

# **Rough Popcornflower (*Plagiobothrys hirtus*) Species Status Assessment Report**

*Version 1.0*



Photo credit: Sam Friedman, U.S. Fish and Wildlife Service

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## EXECUTIVE SUMMARY

Rough popcornflower (*Plagiobothrys hirtus* (Greene) I.M. Johnston) is an herbaceous annual or perennial plant in the “borage or forget-me-not” family (Boraginaceae), endemic to Douglas County, Oregon (Meinke 1982, p. 268). The species was federally listed as an endangered species without critical habitat on January 25, 2000 (65 FR 3866) with adoption of a recovery plan in 2003 (U.S. Fish and Wildlife Service 2003, entire). The species was listed due to a limited number of populations (see definitions in Appendix 1), the documented loss of populations due to urban development, and the low population sizes in many populations (U.S. Fish and Wildlife Service 2003, pp. 12-17). At the time of listing, the total number of rough popcornflower individuals was estimated to be 7,000 plants.

In 2010, a 5-year review was finalized and at that time, the U.S. Fish and Wildlife Service did not recommend the species for downlisting due to not meeting several of the criteria set forth in the recovery plan (U.S. Fish and Wildlife Service 2010, p. 29). An amendment to the recovery plan was completed on November 3, 2019 (U.S. Fish and Wildlife Service 2019a, entire). This amendment revised the downlisting criteria and included delisting criteria, originally not in the recovery plan. Currently, 18 populations are documented in southwestern Oregon adjacent to 4 Umpqua River tributaries, disparately distributed from Yoncalla Creek, near Rice Hill, south to the Sutherlin Creek, near Wilbur, and east to a tributary of the North Umpqua River. In this Species Status Assessment Report, we evaluate the biological status of this plant, both currently and into the future, by considering the viability of the species as characterized by the conservation principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 139-140; Wolf *et al.* 2015, entire; Smith *et al.* 2018, entire).

Multiple populations of rough popcornflower are needed across its limited range to maintain the species’ resilience and persistence into the future. Through recovery efforts, we conclude the resiliency and redundancy of rough popcornflower have improved since its listing in 2000, allowing the species to better endure stochastic or catastrophic events. Further, through our re-introduction efforts, the species is likely to have less genetic isolation and improved adaptive capabilities, resulting in better representation. The combination of these conditions give the species a higher likelihood of survival. Some populations of rough popcornflower are vulnerable to habitat degradation and other natural and human caused events (*e.g.*, drought, uncontrolled succession, invasive species, etc.) due to their limited geographical area and small sizes. However, the majority of the populations are now secure and/or have larger population numbers than they did previously. Through the work of multiple stakeholders, over the past decade, the rough popcornflower has increased to over 883,154 plants in 18 populations, 11 of which have some form of secured habitat. The species has made significant progress toward recovery in the 18 years since it was listed.

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## INTRODUCTION

Rough popcornflower (*Plagiobothrys hirtus* (Greene) I.M. Johnston) is an herbaceous plant in the borage or “forget-me-not” family (Boraginaceae) and is endemic to Douglas County, Oregon (U.S. Fish and Wildlife Service 2010; Amsberry and Meinke 2017). The U.S. Fish and Wildlife Service (Service) listed the rough popcornflower as an endangered species, without critical habitat, under the Endangered Species Act of 1973, as amended (“Act,” 16 U.S.C. 1531 *et seq.*), on January 25, 2000 (65 FR 3866). The Service completed the recovery plan for the rough popcornflower on July 28, 2003 (U.S. Fish and Wildlife Service 2003, entire). Recently, amendments to the recovery plan to add delisting criteria have been accepted (U.S. Fish and Wildlife Service 2019a, entire). Delisting criteria were not initially included because the best available information indicated that the species was too range restricted to be recoverable. However, as more information has been collected, refinements to the downlisting criteria and development of delisting criteria are appropriate (see Recovery Plan section below).

This Species Status Assessment report (SSA) is a comprehensive biological review of rough popcornflower, incorporating the best available information to conduct an in-depth review of a species’ biology and threats, evaluate its biological status, and assess its resources and conditions needed to maintain long-term viability. This SSA report will provide the background information to guide future actions and documents, which may include additional listing rules, revised recovery plans, 5-year reviews, and section 7 consultations. We will update this SSA as new information becomes available for the species. The Service last evaluated the status of rough popcornflower in 2010, at which time concluded that the species remained appropriately classified as endangered (U.S. Fish and Wildlife Service 2010, p. 29). This SSA report is intended to serve as the biological basis for the Service’s current 5-year review of the status of rough popcornflower, initiated on February 12, 2016 (81 FR 7571). If any change in status is recommended as the result of our 5-year review, a proposed rule may be published in the Federal Register and made available for public comment prior to any final decision.

This SSA report is intended to be a concise review of the species’ biology and factors influencing the species, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain the species’ long-term viability. For the purposes of this assessment, we define viability of rough popcornflower as its ability to sustain multiple resilient populations distributed across its range over time. Viability is further analyzed in the Future Scenarios section below. Using the SSA framework, we will evaluate viability in terms of **resiliency**, **redundancy** and **representation** (together, the 3Rs) (Smith et al. 2018, p. 304). See Appendix 1 for Definitions of terms used in this SSA.

**Resiliency** – the ability of a species to withstand stochastic disturbance (Smith *et al.* 2018, p. 304) or the ability to “ride out” environmental fluctuations within the usual range of variability. Resilient populations are better able to recover from losses caused by random variation, such as fluctuations in recruitment (demographic stochasticity), or variation in precipitation (environmental stochasticity). Resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations. Later in the evaluate a population’s resiliency assessing habitat size, population size, habitat

quality, connectivity, management, protection, reproduction, abundance of insect pollinators, and rainfall.

**Redundancy** – the ability of a species to withstand catastrophic events by spreading risk among multiple populations or across a large area (Smith *et al.* 2018, p. 304). Redundancy can be measured through the duplication and distribution of populations across the range of the species. In general, the greater the number of populations distributed over a larger landscape, the greater the probability that the species will be able to withstand potential catastrophic events. A species with a greater number of populations is better able to compensate losing some populations due to catastrophic events than a species with fewer populations.

**Representation** – the ability of a species to adapt to changing environmental conditions over time as characterized by the breadth of genetic and environmental diversity within and among populations (Smith *et al.* 2018, p. 304). Representation is a measure of adaptive capacity or the ability of the species to adapt to changing environmental conditions and can be measured directly through genetic diversity within and among populations, and indirectly through the ecological diversity of populations distributed across the species' range. As data for direct measures of genetic diversity are often lacking, we often use ecological diversity as a proxy for measures of representation. In general, greater diversity corresponds to greater capacity of a species to adapt to environmental changes.

The Act defines an endangered species as a species that is “in danger of extinction throughout all or a significant portion of its range” and a threatened species as a species that is “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” The determination as to whether a species meets the definition of endangered or threatened is, therefore, based on an assessment of the species' risk of extinction. To inform this assessment of extinction risk, we describe the species' current biological status and assess how this status may change in the future under a range of plausible, but uncertain, scenarios. We evaluate the current biological status of rough popcornflower by assessing the species threats (stressors), as well as those factors benefiting the species, to describe its current condition in terms of the 3Rs. We then evaluate the species' future biological status by describing a range of plausible future scenarios that represent a range of conditions for the primary factors affecting the species, and forecast the most likely future condition for each scenario in terms of the 3Rs. As a matter of practicality, the full range of potential future scenarios and the range of potential future conditions for each potential scenario are too large to individually describe and analyze. These scenarios do not include all possible futures, but rather include three plausible scenarios representing best, worst and moderate scenarios. Consequently, the results of this SSA do not describe the overall risk to the species. Recognizing these limitations, the results of this SSA nevertheless provide a framework for considering the overall risk to the species to inform our evaluation of the appropriate and most current status of the species under the Act.

## SPECIES INFORMATION

### TAXONOMY AND DESCRIPTION

Rough popcornflower was collected occasionally in the Umpqua Valley of Douglas County, Oregon, from 1887 to 1961. *Allocarya hirta* Greene was the original scientific name applied to the species in 1888. Since then, the species has undergone a number of taxonomic re-arrangements, including *Allocarya scouleri* var. *hirta*, *Allocarya calycosa*, and *Plagiobothrys scouleri* var. *hirtus*. Since the 1961 edition of Plants of Oregon, it has remained *Plagiobothrys hirtus* (Peck 1961, p. 661), and this classification is recognized as valid by the U.S. Department of Agriculture Plants Database (U.S. Department of Agriculture 2018, website) and the Integrated Taxonomic Information System (Integrated Taxonomic Information System 2019, website).

Individual rough popcornflower plants are between 7 centimeters (cm) (2.75 inches [in]) to 60 cm (23.6 in) tall, with narrow, simple hairy-margined bright-green leaves along hairy stems. The non-fragrant flowers consist of five fused petals, are trumpet-shaped, mostly white with yellow centers, and positioned in a hairy calyx. The flowers are helicoid in development and occur on paired coiled inflorescences. Each flower produces four tan to black-colored, one-seeded nutlets, which loosely adhere to the receptacle, until they drop. These nutlets will germinate readily (Amsberry and Meinke 2002, p. 24). However, due to fruit abortion or lack of pollination, flowers with fewer than four nutlets are often observed. As in most members of the Boraginaceae family, anthers are included and epipetalous (having stamens attached to the inner corolla surfaces).

Rough popcornflower can be either an annual or a short-lived perennial. Rough popcornflower exhibits two distinct growth forms in the northern and southern portions of its range in Douglas County. In the northern part of its range near Yoncalla, the plants are more robust, slightly taller, and predominantly perennial (Figure 1). Here rough popcornflower has the ability to produce adventitious roots that easily establish in the moist soil of their wetland habitats. In the southern part of the range, 25.8 kilometers [km] (16 miles [mi]) south of the Yoncalla population, from the general area of Sutherlin to Wilbur, the population include annual plants, often in clusters, with a few sporadic perennial plants.

The rough popcornflower and fragrant popcornflower (*P. figuratus*) are found in similar wetland habitat in northern Douglas County. Both are members of the subgenus *Allocarya* (Peck 1961, p. 66), and are quite similar in appearance. Rough popcornflower differs from fragrant popcornflower in that the entire plant is larger and has less fragrant flowers, hairier stems and fruits, more robust stems, and blooms several weeks later. The larger rough popcornflower plants grow with more arched stems as well. Rusty popcornflower (*P. nothofulvus*) is a widespread annual plant in the western United States that occurs in the general vicinity of rough and fragrant popcornflower in Douglas County. It is confined to upland areas, and has basal rosette-forming leaves, unlike rough and fragrant popcornflower. Unlike rough or fragrant popcornflower, the rusty popcornflower flower has a circumscissile attachment to the fruit.

## PHENOLOGY AND REPRODUCTION

Rough popcornflower plants, whether annual or perennial, reach sexual maturity and produce fruits in their first year. The plants generally germinate in the fall, remain vegetative until the spring, bloom in late spring and early summer, produce seed beginning late-June, and then senesce usually between July and November, but some stems or adventitious roots survive the



**Figure 1. Rough popcornflower plants growing as clusters with some larger more robust plants, in their mesic habitat, Douglas County, Oregon.**

year and sprout back in the spring. The plants may exhibit different phenologies (flowering in May, June, July, or August) depending on their habitat, range, and the soil types (Amsberry and Meinke 2001, p. 19). Plants in the southern portion of the range flower earlier (late May to early July) than the more northerly populations (July to August). The species is capable of either self or cross-fertilization; however, generalist insect pollination appears to be the predominant vector enabling rough popcornflower reproduction (Amsberry and Meinke 2001, pp. 12-13). The variety of pollinators for the species include insects in the families *Apidae*, *Bombyliidae*, *Halictidae*, *Megachilidae*, *Syrphidae*, and *Tachinidae*. The moths (*Ctenucha* [*Arctiidae*]) and beetles (*Hemiptera*) have been observed visiting flowers, but no pollen grains were detectable on their legs or other body parts (Amsberry and Meinke 2001, p. 19).

Pollination biology of rough popcornflower is not well documented but we are not currently considering lack of pollination or seed production a stressor, but are more concerned with connectivity and habitat quality since pollination is dependent of habitat corridors of an adequate variety of native and non-native plants (habitat quality). We know that the typical high seed set indicates that pollination is highly successful since the flowers are visited by a diverse group of generalist pollinators, and that pollination is not currently a limiting factor for this species.

Connectivity and habitat quality is essential to ensure that genetic exchange is taking place within and among populations by these pollinators (U.S. Fish and Wildlife Service 2003, p. 54).

Rough popcornflower seed set was evaluated at multiple sites (Popcorn Swale, Yoncalla, Church, and a common garden site in Salem, Oregon) in 1997 by recording the number of realized/potential nutlets (seed:ovule ratio) produced for each flower. At each site, seed set for rough popcornflower appeared to be produce enough seedlings to fill all available habitat (Amsberry and Meinke 2001, p. 8). During years with below average precipitation or drought, seed set could fall short of what is needed to maintain population stability. However, with a large amount of seed produced by plants, it is likely that any periodic depletion of seed back will be short term and replenished.

## VARIATION

A genetic analysis of rough popcornflower has never been performed. However better understanding of the species has been gained by greenhouse-based seed germination trials with various populations. For example, a study conducted by Amsberry and Meinke (2002, pp. 23 - 24) showed that in various populations, at least three distinct morphologic/phenotypic lines are present. The northern populations near Yoncalla, bloom later in the year, have a perennial growth form, appear to be more clonal in nature, and produce fewer flowers than the southern populations. Some populations near Sutherlin Creek flower early to mid-summer and include individuals that are perennial and have a taller growth form, intermixed with individuals that are strictly annual and quickly die off in the summer. Several southern populations, including those in both the Sutherlin and Wilbur areas, predominately include the early summer flowering, short-lived annual plants that put more reproductive effort into seed production and often grow shorter and in dense clusters (Amsberry and Meinke 2002, p. 15). The southern populations are comprised of plants with variable morphologies whereas the individuals found in northern populations are more homogenous. The plants in the Yoncalla site populations may have lower genetic variation because most plants are perennial and clonal (Amsberry and Meinke 2001). Plants established at the Bureau of Land Management's (BLM) North Bank Habitat Management Area (NBHMA) populations (Soggy Bottoms, Soggy Bottoms Sister and Westgate), the Oregon Department of Transportation's (ODOT) Wilbur Mitigation Site, the Southside Swale site, and the Orenco Ponds site were sourced from multiple populations and likely have greater genetic diversity than non-augmented populations. Field observations along with the in-house genetic study, suggest that although rough popcornflower exhibits morphologic and phenotypic traits, we cannot assess the extent the species suffers from genetic mutations, genetic bottlenecks, or genetic drift. For these reasons, we believe that rough popcornflower populations are likely able to adapt to some edaphic and climatic variability (*i.e.*, representation).

Evidence of inbreeding depression have not been observed in any wild rough popcornflower population (Amsberry and Meinke 2001, pp. 22-33). The plants that occur in the northern populations are more clonal and exhibit less phenotypic variation than those in the southern portion of the species range. This may indicate that northern populations have lower genetic diversity but genetic studies are necessary to confirm this assessment. In an attempt to enhance genetic diversity and increase the success of augmentations and introduction efforts, outplanted individuals were sourced from a variety of populations to capture the genetic diversity that

maybe present across the species' range. As a result, inbreeding depression and low genetic diversity should not be a concern for rough popcornflower populations.

## HABITAT

Rough popcornflower is a plant closely associated with seasonally wet, relatively level, open habitats in Douglas County formed from poor draining clay-loam soils, concentrated in the Sutherlin Creek basin in Oregon. These wet habitats are unique to the Sutherlin area and correspond to a particular type of soil series known as Conser silty clay-loam. The majority of rough popcornflower populations largely correspond to Conser soils, which is a poorly draining silty clay-loam series soil. To a lesser extent, the species occurs on clay or loam soils including Bashaw clay, Brand silty clay loam, Curtin clay, Dixonville silty clay loam, Nonpareil loam, Oakland clay-loam, Packard silty loam, Philomath-Dixonville complex, Sibold clay, and Waldo silty clay loam soil types.

Rough popcornflower habitat corresponds to emergent wetlands within seasonally wet meadows or prairie, seasonally-ponding mudflats, and Oregon ash (*Fraxinus latifolia*) swale openings dominated by native wetland-associated herbs and graminoids in valley lowlands where the ground is moist well into the summer season. The species appears to be adapted to early seral succession habitat so it does not often occur under dense shade. Native perennial plant species commonly associated with rough popcornflower habitat include Oregon ash, dense sedge (*Carex densa*), green-sheathed sedge (*C. feta*), one-sided sedge (*C. unilateralis*), spreading rush (*Juncus patens*), pointed rush (*J. oxymeris*), common rush (*J. effusus*), tufted hairgrass (*Deschampsia cespitosa*), great white camas (*Camassia leichtlinii*), rush-leaved coyote thistle (*Eryngium petiolatum*), Willamette gumweed (*Grindelia integrifolia*), and western manna grass (*Glyceria occidentalis*). Native annuals commonly associated with rough popcornflower include American sloughgrass (*Beckmannia syzigachne*), skullcap speedwell (*Veronica scutellata*), Cascade calicoflower (*Downingia yina*), and Douglas meadowfoam (*Limnanthes douglasii*).

Common invasive plant associates in rough popcornflower habitat include trees (e.g. European pear [*Pyrus communis*]); shrubs (e.g. Armenian blackberry [*Rubus armeniacus*] and English hawthorn [*Crataegus monogyna*]); herbaceous plants (e.g. meadow knapweed [*Centaurea moncktonii*], teasel [*Dipsacus fullonum*], Canada thistle [*Cirsium arvense*], pennyroyal [*Mentha pulegium*], and curly dock [*Rumex crispus*]); and graminoids (e.g. reed canarygrass [*Phalaris arundinacea*] and tall fescue [*Schedonorus arundinaceous*]). Pennyroyal and tall fescue are nearly always present in or around rough popcornflower habitat.

Rough popcornflower appears to be a species that requires early seral habitat and is not associated with habitat under dense tree or shrub canopies. Grazing helps to control invasive and native plant competitors and provides a measure of disturbance that maintains the preferable more-early seral and open habitat conditions for rough popcornflower. Flooding, fire, and native ungulate grazing, also likely played a large role in the development and maintenance of habitat for the plant (U.S. Fish and Wildlife Service 2000, p. 3867). When such natural disturbance events are lacking, active management is necessary to control competing vegetation and maintain requisite conditions for this plant to compete with naturally occurring and non-native plant

species. An increase in abundance of Oregon ash or spreading rush can result in a loss of rough popcornflower habitat without mowing, grazing, or fire to restore habitat suitability.

## **DISTRIBUTION AND ABUNDANCE**

Rough popcornflower is found only in northern Douglas County, Oregon, occurring at low elevations (100 and 230 meters (m) [328 to 755 feet (ft)]) within the Umpqua River basin, distributed in the Elk Creek, Umpqua River, and Lower North Umpqua River watersheds. Prior to listing, rough popcornflower was thought to be extinct, as the most recent collection of the species was in 1961 along a major highway (Meinke 1982, p. 268). However, surveys in the early 1980s rediscovered several populations, all within the Umpqua Valley drainage in Douglas County, Oregon, but most concentrated in the Sutherlin Creek subwatershed. The abundance and distribution of this species has likely been affected by the conversion of seasonal wet meadow habitat to agricultural use since the time of European settlement, and more recently by urban and industrial development in the Sutherlin area. At the time of listing in 2000, 17 extant rough popcornflower habitat patches covering approximately 18 hectares (ha) (45 acres) had been documented (January 25, 2000; 65 FR 3866). These patches corresponded to 8 populations supporting an estimated 7,000 individuals. Subsequently, through extensive surveys and introduction efforts, the number of populations has more than doubled to 18, with a population estimate of over 883,154 mature, reproductive individuals. Currently, the 18 populations are distributed discontinuously from Yoncalla Creek, near Rice Hill, Oregon, 20 kilometers (km) (12.4 miles [mi]) south to Sutherlin Creek, near Wilbur, and in the Umpqua River watershed (Maddux and Meyers 2008, entire; U.S. Fish and Wildlife Service 2010, p. 1) (Figure 2). Nearly half of the populations occur within the Sutherlin Creek subwatershed. A detailed description of each of these populations, including conservation and management at each site, is provided in Appendix 2.

The majority of the total rough popcornflower plant estimate (883,154 plants) derives from a single extensive rough popcornflower population known as the Horsepasture 2 site (formerly Sutherlin 1/Horsepasture 2). This population occurs on a private ranch, south of Sutherlin and although it has not been thoroughly inventoried due to its size, may account for as many as 700,000 individuals (81percent of the total number of individuals). The 18 populations have not been monitored consistently in each location due to a limitation of accessibility.

During favorable years, rough popcornflower tends to increase in spatial distribution and density (U.S. Fish and Wildlife Service 2010, p. 23), with decreases common in years with harsher growing conditions. For example, the Southside Swale population size has fluctuated between a low of 3,725 plants in 2016, and a high of approximately 10,000 plants in 2007 (U.S. Fish and Wildlife Service 2020, p. 1). The reason for the fluctuation may have to do with increased vegetation management in 2016 and erratic seasonal weather patterns. Other populations occur on marginally suitable habitat. The Hawthorne population, in Sutherlin, occurs on habitat that has declined from 300-500 plants in 2006 to about 10-15 plants in 2019, presumably due to a drop in ground moisture and encroachment of non-native invasive vegetation.

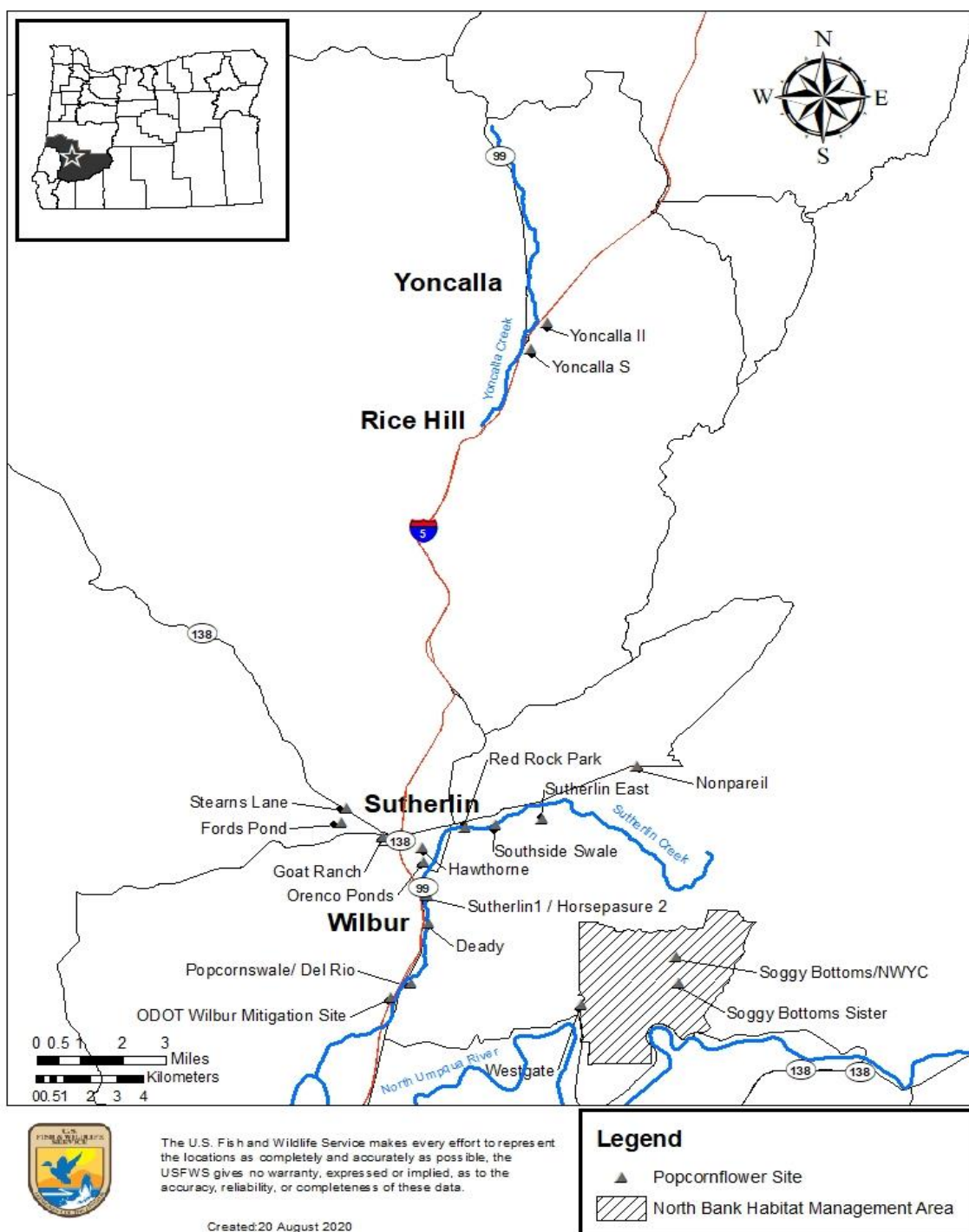
The known populations of rough popcornflower include six that were established via outplanting in the southern range of the species at the BLM's NBHMA (Soggy Bottoms, Soggy Bottoms

Sister, Westgate), at Goat Ranch, Orenco Ponds in Sutherlin, and at the Oregon Department of Transportation (ODOT) Wilbur Mitigation Site in Wilbur (Figure 2). Two naturally occurring populations have also been augmented to increase population size (Southside Swale and Del Rio) on Douglas Soil and Water Conservation District (DSWCD) and ODOT lands. Thirteen populations have been stable over the last 10 years, ranging from 175 plants to up to 700,000 plants. Two populations, one recently discovered at Ford's Pond in Sutherlin and the Soggy Bottoms Sister population introduced to BLM's NBHMA in 2016, do not yet have a 5-year monitoring record but initial surveys recorded approximately 950 plants and 2,900 plants respectively. Rough popcornflower populations display significant fluctuation in the individuals from year to year; however, the majority of the populations (13 of 18) appear to be stable (Amsberry and Meinke 2017, p. 6).

Rough popcornflower occurs in dense clusters or broadly dispersed throughout a particular area. Plants are found grouped within circular wetland depressions or in linear patterns, such as ditch lines or tire ruts. Less often, plants grow around semi-permanent to permanent water features. The distribution of rough popcornflower is closely tied to soil moisture patterns, but the variation in plant density from one patch to the next is not well understood. This could reflect differences in underlying soil characteristics, associations of competing herbaceous plants, herbivore presence, and seed distribution. A 50 square meters ( $m^2$ ) (538 square feet [ $ft^2$ ]) rough popcornflower patch having a density of 100 plants/ $m^2$  (100 plants/538 square feet) or greater is likely an upper limit of plant density. Other patches can be much sparser and occur over much greater areas. The variation in plant density, results in challenges to conducting plant inventories. Counting individual plants in small, dense patches is time consuming and can require hours to tally individual plant stems. Accurate surveys can be challenging, as clusters of the white flowers can be one very robust plant with many spreading stems occupying a relatively large area. In cases of large, dense populations, counting plant stems within a sufficient number of random sample plots or quadrats can be used to estimate the population size for the entire population (quadrat-style estimation).

## **RANGE OF ESTIMATED HABITAT**

In the Umpqua Valley, conversion of wetlands to agricultural lands has reduced the extent of seasonal wetlands that support rough popcornflower (Amsberry and Meinke 2001, p. 5) and the species was likely historically more common than it is currently. Currently rough popcornflower is estimated to occur across 48 hectares (ha) (118 acres) in Douglas County. While several rough popcornflower populations have become fragmented or extirpated due to urban development (*i.e.*, Horsepasture 1, Sheep Meadow, Val Street) (U.S. Fish and Wildlife Service 2000, p. 3869), surveys since 2003, have discovered some previously-unknown populations (*e.g.*, Ford's Pond and Sutherlin Red Rock Park). These new populations did not significantly extend the range of the species, but have changed its known distribution within the Sutherlin Creek Recovery Unit and increased its overall abundance.



**Figure 2. Distribution of rough popcornflower in Douglas County, Oregon.**

## POPULATION TRENDS AND DISTRIBUTION

### Census and Monitoring Information

Various entities have been monitoring rough popcornflower populations on public lands for a number of years, while census information on several populations on private lands is limited (Table 2). Small rough popcornflower populations or patches are monitored by counting all individual plant stems. Counting all individual plant stems can be difficult for larger areas, such as Horsepasture 2, where the extent of the population is over 2,000 m<sup>2</sup> (0.49 acre). Other populations that occur on inaccessible private lands are difficult to estimate and to determine whether they have increased or decreased from year to year. For populations that can be easily accessed, and are within an area that be censused within several hours, all individual plant stems are counted with the aid of measuring tape and various shaped sampling plots (Amsberry and Meinke 2017, p. 5). Larger populations are inventoried by counting all stems within several sampling plots and extrapolating the plot areas to the area of the population to estimate the number of individuals in the entire population (Amsberry and Meinke 2017, p. 5). A full record of the population monitoring is provided in Appendix 3.

### Monitoring Accuracy and Confidence Values

Each rough popcornflower population is located on lands with different ownerships and are monitored differently out of necessity. While individual plant stems are inventoried carefully at accessible populations such as the TNC Popcornswale and the Westgate (BLM land) population, other populations occur on private land without access. When populations are censused annually by counting all individuals stems within the population, we would expect a high level of precision and have high confidence in the survey. When a population can only be viewed from several meters away, such as from a roadside, and the population estimate is based on a comparison with other populations, we would expect a low level of precision and have very low confidence in the value, especially if it only was monitored every few years.

We have defined Precision and Confidence Values as how accurate the results of a population census are at any given location (See Appendix 1 for Confidence and Precision Values). A ‘good’ monitoring precision score depends on careful attention to each stem nearly every year. In this scenario, a population is surveyed by counting every individual stem and if necessary measuring tape or monitoring plots are utilized to avoid double-counting, missing plant stems, or to employ quadrat-style estimation in larger or denser populations (greater than 1,000). A ‘moderate’ score indicates a population is closely surveyed half of the years and in between survey years is merely afforded a quick estimate and rounded up to an even number in the 100<sup>th</sup> or 1,000<sup>th</sup> integer. A ‘low’ score indicates a population is surveyed nearly every time with a quick estimate and rounded to a 100<sup>th</sup> or 1,000<sup>th</sup> integer each time. If a population count actually ends with even 100<sup>th</sup> or 1,000<sup>th</sup> integer, it should be documented. The precision scoring results indicate that 10 populations received a ‘good’ score, 3 populations received a ‘moderate’ score and 5 populations received a ‘poor’ score (Table 1).

Monitoring confidence values are based on the frequency of surveys. Overall monitoring of the 18 extant rough popcornflower populations is extremely patchy and while some receive quite regular inventories, others are monitored quite infrequently and sporadically. The populations

with highest ranked monitoring confidence value were scored with a fraction of sampled years divided by the total number of years that the population was known. A 'Poor' indicates less than 25 percent of all the years, the populations has been monitored, a 'Moderate' indicates between 25 and 50 percent of all the years, the populations has been monitored, and 'Good' indicates more than 50 percent of all the years, the populations has been monitored. In the monitoring confidence scoring, 8 populations received a 'good' score, 3 received a 'moderate' score and 7 received a 'poor' score (Table 1). We believe that this indicates that 7 populations or an additional 40 percent of the total populations are in need of more frequent monitoring.

#### Population sizes

Rough popcornflower has been documented at 23 populations historically; 18 are extant and 5 are extirpated (Table 2). Five of the known populations occur on private land and lack monitoring access. Despite this, the species is estimated to have greater than 883,154 mature, reproductive individuals across its range. Of the 18 extant populations, 1 is very large (700,000 plants), 10 are relatively large (5,000-70,000 plants), 4 are medium (1,000-4,999 plants), and 3 are small (less than 1,000 plants). While smaller populations, in general, are more vulnerable to extirpation from stochastic events and genetic drift than larger populations (Szczecińska et al. 2016, p. 17; Ma et al. 2013, p. 805), the majority of rough popcornflower populations support more than 5,000 individuals and we believe are less susceptible to stochastic events and genetic issues.

Through extensive surveys and augmentation and introduction efforts, the 7,000 individuals within 8 populations known at the time of listing has increased to 18 populations, with a total population estimate of over 883,154 individuals. The bulk of this estimate includes a single extensive rough popcornflower population south of Sutherlin, which has not been adequately censused but may have as many as 700,000 individuals.

**Table 1. Rough popcornflower population monitoring confidence and precision values (Amsberry and Meinke 2017; Service 2020)**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Population                        | Monitoring Precision Score <sup>1</sup> | Population Years <sup>2</sup> | Monitoring Years <sup>3</sup> | Years not monitored | Confidence Value <sup>4</sup> | Monitoring Score <sup>5</sup> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------------|-------------------------------|-------------------------------|---------------------|-------------------------------|-------------------------------|
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Horsepasture 2                    | Poor                                    | 24                            | 4                             | 20                  | 0.17                          | Poor                          |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | TNC/ ODOT Del Rio Mitigation Site | Good                                    | 26                            | 16                            | 10                  | 0.62                          | Good                          |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ODOT Wilbur Mitigation Site       | Good                                    | 21                            | 5                             | 16                  | 0.24                          | Poor                          |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Hawthorne                         | Good                                    | 24                            | 23                            | 1                   | 0.96                          | Good                          |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Orenco Ponds                      | Good                                    | 11                            | 7                             | 4                   | 0.64                          | Good                          |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Sutherlin Red Rock Park           | Good                                    | 18                            | 12                            | 6                   | 0.67                          | Good                          |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Southside Swale                   | Moderate                                | 18                            | 8                             | 10                  | 0.47                          | Moderate                      |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Ford's Pond                       | Good                                    | 4                             | 4                             | 0                   | 1.00                          | Good                          |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Stearns Lane                      | Moderate                                | 23                            | 19                            | 4                   | 0.83                          | Good                          |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Nonpareil                         | Poor                                    | 13                            | 2                             | 11                  | 0.15                          | Poor                          |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Soggy Bottoms/ NW Youth Corps     | Good                                    | 22                            | 16                            | 6                   | 0.70                          | Good                          |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Soggy Bottoms Sister              | Moderate                                | 5                             | 3                             | 2                   | 0.60                          | Good                          |
| 13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Westgate                          | Good                                    | 18                            | 16                            | 2                   | 0.89                          | Good                          |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ODOT Yoncalla South               | Good                                    | 24                            | 4                             | 20                  | 0.17                          | Poor                          |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ODOT Yoncalla 2                   | Good                                    | 18                            | 8                             | 10                  | 0.44                          | Moderate                      |
| 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Deady                             | Poor                                    | 24                            | 3                             | 21                  | 0.13                          | Poor                          |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Sutherlin East                    | Poor                                    | 23                            | 2                             | 21                  | 0.09                          | Poor                          |
| 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Goat Ranch                        | Poor                                    | 17                            | 2                             | 15                  | 0.12                          | Poor                          |
| <b>1 Monitoring Precision Score</b> = This is score is based the attention and time provided when censusing a rough popcornflower population. A 'poor' score would be performing a limited observation from a roadside for 80 – 90 percent of the surveys. For a 'moderate' score, half of years are surveyed with precision and half with a limited observation. A 'good' score would be a systematic counting of individual stems to ensure relatively high confidence for all surveys. <b>2 Population Years</b> = The total number of years the population has been documented; <b>3 Monitoring Years</b> = The number of years the population has been monitored; <b>4 Confidence Value</b> = The number of monitoring years divided by the total years population has been documented; <b>5 Monitoring Score</b> = Based on the confidence value; 'Poor' indicates below 25 % of the years monitored, 'Moderate' indicates between 25 and 50 % of the years monitored, and 'Good' indicates more than 50 % of the years monitored. |                                   |                                         |                               |                               |                     |                               |                               |

**Table 2. Recovery status of rough popcornflower populations, Douglas County, Oregon.**

| Population | Habitat Patch                                               | ORBIC EO# <sup>1</sup> | Recovery Unit    | Area (square meters) | Population Size (census year) | Notes                                                                          | Status  | Reserve <sup>2</sup> |
|------------|-------------------------------------------------------------|------------------------|------------------|----------------------|-------------------------------|--------------------------------------------------------------------------------|---------|----------------------|
| 1          | Horsepasture 2                                              | 1                      | Sutherlin Creek  | 10,700               | Estimated 700,000 (2016)      | Private property. Largest known population; strategically grazed for 30 years. | Extant  | Yes <sup>3</sup>     |
| 2          | The Nature Conservancy (TNC) Oerding Preserve-Strip Patch N | 9                      |                  | 150                  | 5,712 (2019)                  | Private property. TNC owned.                                                   | Extant  | Yes                  |
|            | TNC Oerding Preserve Field Patch                            |                        |                  | 200                  | 342 (2019)                    | Private property. TNC owned.                                                   |         |                      |
|            | Oregon Department of Transportation (ODOT) Del Rio Site     |                        |                  | 93.5                 | 6,750 (2020)                  | ODOT owned. Augmented, and managed.                                            |         |                      |
|            | Glide lumber Strip                                          |                        |                  | 13                   | 20 (2008)                     | Private property.                                                              | Unknown |                      |
| 3          | ODOT Wilbur Mitigation Site                                 | None                   |                  | 914                  | 69,288 (2018)                 | ODOT owned. Introduced in 1999; biennially monitored.                          | Extant  | Yes                  |
| 4          | Hawthorne                                                   | 7                      |                  | 5                    | 10-15 (2018)                  | Private property. Heavily impacted and fragmented                              | Extant  | No                   |
| 5          | Orenco Ponds                                                | None                   |                  | 1,344                | 17,326 (2016)                 | County property. Introduced in 2011; mitigation site, wetlands protected.      | Extant  | Yes                  |
| 6          | Sutherlin Red Rock Park West Patch                          | None                   |                  | 600                  | 15,111 (2019)                 | City property. Annually monitored; 2 patches extant, 1 extirpated.             | Extant  | Yes                  |
|            | Sutherlin Red Rock Park East Patch/Waite St.                | 6                      |                  | 79                   | 250 (2019)                    |                                                                                |         |                      |
| 7          | Southside Swale Patch A                                     | None                   |                  | 600                  | 5,500 (2019)                  | DSWCD owns half of patch. Augmented in 2006.                                   | Extant  | Yes                  |
|            | Southside Swale Patch B                                     |                        |                  | 2,185                | 10,000 (2006)                 | Private Property. 1 patch.                                                     | Unknown | No                   |
| 8          | Ford’s Pond                                                 | None                   | Callapooya Creek | 150                  | 950 (2019)                    | City property. Annually monitored.                                             | Extant  | No                   |
| 9          | Stearns Lane                                                | 14                     |                  | 2                    | 175 (2019)                    | Private property. 1 patch.                                                     | Extant  | No                   |
| 10         | Nonpareil                                                   | 3                      |                  | 10,000               | 6,000 (2019)                  | Private Property. Roadside observation; east of Sutherlin.                     | Extant  | No                   |

Table 2. cont.

| Population    | Habitat Patch               | ORBIC EO# <sup>2</sup> | Recovery Unit                       | Area (m <sup>2</sup> ) | Population Size (year of latest census) | Notes                                                        | Status     | Reserve    |
|---------------|-----------------------------|------------------------|-------------------------------------|------------------------|-----------------------------------------|--------------------------------------------------------------|------------|------------|
| 11            | Soggy Bottoms Patch         | None                   | Umpqua Management Area <sup>4</sup> | 1                      | 10 (2017)                               | BLM land. Introduced 1998; annually monitored.               | Extant     | No         |
|               | Northwest Youth Corps Patch | None                   |                                     | 106.8                  | 3,353 (2016)                            | BLM land. Introduced; annually monitored.                    |            |            |
| 12            | <b>Soggy Bottoms Sister</b> | None                   |                                     | <b>500</b>             | <b>11,222</b> (2020)                    | BLM land. Introduced in 2016; annually monitored.            | Extant     | <b>Yes</b> |
| 13            | <b>Westgate</b>             | None                   |                                     | 229                    | <b>10,110</b> (2016)                    | BLM land. Introduced; annually monitored.                    | Extant     | <b>Yes</b> |
| 14            | <b>ODOT Yoncalla South</b>  | 4                      | Yoncalla Creek                      | 99                     | <b>6,123</b> (2016)                     | ODOT Right of Way. Biennially monitored; 2 patches.          | Extant     | <b>Yes</b> |
| 15            | <b>ODOT Yoncalla 2</b>      | 16                     |                                     | <b>800</b>             | 14,248 (2015)                           | ODOT Right of Way. Biennially monitored; 1 patch.            | Extant     | <b>Yes</b> |
| 16            | Deady 1                     | 5                      | Sutherlin Creek                     | <b>500</b>             | <b>5,000</b> (2005)                     | Private property. 2 patches.                                 | Unknown    | No         |
|               | Deady 2                     | 12                     |                                     |                        | 1,000 (2005)                            |                                                              |            |            |
| 17            | Sutherlin East              | 15                     |                                     | 6                      | Up to 1,000 (2006)                      | Private property. 1 patch.                                   | Unknown    | No         |
| 18            | Goat Ranch                  | None                   | Calapooya Creek                     | 5                      | 75 (2005)                               | Private property. 1 patch.                                   | Unknown    | No         |
| <b>TOTALS</b> |                             |                        |                                     | <b>49,535</b>          | <b>883,154</b>                          |                                                              |            |            |
| 19            | Horsepasture 1              | 10                     | Sutherlin Creek                     | 0                      | 0 (2005)                                | Private property.                                            | Extirpated | No         |
| 20            | Sheep Meadow                | 11                     | Sutherlin Creek                     | 0                      | 0 (2005)                                | Private property.                                            | Extirpated | No         |
| 21            | Val Street                  | 13                     | Sutherlin Creek                     | 0                      | 0 (2005)                                | Private property.                                            | Extirpated | No         |
| 22            | Powerline                   | None                   | Umpqua Management Area              | 0                      | 0 (2016)                                | BLM property. Periodically monitored.                        | Extirpated | No         |
| 23            | Yoncalla North              | 2                      | Yoncalla Creek                      | 0                      | 0 (2005)                                | Private property. No plants seen since 1939 Peck collection. | Extirpated | No         |

Amsberry and Meinke 2017, USFWS 2020, A. Kercher, pers. comm. 2020.

**Bolded text and figures** indicate populations and metrics meeting or exceeding downlisting criteria, either for area, population size or protected status as defined per the Recovery Plan (U.S. Fish and Wildlife Service 2019).

Habitat Patches (n = 24) are sub populations. Populations (19-23) shaded dark grey are extirpated.

<sup>1</sup> Oregon Biodiversity Information Center Element Occurrence Record (see Appendix 1 for definition).

<sup>2</sup> Reserves contain a minimum of 5,000 plants each and are protected and managed to assure their long-term survival.

<sup>3</sup> This privately owned property is a working livestock ranch that has been managed to support rough popcornflower for over 30 years and there is no indication this will change in the future.

<sup>4</sup> The Umpqua Management Area, which includes the Bureau of Land Management's North Bank Habitat Management Area, contributes to recovery (U.S. Fish and Wildlife Service 2019, p. 5).

## **SUMMARY OF INDIVIDUAL, POPULATION, AND SPECIES REQUIREMENTS**

Rough popcornflower is a plant closely associated with seasonally wet, relatively level, open habitats in Douglas County. Habitat for the species includes seasonally wet meadows or prairie, seasonally-ponding mudflats, and Oregon ash swale openings dominated by native wetland-associated herbs and graminoids in valley lowlands where the ground is moist well into the summer season. The species appears to be adapted to early seral habitat within a diverse range of types of habitats. No quantitative analysis has been completed to determine the minimum number of populations necessary for rough popcornflower to be viable. However, expert opinion and published information of minimum viable populations for other species (as discussed below in the Recovery section) helped inform and set goals for the necessary number of rough popcornflower populations per recovery units and the Umpqua Management Area (The area that contributes to recovery at the BLM's NBHMA). The intent of these goals was to ensure the distribution of resilient populations across its historical range to ensure redundancy and adequate ecological and genetic representation.

## **SUMMARY OF STRESSORS AFFECTING THE SPECIES**

When listed as endangered, the known stressors to rough popcornflower included urban and rural development, grazing by livestock, and small population sizes. On an individual, population, and species level, rough popcornflower is primarily dependent on suitable wet swale or meadow habitats in Douglas County, which have been reduced due to residential and road development. Disease and over-collection for scientific or horticultural purposes also were included as potential stressors (January 25, 2000; 65 FR 3866). Browsing by cattle and deer, disease and predation, and fire were included as potential stressors in the recovery plan and the subsequent 5-year review (U.S. Fish and Wildlife Service 2003, p. 14; U.S. Fish and Wildlife Service 2010, pp. 4-5).

The species appears to be adapted to early seral succession habitat and cannot compete with later successional vegetation such as Oregon ash, rushes, and tall fescue for light, moisture, and space. Stressors to rough popcornflower habitat include encroachment by Oregon ash and European pear, Armenian blackberry and English hawthorn, pennyroyal, teasel, Canada thistle, curly dock, spreading rush and reed canarygrass), which compete for moisture, light, and space. Pennyroyal is nearly always present in rough popcornflower habitat and is an ever-present competitor. Studies in 2008, determined that pennyroyal produces allelochemicals, which have a detrimental effect on the germination and growth of rough popcornflower (Amsberry and Meinke 2008, p. 16). Other widespread non-native plants in Douglas County lowlands, including meadow knapweed and tall fescue occur in drier habitats than rough popcornflower but these species may encroach on rough popcornflower habitat during dry periods.

Development was described as a serious stressor to rough popcornflower. In addition to direct loss of habitat due to placement of fill, habitat can become degraded by both channelization (*e.g.* ditching) and filling of wetland habitat.

On a species level, rough popcornflower is reliant on protected (property is publicly owned, owned by conservation minded organization, under a land trust, or under a conservation

easement or deed restriction) suitable habitat distributed throughout its range sufficient to establish and maintain a network of multiple populations (*i.e.*, redundancy) across the gradient of ecological settings known to be occupied by the species (*i.e.* representation). On a population level, rough popcornflower requires individuals in sufficient density and number (*i.e.* resiliency) to survive native and non-native species encroachment through environmental stochasticity, maintain sufficient reproductive capacity and genetic diversity, lessen effects of genetic drift and inbreeding depression, and increase the ability of the species to adapt to a changing climate. On an individual level, rough popcornflower plants, as with any plant, must flower and set viable seed, which in turn must germinate at the appropriate time of year in habitat with proper moisture levels, with access to nutrients from the soil, and with sunlight sufficient to allow the plant to grow to an adult size. See Tables 3 and 4 for species requirements and stressors respectively.

**Table 3. Species requirements on an individual, population, and species level (see Appendix 1).**

| Individual                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Population                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Species                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Emergent wetlands, seasonal depressions, or ditches with sufficient moisture.</li> <li>Elevations from 100 to 230 m [328 to 755 feet].</li> <li>Conser, Curtin, Bashaw, Brand, Dixonville, Nonpareil, Oakland, Philomath-Dixonville, or Sibold soil series.</li> <li>Disturbance gives the plants a competitive advantage.</li> <li>Average annual precipitation of at least 0.8 m (33 in).</li> <li>Pollinators: honeybees (<i>Apis</i> spp.), bumblebees (<i>Bombus</i> spp.), halictid and megachilid bees, Hemiptera (true bugs), bombyliid, syrphid, tachinid flies, and red-shouldered <i>Ctenucha</i> moths (<i>Ctenucha rubroscapus</i>). These insects require diverse native vegetation and minimal pesticide exposure.</li> </ul> | <ul style="list-style-type: none"> <li>Resiliency: 5,000 or more individuals.</li> <li>A diversity of pollinators to ensure abundant seed set.</li> <li>Patches comprising populations are within 1 km (0.6 mile) of each other to allow pollinator movement and gene flow.</li> <li>Habitat supporting a community of native plant species.</li> <li>Habitat containing sufficient size (minimum 500 m<sup>2</sup> [5,382 ft<sup>2</sup>]).</li> <li>Wetlands and poorly drained soils found on edges of ash swales and seasonally inundated ponds or microsites with open sparse vegetation cover.</li> </ul> | <ul style="list-style-type: none"> <li>Representation: Existing genetic diversity conserved throughout the range.</li> <li>Redundancy and Resiliency: The amended recovery criteria recommend one or more reserve populations in each recovery unit (Callapooya Creek, Sutherlin Creek, and Yoncalla Creek), with a minimum of 5 in the Sutherlin Creek Recovery Unit and 2 more viable populations located within the Umpqua Management Area.</li> </ul> |

**Table 4. Summary of stressors affecting rough popcornflower.**

| <b>Listing Factors</b>                                                                      | <b>Individual</b>                                                                                                                                                                                  | <b>Population</b>                                                                                                                                                                                                                                                                     | <b>Species</b>                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A. The present or threatened destruction, modification, or curtailment of habitat or range. | <ul style="list-style-type: none"> <li>Habitat loss, degradation, and fragmentation can directly displace plants change seasonal hydrology, resulting in a lack of moisture for plants.</li> </ul> | <ul style="list-style-type: none"> <li>Habitat loss can displace plants while degradation and fragmentation can change seasonal hydrology, allow invasive plants to colonize habitat, reduce population size and potentially reduce genetic variability.</li> </ul>                   | <ul style="list-style-type: none"> <li>Population fragmentation and isolation reduces gene flow within and among populations, reducing representation and resiliency.</li> </ul> |
| B. Over-utilization for commercial, recreational, scientific, or educational purposes.      | Not likely a concern.                                                                                                                                                                              | <ul style="list-style-type: none"> <li>Plant and seed collecting can reduce population size, potentially reduce genetic variability, and lead to loss of populations.</li> </ul>                                                                                                      | <ul style="list-style-type: none"> <li>Loss of populations reduces representation and redundancy.</li> </ul>                                                                     |
| C. Disease or predation                                                                     | <ul style="list-style-type: none"> <li>Grazing by native wildlife and livestock could have negative (consumes, uproots, or smothers plants) effects on individual survival.</li> </ul>             | <ul style="list-style-type: none"> <li>Could have negative effects on populations.</li> </ul>                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>Could potentially have negative effects on species resiliency.</li> </ul>                                                                 |
| D. Inadequacy of existing regulatory mechanisms.                                            | <ul style="list-style-type: none"> <li>Plants have no legal protection on private lands.</li> </ul>                                                                                                | <ul style="list-style-type: none"> <li>Populations could be destroyed on private lands for projects affecting habitat.</li> <li>Reduction of wetland protections by the Army Corps of Engineers due to recodification of Waters of the United States (EPA 2019, p. 56626).</li> </ul> | <ul style="list-style-type: none"> <li>Loss of populations reduces representation and redundancy of the species.</li> </ul>                                                      |

**Table 4. Cont.**

| <b>Listing Factors</b>                                                 | <b>Individual</b>                                                                                                                                                                                                                                                                             | <b>Population</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Species</b>                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E. Other natural or manmade factors affecting its continued existence. | <ul style="list-style-type: none"> <li>• Lack of moisture in the soil during the growing period can reduce survival of plants.</li> <li>• Encroachment by native and non-native plants displaces individual plants</li> <li>• Lack of pollinators could impede plant reproduction.</li> </ul> | <ul style="list-style-type: none"> <li>• Lack of habitat disturbance, such as mowing or vegetation maintenance, can lead to competition by native and non-native invasive plants.</li> <li>• Lack of pollinators could reduce population seed production.</li> <li>• Climate change could reduce suitable habitat within populations.</li> <li>• Low genetic intra-population variation can lead to a collapse of a population.</li> <li>• Smaller populations are more vulnerable to catastrophic events and likely contain lower genetic diversity than larger populations.</li> </ul> | <ul style="list-style-type: none"> <li>• Endemism limits the geographic range and redundancy of the species.</li> <li>• Climate change potentially reduces the species' range and distribution, reducing representation and redundancy.</li> </ul> |

## **HABITAT LOSS AND FRAGMENTATION**

Urban and Rural Development. The final listing decision (U.S. Fish and Wildlife Service 2010, p. 3869) described how rough popcornflower populations had become fragmented due to draining and filling of wetlands from properties being developed, primarily in the city of Sutherlin area. For example, between 1995 and 2002, four rough popcornflower populations were either heavily impacted or lost due to urban development, mostly prior to the species' listing. Currently, we consider urban development in the general vicinity of Sutherlin (within and just beyond the Urban Growth Boundary) as a threat to four populations (Hawthorne, Southside Swale, Sutherlin East, and Stearns Lane). However, 11 of the 18 populations (151,195 of 883,154 total plants) throughout the species' range are under Federal, State, municipal, or land trust protections providing for the long-term persistence of these populations. At other privately owned populations on rural pasturelands (Horsepasture 2, Nonpareil), long-term persistence has been documented for over 30 years. Additionally, developers, State and Federal wetland regulators, and city and county governments are doing an increasingly better job of recognizing rough popcornflower habitat and avoiding and minimizing (or mitigating) development impacts. Because the majority of the population is protected and the species is benefitting from increased awareness, the threat posed by development has been significantly diminished. Nine rough popcornflower populations occur on Federal, State and Municipal owned lands, where management of the species is directed by species-specific management plans and regulations (Table 2).

Rough popcornflower is distributed across properties with a mix of ownership (Table 2) and land use practices. These land use practices on privately owned land may or may not be consistent with rough popcornflower conservation. For example, while some landowners mow rough popcornflower during its growing period, seed with non-native pasture grass, and use selective herbicides to promote hay or agricultural crops (*i.e.*, practices that can be detrimental to the species), other landowners are interested in conserving the species, mow, and graze when competition with invasive non-native species is problematic for the species. As discussed above in the Habitat section, some forms of land use practice can be beneficial to the species. The fact that lands are held in private ownership in and of itself does not constitute a threat to the species. In fact, three of the largest rough popcornflower populations occur on private lands where the property is not specifically managed to benefit the species (Table 2). Of the 18 extant rough popcornflower populations, 4 with greater than 5,000 individuals occur partially or wholly on private lands which are grazed beneficially for the species.

At the time of listing, only five populations of rough popcornflower were protected from detrimental land-use activities. Since listing, significant progress has been made in protecting and managing sites supporting rough popcornflower. Because 12 of the 18 of the populations are now considered protected or on adequately managed land, the threat from development activities is no longer as severe.

## **SMALL POPULATION SIZE**

The final listing rule (U.S. Fish and Wildlife Service 2000, pp. 3869-3870) described the distribution of the rough popcornflower as 17 small patches (approximating 7,000 plants) which were threatened by natural (*i.e.*, flood) and / or anthropogenic (*e.g.*, herbicide treatment) events. At the time, the species' small population size was considered a *threat* because a single natural or man-made event could have the potential to extirpate a small rough popcornflower patch. Although small populations occur that are still vulnerable to extirpation, there are now multiple, large populations of rough popcornflower occurring in patches larger than those at the time of listing, providing added resilience to the species. In addition, at the time of listing there were concerns that a small, isolated population might not be able to sustain adequate genetic variation, or that reproduction may be impaired (see Fertilization, below). There was also a concern that a lack of connectivity between isolated patches and populations would limit pollinator-mediated gene flow. Since then, these concerns have since been alleviated to a significant extent.

At the time of listing, the limited number of individuals and populations was considered a threat. Today, eight of the 18 populations are dispersed over a much larger area (over 500 m<sup>2</sup> [5382 ft<sup>2</sup>]) than in the past and are likely large enough to withstand a single random natural or anthropogenic event. However, the Hawthorne, Stearns Lane, and Ford's Pond populations are located in small discrete areas and are vulnerable. Even so, these small populations are broadly distributed and the likelihood of large-scale event affecting them collectively is unlikely. Overall, while this species' relatively small population is still of some concern, it is much less vulnerable than when it was listed.

## **HERBIVORY**

Herbivory by Columbian white-tailed deer (*Odocoileus virginianus leucurus*), black-tailed deer (*Odocoileus hemionus columbianus*), assorted rodents, and livestock, particularly sheep, has occasionally been documented and could be a threat to rough popcornflower (U.S. Fish and Wildlife Service 2000, p. 3871). Densities of white-tailed and black-tailed deer are high in much of the Sutherlin Creek area and generally overlap with the distribution of rough popcornflower. Deer herbivory was evident following introduction of rough popcornflower to a wetland mitigation site (U.S. Fish and Wildlife Service 2020, p. 2) and some evidence of sheep herbivory has been documented (U.S. Fish and Wildlife Service 2000, p. 3871). Despite the densities of deer, herbivory does not appear to be causing widespread damage to most rough popcornflower populations.

## **INVASIVE PLANT ENCROACHMENT**

Non-native invasive plants are a primary threat to the establishment of rough popcornflower due to their encroachment of habitat and elimination of bare-ground, which popcornflower seeds require to germinate. Invasive pennyroyal is present at many rough popcornflower sites and controlling this species requires constant effort and is a management priority at the NBHMA, TNC Popcorn Swale Preserve, and Red Rock Park populations. Similarly, teasel and Canada thistle control requires constant effort at the NBHMA, Yoncalla South and the TNC Popcorn Swale Preserve populations. Reed canary grass covered over 70 percent of the Red Rock Park

rough popcornflower site for several years and required three years of repeated manual weeding efforts and herbicide treatments to reduce this invasive plant to manageable levels. As discussed above, rough popcornflower is conservation reliant in that some form of active management is necessary to maintain habitat in an early-successional condition. For example, prescribed fire, mowing, manual weeding, and herbicide treatment may be required to help maintain many of the rough popcornflower populations into the future (U.S. Fish and Wildlife Service 2010, p. 27). This is exemplified by the active management practices and population response at multiple locations (see Appendices 2 and 3).

Invasive plants appears to be less of a concern on private lands because livestock grazing controls invasive plant growth (citation). Strategic grazing by livestock, in terms of seasonal grazing periods and intensity, when closely monitored, can benefit rough popcornflower populations by reducing plant competition and creating open ground that facilitates seed germination and enables population expansion (U.S. Fish and Wildlife Service 2020, p. 2).

Competition with invasive plants is an ongoing threat to rough popcornflower. However, investments in weed control and lessons learned in how to combat invasive species has resulted in flourishing populations. A continued commitment will be needed to maintain these populations (see Appendices 3 and 4). While invasive plants remain a threat to rough popcornflower, this threat can be successfully managed.

## **FIRE**

At the time of listing, fire was considered a necessary natural event key to the formation and maintenance of rough popcornflower habitat (U.S. Fish and Wildlife Service 2000, p. 3867). In late September 2003, an accidental fire occurred at the Soggy Bottoms meadow within the BLM's NBHMA and burned across the introduced rough popcornflower population. The intensity of the fire was moderate but did not sterilize the soil's organic layers. Following the burn, staff noted that individual rough popcornflower plants were much larger, robust, and the population increased from 1,193 plants in July 2003 to 1,869 plants in July 2004. However, by 2009 the population had been reduced to 15 individuals. The BLM and the Service attributed the rapid population decline to factors other than the burn, including changes in water flow and increased erosion due to stream channelization at the site that affected the hydrology of the site. While the effects of fire in rough popcornflower habitat restoration are still unknown (U.S. Fish and Wildlife Service 2010, p. 27), the fire at North Bank/Soggy Bottoms suggest that low to moderate intensity fire can have short-term beneficial effects to the species.

## **CLIMATE CHANGE**

The likely impacts of climate change on rough popcornflower's ecological processes are closely connected to availability of water. Due to their shallow and ephemeral nature, wet swales in southwestern Oregon are particularly sensitive to increases in evaporation or reductions in rainfall. Strong climate variability is likely to persist in the Pacific Northwest, owing in part to the year-to-year and decade-to-decade climate variability associated with the Pacific Ocean (May *et al.* 2019, p. 1039). Periods of prolonged drought are projected to intersperse with years featuring heavy rainfall driven by powerful atmospheric rivers and strong El Niño winters (May

*et al.* 2019, p. 1039). Even modest increases in warming could result in more runoff in winter and less in spring and summer, more winter flooding, and drier summer soils, thereby altering the seasonality and duration of wetland hydration (Field *et al.* 2017, p. 18). Climate change is expected to lead to increased variability in precipitation and to an increased loss of soil moisture due to evaporation and transpiration (Field *et al.* 2017, p. 18), which may exacerbate effects due to drought. Drought-mediated decreases in water depth and inundation periods could increase the frequency at which wetlands dry before rough popcornflower has completed their flowering and fruiting stages. Climate change could also cause temperatures to exceed those suitable for growth of the species (U.S. Fish and Wildlife Service 2010, p. 28). The expected negative effects of climate change on rough popcornflower include heavier winter rains and limited spring moisture, which would result in decreased fruit production.

## CONSERVATION EFFORTS

Rough popcornflower is a conservation reliant species, meaning that the species will require continued conservation efforts to survive (U.S. Fish and Wildlife Service 2010, p. 30) due to continuous encroachment from natural seral succession (*e.g.* Oregon ash and spreading rush) and non-native invasive plants (*e.g.* pennyroyal and teasel). Since listing the species in 2000, various stakeholders including BLM, City of Sutherlin, DSWCD, ODA, ODOT, TNC, Douglas County, and the Service have been involved in conservation actions for the species.

### Vegetation Control

Mowing is a management tool utilized in rough popcornflower habitat to control competing native plant species and invasive species as well as to prepare for outplanting efforts. The Red Rock Park, Wilbur Mitigation Site, the Southside Swale, and the ODOT Yoncalla South populations are regularly mowed and rough popcornflower populations have expanded. A late summer and fall mowing at Red Rock Park was instrumental in combatting pennyroyal growth throughout much of the site and resulted in the largest ever plant count at this location (U.S. Fish and Wildlife Service 2020, p. 2) (Table 2). The Service funds mowing at the Southside Swale and the TNC Popcorn Swale Preserve to control native graminoids, non-native grass, and pennyroyal.

In the last 15 years, the Service funded various non-native invasive plant and native vegetation management at four rough popcornflower populations (Southside Swale, Red Rock Park, TNC Popcorn Swale Preserve, and Orenco Ponds). The initial results were promising for the four sites, which saw increased population numbers. Non-native and native tree thinning conducted in 2004, at the TNC Popcorn Swale Preserve resulted in the highest number of rough popcornflower plants recorded for the preserve (three years post-treatment). Unfortunately, over time and without further vegetation management, the native and non-native plants (spreading rush and pennyroyal) responded more aggressively than rough popcornflower and encroached on much of the habitat formerly occupied by the plant, leading to an overall population decline. The population is slowly rebounding and TNC has plans to mow the property annually, with the expectation that plants will spread into previously occupied habitat. There is no planning to utilize grazing or prescribed burns for vegetation control at this time.

### **Fencing**

Fencing can protect populations from anthropogenic disturbance. The Sutherlin Red Rock Park rough popcornflower population was regularly affected by horse trampling and used horse bedding was tossed into the wetland area supporting rough popcornflower. The plants were often smothered while competing with aggressive grass and pennyroyal. Since the area was enclosed with fencing and signed with information about rough popcornflower, the plants are no longer subject to trampling and no longer smothered with the bedding and thus are able to grow in denser patches, compete better with the grass and pennyroyal, and occupy more space than prior to fencing.

### **Introductions and Augmentation**

In 1998, before the species was listed, rough popcornflower plants were introduced to three locations on BLM managed lands. Two of the populations were successful and are still extant. Rough popcornflower was also introduced to the Orenco Ponds mitigation site in 2011 on a parcel owned by Douglas County and at a privately held mitigation site in 2001 (ODOT Wilbur Mitigation Site). Rough popcornflower was also successfully augmented at the Douglas SWCD property, the ODOT Wilbur Mitigation Site, and a second ODOT mitigation site (Del Rio Mitigation Site). In 2016, a new population was introduced to the NBHMA (Soggy Bottoms Sister) and is a recovery level population (*i.e.*, greater than 5,000 plants) (J. Brown, pers. comm. 2020).

### **Stakeholder workshops**

Five stakeholder meetings occurred between 2004 and 2016, at which population and species needs, recovery targets, and habitat conservation were discussed. At the most recent meeting, the agencies and landowners indicated that the species was making significant progress in recovery.

### **Conservation Agreements**

Collaboration among stakeholders plays an important role in species management. For example, a Management Plan between the Service, City of Sutherlin, ODA, and Douglas SWCD was finalized to protect and maintain the populations on Sutherlin and Douglas SWCD properties in 2007. For information specific to each reserve and other populations of rough popcornflower, see Appendices 2 and 3.

## **RECOVERY PLAN**

The Service completed a recovery plan for the rough popcornflower on July 28, 2003 (U.S. Fish and Wildlife Service 2003, entire). Between 2003 and 2016, the Service sponsored a series of workshops that included Service and ODA species experts and staff, land managers, and owners of private property with rough popcornflower. These workshops discussed revising recovery criteria as the best available information indicated potential changes to existing criteria (*i.e.*, recovery unit boundaries) and information available to develop delisting goals (*i.e.*, population and distributional information along with advances in reintroduction techniques and available areas). From these workshops, species experts agreed that rough popcornflower populations occurred disproportionately in the Sutherlin Creek Recovery Unit, were rarer in the Callapooya

and Yoncalla recovery units, and that this disparity is most likely reflective of historical wet-swale conditions and abundance of suitable soil types rather than human caused disturbance in other recovery units. The species experts also agreed that the rough popcornflower's successful reintroduction at the BLM's NBHMA (Umpqua Management Area) should contribute to recovery as well. Because of this, it was determined that the original recovery goals should be revisited to reflect more realistic recovery unit areas and abundance and population distribution goals within the units. Further, species experts agreed that because of a few recent successful population reintroduction and augmentation efforts, continuing introductions of populations on protected properties (*e.g.* city, county, private [*i.e.*, with landowner agreements], State or Federal ownership) should be a priority; many of these recommendations were provided in Amsberry and Meinke (2017, p. 48).

Amsberry and Meinke (2017 p. 48) concluded that due to committed efforts by many agencies and non-profit organizations, that the rough popcornflower was moving toward recovery. They considered the increase in species conservation techniques have successfully mitigated the stressors to rough popcornflower and should re-evaluate the recovery plan in light of the nearly two decades of research that have been completed since the species became a focus of ODA's investigations in 1996. In Amsberry and Meinke (2017, p. 48), the authors noted that the species did not meet downlisting criteria for a variety of reasons, including a lack of designated reserves and insufficient population trend information. In 2019, the Service amended the recovery plan to reflect an improved understanding of the species' recovery potential.

The Service's rough popcornflower recovery plan (U.S. Fish and Wildlife Service 2003 and 2019a) developed a strategy to downlist the species by conserving populations throughout its range, conserving genetic diversity, maintaining existing populations within a network of recovery units, and introducing new populations into the natural range of the species. The rough popcornflower recovery plan assigned each known natural population to one of three recovery units. The recovery units correspond to drainage basins within the Lower North Umpqua system, and represent groups of populations, which share phenotypic similarities and are potentially genetically similar to one another. Populations in each recovery unit are also morphologically distinct from those in other recovery units, with some plants larger than other plants; larger plants have a greater tendency to exhibit a perennial life history (U.S. Fish and Wildlife Service 2003, p. 5).

The recovery plan amendment (U.S. Fish and Wildlife Service 2019a) revised the current downlisting criteria and provided delisting criteria below. The new criteria to downlist rough popcornflower from endangered to threatened status are as per the following recommendations:

*Criterion 1. At least 9 reserves, containing a minimum of 5,000 plants each, are protected and managed to assure their long-term survival. A reserve may be composed of one or more patches of rough popcornflower located within 1 km (0.6 mi) of each other.*

**Justification:** Here we do not suggest any changes to the actual metrics, but simply combine two of the original downlisting criteria (Downlisting Criteria 1 and 4). The number of recommended reserves provides redundancy such that rough popcornflower should be able withstand random stochastic events into the foreseen future. A protected, managed

population with 5,000 individuals per reserve will likely contribute to resiliency to withstand stochastic events (Culotta 1995, pp. 31–32; Traill *et al.* 2010, p. 30). The distance of 1 km (0.6 mi) between patches within a reserve will permit pollinator-mediated gene flow or connectivity across the population and between populations (NatureServe 2020, webpage; Kojcik and McBride 2012, p.593), maintaining representation in the form of genetic or ecological diversity. This will enable rough popcornflower to maintain capacity to adapt to future environmental changes.

*Criterion 2. A minimum of 500 m<sup>2</sup> (5,382 ft<sup>2</sup>) is occupied by the rough popcornflower within each reserve. Occupied habitat should be determined by using a GPS device to delineate patches of plant, with the GPS data then uploaded into a GIS program to calculate total area. The maximum allowable location error is +/- 3 m (9.8 ft). For patches too small to be delineated accurately, a GPS point location should be recorded along with a measurement of the occupied area.*

Justification: Nine locations with 500 m<sup>2</sup> (5,382 ft<sup>2</sup>) occupied by rough popcornflower across the species range should address redundancy so that the species would survive a random natural event. In the original recovery plan, Downlisting Criterion 2 called for each reserve to have a minimum area of 50 m<sup>2</sup> (538 ft<sup>2</sup>) of occupied habitat with a minimum density of 100 plants per square meter (11 square feet). Due to an improved understanding of the species, this portion of Downlisting Criterion 2 was determined to be inappropriate given the species' ecology. The perennial life-history strategy of rough popcornflower plants vary by population and larger, perennial plants tend to occur at lower densities than smaller, annual plants, making it more difficult for some populations to meet this recommendation. Plant density also varies annually, with lower densities associated with the perennial life cycle that is promoted during wet years and higher densities associated with the annual life cycle that is favored under dry conditions. Although competition with other plant species is noted as a threat, native and non-native vegetation can co-exist with rough popcornflower within occupied habitat, which results in lower density of rough popcornflower without necessarily posing a problem for its long-term survival. In some cases, the spatial distribution of suitable habitat is diffuse within a site, which can limit the amount of area that is densely occupied. For these reasons, the minimum density recommendation from Downlisting Criterion 2 did not reflect a realistic expectation and is not reflective of desirable conditions. Therefore, it was removed in this modification.

*Criterion 3. A minimum of nine reserves, each meeting the requirements in Downlisting Criteria 1 and 2, are distributed with at least one reserve each in the Calapooya Creek and Yoncalla Creek recovery units, and a minimum of five reserves in the Sutherlin Creek recovery unit. The remaining two required reserves may be located within any of the natural recovery units, or elsewhere within the Lower North Umpqua River (1710030111), Calapooya Creek 6 (1710030301), and Elk Creek (1710030303) Hydrologic Unit Code 10 watersheds containing the recovery units.*

Justification: By ensuring that populations are distributed across the current range of the species, our confidence that the species will persist in the face of catastrophic events (i.e.,

redundancy) increases. The original recovery plan called for an even distribution of reserves across the species' known range. Unfortunately, this did not match the naturally patchy distribution of populations across the species' range, nor did it account for populations outside the known natural range that could be established or in suitable habitat. By accepting the species' range to encompass the full Hydrologic Unit Code 10 watersheds from which the original three recovery units were derived, additional rough popcornflower populations established at the Umpqua Management Area can be considered when assessing recovery of the species. This species status assessment considered the Umpqua Management Area to contribute to rough popcornflower recovery.

*Criterion 4. Over a 5-year period with a minimum of 3 individual years of monitoring, demographic data indicate that at least seven of the nine reserves have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.*

Justification: Stable or increasing populations are an indicator of resiliency. While some inter-annual variability is expected due to demographic and environmental stochasticity, this criterion is intended to provide sufficient confidence that large sustained declines will not occur. The recommendation to conduct monitoring for a minimum of 3 years during the 5-year monitoring period prevents the likelihood of data gaps greater than 2 years and requires close tracking of population trends. Because rough popcornflower is an annual or short-lived perennial, stable or increasing populations indicate sufficient reproduction. Additionally, the rough popcornflower has a high rate of reproduction (Amsberry and Meinke 2017, p. 48), alleviating previous concerns about seed production and recruitment (Amsberry 2002, pp. 13-17). The original Downlisting Criterion 5, as amended, is now Criterion 4 due to combining the original Criterion 4 with Criterion 1, as described above.

The new criteria to delist rough popcornflower are as follows:

*Criterion 1. At least 9 reserves will have established management plans or conservation agreements that include requirements for periodic monitoring and habitat maintenance. Habitat maintenance must prioritize the removal of woody vegetation and non-native invasive plants.*

Justification: Even when reserves are protected from development, woody succession and non-native invasive plants may lead to habitat changes and competition that could result in a loss of resiliency. Agreements to monitor and mitigate these potential problems as well as others will ensure that protected reserves maintain their capacity to support rough popcornflower populations into the near future.

*Criterion 2. Seed accessions need to be collected from all 9 reserves and submitted for long-term storage at a local seed bank repository, with a minimum of 15,000 seeds per reserve stored for use in future augmentations or to re-establish each source population should one ever be extirpated.*

Justification: The collection and long-term storage of seed provides a valuable contingency in the event that one or more populations is extirpated (*e.g.*, seed bank depletion following unfavorable climatic conditions). Stored seed allow for the potential re-establishment or augmentation of rough popcornflower populations, providing additional assurance that resiliency and redundancy are maintained into the foreseeable future. The quantity of seed was based on the amount needed to re-establish an extirpated population to the desired minimum population size of 5,000 plants (assuming a 50 percent germination rate).

*Criterion 3. Over a 10-year period with a minimum of 7 years of monitoring, demographic data indicate that populations in at least seven of the nine recovery reserves have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.*

Justification: Stable or increasing population trends are an indicator of resiliency. While some inter-annual variability is expected due to demographic and environmental stochasticity, this criterion is intended to provide assurance that no large sustained declines are occurring or to provide a warning that a population needs attention. The requirement to conduct monitoring during a minimum of 7 years over the 10-year monitoring period reduces the likelihood of data gaps greater than 3 years and increases confidence that any decreasing trends would be documented.

## ASSESSMENT OF CURRENT CONDITION

Rough popcornflower populations are delineated by habitat patches or occurrences. The populations are distributed across a patchy and fragmented landscape, the former because of the natural distribution of seasonal wet meadow/prairie systems and the latter because years of infrastructure, transportation, and urban/rural development have resulted in lost or compromised habitat. No quantitative viability assessment models have been developed to calculate extinction probabilities for rough popcornflower. In this SSA, we qualitatively evaluate the current resiliency condition of rough popcornflower populations at the scale of the recovery unit area based on the number of individuals, connectivity, habitat quality, habitat quantity, management, reproduction, and the degree of protection afforded to each population. We will give a score for each population in Table 5 below. Rough popcornflower Recovery Units correspond to Callapooya, Lower North Umpqua, Sutherlin, and Yoncalla code 10 hydrologic units (subwatersheds).

### Assessment of Population Viability

For rough popcornflower to maintain viability, its populations or some portion thereof must be resilient. Stochastic events that have the potential to affect rough popcornflower populations include drought, fire, and climate change. Factors that influence the resiliency of populations include habitat area, population size, habitat quality, connectivity, management, protection, reproduction, abundance of insect pollinators, and rainfall. Additionally, secondary factors include agents of seed dispersal (wind, water, mammals, and birds) and temperature for seed germination. Influencing those factors are elements of popcornflower habitat that determine whether populations can grow to maximize habitat occupancy, thereby increasing the resiliency of populations. Reproduction takes into account pollinator success and pollinator abundance. Therefore, we will assume pollinator abundance would be a factor related to habitat quality and connectivity. Rainfall would be nearly equal at each population site because the total range of the species occupies a relatively small and discrete area of Douglas County. We would consider seed dispersal and temperature for seed germination to be similar at all populations.

### Population and Habitat Elements (hereafter Elements) that Influence Resiliency

Population size – In order to have a stable, ongoing population, it is necessary to have a minimum number of plants at all life stages in that population, including seeds in a seed bank, and mature plants. Since rough popcornflower germinates and reaches full maturity each year, we do not need to evaluate the life stages in the population and are using the number of plants as the overall indicator of abundance for popcornflower populations. Without a Population Viability Analysis (PVA) to indicate what an optimal abundance level should be, using our best professional judgement, we consider a population with over 5,000 mature plants to be in high condition, over 1,000 plants to be in medium condition, and under 200 plants to be in low condition. The largest current population (Sutherlin /Horsepasture) has an estimated population size of 700,000 plants with 10 populations currently exceeding 5,000 plants, 5 populations are between 1,000 and 5,000 plants and 2 populations are under 200 plants. However, excluding the Horsepasture 2 population, the remaining extant populations range from 10 – 69,288 plants (Table 2). Some populations may have less than 5,000 plants (medium condition); yet with other

factors taken into consideration such as habitat quantity, habitat quality, connectivity, management, protection, reproduction, may still be considered to have high resiliency. Conversely, some populations may have over 5,000 plants, but could have poor habitat quality, quantity and poor connectivity and be considered to be medium or low resiliency condition score.

**Habitat Quantity** - The development of revised goals for occupied areas within reserves were determined to be 500 m<sup>2</sup> (5,382 ft<sup>2</sup>) as measured by current technology, such as GPS. Therefore, using our best professional judgement, based on population field monitoring data (Amsberry and Meinke 2017, p. 5; US Fish and Wildlife Service 2019a, p. 5), we consider a population area greater than 500 m<sup>2</sup> to be high condition for these population complexes, from 250–500 m<sup>2</sup> to be moderate condition, and less than 250 m<sup>2</sup> to be low (poor) condition. At the time of this report, 8 rough popcornflower populations occupy 500 m<sup>2</sup> (5,382 ft<sup>2</sup>) or more (Amsberry and Meinke 2017, p. 6; US Fish and Wildlife Service 2020, entire) (Table 2).

Suitable rough popcornflower habitat may be occupied by a number of species, which may compete with the plant for moisture, space, and light. At one of the largest rough popcornflower populations, there is poor native plant diversity, but active disturbance associated with horse and cattle grazing occurs on a regular basis and helps support the population by restricting competition. At the TNC Popcornswale Preserve, a few non-native invasive plants are encroaching on the habitat, but native plants far exceed non-natives in abundance and variety. 13 of the 18 known rough popcornflower populations have stable or increasing numbers.

**Connectivity** – Connectivity among populations and between patches is necessary to ensure rough popcornflower genetic exchange. The degree of connectivity is related to the efficiency of pollinators, probability of fertilization, and genetic diversity as well as spatial distance among patches and populations. The Rough Popcornflower Recovery Plan recommends that populations or patches occur within 1 km (0.62 miles) to provide adequate connectivity (US Fish and Wildlife Service 2003, p. 23). Although some populations are within 1 km, they may be separated by barriers such as development, roads, or expanses of non-suitable habitat. For the purposes of this analysis, we designate a high connectivity of patches and populations that are within a 950 m (3,117 ft) area. Habitat with moderate connectivity would include patches within an average distance of 951 to 1,500 m (3,120 to 4,921 ft). Habitat with low connectivity would include patches separated by more than 2000 m (6,562 ft) to the nearest neighbor.

**Management** – Rough popcornflower requires some form of management to enable habitat conditions to remain suitable and thus provide resiliency for this species. Various native and non-native invasive plants continuously colonize most suitable habitat occupied by rough popcornflower and will encroach on occupied habitat if provided no maintenance activities. High quality active management can include periodic mowing, targeted non-native plant removal, prescribed fire, grazing, or incidental disturbance caused by vegetation control or grazing activities. For the purposes of this analysis, we would designate a high degree of management for populations that receive regular continuous, annual, or biennial management, for a medium degree of management; populations would receive management every three to five years. For a low degree of management, populations would receive management activities more than five years apart to no management.

Protection – Protected populations are typically populations that occur on properties owned and managed by a public entity such as the BLM, ODOT, Douglas County, or the City of Sutherlin. The Nature Conservancy property that maintains a rough popcornflower population is included in our assessment of a protected population. Other properties that we can consider protected are ones with conservation easements, restrictive covenants, or other agreements. We may consider a property under a protected status if it can be demonstrated that the property has maintained a rough popcornflower population for sustained period of time and the property owner has no plans to sell or develop the land in the near future. We rank popcornflower populations on protected habitat with a 1 (yes) and unprotected habitat is ranked as 0 (no).

Habitat Quality – The most important factors that can limit popcornflower populations are the availability and quality of suitable habitat. The indicator of population viability is suitable habitat associated with native plants and a low degree of non-native invasive plants such as reed canary grass, pennyroyal, meadow knapweed and Armenian blackberry. Unfortunately, the majority of known populations are competing with at least one aggressive non-native plant species. Native plants such as spreading rush and Oregon ash can encroach on occupied rough popcornflower habitat as well. The most successful plant populations tend to be ones that have regular management to control both the non-native and native plants and encourage abundant germinate and unrestricted growth of rough popcornflower. We rank popcornflower populations as high quality habitat when they have no presence of non-native invasive plants and are dominated by native species; medium quality habitat is designated with only 1 or 2 non-native invasive species and occupied by a majority of native species. A population considered to have low quality habitat would have almost no native plants and be dominated by non-native invasive plants.

Reproduction – For annual plants, reproductive success dictates that plants must produce a large number of viable seeds, that the seed must have the right conditions for germination, and that these seedlings have the necessary habitat elements to allow them to grow to maturity. An increasing population trend would indicate that mature plants are producing an abundant number of seeds, that there is an adequate, viable seed bank, that conditions exist such that germination is effective, and that the habitat needs of the plants are being provided. An optimal (high) reproduction condition could be demonstrated as an increasing or stable population trend (over 5,000 plants) and well as repeated observations of high seed production (100 percent). A medium reproductive condition would be inferred either by a more fluctuating population trend, with lower population trend (under 5,000 plants, but higher than 3,000 plants) or by lower seed production 75 – 99 percent). A declining population trend below 3,000 plants or a seed production from 0 to 74 percent would demonstrate a low reproduction condition. In the case of rough popcornflower, field monitoring typically detects the percent of flower plants during the peak flowering season, but seed set is rarely documented during field surveys. In the case of annual plants, such as rough popcornflower, flower and seed production are typically accomplished during years of appropriate precipitation, ensuring a maximum reproductive effort with abundant seed set.

## Methodology

To summarize the overall current resiliency of rough popcornflower populations, we ranked most of the population factors and habitat elements discussed above into three condition categories (high, moderate, and low) or yes and no categories for protection, based on the three population factors and six habitat elements discussed above. The current condition category is a qualitative assessment of the likelihood of persistence based on the analysis of the three population factors and seven habitat elements.

We gave a numerical value to the habitat factors of 3 to each high condition, 2 to each moderate condition, 1 to each low (poor) condition. The Horsepasture 2 population has the highest number of individuals of any rough popcornflower population and high connectivity; we consider this population to be an overall high condition population. Since we do not have a PVA, we used the Soggy Bottoms Sister population as a benchmark for overall condition, and we considered an average score of 3 or greater to be high overall condition, 2 to be moderate overall, 1 to be low (poor) overall condition. Table 5 displays the rankings for each habitat element.

To summarize the cumulative habitat element scoring, we considered how the overall condition of a population would translate into likelihood of persistence over approximately 30 years. We use a percentage-based system to approximate our best professional judgement based on habitat and population factor assessments. As shown on Table 5, for populations with a cumulative total of all habitat elements scale of 16-19, we estimate that the probability of persistence over the next 30 years would be high (in other words, a low probability of extirpation). For populations in moderate condition (a scale of 12-15), we estimate that the probability of persistence over approximately the next 30 years would be moderate. For populations in low (poor) cumulative habitat condition (with a score of 6 to 11), we estimate a low probability of persistence over 30 years (the lowest probability of extirpation). Of the 18 total populations, 11 had a higher probability of persistence, 3 had a moderate probability of persistence, and 4 had a low expected persistence over the next 30 years.

**Table 5. Rough popcornflower Habitat Element Viability Assessment Scores.** Explanation of Habitat Element Assessment – The seven-habitat element viability assessment provides our rationale for determining the resiliency of each population. For each habitat element, we assigned a high ranking score of 3, a medium ranking a score of 2, and a low ranking a score of 1. The highest possible score is 19 and lowest possible score is 6.

| Population                       | Population Size | Habitat Quantity | Connectivity | Management | Protection | Habitat Quality | Reproduction | Total Score | Overall Resiliency |
|----------------------------------|-----------------|------------------|--------------|------------|------------|-----------------|--------------|-------------|--------------------|
| Horsepasture 2                   | High            | High             | High         | High       | Yes        | High            | High         | 19          | High               |
| TNC/ODOT Del Rio Mitigation Site | High            | Medium           | High         | High       | Yes        | Medium          | High         | 17          | High               |
| ODOT Wilbur Mitigation Site      | High            | High             | Medium       | High       | Yes        | Medium          | High         | 17          | High               |
| Hawthorne                        | Low             | Low              | High         | Low        | No         | Low             | Low          | 8           | Low                |
| Orenco Ponds                     | High            | High             | High         | Medium     | Yes        | Medium          | High         | 17          | High               |
| Red Rock Park                    | High            | High             | High         | High       | Yes        | Medium          | High         | 18          | High               |
| Southside Swale                  | High            | High             | High         | Medium     | Yes        | Medium          | High         | 17          | High               |
| Ford's Pond                      | Medium          | Medium           | Medium       | Medium     | Yes        | Medium          | High         | 14          | Moderate           |
| Stearns Lane                     | Low             | Low              | Medium       | High       | No         | Low             | High         | 11          | Low                |
| Nonpareil                        | High            | High             | Low          | Medium     | No         | Low             | High         | 13          | Moderate           |
| Soggy Bottoms/NW Youth Corps     | Medium          | Medium           | High         | High       | Yes        | Medium          | High         | 16          | High               |
| Soggy Bottoms Sister             | High            | High             | High         | High       | Yes        | High            | High         | 19          | High               |
| Westgate                         | High            | Medium           | Low          | High       | Yes        | High            | High         | 16          | High               |
| ODOT Yoncalla South              | High            | Medium           | High         | High       | Yes        | Medium          | High         | 17          | High               |
| ODOT Yoncalla 2                  | High            | High             | High         | High       | Yes        | High            | High         | 19          | High               |
| Deady                            | High            | Low              | High         | Low        | No         | High            | High         | 14          | Moderate           |
| Sutherlin East                   | High            | Low              | Low          | Medium     | No         | Low             | Medium       | 10          | Low                |
| Goat Ranch                       | Low             | Low              | Low          | Low        | No         | Low             | Low          | 6           | Low                |

Since the plant was listed as endangered in 2000, the number of documented rough popcornflower populations has increased from 8 to 18. The increase in the number of populations is a result of documenting new or previously unknown populations as well as the establishment of new populations via outplanting. This increase in the number of populations also has expanded the species known range. As recently as 2020, 5,000 or more individuals have been documented at 10 of these populations and an overall 883,154 plants.

## Species-level Assessment

### Species Representation

Maintaining representation in the form of genetic or ecological diversity will maintain rough popcornflower capacity to adapt to future environmental changes. An abundance of insect pollinators and habitat connectivity leads to genetic diversity by the process of cross-pollination between patches within a population. There is a need to maintain the genetic variation between populations as their potential genetic and life history attributes may buffer the species to adapt to environmental changes over time. At this time, we do not know the degree of genetic variation among rough popcornflower populations and whether connectivity and active genetic exchange is occurring across populations and within patches or within populations. Most rough popcornflower populations are not isolated from one another by over 2.0 km (1.24 miles) and it is assumed that gene flow occurs among the majority of the population.

### Species Redundancy

Rough popcornflower requires multiple resilient populations distributed throughout its range to provide for redundancy. The more populations, and the wider the distribution of those populations, the more redundancy the species will exhibit. Redundancy reduces the risk that a large portion of the species' range will be negatively affected by a catastrophic natural or anthropogenic event at a given point in time.

### Callapooya Creek Recovery Unit

The Callapooya Recovery Unit currently includes three rough popcornflower populations (Table 2). The largest population (Nonpareil) in this unit is located in the eastern portion of the recovery unit east of Sutherlin. It numbers approximately 6,000 plants and occurs on multiple privately owned rangelands. This population, first reported in 1932, has persisted over decades. The site occurs across several properties that are alternately grazed, rested, or graded which at least on one or more properties, provides disturbance, allowing plants to have a competitive advantage over invasive and native vegetation. The site is not observed consistently.

A publically protected population discovered in 2017, on municipal land west of Sutherlin (Ford's Pond site) currently supports approximately 950 plants. This population, which occurs on a dike adjacent to Ford's Pond, has increased each year since its discovery and we anticipate will continue to increase due to favorable habitat conditions. The City of Sutherlin has plans to build a recreational path around the lake and intends to avoid existing rough popcornflower patches (B. Meiering, pers. comm. 2020).

The Stearns Lane population, which was documented in 1997, occurs on private land, near Ford's Pond, and consistently supports approximately 175 plants. The site is periodically mowed which helps maintain this small population at a site with low quality habitat.

### **Sutherlin Creek Recovery Unit**

The Sutherlin Recovery Unit includes the six largest rough popcornflower populations, most exceeding 5,000 plants each, and one smaller population (Hawthorne) near Sutherlin and Wilbur. The Unit includes five protected populations and two on private lands with land use practices compatible with rough popcornflower. The populations collectively support 813,623 plants and occur on State, Municipal and privately owned lands, one of which is owned by TNC. Near Wilbur, there are two additional populations that are managed by ODOT and TNC. Three populations, Horsepasture 1, Sheep Meadow, and Val Street are extirpated.

### **Yoncalla Creek Recovery Unit**

The Yoncalla Recovery Unit currently includes two rough popcornflower populations, near Yoncalla, which number 6,123 (Yoncalla South) and 14,248 (Yoncalla 2) plants. The Unit includes one population with 5,000 plants. The populations occur in the most northern extent of the rough popcornflower range and are both managed and protected by ODOT. The Yoncalla North population was documented in 1939, but is now extirpated.

### **Umpqua Management Area**

Three reintroduced rough popcornflower populations were established in the BLM managed NBHMA via outplanting. Two of these populations supports over 5,000 individuals. The other population at NBHMA supports approximately 3,363 (Soggy Bottoms/ Northwest Youth Corps [NWYC]) individuals. The reintroduced Powerline population became extirpated in 2012, due to lack of available moisture. The three surviving populations are afforded long-term protection by BLM. BLM regularly monitors the populations and performs vegetation management to control encroachment of invasive non-native plants.

Based on the most current data, we have determined a high levels of species resiliency due to 10 of the populations meeting 5,000 or more individuals, redundancy due to the distribution of the populations within the species range, and representation due to the distribution of recovery level populations across four hydrologic units.

### **Resiliency**

Here, we determined the resiliency of rough popcornflower populations using population size, current habitat conditions, protections from development impact, and site management for restoration and maintenance of appropriate habitat condition. Consistent, long-term monitoring data are not currently available for the majority of rough popcornflower populations, and was not a component of our resiliency assessment, although these data are available for a limited number of sites (see Appendix 2).

Based on Traill *et al.* 2010, (p. 30) and expert opinion, the Service determined that a rough popcorn flower population size of 5,000 or more individuals constitutes a resilient population (See Recovery Plan section). Overall, we estimate the species' total size to be in excess of 883,154 individuals. This estimate is primarily attributed to a single population (Table 2 [Horsepasture 2]) located on a privately owned parcel. The viability of the species (meeting

population targets with multiple resilient populations distributed throughout its range) is not strictly dependent on this population. This population is currently managed appropriately using strategic grazing and other best management practices. However, long-term management agreements are not in place but establishing such agreements is a priority for the species' conservation. Without the population, we would still have approximately an excess of 200,000 individual rough popcornflower plants. The 9 protected reserve level populations together with 4 additional non-declining populations (Ford's Pond, Soggy Bottoms Sister, Soggy Bottoms/NWYC, and Stearns Lane) are well-distributed across the species' range. Based on the best available information, at least 14 of the 18 populations are contributing to the recovery of the species.

Based on the number of extant populations, their size, habitat condition, and protection status, it is likely that 11 of the 18 known rough popcornflower populations are resilient and would survive most random environmental events. The remaining seven populations would not meet our resiliency standard.

#### Redundancy and Representation

Redundancy is a species' ability to withstand catastrophic events and is a function of the number and resilience of populations, as well as their distribution and connectivity. The distribution across the range of the species of the 11 resilient populations satisfies the species' redundancy standard and 10 of these are managed specifically as reserve populations or are protected. Securing additional populations will ensure greater redundancy and buffer against potentially catastrophic events. The distribution of the remaining seven populations also contribute to the species' redundancy, but they do not meet our resiliency standard and for the two on private lands, we do not know if they will receive protection into the future.

Our analysis indicates that stressors to rough popcornflower have decreased since listing. Twelve populations (of 18) receive some degree of protection from habitat loss and fragmentation. Succession and competition from invasive plant species continue to threaten the species, but 12 populations receive some form of habitat management, such as mowing, grazing, prescribed burning, or invasive plant control. As this is a conservation reliant species, regular ongoing, management is necessary to maintain habitat quality and thus future resiliency (Appendices 2 – 4).

#### Representation

Representation is the ability of a species to adapt to change, and is assessed using geographic, genetic, ecological, and niche diversity data. Recommendations to increase representation include having nine populations distributed in the Elk Creek, Umpqua, and Lower North Umpqua watersheds - these correspond to Yoncalla, Callapooya, and Sutherlin Creek recovery units and includes the Umpqua Management Area. Currently, there are eight populations meeting recovery criteria in these three recovery units. Having multiple genetically diverse populations within two of the southern recovery units and NBHMA will facilitate the preservation of the genetic diversity present within each unit. The two ODOT Yoncalla populations are isolated from the southern portion of the species' range by approximately 16 km (10 mi), which will deter genetic exchange with the other populations. Although a low level of genetic differentiation among populations is not unusual for endemic taxa (Crawford et. al. 2001, p. 2195), evidence of allelic diversity occurs in most populations of rough popcornflower

(Amsberry and Meinke 2017, p.32). Genetic differentiation can be inferred based on the different plant growth forms and phenologies between the Yoncalla populations and the rest of the populations. Although only 6 of the 18 extant populations have fewer than 5,000 plants and could have low genetic variation, the presence of a wide variety of pollinators assist in gene transfer and could boost the genetic variation of these populations. Small populations that are isolated from other populations may be able to persist if they possess a sufficient level of genetic diversity (Lande *et al.* 1995, p. 788).

In conclusion, the species retains a distribution that is analogous to its historical range within the three recovery units. Populations currently occur in Yoncalla Creek, Callapooya Creek, Sutherlin Creek, and the Lower North Umpqua watershed, with the Sutherlin Creek subwatershed including about half of the populations likely due to the better quality habitat conditions. Overall, based on the best available information on population characteristics, most populations occurring in recovery units as well as in the Umpqua Management Area are resilient. These populations also reflect adequate redundancy, with multiple populations occurring in two of the three recovery units. Measures of representation also appear sufficient, with natural and reintroduced populations distributed across the species' historical range (Table 6).

**Table 6. Summary of current conditions of rough popcornflower.**

| Individual                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Population                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Species                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Overall, individuals are healthy and producing seed each year, but are challenged by resource competition from invasive non-native plants such as pennyroyal and reed canarygrass and the seral succession of native graminoids and trees.</li> <li>Active habitat management is occurring and maintaining many of the populations. However, two populations, the TNC popcorn swale preserve and Southside Swale, are overgrown with native grasses and graminoids and would benefit from mowing or disturbance.</li> </ul> | <ul style="list-style-type: none"> <li>Although the number of populations may fluctuate from year to year, the majority of the 18 extant populations have thousands of reproductive individuals with evidence of cross-pollination occurring. A long-term, downward declining trend has only been documented in one populations (Hawthorne) due to changes in hydrology.</li> <li>Eleven of the 18 extant populations meet or exceed the resiliency criterion size of 5,000 individuals (see Appendix 1). Nine of these are protected (including ones with no plans for development) and receive habitat management.</li> <li>Eight populations cover a minimum of 500 m<sup>2</sup> (5382 ft<sup>2</sup>) (Table 2).</li> <li>Populations are distributed in the Yoncalla, Sutherlin, Yoncalla Creek subwatersheds and the Lower North Umpqua watershed. This distribution represents what we know as the full historical range of the species.</li> <li>No population trends associated with climate change have been detected or documented.</li> </ul> | <ul style="list-style-type: none"> <li>Representation: The species is distributed in the Yoncalla, Sutherlin, Yoncalla Creek subwatersheds and the Lower North Umpqua watershed. This distribution infers ecological diversity and infers genetic variation based on habitat differences; differences in annual and biennial life histories; and form.</li> <li>Thirteen of 18 populations show generally stable or improving trends in last 10 years.</li> <li>Redundancy: Currently each of the three recovery units contain a minimum of two populations, with the Sutherlin Creek Recovery Unit having eight populations. Although not all populations in the species range have a population size of 5,000 plants, they are distributed over a larger landscape which increases the probability the species will be able to withstand potential catastrophic events. One viable and stable population occurs outside the recovery units.</li> <li>Resilience: 10 of the 18 extant populations meet the resiliency standard of 5,000 or more plants.</li> </ul> |

## VIABILITY - Future Species Condition Scenarios

For the purpose of this analysis, we define the viability of rough popcornflower as its ability to persist in the wild for a 30-year period. We concluded that 30 years is a reasonable timeframe to make reliable predictions about the status of the species and its response to future stressors.

Our viability assessment (Shaffer and Stein 2002, pp. 139–140; Wolf *et al.* 2015, entire; Smith *et al.* 2018, pp. 304, 306–307) is characterized in terms of the resiliency, redundancy, and representation of the species as projected under various plausible future conditions. We project the viability of rough popcornflower from 2020 to 2050 under three possible future scenarios based on anticipated trends with partners, climate patterns, and population demographics. The “better than expected” scenario represents improvements over current conditions. The “moderate” scenario represents the most likely conditions if current trends continue. The “worse than expected” scenario represents conditions that are worse than current conditions. Below, we describe the relevant characteristics of these scenarios, and subsequently, their population-level effects (in terms of viability) as well as the likelihood that the suggested scenarios will occur (Table 7).

### **Better than Expected Scenario**

*Conservation support:* Government agencies, conservation organizations, colleges, local schools, and private landowners collaborate and contribute sufficient resources to conserve rough popcornflower and its habitats. Private landowners throughout the species’ range are aware of the species and enthusiastically support its conservation, permitting plants to be outplanted in suitable habitat. Development projects are evaluated and modified, if necessary, to avoid detrimental impacts to rough popcornflower and its habitats (Table 7).

*Surveys:* Qualified botanists obtain access to survey most parcels with the highest likelihood of supporting the species. Rough popcornflower population monitoring results in better understanding of the species’ ecology, management, abundance, genetics, and refine its historical range.

*Geographic range:* Although the range is not expected to expand, several new extant rough popcornflower populations are documented within the range of potential habitats that previously were not accessible.

*Habitat management:* Extant populations are managed appropriately. This may include prescribed burning, mowing, manual or chemical control of non-native herbaceous plants and other practices to maintain a high diversity of native plants and healthy pollinator populations. Pennyroyal, teasel, and reed canarygrass are consistently controlled as needed using proven techniques.

*Population management:* Demographic trends are monitored at all populations. Observed stressors, such as competition with Oregon ash trees, spreading rush, pennyroyal, reed canary grass encroachment, or excessive livestock grazing, are mitigated or prevented before populations are significantly impacted. Small, declining populations are recovered through facilitated outplanting or other effective practices.

*Climate change:* Under scenarios where greenhouse gas emission level (leveling off scenarios) by mid-century, Oregon's average temperatures are expected to warm 1.11 – 2.77 °C (2–5 °F) by the 2050s and 1.11 – 3.88 °C (2–7 °F) by the 2080s, and as much as 7.6 °C (13.7 °F) during the summer (Dalton *et al.* 2017, p. 8). In this report, annual precipitation is projected to increase slightly, although with a high degree of uncertainty. Summers are expected to warm more than the annual average and are likely to become drier. Extreme heat and precipitation events are expected to become slightly more frequent (Dalton *et al.* 2017, p. 8). The effects of climate changes on rough popcornflower habitats could be relatively moderate since the plant seeds are able to delay germinating during unsuitable conditions and due to their buoyancy, may tend to congregate in the wetter parts of their habitat. With the help of ungulates, other mammals or birds, seed could be distributed to suitable areas. The plants could also adjust to warmer temperatures by flowering and producing earlier fruit. Populations would likely occupy moister habitat gradients. The species would continue to survive within the three recovery units and the introduced populations at the Umpqua Management Area.

**Table 7. Future viability for rough popcornflower under considered plausible scenarios.**

| <b>Viability Elements</b>        | <b>Scenarios</b>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                             |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                  | <b>Better than Expected</b>                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Moderate</b>                                                                                                                                                                                                                                | <b>Worse than Expected</b>                                                                                                                                                                                                                                  |
| Population Resilience            | Reserve populations ( $\geq 12$ ) meet or exceed criterion of $\geq 5,000$ individual plants and show stable or positive demographic trends. The population number is 25. Stable or increasing population counts occur 8 out of 10 years.                                                                                                                                                                                      | Reserve populations ( $\geq 10$ ) meet or exceed criterion of $\geq 5,000$ individual stems and show stable or positive demographic trends. The total population number is 20. Stable or increasing population counts occur 7 out of 10 years. | Reserve populations ( $\geq 8$ ) meet criterion of $\geq 5,000$ individual stems and show irregular demographic trends. The total population number is 18, but 4 populations are declining. Stable or increasing population counts occur 6 out of 10 years. |
| Species Redundancy               | 25 populations occurring across the range of the species would allow the species to withstand catastrophic events.                                                                                                                                                                                                                                                                                                             | Redundancy is provided by having 20 populations present across the range to withstand catastrophic events.                                                                                                                                     | Redundancy is present due to 18 populations occurring across the geographic range of the species. Declines in populations are occurring, due to poor adaptability to sporadic climate shifts, but most populations remain intact.                           |
| Species Representation           | 25 populations, distributed across the range would provide genetic and ecological diversity for the species.                                                                                                                                                                                                                                                                                                                   | 20 populations, distributed across the range of the species would provide genetic and ecological diversity for the species. Evidence of inbreeding depression is rare.                                                                         | 18 populations, distributed across 3 of the 4 watersheds would provide for minimal genetic and ecological diversity for the species. However, evidence of inbreeding depression is present in some of the smaller populations.                              |
| Overall Viability                | Excellent: Species is resilient from stochastic variability due to ample redundancy and at least 12 populations are reserve status. Habitat management plans are in place for the populations and funding is available. Management will be needed unless populations are located in habitats where key natural ( <i>e.g.</i> , flooding, maybe fire) or introduced ( <i>e.g.</i> , grazing) disturbance processes are present. | Moderate: The species is able to adapt to climate change and species received adequate monitoring to inform management needs. Species requires continued management.                                                                           | Poor: Continued management falls short, resiliency is reduced in 10 of the 18 populations and declining populations due to irregular climate patterns result in a steady decline.                                                                           |
| Likelihood of Scenario occurring | Likely: Based on additional funding for outplanting, native and invasive vegetation control, and increased stakeholder and partner conservation efforts.                                                                                                                                                                                                                                                                       | More likely: Based on current agency commitments, outplanting successes, ability to place conservation agreements, staffing levels, current regulations, genetic diversity and distribution, and demographic trends.                           | Less likely: A reduction in agency commitments, long-term demographic declines, and poor outplanting results. Based on past and present trends, we believe this scenario is less likely.                                                                    |

*Resiliency:* Within 30 years, 12 populations (Red Rock Park, ODOT Wilbur Mitigation Site, Orenco Ponds, TNC Popcorn Swale Preserve, Southside Swale, Westgate, Yoncalla 2, Yoncalla South, Horsepasture 2, and three more) support 5,000 or more individuals and persist in the Sutherlin and Yoncalla Creek Recovery Units while an additional two populations persist at the Umpqua Management Area. The larger Horsepasture 2 population and portions of the Nonpareil population are protected by public ownership or a conservation easement. The Ford's Pond and Nonpareil populations in the Callapooya Creek Recovery Unit continue to increase in the number of individuals and occupied area. The protected and unprotected populations continue to survive, and exhibit consecutive years of stable or increasing population numbers (8 out of 10 years), although, infrequently lower numbers are documented in some years (2 out of 10 years). It is reasonable to assume that habitat maintenance activities will continue at each site.

*Redundancy:* The number of rough popcornflower populations increase to 25 as a result of documenting new populations and from introductions within the range of the species in each of the Yoncalla, Callapooya, and Sutherlin Creek Recovery Units. New populations are introduced in the Yoncalla, Callapooya, and Sutherlin Creek Recovery Units at protected sites.

*Representation:* Protected rough popcornflower populations are distributed in all recovery units, although still concentrated in Sutherlin Creek, but with better representation in Yoncalla and Callapooya Creek Recovery Units. Rough popcornflower populations continue to exhibit morphological variation within populations and between populations, which will presumably allow them to adapt to habitat or climate changes with appropriate management. Genetic variation is maintained within all populations across the range of the species with no evidence of inbreeding depression or genetic drift.

### **Moderate Scenario**

*Conservation support:* Government agencies, non-profit conservation organizations, academic institutions, and private landowners collaborate and contribute some conservation resources to rough popcornflower and its habitats. Public outreach increases awareness of the species among private landowners and generates increasing support for conservation. Development projects are evaluated and modified, if necessary, to minimize or mitigate impacts to rough popcornflower and its habitats (Table 7).

*Surveys:* Qualified botanists obtain access to survey a representative sample of the highest-potential habitats mostly on public lands. Adequate rough popcornflower population monitoring results in a better understanding of the species' management.

*Geographic range:* Two new extant rough popcornflower populations are documented within the range of potential habitats in either Callapooya, Sutherlin or Yoncalla Recovery Units.

*Habitat management:* All protected populations are managed appropriately. This may include prescribed burning, shrub thinning, mowing, manual or chemical control of non-native herbaceous plants and other practices to maintain a high diversity of native plants and healthy pollinator populations.

*Population management:* Populations are monitored at least every three years to track demographic trends. Observed threats, such as ash tree or reed canary grass encroachment or excessive livestock grazing, are mitigated or prevented before populations are significantly impacted.

*Climate change:* The 3rd Oregon Climate Assessment Report estimates that under a continually increasing greenhouse gas emission scenario, Oregon's climate is projected to warm on average 1.67-3.88 °C (3–7 °F) by the 2050s and 2.77 – 6.1°C (5–11 °F) by the 2080s (Dalton *et al.* 2017, p. 8). In this scenario, the amount of annual precipitation is projected to be highly uncertain. Summers are expected to warm more than the annual average and are likely to become drier. Extreme heat and precipitation events are expected to become more frequent (Dalton *et al.* 2017, p. 8). The effects of climate changes on rough popcornflower habitats may be relatively moderate and most plants would likely adjust to warmer temperatures by dispersing to moister habitats, flowering earlier, and shortening their flowering period. Climate change may limit rough popcornflower's growing season and habitat as well as moisture availability. Populations would likely occupy moister habitats. The species would continue to survive within the three recovery units and the introduced populations at the Umpqua Management Area.

*Resiliency:* Within 30 years, 10 reserve-level populations persist in Sutherlin, Callapooya, and Yoncalla Creek Recovery Units and the Umpqua Management Area. The Ford's Pond population and a newly introduced population in the Yoncalla Creek Recovery Unit support 5,000 or more individuals and continue to be protected. The protected populations continue to survive, but exhibit fluctuations in population counts in seven out of 10 years. Habitat management continues to occur infrequently at each site, leading to increased competition and reduced populations.

*Redundancy:* Protected rough popcornflower populations are distributed in all recovery units, with an increase of five newly discovered or established populations for a total of 18 in the range of the species.

*Representation:* Rough popcornflower populations are well distributed across the three recovery unit/subwatersheds (Yoncalla, Callapooya, and Sutherlin Creek) and Umpqua Management Area. Based on evidence in the field, no evidence of inbreeding depression or genetic drift has been detected in any of the populations (Amsberry and Meinke 2017, p. 2).

### **Worse Than Expected Scenario**

*Conservation support:* Government agencies, non-profit conservation organizations, collegiate institutions, local schools, and private landowners collaborate less and only partially contribute resources for rough popcornflower conservation. No privately owned populations come into protected status via conservation easements and conservation minded landowners do not seek to protect their land. Private landowners aware of the species develop their land for agriculture or housing. Development projects within rough popcornflower habitat are not evaluated prior to implementation and the majority of suitable habitat is lost (Table 8).

*Surveys:* Qualified botanists are only able to access limited habitats within portions of the species range.

*Geographic range:* No new rough popcornflower populations are documented throughout its range.

*Habitat management:* Populations are not managed appropriately. Mowing rarely occurs and herbicide control of non-native invasive plants within rough popcornflower habitat is focused on managing agricultural or landscaping projects.

*Population management:* Monitoring rough popcornflower populations occurs two to three times within a 10-year cycle. Observed threats, such as ash tree, spreading rush, or reed canary grass encroachment or excessive livestock grazing, are not documented until they have damaged rough popcornflower habitat. Appropriate management provides necessary benefits. Small, declining populations are lost due to a lack of facilitative outplanting.

*Climate change:* For the purposes of this report, under an anticipated heightened greenhouse gas emission scenario, Oregon's climate is projected to warm between 1.67–3.88 °C (3–7 °F) by the 2050s and 3.88–7.22 °C (7–13 °F) by the 2080s (Dalton et al. 2017, p. 8). We assume that annual precipitation is projected to become more sporadic. Summers are expected to have higher average annual temperatures and likely would become drier. Extreme heat and precipitation events are expected to become more unpredictable. The effects of climate change on rough popcornflower habitats may be severe but based on evidence in the field (Amsberry and Meinke 2017, p. 10) the plants would likely partially adapt to the warmer temperatures by dispersing to moister gradients in drier years and dispersing to less moist gradients in cooler moister years. Plants would have a shortened flowering period in some years.

*Resiliency:* Within the 30-year worse than expected scenario, only nine rough popcornflower populations (Red Rock Park, Orenco Ponds, Westgate, Yoncalla 2, Yoncalla South, Horsepasture 2 and Wilbur) support 5,000 or more individuals, due to a drier climate and shortened flowering periods. The Ford's Pond, Hawthorne, Stearns Lane, and TNC popcorn Swale Preserve populations decline below what is considered viable. Only one new population is established in the Yoncalla Creek Recovery Unit under public ownership or under a conservation easement. The protected and unprotected populations continue to survive, but habitat is invaded by non-native invasive plants and populations are viability in 6 of 10 years. Habitat maintenance activities decrease, but continue sporadically at seven of 18 populations.

*Redundancy:* The number of populations remain at 18. A new population established in the Yoncalla Creek subwatershed offsets an extirpated population in the Sutherlin Creek subwatershed. Due to a drier and more sporadic climate, smaller populations decline and only the larger populations remain resilient. The new Yoncalla Creek Recovery Unit does not reach 5,000 individuals. No other new populations are established or discovered.

*Representation:* Protected rough popcornflower populations remain distributed in all recovery units, with the biggest concentration in the Sutherlin Creek subwatershed. A loss of one population occurs in the Sutherlin Creek subwatershed, but the remainder of the populations continue to persist. In the larger populations, plants are able to adapt to the sporadic climate of drier summers and more sporadic precipitation. In the smaller populations, plants begin to

exhibit less within population phenotypic diversity, but the northern populations exhibit no changes in morphologic variation. Some evidence of inbreeding depression or genetic drift is documented in the four smaller populations.

### **Summary**

The most likely scenario is the moderate scenario. We estimate that government agencies, non-profit conservation organizations, academic institutions, and private landowners will continue to collaborate and contribute some conservation resources to rough popcornflower and its habitats. Public outreach is likely to support awareness of the species among private landowners and the public. This will continue to generate support for conservation. Development projects will be evaluated and modified, at least by the Service, the Oregon Department of State Lands and the ODA, to minimize or mitigate impacts to rough popcornflower and its habitats. We will continue to ensure that at least 8 populations are monitored regularly and with ‘good’ precision and confidence value. We estimate that a few populations will be reintroduced and other populations will be augmented to improve resiliency and do not expect any protected populations to become extirpated.

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## APPENDIX 1. Definitions

**Confidence Value:** We use the Confidence Value in this SSA to denote reliability or trust of given quantity. A value of 0 to 0.25 indicates a low monitoring confidence score; a value of 0.26 to 0.50 indicates a medium monitoring confidence score; and a value of 0.51 to 1 indicates a high confidence score in monitoring.

**Downlisting and Delisting Criteria:** The 2003 recovery plan identified four criteria to downlist rough popcornflower from endangered to threatened status. These criteria have been revised<sup>1</sup> and are presented on pages 25-27. Delisting criteria were not presented in the 2003 recovery plan because the Service did not consider it possible to delist rough popcornflower at the time, since the species occupied such a limited geographic range with a rather limited distribution and population density<sup>1</sup>. The Service accepted four criteria to delist rough popcornflower and these are presented on pages 27-28 (U.S. Fish and Wildlife Service 2019a).

**Extirpated:** No plants have been detected from a population after three seasonal visits.

**Foreseeable:** This term indicates what can be predictable. "Foreseeable future" is a term that describes the extent to which the Secretary can reasonably rely on predictions about the future in making determinations about the future conservation status of the species.

**Minimal Viable Population:** Based on studies by Lande (1995) and Lynch *et al.* (1995) we have recommended the recovery level population size for rough popcornflower as 5,000 plants per population. This figure is based on the authors' suggestion that in most cases, 5,000 individuals in a population, is necessary to maintain above normal levels of potentially adaptive genetic variability under a balance between mutation and random genetic drift. The authors suggested number to take into effect potential clonal plants, establishing redundant advantageous alleles, and to represent a robust and resilient population size. This target population size is presented in Criterion 1 for downlisting in the 2019 recovery plan amendment (U.S. Fish and Wildlife Service 2019a).

**Monitoring Precision:** This score is based the attention and time provided when censusing a rough popcornflower population. A 'poor' score would be performing a quick observation from a roadside for 80 – 90 percent of the surveys. For a 'moderate' score, half of years are surveyed with careful precision and half with a quick observation. A 'good' score would be a careful counting of individual stems using measuring tape or monitoring plots to ensure higher confidence 90 to 100 percent for all surveys.

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<sup>1</sup> On October 25, 2019, we published a proposed amendment to the recovery plan that provides delisting criteria for rough popcornflower (84 FR 57468, U.S. Fish and Wildlife Service 2019b). That proposal was finalized on December 20, 2019 (U.S. Fish and Wildlife Service 2019a).

**Occurrence:** In this review, an occurrence or an Element Occurrence (EO), as described by NatureServe (NatureServe 2020) refers to a grouping of patches or sub-populations of the plant that are found within 1 km (0.62 mile) of each other. There are some reasons why a two or more populations could be located within a 1 km, such as populations on opposite sides of a river, populations separated by large gaps of no habitat, or populations. EO records prior to 2000, occasionally were incorrectly established within 1 km (0.62 mile) of each other.

**Patch:** “Habitat patch,” “patch,” or “sub-population,” as described in the final listing rule (U.S. Fish and Wildlife Service 2000) refers to any discrete grouping of plants of a particular species that can breed and access sufficient moisture, nutrients, and sunlight. Patches may be isolated or separated by houses, roads, or water features from other nearby patches. Several patches can occur within a population or occurrence.

**Population:** A population is defined as a group of organisms of one species that interbreed and live in the same place at the same time (*e.g.*, plant population). The term may be used interchangeably with “occurrence” in this review. A distinct patch may be considered to be a separate population if it is well isolated from other patches by sufficient distance (usually 1 km (0.62 mile), or separated by an impediment to genetic exchange, such as a building complex, or a 0.8 km (0.5 mile) habitat gap.

**Protection:** Habitat protection includes the preservation of the hydrologic, topographic, and edaphic features that support ecologically functional rough popcornflower habitat. Habitat can be protected in a variety of ways, but public ownership or ownership by a land trust is likely the most secure. The purchase of conservation easements by a public or non-public entity also qualifies as protected. A privately owned property that has been in beneficial management for a sustained period with no indication of property sale or development, with a stable rough popcornflower population may be considered protected. In all cases, a management plan to control non-native species and maintain the hydrology of the rough popcornflower habitat is important to guide the management of the species.

**Ramets:** Genetically identical plant tissues (such as stems) detached from a parent plant and then grow into independent plants.

**Redundancy:** Having a sufficient number of populations for the species to withstand occasional catastrophic events. Redundancy is a function of the number and resilience of populations, as well as their distribution and connectivity.

**Recovery Units:** A recovery unit is a special unit of the listed entity as defined in a final recovery plan that is geographically or otherwise identifiable and is essential to the recovery of the entire listed entity, *i.e.*, recovery units are individually necessary to conserve genetic and demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the entire listed entity (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2010, section 5.1.7.1; U.S. Fish and Wildlife Service 2003, pp. 18-19). To ensure that the rough popcornflower is conserved throughout its range and that the genetic variation currently present in this species is maintained, the recovery plan

assigned all known populations to one of three<sup>2</sup> recovery units (Figure 1). We established recovery units for the natural occurrences of rough popcornflower to correspond to three watersheds within the North Umpqua system and represent the full genetic diversity of the species. The populations of rough popcornflower in each recovery unit are also morphologically distinct from those in other populations, as some are generally larger than other plants, and have a greater tendency to exhibit a perennial life history (U.S. Fish and Wildlife Service 2003, p. 5).

**Reintroduction:** Reintroduction broadly refers to reintroducing populations that have become extirpated. This includes augmenting extant populations and reintroducing populations that have become extirpated. All population reintroductions should occur in areas within the species' historical range within suitable habitat.

**Representation:** The capacity of a species to adapt to environmental change, based upon considerations of geographic, genetic, ecological, and niche diversity. Representation overlaps with redundancy.

**Reserves:** According to criterion 1 of the amended recovery plan, a rough popcornflower population of at least 5,000 individuals (reflecting an effective population size of 500 individuals), in a protected area (land under public ownership or private land under a conservation easement, or restrictive deed status) and with a management plan in place, is considered a "reserve." We will consider a site a reserve if it has been managed to maintain a population of over 5,000 plants for a sustained period with no plans for development. The number of individuals was determined from two studies (Lande 1995 and Lynch *et al.* 1995; see U.S. Fish and Wildlife Service 2003, p. 17). A management plan is an important requirement for reserves to maintain requisite habitat condition and ensure long-term viability. Establishing reserves in each recovery unit is one of the downlisting criteria for rough popcornflower in the recovery plan and its amendment (U.S. Fish and Wildlife Service 2003, p. 22; U.S. Fish and Wildlife Service 2019a, entire).

**Resiliency:** Having sufficiently large populations to withstand stochastic events (random variation in environmental change or demographic factors, such as variability in rainfall or changes in sex ratios).

**Stressor:** Any physical, chemical, or biological alteration of resources (*i.e.*, increase, decrease, or introduction) that induces an adverse species response.

**Viability:** The ability of a species to maintain multiple (redundant), self-sustaining (resilient) populations distributed across a range that captures the ecological and genetic diversity of the species (representation).

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<sup>2</sup> The amendment to the recovery plan published on October 25, 2019 (84 FR 57468) expands the extent of the originally established recovery units for rough popcornflower (U.S. Fish and Wildlife Service 2019a, pp. 5–6).

## APPENDIX 2. Area Specific Information

Extirpated and extant populations have surveyed periodically from 1995 to 2020. In 2009, the Nonpareil rough popcornflower population (EO\*3), although not observed since 1932, was rediscovered and mapped (U.S. Fish and Wildlife Service 2010, p. 19). Currently there are 18 occurrences of this species, including 12 naturally occurring and six introduced populations (Table 2). These correspond to approximately 24 habitat patches, which support this species, including introduced populations. The following descriptions provide location information, habitat description, and a description of the demography trends and a confidence value for each population. The confidence value is the number of years of surveys divided by total years the population was discovered or introduced. The quantity of rough popcornflower plants is estimated for all populations. In some populations, individual plant stems are censused using measuring tape or small monitoring plots; while others, especially those where there is no legal access, are estimated from a distance, such as along a roadside.

### Deady (1 and 2) South

Rough popcornflower is estimated to occupy approximately 500 m<sup>2</sup> (5,382 ft<sup>2</sup>) in two main patches located on privately owned wetlands accessed from Deady Road to areas just north of Wilbur, Oregon and just east of Highway 99, and west of Sutherlin Creek. This area is about 1 km (0.62 mi) from the Horsepasture 2 site on soil underlain by Brand silty clay loam. When the patches were first surveyed in 1997, 300 plants were estimated within the area. In 2005, it was estimated that up to 6,000 plants occurred within the patches. No observations have been made since that time.

The two patches occur on privately owned roadside pasturelands and old equipment yards. Current land practices appear to be compatible with the continued persistence of these patches. The risk of development or disturbance to the populations is unknown. Securing a conservation easement or establishing other protection tools for one or more parcels would provide significant conservation benefits to the species.

Monitoring history: The patches have been monitored only 2 to 3 times since they were identified in 1998. The censuses were made from a roadside and have never had fine precision, which would indicate the confidence value would be low. More recently, a gate that allowed entry to the property has been locked and assessments cannot be made at this time.

Monitoring Confidence value: The Deady population has been monitored 3 times in the past 24 years and has a confidence value of 0.13.

### DSWCD Southside Swale

The Southside Swale population occurs on DSWCD managed and private land in Sutherlin. The patches include 600 m<sup>2</sup> (6,458 ft<sup>2</sup>) and 2,185 m<sup>2</sup> (23,519 ft<sup>2</sup>) areas that were first observed in June 2003 and in May 2006, respectively. The habitat is open Oregon white oak (*Quercus garryana*) and Oregon ash woodlands with several wetlands. The underlying soil type of the property is Conser silty clay loam and the site is dominated by tall fescue in the drier parts of the property and Oregon ash in the wetter

parts. The population is approximately 1.20 km (0.75 miles) east of the Sutherlin Red Rock Park population. Lower confidence population estimate of 500 plants was documented prior to the 2004 outplanting effort, but most recently is estimated to have 5,500 plants (U.S. Fish and Wildlife Service 2020, p 2.). The patch also includes an estimated 10,000 rough popcornflower plants on the adjacent private properties, east of the fence line. The site has moderately good native plant habitat and is underlain by Conser silty clay loam soil. Nonnative plants that pose a threat to rough popcornflower at the property are English hawthorn, meadow knapweed, Armenian blackberry, and tall fescue. The Oregon ash and hawthorn have potential to shade portions of the rough popcornflower population. There is no ONHIC EO record associated with this population yet. In 2006, with Fish and Wildlife Partners Program funding, ODA, DSWCD and Service staff augmented the population with 1,400 plants and 5,000 seeds.

DSWCD is a State agency affiliate and this rough popcornflower patch falls under State regulatory protection. Although no management plan has been developed for this population, habitat enhancement has been implemented (U.S. Fish and Wildlife Service 2007). Currently the Service has funded DSWCD to mow the site for the next three years. The potential acquisition of title or easements of the rough popcornflower habitat adjacent to this property by a public agency or land trust would be a significant benefit to the long-term protection of the occurrence.

Monitoring history: The DSWCD patch has been monitored 8 times since it was identified in 2003, with a lapse in monitoring from 2011 to 2015. The patch has been censused with careful precision 4 of the 8 times.

Monitoring Confidence value: The Southside Swale patch has been monitored 8 times in the 17 years since it was documented and has a confidence value of 0.47.

#### Ford's Pond

The Ford's Pond population occurs on City of Sutherlin managed land in Sutherlin. The patches include a 250 m<sup>2</sup> (2691 ft<sup>2</sup>) area that was first observed in June 2018. The habitat is emergent wetland dominated by Willamette gumweed. The underlying soil type of the property is Conser silty clay loam. The population is approximately 0.5 km (0.3 miles) south of the Stearns Lane population. The population includes an estimated 950 rough popcornflower plants. Nonnative plants that pose a threat to rough popcornflower at the property are meadow knapweed and Armenian blackberry. There is no ONHIC EO record associated with this population yet.

The City of Sutherlin plans to construct a recreational trail around the pond and will avoid the rough popcornflower population (B. Meiering, pers. comm. 2020). This rough popcornflower patch falls under State regulatory protection due to occurring on municipal land.

Monitoring history: The Ford's Pond population has been monitored 4 times since it was identified in 2017, with no lapses in monitoring. Each population census has been a count of all plant stems.

Monitoring Confidence value: The Ford's Pond population has been monitored 4 times in the 4 years since it was documented and has a confidence value of 1.00.

### Goat Ranch

This introduced rough popcornflower population was established in 2004 on a privately-owned parcel (Case Property) in Sutherlin, east of Interstate 5, near the Fort McKay Road and Highway 138 junction (Maddox and Meyers 2008, p. 3). The 5 m<sup>2</sup> (53.8 ft<sup>2</sup>) population is underlain with Oakland silt loam soil and provides suitable hydrology for rough popcornflower. The source of the seeds used to establish this patch were from three individual rough popcornflower plants from the ODOT Yoncalla South population and the nearby Stearns Lane population. In 2005, an estimated 75 plants were observed (Maddox and Meyers 2008, p. 3); it is unknown if the population persists.

Annual field practices include goat grazing and appears to be compatible with the continued survival of this population. There are no known developments planned for this area and there are no protections or provisions to conserve this population. Securing a conservation easement or establishing other protection tools for one or more parcels would provide significant conservation benefits to the species.

Monitoring history: The population has only been monitored in 2004 and 2005 since it was identified. The only census at the population was a complete count. Access to the private property where population occurs, cannot be made at this time.

Monitoring Confidence value: The Goat Ranch population has been monitored 2 times in the past 17 years and has a confidence value of 0.12.

### Hawthorne

This rough popcornflower population, located on private land, occurs in an old pasture and tree orchard in central Sutherlin, near the junction of Taylor and Hastings streets and was once the largest known population. The habitat is underlain by Conser silty clay loam soil. In 1983, approximately 1,500 plants across a 2,500 m<sup>2</sup> (26,910 ft<sup>2</sup>) area were estimated to occur at the site (ONHIC 2008). From 1998 to 2005, a housing development was built and wetlands were filled and drained on the property (U.S. Fish and Wildlife Service 2010). By 2007, only 300 to 500 plants remained (ONHIC 2008). By 2010, about 300 plants were observed in an 80 m<sup>2</sup> (861 ft<sup>2</sup>) area and by 2018, only 10-15 plants were observed (U.S. Fish and Wildlife Service 2018).

The population is now so small that any change in hydrology could result in the patch's extirpation. The extension of Hastings Street through a portion of the population has been on the municipal master plan for several years, but to date construction has not occurred (U.S. Fish and Wildlife Service 2010, p. 18).

Monitoring history: The Hawthorne population has been casually monitored 23 times since it was identified in 1998. The population censuses have not had high precision, as most numbers are rounded to the nearest 50th or 100th integer.

Monitoring Confidence value: The Hawthorne population has been monitored 23 times in the 24 years since it was documented and has a confidence value of 0.96.

### Horsepasture 2

This rough popcornflower occurrence is located on the North Star Ranch just south of Sutherlin, east of the railroad tracks, and north of a large pond and is managed rangeland. The patch (Horsepasture 1) was located west of the railroad tracks, but has since been extirpated (Maddox and Meyers 2008, p. 18). In 1997, a 3,000-plant (estimate from a distance) rough popcornflower patch located 300 m (984 ft) southeast of the patch was documented at a location called Horsepasture 2. In 2009, the Horsepasture 2 patch was revisited and incorrectly estimated (no actual on the ground counting) to have approximately 6,000 plants (U.S. Fish and Wildlife Service 2010, p.16). In 2011, ODA performed a complete census of the patch and estimated it to support up to 700,000 plants, making this the largest rough popcornflower population (Amsberry and Meinke 2017, p. 27).

This patch occurs around a 1-ha (2.5-acre) pond and is underlain by Brand silty clay loam. Over the past 30 years, field practices appear to be compatible with the conservation of the species and no observations of impacts or declines in this population have been reported. There are no known developments planned for the area and thus, we will consider this site in reserve status. Securing a conservation easement or establishing other protection tools for one or more parcels would provide significant conservation benefits to the species.

Monitoring history: The Horsepasture 2 population has been censused 4 times since the first recorded population estimate in 1997, with the largest lapses in monitoring from 1998 to 2007 and 2014 to 2020. This population is on private land, but access can be permitted if scheduled with the landowner. Plant counts have to be estimated due to the extreme size of the population. The confidence value of these censuses would be low.

Monitoring Confidence value: The Horsepasture 2 population has been monitored 4 times in the 24 years since it was documented and has a confidence value of 0.17.

### Nonpareil

This rough popcornflower population was first vouchered in 1915. It occurs in 8 non-contiguous patches, across 10 different privately-owned land parcels covering an approximately 10,000 m<sup>2</sup> (107,639 ft<sup>2</sup>) area located 3.7 km (6 miles) east of Sutherlin near the junction of Nonpareil and Plat K roads (U.S. Fish and Wildlife Service 2010, p. 6). The habitat for these properties are underlain by Conser silty clay loam soil and Packard gravelly loam. This population was observed in 2008, in 2019, was estimated to be approximately 6,000 plants. The population has never been fully surveyed due to limited access on the private lands.

Because the population is mostly on private-pasturelands, and distant from residential development, threats to plants are considered low. Annual agricultural practices

currently appear to be compatible with the survival of this population and deleterious practices have not been observed. Securing a conservation easement or establishing other protection tools for one or more parcels would provide significant conservation benefits to the species. Since the extant population has existed on this private lands setting since the discovery in 1915, it would appear the outlook is favorable for the continued existence of the plants.

Monitoring history: The Nonpareil population was assessed 2 times since it was rediscovered in 2008. The population censuses were made from a roadside and have never had fine precision, which would indicate the confidence value would be low. The population census has not had accurate precision, as numbers are rounded to the nearest 1000th integer.

Monitoring Confidence value: The Nonpareil population has been monitored 2 times in the 13 years since it was documented and has a confidence value of 0.15.

#### ODOT Wilbur Mitigation Site

The 914 m<sup>2</sup> (9,838 ft<sup>2</sup>) Wilbur ODOT population is one of the most successful reintroduced populations. This site, formerly managed as a hay field, is underlain by Conser silty clay loam soil and located near Wilbur, Oregon. It was purchased by a local business for compensatory wetland mitigation in 1999 and sold to ODOT in 2008. Since this time, restoration activities have included removal of cattle, periodic mowing, removal or disruption of drain tiles, blocking of ditches to increase water storage, introduction of native grass seed, native shrub and tree establishment, and excavation of swales or pools to provide additional wetland habitat. Approximately 800 small plants were grown in greenhouses in Corvallis, Oregon from seeds sourced from across the species' range and were planted at the site's created swales in 1999 and 2001. In 2001, additional rough popcornflower seed was sown at the site.

Less than 500 rough popcornflower plants were recorded between 2000 and 2007. In 2008, over 900 plants were documented and in 2009, 3,982 plants were tallied. In 2018, 69,288 plants were documented over 900 m<sup>2</sup> (9,688 ft<sup>2</sup>). The native grasses, tufted hairgrass and American sloughgrass, have also been gradually becoming more dominant each year, but have slightly different growing periods and have not been competing with rough popcornflower.

Threats to this patch are minimal due to the site having protected status. The overall site is restricted to four discreet plant groups covering less than 2 ha (5 acres) of habitat. The habitat for rough popcornflower is limited to the created swales, but there are opportunities to expand suitable habitat for the plant.

Monitoring history: The ODOT Wilbur Mitigation Site has been monitored 7 times since the first recorded census in 2000, with the largest lapse in monitoring from 2010 to 2013. The patch has been censused with careful precision each time.

Monitoring Confidence value: The ODOT Wilbur Mitigation Site population has been monitored 7 times in the 21 years since it was documented and has a confidence value of 0.33.

#### ODOT Yoncalla 2 population

This 26 m<sup>2</sup> (280 ft<sup>2</sup>) population is within an ODOT Special Management Area (SMA) and is located 0.74 km (0.46 mile) north of the ODOT Yoncalla South population. An SMA is a roadside area maintained by ODOT to avoid damaging rare or listed wildlife or plants and their habitats from routine road maintenance activities. The habitat is emergent wetland swale within an open meadow. The habitat is underlain with Conser silty clay loam. The population was discovered in 2004 by ODOT crews. Originally, 150 rough popcornflower plants, located west of a cattle fence, were documented at the population. Several plants occurred east of the fence, but it appeared several plants had been trampled. In 2007, ODOT determined that its property extended 950 m (3,116 feet) beyond the fence and the cattle were removed. In 2009, 5,946 plants were counted at the site and by 2015, 14,248 plants were documented. The rough popcornflower patch is somewhat isolated from Interstate 5 so is buffered from roadside maintenance, accidental vehicle impacts, and other disturbances. The Service and ODOT are agreeable to augment the population with additional individuals east of the fence.

Management at this site includes annual mowing and there are restrictions on grading and herbicide use. ODOT mows after rough popcornflower has gone to seed to avoid disrupting its growing cycle. Biennial monitoring has been conducted at the site since 2007. Primary threats to this site are non-native invasive plants, which can encroach and limit rough popcornflower establishment.

Monitoring history: The ODOT Yoncalla II population has been monitored 8 times since the first recorded census in 2003, with the largest lapses in monitoring from 2010 to 2015. The patch has been censused with careful precision each time.

Monitoring Confidence value: The ODOT Yoncalla II population has been monitored 8 times in the 18 years since it was documented and has a confidence value of 0.44.

#### ODOT Yoncalla South population

The ODOT Yoncalla South population is located within an ODOT SMA. This population includes two rough popcornflower patches located west of a fenced area and a “triangle patch” located north of these two patches. The occurrence was discovered in 1983. The east side of the fence is privately owned and is occupied by a 50-m<sup>2</sup> (538-ft<sup>2</sup>) area of extremely dense and vigorous rough popcornflower. Soils at the site are Dixonville silty clay loam and Conser silty clay loam. The most recent population estimate at ODOT Yoncalla South (west of the fence) is 6,123 plants from the two combined patches (Oregon Department of Transportation 2009, entire). The previously described ODOT Yoncalla 2 site is located approximately 0.74 km (0.46 miles) north of this location.

Management at this site includes annual mowing and restrictions on grading and herbicide spraying and monitoring has been conducted since 2003. The acquisition by ODOT of the rough popcornflower habitat on the adjacent private parcel would be a significant boost to the long-term conservation of the species at this population.

Monitoring history: The ODOT Yoncalla South population has been monitored 4 times since the first recorded census in 1998, with the largest lapses in monitoring from 1998 to 2005 and 2010 to 2015. The patch has been censused with careful precision each time.

Monitoring Confidence value: The ODOT Yoncalla South population has been monitored 4 times in the 24 years since it was documented and has a confidence value of 0.17.

### Orenco Ponds

The wetlands that comprise this county owned population (also known as Orenco Wetland Mitigation Site and the Sutherlin Log Pond) were created as part of the mitigation required by a removal-fill permit issued by the Oregon Department of State Lands and a Clean Water Act Section 404 Permit issued by the U.S. Army Corps of Engineers (Douglas County Board of Commissioners 2010, website). Prior to 1991, the site consisted of a log pond and associated fields owned by Georgia-Pacific LLC. Located on Conser silty clay loam soils, this property is immediately north of Sutherlin Creek and south of Hastings Avenue in central Sutherlin. The population is now permanently conserved as a wetland. The wetlands on the property are protected with a deed restriction. Douglas County will permit the Service to monitor rough popcornflower at the site.

During the construction of the wetlands at the mitigation site, several pools were constructed by heavy machinery, providing ideal rough popcornflower outplanting sites. Tufted hairgrass was seeded throughout the site. Native *Juncus patens* (spreading rush), *Juncus oxymeris* (pointed rush) and *Eleocharis palustris* (common spikerush) are common native wetland plants which already occurred at the site. Unfortunately, exotic invasive weeds such as meadow knapweed, Scotch broom (*Cytisus scoparius*), moneywort (*Lysimachia nummularia*), (thistles (*Cirsium* spp.)), and Armenian blackberry occur within or in the periphery of the site.

In October 2012, 512 greenhouse-grown rough popcornflower plugs were planted by ODA and Service staff in a series of locations across the property in various moisture regimes to determine which areas would support the best survival (Amsberry and Meinke 2017, pp. 11-14). Initial monitoring in the summer of 2013, documented poor survival compared to other reintroduction efforts that were outplanted in other locations. Only 298 scattered plants were relocated the second year and several of which appeared to have been removed and reestablished in other areas. These plants were smaller than those outplanted at other sites, produced fewer flowers, and produced an abnormally low number of seeds per flower. Survival varied greatly among the five pools where individuals were planted, with 93.8 percent surviving in Pool 1, 41.1 percent in Pool 2, 30.2 percent in Pool 3, 26.3 percent in Pool 4, and 68.8 percent in Pool 5, indicating that

future outplanting would focus on Pools 1 and 5. Altered soils and hydrology, as well as high levels of grazing, were suggested as reasons for the poor survival at pools 2, 3, and 4 (Amsberry and Meinke 2017, p. 14).

In 2016, the number of plants at Orenco Ponds increased to 17,326 individuals, but the occupied area had decreased. At this time, 1,345 m<sup>2</sup> (14,477 ft<sup>2</sup>) of habitat supported rough popcornflower plants in this population and as expected for a self-sustaining population, some patches of plants were very dense, with 142 m<sup>2</sup> (1,528 ft<sup>2</sup>) occupied at densities greater than 100 plants/m<sup>2</sup>. Water was present in all occupied pools during our mid-May monitoring date and many pollinators were observed (*e.g.*, bees, moths, beetles). In addition, more than 40 inflorescences were observed on some of the large overwintering plants, creating the potential for another large seed crop.

Between 2017 and 2019, the spatial distribution of the population expanded and shifted dramatically. The new areas colonized within the introduction area were dispersed due to water flow patterns at the site. As of the most recent survey, a total area of 1,344 m<sup>2</sup> (14,466 ft<sup>2</sup>) was occupied by 17,326 plants and the population continues to meet criteria of a recovery-level population. From 2015 – 2019, the Service funded herbicide treatment at the site, focused on meadow knapweed, Scotch broom, and Armenian blackberry control.

Monitoring history: The Orenco Ponds population has been monitored 7 times since the first recorded census in 2010, with no lapses in monitoring of more than one year. Access is permitted to the site, but Douglas County needs to be notified. The patch has been censused with careful precision each time.

Monitoring Confidence value: This population has been monitored 7 times in the 11 years since it was documented and has a confidence value of 0.33.

#### Soggy Bottoms/NWYC

Originally, 500 rough popcornflower plants were reintroduced to the Soggy Bottoms site on BLM's NBHMA in 1998. The area is an open wetland meadow dominated by spreading rush and pennyroyal within Oregon oak woodland habitat and underlain by Curtin clay soil. The plants were grown from seed collected from throughout the species range in greenhouses in Corvallis, Oregon (Amsberry and Meinke 2002, p. 26). The introduction was successful for several years with census numbers averaging 1,100 plants per year. After a fire swept through the area in 2003, the population increased from 1,193 to 1,869 plants. Then the following winter, extensive erosion occurred in the area, eventually changing the hydrology of the site from a shallow wet swale to an incised channel bank. The population plummeted to 38 plants the next year and has been declining each year since. Only 10 plants were documented in the most recent census (Amsberry and Meinke 2017). The BLM recently performed extensive work on the stream channel to restore wetland conditions in the meadow. The response of the rough popcornflower population will be closely monitored over the next few years and is expected to improve.

In 2006, approximately 1,500 rough popcornflower plants were transferred from the Westgate population and the OSU greenhouse in Corvallis, Oregon, as part of a salvage project, and outplanted to suitable wetland habitat near Soggy Bottoms by the NWYC working with BLM under an assistance agreement. The 1,000 plants transferred from the Westgate population and 500 plants grown from seed collected previously from several sites in the Sutherlin area were planted in prepared microhabitats. In 2009, 350 rough popcornflower plants were documented at the site and by 2016; this number had grown to 3,353 (Amsberry and Meinke 2017, p. 38).

The introduced Soggy Bottoms/NWYC population has been variable, but overall has maintained a population level above 3,000 plants since 2016. Habitat restoration and additional augmentation may greatly benefit this site and achieve a recovery-level population size. Augmentation would be determined by available hydrology at the site, suitable for rough popcornflower (Amsberry and Meinke 2017, p. 38). Rough popcornflower occupies 107.8 m<sup>2</sup> (1,160 ft<sup>2</sup>) at the two patches.

Monitoring history: The Soggy Bottoms/NWYC population has been monitored 7 times since the first recorded census in 1998, with only one lapse in monitoring from 2017 to 2019. The patches have been censused with careful precision each time.

Monitoring Confidence value: The Soggy Bottoms/NWYC population has been monitored 16 times in the 23 years since it was documented and has a confidence value of 0.70.

#### Soggy Bottoms Sister

In mid-November 2016, 2,793 greenhouse-grown transplants were established at the Soggy Bottoms Sister site using cultivation protocols (Amsberry 2001, pp. 21-50). The area is also open wetland meadow dominated by spreading rush and pennyroyal within Oregon white oak woodland habitat and underlain by Curtin clay soil. The site is located 1.0 km (0.62 mile) south of the Soggy Bottoms/NYCC site. The plants were grown from seed collected from species populations at NBHMA and the Sutherlin area and grown in greenhouses in Corvallis, Oregon (Amsberry and Meinke 2017, p. 39). The introduction was successful with 1,355 plants present the following year and then 11,222 plants recorded in 2020. The plant is estimated to occupy over 500 m<sup>2</sup> [5,382 ft<sup>2</sup>]) at this site. (J. Brown, pers. comm. 2020).

Monitoring history: The Soggy Bottoms Sister population has been monitored 3 times since the first recorded census in 2016, with one lapse in monitoring from 2017 to 2018. The patch has been censused with careful precision each time.

Monitoring Confidence value: The Soggy Bottoms Sister population has been monitored 3 times in the 5 years since it was documented and has a confidence value of 0.60.

#### Stearns Lane

The Stearns Lane site is a small rough popcornflower patch in the Calapooya Creek Recovery Unit that was first documented in 1997 and is estimated to support 100 to 200

plants. It occupies less than a 2 m<sup>2</sup> (22 ft<sup>2</sup>) area (Maddox and Meyers 2008, p. 9) within a small open 600 m<sup>2</sup> (0.15-acre) field east of Sutherlin, Oregon near the Fords Pond and Stearns Lane junction. The site occurs on Conser soils in a field, which is occasionally used for parking vehicles. Although the field is infested with meadow knapweed, it does not occupy the wetland supporting rough popcornflower. This population one of three only naturally occurring populations in the Calapooya Creek Recovery Unit and preservation of its genetic materials is a priority.

This vulnerable occurrence is located on private land and not in reserved status or a special management provisions. The property is managed for agriculture (hay) and occasional vehicle parking, which may benefit rough popcornflower. We are not aware of any pending development plans. The plants in this population are similar in morphology to the Yoncalla Creek Recovery Unit plants. Their stature is more robust, they are taller, have thicker leaves, a later blooming period, and they have characteristics of perennial plants, unlike rough popcornflower plants that occur in the southern Sutherlin Creek Recovery Unit populations (Amsberry and Meinke 2002, p. 21).

Monitoring history: The Stearns Lane population has been censused 19 times since the first recorded census in 1998, with one lapse in monitoring from 1999 to 2001. Because the population is on private land, access is not permitted and censuses have been made from the roadside without fine precision. The confidence value of these censuses would be low.

Monitoring Confidence value: The Stearns Lane population has been monitored 19 times in the 23 years since it was documented and has a confidence value of 0.83.

#### Sutherlin East

This population occurs in a privately owned agricultural land parcel and was first documented in 1998. The population was then estimated to have 1,000 rough popcornflower plants (Amsberry and Meinke 2002, p. 23). The location is four miles east of Sutherlin, just west of Southside Road and 2.25 km (1.4 miles) northeast of Cooper Creek Reservoir and is underlain by Conser silty clay loam and Nonpareil loam. The patch was determined extant in 2001, after plowing had recently been accomplished, but only a few plants were visible at that time (Amsberry and Meinke 2002, p. 23). The population was last observed in 2007, from the roadside. The occurrence was estimated to have up to 1,000 plants within a 6 m<sup>2</sup> (64.5 ft<sup>2</sup>) area (Maddox and Meyers 2008, p. 10).

Grazing and mowing have been conducted at this site for several decades. The rough popcornflower population had been able to survive despite periodic plowing practices. Development is not expected to occur in this rural farming area, however; the population is not very large, and is not reserved. The population could be significantly impacted depending on the extent of agricultural practices (*e.g.* ditching, plowing, and herbicide application).

Monitoring history: The Sutherlin East population has been censused 2 times since the first recorded population estimate in 1998, with the largest lapses in monitoring from

1999 to 2004 and 2006 to 2020. The population is on private land so access is not permitted and censuses are made from the roadside without fine precision. The confidence value of these censuses is low.

Monitoring Confidence value: The Sutherlin East population has been monitored 2 times in the 23 years since it was documented and has a confidence value of 0.09.

#### Sutherlin Red Rock Park

The Sutherlin Red Rock Park is located within the Sutherlin Creek Recovery Unit on Sutherlin administered property. This population includes two rough popcornflower patches (East and West enclosures) within a 679 m<sup>2</sup> (7,308 ft<sup>2</sup>) area, 20 m (65.5 feet) south of Sutherlin Creek. The site is underlain by Conser silty clay loam soil. In 2009, over 8,000 plants were documented in a population estimate (U.S. Fish and Wildlife Service 2010, p. 15).

The Sutherlin Red Rock Park population is managed to conserve rough popcornflower. In 2006, the East patch enclosure was inadvertently buried by a non-city affiliated recreational group. Since then, the city restored the patch and drafted a management plan and conservation agreement for all of Sutherlin's rough popcornflower populations that was signed and implemented by the City, the Oregon Department of Agriculture Native Plant Conservation Program, the Service, and the Native Plant Society of Oregon. In 2007, reed canarygrass displaced several meters of rough popcornflower in the West patch enclosure and the plants had become extirpated in the East patch enclosure. The plant total at this time was 3,215 individuals (U.S. Fish and Wildlife Service 2020, p. 2). In 2009, the Service funded an information kiosk and a wooden fence enclosing the two rough popcornflower patches. In addition, some string trimming and a plastic sheet was placed on the reed canarygrass in an attempt to stifle the grass shoots. Although the population increase to over 8,000 individuals, the plastic did not contain the grass for very long. In 2015, the Service funded a three-year grass removal treatment using hand removal, line trimming, and herbicide. By the fall of 2018, the reed canarygrass infestation was largely controlled and the pennyroyal mowed to the ground. Rough popcornflower expanded into most of the areas overtaken by reed canarygrass and pennyroyal. Over 15,000 rough popcornflower plants were counted at both patches in the summer of 2019, suggesting that these efforts were successful.

The patches are protected by the Oregon Endangered Species Act regulations (Oregon Senate Bill 533 and its corresponding Oregon Revised Statue 564). Since the finalization of the Conservation Agreement and management plan, rough popcornflower has been annually surveyed, the city stopped allowing horse traffic through the area, and permanent fencing has been constructed around the rough popcornflower patches.

Monitoring history: The Red Rock Park population has been censused 12 times since the first recorded population estimate in 2003, with the largest lapse in monitoring from 2017 to 2018. The patch has been censused with careful precision each time.

Monitoring Confidence value: This population has been monitored 12 times in the 18 years since it was documented and has a confidence value of 0.67.

#### TNC Oerding Popcorn Swale Preserve/Del Rio Mitigation Site

This population is managed by TNC and ODOT. The habitat is a mix of wet and upland meadows, Oregon ash, and riparian habitats on Bashaw clay and Conser silty clay loam soils. The TNC preserve includes three patches of rough popcornflower, which are separated by Highway 99. Two patches occur west of the highway in a narrow 9.6-ha (23.7-acre) strip between Highway 99 and Interstate-5. The other patch occurs east of Highway 99 in a 2.5-ha (6.3-acre) wet prairie and extends into Oregon white oak - Oregon ash stands. The 2-ha (5-acre) ODOT owned Del Rio Mitigation Site occurs north of the TNC site, east of the highway.

A 2019 census, documented 5,718 rough popcornflower plants in the patch west of the highway and 366 were tallied in the patch east of the highway (M. Morison, pers. comm. 2019). Approximately 500 plants were outplanted at Del Rio Mitigation site in 2014, but only ten individuals were observed in 2016. Another outplanting effort was completed in 2019, after extensive management efforts to reduce competition from native plant and non-native herbaceous species. In 2020, a Del Rio plant census performed by ODA and ODOT documented 6,750 plants (A. Kercher, pers. comm. 2020)

While rough popcornflower is not formerly protected under a restrictive covenant or conservation easement on the TNC-owned portion of the preserve, TNC's mission is to protect environmentally sensitive and rare habitat. The ODOT-owned portion is protected under the State Endangered Species Act. TNC routinely manages the habitat via weed removal and performs periodic monitoring of rough popcornflower and general habitat condition. Management activities at the preserve include removal of teasel, reed canarygrass, Canada thistle, Italian thistle and Armenian blackberry, non-native trees, oak and ash thinning, and native plant seed sowing.

In 2003, the Service provided funding to TNC to restore the 2.5-ha (6.3-acre) meadow habitat by removing the non-native pear, English hawthorn, and ash trees. The project was implemented as planned, however, after three years spreading rush and pennyroyal, filled into the more open meadow habitat and displaced rough popcornflower significantly likely due to a change in hydrology and a lack of vegetation control. Currently, approximately twenty small groups of the plant are extant in this area. The Service is has funded a series of mowing treatments to control herbaceous vegetation with expectations that rough popcornflower will spread into the treated habitat.

The TNC-owned portion of the population is the southern-most occurrence within the range of rough popcornflower. It blooms about a week earlier than the remainder of the populations, and has an overall more diminutive stature than plants from more northern populations. Like other populations, the plants in this occurrence include a range of few-flowered and diminutive to many-flowered, extremely robust and rangy specimens. Plants at this site may be adapting to the poor hydrological conditions, have experienced a recent hybridization event with the more common fragrant popcornflower, or are

manifesting genetic differences unique to the population (Amsberry and Meinke 2002, p. 21).

Monitoring history: The TNC Popcornswale Preserve/Del Rio Mitigation Site population has been monitored 16 times since the first recorded census in 1995, with lapses in monitoring from 2007 to 2010 and 2012 and 2014. The patch has been censused with careful precision each time.

Monitoring Confidence value: The population has been monitored 16 times in the 26 years since it was documented and has a confidence value of 0.62.

### Westgate

The Westgate population is located within the BLM's NBHMA, approximately 11.3 km (seven miles) east of the Popcorn Swale Preserve. This site includes a robust rough popcornflower population that was introduced in 1998 and 1999. The source material was cultivated in greenhouses in Corvallis, Oregon from seed collected from various populations throughout the species' range. Approximately 1,000 rough popcornflower seedlings were outplanted in both shaded and open areas. Plants that were introduced to shady areas fared poorly, while plants introduced to open areas spread. Since the introductions, the population has been gradually expanding to occupy most of the accessible suitable habitat as well as into a nearby roadside ditch.

In 2006, the BLM worked with the NWYC to salvage the rough popcornflower plants that had expanded into the ditch before a road maintenance and ditch-cleaning project was initiated. Nearly 2,000 plants were salvaged and were outplanted to a wet meadow near the Soggy Bottoms introduction site. The overall population was unaffected by the salvage. Currently the population faces threats from the invasive rhizomatous plant, Canada thistle. The most recent population estimate at the population was 10,100 plants (Amsberry and Meinke 2017, p. 44). An estimated population count performed in 2020 documented roughly 6,000 plants.

The BLM's Roseburg District Office manages this population through protective provisions under the Act. Since 2001, BLM and ODA have conducted annual population censuses and reproductive assessment evaluations. The Westgate population is included in an area-wide management plan for the NBHMA, which includes provisions for invasive weed control and allows for introduction of grazing to this site. BLM routinely enacts area-wide invasive plant control efforts. Threats to this introduced population are overcrowding from invasive plants.

Monitoring history: The Westgate population has been monitored 20 times since the first recorded census in 1999, with one lapse in monitoring from 2018 to 2019. The patch has been censused with careful precision each time, with the exception being a coarse estimate in 2020.

Monitoring Confidence value: The population has been monitored 16 times in the 18 years since it was documented (established) and has a confidence value of 0.89.

### APPENDIX 3. Summary of rough popcornflower censusing.

| Year | Population                                                  | 1995   | 1996 | 1997  | 1998  | 1999   | 2000  | 2001   | 2002   | 2003   | 2004   | 2005   | 2006   | 2007   | 2008   | 2009   | 2010   | 2011   | 2012    | 2013    | 2014   | 2015   | 2016   | 2017  | 2018   | 2019   | 2020   | Total Years Documented |
|------|-------------------------------------------------------------|--------|------|-------|-------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|--------|--------|--------|-------|--------|--------|--------|------------------------|
| 1    | Horsepasture 2                                              |        |      | 160   | NA    | NA     | NA    | NA     | NA     | NA     | NA     | NA     | NA     | NA     | 5,000  | NA     | NA     | NA     | 700,000 | 700,000 | NA     | NA     | NA     | NA    | NA     | NA     | NA     | 24                     |
| 2    | The Nature Conservancy (TNC) Oerding Preserve-Strip Patch N | 16,000 | 394  | 3,627 | 2,548 | 4,405  | 4,307 | 7,785  | 4,671  | 13,065 | 24,014 | 10,998 | 30,139 | NA     | NA     | NA     | NA     | 10,510 | NA      | NA      | NA     | 4,245  | 3,722  | NA    | NA     | 6,403  | NA     | 26                     |
|      | TNC Oerding Preserve Field Patch                            |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        |        |       |        |        |        |                        |
|      | TNC Oerding Preserve Strip South Patch                      |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        |        |       |        |        |        |                        |
|      | Oregon Department of Transportation (ODOT) Del Rio Site     | 50     | NA   | NA    | NA    | NA     | NA    | NA     | NA     | NA     | NA     | 358    | NA     | NA     | NA     | NA     | NA     | NA     | 1,936   | 8,164   | NA     | 1,235  | 329    | NA    | NA     | NA     | 5,000  |                        |
| 3    | ODOT Wilbur Mitigation Site                                 |        |      |       |       |        | 400   | NA     | NA     | NA     | NA     | 120    | NA     | NA     | 900    | 3,982  | NA     | NA     | NA      | NA      | 19,963 | 15,436 | NA     | NA    | 69,288 | NA     | NA     | 21                     |
| 4    | Hawthorne                                                   |        |      | 800   | 200   | 300    | 200   | 200    | 200    | 250    | 250    | 300    | 100    | 125    | 200    | 100    | 50     | 50     | 45      | 2       | 5      | 0      | 10     | 15    | 10     | 0      | NA     | 24                     |
| 5    | Orenco Ponds                                                |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        | 2,000  | NA     | 512     | NA      | 749    | 13,956 | 17,326 | NA    | 2,400  | 6,500  | NA     | 11                     |
| 6    | Sutherlin Red Rock Park West Patch                          |        |      |       |       |        |       |        |        | 300*   | NA     | 1,001  | NA     | 3,215  | 8,491  | 8,000* | 518    | 2,467  | 2,828   | 600*    | NA     | 5,470  | 4,337  | NA    | NA     | 15,111 | NA     | 18                     |
|      | Sutherlin Red Rock Park East Patch/Waite St.                |        |      |       |       |        |       |        |        |        |        | 82     | NA     | 37     | 131    | 323    | 3      | 141    | 153     | 0       | 0      | 0      | 0      | 0     | 0      | 248    | NA     |                        |
| 7    | Southside Swale Patch A                                     |        |      |       |       |        |       |        |        | 500    | NA     | 500    | NA     | 10,000 | 6,300  | 6,300  | 3,113  | NA     | NA      | NA      | NA     | NA     | 3,725  | NA    | NA     | 5,000  | NA     | 18                     |
|      | Southside Swale Patch B                                     |        |      |       |       |        |       |        |        |        |        |        |        | 10,000 | NA     | NA     | NA     | NA     | NA      | NA      | NA     | NA     | NA     | NA    | NA     | NA     | NA     |                        |
| 8    | Ford's Pond                                                 |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        |        | 8     | 247    | 950    | 950    | 4                      |
| 9    | Stearns Lane                                                |        |      |       | 200   | NA     | NA    | NA     | 500    | NA     | 250    | 100    | 175    | 175    | 202    | 250    | 175    | 150    | 125     | 175     | 175    | 200    | 150    | 200   | 170    | 170    | 200    | 23                     |
| 10   | Nonpareil (1932)                                            |        |      |       |       |        |       |        |        |        |        |        |        |        | 5,000  | NA     | NA     | NA     | NA      | NA      | NA     | NA     | NA     | NA    | NA     | 6,000  | NA     | 13                     |
| 11   | Soggy Bottoms Patch                                         |        |      |       | 358   | 3,373  | 2,087 | 1,065  | 1,075  | 1,055  | 1,869  | 38     | 20     | NA     | 15     | 15     | 46     | 53     | NA      | NA      | NA     | 11     | NA     | NA    | NA     | 10     | 11     | 22                     |
|      | Northwest Youth Corps Patch                                 |        |      |       |       |        |       |        |        |        |        |        | 2,000  | 1,250  | 650    | 250    | 250    | 997    | 465     | NA      | 2,226  | 611    | 3,343  | NA    | NA     | NA     | 3,500  |                        |
| 12   | Soggy Bottom Sister                                         |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        | 2,000  | NA    | NA     | 3,231  | 11,222 | 5                      |
| 13   | Westgate                                                    |        |      |       |       | 10,758 | 4,652 | 16,898 | 16,666 | 7,833  | 14,337 | 3,838  | 2,673  | 13,590 | 23,495 | 18,210 | 12,024 | 11,628 | 3,378   | 145     | 25,000 | 14,868 | 10,110 | 8,500 | NA     | NA     | 7,500  | 18                     |
| 14   | ODOT Yoncalla South                                         |        |      | 3,500 | NA    | NA     | NA    | NA     | NA     | NA     | NA     | NA     | NA     | 2000*  | NA     | 5,053  | NA     | NA     | NA      | NA      | NA     | NA     | NA     | 6,944 | NA     | NA     | NA     | 24                     |
| 15   | ODOT Yoncalla 2                                             |        |      |       |       |        |       |        |        | 150    | NA     | 161    | 500    | NA     | 105    | 5,893  | NA     | NA     | NA      | NA      | NA     | 14,248 | 3,610  | 8,840 | NA     | NA     | NA     | 18                     |
| 16   | Deady 1                                                     |        |      | 75    | NA    | NA     | NA    | NA     | NA     | NA     | NA     | 1,000  | NA     | NA     | NA     | NA     | NA     | NA     | NA      | NA      | NA     | NA     | NA     | NA    | NA     | NA     | NA     | 24                     |
|      | Deady 2                                                     |        |      | 300   | NA    | NA     | NA    | NA     | NA     | 30     | NA     | 5,000  | NA     | NA     | NA     | NA     | NA     | NA     | NA      | NA      | NA     | NA     | NA     | NA    | NA     | NA     | NA     |                        |
| 17   | Sutherlin East                                              |        |      |       | 1,000 | NA     | NA    | NA     | NA     | NA     | NA     | 1,000  | NA     | NA     | NA     | NA     | NA     | NA     | NA      | NA      | NA     | NA     | NA     | NA    | NA     | NA     | NA     | 23                     |
| 18   | Goat Ranch                                                  |        |      |       |       |        |       |        |        |        | 25     | 75     | NA     | NA     | NA     | NA     | NA     | NA     | NA      | NA      | NA     | NA     | NA     | NA    | NA     | NA     | NA     | 17                     |
|      | Not Available (Not censused)                                |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        |        |       |        |        |        |                        |
|      | Population censused                                         |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        |        |       |        |        |        |                        |
|      | population not yet introduced or discovered                 |        |      |       |       |        |       |        |        |        |        |        |        |        |        |        |        |        |         |         |        |        |        |       |        |        |        |                        |

## APPENDIX 4. Summary of conservation actions for rough popcornflower.

| Action                        | Location                                                | Description                                                                                                                                                                      | Partners                         | When                    | Result                                                                                                                                                                                                                                       |
|-------------------------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fencing                       | Sutherlin                                               | Conservation Agreement and Management Plan. Construction of a fence and signage around rough popcornflower population at Red Rock Park to prevent rodeo traffic and hay disposal | Sutherlin and Service            | 2010                    | A fence has been constructed around the population and informational signage is in place.                                                                                                                                                    |
| Mowing                        | ODOT Wilbur Site                                        | ODOT Ownership: Annual mowing on property to reduce competition with RPF                                                                                                         | ODOT                             | Annually 2000 – present | ODOT has regularly mowed the Wilbur Mitigation Site. The population has increased steadily.                                                                                                                                                  |
| Mowing                        | City of Sutherlin                                       | Three year mow on property in order to keep competing vegetation low                                                                                                             | Service, DC Work Crew, Sutherlin | 2015-2018               | Competing vegetation is controlled. 2019 will be first census since project completed.                                                                                                                                                       |
| Invasive species Control      | City of Sutherlin                                       | Control reed canary grass at the Sutherlin Red Rock Park population.                                                                                                             | Service, DC Work Crew, Sutherlin | 2015-2018               | Reed canary grass controlled. 2019 will be first census since project completion.                                                                                                                                                            |
| Invasive Species Control      | DSWCD and DC Orenco Ponds                               | Control three invasive species that compete with rough popcornflower                                                                                                             | Service DSWCD and Douglas County | 2014-2018               | Meadow knapweed, English hawthorn, Armenian blackberry, and spurge laurel decreased. Population stable.                                                                                                                                      |
| Introduction and Augmentation | BLM, DC Orenco Ponds, ODOT Del Rio, ODOT Wilbur, DSWCD, | Introduced or augment rough popcornflower in 8 locations                                                                                                                         | Service, ODA, BLM                | 1998-2016               | Populations were introduced at four BLM locations, DC Orenco Ponds, DSWCD Southside Swale, and ODOT Del Rio and Wilbur locations. Populations at four locations were successful; three were partially successful while one was unsuccessful. |
| Tree removal                  | TNC                                                     | Annual mowing with removal of ash, pear, and English hawthorn from large area of property                                                                                        | Service, TNC                     | 2003                    | Meadow vegetation restored, but rough popcornflower population declined due to competition with native plant species and or change in hydrology.                                                                                             |

## **APPENDIX 5. Proposed Conservation Actions for Recovery of Rough Popcornflower.**

### **A. Prioritize Conservation of Existing Populations**

As discussed in the Conclusion, the protection of existing occurrences will continue to be a high priority. The purchase of fee title or conservation easements of occupied local prairie parcels by public entities or land trusts will promote the protection and conservation of habitats, which support rough popcornflower. Management of these habitats would include population augmentation as needed.

The new population on Ford's Pond increased 50-fold from 2018 to 2019, so there is promise this population will remain viable. The Yoncalla Creek Recovery Unit currently has two recovery level populations on ODOT property. One more protected population would satisfy this recovery unit's quota towards meeting recovery criterion number 3.

### **B. Continuation of the Technical Workshops**

We will continue to hold technical workshops to advance recovery and create partnerships. Recovery workshops can assist in the recovery by sharing information and expertise with private landowners, public agencies, and non-profit conservation groups. The workshops should convene at least annually and include important stakeholders from the private sector, state and local agencies (DSWCD, TNC, BLM, ODOT, ODA), and Service staff. Annual research needs, conservation objectives, and recovery goals will be discussed and conservation priorities set.

### **C. Provide for Restoration Opportunities**

Restoration of occupied habitat through conservation partnerships with local stakeholders will ensure that existing populations are healthy and that habitats supporting this species are maintained in an early successional status. Restoration is necessary across the species' range to control the encroachment of competing native and non-native vegetation.

### **D. Prioritize Reintroduction Efforts**

Meeting recovery criteria will require establishing new populations on protected lands or on lands where the landowner considers the conservation of rough popcornflower a high priority. Given that the species has high seed production and propagation and outplanting protocols are well-developed, we are confident that outplanting can result in viable populations. We use the term reintroduction broadly to include augmenting extant populations, reintroducing populations that have become extirpated, and establishing populations in areas within the species' historical range where it was not previously known to occur.

### **E. Refine and Continue the Reintroduction Site Selection Process**

The process to select reintroduction sites should be continued, assessed and revised with the assistance of the technical workshop and/or species experts. The habitat areas of highest

reintroduction importance should be areas where there are significant gaps in protection in the species' distribution. To refine the site evaluation process, species experts will recommend experimental planting at potential reintroduction sites and experimental outplantings will be monitored to determine their suitability. This effort will shed light on optimal characteristics for reintroduction sites. The identification of critical environmental factors will assist with selecting future optimal sites.

The site evaluation process, incorporating experimental plantings, is continuing in northern Douglas County. Experimental plantings in other parts of the Umpqua Valley, such as the NBHMA also have provided feedback for successful reintroductions for the species.

## **F. Potential Research Needs**

Rangewide rough popcornflower population assessments should continue every two to three years. Experimental studies with controls addressing the biology and response to management actions such as grazing and vegetation control will further increase our knowledge of the species. The following topics should be considered in the next five years:

- The use of prescribed fire should be studied as a restoration tool. Preliminary evidence shows that burning may be a useful in habitat restoration and shows promise in maintaining rough popcornflower habitat.
- Non-native invasive plants are a primary inhibitor of rough popcornflower establishment and degrade habitat (Amsberry 2008). Control of these plants is a management priority at North Bank Habitat Management area and TNC Oerding Popcorn Swale Preserve. A focused study on effective methods of non-native invasive plant control should be initiated.
- Inbreeding/outbreeding depression and genetic bottlenecks have not been documented in rough popcornflower. The question whether genetic outbreeding or inbreeding depression exists in populations has not been answered. Results from greenhouse interspecific crosses between rough popcornflower and *P. figuratus* can produce viable offspring, but usually have a lower viability (Amsberry and Meinke 2002, p. 28). Plants at the some of the Southern Douglas County populations are smaller and have lower reproductive capacity; however, this does not confirm that genetic issues are present.
- Grazing by domestic animals should be studied to evaluate whether grazing can be compatible with long-term rough popcornflower survival, has merit in habitat restoration, and has the ability to maintain habitat.