Sand Flax
(*Linum arenicola*)

5-Year Status Review:
Summary and Evaluation

Photo credit: Lydia Cuni

U.S. Fish and Wildlife Service
Southeast Region
Florida Ecological Services Field Office
Vero Beach, Florida

March 2024

Sand flax (*Linum arenicola*)
5-YEAR STATUS REVIEW

GENERAL INFORMATION

Current Classification: Endangered

Lead Field Office: Florida Ecological Services Field Office

Review Authors:

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Reviewers:
Lead Regional Office: Southeast Region, Carrie Straight, (404) 679-7226
National Key Deer Refuge: Chris Eggleston and Greg Boling

Date of original listing: October 31, 2016 (81 FR 66842; September 29, 2016)

Critical habitat/4(d) rule/ Experimental population designation/Similarity of appearance listing: proposed critical habitat rule: October 14, 2022 (87 FR 62502)

Methodology used to complete the review:
In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants (50 CFR 424.11). We announced initiation of this review in the Federal Register on July 14, 2021 (86 FR 37178), with a 60-day comment period and did not receive any comments. The primary sources of information used in this analysis were the 2016 final listing rule (81 FR 66842), peer reviewed scientific publications, unpublished reports, and field observations of experienced biologists. The review was contracted to Fairchild Tropical Botanic Garden (Fairchild) biologists, and it was reviewed and finalized by biologists in the Florida Ecological Services Field Office (FLESFO). Literature and documents used for this 5-year review are on file at the FLESFO. All recommendations resulting from this review are a result of the Service's thorough review of the best available information on sand flax's biology, habitat, and threats. **FR Notice citation announcing the species is under active review:** July 14, 2021 (86 FR 37178)

Species' Recovery Priority Number at start of 5-year review (48 FR 43098):
5. Sand flax is considered a species with a high degree of threat and a low recovery potential.

Review History:
This is the first 5-year status review for this species.

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature
The Integrated Taxonomic Information System (2021), Atlas of Florida Vascular Plants (Wunderlin et al. 2021), and the Flora of North America (Morin 2017), all indicate *Linum arenicola* is a distinct taxon, endemic to Miami-Dade and Monroe Counties in Florida.

Distinct Population Segment (DPS) (61 FR 4722)
The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing of a DPS to only vertebrate species. Because the species under review is a not a vertebrate, the DPS policy does not apply.

Recovery Criteria

Recovery Plan or Outline
At the time of this review, recovery criteria for this species have not been finalized.

Biology and Habitat Summary

Sand flax is a perennial herb endemic to Miami-Dade and Monroe Counties in South Florida (Figure 1), where it occupies habitats including pine rockland, marl prairie, and disturbed areas which were once pine rockland or marl prairie (Bradley and Gann 1999, Hodges and Bradley 2006, Service 2013, Service 2016). A thorough review of the biology and life history of sand flax was included in the 2013 Species Assessment and Listing Priority Assignment Form (Service 2013) and in the proposed and final listing rules (Service 2015, 2016). A brief overview of information that is relevant to the status of this species is presented below.

At the time of listing (2016), there were 12 extant populations and 14 extirpated populations (Service 2016). Sand flax is currently extant in 15 locations and extirpated in 14 locations (Table 1). Three of the current extant occurrences were not included in the 2016 final rule. One was previously unknown to the Service (C-111 Canal), and two are reintroductions by Fairchild (Rockdale Pineland and No Name Key). While one population that was identified in the final rule as extant has since become extirpated (Everglades Archery Range), another population that was considered extirpated in the final rule is now considered extant (George Avery Pineland Preserve). More detailed information on extant and extirpated populations are provided in Appendix A.

Distribution. Since the listing, the spatial distribution of sand flax has altered with the two population introductions (described below), one discovered population, and one presumed extirpated population. This species is still found in the Lower Florida Keys of Monroe County and in Miami-Dade County (Figure 1). The changes in spatial distribution since listing have not significantly altered the species' range.

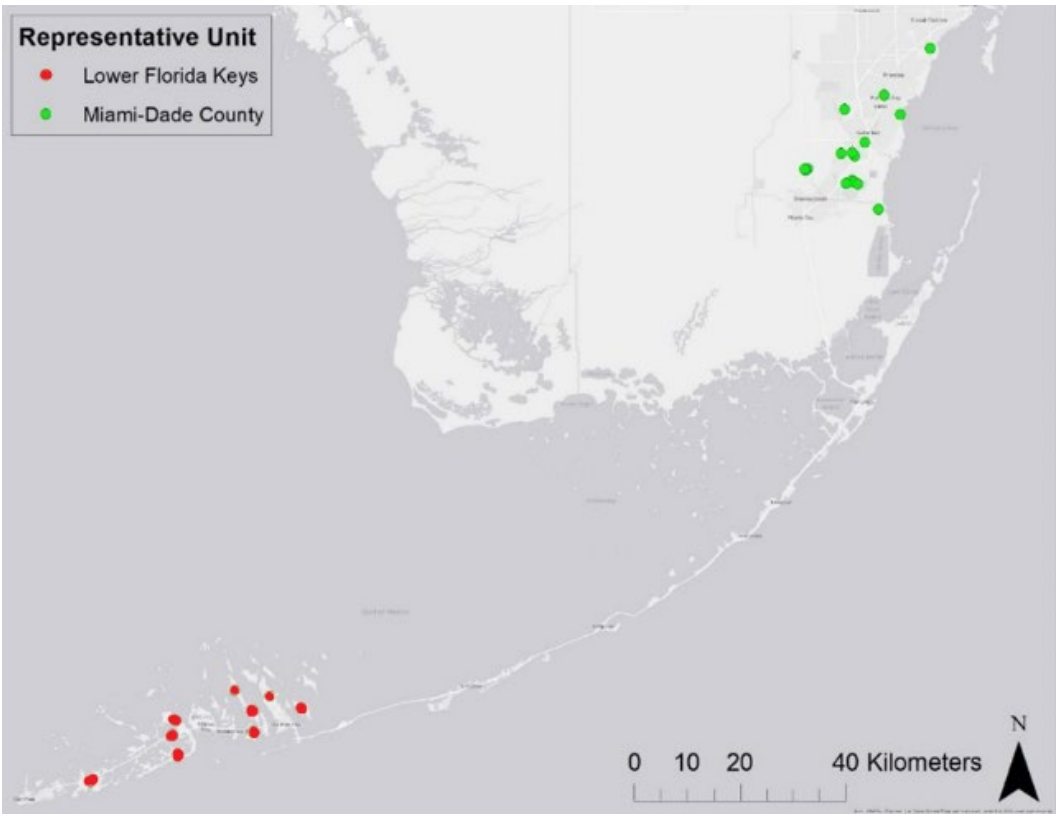

Figure 1: Map of sand flax range in south Florida, including the occurrences in the Lower Florida Keys to the south (red dots) and the northern group of occurrences in Miami-Dade County, Florida (green dots).

Table 1: Summary of the ownership of known extant and extirpated populations of sand flax. SFWMD=South Florida Water Management District, NGO=non-government organization.

Ownership	Number of Extant Populations	Number of Presumed Extirpated Populations
Federal	3	0
State	3	0
Miami-Dade County	4	3
SFWMD	3	0
NGO	1	0
Unknown	0	6
Private	0	5
Mixed Ownership	1	0
Total	15	14

Life History. Pérez and Ochoa Chumana (2020) studied the germination ecology of sand flax in response to variations in temperature, salinity, and light. Their findings indicated that germination is promoted by drying for approximately one month, optimal temperatures for seed germination were approximately 22°C (76°F), seeds did not require light to germinate, and seedlings exposed to water with as little as 2 parts per thousand (ppth) salinity had inhibited

growth. Germination decreased with increasing salinity over 2 ppth. This finding indicates sand flax is salinity sensitive during the beginning stages of plant development. Cuni et al. (2020) determined that seeds of sand flax are capable of surviving desiccation and freezer-storage. Harris and Koptur (2022) found the species utilizes a mixed mating system, determining that sand flax is self-compatible, but seed set is higher with cross-pollination. Following pollination, capsules took two weeks to mature (Harris and Koptur 2022).

Introduced Populations. Cuni et al. (2020) conducted introductions of sand flax in two locations: 1) Rockdale Preserve and 2) No Name Key, National Key Deer Refuge. The Rockdale introduction compared success rates of seeds versus whole plants, as well as the timing of seed sowing. At one year, only one whole plant (out of six) remained (17% survival), and seedlings had a 3.5% (14 seedlings) emergence for the summer sowing and a 10.5% (42 seedlings) emergence for the fall sowing. At No Name Key, Cuni et al. (2020) sowed 320 sand flax seeds which consisted of both fresh and desiccated seeds. Seedling emergence was 25% for fresh and 34% for desiccated seeds. However, survival of germinated seedlings was low (less than ten plants). These two introductions are included in the population tables, however, with the low emergence and survival rates it is unknown if these populations will persist and become self-sustaining.

Threats (Five-Factor Analysis) Summary

The status of sand flax is determined from an assessment of factors specified in section 4 (a)(1) of the Act, including: Factor A: the present or threatened destruction, modification, or curtailment of its habitat or range; Factor C: disease or predation; Factor D: the inadequacy of existing regulatory mechanisms; Factor E: other natural or manmade factors affecting its continued existence. We have no indication that overutilization for commercial, recreational, scientific, or educational purposes (Factor B) is a known threat to the species. A summary of this assessment is detailed below.

Of the 15 existing populations, 10 occur on federal, county, and state lands that are provided some form of protections from development or other impacts (see Factor D discussion below). Most of the populations of sand flax on protected and unprotected lands occur on roadsides or canal banks, which are less likely to be developed for other uses. Despite a low risk of development, the populations that are not in protected areas are subject to a number of threats, including illegal dumping, invasive plant encroachment, herbicide spray, and incompatible mowing practices. Harris (2016) determined there was a strong negative effect on pollinator visitation rates on sand flax in the Lower Keys, with substantially lower visitation rates after application of pesticides for mosquitos, compared to visitation rates to the same plants before application (Factors A and D). Although sand flax is self-compatible, Harris and Koptur (2022) discovered seed set is higher with cross pollination which is commonly from pollinator visitation. Reduced pollination rates, caused by pesticides, can result in reduced recruitment of new plants which can lead to reduced genetic exchange between plants. Reduced genetic exchange limits the ability to adapt to changing circumstances and decreases the resiliency and representation of the species.

Sand flax habitat requires frequent disturbance to prevent habitat succession that is unfavorable to the species. Disturbances such as fire and mowing regimens are necessary to combat

displacement of native species by non-native species. Disturbances also limit dense canopy structure that can shade out understory species like sand flax, and alter leaf litter, soil moisture, and nutrient availability that can reduce native seed germination and seedling establishment (Service 2016). Habitat succession is the predicted cause of extirpation of several populations (Table 1; Appendix A). Without periodic disturbance like prescribed fire and mowing regimens, populations within the Martinez Preserve, George N. Avery Pineland, and portions of National Key Deer Refuge areas are highly susceptible to extirpation (Factor A, D, and E).

Harris and Koptur (2022) found significant herbivory on sand flax in the Lower Keys during their 2015-2016 field studies. Key deer (*Odocoileus virginianus clavium*), a subspecies of white-tailed deer federally listed as endangered, were the most frequent herbivore. Key deer were responsible for grazing on 35% of all tagged study plants on Big Pine Key. Key deer are restricted to the Keys and would only impact the five populations in Monroe County. However, it would be expected that some herbivory from white-tailed deer (*O. virginianus*) occur in the populations in Miami-Dade County. Additionally, Harris and Koptur (2022) found 7% of plants were preyed upon by flower gall midge, and 3% by lepidoptera larvae (Factor C). Given this low rate of predation, we expect flower gall midges and lepidoptera larvae have a minor impact to the species range wide.

Three extant populations of sand flax occur on federal lands (Table 1; Appendix A). These populations are provided some protections from habitat modification and from unauthorized harm or collection/destruction of the species. Additionally, some populations that are located on state or county lands are offered protections where permits are required for destruction, harvest, or transport of listed species. However, local, state, and federal regulatory mechanisms are inadequate to protect the species from habitat degradation (Factor D), as described above, as well as impacts caused by climate change and saltwater intrusion, described below.

Sea level rise (Factor E) is expected to significantly reduce the land area within the range of sand flax in the coming decades (Sweet et al. 2022), especially for the populations in Monroe County. Increased frequency and duration of severe hurricanes, increased precipitation rates, and magnitude of storm surges (Intergovernmental Panel on Climate Change 2019) have the potential to modify or destroy the remaining habitat throughout the species' historical range. While the hydrologic requirements for sand flax are not well understood, increased inundation for longer periods than normal or increased soil salinity from storm surges and sea level rise has the potential to harm individuals, reduce germination and recruitment as described above, as well as negatively impact the integrity of the habitat. With alterations to the hydrological periods, coastal pine rockland habitats will slowly degrade and shift to buttonwood/mangrove habitats (Ross et al. 2009; Saha et al. 2011), making sites unsuitable for sand flax. The five populations in Monroe County are expected to be affected the most from the impacts of sea level rise.

Synthesis

Sand flax is a perennial herb endemic to Miami-Dade and Monroe counties in South Florida, where it occupies habitats including pine rockland, marl prairie, and disturbed areas which were once pine rockland or marl prairie. Currently there are 15 extant populations and 14 presumed extirpated populations. Studies have been conducted to better understand seed ecology and augmentation strategies. The species thrives on disturbed pine rockland edges and canal banks,

making the amount of potential habitat available for reintroductions high. However, reintroduction success rates have been low. Since the species listing in 2016, threats to sand flax have not been abated. Recent surveys suggest declines in several populations, especially those in Monroe County. Throughout the species' range, populations are threatened by fire suppression, habitat succession, sea level rise and other climate factors, as well as stochastic and catastrophic factors stemming from narrow geographical range and small population sizes. Based on the best available information, sand flax continues to meet the definition of an endangered species.

RECOMMENDED FUTURE ACTIVITIES

This species does not have a final recovery plan. While completing this status review, we have identified the following potential activities to progress the recovery of this species.

Recovery Activities

- Work with land managers to incorporate conservation mowing regimes beneficial to the species.
- Conduct or continue to conduct habitat restoration on all occupied sites, including (a) removal of native hardwoods and non-native invasive plants and (b) establish a prescribed burn or mowing regimen.
- Coordinate with the South Florida Water Management District (SFWMD) and other partners conducting Everglades restoration projects in and around the L-31E and nearby intersecting canals to ensure that sand flax is not impacted or that mitigation occurs.
- Develop a captive propagation and reintroduction plan for the species that assesses risks and guides future introductions.
    - Determine if translocations may be beneficial to occupy suitable habitat.
    - Assess reintroduction locations where sand flax has been extirpated.
    - Consider prioritizing augmenting populations that have less than ten plants to ensure population survival and genetic exchange.
    - Assess collections currently in seed banks and prioritize new locations for collection for seed banking with a focus on those that are not yet represented or are under-represented in storage.
- Establish best horticultural practices for ex situ cultivation.
- Acquire land or develop conservation agreements in occupied habitat or unoccupied suitable habitat.
- Rescue sand flax in cases where development is scheduled.
- Discuss potential for reducing pesticides use in and around areas with this species with local mosquito control districts.

Monitoring and Research Activities

- For all populations with fewer than 100 individuals, monitor at least once per year.
- Research the possibility of hybridization with other species of *Linum*, namely *L. medium* and *L. floridanum* before reintroduction to northern portions of the range.
- Conduct genetic research to determine the amount of genetic variation between and within populations.

- To determine how long viability is retained in storage, re-test seeds that Fairchild has banked at 5 years and repeat tests every 5 years thereafter.
- Further investigate impacts of pesticides on pollination rates.

Outreach Activities

- Increase public awareness and appreciation for native plants and habitats.
    - Attend public events when appropriate to improve community understanding of management techniques and policies, such as prescribed fire, in pine rockland habitats.

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RESULTS

U.S. Fish and Wildlife Service
Status Review of Sand Flax

Status Recommendation:

On the basis of this review, we recommend the following status for this species. A 5-year review presents a recommendation of the species status. Any change to the status requires a separate rulemaking process that includes public review and comment, as defined in the Act.

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist:
____ *The species is extinct*
____ *The species does not meet the definition of an endangered or threatened species*
____ *The listed entity does not meet the statutory definition of a species*
__X__ No change needed

FIELD OFFICE APPROVAL:

Division Manager, Florida Classification and Recovery, Florida Ecological Services Field Office, Fish and Wildlife Service

Approve LOURDES MENA Digitally signed by LOURDES MENA Date: 2024.03.22 18:12:32 -04'00' Adobe Acrobat version: 2023.008.20533

LEAD REGIONAL OFFICE APPROVAL:
Acting for **Assistant Regional Director – Ecological Services, Fish and Wildlife Service**

Approve AARON VALENTA Digitally signed by AARON VALENTA Date: 2024.03.27 08:04:05 -04'00'

APPENDIX A. SUPPORTING DOCUMENTATION

Summary of the status and trends of the known extant occurrences of the sand flax. Introduced populations are denoted with an asterisk. SFWMD=South Florida Water Management District, NGO=non-government organization, FDOT=Florida Department of Transportation, HARB= Homestead Air Reserve Base, SOCSOUTH=Special Operations Command South.

Population Name from the Listing Rule (2016)	Site	County	Ownership	Population Est. from Listing Rule (Year)	Most Recent Population Est. (Year)	Trend
C-102 canal levee	C-102 canal levee	Miami-Dade	SFWMD	1,000–10,000 (2013)	101-1000 (2022 [a])	Declining
N/A [Population not known at the time of listing]	C-111 canal levee	Miami-Dade	SFWMD	N/A	101-1000 (2022 [b])	Insufficient data
George Avery Pineland Preserve	George N. Avery Pineland	Miami-Dade	NGO (IRC)	Presumed Extirpated	11-100 (2023 [c])	Insufficient data
HARB	HARB	Miami-Dade	Federal	37 (2011)	10,001-100,000 (2013 [d])	Increasing
L–31E canal	L-31E canal levee, and levees of several intersecting canals	Miami-Dade	SFWMD	N/A	1001-10,000 (2013 [l])	Stable
Martinez Pineland	Martinez Preserve	Miami-Dade	County	100–200 (2013)	1-10 (2023 [b])	Declining
N/A [Introduced in 2020]	Rockdale Preserve*	Miami-Dade	County	N/A	11-100 (2023 [b])	N/A
SOCSOUTH	SOCSOUTH	Miami-Dade	Federal	74,000 (2009)	10,001-100,000 (2013 [f])	Stable
Zoo Miami	Zoo Miami	Miami-Dade	County	56 (2014)	101-1000 (2022 [g])	Increasing
HAFB (S of Naizare blvd)	HAFB (decommissioned)	Miami-Dade	County	24,000 (2013)	24,000 (2013 [l])	Insufficient data
Big Pine Key	Big Pine Key	Monroe	Federal, State, County, Private	2,676 (2007)[o]	1001-10,000 (2022)[h]	Stable
Big Torch Key	Big Torch Key	Monroe	State (roadside)	1 (2010)	11-100 (2023 [i])	Increasing
Lower Sugarloaf Key	Lower Sugarloaf Key	Monroe	FDOT (roadside)	531 (2010)	11-100 (2020 [h])	Declining
N/A [Introduced in 2020]	No Name Key*	Monroe	Federal	N/A	1-10 (2021 [b])	N/A
Upper Sugarloaf Key	Upper Sugarloaf Key	Monroe	State (roadside)	73 (2010	11-100 (2020 [h])	Insufficient data

Summary of the presumed extirpated populations of sand flax.

Population Name from the Listing Rule	Site	County	Ownership	FR Document Presuming Extirpation	Year of Last Observation
Bauer Drive (Country Ridge Estates)	Bauer Drive	Miami-Dade	Unknown	Listing Rule	1996 [m]
Camp Jackson	Camp Jackson Area	Miami-Dade	Unknown	Listing Rule	1907 [n]
Camp Owaissa Bauer	Camp Owaissa Bauer	Miami-Dade	County	Listing Rule	1983 [l]
Coco Plum Circle	Cocoplum	Miami-Dade	Private	Listing Rule	1996 [m]
HAFB (Community Partnership Drive)	HAFB Community Partnership Drive	Miami-Dade	County	Listing Rule	2010 [l]
Everglades Archery Range	Everglades Archery Range	Miami-Dade	County	Status review (2023)	2012 [l]
Big Hammock Prairie	Homestead to Big Hammock Prairie	Miami-Dade	Unknown	Listing Rule	1911 [n]
Allapatah Drive and Old Cutler Road	Old Cutler Rd. & Allapatah Dr.	Miami-Dade	Private	Listing Rule	1996 [m]
Palmetto Bay Village Center	Palmetto Bay Village Center (Former Burger King headquarters)	Miami-Dade	Village of Palmetto Bay	Listing Rule	1996 [m]
Silver Green Cemetery	Silver Green Cemetery	Miami-Dade	Private	Listing Rule	1996 [m]
Boca Chica	Boca Chica Key	Monroe	Unknown	Listing Rule	1912 [j]
Middle Torch Key	Middle Torch Key	Monroe	Private?	Listing Rule	2005 [j]
Park Key	Park Key	Monroe	Unknown	Listing Rule	1961 [j]
Ramrod Key	Ramrod Key	Monroe	Unknown	Listing Rule	1979 [k]

[a] Frade (2022)
[b] Fairchild unpublished data
[c] Seasholtz (2022)
[d] van der Heiden and Johnson (2013a)
[e] Hodges (2010)
[f] van der Heiden and Johnson (2013b)
[g] Moore (2022)
[h] Cuni et al. (2020)
[i] Hess pers. comm (2023)
[j] Hodges and Bradley (2006)
[k] Austin et al. 1980 in Florida Natural Areas Inventory
[l] Bradley and Van Der Heiden (2013)
[m] Kernan and Bradley (1996)
[n] Bradley and Gann (1999)
[o] Bradley and Saha (2009)

Summary of extant sand flax populations

C-102 canal levee. This property is owned by the South Florida Water Management District (SFWMD). Bradley and van der Heiden (2013) reported that there were between 1,000 and 10,000 sand flax individuals along the C-102 canal levee in their undated survey. Frade (2022) resurveyed the population in March and counted 191 plants.

C-111 canal levee. The population of sand flax on the north bank of the C-111 canal was previously unreported in Service documents. An estimated 1,000 plants were observed by Fairchild biologist James Lange in late May of 2017 (Fairchild unpublished data). Noah Frade (2022) revisited this population in March 2022, estimating that approximately 100 individuals were present.

George N. Avery Pineland. The George N. Avery Pineland population of sand flax was reported as extirpated in the proposed and final listing rules (Service 2015, 2016). The preserve is located in the Goulds area between Miami and Homestead and is owned and managed by The Institute for Regional Conservation (IRC). The populations is still extant, though small. Plants are monitored frequently, with the population fluctuating between 1 and 9 plants in recent years. The most recent population count in 2022 found 3 plants (Seasholtz 2022). IRC and Fairchild intend to cooperate on a sand flax augmentation effort at this location.

Homestead Air Reserve Base (HARB). This location has the largest population of sand flax, with tens of thousands of individuals present (van der Heiden and Johnson 2013a). The Base is currently working with the Service and IRC to restore parcels containing (or that could potentially contain) sand flax and Small's milkpea, and to develop best management practices for both species.

L-31E canal levee, and levees of several intersecting canals. Sand flax is scattered along a 15-kilometer-long stretch of the L-31E canal, on both banks, from SW 256 Street on the north to Card Sound Road on the south. Along this stretch, the canal passes by Biscayne National Park and Homestead Bayfront Park (to the east) and through Florida Power and Light property associated with the Turkey Point Nuclear Power Plant. Bradley and van der Heiden (2013) estimated that there are between 1,000 and 10,000 plants along the canal banks, but they did not conduct detailed counts of this population. The actual population may be an order of magnitude higher, considering the entire stretch of the population, which is now known to extend further north than Bradley and van der Heiden believed (Cuni 2016). The species is also found on portions of canal levees that intersect the L-31E, including Military Canal and the Princeton Canal (Bradley 1999, Cuni 2016). The Bradley voucher lists the location as Homestead Bayfront Park, but the coordinates provided on the specimen label are actually on an intersecting canal levee west of the park's western boundary, and west of the L-31E canal.

Martinez Preserve. The Martinez Preserve within the Richmond pine rocklands is part of the Miami-Dade County Environmentally Endangered Lands (EEL) Program. Only 13 plants were located during a spring 2022 survey by Fairchild staff, which is a decline from past estimates of 100-200 plants (Service 2015). However, staff noted that vegetation management crews had recently been working in the area, which could have temporarily suppressed the population.

Rockdale Preserve. The Rockdale Preserve is also part of the EEL Program and was one of two locations where Cuni et al. (2020) introduced plants and seeds of sand flax in 2019. As of spring 2022, there were six reproductive plants remaining. For more details on this experimental reintroduction, see section 1g.

Special Operations Command South (SOCSOUTH). The SOCSOUTH population is located within HARB. It is one of the largest populations, with van der Heiden and Johnson (2013b) estimating a population size between 29,128 and 33,670 plants.

Zoo Miami. Both subpopulations at this location are on EEL-managed portions of Zoo Miami property. One of the two subpopulations at Zoo Miami (unit 11) was monitored most recently by Zoo Miami staff members Tiffany Moore and Frank Ridgley (Moore, pers. comm. 2022), who counted 213 individuals. The other subpopulation (located along the service road between units 13 and 15) burned in a prescribed fire just a few weeks prior. The total known population at the previous census was 56 plants (Service 2016). The Coast Guard property in Richmond pine rocklands, adjacent to this population, experienced a minor wildfire in December 2023. It is unlikely the fire impacted the sand flax population at this location.

Big Pine Key. Sub-populations at this location occur on land owned by the Service, Florida Department of Transportation (FDOT), Monroe County, and private property. Most sand flax individuals on Big Pine Key are protected within National Key Deer Refuge, where the population was estimated to be 1,001-10,000 plants by Bradley and Gann (1999) and Hodges (2010). Although it has been over a decade since the Hodges survey, Cuni et al. (2020) confirmed this estimate on the Refuge. However, in 2007 Bradley and Saha (2009) used sampling methods to estimate there were only 2,676 plants, writing that the species was extremely rare on the island. It should be noted that there are privately-owned and County-owned tracts of pine rockland in the Port Pine Heights neighborhood of Big Pine Key that have no known sand flax survey data.

Big Torch Key. Sand flax was recently rediscovered at this location in January 2023 by Florida Natural Areas Inventory and Florida Fish and Wildlife Conservation Commission staff (Hess pers. comm. 2023). Previously the species had not been observed on Big Torch Key since 2010, when Hodges observed a single plant (Hodges 2010). A 2016 survey by Fairchild biologists also failed to locate plants (Lange and Harris 2016). Given the storm surge from Hurricane Irma in 2017 combined with Hodges' speculation that roadside maintenance was causing the species to decline, this population was presumed extirpated until the 2023 survey was conducted. This population is along the roadside adjacent to the Florida Keys Wildlife and Environmental Area.

Lower Sugarloaf Key. There has not been a census of sand flax on roadsides on Lower Sugarloaf Key since Hodges (2010) counted 531 plants. However, Harris and Koptur (2022) studied this population in their 2015-2016 field work; Lange and Harris (2016) estimated 101-1,000 plants; and Fairchild biologists observed the population in 2020, estimating between 11 and 100 individuals were present (Cuni et al. 2020). This last, most recent estimate is used in Table 1, however, there are insufficient data to determine whether this is accurate or to determine any trends over time.

No Name Key. This site was the second of two locations where Cuni et al. (2020) introduced seeds of sand flax in 2019. By late 2021, there were nine plants remaining. For more details on this experimental reintroduction, see introduced populations on page 4.

Upper Sugarloaf Key. Hodges (2010) reported that sand flax appeared to be thriving at the Upper Sugarloaf Key, noting 73 plants. Cuni et al. (2020) revisited this population and estimated 11-100 plants were present. This low-lying roadside population is particularly vulnerable to impacts from roadside maintenance and storm surge.

Populations Extirpated or Presumed Extirpated

There are 14 documented sand flax occurrences that are now known to be extirpated or are presumed extirpated. The final rule document listed 14 extirpated sites (Service 2016). With this review, the one site below was listed as extant in the final rule and is now considered to be extirpated and one site previously considered extirpated (George Avery Pineland Preserve) was found to be extant (Seasholtz 2022).

Everglades Archery Range. Sand flax has not been observed at the Everglades Archery Range since 2012, when Bradley counted 23 individuals (Bradley and van der Heiden 2013). The area where Bradley mapped sand flax has not been developed, but it is dominated by non-native herbaceous vegetation. To date, surveys by Fairchild and IRC biologists in July 2006, September 2011, May 2017, and March 2022 failed to observe the species at this location (Fairchild unpublished data).