

**DRAFT RECOVERY PLAN**  
**FOR THE**  
**ROUGH POPCORN FLOWER**  
*(Plagiobothrys hirtus)*

**(November 2002)**

**Region 1**

**U.S. Fish and Wildlife Service**

**Portland, Oregon**

Approved: XXXXXXXXXXXXXXXXXXXXXX  
Regional Director, Region 1, U.S. Fish and Wildlife Service

Date: XXXXXXXXXXXXXXXXXXXXXX

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, often with the assistance of recovery teams, contractors, State agencies, and others. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies, other than the U.S. Fish and Wildlife Service, involved in the plan formulation. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

## **LITERATURE CITATION**

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## **ACKNOWLEDGMENTS**

This draft recovery plan was prepared for the U.S. Fish and Wildlife Service by Kelly Amsberry and Robert J. Meinke, Oregon Department of Agriculture, Plant Conservation Biology Program.

## EXECUTIVE SUMMARY

**Current Status:** The rough popcorn flower (*Plagiobothrys hirtus* Greene Johnst.) is a federally listed endangered plant species (65 FR 3866) with 17 known extant occurrences distributed only in the Umpqua River drainage in Douglas County, Oregon. This species occurs along the Sutherlin Creek drainage from Sutherlin to Wilbur, adjacent to Calapooya Creek west of Sutherlin, and in roadside ditches near Yoncalla Creek just north of Rice Hill. The rough popcorn flower has an annual or short-lived perennial life history.

**Habitat Requirements and Limiting Factors:** The rough popcorn flower occurs only in seasonal wetlands where it remains submerged under standing water from late fall through early spring. The majority of the extant and extirpated sites occur on the Conser soil series (deep, poorly drained soils present in depressions in alluvial stream terraces).

Most of the sites are moderately to highly disturbed due to agricultural and development activities. Urban and agricultural development, invasion of nonnative species, habitat fragmentation and degradation, and other human-caused disturbances have resulted in substantial losses of seasonal wetland habitat throughout the species' historic range. Conservation needs include establishing a network of protected populations in natural habitat distributed throughout its native range.

**Recovery Priority Number:** The recovery priority number for the rough popcorn flower is 2 on a scale of 1 to 18, indicating that it is: 1) taxonomically, a species; 2) facing a high degree of threat; and 3) rated high in terms of recovery potential.

**Recovery Objective:** Downlist to threatened. Interim goals of this recovery plan include stabilizing and protecting populations, conducting research necessary to refine reclassification and recovery criteria.

**Recovery Criteria:** The rough popcorn flower should be considered for downlisting when all of the following criteria are met.

1. At least 9 reserves, containing a minimum of 5,000 plants each are protected and managed to assure their long-term survival.

2. A minimum of 1,000 square meters (3,280 square feet) are occupied by the rough popcorn flower within each reserve, with at least 100 square meters (328 square feet) having a density of 100 plants/square meter (100 plants/square foot) or greater.
3. A minimum of nine reserves are distributed among the three natural recovery units (Calapooya Creek, Sutherlin Creek, Yoncalla Creek), with at least three reserves present in each unit.
4. Patches within each reserve are within 1 kilometer (0.6 mile) (Levin 1993) of each other to allow pollinator movement and gene flow among them.
5. An average of 5 years of demographic data indicate that populations in at least seven of the nine reserves within Units 1 through 3 have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.
6. Seventy-five percent or more of the plants are reproductive each year, with evidence of seed maturation and dispersal in all populations.
7. Seed germination and seedling recruitment are occurring in all populations.

Not delistable unless vigorous natural occurrences of rough popcorn flower are found in its native range that are not threatened and can be secured and protected. Specific criteria for this hypothetical case cannot be developed at this time.

**Actions Needed:**

1. Conserve existing patches and develop new protected populations within each recovery unit.
2. Establish long-term, ex situ conservation of rough popcorn flower seeds.
3. Research factors that threaten recovery of the species.
4. Provide outreach and education opportunities for land managers/landowners.

**Total Cost of Downlisting (\$1,000):**

<u>Year</u>	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Total</u>
2002	120	15	40	05	180
2003	233	05	40	05	283
2004	343	05	40	05	393
2005	285	05		05	295
2006	285	05		05	295
2007	285			05	290
2008	285			05	290
2009	285			05	290
2010	285			05	290
2011	285			05	290
<u>Total</u>	<u>2,691</u>	<u>35</u>	<u>120</u>	<u>50</u>	<u>2,896</u>

**Date of Downlisting:** Downlisting may be considered in 2011 if the recovery criteria have been met.

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# **Rough Popcorn Flower Recovery Plan**

## **I. INTRODUCTION**

The rough popcorn flower (*Plagiobothrys hirtus* Greene Johnst.) was collected infrequently in the Umpqua Valley of Douglas County, Oregon, from 1887 to 1961. However, by 1978, no extant populations were known (Siddall and Chambers 1978). Surveys in the early 1980's rediscovered several populations, all within the Umpqua Valley drainage. All extant populations are small, and all have been impacted since the time of European settlement by the conversion of wetlands to agricultural lands, and more recently by rapid urban and industrial development in the Sutherlin area. In response to this anthropogenic decline, we (the U.S. Fish and Wildlife Service) listed the rough popcorn flower (also called the hairy popcorn flower) on January 25, 2000 (65 FR 3866). This species is also listed as endangered by the State of Oregon (OAR 603-73-070).

### **Description of Species**

The rough popcorn flower is an herbaceous plant which can be 50 to 60 centimeters (20 to 24 inches) tall and perennial, or considerably smaller and annual, depending on environmental conditions (Amsberry and Meinke 1998). The upper stems are distinctly hairy with hairs perpendicular to the stem, and the bright green, simple linear leaves have hairy margins. Flowering stems are spreading, with paired coiled inflorescences bearing white, five-petaled flowers with yellow centers (fornices). Large plants can consist of over 50 flowering stems, and each stem produces 10 to 100 flowers. As in most members of the Boraginaceae, anthers are included and epipetalous (having stamens instead of corolla). Each flower can produce four tan-colored to black nutlets; due to fruit abortion or lack of pollination, calyces (the outer set of floral leaves making up the external part of the flower and consisting of separate or fused sepals that are usually green and foliaceous, but often colored like the corolla) with fewer than four nutlets are often observed.

The rough popcorn flower and fragrant popcorn flower (*Plagiobothrys figuratus*), the other species of popcorn flower found throughout western Oregon, are both members of the subgenus *Allocarya*, (Abrams 1951, Peck 1961) and are quite similar in appearance. The rough popcorn flower is the larger of the two, growing to 70 centimeters (24 inches) in height (*P. figuratus* generally reaches only 15 to 45 centimeters [6 to 18 inches], with stouter stems (4 to 5 millimeters [3/8 inch] wide as compared to approximately 2 millimeters [3/16 inch] in *P. figuratus*), and often larger flowers. Nutlets, the basis for taxonomic differentiation within *Plagiobothrys*, are remarkably similar in the two species, although the attachment scar is generally basal in *P. hirtus*, and lateral in *P. figuratus*. In the field, the two taxa are readily discernable by the distinctly spreading (rather than appressed) pubescence, large size, and facultatively perennial nature of *P. hirtus*, which easily distinguish it from *P. figuratus*, as well as other species (*P. scouleri*, *P. nothofulvus*) that may be present in our area. Seedlings of the flower germinate in fall and overwinter as submerged rosettes; this aquatic juvenile stage is similar in appearance to the rosettes of many species of wetland plants, and is difficult to identify.

## **Distribution**

The rough popcorn flower is found only in the Umpqua River drainage in Douglas County, Oregon, at sites ranging from 102 to 232 meters (311 to 707 feet) in elevation. Extant, naturally occurring populations of this species occur along the Sutherlin Creek drainage from Sutherlin to Wilbur, adjacent to Calapooya Creek west of Sutherlin, and in roadside ditches near Yoncalla Creek just north of Rice Hill. The northernmost reported site is near Yoncalla, and the southernmost at Wilbur. Until 1998, all known sites were east of Interstate Highway 5 (I-5), but a site has been discovered at the junction of Stearn's Lane and Highway 138, 0.8 kilometer (0.5 mile) west of I-5. The easternmost currently known extant population is just east of Plat K Road outside Sutherlin. Historic collections have been made farther east near Nonpareil, but recent surveys (1998 to 1999), although limited due to private ownership of most land in this area, did not locate any populations in this area. Collections from outside this area of Douglas County are probably misidentified collections of *P. figuratus* (K. Chambers herbarium notes - Oregon State University Herbarium).

In the final listing rule for the rough popcorn flower, we described 17 extant populations or patches of the rough popcorn flower based on information from our files, Oregon Department of Agriculture, The Nature Conservancy, and the Oregon Natural Heritage Program (65 FR 3866). A recent review of the Oregon Natural Heritage Program database indicates that, since the initial collection and description of the rough popcorn flower, this species has been reported and/or collected from a total of 15 naturally occurring sites (not including populations created as part of mitigation or enhancement projects). Several Oregon Natural Heritage Program sites are made up of multiple U.S. Fish and Wildlife Service identified patches, and one site listed by us is not on the Oregon Natural Heritage Program List (all known sites are listed in Appendix 1 and shown on Maps 1-3).

Throughout this report, “occurrence,” “site,” “patch,” or “population” will represent a U.S. Fish and Wildlife Service site as described in the listing package (65 FR 3866); corresponding Oregon Natural Heritage Program Element Occurrence codes (EO-codes) will be listed in parentheses. These terms are used in a practical sense to indicate the occurrence of one or more plants at a defined geographical location, and not to imply that the designated group of plants is necessarily a “population” in the strict biological sense of the word.

In addition to the naturally occurring populations, rough popcorn flower transplants have been introduced at two sites on the North Bank Habitat Management Area, a Bureau of Land Management Area of Critical Environmental Concern on North Bank Road east of Wilbur. These sites occur along two small drainages: Soggy Bottom and Chasm Creek, which drain directly into the North Umpqua River. A population was also created on private land as part of a mitigation project by Land and Water Environmental Services, Inc. (Barnes, 2000, pers. com). This site is on Sutherlin Creek, just west of I-5, across the highway from The Nature Conservancy’s William Oerding Popcorn Swale Preserve.

Five patches are considered protected. Two patches (EO\*004) are owned by the Oregon Department of Transportation and three patches, which constitute the Popcorn Swale Preserve (EO\*009), are managed by The Nature Conservancy for

the popcorn flower. The remaining extant populations are on private, commercial, residential, and agricultural land. Protection can be achieved through a variety of means: permanent protection of sites on public lands through management plans, acquisition through purchase or land exchange, and long-term or permanent conservation agreements or easements with willing landowners.

To ensure that the rough popcorn flower is conserved throughout its range, and that the genetic diversity currently present in this species is maintained, we assigned each known natural population to one of three recovery units (Map 2). The recovery units correspond to drainage basins within the North Umpqua system, and represent groups of populations which (based on our observations and preliminary research) are the most genetically similar.

The Calapooya Creek (including Cook Creek) Recovery Unit supports one extant population (EO\*014 - public and/or privately owned) and contains the site of an historic collection made in 1932 (EO\*003).

The Yoncalla Creek Recovery Unit contains two publicly owned (Oregon Department of Transportation) extant patches (EO \*004), and contains the site of an historic collection made in 1939 (EO\*002).

The majority of the extant 14 populations (EO\*001, EO\*005, EO\*007, EO\*012, EO\*013, EO\*015) occur in the Sutherlin Creek Recovery Unit - this area also contains 4 of the 6 extirpated populations (EO\*006, EO\*007, EO\*010, EO\* 011), in addition to 1 small newly created population on private land.

### **Habitat and Ecology**

The rough popcorn flower occurs only in seasonal wetlands where it remains submerged under standing water from late fall through spring. The majority of extant and extirpated sites occur on the Conser soil series (Appendix 2) which are deep, poorly drained soils present in depressions in alluvial stream terraces. An apparent water table is at its uppermost limit within these soils from November to May. The plant also appears on the Brand soil series which are poorly drained

soils in low stream terraces with apparent water tables at or near the soil surface from November to May (Natural Resources Conservation Service 1997, Soil Survey Division 2000). Several other soil series are occasionally associated with the plant; most are poorly drained flood plain soils. Map 3 shows distribution of potential habitat within recovery units based on soil type.

The rough popcorn flower often occurs in dense, monospecific groups in the deepest portion of the shallow pools in which it resides. Associated species occurring along the immediate periphery of rough popcorn flower populations are typical of sedge/grass-dominated open marsh. Native herbaceous associates include green-sheathed sedge (*Carex feta*), clustered sedge (*C. arcta*), one-sided sedge (*C. unilateralis*), common rush (*Juncus effusus*), pointed rush (*J. oxymeris*), tapered rush (*J. acuminatus*), western mannagrass (*Glyceria occidentalis*), sloughgrass (*Beckmannia syzigachne*), tufted hairgrass (*Deschampsia caespitosa*), and Leichtlin's camas (*Camassia leichtlinii*). Annuals present in these sites include skullcap speedwell (*Veronica scutellata*), Willamette downingia (*Downingia yina*), and Douglas' meadow-foam (*Limnanthes douglasii*). Most sites are moderately to highly disturbed due to agricultural and development activities. Consequently, they suffer from infestations of exotic weeds, including teasel (*Dipsacus sylvestris*), Himalayan blackberry (*Rubus discolor*), pennyroyal (*Mentha pulegium*), and knapweed (*Centaurea* sp).

Native oaks (*Quercus garryana*) and ash (*Fraxinus latifolia*), as well as introduced *Pyrus* sp., exist on the perimeters of some pools, but the rough popcorn flower does not occur in the shaded understories of these sites. Both circumstantial and experimental evidence suggest that shading diminishes the vigor and reproductive capacity of the rough popcorn flower, and reduces seedling recruitment and establishment (Amsberry and Meinke 1999). Before European settlement, sites were probably kept open by periodic burning due to fires purposefully set by Native Americans, or occurring naturally from lightning strikes (Johanessen *et al.* 1971).

The interaction of the rough popcorn flower and other organisms present in its ecosystem has not yet been well-studied. Caterpillars and aphids have been observed eating foliage and flowers of the rough popcorn flower, and plants

showing evidence of herbivory by deer and small rodents have also been documented. Beetles use the flowers for breeding platforms, and spiders are often seen hunting in the dense foliage in summer. Native ctenuchid moths (*Ctenucha*) are seen consistently on the plants throughout the spring and summer, and have been observed obtaining nectar from the flowers, but the importance of the flower to the moth, or vice versa, is not known.

### **Life History and Demography**

The rough popcorn flower has an annual or short-lived perennial life history. Seeds are dispersed as they mature in summer and fall, and begin to germinate with the initiation of fall rains. In the greenhouse, 65 to 95 percent of field-collected seed germinated within 5 days, provided the germination medium was adequately moist. Germination is also prolific in the field, with zero to 78 seedlings present per 10 square centimeter (4 square inch) plot after natural seed dispersal from introduced plants at the North Bank Habitat Management Area. Seedling mortality in these plots was quite high; we observed 26 to 65 percent mortality within the first month after germination. Intraspecific competition, damage due to uprooting by seasonally rapid stream flows, and other stochastic events contributed to the high levels of mortality observed.

Those seedlings that survive over winter as submerged rosettes, like many seasonally aquatic vernal pool plants, exhibit a morphology very different from the adult plants. Immersed plants produce rosettes of glabrous, terete (round, smooth) leaves with extensive lacunal (cavity or depression) airspace. These submerged rosettes are so distinct from the hirsute, flattened foliage produced by emergent plants as to be almost unrecognizable as the same species. This type of submerged vegetation (appropriately titled an 'isoetoid' growth form, as it is typified by the wetland plant *Isoetes*) enhances carbon assimilation in wetland habitats, and is common in seasonally aquatic plants (Keeley and Zelder 1998).

As water recedes in later spring, rosettes emerge and begin to develop flowering stems, which elongate and begin to produce flowers. Flowering is indeterminate and continues throughout the summer, with up to 100 flowers produced per flowering stem, but only 3 to 7 flowers open at any one time. Plants are self-

compatible, but require insects for pollination. A variety of pollinators have been observed on the flower, including ctenuchid moths (*Ctenucha*), bumble bees (Bombidae), honey bees (Apidae), hover flies (Syrphidae), and butterflies. In the presence of pollinators, four nutlets per flower can be produced, although, due to fruit abortion, less than this number are often observed.

As well as producing flowers, elongating stems on plants growing in optimal conditions root at the nodes, producing large foliar mats made up of many interconnected, rooted rosettes. As the pools where they grow become completely dry, plants of the flower begin to senesce (go dormant). In less than optimal conditions (*i.e.* shallower, drier pools), plants die as flowering is completed. In pools which retain adequate moisture, plants are reduced to a series of small rosettes, but remain green throughout the fall. As pool water levels again increase with the advent of winter rains, plants become submerged, and adapt their morphology to function as aquatics. During the winter, connecting internodes between rosettes rot away, leaving a series of independent, but genetically identical individuals. Established rough popcorn flower populations in most sites are made up of both perennial ramets and first year seedlings.

Research has shown that a propensity for a perennial life history in this species is both genetically and environmentally controlled. Plants in some populations, most notably those at the Yoncalla Site (EO\*004) and Stearn's Lane (EO\*014), are much more likely to perennate (remain) than those in others, such as Popcorn Swale (EO\*009), even when grown from seed under identical growing conditions in the greenhouse. Other morphological and phenological differences are evident among populations of the rough popcorn flower, indicating the existence of significant genetic variation among populations. In the greenhouse, plants grown from seed collected at Popcorn Swale (EO\*009) and the Hawthorne Street Site (EO\*007) begin to bloom 2 to 3 weeks before those grown from seed collected at Stearn's Lane (EO\*014) and the Yoncalla (EO\*004) sites. In created populations made up of greenhouse-grown plants from various sources, the number of flowers produced per plant, as well as the numbers of flowers per inflorescence, varied significantly among plants grown from three seed sources (Amsberry and Meinke 1999). Phenotypic variation is not unexpected among plant populations, even in the presence of (a limited level) gene flow (Levin 1993). As naturally occurring

populations are clustered on three distinct stream basins (Recovery Units 1 through 3), gene flow among these clusters has probably always been limited, maintaining variation and promoting population differentiation through genetic drift or selection. Gene flow among formerly interbreeding populations has become further restricted in recent times due to the fragmentation of previously continuous habitat, further fostering the fixation of adaptive or random traits (Barrett and Kohn 1991).

### **Reasons for Listing**

***The present or threatened destruction, modification, or curtailment of habitat or range.*** Land use patterns since the time of European settlement have greatly influenced vegetation patterns throughout the West, and habitat destruction has been of particular importance to the loss of vernal pool and seasonal wetland species. Conversion of wetlands to agricultural fields was identified as a major contributor to the extinction of vernal pool species as early as 1941 (Hoover 1941), and researchers currently estimate that 60 to 90 percent of pools extant at the time of European settlement have now been destroyed, along with the endemic plant and animal species associated with them (Keeley and Zedler 1998; King 1998). In the Umpqua Valley, conversion of wetlands to agricultural lands through hydrological alterations has drastically reduced the number of seasonal wetlands that can support the rough popcorn flower. Even within areas that have escaped wholesale destruction due to development or agriculture, changes in land management practices in neighboring wetlands have altered the nature of remaining pools. Draining of adjacent land has affected pool depth and size, reducing the suitability of these habitats for the rough popcorn flower.

In addition to being subject to filling and draining, wetlands have also been modified to the point of unsuitability for the rough popcorn flower by other land management practices. Fire suppression since the time of European settlement has drastically altered vegetation successional patterns in seasonal wetlands (Johannessen *et al.* 1971). Increasing shade due to canopy closure over pools that were previously kept open by fire has reduced suitability for the rough popcorn flower, and encroachment of competing native and exotic wetland vegetation has decreased the vigor and viability of existing populations. Sustained heavy



grazing, especially by sheep, has destroyed plants and damaged wetland integrity and stability.

Despite the negative effects of agriculture, the most devastating threat to the rough popcorn flower has occurred in recent years due to the rapid human population increase, and subsequent urban expansion, in the Sutherlin area. Sutherlin experienced a 3.8 percent annual growth rate from 1990 to 2000, one of the most rapid rates in the nation (Sutherlin Creek Stakeholders Meeting, November 15, 2000). This rapid growth rate, in a city built almost entirely within the historic drainage of Sutherlin Creek, has resulted in the filling and draining of wetlands for residential and commercial development at an unprecedented pace. Four populations of the rough popcorn flower within the boundaries of Sutherlin - Hawthorne 1 (EO\*007), Horsepasture 1 (EO\*010), Waite Road (EO\*006), Sheep Meadow (EO\*011) - have been lost to residential development within the last 5 years. One more (previously the largest known population Hawthorne 2 [EO\*007]) is currently on the brink of extirpation due to illegal filling and draining in preparation for a housing development (Franklin, 2000, pers. com.). Recovery Criteria 1, 2, and 3, when accomplished, will reduce threats from destruction and modification of habitat.

***Overutilization for commercial, recreational, scientific, or educational purposes.*** The rough popcorn flower is not known to be collected for any purpose. However, plants could potentially be collected for horticultural use, or to be tested for medicinal compounds. As this species is difficult to distinguish from other members of its genus, the initiation of large scale collecting of any species of *Plagiobothrys* could result in accidental collection of the rough popcorn flower. A more likely threat, however, is purposeful destruction of plants and their habitat through intentional vandalism. Several incidents of vandalism in the Sutherlin area have been documented, both by farmers who are concerned that their ability to farm will be curtailed by the presence of the rough popcorn flower on their land, and by developers concerned that they will not be able to develop their property. No threats were documented for collection of plants however, Recovery Criteria 1, 2, and 3, when accomplished, will reduce threats from vandalism.

***Disease or predation.*** Aphids may limit seed set by damaging inflorescences and reducing pollinator visitation, although the high seed set recorded in natural and experimental populations (up to 8,000 seeds/plant) indicates that aphid damage does not routinely have a dramatic impact on seed production (Amsberry and Meinke 1999, Amsberry 2001). Aphid populations vary greatly among populations and among years, and seem to be adequately restrained by natural controls. Deer, caterpillar, and rodent herbivory have been occasionally reported from most sites. The small amount of biomass removed by this type of herbivory appears to have little or no effect on plant growth or fecundity.

Grazing by domestic sheep and cattle appears to negatively affect populations of the rough popcorn flower. Populations present in fields where extensive grazing occurs are reduced to a few plants subsisting in and under patches of *Juncus* (which is not grazed by cattle), although in ungrazed fields plants prefer open areas away from *Juncus* clumps. However, populations in fields with limited grazing, especially by horses, appear to be growing well and reproducing prolifically. Limited grazing may, to some extent, mimic the biomass removal aspects of natural disturbances such as fire, and has the potential to be used as a management tool to maintain rough popcorn flower habitat. However, further research would be needed to determine optimal grazing regimes before this tool could be recommended. No Criteria were developed for insect predation since this is not a significant threat. However, Recovery Criteria 1, 2, and 3, when accomplished, will reduce threats from grazing of domestic sheep and cattle.

***Inadequacy of existing regulatory mechanisms.*** The rough popcorn flower is listed as endangered by the State of Oregon (OAR 603-73-011-010). However, State law does not protect listed plants when they occur on private land, and so has little effect on the majority of rough popcorn flower sites. These plants are afforded a certain level of protection because they are hydrophytic (typically found in wetlands) and wetlands are regulated as waters of the State under Oregon's Removal-Fill Law (ORS 196.800-196.990), and as waters of the United States under Section 404 of the Clean Water Act. Therefore, both State and Federal permits are required to fill or drain wetlands in Oregon. Nevertheless, from a practical standpoint, farm use exemptions combined with a "Federal nationwide permit program" contribute to significant cumulative wetland losses

and degradation. Also, as administered by the Oregon Division of State Lands and the U.S. Army Corps of Engineers, both the Removal-Fill Law and the Clean Water Act, respectively, allow most permit applicants issuance of their permits. While there are provisions for mitigation through avoidance and compensation under both the State and Federal authorities, the track record for mitigation success is poor. In addition, there are a large number of unauthorized activities occurring that further the amount of wetland loss and degradation. Provisions for enforcement of violations under Oregon's Removal-Fill Law and the Clean Water Act are meager. Subsequently, enforcement actions are confined to a relatively small percentage of the total number of violations and the successes of the actions applied are largely dependent on voluntary compliance.

However, since permitting under Section 404 of the Clean Water Act constitutes a Federal action (by the U.S. Army Corps of Engineers), there is a Federal nexus for section 7 consultation under the Endangered Species Act. But the Endangered Species Act does not allow a provision for the take of plants. Unless the proposed wetland fill activity will result in jeopardy to a listed species, in this case the rough popcorn flower, the action can not be denied. Recovery Criteria 1, 2, and 3, when accomplished, will reduce threats from fills and thus provide protection from inadequate regulatory mechanisms.

***Other natural or manmade factors affecting its continued existence.*** Other than habitat destruction, competitive exclusion from native and nonnative wetland vegetation probably represents the most significant ongoing threat to the rough popcorn flower. Pennyroyal (an exotic) and rushes (native) compete directly with the rough popcorn flower and appear to reduce plant size, fecundity, and especially seedling establishment. Severely invasive exotics, such as teasel and knapweed can completely choke wetlands, eliminating native plants and reducing wetland functions. Transplants of the rough popcorn flower establish better with vegetation removal (research in progress), as have other studies of transplant success and seedling recruitment in relation to vegetation removal (Carslen *et al.* 2000, Pendergrass *et al.* 1999).

Because the administratively protected populations (two patches owned by Oregon Department of Transportation; EO\*004, and three by The Nature

Conservancy; EO\*009) are adjacent to roadways (I-5 and County Road 338), the potential for chemical spills due to highway accidents is a conceivable threat to the rough popcorn flower. An accident of this type, although unlikely, could easily destroy a large portion of the protected populations. Accidental herbicide spraying as part of routine highway maintenance is also a possibility, although Oregon Department of Transportation's commitment to the rough popcorn flower conservation makes this scenario unlikely. Privately owned populations near the railroad tracks (the Deady Crossing Sites, Glide Lumber Site, and Horsepature 2 Site- EO\* 005, EO\*012, EO\*001) face a similar potential for destruction due to chemical spills and routine maintenance activities.

Habitat fragmentation is another way in which human intervention on the landscape has negatively affected the rough popcorn flower. The partitioning of a previously contiguous population into a series of isolated smaller ones serves to segregate the formerly large, interbreeding group of plants into a series of independent patches. These smaller, isolated populations no longer interbreed, and experience restricted gene flow, with a subsequent reduction in genetic variability within populations. Populations below an effective size of about 5,000 individuals will generally maintain insufficient adaptive genetic variability for evolution to occur, and those below 1,000 individuals will experience the accumulation of deleterious alleles which will ultimately result in population decline. As effective size includes only those plants that are effectively cross-breeding, actual population sizes (by census) need to be considerably larger, on the order of 5,000 to 10,000 individuals, in order to prevent the negative genetic consequences of small population size (Culotta 1995, Lande 1995, Lynch *et al.* 1995). Criteria 3 of the recovery objectives, when accomplished, will reduce threats from catastrophic events such as chemical spills because there will be at least three reserves in each recovery unit. Recovery Criteria 1, 2, 4, 5, 6, and 7, when accomplished, will reduce threats from habitat fragmentation, competition, and small population size.

### **Conservation Measures**

Conservation measures, including regulatory protection, land management plans, inventory of existing populations, and a series of research projects (including the

creation of new populations) have been developed by various agencies. Listings of the rough popcorn flower as endangered by the U.S. Fish and Wildlife Service and the Oregon Department of Agriculture provide regulatory protection for extant populations of the rough popcorn flower on Federal and State lands.

Land management plans promoting the persistence of extant rough popcorn flower populations have been developed by Oregon Department of Transportation and The Nature Conservancy. The Yoncalla patches (EO\*004) are managed by Oregon Department of Transportation as a Special Management Unit - these populations are mowed as part of a regular maintenance regime only in late summer to prevent damage to actively growing or reproducing plants. Other maintenance activities (such as spraying or ditching) are prohibited within this site. Removal of, or damage to, rough popcorn flower plants is prohibited. The Nature Conservancy actively manages for viability of the rough popcorn flower within the Popcorn Swale Preserve (EO\*009). Weedy competitors are removed on a regular basis, and populations are monitored annually to evaluate population status (Borgias, 2000, pers. comm.).

Several inventories for new populations have been completed, including a thorough search of the Sutherlin area by James Kagan (Oregon Natural Heritage Program) in the early 1980's, and a more recent survey by the Oregon Department of Agriculture in 1998. Surveys are generally confined to roadsides, as most rough popcorn flower habitat is in private ownership. A record of all known populations is maintained by the Oregon Natural Heritage Program, and is updated as new information is provided. Although anecdotal reports of new populations are frequently related, follow-up searches in response to these reports have not often been fruitful. The difficulty in identifying this species, and especially its similarity to the fragrant popcorn flower (*P. figuratus*) makes identification of this species by amateurs problematic. Public outreach efforts such as the Glide Wildflower Show provide an opportunity to display the two species, and educate the public on identification and conservation issues related to the rough popcorn flower.

As little published research on the rough popcorn flower had been completed prior to 1995, recent cooperative projects by the Oregon Department of

Agriculture, Oregon State University, and U.S. Fish and Wildlife Service on population-level genotype variation, reproductive biology, and life history traits have provided valuable information on the biology and ecology of this rare species. In addition, the elucidation of propagation, cultivation, and transplant requirements have permitted the large scale production of transplants to be used for population creation and reintroduction. A population augmentation project at two sites near Sutherlin, and the creation of two new populations on the North Bank Habitat Management Area, have both been successful in increasing the potential viability of the rough popcorn flower.

### **Recovery Strategy**

The rough popcorn flower will be conserved by establishing a network of protected populations in natural habitat distributed throughout its native range. To ensure conservation of currently existing genetic variability, and to prevent stochastic and demographic collapse, the plan requires that a minimum of 3 viable populations of 5,000 individuals be protected within reserves in each of the three recovery units. Watersheds are used as a basis for recovery unit distribution, as they are natural units of the landscape, and because evidence suggests that genetic differentiation may follow watershed boundaries. The strategy for each recovery unit will include rehabilitation of habitat, restoration of extant historic populations, reestablishment of extirpated populations, and creation of populations in never before occupied suitable habitat.

The importance of individual recovery units to the rough popcorn flower relies on providing for the distribution of rough popcorn flowers across their native range and maintaining adaptive ability to ensure long-term persistence. When total population numbers within the recovery unit fall below 5,000 individual rough popcorn flower plants, these populations could experience the accumulation of deleterious alleles which ultimately result in population declines and extirpation. In order for the species to survive and recover in the future, all the genetic diversity across the total range of the species must be conserved in order to provide the species with adaptive abilities when the future environments change. Since each of the recovery units are based on preserving the genetic differentiation across the species range, all of these recovery units are necessary

for both the survival and recovery of the species. Thus, the loss of all the unique genetic material from one of the recovery units may spell extinction for the species when the environment undergoes a rapid change. Having reached this conclusion, that these recovery units are necessary for both the survival and recovery of the species, we shall consider the effects of proposed Federal actions undergoing section 7 consultation on the recovery unit, rather than on the species as a whole. This means that a determination that a proposed Federal action violates section 7(a)(2)'s prohibition against jeopardizing the continued existence of a listed species need only consider effects to a recovery unit, and not wide ranging effects to the species as a whole.

To be counted toward the recovery objective, reserves must consistently maintain adequate numbers of rough popcorn flower plants. Density is calculated by counting the number of rooted stems/nodes present in a 1 square meter (3.28 square feet) plot with no regard to origin. Because this species spreads through vegetative reproduction (adventitious stem rooting), individual, independent plants may not represent genetically distinct individuals. Measures of occupied habitat, combined with density, provide a practical method for evaluating the viability of both extant, reestablished, and newly created populations.

Both extant, historic, reestablished, and newly created populations will require management. Encroaching vegetation must be controlled, and populations may require periodic augmentation. Various land management regimes should be evaluated for efficiency, and prescribed management adjusted accordingly.

## II. RECOVERY

### Recovery Objective

The objective of the recovery plan is to reduce the threats to and increase population viability of the rough popcorn flower to the point that it can be downlisted to threatened. Implementation of the recovery actions and tasks specified in the plan should allow this species to become capable of sustaining itself indefinitely within its historic range. This plan addresses the major threats to the rough popcorn flower, and recommends actions to reduce or eliminate these threats: habitat destruction and fragmentation will no longer occur within protected reserves, appropriate management plans will not allow heavy grazing or other destructive actions (such as herbicide spraying), and encroaching vegetation will be controlled or removed.

### *Criteria for reclassification to threatened status.*

The rough popcorn flower should be considered for downlisting to threatened when all of the following criteria are met.

1. At least nine reserves, containing a minimum of 5,000 plants each, are protected and managed to assure their long-term survival.
2. A minimum of 1,000 square meters (1,200 square yards) are occupied by the rough popcorn flower within each reserve, with at least 100 square meters (120 square yards) having a density of 100 plants/square meter (100 plants/120 square yard) or greater. "Occupied habitat" is defined based on a vegetation sampling procedure using 1 meter x 1 meter (1.20 yard x 1.20 yard) plots that are scored for the presence or absence of the rough popcorn flower. Density is calculated by counting the number of rooted stems/nodes present in a 1 square meter (1.20 square yard) plot. Due to the clonal nature of the rough popcorn flower, independent stems can be considered "ramets", and may not represent genetic individuals.
3. A minimum of nine reserves are distributed among the three natural recovery units (Calapooya Creek, Sutherlin Creek, Yoncalla Creek), with at least three reserves present in each unit.



4. Patches contained in each reserve are within 1 kilometer (0.6 mile) (Levin 1993) of each other to allow pollinator movement and gene flow among them.
5. An average of 5 years of demographic data indicate that at populations in at least seven of the nine reserves within Units 1 through 3 have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.
6. Seventy-five percent or more of the plants are reproductive each year, with evidence of seed maturation and dispersal in all populations.
7. Seed germination and seedling recruitment are occurring in all populations.

Appendix 3 links recovery criteria to the five listing factors and recovery tasks.

The total size of a reserve will be considerably larger than its area of occupied habitat, and each reserve will contain multiple patches of the rough popcorn flower. Populations of this species may move into and out of suitable habitat, requiring that available habitat surrounding existing or created patches be kept in suitable condition to allow for frequent colonization, abandonment, and recolonization of these areas.

The rough popcorn flower is not delistable unless vigorous natural occurrences are found in the native habitat that are not threatened, and can be secured and protected. Specific criteria for this hypothetical case cannot be developed at this time.

### **Step Down Outline of Recovery Actions and Tasks**

#### **1. Conserve and manage a minimum of nine reserves within three recovery units**

##### **1.1 Conserve existing patches within recovery units**

###### **1.1.1 Evaluate the status of all existing populations**

###### **1.1.2 Conduct surveys to search for new populations**

###### **1.1.3 Select and delineate reserve sites**

###### **1.1.4 Protect habitat to be included in reserves**

###### **1.1.5 Improve management of existing sites**

- 1.1.5.1 Provide educational opportunities for landowners/managers
    - 1.1.5.2 Use of existing authorities and applicable regulations
    - 1.1.5.3 Reduce competition and reduce impacts of succession from native and nonnative competitors
      - 1.1.5.3.1 Evaluate techniques to reduce competition from native and nonnative species
      - 1.1.5.3.2 Evaluate techniques to reduce impacts of woody succession from native and nonnative species
      - 1.1.5.3.3 Implement control measures
    - 1.1.5.4 Augment size of existing populations
      - 1.1.5.4.1 Collect seeds from extant sites
      - 1.1.5.4.2 Produce and establish transplants
    - 1.1.5.5 Monitor existing populations
  - 1.2 Develop new protected populations in each recovery unit
    - 1.2.1 Select appropriate sites for new populations
      - 1.2.1.1 Identify ecologically appropriate habitat
      - 1.2.1.2 Protect population creation sites
    - 1.2.2 Collect seeds
    - 1.2.3 Produce and establish transplants
    - 1.2.4 Manage populations to promote viability
    - 1.2.5 Monitor new populations to determine viability
- 2. Ex-situ conservation
  - 2.1 Rank populations
  - 2.2 Collect and bank seeds
- 3. Research factors that threaten the recovery of the species
  - 3.1 Evaluate population genetic diversity
  - 3.2 Evaluate the availability of pollinators
- 4. Provide outreach services for owners of reserve populations and the general public

## Narrative Outline of Recovery Actions

**1. Conserve and manage a minimum of nine reserves within three recovery units.** All extant populations of the rough popcorn flower are fragmented and subject to disturbance and probable extirpation. In order to reverse the current downward trend for this species, and ensure its viability, at least three reserves, distributed within the three natural recovery units, should be conserved and managed for the long-term benefit of the species. Protection of these reserves can be accomplished by conservation agreements with current landowners, land acquisition, and integration of conservation priorities into land use planning by local agencies such as the City of Sutherlin.

To maximize genetic and ecological variation in the rough popcorn flower, and reduce its vulnerability to random events, reserves should be distributed among three natural recovery units. The three natural units are located along three subbasins of the North Umpqua River: Yoncalla Creek, Calapooya Creek (including Cook Creek), and Sutherlin Creek.

The Yoncalla Creek Unit currently supports two extant patches (EO\*004), the only ones on publicly owned land (Oregon Department of Transportation, Roseburg, Oregon). Plants in this population are morphologically distinct from those in other populations, as they are generally larger than other plants, and have a greater tendency to exhibit a perennial life history (research in progress). Herbarium collections from an extirpated site on Yoncalla Creek (EO\*002) also exhibit this larger, more perennial-appearing morphology, indicating that plants growing along this watershed may represent a genetically distinct group. This possible genetic distinctiveness, combined with their location at the far north end of the range for the rough popcorn flower, makes these populations especially worthy of conservation (Lesica and Allendorff 1995). As these two patches are close enough to interbreed and contain more than 5,000 plants between them, they constitute the basis for one reserve. This Unit must contain at least three reserves, requiring the creation of new populations in two new protected reserves.

The Calapooya Creek Unit currently supports one extant patch (Stearn's Lane, EO\*014). An extirpated site east of Sutherlin (represented by Cole's 1932 collection at Nonpareil, EO\*003) is also located along the Calapooya. Although

these two populations are currently too distant from each other to interbreed, undocumented intermediary populations may have once existed along this watershed, allowing gene flow among these sites to occur. The Stearn's Lane population is currently very small (less than 0.2 hectare [0.5 acre] and 500 plants) and isolated from other populations. As it is within a few meters of the County Road, it is at least partly on public land and is nominally protected. Augmentation of this population, as well as clarification of its ownership and protection, will be necessary if it is to be included as a reserve population. The Calapooya Unit must support three populations on protected land, near enough to each other to interbreed. The area around Ford's Pond has been suggested as an appropriate site for the creation of new populations of the rough popcorn flower (Sullivan, 2000, pers. comm.), and may meet the administrative and ecological criteria to be incorporated into a reserve.

The Sutherlin Creek Unit contains the remainder of the extant and extirpated patches (18), and makes up the central core of the rough popcorn flower's range. At least 3 of the 18 patches are within The Nature Conservancy's Popcorn Swale Preserve where they are protected and managed. A progression of patches stretching north from Popcorn Swale to Sutherlin currently exists, creating a series of interbreeding populations which can fill appropriate habitat as it becomes available. A created population also exists within this Unit as part of a wetland mitigation project (Barnes, 2000, pers. comm.).

Protection of these existing patches, as well as the currently unoccupied habitat between them, is of paramount importance to successful recovery. These intermediary populations are currently privately owned. Securing these sites through acquisition, conservation agreements, and other means is a priority for recovery. Extirpated and extant sites within and around the City of Sutherlin should also be protected. Four populations in this Unit have been lost since 1995, resulting in a serious reduction in viability of the species. The remaining extant sites, (part of the Hawthorne Road Site [EO\*007], Southside Road [EO\*015], and Sutherlin 1 [EO\*001]) should be protected as part of the City of Sutherlin's urban development plan. Populations within at least three reserves must be protected in this Unit. Development of more than three reserves would promote stability of this species.

The North Bank Habitat Management Area currently supports two created populations of the rough popcorn flower. Created in 1998 and 1999, these populations are currently proliferating and appear stable (Amsberry and Meinke 1999). Despite the lack of evidence that the rough popcorn flower historically occurred in this site, the administrative protection and beneficial land management practices in this area make these ancillary populations a good choice for future reintroduction and research studies.

**1.1 Conserve existing patches within recovery units.** Conservation of all currently extant populations of the rough popcorn flower is essential to recovery of this species. Creation of new viable populations is a difficult process, and efforts to recreate populations of rare plants have often been unsuccessful (Allen 1994). Little is known about the ecological needs of the rough popcorn flower, and, although our initial efforts have been successful, a better understanding of the plants ecology is needed to ensure created populations can persist. Although reintroducing populations of the rough popcorn flower within the three recovery units will be an important component of recovery, these created populations will be considered *in addition* to currently extant populations and not as substitutes for them. Research currently in progress at Oregon State University indicates that significant genetically-based variation in ecologically important traits such as life history exists among populations; the conservation of genetic material from all extant populations will be needed to conserve the genetic integrity of the species.

**1.1.1 Evaluate the status of all existing populations.** The purpose of this task is to assemble all available information necessary to make informed decisions about which populations can (or cannot) contribute to the recovery of the species. Population size, threats to viability, landownership, and land management objectives should be determined for all sites. Sites which are being threatened by potential filling and draining of wetlands should be identified.

**1.1.2 Conduct surveys to search for new populations.**

Although several surveys have been completed in the Sutherland

Unit, continued reports of previously unknown populations, combined with the ability of the rough popcorn flower to advance and retreat into marginal areas in response to changing habitat conditions, requires further surveys. In order to maximize success, surveys should be done in late-June through mid-July, when plants are in flower.

**1.1.3 Select and delineate reserve sites.** Reserve sites in the three recovery units will be selected in consultation with private landowners, public agencies, and other interested groups or individuals. The most suitable sites will be selected based on land ownership, site management, and other relevant factors - all currently extant sites should be included in reserves if possible.

Boundaries of selected reserves should be accurately identified to ensure precision and efficiency in habitat acquisition and development. Reserve size, location and boundaries will be determined by land ownership, current and projected management practices, distance between extant populations, and provision for unoccupied habitat to allow for population expansion. Boundaries should also be designated to promote site security, to allow for maintenance of adjacent areas, and to protect hydrologic integrity of protected populations.

Once reserve boundaries have been identified, they should be accurately depicted on aerial photos, large scale topographic maps, and accessible geographic information data bases. Boundaries should also be clearly marked in the field to avoid unintentional disturbance of rough popcorn flower populations.

**1.1.4 Protect habitat to be included in reserves.** All extant populations will be needed as key components of the projected series of interbreeding patches, as well as serving as seed sources for recreating this network of viable populations. The populations within the Sutherlin Creek Unit are especially significant, as they form an interconnected series of populations that can interbreed,

and constitute the central core of the species' range. Conservation of larger populations (such as Horsepasture 2, The Nature Conservancy's Popcorn Swale Preserve [EO\*009], Deady Crossing South [EO\*012] and Oregon Department of Transportation's Yoncalla populations [EO\*004]) is a top priority, as these can serve as seed sources for both human mediated and natural dispersal into available habitat. Conserving peripheral populations is also important because their isolation may indicate that they are genetically divergent from their neighbors, thereby contributing to within-species genetic diversity, and providing an opportunity for the species to evolve (Lesica and Allendorf 1995).

In order to reliably provide for the recovery and long-term survival of the rough popcorn flower, naturally occurring sites on private lands must be permanently protected. This can be done through acquisition by groups interested in rough popcorn flower recovery, conservation agreements, mitigation banking agreements, and easements with landowners. Naturally occurring sites on public lands may be protected by management plans, conservation agreements, and establishment of populations within wetland mitigation sites monitored by the U.S. Army Corps of Engineers and Oregon Division of State Lands.

**1.1.5 Improve management of existing sites.** Removal of the threats of development and habitat destruction alone will not provide for the recovery of the rough popcorn flower. Land management practices since the time of European settlement have greatly altered wetland ecosystems, and active management of sites which support this species will be necessary.

**1.1.5.1 Provide education opportunities for landowners/managers.** Appropriate strategies for managing the rough popcorn flower will depend on the goals of the managers at each site. Integration of managers' current goals with rough popcorn flower recovery will ensure that recovery objectives outlined in

this recovery plan will be met. This species tolerates some disturbance, and naturally grows in dense patches within fairly restricted areas. Due to these ecological traits, many types of agriculture, and in some cases even development plans, can be modified to promote rough popcorn flower viability, while still allowing these uses to continue.

Many extant populations in the Sutherlin Creek Unit (other than those owned by The Nature Conservancy) currently suffer from damage due to domestic animals. Cattle and sheep graze rough popcorn flower plants, and trampling damages wetland habitat. Reduction in grazing pressure can be expected to improve the viability of populations of this species, and would be especially beneficial in sites which currently support scattered patches of rough popcorn flower plants (*i.e.* the Wilbur and Deady Crossing Sites - EO\*005, EO\*012). However, the reduction in the biomass of competitive vegetation produced by appropriate levels of grazing may also promote rough popcorn flower reproduction and recruitment. Determination of optimal levels of grazing, and subsequent dissemination of this information to land managers, will help with the development of acceptable management plans.

**1.1.5.2 Use of existing authorities and applicable regulations.** Efforts by municipalities, County, State, and Federal entities to use existing authorities should be explored. For example, to secure known and potential wetland habitats, Wetland Conservation Plans under Oregon Division of State Lands, Special Area Management Plans under the U.S. Army Corps of Engineers, and local zoning and land use planning under county and city planning departments all can play a role in conserving this species and its associated habitats. The City of Sutherlin has funded a local wetlands inventory to address State-wide Planning Goal 5 Guidelines. The project was funded, in



part, by the Oregon Division of State Lands. We contributed towards a concurrent inventory of potential habitat for the rough popcorn flower (Pacific Habitat Services 2001). Information from this inventory could lead to the development of a conservation planning (a Wetland Conservation Plan or Special Area Management Plan) effort using existing authorities to conserve the rough popcorn flower. Use of the U.S. Army Corps of Engineers existing regulatory authorities under Section 404 of the Clean Water Act and under section 7(a)(1) and 7(a)(2) of the Endangered Species Act should be pursued.

**1.1.5.3 Reduce competition and reduce impacts of succession from native and nonnative species.** Burning probably occurred historically in the Umpqua Valley. In the absence of a regular fire regime, some form of vegetation removal will be necessary to prevent encroachment at rough popcorn flower sites. Removal of competing vegetation has been instigated at The Nature Conservancy's Popcorn Swale Preserve (EO\*009),(Borgias, 2000, pers. comm.), and has always been part of Oregon Department of Transportation's management at the Yoncalla Site (EO\*004). Mowing appears to have been successful in preventing encroachment at this site, and may have contributed to the former vigor of the Hawthorne Road Sites (EO\*007). Mowing should take place in late summer, after maturation and dispersal of seeds. Carefully monitored grazing should also be evaluated as a potential mechanism for vegetation removal. Mowing, burning, and controlled grazing are three methods which merit further study to evaluate their efficacy in removing encroaching vegetation, and their effects on rough popcorn flower plants and seeds.

**1.1.5.3.1 Evaluate techniques to reduce competition from native and nonnative species.**

Plots should be established to assist in evaluation of burning, mowing, grazing, and vegetation removal techniques for removing competition. Plots should be of sufficient size to represent conditions in treatment areas and allow for the basic ecological needs of the rough popcorn flower.

**1.1.5.3.2 Evaluate techniques to reduce impacts of woody succession from native and nonnative species.** Succession of the rough popcorn flower's wet meadow habitat to ash/oak woodland in the absence of fire must be prevented. Trees should be removed as they develop, as this species does poorly in shaded areas (Amsberry and Meinke 1999). Plots should be established to assist in evaluating burning, mowing, grazing, and vegetation removal techniques to control woody succession.

**1.1.5.3.3 Implement control measures.** Based on information gained from Tasks 1.1.5.3.1 and 1.1.5.3.2, implement appropriate management to reduce competition and control woody plant succession.

**1.1.5.4 Augment extant populations.** Extant populations may require population augmentation as well as habitat improvement to reach the minimum required population size.

**1.1.5.4.1 Collect seed from extant sites.** Plants to be used for population augmentation should be grown only from seeds collected from within that population in order to preserve any locally adapted genotypes that may occur, and to avoid outbreeding depression. Seed should be collected from

as many individuals as possible in order to represent the range of genetic diversity present. Seeds from each individual should be labeled and stored separately (Guerrant 1996). Seeds should be collected when ripe (dark brown or black) - generally in July through September. Due to their indeterminate growth form, individual plants of the rough popcorn flower produce seed for an extended period. Providing that seed is collected carefully, without damaging inflorescences, plants will continue to develop after the seed collection process is complete, and will produce seed to be dispersed naturally within the collection site.

#### **1.1.5.4.2 Produce and establish transplants.**

Transplants have been successfully produced and established in new populations at the North Bank Habitat Management Area (Amsberry and Meinke 1999, Amsberry 2001). Two years after initial transplanting of 1,500 plants, over 5,000 plants are currently persisting in 2 areas at this site, with reproduction of original transplants and recruitment of new seedlings occurring. Plants are not difficult to grow from seed in the greenhouse, and increase rapidly when transplanted into appropriate habitat. Seeds germinate within a few days on moist media without pretreatment, and grow vigorously under standard greenhouse conditions (although care must be taken to avoid infestations by aphids). To avoid the need for supplemental watering, transplanting of potted non-flowering rosettes should be done in April.

**1.1.5.5 Monitor existing populations.** All currently extant populations should be periodically monitored for population size, number of individuals and evidence of

reproduction and recruitment. Monitoring should be completed at least once per year, and should include those populations on private land. Landowner outreach and education opportunities (Task 1.1.5.1) should include opportunities for population monitoring by the landowner, or by outside interested parties.

## **1.2 Develop new protected populations in each recovery unit.**

Replacing a rare species in sites from which it has been extirpated (and restoring suitable conditions to allow it to perpetuate) reestablishes a potentially important component of the original community for those sites, and promotes restoration of functioning ecosystems (Lande 1988).

Introduction of populations into new or historic sites within the general locality of established native populations, and augmentation of existing populations, also improves the demographic dynamics of the species as a whole. In the event of extirpation of some populations due to a catastrophic event, surviving populations can serve as seed sources to reestablish new populations into vacated sites, naturally, or by human-mediated seed dispersal (Menges 1991). A larger number of populations also allows for the development of increased genetic differentiation among sites, increasing overall heritable diversity, and providing more chances for the species to evolve in response to varying selective pressures (Huenneke 1991). As fragmentation of populations has been shown to interrupt pollinator movement, and consequently reduce seed set (Jennersten 1988; Agren 1996), reintroducing populations within a network that has been disrupted can improve pollinator services and increase fecundity of existing populations (Huxel and Hastings 1999). Due to the limited number of extant populations, their history of severe decline, and their low chances of long-term survival, the creation of new populations of the rough popcorn flower within its historic range will be an important component of its recovery.

**1.2.1 Select appropriate sites for new populations.** Site selection is one of the most important factors influencing the success of created or reintroduced populations of rare plants. Sites that are biologically appropriate and administratively secure

should be chosen (Fiedler and Laven 1996). Each of the three recovery units will require selection of sites for new populations; at least two sites must be chosen within the Yoncalla Unit and two within the Calapooya Unit.

**1.2.1.1 Identify ecologically appropriate habitat.**

Selection of sites likely to support new populations of the rough popcorn flower will be based on several factors. Naturally occurring populations of this species are generally associated with specific soil series (Conser, Brand, and Bashaw). Selection of sites on these soil types will maximize the likelihood of successful new populations. Persistent naturally occurring populations exist in shallow vernal pools, with little or no overstory. Use of a plant community composition model developed at Oregon State University (Amsberry 2001) to identify areas likely to support created populations of the rough popcorn flower would expedite successful site selection. An inventory of suitable sites by Pacific Habitat Services is currently in progress (Farrell *et al.* 2001). This study should also be consulted when selecting sites.

**1.2.1.2 Protect population creation sites.** In order to reliably provide for the recovery and long-term survival of the rough popcorn flower, naturally occurring and created sites must be permanently protected. This can be done through acquisition, conservation agreements, mitigation banking agreements, and easements with landowners. Similarly to natural sites, sites of created populations may be protected on public lands by management plans, by conservation agreements and easements with interested landowners, by establishment of populations within wetland

mitigation sites monitored by the U.S. Army Corps of Engineers and Oregon Division of State Lands, or through land acquisition by groups interested in rough popcorn flower recovery.

**1.2.2 Collect seed.** Seeds to be used in the creation of new populations should be collected as soon as possible from all known extant populations. Since research has shown that ecologically important traits vary among populations, collection of seeds from all populations is especially important.

**1.2.3 Produce and establish transplants.** See Task 1.1.5.4.2

**1.2.4 Manage populations to promote viability.** Management of new populations will probably be necessary to ensure their persistence. See Task 1.1.5 for more information on management improvement.

**1.2.5 Monitor new populations to determine viability.** See Task 1.1.5.5

**2. *Ex-situ* conservation.** Banking (long-term cryogenic storage) of rough popcorn flower seeds is recommended to provide an additional level of security to the recovery efforts. A reserve of banked seeds can be used for future augmentation and reintroduction projects, helping to produce appropriate types and levels of genetic diversity in created and augmented populations. Banked seeds may be used to increase genetic diversity in populations that are believed to be suffering from inbreeding depression, and to replace populations lost through environmental disasters.

**2.1 Rank populations.** All extant populations should be ranked to expedite seed collection. Seed from populations believed vulnerable to imminent disturbance or destruction should be collected as soon as possible. Populations that represent geographic outliers (*i.e.* the Yoncalla

patches - EO\*004), and those that represent morphological or phenological variation, should also be a priority for seed collection.

**2.2 Collect and bank seeds.** As well as being used to create new populations, collected seed should be deposited at the Berry Botanic Garden Seed Bank for Rare and Endangered Plants of the Pacific Northwest, located in Portland, Oregon, for long-term storage for potential future use. See Task 1.1.5.4.1 for more information on seed collection.

**3. Research factors that threaten the recovery of the species.** Although previously completed research has begun to provide information about the biology of the rough popcorn flower, many critical questions remain. Greater understanding of among-population genetic diversity, and study on pollinators are needed. Tasks 1.1.5.3.1 and 1.1.5.3.2 undertook studies to consider development of practical and effective strategies for controlling competing or overstory vegetation.

**3.1 Evaluate population genetic diversity.** Current research indicates that considerable morphological, ecological, and phenological differentiation exists among populations (research in progress). Further research to determine the levels of variation, possibly through molecular analysis, would be helpful in evaluating the extent of this differentiation, and would provide information critical to the creation of genetically representative populations.

Research on genetic variation within populations would also be valuable, as this would provide information on the potential for the development of inbreeding depression, and would illuminate population genetic structure. Because the rough popcorn flower reproduces asexually through adventitious stem rooting, populations have the potential to be made up largely of clonal ramets, with little or no variation among individuals. However, as plants in naturally occurring and created populations produce large numbers of seeds and seedlings, high levels of variation are also possible. Further information on population structure would assist in

developing new populations with genetic structure similar to that of existing patches.

**3.2 Evaluate the availability of pollinators.** Information is needed on which species are pollinators of the rough popcorn flower and the availability of these pollinators. The impacts of various vegetation control methods on the availability of pollinators also need to be evaluated.

**4. Provide outreach services for owners of reserve populations and the general public.** As recovery progresses, reserve sites are expected to be in a variety of ownerships, and this recovery plan will be effective only with the participation of the public and private landowners with jurisdiction over rough popcorn flower populations. Managers should be provided with information on efficient and beneficial management techniques, and assistance with population monitoring, as well as any other information or assistance they require. Public outreach efforts such as the Glide Wildflower Show provide an opportunity to share information, and educate the public on identification and conservation issues related to the rough popcorn flower.



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#### IV. IMPLEMENTATION SCHEDULE

The following Implementation Schedule is a guide for meeting the objectives discussed in Part II of this plan. This schedule indicates task priorities, task numbers, brief task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat. Priorities in column one of the following implementation schedule are assigned as follows:

- Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- Priority 2: An action that must be taken to prevent a significant decline in the species' population/habitat quality or some other significant negative impact short of extinction.
- Priority 3: All other actions necessary to meet the recovery objective.

Key to Acronyms used in Implementation Schedule:

Annual - Task expected to occur annually until species recovered.

Berry - Berry Botanical Garden

BLM- Bureau of Land Management

CITY- City of Sutherlin

COE- Corps of Engineers

DSL- Oregon Division of State Lands

EPA- U.S. Environmental Protection Agency

FHA- Federal Highway Administration

FWS- U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office

ODA- Oregon Department of Agriculture

ODOT- Oregon Department of Transportation

Total Cost- Projected cost of task from start to completion. Total cost of “annual” tasks are based on estimated time to downlisting (10 years).

\* - Lead Agency

**Recovery Plan Implementation Schedule for the Rough Popcorn Flower**

Priority #	Task #	Task Description	Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year				
						FY1	FY2	FY3	FY4	FY5
Conserve and manage 9 recovery units										
1	1.1.1	Evaluate the status of all existing populations	1	FWS*, ODA, ODOT, CITY,	30	30				
1	1.1.2	Conduct surveys to search for new populations	1	FWS*, ODA, ODOT, CITY	30	30				
1	1.1.3	Select and delineate reserve sites	2	FWS*, ODA, BLM, TNC	76		38	38		
1	1.1.4	Protect habitat to be included in reserves	10	FWS*, ODA, BLM, TNC, ODOT, COE, DSL, EPA, CITY	360		40	40	40	40
1	1.1.5.1	Education opportunities for landowners/ managers	Annual	FWS*, ODA, ODOT, CITY,	45		5	5	5	5

**Recovery Plan Implementation Schedule for the Rough Popcorn Flower**

Priority #	Task #	Task Description	Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year				
						FY1	FY2	FY3	FY4	FY5
1	1.1.5.2	Use of existing authorities and applicable regulations	Annual	FWS*, ODA, ODOT, DSL, COE, CITY	200	20	20	20	20	20
2	1.1.5.3.1	Evaluate techniques to reduce competition	3	FWS*, BLM, ODA, ODOT	30	10	10	10		
2	1.1.5.3.2	Evaluate techniques to reduce impacts of woody succession	3	FWS*, BLM, ODA, ODOT	30	10	10	10		
2	1.1.5.3.3	Implement control measures	Annual	FWS*, ODA, BLM, TNC,	160			20	20	20
2	1.1.5.4.1	Collect seeds from extant sites	Annual	FWS, ODA*	80			10	10	10

**Recovery Plan Implementation Schedule for the Rough Popcorn Flower**

Priority #	Task #	Task Description	Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year				
						FY1	FY2	FY3	FY4	FY5
2	1.1.5.4.2	Produce and establish transplants	Annual	FWS, ODA*	160			20	20	20
2	1.1.5.5	Monitor existing populations	Annual	FWS*, ODA, BLM, TNC,	320			40	40	40
Conserve and manage 9 recovery units					1521	100	123	213	155	155
Develop new protected population in each recovery unit										
2	1.2.1.1	Identify ecologically appropriate habitat	2	FWS*, ODA,	40	20	20			
2	1.2.1.2	Protect population creation sites	Annual	FWS*, ODA, COE, DSL, COE, CITY	360		40	40	40	40
2	1.2.2	Collect seeds	Annual	ODA	90		10	10	10	10



**Recovery Plan Implementation Schedule for the Rough Popcorn Flower**

Priority #	Task #	Task Description	Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year				
						FY1	FY2	FY3	FY4	FY5
2	1.2.3	Produce/ establish transplants	Annual	ODA	180		20	20	20	20
2	1.2.4	Manage populations to promote viability	Annual	FWS*, ODA, BLM, TNC, ODOT, FHA	180		20	20	20	20
2	1.2.5	Monitor new populations to determine viability	Annual	FWS*, ODA, BLM, TNC, ODOT, FHA	320			40	40	40
Develop new protected populations in each recovery unit					1170	20	110	130	130	130

**Recovery Plan Implementation Schedule for the Rough Popcorn Flower**

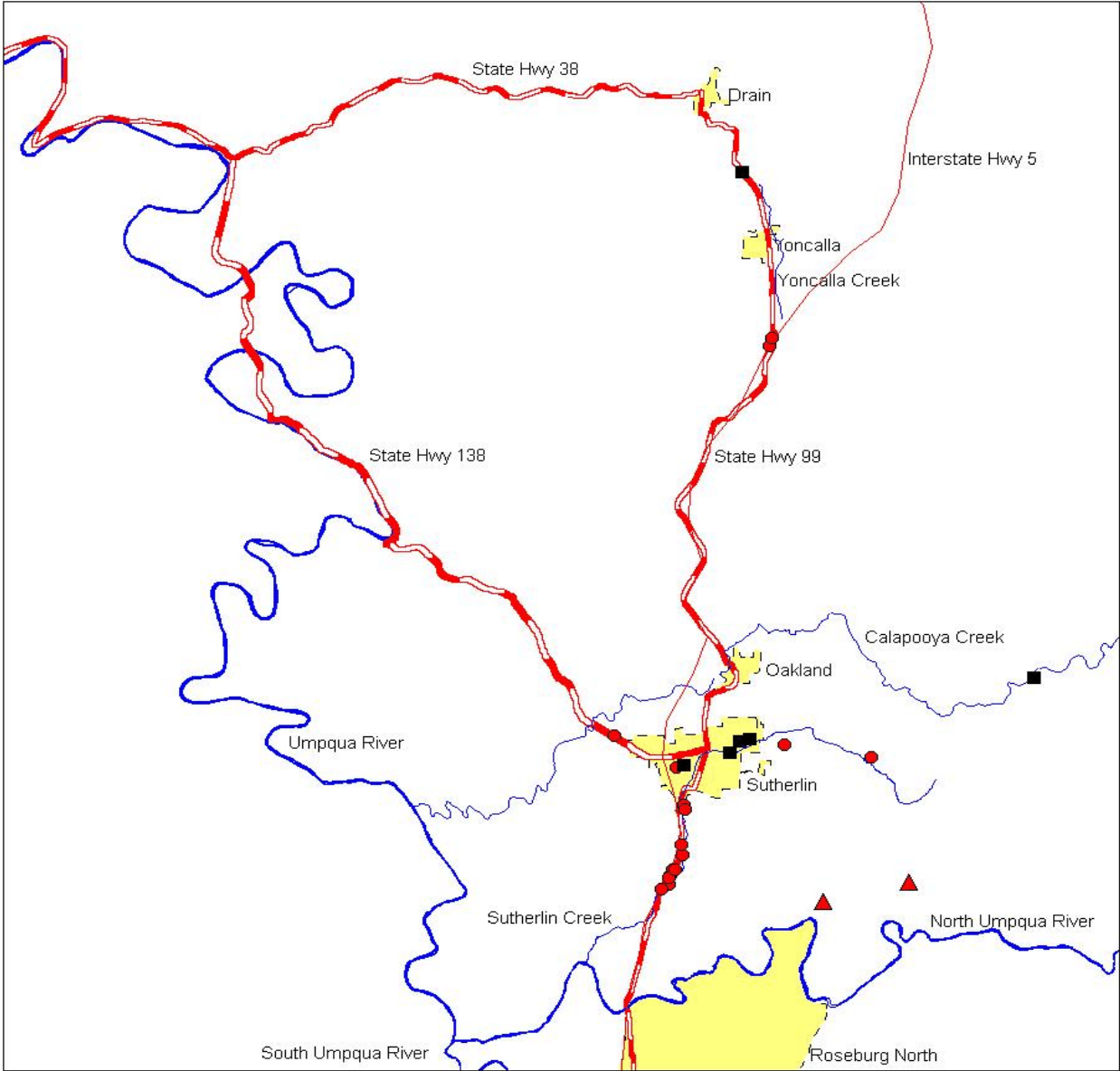
Priority #	Task #	Task Description	Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year				
						FY1	FY2	FY3	FY4	FY5
Ex-situ conservation										
2	2.1	Rank populations	1	FWS*, ODA,	10	10				
2	2.2	Collect and bank seeds	5	Berry	25	5	5	5	5	5
Establish long-term, ex situ conservation of popcorn flower seeds					35	15	5	5	5	5
Research factors that threatened recovery of the species										
2	3.1	Evaluate population genetic diversity	3	FWS, ODA*	60	20	20	20		
2	3.2	Evaluate pollinator availability	3	FWS*, ODA	60	20	20	20		
Research on factors threatening recovery					120	40	40	40	0	0

**Recovery Plan Implementation Schedule for the Rough Popcorn Flower**

Priority #	Task #	Task Description	Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year				
						FY1	FY2	FY3	FY4	FY5
Public involvement										
3	4	Provide outreach services for owners of reserve and the general public	Annual	FWS*, ODA	50	5	5	5	5	5
Total cost of recovery task implementation to downlisting					2896	180	283	393	295	295

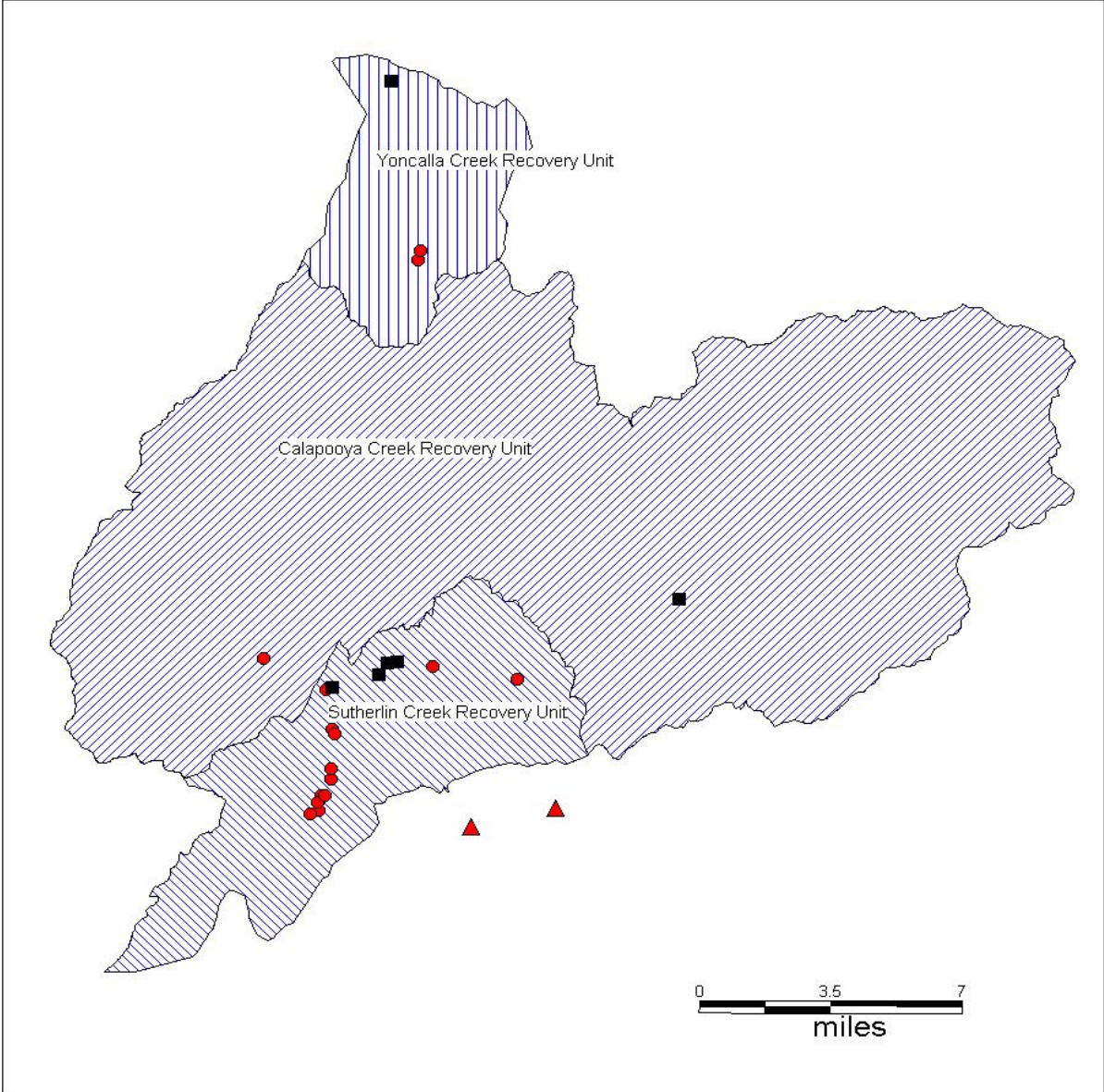
Map 1 *Plagiobothrys hirtus* distribution in Douglas County Oregon

- Extant population
- Extirpated population
- ▲ Ancillary population



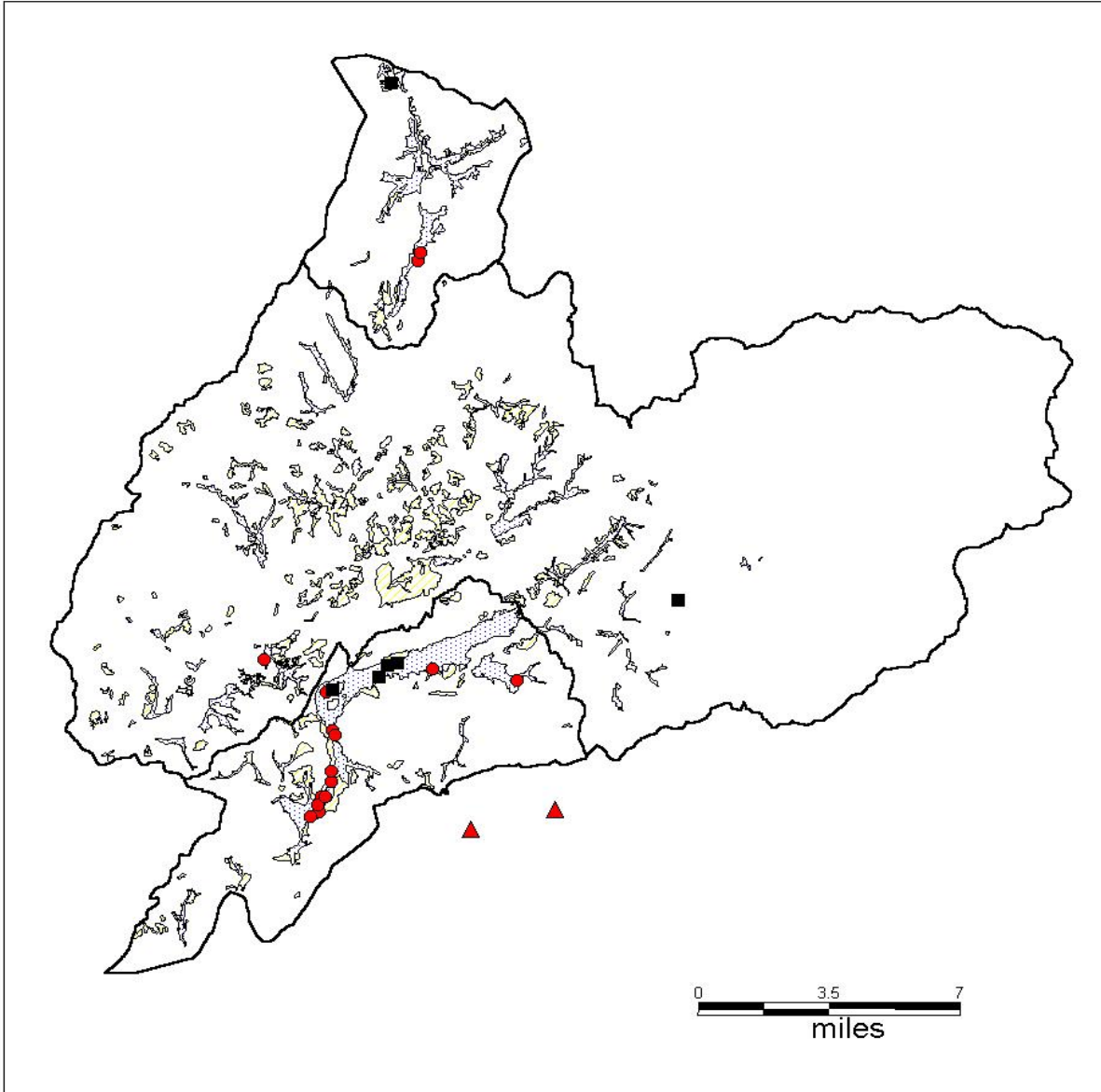
Map 2 *Plagiobothrys hirtus* Recovery units

- Extant population
- Extirpated population
- ▲ Ancillary population



Map 3 *Plagiobothrys hirtus* Potential Habitat within Recovery units

- Extant population
- Extirpated population
- ▲ Ancillary population
- ▨ Preferred Habitat ( Soils Conser)
- ▧ Not Preferred Habitat (Soils Bashaw, Brand, Nonpareil, Oakland, & Sibold)



## Appendix 1. Site Summary

### *Extant*

<b>Site Name</b>	<b>*ONHP</b>	<b>Acreage</b>	<b>Recovery Unit</b>
Hawthorne 2 (Dawn St.)	EO*007	1.67	Sutherlin Creek
Sutherlin 1 (Danny Lang)	EO*001	0.35	Sutherlin Creek
Popcorn 1 (east of road)	EO*009	1.24	Sutherlin Creek
Popcorn 2 (north on west side of road)	EO*009	17.02	Sutherlin Creek
Popcorn 3 (south on west side of road)	EO*009	6.39	Sutherlin Creek
Glide Lumber	EO*012	0.63	Sutherlin Creek
Wilbur North	EO*012	0.16	Sutherlin Creek
Wilbur South	EO*012	0.51	Sutherlin Creek
Deady Crossing North (O&K)	EO*005	0.53	Sutherlin Creek
Deady Crossing	EO*005	0.57	Sutherlin Creek
Deady Crossing South	EO*012	2.48	Sutherlin Creek
Horsepasture 2	none	5.51	Sutherlin Creek
Southside Road	EO*015	~5.5	Sutherlin Creek
Val Street	EO*013	~0.5	Sutherlin Creek
Stearn's Lane	EO*014	~0.5	Calapooya Creek
Yoncalla 1	EO*004	1.05	Yoncalla Creek
Yoncalla 2	EO*004	0.51	Yoncalla Creek
<b>Total = 17</b>	<b>9.5</b>	<b>39.12</b>	

### *Extirpated*

<b>Site Name</b>	<b>*ONHP</b>	<b>Acreage</b>	<b>Recovery Unit</b>
Hawthorne 1	EO*007	0.82	Sutherlin Creek
Horsepasture 1 (Lot 18)	EO*010	0.11	Sutherlin Creek
Waite Road	EO*006	0.12	Sutherlin Creek
Sheep Meadow (Grove Street)	EO*011	?	Sutherlin Creek
Peck Collection	EO*002	?	Yoncalla Creek
Cole Collection	EO*003	?	Calapooya Creek
<b>Total = 6</b>	<b>5.5</b>	<b>?</b>	

\*ONHP=Oregon Natural Heritage Program

**Appendix 2. Soils Chi Square Analysis for Rough Popcorn Flower**

Plagiobothyrus hirtus			Soil types					
	Number of Soils	total micro-cells	15a Bashaw Clay	29a Brand Silty Clay Loam	44a Conser Silty Clay Loam	166c & e Nonpareil Loam	170d Oakland Silt Loam	224b Sibold Fine Sandy Loam
Grid location	6	35						
Observed			2	5	21	3	2	2
Expected			5.833	5.833	5.833	5.833	5.833	5.833
(Obs-Exp) <sup>2</sup> /Exp			2.5190476	0.1190476	39.433333	1.3761905	2.5190476	2.5190476
43123C3:AD05					X			
43123C3:AA21							X	
43123C3:AA22						X		
43123C3:AB22						X		
43123C3:AD06					X			
43123C3:AD07				X				
43123C3:AD15				X				
43123C3:AD17				X				
43123C3:AD18				X				
43123C3:AE06				X				
43123C3:AE07					X			
43123C3:AF07					X			
43123C3:W27					X			
43123C3:W28					X			
43123C3:X26					X			
43123C3:X27			X					
43123C3:Y24					X			
43123C3:Y25					X			
43123C3:Y26			X					
43123C3:Z23							X	
43123C3:Z24					X			
43123D2:BM48					X			
43123D2:N68					X			
43123D3:AB71					X			
43123D3:AC71					X			
43123D3:AD70					X			
43123D3:AS67					X			
43123D3:AV65								X
43123D3:AY64								X
43123D3:BJ65						X		
43123D3:H63					X			
43123E3:BE40					X			
43123E3:BE41					X			
43123E3:BF39					X			
43123F3:AW72					X			

$\chi^2 = 48.49$ ;  $p < 0.001$



### Appendix 3. Summary of Threats and Recommended Recovery Actions.

<b>LISTING FACTOR</b>	<b>THREAT</b>	<b>RECOVERY CRITERIA</b>	<b>TASK NUMBERS</b>
<b>A</b>	Conversion of wetlands to agricultural lands	1, 2, 3, 5	1.1, 1.2
<b>A</b>	Fire suppression and vegetational succession	1, 2, 3, 5	1.1, 1.2, 4
<b>A</b>	Excessive livestock grazing	1, 2, 3, 5	1.1, 1.2, 4
<b>A</b>	Filling and draining of wetlands for residential and commercial development	1, 2, 3, 5	1.1, 1.2
<b>B</b>	Plant collectors	1, 2, 3, 5	1.1, 1.2, 4
<b>C</b>	Excessive livestock grazing	1, 2, 3, 5	1.1, 1.2, 4
<b>C</b>	Herbivory by aphids, deer, caterpillars, and rodents	NA	
<b>D</b>	Inadequate enforcement of State and Federal wetland legislation.	NA	4
<b>E</b>	Competitive exclusion by native and nonnative wetland vegetation.	1, 2, 3, 5	1.1, 1.2
<b>E</b>	Accidental herbicide spraying or chemical spills near railroad or highway rights of way.	3,5	1.1, 1.2, 4
<b>E</b>	Habitat fragmentation	1, 2, 4, 5, 6, 7	1.1, 1.2, 2.1, 2.2, 3.1, 3.2

**Listing Factors:**

- A. The Present or Threatened Destruction, Modification, or Curtailment Of Its Habitat or Range
- B. Overutilization for Commercial, Recreational, Scientific, Educational Purposes (not a factor)
- C. Disease or Predation
- D. The Inadequacy of Existing Regulatory Mechanisms
- E. Other Natural or Manmade Factors Affecting Its Continued Existence

**Recovery Criteria**

1. At least nine reserves, containing a minimum of 5,000 plants each, are protected and managed to assure their long-term survival.
2. A minimum of 1,000 square meters (1,200 square yards) are occupied by the rough popcorn flower within each reserve, with at least 100 square meters (120 square yards) having a density of 100 plants/square meter (100 plants/120 square yard) or greater.
3. A minimum of nine reserves are distributed among the three natural recovery units (Calapooya Creek, Sutherlin Creek, Yoncalla Creek), with at least three reserves present in each unit.
4. Patches contained in each reserve are within 1 kilometer (0.6 mile) of each other to allow pollinator movement and gene flow among them.
5. An average of 5 years of demographic data indicate that at populations in at least seven of the nine reserves within Units 1 through 3 have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.
6. Seventy-five percent or more of the plants are reproductive each year, with evidence of seed maturation and dispersal in all populations.
7. Seed germination and seedling recruitment are occurring in all populations..