Papery whitlow-wort
(Paronychia chartacea)

5-Year Review:
Summary and Evaluation

Photo by Stacy Smith

U.S. Fish and Wildlife Service
South Atlantic-Gulf Region
Florida Ecological Services Field Office
Vero Beach, Florida

5-YEAR REVIEW
Papery whitlow-wort (*Paronychia chartacea*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historical and contemporary distributions, life histories, genetics, habitats, and threats of this species. This review includes information from the previous 5-year review (U.S. Fish and Wildlife Service [Service] 2008) that is still applicable to the species, with updated or new information incorporated, as appropriate. We announced initiation of this review and requested information in a published *Federal Register* (FR) notice with a 60-day comment period in 2018 (83 FR 38320). We did not receive any public comments during the open comment period. We also used a variety of information resources, including monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. Specific sources included the final rule listing this plant under the Endangered Species Act of 1973, as amended (ESA) (52 FR 2227), the Recovery plan (Service 1999), the last 5-year review (Service 2008), peer reviewed scientific publications, and unpublished field observations by Federal, State, and other experienced biologists. The Florida Ecological Services Field Office (FESFO) Vero Beach contracted with Archbold Biological Station's (ABS) plant ecologist to update this review, which the lead recovery biologist for papery whitlow-wort in the FESFO Vero Beach finalized. Literature and documents used for this 5-year review are on file at the FESFO. All recommendations resulting from this review are a result of thoroughly reviewing the best available information on Papery whitlow-wort. The Service did not seek additional peer review for this updated 5-year review.

B. Reviewers

Lead Region: South Atlantic-Gulf Region, Carrie Straight, Carrie_Straight@fws.gov, (404) 679-7226

Lead Field Office: FESFO, Vero Beach, Emily Bauer, Emily_Bauer@fws.gov, (772) 562-3909

Cooperating Field Office(s): FESFO, Jacksonville, Jay Herrington, Jay_Harrington@fws.gov, (904) 731-3336; FESFO, Panama City, Vivian Negron-Ortiz, Vivian_Negronortiz@fws.gov, (850) 769-0552

C. Background

1. FR Notice citation announcing initiation of this review: August 8, 2018, 83 FR 38320.

2. Listing history:

Original Listing
FR notice: 52 FR 2227
Date listed: January 21, 1987
Entity listed: Species
Classification: Threatened

3. Associated rulemakings: There are no associated rulemakings for this species.

4. Review History: Each year, the Service reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we performed a yearly recovery data call. The last 5-year status review conducted in 2008 showed this species as unknown with no change recommended to the species' status due to the lack of detailed data and population trends for some populations.

Previous 5-year reviews: 1991 (56 FR 56882) and 2008 (72 FR 20866).

5. Species' Recovery Priority Number at start of review: 8. A recovery priority number of "8" represents a moderate degree of threat and high recovery potential.

6. Recovery Plan or Outline
Name of plan: South Florida Multi-Species Recovery Plan (Service 1999)
Date issued: May 18, 1999
Dates of previous plan: January 29, 1990 (Recovery Plan for Eleven Florida Scrub Species) and June 20, 1996 (Recovery Plan for Nineteen Central Florida Scrub and High Pineland Plants).

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. Is the species under review listed as a DPS? No. The ESA 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 DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, we do not address the application of the DPS policy to the species listing further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes. However, the plan does not adequately consider the existence of two varieties, *Paronychia chartacea* var. *chartacea* and *P. c.* var. *minima*, each with different habitat requirements, threats, and management needs.

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No. Recovery criterion 3 (below) does not cover the unique habitat type around the margins of karst ponds for *P. c.* var. *minima*.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors* are addressed by that criterion. If any of the 5 listing factors are not relevant to this species, please note that here.

The recovery criteria as presented in the recovery plan is broken down into four parts ([1-4] in bold below) for clarity purposes (Service 1999). These criteria address factors A) the present or threatened destruction, modification, or curtailment of its habitat or range; D) inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors affecting its survival. Factors B (overutilization for commercial, recreational, scientific, or educational purposes) and C (disease or predation) are not relevant to this species.

Papery whitlow-wort may be delisted when:

[1] Enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95 percent probability of persistence for 100 years;

This criterion has not been met. This criterion sets a very high bar for recovery (i.e., 95 percent probability of persistence for 100 years) and requires extensive data collection. This criterion could be more easily addressed by using redundancy (number of populations) to ensure resiliency for the species. Demographic data are limited on either variety of papery whitlow-wort. Each variety needs separate analyses, and each analysis would require collection of detailed demographic data (*sensu* Menges and Gordon 1996) from multiple populations over several years, as well as data on the reproductive biology, seed ecology, and perhaps genetics. Analyses would have to consider the effect of the fire regime for *P. c.* var. *chartacea* and hydrology for *P. c.* var. *minima*. To provide adequate assurance of persistence for 100 years for the two varieties, models will also require data collected from subpopulations with differing hydrology, fire, and management histories. At present, however, population data being collected are not at the level of detail required for demographic modeling. Data currently being collected for *P. c.* var. *chartacea* at the Lake Wales Ridge State Forest (LWRSF) consists of locations; other populations of either *P. c.* var. *chartacea* or *P. c.* var. *minima* are not closely monitored.

[2] When these sites, within the historic range of *P. chartacea*, are adequately protected from habitat loss, degradation, and fragmentation;

For *P. c.* var. *chartacea,* this criterion has been largely met through the acquisition of conservation lands by federal, state, county, and private conservation agencies or organizations. Protected populations of *P. c.* var. *chartacea* occur in Lake, Polk, and Highlands county (Florida National Areas Inventory [FNAI] 2019). The majority of the range occurs in Polk and Highlands counties (66 occurrences), with only 14 occurrences in Lake (7), Orange (6), and Osceola (1) counties (FNAI 2019). Most of the few populations off the Lake Wales Ridge (LWR) in Lake, Polk, Orange, and Osceola counties are unprotected. The historic range of the species specified in this criterion does not reflect the fact that in some unprotected areas development has resulted in no available suitable habitat remaining for the species. This is especially the case for occurrences in Orange County, where FNAI (2019) reports that all but one occurrence is extirpated or likely extirpated. Altogether there are 80 FNAI Element Occurrence Records (EORs) of *P. c.* var. *chartacea* including 47 (approximately 59 percent) protected EORs on 39 properties managed by a variety of federal and state agencies, as well as private organizations (for details, see later section of this review) (FNAI 2019).

P. c. var. *minima* was not recognized until 1991 and its original range is unknown. Currently, there are 21 known EORs in Washington and Bay counties, 9 of which are protected on the Ecofina Creek Water Management Area (WMA) (FNAI 2019).

[3] When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support *P. chartacea*; and

This criterion has been partially met. This criterion fails to account for differences in the preferred habitats of the two varieties. However, the criterion retains its validity in that it requires the application of appropriate management activities to maintain habitat. For *P. c.* var. *chartacea*, appropriate management of its preferred rosemary scrub habitat involves infrequent high intensity fire at intervals of 10 to 30 years. In unprotected sites, the application of prescribed fire at these frequencies is not likely since these lands are rarely managed to maintain scrub habitats. Most protected areas include prescribed fire in their management plans, but lack of funding, drought, and proximity to residential areas often hinders the application of prescribed fire at the desired frequency. No data are available on the management needs of *P. c.* var. *minima*.

[4] When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species.

This criterion has largely been met for *P. c*. var. *chartacea*. A criterion for stability is not easily measured for species such as papery whitlow-wort that are characterized by local populations that boom in response to fire, hydrology, or other disturbances and

decline with time-since-fire (e.g., Johnson and Abrahamson 1990; Menges and Kohfeldt 1995; Schafer et al. 2010, 2013). There is little ongoing monitoring of either variety beyond occasional level 1 surveys (*sensu* Menges and Gordon 1996). Nonetheless, *P. c*. var. *chartacea* is stable in terms of its resiliency. It has 80 EORs that occur throughout the majority of the species' historic range and mostly (59 percent) on protected areas. Population sizes are often large (exceeding 1,000 and sometimes greater than 100,000 individual plants), at least at times. In addition, a persistent soil seed bank helps the variety recover from disturbance like fire, and although populations fluctuate, protected areas are not known to have lost any populations.

This criterion has not been met for *P. c*. var. *minima.* Detailed data for the variety are unknown and over half of the known occurrences are on unprotected lands that are not routinely surveyed.

C. Updated Information and Current Species Status

P. c. var. *chartacea* occurs in scrub habitats on the LWR and adjacent uplands in Central Florida; *P. c.* var. *minima* occurs on the margins of karst ponds in the Florida panhandle. Because the two varieties occur in different geographic locations and in different habitats, we discuss each separately below.

1. Biology and Habitat

a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:

P. c. var. *chartacea*

Abundance - Surveys typically either note its presence (level 1 monitoring *sensu* Menges and Gordon 1996) or make broad estimates of population sizes (e.g., hundreds, thousands, tens of thousands). Only a few datasets contain data based on actual counts, but it is known that the species can reach high population densities. For example, LWRSF estimated roughly 17,000 to 35,000 individuals of *P. c.* var. *chartacea* (these data span nine EORs) (Clanton 2007; H. Rosner-Katz, Florida Forest Service, pers. comm., 2019). At ABS over 1,400 individual plants from 16 rosemary scrub sites and 4 roadside plots (representing one EOR) were censused (Schafer et al. 2010), with plant density over three times higher in roadside than in scrub sites (12.7 per m^2 vs. 4.29 per m^2) (Schafer et al. 2010).

FNAI EOR data provide estimates of population sizes. While rough, these estimates, conducted over many sites and through time, offer some insight into population dynamics. Most *P. c.* var. *chartacea* EORs are large, with 11 reported as over 10,000, 5 between 1,000 and 9,999, 13 between 100 and 999, and 11 less than 100. In addition, FNAI (2019) reports seven other EORs as "large, abundant, or common" and likely exceed 10,000 plants. FNAI EOR data over time support the idea that

papery whitlow-wort numbers can vary widely. In unmanaged areas, these changes mainly show population declines from over 10,000 to thousand, hundreds, or fewer (FNAI 2019). FNAI data (2019) suggest that 11 EORs have probably or certainly gone extinct, all associated with land clearing or other human development. In managed areas, *P. c*. var. *chartacea* underwent large increases and decreases over time, although population loss was not observed.

Population trends - Given that *P. chartacea* var. *chartacea* has many populations, some large, Menges et al. (2019) recommends Level 2 monitoring (counting individuals in defined areas) every 2 to 5 years during peak flowering for determining the effects of management. Limited Level 3 monitoring (demographic data collection involving individually marked plants (Menges and Gordon 1996)) has been conducted. One Level 3 study documented overall declines despite occasional recruitment booms over a 2-year study period (Schafer et al. 2013).

FNAI ranks the viability (EORANK) of the EORs based on the size of the EOR, general condition of the EOR, and the condition of the landscape surrounding the EOR. EORANK specification for *P. c*. var. *chartacea* are provided below in Table 1.

Table 1. EORANK specifications and numbers for *P. c*. var. *chartacea*. For additional detail on ranks see: http://www.natureserve.org/explorer/eorankguide.htm.

EORANK	EORANK Description	Number of EORs in Classification
A	Excellent estimated viability	7
A?	Possibly excellent estimated viability	1
AB	Excellent or good estimated viability	7
AC	Excellent, good, or fair estimated viability	1
B	Good estimated viability	10
B?	Possibly good estimated viability	4
BC	Good or fair estimated viability	8
BD	Good, fair, or poor estimated viability	1
C	Fair estimated viability	1
C?	Possibly fair estimated viability	1
CD	Fair or poor estimated viability	6
D	Poor estimated viability	2
E	Verified extant (viability not assessed)	12
F	Failed to find	1
H	Historical	9
X	Extirpated	3
X?	Possibly extirpated	6

Based FNAI data (2019) there were 71 EORs of *P. c*. var. *chartacea* considered extant, 1 EOR that was not found during recent visits (F), 3 EORs that were considered extirpated (X), and 6 EORs that were possibly extirpated (X?) (Table 1). Of the extant EORs, 16 (approximately 23 percent) were A-ranked (A, A?, AB, or

AC), 22 (approximately 31 percent) were B-ranked (B, B?, or BC), 2 (approximately 3 percent) were C-ranked (C or C?), and 2 (approximately 3 percent) were D-ranked (Table 1). With the exception of the BD and CD ranks, EORs that were in the A-, B-, or C-ranked categories were considered viable. There were 40 (approximately 56 percent) EORs ranked as viable (Figure 1). The BD-, CD-, and E-ranked EORs, were considered to have uncertain viability and totaled 19 (approximately 48 percent) (Figure 1). Of the 19 EORs with uncertain viability, 11 occurred on unprotected sites (site with no known habitat management). Surveys are needed to determine the viability of these EORs. Over one-quarter (21) of the EORs were ranked as non-viable (i.e., D, F, H, X, or X? ranked) (Table 1, Figure 1). Of these 21 EORs, 15 were located on unprotected sites (Figure 1). 30 of the 40 viable EORs are located on protected sites and are managed to maintain suitable habitat conditions that will allow for self-sustainability of *P. c.* var. *chartacea* into the foreseeable future (Figure 1).

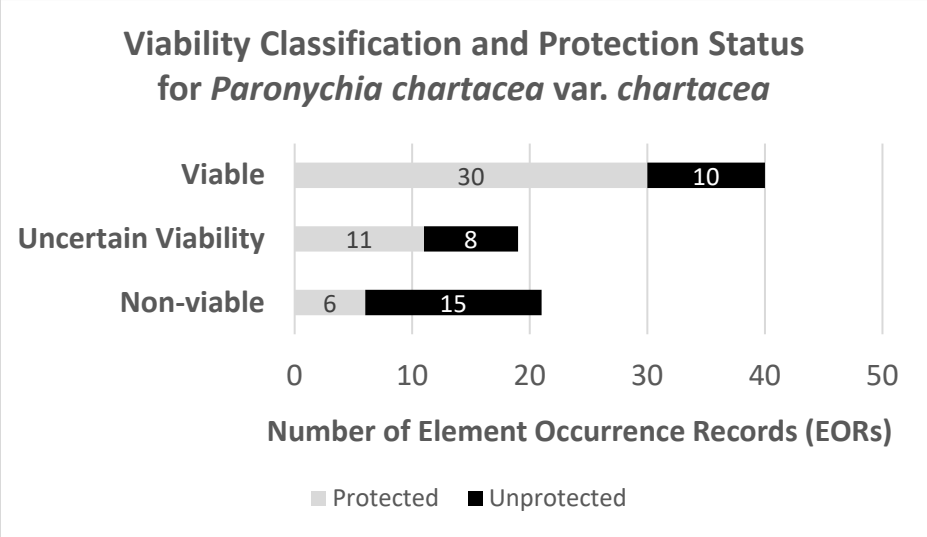

Figure 1. Viability classification and Protection Status for *Paronychia chartacea* var. *chartacea*.

Demographic features - *P. c.* var. *chartacea* is a short-lived perennial that can live for as long as seven years (Anderson 1991; Schafer et al. 2013). The median lifespan for the species in rosemary scrub and roadside habitats was 9 and 6.8 months, respectively, with approximately one-third of individuals surviving more than a year and often flowering twice (Schafer et al. 2013). *P. c.* var. *chartacea* is gynodioecious, with bisexual plants producing far fewer fruits than female plants, suggesting that *chartacea* may have three sexual morphs: females, functional males, and true bisexuals (hermaphrodites), with a cryptically dioecious / sub-dioecious breeding system (Sullivan, pers. comm. 2008; Schafer et al. 2013).

Fire kills the species (Weekley and Menges 2003) and it recovers through germination (Menges and Kohfeldt 1995) from a persistent soil seed bank (Navarra et al. 2011). The seed bank may allow germination after many years as *P. c.* var. *chartacea* appears in areas where it was not present pre-fire (Johnson and

Abrahamson 1990). It is a gap specialist: more likely to occupy the center of large gaps than edges of large gaps or small gaps (Schafer et al. 2010), and densities are highest in open areas (Hawkes and Menges 1996) and in larger gaps (Dee and Menges 2014). Density decreases with time-since-fire (Johnson and Abrahamson 1990; Schafer et al. 2010). Seedling recruitment is inhibited by ground lichens (Hawkes and Menges 2003), favored by bare sand (Stephens et al. 2012), and not suppressed by Florida rosemary leachates (Hunter and Menges 2002). Seeds germinate better from shallow than deep soil depths (Petrů and Menges 2004). Local extinction was lower in burned areas and in larger gaps, and burning resulted in higher colonization (Menges et al. 2017). Abundance was greatest in the centers of large gaps (as opposed to small gaps or the edges of large gaps) (Schafer et al. 2010). The density of roadside populations was similar to recently-burned scrub populations (Schafer et al. 2010). Seedling recruitment was highest along roadsides, but seed production was highest in rosemary scrub (Schafer et al. 2013). Median lifespan was longest in long-unburned sites, suggesting plants can persist despite growing with litter and shrub competition (Schafer et al. 2013). Schafer et al. (2013) suggested a 15 to 40-year fire return interval for persistence of *P. c*. var. *chartacea* in rosemary scrub.

Germination percentages of papery whitlow-wort vary among studies and with experimental treatments. Some studies have shown high rates of germination for *P. c*. var. *chartacea* (e.g., Hawkes and Menges 2003; Petrů and Menges 2003; C. Steppe, University of Florida, pers. comm. 2019), while others have found surprisingly low levels of germination across microhabitats, despite supplemental watering and the application plant growth hormone (L. Sullivan, Washington University, pers. comm. 2008). Results from studies on the effects of biotic soil crusts on germination are also variable. Results have varied from no significant difference in germination of *P. c*. var. *chartacea* with placement on native soils to germination being promoted by both the removal of terrestrial lichens (Hawkes and Menges 2003) and the addition of soil crusts and soil crust depth in some years (Hamman and Hawkes 2013). *P. c*. var. *chartacea* shed their seeds in the winter; however, germination was highest when seeds were placed at a high temperature and then moved to a moderate temperature (Steppe, pers. comm. 2019). Carpenter ants (*Pogonomyrmex badius*) sometimes collect *P. c*. var. *chartacea* seeds, but were poor seed dispersers (Sullivan, pers. comm. 2008).

P. c. var. *minima*

Abundance - Current FNAI data (2019) include population estimates for *P. c*. var. *minima* at some EORs, with one EOR over 100,000; four EORs between 1,000–10,000; five EORs between 100–999; and only two EORs smaller than 100 plants. In addition, three EORs may also be large, described as “numerous”, “very large”, and “entire perimeter”. Many EORs in managed areas are very large. In contrast, many EORs in unmanaged areas number in the hundreds or less, with only a few larger. EORs of *P.c.* var. *minima* fluctuate widely in response to water levels, fire, and other disturbance factors.

Population trends - The FNAI database for *P. c.* var. *minima* has expanded from 12 EORs during the last review (Service 2008) to 21 EORs (FNAI 2019) (Table 2). This is not necessarily an expansion in the known range of the species, as all reported EORs remain within Washington and Bay County. Of the 21 EORs, most (15 or approximately 71 percent) range from excellent to fair estimated viability (Table 2). Nine of the 21 EORs occur on a single protected area, the Ecofina Creek WMA; the other 12 EORs occur on unprotected lands (Figure 2). The EORANK for the EORs on managed lands range from A to D, with 7 EORs classified as viable and one EOR each classified as uncertain viability and non-viable (Figure 2). For the 12 unprotected EORs, FNAI (2019) classified 8 as viable, 2 as uncertain viability, and 2 as non-viable (Figure 2). Lakeshore clearing or scraping negatively affected four of the known unmanaged EORs. FNAI (2019) reported two of the EORs as likely extirpated (X?).

Table 2. EORANK specifications and numbers for *P. c.* var. *minima*. For additional detail on ranks see: http://www.natureserve.org/explorer/eorankguide.htm.

EORANK	EORANK Description	Number of EORs in Classification
A	Excellent estimated viability	1
AB	Excellent or good estimated viability	5
B	Good estimated viability	4
BC	Good or fair estimated viability	3
C	Fair estimated viability	2
CD	Fair or poor estimated viability	1
D	Poor estimated viability	1
E	Verified extant (viability not assessed)	2
X?	Possibly extirpated	2

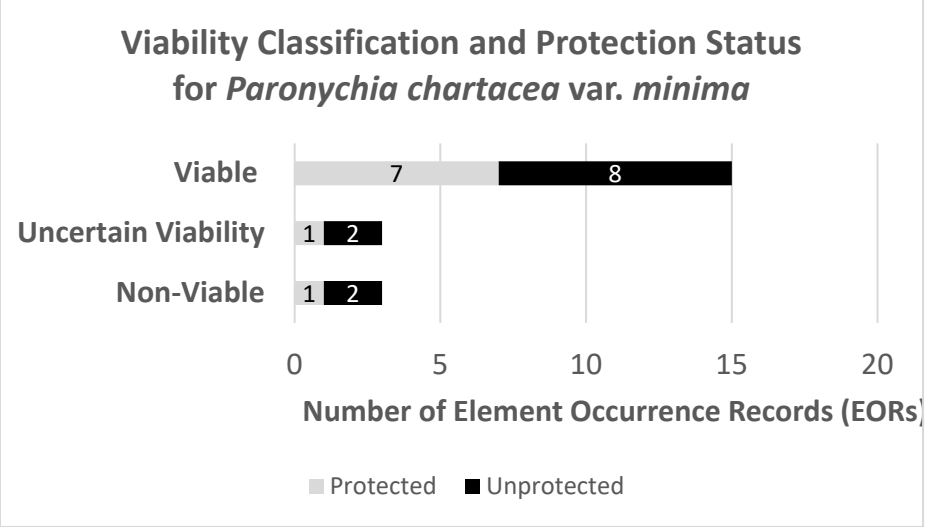

Figure 2. Viability classification and Protection Status for *Paronychia chartacea* var. *minima*.

Demographic features - There have been no long-term demographic studies of *P. c.* var. *minima.*

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding): No genetic studies have been conducted on either variety of *P. chartacea*.

c. Taxonomic classification or changes in nomenclature: In accordance with 50 CFR Subpart B, section 17.12(g), when the Service listed papery whitlow-wort as threatened all lower taxonomic units were included as the listed entity. Thus, the same threatened status applies to the two varieties: *P. c. chartacea* and *P. c. minima*.

Anderson (1991) separated the two subspecies based on morphological, life history, geographic, and habitat differences. Currently, the Integrated Taxonomic Information System (ITIS) (2021) recognizes these taxa as varieties. *P. c.* var. *minima* exhibits more pronounced sexual dimorphism than *P. c.* var. *chartacea*. *P. c.* var. *minima* is an annual, while *P. c.* var. *chartacea* is a short-lived perennial.
There have been no specific challenges to Anderson (1991), although Wunderlin et al. (2021) do not recognize the two subspecific taxa. The ITIS (2021) accepts the taxonomic status of the species and both varieties. The ITIS does not accept the subspecies.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range):

P. c. var. *chartacea*

Of all the listed LWR scrub endemics, *P. c.* var. *chartacea* is one of the most widely distributed, and it may occur in other sites as well. The variety occurs at 80 EORs, in Highlands (36), Polk (30), Lake (7), Orange (6), and Osceola (1) counties (FNAI 2019; Wunderlin et al. 2021). All but one of the Orange County EORs are reported as extirpated or likely extirpated (FNAI 2019). No plants were observed at the only Osceola County site during the last two site visits. The last observed EORs range from 1983 to 2019, with the modal last observation from 1991 (FNAI 2019). The managed areas on the LWR provide relatively good protection for the variety, but most of the few populations off the LWR in Lake, Orange, and Polk counties are unprotected. It is not clear how many of these populations are extant. FNAI (2019) reports that 21, 14, and 10 unprotected sites were last checked in the 1980s, 1990s, and 2000s, respectively.

About 59 percent of FNAI's known *P. c.* var. *chartacea* EORs (47 of 80) occur on protected areas (Figure 1), which is comprised of at least 39 separate properties. These include EORs on Lake Wales Ridge Wildlife and Environmental Area

(LWRWEA) (20 EORs), LWRSF (9 EORs), Seminole State Forest (1 EOR), Allen David Broussard Catfish Creek Preserve State Park (3 EORs), Highlands Hammock State Park (3 EORs), Lake June in Winter State Park (1 EOR), and Lake Wales Ridge National Wildlife Refuge (2 EORs) (FNAI 2019; Menges et al. 2019). Privately protected populations include ABS (1 EOR), Saddle Blanket Scrub (2 EORs), Tiger Creek Preserve (1 EOR), and Crooked Lake Sandhill (1 EOR). Other protected tracts with a single EORs are Serenoa Preserve, Schofield Tract, Shadow Bay Park (possibly extirpated), Fisheating Creek/Smoak Groves Conservation Easement, Upper Marion Creek Watershed, Sandy Gully Agricultural and Conservation Easement, Crooked River Preserve and Palatlakaha River Park, and Upper Lake Basin Watershed. Occurrences of *P. c.* var. *chartacea* on the LWR are reasonably well distributed. Protected occurrences outside LWR include Lake Blue, Shadow Bay Park, and the Fisheating Creek/Smoak Groves Conservation Easement.

P. c. var. *minima*

The FNAI database for *P. c.* var. *minima* has expanded from 12 EORs during the last review (Service 2008) to 21 EORs (FNAI 2019). This is not necessarily an expansion in the known range of the species, as all reported EORs remain within Washington and Bay County (Wunderlin et al. 2021). Nine of the 21 occur on a single managed area, the Ecofina Creek WMA in Washington and Bay counties. The other 12 EORs also occur within these two counties. Overall, Washington County has 16 occurrences while Bay County has 5. Nearly all documented EORs occur on the white sand margins of karst ponds within Florida rosemary scrub sites, with a single EOR on a sandhill site (L. Keppner, Keppner Biological Services, pers. comm. 2008).

P. c. var. *minima* is poorly protected within its range, with less than half of the known 21 EORs on protected lands (FNAI 2019). Although Ecofina Creek WMA may encompass the epicenter of its distribution, large peripheral populations may harbor genetic variants critical to the maintenance of the taxon.

Surveys for *P. c*. var. *minima* occurred at additional locations, outside of known EORs, on private lands in Bay and Washington counties (surveys conducted from 2008 to 2009). The survey results, however, are confidential and were not available at the time this review was completed (Keppner, pers. comm. 2019).

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

P. c. var. *chartacea*

Based on surveys on the LWR in Highlands County, Menges et al. (2007) characterized *P. c.* var. *chartacea* as a soil generalist. Forty percent of occurrences in Highlands County were recorded from gray sands supporting scrubby flatwoods (e.g., Satellite sand) and an almost equal percentage of white sands supporting Florida rosemary scrub (e.g., Archbold and St. Lucie sands). *P. c.* var. *chartacea* was rarely

recorded on sandhill or flatwoods soils (<10 percent for each category). Although the soil preferences of *P. c.* var. *chartacea* elsewhere on the LWR have not been quantified, it is well known from white, gray, and yellow sands throughout its range, being most abundant on white sands.

FNAI (2019) reports sand pine scrub/rosemary scrub is the most common habitat for *P. c.* var. *chartacea* (27 EORs), with scrub or scrub mixtures (17 EORs), oak scrub (16 EORs), and sandhill (8 EORs) as other common habitats.

Papery whitlow-wort occurs on properties with a range of sizes, with the smallest habitat patch at approximately 0.02 acres (ac) and the largest at 2,940 ac (an approximate median and mean of 20 ac and 193 ac, respectively) (FNAI 2019). The difference between the mean and the median suggests a skewed distribution of habitat patch sizes, with many small patches and fewer large habitat areas.

P. c. var. *minima*

P. c. var. *minim*a is a habitat specialist, with nearly all EORs in the FNAI database described as karst ponds or sandhill upland lakes. One EOR was an upland (sandhill) area now planted in longleaf pine; another was described as an "open exposed trail". Other than its preference for the margins of karst ponds, the habitat requirements of *P. c.* var. *minima* is unknown. The role of fire, flooding, or other disturbance in the maintenance of populations is unknown (Keppner, pers. comm. 2008). The variety occurs at 21 EORs ranging from 0.030 to 1,125 ac, with a median size of 2.8 ac and a mean size of 122 ac (FNAI 2019).

f. Other: N/A

2. Five-Factor Analysis

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat on protected lands is critical for the recovery of *P. c*. var. *chartacea*. Weekley et al. (2008) estimated the aerial extent of post-Columbian xeric upland habitat loss on the LWR exceeds 85 percent. Habitat loss through agricultural and residential development on unprotected lands is still occurring and likely to continue into the future. If trends continue, Carr and Zwick (2016) estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 ac in 2010 to 9,525,000 ac by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for *P. c.* var. *chartacea*. At present, about 41 percent of *P. c.* var. *chartacea* EORs are not protected from threats that are range-wide in scope. On unprotected sites, many populations are possibly extirpated; surveys of unprotected FNAI EORs will be required to determine if they are still extant. *P. c.*

var. *chartacea* has at least 47 occurrences in 39 managed areas, mainly on the LWR.

Human development has disrupted the natural disturbance regime for *P. c.* var. *chartacea*. This species occurs in ecosystems that depend on fire, and fire suppression is likely to eliminate populations. This threat was considered under Factor E in the listing (52 FR 2227) and 2008 five-year review (Service 2008). The species is likely to tolerate fire return intervals ranging from 10 to 30 years (Menges et al. 2019). Inadequate use of fire may reduce population sizes or adversely affect demographic performance. Fire suppression is pervasive at unprotected sites and gradually alters habitat over a period of years. Even in managed sites, fire management may not always be adequate to protect *P. c.* var. *chartacea* populations. Appropriate management for the species means burning Florida rosemary scrub often enough to maintain large gaps within the rosemary shrub matrix (i.e., 10 to 30 years (Menges et al. 2019)). The limited information available on the effects of mechanical treatments on *P. c.* var. *chartacea* suggests a positive response by the species in combination with prescribed fire (Smith et al. 2009; Menges, unpublished data).

For *P. c.* var. *minima*, it is unknown how many populations may have already been lost and its historical range is undocumented. Clearing or scraping has negatively impacted at least four sites. Development or habitat modification could destroy all occurrences on privately owned land. Further surveys are needed to determine the current status of populations and the threats to each. In the absence of data on the biology and ecological needs of *P. c.* var. *minima*, its management needs cannot be determined. The preferred habitat of this variety on the margins of karst ponds suggests that disturbances other than fire may be required for the maintenance of its populations (L. Keppner, pers. comm. 2008).

b. Overutilization for commercial, recreational, scientific, or educational purposes: Not known as a threat at the time of listing or at present for either variety.

c. Disease or predation: Not known as a threat at the time of listing or at present for either variety.

d. Inadequacy of existing regulatory mechanisms: *P. chartacea* is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations.

Existing federal (ESA) and state regulations (FDACS Rule 5B-40) prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a Federal nexus is involved. In addition, state regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants. In conclusion, no

existing regulatory measures reduce or remove the threat of loss of populations or the removal/destruction of plants on private property. Furthermore, existing regulatory mechanisms are inadequate to protect the species.

e. Other natural or manmade factors affecting its continued existence:

Isolated Populaitons Within a Limited Geographic Range

P. c. var. *chartacea* occurs within a relatively limited geographic range consisting of five Central Florida counties. The species' limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas that provide habitat have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. Given the limited geographic range of the species, a single catastrophic event could greatly reduce redundancy. In addition, the fragmented landscape may prevent 'rescue' or 'repopulation' from surrounding nearby populations.

Climate Change

There is currently no evidence of negative impacts to papery whitlow-wort from climate change factors, but this could change in the future. Florida is vulnerable to changes in rainfall and temperatures expected due to climate change. Strong influence of ocean currents makes projecting regional climate in Florida difficult (Kirtman et al. 2017). Estimates project by 2100 Florida's average annual temperatures will increase approximately 1.5 to 5.5°F (0.8 to 3.1°C) by 2050 and from 2 to 11.5°F (1.1 to 6.4°C), depending on the greenhouse gas emission rates and the region in Florida (Runkle et al. 2017). In addition, predictions for summer rainfall (wet season) in the Central Florida and the Panhandle regions estimate a decrease up to 5 percent by 2050 (Runkle et al. 2017). Higher temperatures and changes in precipitation patterns could alter relative humidity levels and evapotranspiration rates, leading to the potential for more frequent and intense droughts and wildfire events. Scrub species, in general, can tolerate drought conditions, but it is unclear how this anticipated future threat will fully affect species like *P. chartacea* or the ability to implement prescribed fire.

In addition to changes in precipitation and temperature pattern, there are also anticipated changes to the severity of tropical storms and hurricanes. Sweet et al. (2017) predicted a 20 percent increase in both rainfall rates and wind speeds new the center of storms due, in part, to higher sea surface temperature.

Sea-level rise is another anticipated consequence of climate change in Florida. Rosemary scrub sites within the Central Florida ridges and Panhandle will not experience the direct impacts of sea level rise that are anticipated for coastal and low elevation areas. However, as sea level rises in coastal regions, development is likely to move inland, further increasing the threat of development in the higher elevation

areas, such as the Central Florida ridges and Panhandle rosemary scrub habitats (Volk et al. 2017).

D. Synthesis

Papery whitlow-wort comprises two geographically isolated varieties which differ in microhabitat preferences, disturbance regimes, threats, life history characteristics, and management needs. The existing recovery criteria for *P. chartacea* are inadequate for *P. c.* var. *minima*, and refining the recovery for the species must begin with an awareness that the recovery requirements of the two varieties may differ.

P. c. var. *chartacea* is nearly ubiquitous in protected scrub sites on the LWR. Forty EORs are classified as viable (FNAI 2019), many of which are very large in size. Away from the LWR, there are only a few protected populations. There is some knowledge of the biology, ecological needs, and demography of *P. c.* var. *chartacea,* although less than most Florida scrub endemics. This variety depends on periodic disturbance, ideally fire. Fire management continues to lag behind schedule in some protected areas and is unlikely at most of the unprotected sites. Populations persist along sand roads and fire lanes, often in great numbers, even in fire-suppressed areas. Populations fluctuate, although the variety's persistent seed bank should allow for recovery after fire. While the status of *P. c.* var. *chartacea* appears to be doing well in protected sites on the LWR, there are 40 EORs classified with uncertain viability (19 EORs) or non-viable (21 EORs). At this time, we do not have enough information to model populations or make an accurate determination on whether *P. c.* var. *chartacea* meets the recovery criteria outlined for the species. Therefore, we recommend more surveys between now and the next 5-year review (2026) to determine if *P. c.* var. *chartacea* still meets the definition of a threatened species and requires the protections of the ESA.

P. c. var. *minima* is poorly protected, with over half of the EORs located outside its one protected area. There are fewer than two dozen EORs in all, 6 of which are classified with uncertain viability (3 EORs) or non-viable (3 EORs). The life history, demographic structure, or management needs of *P. c. minima* are poorly known. Populations fluctuate widely in response to hydrology and many habitat areas are being lost to development. Due to the probability of continued population losses at unprotected sites and the lack of management needs for the variety, *P. c.* var. *minima* continues to meet the definition of a threatened species under the ESA.

III. RESULTS

A. Recommended Classification:

_X_ **No change is needed**

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Conduct surveys for *P. c.* var. *minima* in areas with appropriate habitat and unknown occupancy to assess the possibility of additional populations and help identify the historic

range of the variety. This could include a habitat suitability analysis to help guide surveys.

- Purchase for conservation or work with private landowners to develop conservation agreements for unprotected lands with *P. c*. var. *minima*.
- Manage Florida rosemary scrub habitat for *P. c. chartacea* through prescribed fire within a fire return interval of 10 to 30 years (Menges et al. 2019).
- Investigate the habitat maintenance requirements of *P. c. minima*, particularly with respect to hydrology.
- Institute or continue Level 1 monitoring for *P. c.* var. *chartacea* between August and November when plants are most abundant.
- Conduct more intensive monitoring of *P. c.* var. *minima*. However, its short lifespan and the very dynamic nature of pond hydrology at most sites will make this monitoring challenging. Understanding seed dormancy in *P. c.* var. *minima* will be key to understanding its limits with respect to hydrological variation.
- Conduct population viability analyses, including detailed demographic data (level 3 monitoring *sensu* Menges and Gordon 1996) collected from multiple populations of both subspecies. Collect data across the full geographic range of both varieties, from populations in contrasting habitats (e.g., rosemary scrub vs. roadsides for subspecies *P. c*. var. *chartacea*, pond margins vs. sandhill for subspecies *P. c*. var. *minima*), and in sites with differing management histories. Relate demographic research on *P. c*. var. *chartacea* to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness. Couple such data for *P. c*. var. *minima* with current and historical data on pond hydrology.
- Conduct studies to understand the genetic diversity of both varieties; this may aid in the identification of new acquisition needs.
- Conduct a study of the reproductive biology of the two varieties to determine the degree of floral dimorphism/sexual gender and sex ratios of populations.

V. REFERENCES

Anderson, L.C. 1991. Paronychia chartacea ssp. minima (Caryophyllaceae): a new subspecies of a rare Florida endemic. Sida 14:435-441.

Carr, M. H., and P.D. Zwick. 2016. Florida 2070. Mapping Florida's Future – Alternative Patterns of Development in 2070. University of Florida. Gainesville, Florida.

Clanton, K. 2007. Information and comments on federally listed plants on the Lake Wales Ridge State Forest in response to the U.S. Fish and Wildlife Service 5-year status review. Florida Division of Forestry.

Dee, J.R. and E.S. Menges. 2014. Gap ecology in the Florida scrubby flatwoods: effects of time-since-fire, gap area, gap aggregation and microhabitat on gap species diversity. Journal of Vegetation Science 25(5):1235-1246.

Florida Natural Areas Inventory (FNAI). 2019. Unpublished element occurrence point data. Submitted to the Eric Menges. Venus, Florida.

Hamman, S.T. and C.V. Hawkes. 2013. Biochemical and microbial legacies of non-native grasses can affect restoration success. Restoration Ecology 21:58-66.

Hawkes, C.V. and E.S. Menges. 1996. The relationship between open space and fire for species in a xeric Florida shrubland. Bulletin of the Torrey Botanical Club 123:81-92.

Hawkes, C.V., and E.S. Menges. 2003. Effects of lichens on seedling emergence in a xeric Florida shrubland. Southeastern Naturalist 2:223-234.

Hunter, M.E. and E.S. Menges. 2002. Allelopathic effects and root distribution of Ceratiola ericoides (Empretaceae) on seven rosemary scrub species. American Journal of Botany 89:1113-1118.

Integrated Taxonomic Information System. 2021. http://www.itis.usda.gov/index.html Checked April 22, 2021.

Johnson, A.F., and W.G. Abrahamson. 1990. A note on the fire responses of species in rosemary scrubs on the southern Lake Wales Ridge. Florida Scientist 53:138-143.

Keppner, L. 2008. Personal communication. Keppner Biological Services. Email of 28 April 2008.

Keppner, L. 2019. Personal communication, Keppner Biological Services. Email of 5 September 2019.

Kirtman, B.P., V. Misra, R.J. Burgman, J. Infanti, and J. Obeysekera. 2017. Florida Climate Variability and Prediction. In: Florida's Climate: Changes, Variations, & Impacts. https://floridaclimateinstitute.org/docs/climatebook/Ch17-Kirtman.pdf.

Menges, E.S., S.J.H. Crate, and P.F. Quintana-Ascencio. 2017. Dynamics of gaps, vegetation, and plant species with and without fire. American Journal of Botany 104:1825-1836.

Menges, E.S. and D.R. Gordon. 1996. Three levels of monitoring intensity for rare plant species. Natural Areas Journal 16:227-237.

Menges, E.S. and N. Kohfeldt. 1995. Life history strategies of Florida scrub plants in relation to fire. Bulletin of the Torrey Botanical Club 122:282-297.

Menges, E.S., S.M. Koontz, K.T. Charton, and S.A. Smith. 2019. Rare plant biology and management on the Lake Wales Ridge. Report to Florida Fish and Wildlife Conservation Commission. May 2019. 63 pp.

Menges, E.S., C.W. Weekley, S.I. Hamzé, and R.L. Pickert. 2007. Soil preferences for federally-listed plants on the Lake Wales Ridge in Highlands County, Florida. Florida Scientist 70:24-39.

Navarra, J.J., N. Kehfeldt, E.S. Menges, P.F. Quintana-Ascencio. 2011. Seed Bank Changes with Time-since-fire in Florida Rosemary Scrub. Fire Ecology 7(2):17–31.

Petrů, M. and E.S. Menges. 2003. Seedling establishment in natural and experimental Florida scrub gaps. Journal of the Torrey Botanical Society 130:89-100.

Petrů, M. and E.S. Menges. 2004. Shifting sands in Florida scrub gaps and roadsides: Dynamic microsites for herbs. American Midland Naturalist 151:101-113.

Rosner-Katz, H. 2019. Personal communication. Florida Forest Service. Email of 4 September 2019.

Runkle, J., K. Kunkel, S. Champion, R. Frankson, B. Stewart, and W. Sweet. 2017. Florida State Climate Summary. NOAA Technical Report NESDIS 149-FL. 4 pp.

Schafer, J.L., E.S. Menges, P.F. Quintana-Ascencio, and C.W. Weekley. 2010. Effects of time-since-fire and microhabitat on the occurrence and density of the endemic *Paronychia chartacea* ssp. *chartacea* in Florida scrub and along roadsides. American Midland Naturalist 163:294-310.

Schafer, J.L., L.L. Sullivan, C.W. Weekley, and E.S. Menges. 2013. Effects of habitat and time-since-fire on recruitment, survival, and reproduction of *Paronychia chartacea* ssp. *chartacea*, a short-lived Florida scrub endemic herb. Journal of the Torrey Botanical Society 140:181-195.

Smith, S.A., C.W. Weekley, and E.S. Menges. 2009. Population dynamics of endemic plants (PDEP), 2008-2009, on the Lake Wales Ridge and Environmental Area in South-Central Florida. Annual report to the Florida Fish and Wildlife Conservation Commission. 14 pp.

Stephens, E.L., L. Castro-Morales, and P.F. Quintana-Ascencio. 2012. Post-dispersal seed predation, germination, and seedling survival of five rare Florida scrub species in intact and degraded habitats. American Midland Naturalist 176:223–239.

Steppe, C. 2019. Personal communication. University of Florida. 25 September 2019.

Sullivan, L. 2008. Personal communication. Washington University. 4 June 2008.

Sweet, W.V, R.E. Kopp, C.P. Weaver, J. Obeysekera, R.M. Horton, E.R. Thieler, and C. Zervas. 2017. Global and Regional Sea Level Rise Scenarios for the United States. National Oceanic and Atmospheric Administration Technical Report NOS CO-OPS 083. Silver Spring, MD.

U.S. Fish and Wildlife Service (Service). 1999. South Florida multi-species recovery plan. U.S. Fish and Wildlife Service, Atlanta, GA. 2178 pp.

U.S. Fish and Wildlife Service (Service). 2008. Papery whitlow-wort (*Paronychia chartacea*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Atlanta, GA. 17 pp.

Volk, M.I., T.S. Hoctor, B.B Nettles, R. Hilsenbeck, F.E. Putz, and J. Oetting. 2017. Florida Land Use and Land Cover Change in the Past 100 Years. In: Florida's Climate: Changes, Variations, & Impacts. http://purl.flvc.org/fsu/fd/FSU_libsubv1_scholarship_submission_1515440747_56b1ed92

Weekley, C.W. and E.S. Menges. 2003. Species and vegetation responses to prescribed fire in long-unburned, endemic-rich Lake Wales Ridge Scrub. Journal of the Torrey Botanical Society 130:265-282.

Weekley, C.W., E.S. Menges, and R.L. Pickert. 2008. An ecological map of Florida's Lake Wales ridge: a new boundary delineation and an assessment of post-Columbian habitat loss. Florida Scientist 71:45–64.

Wunderlin, R.P., B.F. Hansen, A.R. Franck, and F.B. Essig. 2021. Atlas of Florida Plants (http://florida.plantatlas.usf.edu/). [S.M. Landry and K.N. Campbell (application development), USF Water Institute.] Institute for Systematic Botany, University of South Florida, Tampa.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Papery whitlow-wort *(Paronychia chartacea)*

Current Classification: Threatened.

Recommendation resulting from the 5-Year Review:

___ **Downlist to Threatened**
___ **Uplist to Endangered**
___ **Delist**
_X_ **No change needed**

Review Conducted By: Emily Bauer, Florida Ecological Services Field Office, Vero Beach.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve ROXANNA HINZMAN Digitally signed by ROXANNA HINZMAN Date: 2021.06.30 12:57:37 -04'00' Date _____

* Since 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.