonnative species, it is uncertain how fire, even under a managed situation, will affect these plants. Bradley and Gann (1999, pp. 13, 71–72) indicated that the control of nonnative plants is one of the most important conservation actions for these plants and a critical part of habitat maintenance.

Management of nonnative invasive plants in pine rocklands in Miami-Dade County is further complicated because the vast majority of pine rocklands are small, fragmented areas bordered by urban development. Areas near managed pine rockland that contain nonnative species can act as a seed source of nonnatives allowing them to continue to invade the surrounding pine rockland (Bradley and Gann 1999, p. 13).

Mowing

Linum carteri var. *carteri*'s occurrence in disturbed, open areas such as firebreaks and road rights-of-way makes it much more susceptible than *Brickellia mosieri* to disturbance factors such as mowing. According to Bradley and van der Heiden (2013, pp. 12–16), five of the seven extant populations of this variety are vulnerable to changes in mowing practices. Mowing can serve to maintain an open understory in the absence of fire (Bradley and Gann 1999, p. 71; Maschinski and Walters 2007, p. 56). For example, at the Montgomery Botanical Center, occasional mowing is thought to keep competing vegetation at bay while still allowing the plants to complete their life cycle (Maschinski 2011, pers. comm.). However, mowing can also threaten this variety depending on the timing, frequency, and intensity of its application (see **Status Assessment**, above). If not properly applied, mowing can eliminate reproduction entirely in very young plants or delay reproductive maturation (Maschinski and Walters 2007, p. 56; 2008, p. 28). In some instances, adult plants may be killed, but typically mowing simply disrupts the apical meristem (as with natural levels of herbivory) and triggers production of additional lateral branches; plants can produce compensatory branches following mowing and live to reproduce at a later time as long as the mowing regime is not too frequent (Maschinski and Walters 2008, p. 28). The impact of mowing can be modified by the timing and frequency of the mowing event, rainfall prior to and following the event, and the numbers of plants that have reached reproductive state prior to mowing (Maschinski and Walters 2008, p. 27). Maschinski and Walters (2008, p. 28) recommended adjusting the timing of mowing to occur at least three weeks after flowering is observed to allow a higher probability of adults setting fruit prior to the mowing event. With flexibility and proper instructions to land managers and ground crews, mowing practices could be implemented in such a way as to scatter seeds and reduce competition with little effect on population reproductive output for the year (Maschinski and Walters 2008, p. 28).

Herbicides

As with mowing, the use of herbicides is more likely to threaten populations of *Linum carteri* var. *carteri*, due to the variety's occurrence in disturbed, open areas, which are also the typical habitat of weedy and nonnative plant species. Two of the seven extant *L. c.* var. *carteri* occurrences—the C-103 Canal and Chapman Field USDA

Subtropical Horticultural Research Station—are in such areas. The use of herbicides for weed control here would be detrimental to these populations.

Recreation and Other Human Activities

Linum carteri var. *carteri*'s occurrence in disturbed, open areas such as firebreaks and road rights-of-way also makes it much more susceptible than *Brickellia mosieri* to recreational and other human activities. These activities may inadvertently impact some populations of *L. c.* var. *carteri*. In the past, mountain biking has been identified as a threat at R. Hardy Matheson Preserve (Bradley and Gann 1999, pp. 71, 74; Bradley 2007, pers. comm.), but this was remedied by placement of protective fencing (Possley 2012, pers. comm.). More recently, a colony of *L. c.* var. *carteri* at Camp Owaissa Bauer Addition has been impacted by "yard sales" and car parking along Krome Avenue (Bradley and van der Heiden 2013, p. 13). While these impacts are usually some distance from the plants, they sometimes encroach on the edge of the natural area and have the potential to trample the plants. This plant occurs in similar habitat on Rockdale Pineland, where it is found along the edges of the abandoned FEC Railroad tracks, adjacent to pine rockland habitat (Bradley and van der Heiden 2013, p. 16). Here, plants have also been trampled from parking vehicles and machinery along the edges of the railroad right-of-way (Bradley and van der Heiden 2013, p. 16). While these activities have affected individual plants in some populations, they are not likely to have caused significant population declines in the taxon.

Effects of Small Population Size and Isolation

Endemic species whose populations exhibit a high degree of isolation are extremely susceptible to extinction from both random and nonrandom catastrophic natural or human-caused events. Species that are restricted to geographically limited areas are inherently more vulnerable to extinction than widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change, and localized catastrophes such as hurricanes and disease outbreaks (Mangel and Tier 1994, p. 607; Pimm *et al.* 1988, p. 757). These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 24–34).

Small, isolated populations, such as those in fragmented habitat, often exhibit reduced levels of genetic variability, although the ultimate effect of these changes is dependent on a plant's specific life history, reproductive system, and interaction with pollinators and dispersal vectors (which may themselves be affected by fragmentation) (Young *et al.* 1996, p. 413). While research results clearly indicate that isolation/fragmentation has population genetic consequences for plants, consequences are varied and for some species there may be a "fragmentation threshold" below which genetic variation is not lost (Young *et al.* 1996, p. 416). No such study has been conducted for *Brickellia mosieri* or *Linum carteri* var. *carteri*, so whether these plants exhibit such a threshold is not known. Reduced genetic variability generally diminishes a species' capacity to adapt and respond to environmental changes, thereby decreasing the probability of long-term persistence (*e.g.*, Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Isolated individuals have difficulty achieving natural pollen exchange, which limits the production of viable seed. The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic (interaction of two or more components) effects with other threats, such as those discussed above.

Only small and fragmented occurrences of these two plants remain. The current ranges of *Brickellia mosieri* and *Linum carteri* var. *carteri* span such a small geographic area—a narrow band (no more than 4.0 km (2.5 mi) in width) along the ridge approximately 30.1 km (18.7 mi) and 26.9 km (16.7 mi) in length, respectively—that all populations could be affected by a single event (*e.g.*, hurricane). Four of the seven remaining populations of *L. c.* var. *carteri* have fewer than 20 individual plants (see Table 2). *B. mosieri* populations occur in higher numbers (Table 1) but are still not considered sizable. *L. c.* var. *carteri* shows great differences in plant numbers from year to year, probably because individuals typically live 1–2 years and grow from seed. This trait makes them more vulnerable than perennials to changes in environment. Viable plant populations for small, short-lived herbs may consist of tens of thousands of plants (Menges 1991, p. 48; Lande 1995, p. 789). Although robust population viability analyses (including minimum viable population calculations) have not been conducted for these plants, indications are that most existing populations for both plants are at best marginal. Lack of dispersal between occurrences may also be a threat (see Habitat Fragmentation under Factor A).

Climate Change

Climatic changes, including sea level rise (SLR), are major threats to south Florida, including *Brickellia mosieri* and *Linum carteri* var. *carteri*. Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (*e.g.*, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007, p. 30; and Solomon *et al*. 2007, pp. 35–54, 82–85.)

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of greenhouse gas (GHG) emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (*e.g.*, Meehl *et al*. 2007, entire; Ganguly *et al*. 2009, pp. 11555, 15558; Prinn *et al*. 2011, pp. 527, 529). Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007, pp. 44–45; Meehl *et al*. 2007, pp. 760–764 and 797–811; Ganguly *et al*. 2009, pp. 15555–15558; Prinn *et al*. 2011, pp. 527, 529).

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (*e.g.*, habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19).

Projected changes in climate and related impacts can vary substantially across and within different regions of the world (*e.g.*, IPCC 2007, pp. 8–12). Therefore, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures (see Glick *et al*. 2011, pp. 58–61, for a discussion of downscaling). With regard to our analysis for *Brickellia mosieri* and *Linum carteri* var. *carteri*, downscaled projections suggest that SLR is the largest climate-driven challenge to low-lying coastal areas in the subtropical ecoregion of southern Florida (U.S. Climate Change Science Program (USCCSP) 2008, pp. 5–31, 5–32). Several populations of *B. mosieri* occur at elevations less than 2 m (6.6 ft) above sea level. In addition, approximately 50 percent of the known occurrences of *L. c.* var. *carteri* are located along a coastal ridge, making the species highly susceptible to increased storm surges and related impacts associated with SLR.

The long-term record at Key West shows that sea level rose on average 0.229 cm (0.090 in) annually between 1913 and 2013 (National Oceanographic and Atmospheric Administration (NOAA) 2013, p. 1). This equates to approximately 22.9 cm (9.02 in) over the last 100 years. IPCC (2008, p. 28) emphasized it is very likely that the average rate of SLR during the 21st century will exceed the historical rate. The IPCC Special Report on Emission Scenarios (2000, entire) presented a range of scenarios based on the computed amount of change in the climate system due to various potential amounts of anthropogenic greenhouse gases and aerosols in 2100. Each scenario describes a future world with varying levels of atmospheric pollution leading to corresponding levels of global warming and corresponding levels of SLR. The IPCC Synthesis Report (2007, entire) provided an integrated view of climate change and presented updated projections of future climate change and related impacts under different scenarios.

Subsequent to the 2007 IPCC Report, the scientific community has continued to model SLR. Recent peer-reviewed publications indicate a movement toward increased acceleration of SLR. Observed SLR rates are already trending along the higher end of the 2007 IPCC estimates, and it is now widely held that SLR will exceed the levels projected by the IPCC (Rahmstorf et al. 2012, p. 1; Grinsted et al. 2010, p. 470). Taken together, these studies support the use of higher end estimates now prevalent in the scientific literature. Recent studies have estimated global mean SLR of 1–2 m (3.3–6.6 ft) by 2100 as follows: 0.75–1.90 m (2.5–6.2 ft; Vermeer and Rahmstorf 2009, p. 21530), 0.8–2.0 m (2.6–6.6 ft; Pfeffer *et al.* 2008, p. 1342), 0.9–1.3 m (3.0–4.3 ft; Grinsted *et al.* 2010, pp. 469–470), 0.6–1.6 m (2.0–5.2 ft; Jevrejeva *et al.* 2010, p. 4), and 0.5–1.40 m (1.6–4.6 ft; National Resource Council 2012, p. 2).

Other processes expected to be affected by projected warming include temperatures, rainfall (amount, seasonal timing, and distribution), and storms (frequency and intensity) (discussed more specifically under Environmental Stochasticity, below). The Massachusetts Institute of Technology (MIT) modeled several scenarios combining various levels of SLR, temperature change, and precipitation differences with human population growth, policy assumptions, and conservation funding changes (see Alternative Future Landscape Models, below). All of the scenarios, from small climate change shifts to major changes, indicate significant effects on coastal Miami-Dade

County.

Prior to inundation, pine rocklands are likely to undergo habitat transitions related to climate change, including changes to hydrology and increasing vulnerability to storm surge. Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically grade from salt to brackish to freshwater species. From the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams *et al.* 1999, pp. 2056–2059), expansion of mangroves into adjacent marshes in the Everglades (Ross *et al.* 2000, pp. 101, 111), and loss of pine rockland in the Keys (Ross *et al.* 1994, pp. 144, 151–155). In one Florida Keys pine rockland with an average elevation of 0.89 m (2.9 ft), Ross *et al.* (1994, pp. 149–152) observed an approximately 65 percent reduction in an area occupied by South Florida slash pine over a 70-year period, with pine mortality and subsequent increased proportions of halophytic (salt-loving) plants occurring earlier at the lower elevations. During this same timespan, local sea level had risen by 15 cm (6.0 in), and Ross *et al.* (1994, p. 152) found evidence of groundwater and soil water salinization. Extrapolating this situation to pine rocklands on the mainland is not straightforward, but suggests that similar changes to species composition could arise if current projections of SLR occur and freshwater inputs are not sufficient to prevent salinization. Furthermore, Ross *et al.* (2009, pp. 471–478) suggested that interactions between SLR and pulse disturbances (*e.g.*, storm surges) can cause vegetation to change sooner than projected based on sea level alone. Alexander (1953, pp. 133–138) attributed the demise of pinelands on northern Key Largo to salinization of the groundwater in response to SLR. Patterns of human development will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; USCCSP 2008, p. 7-6).

The Science and Technology Committee of the Miami-Dade County Climate Change Task Force (Wanless *et al*. 2008, p. 1) recognizes that significant SLR is a very real threat to the near future for Miami-Dade County. In a January 2008 statement, the committee warned that sea level is expected to rise at least 0.9–1.5 m (3–5 ft) within this century (Wanless *et al*. 2008, p. 3). With a 0.9–1.2 m (3–4 ft) rise in sea level (above baseline) in Miami-Dade County: "Spring high tides would be at about 6 to 7 feet; freshwater resources would be gone; the Everglades would be inundated on the west side of Miami-Dade County; the barrier islands would be largely inundated; storm surges would be devastating; landfill sites would be exposed to erosion contaminating marine and coastal environments. Freshwater and coastal mangrove wetlands will not keep up with or offset SLR of 2 ft per century or greater. With a 5-ft rise (spring tides at nearly +8 ft), Miami-Dade County will be extremely diminished" (Wanless *et al*. 2008, pp. 3–4).

Drier conditions and increased variability in precipitation associated with climate change are expected to hamper successful regeneration of forests and cause shifts in vegetation types through time (Wear and Greis 2012, p. 39). Although it has not been well studied, existing pine rocklands have probably been affected by reductions in the mean water table. Climate changes are also forecasted to extend fire seasons and the frequency of large fire events throughout the Coastal Plain (Wear and Greis 2012, p. 43). While restoring fire to pine rocklands is essential to the long-term viability of *Brickellia mosieri* and *Linum carteri* var. *carteri* populations, increases in the scale, frequency, or severity of wildfires could have negative effects on these plants considering their general vulnerability due to small population size, restricted range, few colonies, and relative isolation.

Alternative Future Landscape Models

To accommodate the large uncertainty in SLR projections, researchers must estimate effects from a range of scenarios. Various model scenarios developed at MIT and GeoAdaptive Inc. have projected possible trajectories of future transformation of the south Florida landscape by 2060 based upon four main drivers: climate change, shifts in planning approaches and regulations, human population change, and variations in financial resources for conservation (Vargas-Moreno and Flaxman 2010, pp. 1–6). The scenarios do not account for temperature, precipitation, or species habitat shifts due to climate change, and no storm surge effects are considered. The current MIT scenarios range from an increase of 0.09–1.0 m (0.3–3.3 ft) by 2060.

Based on the most recent estimates of SLR and the data available to us at this time, we evaluated potential effects of SLR using the current "high" range MIT scenario as well as comparing elevations of remaining pine rockland fragments and extant and historical occurrences of *Brickellia mosieri* and *Linum carteri* var. *carteri* occurrences.

The "high" range (or "worst case") MIT scenario assumes high SLR (1 m (3.3 ft) by 2060), low financial resources, a 'business as usual' approach to planning, and a doubling of human population. Based on this scenario, pine rocklands along the coast in central Miami-Dade County, including one occurrence of *L. c.* var. *carteri* at R. Hardy Matheson Preserve, would become inundated. The "new" sea level would come up to the edge of pine rockland fragments at the southern end as well, translating to partial inundation or, at a minimum, vegetation shifts in the pine rocklands in and around Navy Wells. While sea level would not overtake other pine rocklands in urban Miami-Dade County, changes in the salinity of the water table and soils would surely cause vegetation shifts in additional areas. In addition, many existing pine rockland fragments are projected to be developed for housing as the human population grows and adjusts to changing sea levels under this scenario. Actual impacts may be greater or less than anticipated based upon high variability of factors involved (*e.g.*, SLR, human population growth) and assumptions made.

When simply looking at current elevations of pine rockland fragments and occurrences of these plants, it appears that an SLR of 1 m (3.3. ft) will inundate the coastal and southern pine rocklands and cause vegetation shifts largely as described above. SLR of 2 m (6.6 ft) appears to inundate much larger portions of urban Miami-Dade County, including all of Navy Wells and its surrounding area, and with it, several extant occurrences of *Brickellia mosieri*. The western part of urban Miami-Dade County would also be inundated (barring creation of sea walls or other barriers), creating a virtual island of the Miami Rock Ridge. After a 2-m rise in sea level, approximately 75 percent of the remaining pine rockland would still be above sea level but an unknown percentage of these fragments would be negatively impacted by salinization of the water table and soils, which would be exacerbated due to isolation from mainland fresh water flows. Above 2 m (6.6 ft) of SLR, very little pine rockland would remain, with the vast majority either being inundated or experiencing vegetation shifts.

Environmental Stochasticity

The climate of southern Florida is driven by a combination of local, regional, and global events, regimes, and oscillations. There are three main "seasons": (1) the wet season, which is hot, rainy, and humid from June through October; (2) the official hurricane season that extends one month beyond the wet season (June 1 through November 30), with peak season being August and September; and (3) the dry season, which is drier and cooler, from November through May. In the dry season, periodic surges of cool and dry continental air masses influence the weather with short-duration rain events followed by long periods of dry weather.

According to the Florida Climate Center, Florida is by far the most vulnerable State in the United States to hurricanes and tropical storms (http://coaps.fsu.edu/climate_center/tropicalweather.shtml). Based on data gathered from 1856 to 2008, Klotzbach and Gray (2009, p. 28) calculated the climatological probabilities for each State being impacted by a hurricane or major hurricane in all years over the 152-year timespan. Of the coastal States analyzed, Florida had the highest climatological probabilities, with a 51 percent probability of a hurricane (Category 1 or 2) and a 21 percent probability of a major hurricane (Category 3 or higher). From 1856 to 2008, Florida actually experienced 109 hurricanes and 36 major hurricanes. Given the low population sizes and restricted ranges of *Brickellia mosieri* and *Linum carteri* var. *carteri*, and the few isolated occurrences of *L. c.* var. *carteri* within locations prone to storm influences, these plants are at substantial risk from hurricanes, storm surges, and other extreme weather. Depending on the location and intensity of a hurricane or other severe weather event, it is possible that these plants could become extirpated or extinct.

Hurricanes, storm surge, and extreme high tide events are natural events that can pose a threat to both plants. Hurricanes and tropical storms can modify habitat (*e.g.*, through storm surge) and have the potential to destroy entire populations. Climate change may lead to increased frequency and duration of severe storms (Golladay *et al*. 2004, p. 504; McLaughlin *et al*. 2002, p. 6074; Cook *et al*. 2004, p. 1015). Both plants experienced these disturbances historically, but had the benefit of more abundant and contiguous habitat to buffer them from extirpations. With most of the historical habitat having been destroyed or modified, the few remaining populations of these plants could face local extirpations due to stochastic events.

Other processes to be affected by climate change, related to environmental stochasticity, include temperatures, rainfall (amount, seasonal timing, and distribution), and storms (frequency and intensity). Temperatures are projected to rise from 2–5 ^{o}C (3.6–9 ^{o}F) for North America by the end of this century (IPCC 2007, pp. 7–9, 13). Based upon modeling, Atlantic hurricane and tropical storm frequencies are expected to decrease (Knutson *et al.* 2008, pp. 1–21). By 2100, there should be a 10–30 percent decrease in hurricane frequency. Hurricane frequency is expected to drop due to more wind shear impeding initial hurricane development. However, hurricane winds are expected to increase by 5–10 percent. This is due to more hurricane energy available for intense hurricanes. In addition to climate change, weather variables are extremely influenced by other natural cycles, such as El Niño Southern Oscillation with a frequency of every 4–7 years, solar cycle (every 11 years), and the Atlantic Multi-decadal Oscillation. All of these cycles influence changes in Floridian weather. The exact magnitude, direction, and distribution of all of these changes at the regional level are difficult to project.

Freezing Temperatures

Occasional freezing temperatures that occur in south Florida are a threat to *Brickellia mosieri* and *Linum carteri* var. *carteri*, causing damage or death to individual plants. Under normal circumstances, occasional freezing temperatures would not result in a significant impact to populations of these plants; however, the small size of some populations means the loss from freezing events of even a few individuals can reduce the viability of the population.

Conservation Efforts To Reduce Other Natural or Manmade Factors Affecting Continued Existence

An IRC program included reintroduction of both *Brickellia mosieri* and *Linum carteri* var. *carteri* in an effort to establish new occurrences of these plants and increase population sizes. To date, *B. mosieri* has been reintroduced to at least one site (George and Avery Pineland), although the status of these plants is currently unknown (Gann 2013b, pers. comm.).

Ex-situ conservation by FTBG consists of seed collection of pine rockland plants, including *Brickellia mosieri* and *Linum carteri* var. *carteri*, to learn about their germination, storage, and cultivation requirements to help safeguard these plants from extinction. FTBG has 22 seed accessions of *B. mosieri*, and a total of 1,589 seeds were provided to the National Center for Genetic Resources Preservation (NGRCP) for long-term storage (Maschinski *et al.* 2009, p. 26). Of *L. c.* var. *carteri*, FTBG has 59 accessions, and 2,643 seeds were provided to NGRCP for long-term storage (Maschinski *et al.* 2009, p. 27). Maschinski *et al.* (2009, p. 19 and 21) indicate that both plants are capable of orthodox seed storage. Frozen *B. mosieri* seeds germinated at 55 percent after 1 week of storage, compared to 54 percent of fresh seeds and 40 percent of desiccated seeds (Maschinski *et al.* 2009, p. 19). Frozen *L. c.* var. *carteri* seeds germinated at 75 percent after 4 months of storage, compared to 69 percent of fresh seeds and 71–88 percent of desiccated seeds (Maschinski *et al.* 2009, p. 21). These results indicate that seed storage may be a useful strategy for future reintroductions and supplementation of existing populations to increase the numbers and sizes of populations of these plants. As part of FTBG's Connect To Protect Network, reintroduction of endemic pine rockland plants such as *B. mosieri* and *L. c.* var. *carteri* is planned in corridors (networks of private stepping-stone gardens and public rights-of-way) they hope to create.

Cumulative Effects of Threats

The limited distributions and small population sizes of *Brickellia mosieri* and *Linum carteri* var. *carteri* make them extremely susceptible to further habitat loss, modification, and degradation and other anthropogenic threats. Mechanisms leading to the decline of these plants, as discussed above, range from local (*e.g.,* lack of adequate fire management, mowing, herbicides), to regional (*e.g.,* development, fragmentation, nonnative species), to global influences (*e.g*., climate change, SLR). The synergistic effects of threats (such as hurricane effects on a species with a limited distribution consisting of just a few small populations) make it difficult to predict population viability. While these stressors may act in isolation, it is more probable that many stressors are acting simultaneously (or in combination) on populations of *B. mosieri* and *L. c.* var. *carteri*.

Summary of Threats

We have determined that the threats to both *Brickellia mosieri* and *Linum carteri* var. *carteri* consist primarily of habitat loss and modification through urban and agricultural development, lack of adequate fire management, proliferation of nonnative invasive plants, and SLR. Threats described under Factor A—habitat loss, fragmentation, and degradation resulting from development and inadequate fire management, and Factor E—competition from nonnative invasive plants, are believed to be the primary drivers in the historical and recent declines of *B. mosieri* and *L. c.* var. *carteri*. *L. c.* var. *carteri* has also been threatened by anthropogenic disturbances which threaten populations in disturbed habitats, such as firebreaks and road rights-of-way, and both plants are suspected to be negatively affected by threats related to small, isolated populations (Factor E). All of these threats are expected to continue to impact populations of these plants in the future. Current local, State, and Federal regulatory mechanisms (Factor D) are inadequate to protect these plants from taking and habitat loss. Despite the existing regulatory mechanisms, *B. mosieri* and *L. c.* var. *carteri* continue to decline.

Other factors that are likely to threaten *Brickellia mosieri* and *Linum carteri* var. *carteri* in the future are climate change (including SLR) and extreme weather events (hurricanes, frost events), especially as effects of these could be catastrophic on isolated, small populations of both plants (Factor E). The majority of the remaining populations of these plants are generally small and geographically isolated. The narrow distribution of their populations in hurricane-prone south Florida makes them more susceptible to extirpation from a single catastrophic event. Furthermore, this level of isolation makes natural recolonization of extirpated populations virtually impossible without human intervention.

The above-described threats have had substantial adverse effects on *Brickellia* *mosieri* and *Linum carteri* var. *carteri* populations and their habitats. Although attempts are ongoing to alleviate some of these threats at some locations, no populations appear to be without one or more major threats.

Proposed Determination

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to *Brickellia mosieri* and *Linum carteri* var. *carteri.* Section 3(6) of the Act defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and section 3(20) of the Act defines a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

As described in detail above, both plants are currently at risk throughout all of their respective ranges due to the immediacy, severity, and scope of threats from habitat destruction and modification (Factor A) and other natural or manmade factors affecting their continued existence (Factor E), and existing regulatory mechanisms are inadequate to reduce these threats (Factor D). Although actions are ongoing to alleviate some threats, no populations appear to be free of major threats. As a result, impacts from increasing threats, singly or in combination, are likely to result in the extinction of these plants.

Brickellia mosieri

Brickellia mosieri has been extirpated from approximately 13 percent of its historical range, and the primary threats of inadequate fire management (Factor A) and competition from nonnative invasive plants (Factor E) are currently active in the remaining populations. Populations of *B. mosieri* are relatively small and isolated from one another, and the species' ability to recolonize suitable habitat between populations is unknown at this time. Because of the current condition of the populations and life-history traits of the species, it is vulnerable to natural or human-caused changes in its currently occupied habitats. Existing regulatory mechanisms are inadequate to eliminate or even reduce these threats (Factor D). Numerous threats are occurring now and are likely to continue in the foreseeable future, at a high intensity, and across the species' entire range; therefore, we have determined the species is currently on the brink of extinction. Because these threats are placing the species in danger of extinction now and not only at some point in the foreseeable future, we find this species meets the definition of an endangered species rather than a threatened species. Therefore, we are proposing to list it as an endangered species. These threats are currently active, and will continue to affect the populations of *B. mosieri* into the foreseeable future, and these threats will individually and collectively contribute to the species' local extirpation and potential extinction.

Linum carteri var. *carteri*

L. c. var. *carteri* has been extirpated from approximately 30 percent of its historical range, and threats of inadequate fire management (Factor A) and competition from nonnative, invasive plants (Factor E), as well as other anthropogenic disturbances (Factor E), are currently active in the remaining populations. Populations of *L. c.* var. *carteri* are small, few in number, and isolated from one another; the taxon's ability to recolonize suitable habitat between populations is unknown at this time. Because of the current condition of the populations and life-history traits of the taxon, it is vulnerable to natural or human-caused changes in its currently occupied habitats. Existing regulatory mechanisms are inadequate to eliminate or even reduce these threats (Factor D). Numerous threats are occurring now and are likely to continue in the foreseeable future, at a high intensity, and across the taxon's entire range; therefore, we have determined the taxon is currently on the brink of extinction. Because these threats are placing the taxon in danger of extinction now and not only at some point in the foreseeable future, we find this taxon meets the definition of an endangered species rather than a threatened species. Therefore, we are proposing to list it as an endangered species. The threats described above are currently active, and will continue to affect the populations of *L. c.* var. *carteri* into the foreseeable future, and these threats will individually and collectively contribute to the taxon's local extirpation and potential extinction.

Significant Portion of Its Range

We evaluated the current ranges of *Brickellia mosieri* and *Linum carteri* var. *carteri* to determine if there is any apparent geographic concentration of potential threats for either taxon. Both plants are highly restricted in their ranges, and the threats occur throughout their ranges. We considered the potential threats due to habitat loss and modification from development, lack of adequate fire management, competition from nonnative plants, and SLR, as well as the threats of incompatible land management and other human activities, hurricanes and other extreme weather, and small populations with restricted range. We found no concentration of threats because of the plants' limited and curtailed ranges, and uniformity of the threats throughout their entire ranges. Having determined that *B. mosieri* and *L. c.* var. *carteri* are endangered throughout their entire ranges, it is not necessary to evaluate whether there are any significant portions of their ranges.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness and conservation by Federal, State, Tribal, and local agencies; private organizations; and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed, preparation of a draft and final recovery plan, and revisions to the plan as significant new information becomes available. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. The recovery plan identifies site-specific management actions that will achieve recovery of the species, measurable criteria that determine when a species may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (comprising species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan will be available on our website (*http://www.fws.gov/endangered*), or from our South Florida Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribal, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (*e.g.*, restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these plants requires cooperative conservation efforts on private, State, and Tribal lands.

If these plants are listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost-share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, under section 6 of the Act, the State of Florida would be eligible for Federal funds to implement management actions that promote the protection and recovery of *Brickellia mosieri* and *Linum carteri* var. *carteri*. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants*.

Although *Brickellia mosieri* and *Linum carteri* var. *carteri* are only proposed for listing under the Act at this time, please let us know if you are interested in participating in recovery efforts for these plants. Additionally, we invite you to submit any new information on these plants whenever it becomes available and any information you may have for recovery planning purposes (see **FOR FURTHER INFORMATION**

CONTACT).

Federal agencies are required to confer with us informally on any action that is likely to jeopardize the continued existence of a species that is proposed for listing. Section 7(a)(4) requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may adversely affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Federal agency actions within these plants' habitat that may require conference or consultation or both as described in the preceding paragraph include, but are not limited to, the funding of, carrying out, or issuance of permits for resource management activities, development of facilities, road and trail construction, recreational programs and any other landscape-altering activities on Federal lands administered by the Department of Defense, National Park Service, Fish and Wildlife Service, and U.S. Forest Service; or the issuance of Federal permits under section 404 of the Clean Water Act (33 U.S.C. 1251 *et seq.*) by the U.S. Army Corps of Engineers; construction and management of gas pipeline and power line rights-of-way by the Federal Energy Regulatory Commission; construction and maintenance of roads or highways by the

Federal Highway Administration; and disaster relief efforts conducted by the Federal Emergency Management Agency.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to endangered plants. All prohibitions of section 9(a)(2) of the Act, implemented by 50 CFR 17.61, apply. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to import or export, transport in interstate or foreign commerce in the course of a commercial activity, sell or offer for sale in interstate or foreign commerce, or remove and reduce the species to possession from areas under Federal jurisdiction. In addition, for plants listed as an endangered species, the Act prohibits the malicious damage or destruction on areas under Federal jurisdiction and the removal, cutting, digging up, or damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. Certain exceptions to the prohibitions apply to agents of the Service and State conservation agencies.

Preservation of native flora of Florida (Florida Statutes 581.185) sections (3)(a) and (b) provide limited protection to species listed in the State of Florida Regulated Plant Index including *Brickellia mosieri* and *Linum carteri* var. *carteri*, as described under Factor D, *The Inadequacy of Existing Regulatory Mechanisms.* Federal listing increases protection for these plants by making violations of section 3 of the Florida Statute punishable as a Federal offense under section 9 of the Act. This provides increased protection from unauthorized collecting and vandalism for the plants on State and private lands, where they might not otherwise be protected by the Act, and increases the severity of the penalty for unauthorized collection, vandalism, or trade in these plants.

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened plant species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.62 for endangered plants, and at 50 CFR 17.72 for threatened plants. With regard to endangered plants, a permit must be issued for activities undertaken for scientific purposes or to enhance the propagation or survival of the species.

The Service acknowledges that it cannot fully address some of the natural threats facing *Brickellia mosieri* and *Linum carteri* var. *carteri* (*e.g.*, hurricanes, tropical storms) or even some of the other significant, long-term threats (*e.g.*, climatic changes, SLR). However, through listing, we provide protection to the known populations and any new population of these plants that may be discovered (see discussion below). With listing, we can also influence Federal actions that may potentially impact these plants (see discussion below); this is especially valuable if either species is found at additional locations. With this action, we are also better able to deter illicit collection and trade.

Our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), is to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a proposed listing on proposed and ongoing activities within the range of species proposed for listing. The following activities could potentially result in a violation of section 9 of the Act; this list is not comprehensive:

(1) Import any such species into, or export any such species from, the United States;

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

(3) Deliver, receive, carry, transport, or ship in interstate or foreign commerce, by any means whatsoever and in the course of a commercial activity, any such species;

(4) Sell or offer for sale in interstate or foreign commerce any such species;

(5) Introduce any nonnative wildlife or plant species to the State of Florida that compete with or prey upon *Brickellia mosieri* or *Linum carteri* var. *carteri*;

(6) Release any unauthorized biological control agents that attack any life stage of *Brickellia mosieri* or *Linum carteri* var. *carteri*; or

(7) Unauthorized manipulation or modification of the habitat of *Brickellia mosieri* or *Linum carteri* var. *carteri* on Federal lands.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Field Supervisor of the Service's South Florida Ecological Services Office (see **FOR FURTHER INFORMATION CONTACT**). Requests for copies of regulations regarding listed species and inquiries about prohibitions and permits should be addressed to the U.S. Fish and Wildlife Service, Ecological Services Division, Endangered Species Permits, 1875 Century Boulevard, Atlanta, GA 30345 (Phone 404–679–7140; Fax 404–679–7081).

If *Brickellia mosieri* and *Linum carteri* var. *carteri* are listed under the Act, the State of Florida's Endangered Species Act (Florida Statutes 581.185) is automatically invoked, which would also prohibit take of these plants and encourage conservation by State government agencies. Further, the State may enter into agreements with Federal agencies to administer and manage any area required for the conservation, management, enhancement, or protection of endangered species (Florida Statutes 581.185). Funds for these activities could be made available under section 6 of the Act (Cooperation with the States). Thus, the Federal protection afforded to these plants by listing them as endangered species would be reinforced and supplemented by protection under State law.

Peer Review

In accordance with our joint policy on peer review published in the **Federal Register** on July 1, 1994 (59 FR 34270), we will seek the expert opinions of at least three appropriate and independent specialists regarding this proposed rule. The purpose of peer review is to ensure that our proposed listing and critical habitat designation are based on scientifically sound data, assumptions, and analyses. We will invite these peer reviewers to comment during this public comment period on our specific proposed rule.

We will consider all comments and information we receive during this comment period on this proposed rule during our preparation of a final determination. Accordingly, the final decision may differ from this proposal.

Public Hearings

Section 4(b)(5) of the Act provides for one or more public hearings on this proposal, if requested. Requests must be received within 45 days after the date of publication of this proposed rule in the **Federal Register**. Such requests must be sent to the address shown in **FOR FURTHER INFORMATION CONTACT**. We will schedule public hearings on this proposal, if any are requested, and announce the dates, times, and places of those hearings, as well as how to obtain reasonable accommodations, in the **Federal Register** and local newspapers at least 15 days before the hearing.

Required Determinations

Clarity of the Rule

We are required by Executive Orders 12866 and 12988 and by the Presidential Memorandum of June 1, 1998, to write all rules in plain language. This means that each rule we publish must:

(1) Be logically organized;

(2) Use the active voice to address readers directly;

(3) Use clear language rather than jargon;

(4) Be divided into short sections and sentences; and

(5) Use lists and tables wherever possible.

If you feel that we have not met these requirements, send us comments by one of the methods listed in **ADDRESSES**. To better help us revise the rule, your comments should be as specific as possible. For example, you should tell us the numbers of the sections or paragraphs that are unclearly written, which sections or sentences are too long, the sections where you feel lists or tables would be useful, etc.

Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.*)*

This rule does not contain any new collections of information that require approval by OMB under the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq*.). This rule will not impose recordkeeping or reporting requirements on State or local governments, individuals, businesses, or organizations. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

National Environmental Policy Act (42 U.S.C. 4321 et seq.*)*

We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act, need not be prepared in connection with listing a species as endangered or threatened under the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A complete list of references cited in this rulemaking is available on the Internet at *http://www.regulations.gov* and upon request from the South Florida Ecological Services Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this package are the staff members of the South Florida Ecological Services Field Office.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Proposed Regulation Promulgation

Accordingly, we propose to amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as set forth below:

PART 17—[AMENDED]

1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; 4201–4245; unless otherwise noted.

2. Amend § 17.12(h) by adding entries for "*Brickellia mosieri*" and "*Linum carteri* var. *carteri*", in alphabetical order under Flowering Plants, to the List of Endangered and Threatened Plants, to read as follows:

§ 17.11 Endangered and threatened wildlife.

*   *   *   *   *

(h) *   *   *

Species		Historical range	Family	Status	When listed	Critical habitat	Special rules
Scientific Name	Common name						
Flowering Plants							
* * * * * * *							
Brickellia mosieri	Brickell-bush, Florida	U.S.A. (FL)	Asteraceae	E		NA	NA
* * * * * * *							
Linum carteri var. *carteri*	Flax, Carter's small-flowered	U.S.A. (FL)	Linaceae	E		NA	NA
* * * * * * *							

* * * * *

Dated: September 25, 2013

Rowan W. Gould

Acting Director, U.S. Fish and Wildlife Service

Billing Code 4310–55

[FR Doc. 2013-24173 Filed 10/02/2013 at 8:45 am; Publication Date: 10/03/2013]