Schiedea laui
(no common name)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawai‘i

5-YEAR REVIEW

Species reviewed: *Schiedea laui* (no common name)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

Chelsie Javar-Salas, Biologist, Pacific Islands Fish and Wildlife Office (PIFWO)
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
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Lead Regional Office:
Interior Region 12, Portland Regional Office

Lead Field Office:
Pacific Islands Fish and Wildlife Office

Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service), beginning in October 2019. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation by Chelsie Javar-Salas, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered status for 38 species

on Molokai, Lanai, and Maui; final rule. Department of the Interior, Federal Register 78 (102): 32014–32065, May 28, 2013.

Date listed: May 28, 2013
Entity listed: *Schiedea laui*
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings:

[USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe; final rule. Department of the Interior, Federal Register 81 (61): 17790–18110, March 30, 2016.

Critical habitat was designated for *Schiedea laui* on Molokaʻi in three units in the montane wet ecosystem (2,068 hectares (ha); 5,110 acres) (81 FR 17888, 18032).

1.3.4 Review History:

This is the first 5-year review for *Schiedea laui*.

1.3.5 Species' Recovery Priority Number at start of this 5-year review:

5

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui)
Date issued: October 2019
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

____**Yes**
__X_**No**

2.1.2 Is the species under review listed as a DPS?

____**Yes**
____**No**

2.1.3 Was the DPS listed prior to 1996?

____Yes
____No

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____Yes
____No

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____Yes
____No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____Yes
____No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

____Yes
__X_No

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____Yes
____No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery?

____Yes
____No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
A synthesis of the threats (Listing Factors A, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2. Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

The recovery plan is currently being drafted. However, the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so the Service also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, the Service has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. Narrow extant range and broad contiguous range are recognized as not needing different numbers of individuals or populations, but that the populations will be distributed more narrowly or more broadly, respectively, across the landscape. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

Stabilizing (interim), downlisting, and delisting objectives have been updated according to the draft revised recovery objective guidelines developed by the HPPRCC (2011). The HPPRCC identifies an additional initial objective, the Preventing Extinction Stage, in addition to the Interim Stabilization, Delisting, and Downlisting objectives. Furthermore, life history traits such as breeding system, population size fluctuation or decline, and reproduction type (sexual or vegetative), have been included in the calculation of goals for the number of populations and reproducing individuals for each stage. The goals for each stage

remain grouped by life span defined as annual, short-lived perennial (fewer than 10 years), or long-lived perennial.

Schiedea laui is a short-lived perennial herb or subshrub. To prevent extinction, which is the first milestone in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections. In addition, a minimum of three populations should be documented on Moloka‘i where they now occur or occurred historically. Each of these populations must be naturally reproducing (*i.e.*, viable seeds, seedlings), with a minimum of 50 mature individuals per population.

This recovery objective has not been met (see Table 1).

Interim Stage
To meet the interim stage of recovery of *Schiedea laui*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant *et al.* 2004) that is secured and well-maintained. Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria
In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

This recovery objective has not been met (see Table 1).

Delisting Criteria
In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
Schiedea laui, a member of the pink family (Caryophyllaceae), is an upright to strongly sloping or leading upward subshrub that is 5 to 15 decimeter (dm) (1.6 to 4.9 feet (ft)) tall. The stems are many-branched and glabrous (free from hair) except for the bracts (modified leaf or scale) and sepals (each of the parts of the calyx of a flower, enclosing the petals). The internodes (a part of a plant stem between two of the nodes from which leaves emerge) are lightly purple-tinged. The leaves are opposite, narrowly oval shape or narrowly oval shape to narrowly or broadly elliptic, dull green, and sometimes purple-tinged. The petioles (the stalk that joins a leaf to a stem) are 0.5 to 1.1 centimeters (cm) (0.2 to 0.4 inches (in)) long. The inflorescences are terminal containing 10 to 18 flowers. The flowers are hermaphroditic (also known as "perfect," which means that each flower contains both male and female structures) and cleistogamous (flowers that do not open and are self-pollinated). The sepals are narrowly lanceolate, 4.0 to 4.5 millimeters (mm) (0.16 to 0.18 in) long, and green to sometimes purple-tinged or nearly purple throughout. The nectary base is obsolete. The capsules are narrowly egg-shaped and approximately 4.0 to 4.5 mm (0.16 to 0.18 in) long. The seeds are orbicular-reniform (having the shape of a flat ring or disk-kidney-shaped) and approximately 1 mm (0.04 in) long (Wagner *et al.* 2005, p. 82).

Schiedea laui has been observed flowering between November to January and in the months of May, June, and September (PEPP 2015, p. 160; PEPP 2016, p. 212; PEPP 2019, entire; U.S. National Herbarium, Smithsonian Institution 2005, entire). It was observed fruiting during the month of January and between March to May and August to September (PEPP 2012, p. 152; PEPP 2017, p. 209; PEPP 2019, entire; National Tropical Botanical Garden 2019). We do not have information about seed viability or under what conditions they germinate. Other life history information is currently unknown, including information on plant growth stages, longevity, and the length of time it takes to flower.

The breeding system of *Schiedea laui* is hermaphroditic (plants containing perfect flowers, each of which has both male and female reproductive organs). The species is capable of both sexual and vegetative reproduction and obligate autogamy through cleistogamy (Wagner *et al.* 2005, p. 2). Obligate autogamy means that *S. laui* is restricted to self-fertilization (flowers are self-pollinated). Cleistogamy refers to plants that produce flowers that do not open, which are developed specifically by self-pollinated flowers and does not support outcrossing (Lloyd and Schoen 1992, p. 359).

Seed dispersal mechanisms for *Schiedea laui* are unknown (Wagner *et al.* 2005, p. 28). However, we can assume that seed dispersal for *S. laui* would follow its close relative, *Schiedea jacobii*, which also grows in wet forest habitats. Seeds of *S. jacobii* are formed in a capsule and ultimately dispersed from open capsules after they have matured on the plant (Wagner *et al.* 2005, p. 28). Therefore, seeds fall and germinate near the parent plant.

In addition, seeds of *Schiedea laui*, and other species in *Schiedea*, are known to exhibit some sort of dormancy, which is most likely an adaptive characteristic that allows the seeds to be developed during the end of the winter wet season. This dormancy will delay germination of the seeds until the winter rainy season begins (Wagner *et al.* 2005, p. 24), allowing for the higher survival of recruitments with increased water availability during the rainy season.

2.3.1.2 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, etc.), or demographic trends:

When *Schiedea laui* was first discovered in 1998, there were 16 mature individuals and 1 immature individual observed along with additional seedlings (no number provided) (U.S. National Herbarium, Smithsonian Institution 2005, entire). The known historic distribution and range for this

species included the windward areas of east Moloka‘i in the Waikolu and Hanalilolilo drainages (Wagner *et al.* 2005, pp. 82-84).

Currently, *Schiedea laui* is found within the Kamakou Preserve from West Kawela to Hanalilolilo (Bakutis 2019, pers. comm.; PEPP 2017, p. 209). In 2000, a follow-up survey and monitoring trip to the wild site of *Schiedea laui* at Kamakou Preserve was only able to relocate 9 individuals with a few immature plants and seedlings (Wagner *et al.* 2005, pp. 90–92). By 2006, only 13 plants were seen (PEPP 2007, p. 57). In 2010, there were 24 to 34 individuals in the same location in Kamakou Preserve (Bakutis 2010, pers. comm.). In 2014, there were 24 mature, 7 immature individuals, and 13 seedlings at the wild population (PEPP 2014, p. 40). Currently, this wild population was last monitored in July 2019 and there were 24 mature, 12 immature individuals, and 32 seedlings (Bakutis 2019, pers. comm.). The number of individuals fluctuates from year to year, but there has never been more than 50 wild mature individuals known at a given time. Overall, the number of wild individuals for *Schiedea laui* is relatively stable but fluctuates from year to year. The only known wild population continues to survive for the last 20 years since it was discovered in 1998.

Currently, there are two translocated sites at Kawela and Pēpē‘Ōpae Stream located within the Kamakou Preserve, which contain approximately 35 individuals of *Schiedea laui* (Bakutis 2019, pers. comm.). No naturally recruited individuals have been observed at the translocated sites.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
N/A

2.3.1.4 Taxonomic classification or changes in nomenclature:
Schiedea laui was first described by W.L. Wagner and S.G. Weller (Wagner *et al.* 2005, p. 82) from a collection made in 1998 by J. Lau and S. Loo at Kamakou Preserve on Moloka‘i in the Hawaiian islands. This species was named in honor of its discoverer, Mr. Joel Q. C. Lau, at the time employed under the Hawai‘i Natural Heritage Program, and noted as “one of the most knowledgeable botanists of the Hawaiian flora” (Wagner *et al.* 2005, p. 84). This species is recognized as a distinct taxon in Wagner *et al.* (2005), the most recently accepted Hawaiian plant taxonomy.

Schiedea laui is most similar in morphology to *S. nuttallii* differing by the presence of cleistogamous flowers and occurring at higher elevations in wet forest habitats, rather than mesic forests (Wagner *et al.* 2005, p. 84). *Schiedea laui* also does not share any unique synapomorphies (a

characteristic present in an ancestral species and shared exclusively by its evolutionary descendants) with *S. nuttallii* (Wagner *et al.* 2005, p. 84).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):
See section 2.3.1.2 above for spatial distribution of the species.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
Schiedea laui is an endemic species to the Waikolu drainage on Moloka‘i (Wagner *et al.* 2005, p. 82). This species is found between the elevations of 1,097 to 1,146 meters (m) (3,599 to 3,760 ft) in the wet forest habitat type (National Tropical Botanical Garden 2019; Wagner *et al.* 2005, p. 82). The wild population is located in a cave along a narrow stream corridor at the base of a waterfall (Wagner *et al.* 2005, p. 82).

The habitat of *Schiedea laui* on Moloka‘i is described as a wet forest with mixed *Metrosideros polymorpha* and *Cheirodendron trigynum* subsp. *trigynum* (U.S. National Herbarium, Smithsonian Institution 2005, entire). Associated native species include *Asplenium lobulatum*, *Asplenium macraei*, *Dryopteris sandwicensis*, *Vandenboschia davallioides*, *Cyrtandra hawaiensis*, *Cyrtandra procera*, *Hymenasplenium unilaterale*, *Hydrangea arguta*, *Coprosma* sp., *Cyanea solenocalyx*, *Dicranopteris linearis*, *Cibotium glaucum*, *Machaerina* sp., *Sadleria* sp., and *Freycinetia arborea* (U.S. National Herbarium, Smithsonian Institution 2005, entire; National Tropical Botanical Garden 2019).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range (Factor A):
Ungulate destruction and degradation of habitat—Destruction and degradation of habitat by feral pigs (*Sus scrofa*) is a threat to *Schiedea laui* at all populations (USFWS 2013, p. 32041; Bakutis 2019, pers. comm.). Feral ungulates modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Ecosystem degradation occurs at all populations by nonnative pigs (USFWS 2013, p. 32041; PEPP 2015, p. 160; Bakutis 2019, pers. comm.).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990, entire). Habitat modification and destruction by invasive nonnative plants negatively affects all occurrences of *Schiedea laui* (USFWS 2013, p. 32037). Nonnative plants with the greatest impacts on *S. laui* include *Rubus argutus* (blackberry), *Psidium cattleianum* (strawberry guava), *Tibouchina herbacea* (glorybush), and *Clidemia hirta* (Koster's curse) (TNCH 2012, p. 15).

Habitat destruction and degradation by landslides, erosion, and flooding—Due to the steep topography of the stream corridor where *Schiedea laui* remains, erosion increases the potential for landslides and rockfalls, which negatively impact this species. Field survey data presented by the Plant Extinction Prevention Program (PEPP 2015, p. 160; Bakutis 2019, pers. comm.) suggest that catastrophic flooding or landslides are possible at a population of *S. laui* located along a narrow stream corridor in the Kamakou Preserve. Landslides and erosion adversely impact the habitat and individuals of *S. laui* by destabilizing substrates, damaging and destroying individual plants, and altering hydrological patterns (PEPP 2015, p. 160; Bakutis 2019, pers. comm.; Stearns 1985).

Climate change loss or degradation of habitat, including hurricanes and drought—Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment was not conducted specifically for *Schiedea laui*; however, at the genus level, *Schiedea* has one of the highest vulnerability scores. The analysis was conducted for 26 other species of *Schiedea*, 17 of which had vulnerability scores greater than 0.5. Considering that *S. laui* is endemic to a single area, its population numbers are very small (one population of fewer than 50 individuals), and threats such as erosion, landslides, and flooding are increasing, it is likely that climate change could affect its ability to persist. Therefore, additional management actions may be needed to conserve this taxon into the future, such as ensuring that adequate viable genetic storage is maintained, identifying suitable microsites where climate change effects are anticipated to occur more slowly, and considering suitable habitat in areas outside of its known range.

Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden

2007; Emanuel *et al.* 2008; Yu *et al.* 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami *et al.* 2013). Hurricanes pose an ongoing and ever-present threat because they can happen at any time. A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):
Not a threat.

2.3.2.3 Disease or predation (Factor C):
Predation and herbivory by rats—Predation of seeds by introduced rats (*Rattus* sp.) is a threat to *Schiedea laui* in the wild (USFWS 2013, p. 32053; Bakutis 2019, pers. comm.).

Slug herbivory—Herbivory by slugs may be a threat to this species (Bakutis 2019, pers. comm.; PEPP 2007, p. 57). Slug herbivory can prevent regeneration through death of individual seedlings and small plants (Joe and Daehler 2008). Label requirements restrict the application of slug pesticides, because populations of *S. laui* are located too close to streams and waterways to apply slug pesticides. Therefore, control of slugs using pesticides cannot occur at the wild site of *S. laui*.

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):
Lack of adequate hunting regulations—Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. The State of Hawai‘i provides game mammal (feral pigs and goats) hunting opportunities (e.g., “sustained yield”) in public hunting areas on the island of Moloka‘i (DLNR 2012). Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations of *Schiedea laui* are at risk (DLNR 2010).

Currently, four agencies are responsible for inspection of goods arriving in Hawai‘i (CGAPS 2009). The Hawai‘i Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on pests of concern to Hawai‘i, especially insects or plant diseases. The U.S. Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations, focusing on non-propagative plant materials, and internationally regulated commercial species under the Convention in International Trade in Endangered Species (CITES). Also included are federally listed noxious seeds and plants, soil, and pests of concern for forests and agriculture. The U.S.

Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine (USDA-APHIS-PPQ) inspects propagative plant material, provides identification services for arriving plants and pests, and conducts pest risk assessments among other activities (HDOA 2009). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 et seq.) and prosecutes CITES violations. The State of Hawai‘i allows the importation of most plant taxa, with limited exceptions. Many invasive plants established in Hawai‘i have expanding ranges. Resources available to reduce the spread of these species and counter their negative ecological effects are limited. Control of established nonnative invasive plants is largely focused on a few invasive species that cause significant economic or environmental damage to public and private lands, and comprehensive control of an array of invasive plants remains limited in scope. The introduction of new invasive plant species to the State of Hawai‘i is a significant risk to *Schiedea laui* and other federally listed species.

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):

Established invasive plant species competition—Nonnative plant species including *Rubus argutus* (blackberry), *Psidium cattleianum* (strawberry guava), *Tibouchina herbacea* (glorybush), and *Clidemia hirta* (Koster’s curse) compete with *Schiedea laui* for water, light, and nutrients (TNCH 2012, p. 15).

Reduced viability due to low numbers—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species’ capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability due to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. *Schiedea laui* is known from a single location with fewer than 25 wild mature individuals on Moloka‘i. In addition, there has been no recruitment observed in translocated populations (Bakutis 2019, pers. comm.).

Current Management Actions:

- Surveys and monitoring—The PEPP monitors occurrences of *Schiedea laui* (PEPP 2017, pp. 45, 209; PEPP 2016, p. 44, 212; PEPP 2015, p. 35, 160).
- Ungulate control—The wild and reintroduced populations of *Schiedea laui* on Molokaʻi are fenced and the fences are monitored for breeches (PEPP 2018, p. 19; TNCH 2012, p. 8-11).
- Nonnative plant control—The Molokaʻi PEPP removed invasive plants around the translocated population at PēpēʻŌpae Stream within the Kamakou Preserve (PEPP 2018, p. 19). Weed control also occurs within the Kamakou Preserve by the Nature Conservancy (TNCH 2012, p. 15-17).
- Captive propagation for genetic storage and reintroduction—
    - The Lyon Arboretum Seed Conservation Laboratory reported more than 12,700 seeds in storage from thirteen accessions representing the wild and reintroduced populations from Kamakou Preserve (Lyon Arboretum 2018).
    - The Lyon Arboretum Micropropagation Laboratory reported more than 1,100 containers of propagules collected from Hanalilolilo representing 15 founders (Lyon Arboretum 2018).
    - The National Tropical Botanical Garden (2018) has more than 650 seeds of *Schiedea laui* in storage collected from Hanalilolilo.
    - The Olinda Rare Plant Facility has 153 potted plants of *Schiedea laui* in their nursery for both *in situ* and *ex situ* purposes. They have propagated 21 individuals for future reintroduction efforts at Hanalilolilo (Olinda Rare Plant Facility 2018).
- Reintroduction and translocation—
    - In 2009, the PEP Program began translocating this species within the Kamakou Preserve on Molokaʻi (PEPP 2009, p. 107-109). In 2010, approximately 92 individuals were reintroduced within the Kamakou Preserve in approximately three sites (two sites at Hanalilolilo and one site at upper Kamakou) (PEPP 2010, p. 108-109). In 2011, 58 individuals were reintroduced at Hanalilolilo (PEPP 2011, p. 168).
    - In 2015, the 75 reintroduced individuals at PēpēʻŌpae Stream that were previously reintroduced were monitored and only 68 individuals were relocated and noted as healthy (PEPP 2015, p. 160). In June 2016, an additional 67 individuals of *Schiedea laui* were reintroduced (PEPP 2016, p. 212). Currently, there is only one reintroduction site at PēpēʻŌpae Stream containing 24 mature individuals that are reproductive and producing lots of seeds (Bakutis 2019, pers. comm.).
    - In July 2015, 52 individuals were reintroduced at PēpēʻŌpae Bog (PEPP 2015). In December 2015, the previously reintroduced individuals were monitored and noted in healthy condition with a

few individuals starting to flower (PEPP 2015). Currently, the status of these reintroduced individuals is unknown.

- In 2010 and 2012, there were 16 reintroduced individuals at Hanalilolilo that were noted as healthy and some flowering (PEPP 2010, p. 109). In 2017, the population at Hanalilolilo was monitored and contained 44 reintroduced individuals (PEPP 2017, p. 209). During that same visit, seeds were collected from that population (PEPP 2017, p. 209). Currently, all of the reintroduced individuals at Hanalilolilo have died as of August 2019 (Bakutis 2019, pers. comm.).
- In August 2015, 22 individuals were reintroduced at West Kawela and they were all vegetative (non-flowering) plants (PEPP 2015). In September 2016, 22 individuals were noted as healthy (PEPP 2016, p. 212). As of July 2019, there are only five reintroduced individuals remaining (Bakutis 2019, pers. comm.).
- In 2016, the Kawela Stream reintroduced population of 20 individuals was monitored and noted as healthy (PEPP 2016, p. 212). In 2017, this population was revisited and two plants were noted as dead (PEPP 2017, p. 209). Currently, there are only six reintroduced individuals remaining (Bakutis 2019, pers. comm.).

Table 1. Status and trends of *Schiedea laui* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	24–34	~16	All threats managed in all 3 populations	Partially, ungulate and nonnative plant control ongoing
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2016 (critical habitat)	24-34	~106	All threats managed in all 3 populations	Partially, ungulate and nonnative plant control ongoing
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2020 (5-year review)	24	~35	All threats managed in all 3 populations	Partially, ungulate and nonnative plant control ongoing
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No

Table 2. Threats to *Schiedea laui* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, fencing
Established ecosystem-altering invasive plant modification and degradation of habitat	A	Ongoing	Partial, nonnative plant control within exclosures
Degradation and destruction of habitat by landslides, erosion, and flooding	A	Ongoing	None
Climate change loss or degradation of habitat, including hurricanes	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	Partial, fencing
Predation or herbivory by rats	C	Ongoing	None
Herbivory by slugs	C	Ongoing	None
Inadequacy of existing regulatory mechanisms	D	Ongoing	None
Established invasive plant species competition	E	Ongoing	Partial, nonnative plant control within exclosures
Reduced viability due to low numbers	E	Ongoing	Partial, seed collection, propagation, and translocation ongoing; however, no natural recruitment observed

2.4 Synthesis

There are 24 mature, 12 immature, and 32 seedlings of *Schiedea laui* at the wild population on Molokaʻi. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini *et al.* (2013). The assessment was not conducted specifically for *S. laui*; however, at the genus level, *Schiedea* has one of the highest vulnerability scores. It is likely that climate change could affect its ability to persist. Genetic representation of the wild population is mostly complete. Collection, propagation, and translocation are ongoing. There are two translocated sites that contain approximately 35 individuals of *S. laui* (Bakutis 2019, pers. comm.). No naturally recruited individuals have been observed at the translocated sites.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). To

prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g*., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collections. In addition, a minimum of three populations should be documented on Moloka'i where they now occur or occurred historically. Each of these populations must be naturally reproducing (*i.e*., viable seeds, seedlings) with a minimum of 50 mature reproducing individuals per population.

The preventing extinction goals for this species have not been met. There is only a single population with approximately 24 mature individuals (Table 1), genetic storage goals have not been met (Table 1), and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Schiedea laui* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

____Downlist to Threatened
____Uplist to Endangered
____Delist
____*Extinction*
____*Recovery*
____*Original data for classification in error*
__X__**No change is needed**

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number:____
Reclassification (from Endangered to Threatened) Priority Number:____
Delisting (regardless of current classification) Priority Number:____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Surveys and inventories—Continue to assess the status of known occurrences of *Schiedea laui* in historical locations and potentially suitable habitat.
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Continue to control established

ecosystem-altering nonnative invasive plant species and those that compete with *S. laui*.

- Predation and herbivory by rats and slugs—Implement effective control measures for rats and slugs at all populations.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction.
- Reintroduction and translocation—Continue to augment populations and increase numbers of populations and individuals in suitable habitat to reduce the impacts of predation and climate change.
- Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals to reduce the impacts of small population size, landslides, erosion, and flooding.
- Population viability monitoring—Continue studies of *Schiedea laui* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Schiedea laui*
(no common name)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____Downlist to Threatened
____Uplist to Endangered
____Delist
_X__No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
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