

Yadon's piperia (*Piperia yadonii*)

**5-Year Review:
Evaluation and Summary**



**U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
Ventura, California**

August 2021

5-YEAR REVIEW
Yadon's piperia (*Piperia yadonii*)

GENERAL INFORMATION:

Species: *Piperia yadonii*

FR citation: 63 FR 43100

Date listed: August 12, 1998

Classification: Endangered

BACKGROUND:

Most recent status review:

U.S. Fish and Wildlife Service. 2009. *Piperia yadonii* (Yadon's piperia) 5-Year Review: Summary and Evaluation. Ventura Field Office. Ventura, California.

FR Notice citation announcing this status review:

Initiation of 5-Year Status Reviews of 66 species in California and Nevada. Notice of initiation of reviews; request for information (85 FR 4692), January 27, 2020.

Critical Habitat Designation:

Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for *Piperia yadonii* (Yadon's piperia) (72 FR 60410), October 24th, 2007.

Primary Constituent Elements:

1. A vegetation structure providing filtered sunlight on sandy soils:
 - a. Coastal pine forest (primarily Monterey pine) with a canopy cover of 20 to 70 percent, and a sparse herbaceous understory on Baywood sands, Narlon loamy fine sands, Sheridan coarse sandy loams, Tangair fine sands, Santa Lucia shaly clay loams and Chamise shaley clay loams underlain by a hardpan; or
 - b. Maritime chaparral ridges with dwarfed shrubs (primarily Hooker's manzanita) on Reliz shaly clay loams, Sheridan sandy loams, Narlon sandy loams, Arnold loamy sands and soils in the Junipero-Sur complex, Rock Outcrop-Xerorthents Association, and Arnold-Santa Ynez complex often underlain by rock outcroppings.
2. Presence of nocturnal, short tongued moths in the families Pyralidae, Geometridae, Noctuidae, and Pterophoridae.

State Listing:

Not listed under the California Endangered Species Act.

ASSESSMENT:

Information acquired since the last status review:

This 5-year review was conducted by the U.S. Fish and Wildlife Service (Service) Ventura Fish and Wildlife Office. Initiation of this review was announced through a Federal Register notice on January 27, 2020. We contacted land managers and species experts to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files. Surveys for the species have continued periodically at several locations including portions of the former Fort Ord, Presidio of Monterey, and a small population managed by the Navy. The Pebble Beach Company and Del Monte Forest Conservancy hired consultants to conduct evaluations of transplanting, seeding, and restoration methods, and the Presidio of Monterey has been attempting to improve habitat through the removal of French broom (*Genista monspessulana*).

Background:

Range and Habitat

Yadon's piperia occurs in Monterey pine forest and maritime chaparral from Palo Colorado canyon, approximately 14 miles (mi) south of the Monterey peninsula, to Elkhorn slough, approximately 20 mi north of the Monterey peninsula. The range is bounded to the west by the Pacific Ocean and extends east to Prunedale and the eastern boundary of the former Fort Ord. The greatest concentration of Yadon's piperia occurs on the Monterey peninsula (Figure 1).

In maritime chaparral, soils where Yadon's piperia occur are typically sandstone or decomposed granite that are shallow and well drained (Graff 2006, p. 4). Hooker's manzanita (*Arctostaphylos hookeri*) is the most common associated manzanita species with Yadon's piperia occurrences (Graff 2006, p. 4). Other commonly associated species include Pajaro manzanita (*A. pajaroensis*), woolly leaf manzanita (*A. tomentosa*), Eastwood manzanita (*A. glandulosa* ssp. *glandulosa*), cushion manzanita (*A. glandulosa* ssp. *cushingiana*), and chamise (*Adenostoma fasciculatum*). Cryptogamic crusts are associated with Yadon's piperia occurrences in maritime chaparral but the species has also been observed in areas that have been recently disturbed (e.g., infrequently used road cuts), but are not actively disturbed (Service 2009, p. 6). The average canopy height of manzanita where Yadon's piperia occurs is 6 inches (in) and is open enough to allow for indirect light on leaves and indirect to direct light on flowering stalks as they emerge through the canopy (Graff 2006, p. 5).

In Monterey pine forest, soils where Yadon's piperia typically occur are sands and loams that are well drained and nutrient poor (McGraw et al. 2006, p. 60). Monterey pine (*Pinus radiata*) canopy cover ranges from 20 to 70 percent where Yadon's piperia occurs on the Monterey peninsula (McGraw et al. 2006, p. 44). McGraw et al. (2006, pp. 40-44) conducted an indicator species analysis to determine species that are indicators of Yadon's piperia habitat as well as species that could be viewed as conraindicators. The study found 15 associated species, the top five of which were coast sanicle (*Sanicula laciniata*), Diego bent grass (*Agrostis pallens*), sticky monkey flower (*Diplacus aurantiacus*), blue wildrye (*Elymus glaucus*), and California bedstraw (*Galium californicum*). Species that typically precluded the presence of Yadon's piperia were poison oak (*Toxicodendron diversilobum*), California blackberry (*Rubus ursinus*), California coffeeberry (*Frangula californica*), coast live oak (*Quercus agrifolia*), and southern hedge nettle (*Stachys bullata*).

Monterey pine forest habitat that supports Yadon's piperia typically has a less dense understory than Monterey pine forest that does not support Yadon's piperia. McGraw et al. (2006, p. 42) found that occupied sites had 30 percent less cover than sites with no Yadon's piperia. The reduction in cover was due to differences in native species abundance. Areas with Yadon's piperia had greater amounts of annual forbs and geophytes compared to areas without Yadon's piperia that were characterized by high vine cover, and greater amounts of shrub, tree, and fern cover (McGraw et al. 2006, p. 42).

Litter depth is negatively correlated with Yadon's piperia presence. As litter depth increases Yadon's piperia presence decreases. McGraw et al. (2006, p. 51) found that the average depth of litter supporting Yadon's piperia presence was 1.6 in, ranging from 0-6 in. Areas without Yadon's piperia averaged 3.0 in of litter, ranging from 0-14 in.

Precipitation has been observed to have significant positive and negative effects on Yadon's piperia inflorescence production, fruit production, density, and disease prevalence (JMC and EWCG 2016, pp. 4-12 – 4-26). Inflorescence production was positively correlated with the current year's total rainfall (July-June), and fruit production was positively correlated with the current year's spring rainfall (February-June). Yadon's piperia density was observed to be negatively correlated with the previous year's spring precipitation while disease prevalence was positively correlated with the previous year's spring precipitation. This suggests that increases in diseased plants from the previous year's spring precipitation may also be responsible for the decrease in Yadon's piperia. Seed that germinates takes three to four years to express above ground leaves, so any increase in fruit production from a current season's rainfall may not offset subsequent decreases in density the following year.

Mycorrhizal Association

Mycorrhizal association with species in the family Orchidaceae is well established (Hadley 1982, entire). A fungal association has been assumed to correlate with presence of Yadon's piperia although the specificity of the fungal host was not understood until a recent paper genetically described the fungal symbionts occurring with Yadon's piperia (Pandey et al. 2013, entire). Pandey et al. (2013, p. 2343) sampled eight populations across both Monterey pine forest and maritime chaparral habitat. Twenty-six operational taxonomic units representing three fungi families (Ceratobasidiaceae, Sebacinaceae, Tulasnellaceae) were identified. Forty percent of sampled plants were found to be associated with multiple operational taxonomic units, 60 percent of sampled plants were associated with a single operational taxonomic unit (Pandey et al. 2013, p. 2345). These results suggest that Yadon's piperia has broad mycorrhizal fungal associates that are widespread and common (Pandey et al. 2013, p. 2348). The lack of specificity of fungal associates implies that the rarity of Yadon's piperia is not directly related to a specific, narrowly occurring, mycorrhizal association.

Pollination

Yadon's piperia are capable of fertilization through pollinator facilitated outcrossing or pollinator facilitated selfing (geitonogamy) but not autogamy (a form of selfing where pollen from a single flower fertilizes itself) (Doak and Graff 2001, pp. 12-13). The number of seeds per

fruit increases when outcrossing occurs but experimental treatments and observations suggest that the most common form of fertilization is through pollinator facilitated selfing (Doak and Graff 2001, p. 15). Nocturnal moths are the dominant pollinator and the plants attract moths by offering a nectar reward that is advertised through release of pheromones at dusk (Doak and Graff 2001, p. 13; Graff 2006, p. 7). Doak and Graff (2001, p. 13) identified 14 moths, nine of which were known to be common, two assumed to be common, and remaining three not known to be rare. The commonness of the pollinators suggests that Yadon's piperia historic distribution was not limited by specific and rare insect-host relationship. However, the necessity of nocturnal moths to initiate seed set in fruits suggests that the continued sustainability of existing populations and/or the possibility of population expansion could be limited if nocturnal moths decline within Yadon's piperia range.

Experimental Translocation and Establishment

From 2006 through 2015 Jodi McGraw Consulting (JMC) and Ecosystems West Consulting Group (EWCG) conducted a study to determine methods and effectiveness of translocation of soil cores, tuber collection and storage, and seed collection and distribution. Translocation of soil cores was conducted with a tree spade to avoid impacting tubers as much as possible. Translocated soil cores were 52 in x 52 in and 48 in deep and placed into unoccupied areas of suitable habitat (JMC and EWCG 2016, p. 2-2). The vegetative emergence in the translocated cores was compared to controls from where cores had been taken each year beginning in 2007 and lasting until 2015. From 2007 through 2013 there was a mean decrease of vegetative plants in 80 percent of the translocated cores compared to a 3 percent decrease in the control plots compared to 2006 densities (JMC and EWCG 2016, pp. 2-10 – 2-15). However, by 2015 there was no difference between the translocated cores and the control plots (71 percent decline in translocated cores and 66 percent decline in control plots) (JMC and EWCG 2016, p. 2-12). The report hypothesized that the eventual mutual decline was due to drought. No additional data have been collected to determine if, following the drought years, the control plots again outperformed the translocated cores.

Recovery of Yadon's piperia tubers from soil sieved through a wire mesh screen collected between 50 to 167 percent of expected tubers based on a count of vegetative plants before soil processing. Values greater than 100 percent represent tubers collected in excess of observed vegetative individuals and values lower than 100 percent suggest tubers lost during the sieving process presumably due to being too small to be caught by the sieve (JMC and EWCG 2016, p. 2-8). Tubers stored in a greenhouse, lath house, and the field were evaluated for survivorship between 2007 and 2015. Tubers stored in the greenhouse had complete mortality three years after storage. Tubers stored in the lath house initially had a high survivorship before declining to approximately 10 percent in 2015. Tubers stored under field conditions were relatively stable with 60 percent of initial tubers emerging in 2015 (JMC and EWCG 2016 pp. 2-18 – 2-21).

Seed was collected by harvesting fruits of Yadon's piperia. Seed was then spread in areas that had been unoccupied but with suitable habitat, with the only pretreatment being removal of litter by raking. The study found that leaf expression may occur 3-4 years following seeding, and that flowering may occur four years after seeding. In 2011, 5 years after seed was introduced to unoccupied plots, 4 of 10 plots had Yadon's piperia. In 2013, 5 of 10 plots had Yadon's piperia

(JMC and EWCG 2016, pp. 3-7 - 3-9). These plots had only litter removed prior to seeding and no further management suggesting that expansion and augmentation have the potential to be passive but could take between 4 and 10 years for populations to become mature (i.e., leaf size/number and fruit and seed set).

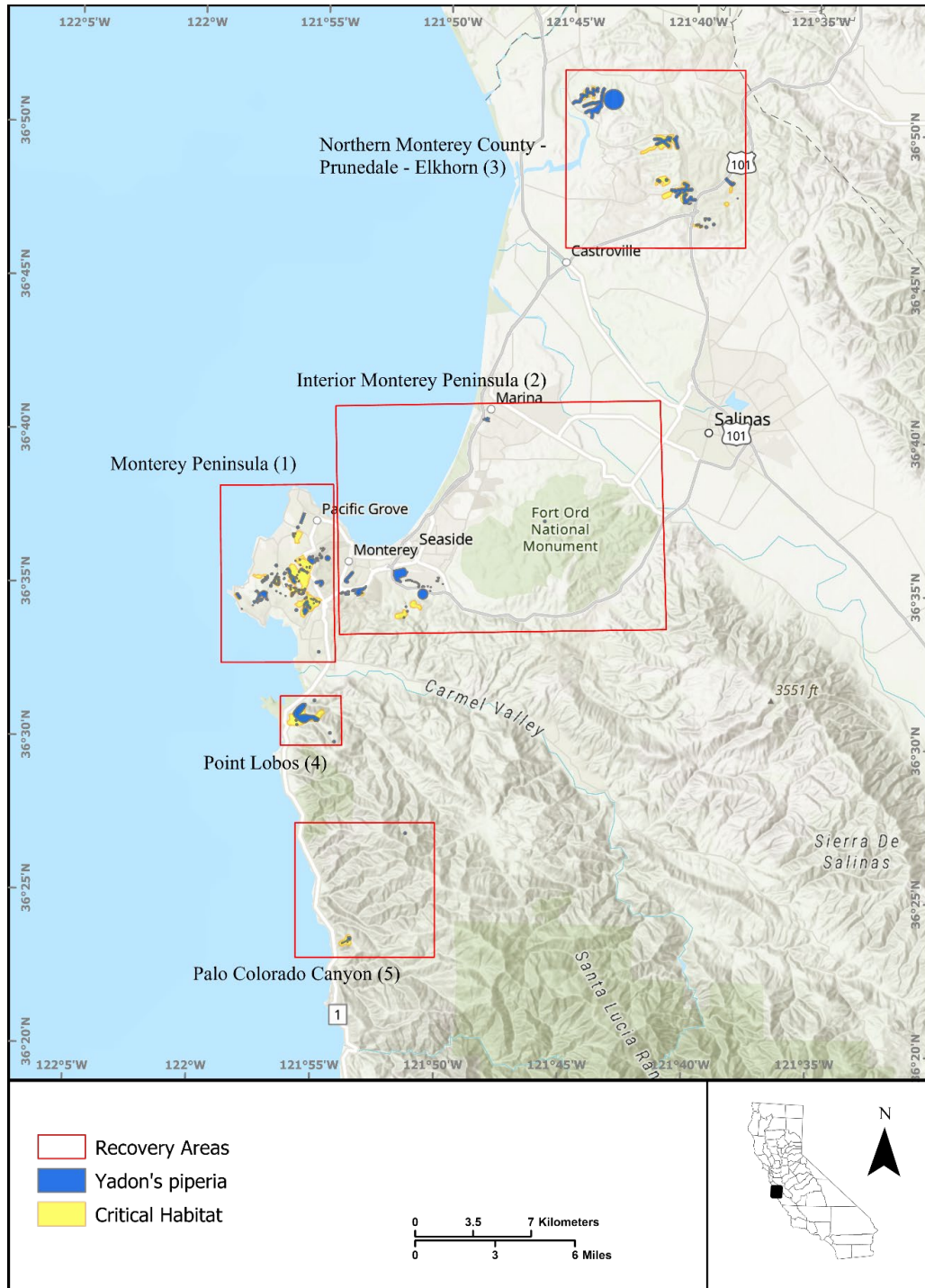


Figure 1. *Yadon's piperia* occurrences, critical habitat, and geographic recovery areas (CNDDDB 2021, data; Service 2007, entire; Service 2004, p. 51). The boundaries of the recovery areas are not general and not strictly delineated and showed be viewed as approximate.

Population data:

Annual surveys for Yadon's piperia throughout its range have not been consistent, preventing assessment of population trends throughout the species range. Annual surveys are necessary to evaluate whether low or high numbers represent negative or positive trends, or just single good or bad years. Yadon's piperia is a perennial species that senesces each year to a tuber and may not express leaves or inflorescences in any given year even if leaves or inflorescences had been expressed the previous year. The amount of vegetative or flowering plants in a single year may not represent the total number of live tubers that exist in the soil. Population data since the 2009 5-year review are presented in the below sections where new data are available. The geographic groupings correspond to recovery areas outlined in the recovery plan (Service 2004, pp. 50-52).

Monterey Peninsula

The Monterey Peninsula populations continue to represent the greatest concentration of Yadon's piperia. The bulk of the populations occur on land that is owned and managed by either the Pebble Beach Company or the Del Monte Forest Conservancy; however, there are no new population data. Many of the areas where Yadon's piperia occurs are protected through scenic easements, fee title ownership by Del Monte Forest Conservancy, or are planned to be protected through easement as part of the 2012 Del Monte Forest Land Use Plan (LCPMC 2012, entire). As part of land use planning, Pebble Beach Company funded extensive research into the habitat requirements and translocation and seeding techniques for Yadon's piperia (McGraw et al. 2006, entire; JMC and EWCG 2016, entire). Together these reports provide updated information regarding environmental conditions that promote Yadon's piperia persistence and best practices for expanding and augmenting populations, as well as mitigating for losses. While no large-scale survey efforts were conducted as part of this research, monitoring of experimental plots found that plant density peaked in 2011 (monitoring beginning in 2006), and declined from 2012-2015 during drought years (JMC and EWCG 2016, p. 3-9). Successful expansion was also documented during seeding trials. Monitoring ceased in 2015 and no follow up surveys have been conducted.

The Presidio of Monterey (Presidio) also occurs in this geographic region and has been conducting surveys since 1995 (HDR 2017a, p. 5-24). Although surveys were nearly regular, gaps in years are present and methodologies changed between years, inhibiting inferences on population trends. Only flowering individuals were counted from 1995 through 2007. Vegetation and flowering individuals were counted in 2008 onward. Beginning in 2016, surveys were formalized to allow for statistical comparisons between years to evaluate trends. The formalized surveys were based on "A Long-term Monitoring Program for the Federally Endangered Yadon's Rein Orchid (*Piperia yadonii*, Orchidaceae)" (Graff 2006, entire), and tailored to address management objectives specific to the Presidio (HDR 2017b, pp. 1-1 – 2-3) and include five discreet areas. The largest of these areas are referred to as Conservation Area 1 and Conservation Area 2. Additionally, the Presidio is engaged in long term French broom removal to increase the amount of suitable habitat for Yadon's piperia (HDR 2018a, entire).

Data prior to 2016 indicate that the Presidio population fluctuates annually in abundance of flowering individuals, ranging from 36 to 371 (no vegetative abundance data available) (HDR 2017a, p. 5-24). Vegetative individuals fluctuated between 396 and 11,861 individuals between

2008 and 2016 (HDR 2017a, p. 5-24). Data collected from 2016 to 2020 suggest that the frequency of vegetative Yadon's piperia has ranged between 15 percent and 24 percent in Conservation Area 1. (HDR 2020, p. 4-4). The frequency of vegetative Yadon's piperia ranged between 6 and 7 percent in Conservation Area 2 2016 to 2018 (HDR 2018b, pp. 5-6 – 5-8). Vegetative surveys were not conducted in 2019 in Conservation Area 2 due to funding restrictions, although subsequent flowering surveys did identify individuals in 3 percent of the plots (HDR 2020, p. 4-4). The frequency monitoring was discontinued in Conservation Area 2 in 2020 because the frequency of Yadon's piperia was too low to detect significant population trends based on the experimental design (HDR 2020, pp. 3-5 – 3-6). The estimated total number of plants across all areas at the Presidio was varied between 3,051 in 2017 to 3,644 in 2020 (HDR 2020, p. 4-6). Overall population trends cannot be inferred, the range of values and lack of extirpation suggest a persistent population with variability between years.

Interior Monterey Peninsula

Survey information is available for Yadon's piperia populations managed by the Naval Support Activity Monterey (NSAM), La Mesa Village (managed by the Presidio), and the former Fort Ord. The NSAM population occurs in small fragments of habitat surrounded by a golf course, RV park, and the Monterey Regional Airport. Since 2003 the population has experienced a low of 330 individuals in 2014 and a high of 8,626 individuals in 2013. Approximately 2,017 individuals were observed in 2021. The mean number of individuals observed between 2003 and 2021 (no data available for 2011 and 2012) is 2,591. These data suggest that the NSAM population may be stable, but with high variability. Data broken down by area suggest that two areas within the population account for most individuals each year, while most other areas had few to zero individuals each year (NSAM 2021, entire).

The La Mesa Village population is currently managed by the Presidio and was formerly managed by NSAM (HDR 2018b, pp. 2-5 – 2-6). From 1993 through 2016, the number of flowering or vegetative individuals ranged between 32 and 1,491. Survey data are not available for all years and phenology (flowering or vegetative) (HDR 2017a, pp. A-9 – A-11) and were conducted between March and July, when leaves are small or hidden by vegetation/litter. From 2016 through 2020, censuses of the La Mesa Village population were conducted (except for 2019 when funding restrictions temporarily halted survey work). Between 1,445 and 2,038 vegetative individuals and 167 to 430 flowering individuals were observed (HDR 2020, p. 4-9).

The known extent of Yadon's piperia at the former Fort Ord has expanded since David Styer began inventorying plant species in 2004. At that time, Yadon's piperia had been documented only near the city of Marina. In 2010, the Yadon's piperia was found in bloom in the Inland Ranges near the southern extent of the former Fort Ord in primarily maritime chaparral habitat. Since 2010, additional observations have been made and the species is known to occur in 14 of 70 regions of the former Fort Ord (Styer 2019, p. 227). Abundance data are not available, but the species has been observed blooming in June and July at this location.

Northern Monterey County/Prunedale/Elkhorn

The Northern Monterey County/Prunedale/Elkhorn recovery area is characterized by occurrences in maritime chaparral habitat and was estimated to account for 21 percent of the population in 1996 (Service 2009, p. 5). No formal surveys are conducted annually on land managed by the Elkhorn Slough foundation although plants are noted when observed (Dunkell 2021, pers. com.). Yadon's piperia has been observed in low numbers (less than 100) at the Elkhorn Highlands Reserve and Renteria properties in 2017, 2019, and 2020 in maritime chaparral habitat.

Point Lobos

Point Lobos Ranch (a State Park) is not currently open to the public and no new survey data for this population are known. In 1997, 7,500 plants were estimated to occur at Point Lobos Ranch in Monterey pine forest habitat. Since 1997 plants have been observed to occur in smaller numbers (30 – 175), but it is not clear if these smaller counts reflect the same area surveyed as the original 1997 estimate (Service 2009, p. 5; CNDDDB 2021, data) The other two occurrences in this region are on private land and no new information is available.

Palo Colorado Canyon

The occurrence at Palo Colorado Canyon remains under private ownership and no new information is available. In 1995, 38 plants were observed in maritime chaparral habitat. The occurrence was observed extant in 2004, although no estimate of abundance was made (Service 2009, pp. 5-6).

Evaluation of Threats:

When listed in 1998, the threats to Yadon's piperia were primarily development, resulting in habitat loss and fragmentation, invasive species, and herbivory (Service 1998, p. 43103). The 2004 Recovery Plan reiterated these threats (Service 2004, pp. 24-25). In 2009, the 5-year review again described the same threats while also noting stochastic extinction, fire suppression, and climate change as additional threats (Service 2009, pp. 7-10). A current evaluation of each of these threats follows.

Development (Habitat Loss and Fragmentation)

A proposed golf course that would have resulted in a high amount of loss of Yadon's piperia and its habitat was the largest single development that threatened the species at the time of listing. This development was denied permits by the Coastal Commission and was not built (Service 2009, p. 7). In 2012, an amendment to the Del Monte Forest Area Land Use Plan was accepted, which planned to put the remaining Yadon's piperia occurrences into easements to protect them from development. As of 2015, many occurrences were in either a scenic easement (owned by Pebble Beach Company) or owned in fee title by the Del Monte Forest Conservancy (DMFC 2015a, na) and assumed protected from development (LCPMC 2012, p. 12, 60). The remaining occurrences on Pebble Beach Company property are in areas where easements are pending (DMFC 2015a, na). These easements have reduced the likelihood of large losses of Yadon's piperia on the Monterey peninsula. The habitat loss and fragmentation from historical development contribute to reduced natural recruitment and expansion, through a lack of available

habitat and dispersal pathways, and the introduction of invasive species such as French broom, reducing chances of recruitment and expansion (discussed further below).

Small development on privately held parcels on the Monterey Peninsula still occur and necessitate mitigation activities, such as transplanting, which may not be successful in offsetting the direct loss of plants where they originally occurred. Similarly, roadside maintenance, mowing of vacant lots, utility line maintenance, and unpermitted recreational activities have all resulted in direct loss of individuals of Yadon's piperia or its habitat (JMC and EWCG 2016, p. 2-3 – 2-6; Armacost 2020, entire; Regan 2017, entire). While these effects may be relatively small compared to the initial threat of golf course development, cumulatively they may contribute to reduced recruitment and expansion, increased invasive species, and/or reduced population sizes.

Invasive Species

French broom, acacia (*Acacia* spp.), and rattlesnake grass (*Briza maxima*) are the dominant invasive species that affect Yadon's piperia habitat, particularly in areas of Monterey pine forest. Removal efforts have been conducted by the Presidio, Pebble Beach Company, NSAM, and at small mitigation areas (JMC and EWCG, 2016, p. 3-1 – 3-25; HDR 2018a, entire; NSAM 2021, entire; Regan 2020, entire). Of these species, the woody species (French broom and acacia) appear to be the most detrimental to Yadon's piperia establishment and persistence. Experimental removal of each of these three species resulted in increased Yadon's piperia abundance on the Monterey peninsula (JMC and EWCG 2016, p. 3-9).

Techniques for removal of invasive species differ by species. Rattlesnake grass was removed by weed whipping above ground vegetation while Yadon's piperia was dormant and then raking litter and biomass. This method was effective for reducing the biomass of rattlesnake grass relative to control plots, but also affected any native vegetation present above ground (JMC and EWCG 2016, p. 3-15). The duration of the effectiveness may only last several years as rattlesnake grass recolonizes (Regan 2021, entire).

French broom control, through manual removal and a cut and herbicide method, was evaluated by both the Presidio and Pebble Beach Company (HDR 2018a, entire; JMC and EWCG 2016, p. 3-18). Both methods were found to be successful at reducing the biomass of French broom, but differed in their labor intensiveness and ground disturbance (HDR 2018a, pp. 4-1 – 4-4; JMC and EWCG 2016, pp. 3-18 - 3-19). Manual removal resulted in greater ground disturbance and was more labor intensive. Cut and herbicide treatments left root material, resulting in less ground disturbance and was less labor intensive, although it required licensed herbicide applicators.

Acacia was removed in Monterey pine forest habitat on land managed by Pebble Beach Company by cutting trees at 12 in (30 cm) above ground and then applying herbicide. In the year following removal, native species increased and Yadon's piperia was present but acacia resprouted and Yadon's piperia again declined to zero within three years (JMC and EWCG 2016, pp. 3-23 – 3-24). The results suggest that acacia treatment must occur over multiple years to ensure mortality of below ground.

The results of invasive species control reiterate that invasive species continue to be a persistent threat to the species that directly reduces abundance and decreases habitat suitability. Additionally, where invasive species are present, annual removal activities are needed to inhibit recolonization.

Herbivory

Herbivory by deer has been documented to occur at high rates at multiple areas in the Monterey Peninsula and Interior Monterey Peninsula (McGraw et al 2006, pp.73-74; JMC and EWCG 2016, pp. 5-1 – 5-7; NSAM 2021, entire; Regan 2021, entire; HDR 2017a, pp. 4-1 – 4-2). For example, 62 percent of flowering Yadon's piperia at 54 sample sites had inflorescences browsed by deer (McGraw et al. 2006, p. 74). Severe herbivory at a receiver site for transplanting threatened the continued success of the transplant project (Regan 2020, entire). The primary effect of herbivory is the reduction in fruit set since the deer seem to prefer the inflorescence stalks rather than vegetative and low-lying leaves. Herbivory has been demonstrated to reduce fruit production by half in exclosure experiments (JMC and EWCG 2016, p. 5-6). Removal of deer is not possible throughout the region and in areas with large populations over large spatial areas deer browsing is unlikely to cause the extinction of the species. However, in small populations, local extirpation from persistent herbivory could occur if mortality surpasses recruitment.

Stochastic Extinction

Stochastic events leading to the extinction of Yadon's piperia are unlikely due to the number of populations over a relatively large spatial extent. However, local extirpation of small patches or populations remains a threat that increases as fragmentation and habitat loss increases. The slow erosion of suitable habitat from development, or other factors that reduce habitat suitability, increases the chances of localized stochastic extinction for populations with small spatial extent and abundance.

Fire Suppression

Fire suppression in areas occupied by Yadon's piperia has resulted in accumulation of Monterey pine needle litter and establishment of woody perennial invasive species in Monterey pine forest habitat, and the accumulation of native and non-native biomass from cooccurring plants in maritime chaparral habitat. Litter removal in both habitat types encourages Yadon's piperia abundance. Fire prevention activities, such as maintaining fire breaks, may also contribute to the establishment of invasive species by creating frequently disturbed areas of low canopy cover that favor invasive species establishment. Fire is not thought to be a necessary part of the life cycle of Yadon's piperia; rather, fire can support habitat conditions that Yadon's piperia is adapted to, specifically, low litter cover and canopy cover between 20 to 70 percent. The frequency of fire needed to maintain these conditions is not known, but it may be infrequent given the persistence of the species in areas that have not been frequently burned in the past.

Climate Change

The tolerance of Yadon’s piperia to changes in annual precipitation, minimum temperature, and maximum temperature are unknown. A plant that produces leaves and a flowering stalk one year may not produce either the following year, or may only produce leaves. Decreases in leaf production and flowering have been observationally correlated with drought. However, there have been climatically typical years within the range of the species where decreased leaf and flower production has also been observed. Current climate modeling suggests that average annual precipitation may increase by 2.6 inches under all future scenarios of carbon emission by 2099 (Table 1, CalAdapt 2021, data). The average minimum and maximum temperatures are also predicted to increase by 3.2 to 4.9 degrees F under the same period (CalAdapt 2021, data). The timing of precipitation coupled with changes in temperature is predicted to lead to more variability with greater frequency of extreme droughts and, conversely, more extreme wet years (Langridge 2018, pp. 16-17).

For commonly occurring species, it is hypothesized that species ranges will change to follow climatic conditions that are favorable for survival (Loarie *et al.* 2008, pp. 3-5). However, this would likely require dispersal pathways, available unoccupied suitable habitat, and a shift in climate gradual enough to allow for passive dispersal. For rare species that have small geographic ranges and are restricted to specific vegetation communities, dispersal along changing climatic gradients is not likely to occur or may be dependent on the ability of components to migrate to the same location. For Yadon’s piperia this would suggest that the species may migrate only if Monterey pine forest or maritime chaparral establish first, and that the fungal associations and pollinators associated with the species are present.

Table 1. Changes in precipitation, minimum average temperature, and maximum average temperature for low and high emission scenarios compared to historical averages Yadon’s piperia throughout its range.

	Precip (inches)	Precip (inches)	Min T (deg. F)	Min T (deg. F)	Max T (deg. F)	Max T (deg. F)
	Historical Average	RCP 4.5 (RCP 8.5)	Historical Average	RCP 4.5 (RCP 8.5)	Historical Average	RCP 4.5 (RCP 8.5)
Yadon’s piperia range	19.7	22.3 (22.3)	45.8	49.1 (50.7)	66.5	69.7 (71.2)

Precip = Precipitation; Min T = Minimum Average Temperature; Max T = Maximum Average Temperature. Reported values for the modeled futures are based on the average of the HadGEM2-ES (warmer and drier) and CNRM-CM5 (cooler and wetter) future scenarios as reported by CalAdapt.org (CalAdapt 2021). The Representative Concentration Pathway (RCP) 4.5 scenario refers to a future scenario where emissions peak near 2040 and then decline, while RCP 8.5 refers to a scenario where emissions continue to rise strongly through 2050 and plateau near 2100. The historical average is based on the years 1950–2005 as reported by cal-adapt.org. The modeled values are estimates from the years 2022–2099. Reported values are from a spatial file delineating the approximate range of the species.

Summary of threats:

Development leading to habitat loss and fragmentation, competition with invasive species, and herbivory are the current primary threats reducing Yadon's piperia abundance and habitat. Fire suppression is likely contributing to a decrease in habitat suitability and some activities associated with fire prevention may promote invasive species establishment. The effects of climate change on Yadon's piperia are unknown, however, if severe drought becomes more frequent, this will have a negative effect on species abundance. Stochastic extinction is not a threat throughout the species range, but may affect small isolated or fragmented occurrences with small spatial extent and low abundance.

EVALUATION OF DOWNLISTING AND DELISTING CRITERIA

Downlisting criteria are described in the Recovery Plan (Service 2004, pp. 50-52). An amendment to the Recovery Plan was published in 2019 describing delisting criteria (Service 2019, pp. 6-7). Downlisting criteria is paraphrased here:

1. Secure and protect areas throughout the present range of Yadon's piperia that contain populations of sufficient size (greater than 100 acres) to ensure the long-term survival and recovery of the species. There are five recovery areas throughout the range of the species. Each recovery area has a suggested minimum number of populations that need to be secured and protected, with funding for long term maintenance, to ensure redundancy throughout the range of the species and representation of both habitat types that the species occurs in. The protected areas must be of adequate size and configuration to ensure the following:
 - a. maintenance of ecosystem and community processes and constituent species (e.g., hydrologic regime, drainage patterns, proximity to pollinator habitat, Monterey pine forest and maritime chaparral community associates);
 - b. continued, unimpeded gene flow between populations, either through wind-dispersed seed or animal-mediated pollen exchange;
 - c. an adequate diversity of sites for population expansion and for colonization of new areas as microhabitat conditions change;
 - d. the persistence of Yadon's piperia populations throughout the full range of environmental conditions they are likely to encounter (e.g., extended drought, wildfire).

The proposed recovery areas and minimum number of suggested protected populations are:

1. Monterey Peninsula– 4 populations
 2. Interior of the Monterey Peninsula – 3 populations
 3. Northern Monterey County-Prunedale- Elkhorn – 3 populations
 4. Point Lobos State Reserve-Point Lobos Ranch – 1 population
 5. Palo Colorado Canyon – 1 population
2. Protected areas are adequately maintained, such that encroachment by non-native plants (e.g., *Genista monspessulana*, *Cortaderia jubata*), excessive herbivory (from deer and

rabbits), edge effects from road maintenance, fuel modification activities, or other threats do not directly or indirectly adversely affect Yadon's piperia and its habitat.

3. Results of monitoring activities have determined that the protected populations of Yadon's piperia are of adequate size to be self-sustaining and to ensure their long-term persistence. Because Yadon's piperia is a perennial that exhibits dormancy, spending an undetermined period underground between seed germination and emergence of first leaf aboveground, it is likely that a minimum of 10 to 15 years of monitoring will be needed to define a population trend.

Downlisting criteria 1 and 2 have been partially met. The current Del Monte Forest Area Land Use Plan established easements throughout most known populations in the Monterey Peninsula Recovery Area (DMFC 2015a, na). The number of populations that occur on land that is protected from development managed by the Del Monte Forest Conservancy depends on how population limits are defined; however, this area represents the greatest contiguous habitat and occurrences in the species range in Monterey pine forest habitat. Land managed by the Presidio also occurs in this recovery area and is protected by the Integrated Natural Resources Management Plan. The Presidio population is surveyed regularly and invasive species control is ongoing in areas occupied by Yadon's piperia, as well as in areas that would be suitable for Yadon's piperia establishment if invasive species were removed.

Funding is not secured for the long-term management of Yadon's piperia in areas managed by the Del Monte Forest Conservancy or the Presidio. In the case of federally managed lands at the Presidio and NSAM, budget constraints may impede continuation of invasive species control and survey work that has been ongoing. Populations that occur on public land elsewhere in this recovery area have no current survey or management work and no funding to initiate those activities.

The Interior Monterey Peninsula has three populations that are actively managed to promote Yadon's piperia: La Mesa (managed by the Presidio), NSAM, and the former Fort Ord. Both the La Mesa and NSAM populations occur in highly fragmented and developed areas where invasive species, accidental trampling or mowing, or other impacts may occur, despite efforts by managers to prevent habitat damage. Additionally, abundance at these areas is small relative to populations in the Monterey Peninsula and Northern Monterey County recovery areas. However, the recent expansion of Yadon's piperia on the former Fort Ord may be illustrative of a larger population in maritime chaparral habitat than previously understood. Currently there are no estimates of population size at the former Fort Ord. Funding is similarly not guaranteed for each of these areas. A fourth population at Palo Corona Regional Park is covered under a Safe Harbor Agreement entered into by the Monterey Peninsula Regional Park District and the Service (MPRPD 2011, entire). The Safe Harbor Agreement lasts for 30 years during which the species and its habitat should be protected. No information regarding research activities or surveys is known to be currently occurring.

The Northern Monterey County-Prunedale-Elkhorn Recovery Area includes three occurrences that have been protected in easement or fee title ownership by the Elkhorn Slough Foundation or The Nature Conservancy since listing in 1998. These occurrences include Blohm Ranch, Long

Valley, and Renteria and Brothers as described in the 2009 5-year review. These occurrences are protected from development since the Elkhorn Slough Foundation manages their lands for the conservation and protection of native habitats and sensitive species (www.elkhornslough.org/stewardship). A fourth occurrence at Manzanita Park (managed by Monterey County) is unlikely to be developed, but is a high use area and the species and its habitat are threatened by recreation, landscape maintenance, facility maintenance, and potentially, facility expansion. Funding is not secured specifically for survey efforts or management at these occurrences and small population sizes and fragmentation may increase risk of extirpation. The remaining known occurrences in this recovery area are privately owned and have no protections.

The Point Lobos Reserve-Point Lobos Ranch Recovery Area contains a single occurrence protected from development and managed by the California Department of Parks and Recreation. Funding has not been secured for surveys or long-term management of Yadon's piperia at this location.

The Palo Colorado Canyon Recovery Area contains no occurrences that are protected from development and no occurrences that have funding to support surveys or long-term management of Yadon's piperia.

Downlisting criteria 3 has not been met. Only the occurrences managed by the Presidio and NSAM have continuous abundance data and these occurrences represent a relatively small portion of the species areal extent and abundance throughout its range. For downlisting criteria 3 to be met, occurrences on land managed by Del Monte Forest Conservancy, the former Fort Ord, The Nature Conservancy, California Department of Parks and Recreation, and the Palo Colorado Canyon need to be monitored annually to allow for evaluation of population trends.

Delisting criteria are not evaluated since downlisting criteria have not been met.

CONCLUSION

The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and the analysis of the status of the species in our 2009 5-year review remain accurate reflections of the species current status. After reviewing the best available scientific information, we conclude that Yadon's piperia remains an endangered species.

RECOMMENDATIONS FOR FUTURE ACTIONS:

1. Secure funding for annual surveys and invasive species management for occurrences in each recovery area that are currently protected from development, but for which funding is absent or expected to be reduced in the future.
2. Promote the establishment of Yadon's piperia through seeding following the methodology of JMC and EWCG (2016, p. 3-7). Results of seeding are likely to take four or more years to determine success, and then require long term management of invasive species and litter. Seeding should be conducted proactively.

3. Create and maintain at least one deer exclusion area in each protected occurrence to ensure reproductive output of at least small portions of larger populations.

APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approved _____

REFERENCES

- Cal-adapt. 2021. Annual Averages Data Viewer. Available on the internet at <<https://cal-adapt.org/tools/annual-averages>>. Accessed July 2021.
- [CNDDDB] California Natural Diversity Database. 2021. Element occurrence reports of *Piperia yadonii*. California Department of Fish and Game, Natural Heritage Division. Accessed July 2021.
- Doak, D.F., and A. Graff. 2001. Reproductive biology and pollination ecology of the federally endangered Yadon's piperia (*Piperia yadonii*, Orchidaceae) in Monterey County, California. Unpublished report prepared for U.S. Fish and Wildlife Service, Ventura Field Office, Ventura, California. 45 pp.
- [DMFC] Del Monte Forest Conservancy. 2015. Properties of the Del Monte Forest Conservancy. Map. 1 p.
- Dunkell, D. 2021. Email from Dash Dunkell, Stewardship Director Elkhorn Slough Foundation to Todd Lemein, Botanist US Fish and Wildlife Service. July 2021.
- Graff, A. 2006. A Long-term Monitoring Program for the Federal Endangered Yadon's Rein Orchid (*Piperia yadonii*, Orchidaceae). Soquel, California. 114 pp.
- Hadley, G. 1982. Orchid mycorrhiza. In Arditti J. [ed.], *Orchid biology: Reviews and perspectives*, II, 85–118. Cornell University Press, Ithaca, New York, USA.
- HDR. 2017a. *Piperia yadonii* Literature and Monitoring Review (1995-2016) Presidio of Monterey, California. Prepared for United States Army Garrison Presidio of Monterey. 122 pp.
- HDR. 2017b. *Final* Yadon's Piperia Monitoring Protocol Presidio of Monterey, and La Mesa Village, California. Prepared for United States Army Garrison Presidio of Monterey. 70 pp.
- HDR. 2018a. *Final* French Broom Study in Yadon's Piperia Habitat may and December 2018. Prepared for United States Army Garrison Presidio of Monterey. 50 pp.
- HDR. 2018b. *Final* Yadon's Piperia Surveys March and June 2018. Prepared for United States Army Garrison Presidio of Monterey. 87 pp.
- HDR. 2020. *Draft* Yaond's Piperia Surveys June 2019 and February 2020. Prepared for United States Army Garrison Presidio of Monterey. 99 pp.
- [JMC and EWCG] Jodi McGraw Consulting and Ecosystems West Consulting Group. 2016. *Piperia Yadonii Studies 2006-2015*. Submitted to County of Monterey Resource Management Agency Planning and Building Inspection Department. 167 pp.
- Langridge, R. (University of California, Santa Cruz). 2018. Central Coast Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.

- [LCPMP] Local Coastal Program Monterey County, California. 2012. Del Monte Forest Area Land Use Plan. Effective date of the LCP Amendment June 22, 2012. 66 pp.
- Loarie, S.R., B.E. Carter, K.H. Hayhoe, S. McMahon, R. Moe, C.A. Knight, and D.D. Ackerly. 2008. Climate Change and the Future of California' Endemic Flora. PLoS ONE 3(6): e2502. Doi: 10.1371/journal.pone.0002502
- McGraw, J., R. Buck, W. Davilla. 2006. Habitat Characterization for Yadon's Piperia (*Piperia yadonii*) with the Forested Habitat of the Monterey Peninsula. Prepared for County of Monterey Resource Management Agency Planning and Building Inspection Department. 92 pp.
- [MPRPD] Monterey Peninsula Regional Parks District. 2011. Safe Harbor Agreement for California Red-Legged Frog (*Rana draytonii*), California Tiger Salamander (*Ambystoma californiense*), Smith's Blue Butterfly (*Euphilotes enoptes smithi*), and Yadon's Piperia (*Piperia yadonii*), at Palo Corona Regional Park, Monterey County, California. 49 pp.
- [NSAM] Naval Support Activity Monterey. 2021. Yadon's Rein Orchid Survey Report 2021. NSA Monterey Public Works Environmental Division. 21 pp.
- Pandey M, J. Sharma, D.L. Taylor, V.L. Yadon. 2013. A narrowly endemic photosynthetic orchid is non-specific in its mycorrhizal associations. Molecular Ecology 22: 2341-2354.
- Regan, P. 2017. Yadon's Piperia Transplant Activities PLN 150669. Memo to Monterey County Resource Management Agency. 21 pp.
- Regan, P. 2020. Yadon's Piperia Transplant Monitoring March 2020 PLN 150669. Memo to Monterey County Resource Management Agency. 8 pp.
- Regan, P. 2021. Yadon's Piperia Transplant Monitoring February 2021 PLN 150669. Memo to Monterey County Resource Management Agency. 6 pp.
- [Service] U.S. Fish and Wildlife Service. 1998. Endangered and Threatened Wildlife and Plants; Final Rule Listing Five Plants from Monterey County, CA, as Endangered or Threatened. 63 FR 43100-43116.
- [Service] U.S. Fish and Wildlife Service. 2004. Recovery Plan for Five Plants from Monterey County, California. U.S. Fish and Wildlife Service, Portland, Oregon. 175 pp.
- [Service] U.S. Fish and Wildlife Service. 2007. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for *Piperia yadonii* (Yadon's piperia) (72 FR 60410), October 24th, 2007.
- [Service] U.S. Fish and Wildlife Service. 2009. *Piperia yadonii* (Yadon's piperia) 5-Year Review: Summary and Evaluation. Ventura, California. 23 pp.
- [Service] U.S. Fish and Wildlife Service. 2019. Recovery Plan for Five Plants from Monterey County, California: Amendment 1. U.S. Fish and Wildlife Service Pacific Southwest Region Ventura, CA. September 2019. 18 pp.

[Service] U.S. Fish and Wildlife Service. 2020. Initiation of 5-Year Status Reviews of 66 species in California and Nevada. Notice of initiation of reviews; request for information (85 FR 4692), January 27, 2020.

Styer, D. 2019. Flora of Fort Ord, Monterey County, California. Monterey Bay Chapter California Native Plant Society. In association with CNPS Press, Sacramento. 276 pp.