

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


**Recovery Plan for  
*Fritillaria gentneri* (Gentner's fritillary)**



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RECOVERY PLAN  
FOR  
*Fritillaria gentneri*  
(Gentner's fritillary)

Region 1  
U.S. Fish and Wildlife Service  
Portland, Oregon

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

Date: JUL 21 2003

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## ACKNOWLEDGMENTS

The draft recovery plan was prepared by Steven D. Gisler and Dr. Robert J. Meinke, Oregon Department of Agriculture, Plant Conservation Program, with the assistance of Dr. Andy Robinson, U.S. Fish and Wildlife Service. The final recovery plan was edited and updated by Kathy L. Pendergrass and Dr. Andy Robinson, U.S. Fish and Wildlife Service. We would like to thank all of those who provided comments and input to the plan.

### **Nomenclature:**

Plant species nomenclature generally follows that of C.L. Hitchcock and A. Cronquist. 1973. *Flora of the Pacific Northwest*. University of Washington Press, Seattle, Washington. 730 pp.

Nomenclature of *Fritillaria gentneri* follows that of H.M. Gilkey. 1951. A new fritillary from Oregon. *Madroño* 11:137-141.

### **Note:**

This recovery plan incorporates field survey information up through 2001 and research findings through April 2003.

## EXECUTIVE SUMMARY

**Current Status:** *Fritillaria gentneri* (Gentner's fritillary) was listed as an endangered species on December 10, 1999 (U.S. Fish and Wildlife Service [USFWS] 1999). Although *Fritillaria gentneri* may be of recent hybrid origin, it is considered to be a valid species. This rare, red-flowered lily is known primarily from Jackson and Josephine Counties in southwestern Oregon, where it occurs in perilously small, widely scattered patches, comprising an estimated 1,696 flowering individuals. One additional small population has just been found in northern California, very close to the Oregon border.

**Habitat Requirements and Limiting Factors:** *Fritillaria gentneri* occurs within a broad array of plant associations but often occupies grassland and chaparral habitats within, or on the edges of, dry, open, mixed-species woodlands at elevations below 1,544 meters (5,064 feet). The species is threatened by a variety of factors including habitat loss associated with rapidly expanding residential and agricultural development, alteration of habitat by invasive weeds and successional encroachment by trees and shrubs, habitat disturbance from timber harvest and recreational activities, and vulnerability associated with extremely small population sizes. Other potential threats include bulb collecting for gardens and herbivory by deer and livestock.

**Recovery Priority Number:** This plant's recovery priority number is a 2 on a scale of 1 (highest) to 18 (lowest), reflecting its taxonomic status as a full species with a high degree of threat and a high potential for recovery.

**Recovery Objective:** Delisting once recovery criteria have been met.

**Recovery Criteria:** Recovery of *Fritillaria gentneri* will be based on the conservation of the species through protected populations ("*Fritillaria* management areas") distributed in natural densities across the historical range of the species in four designated recovery units. The species will be considered for reclassification from endangered to threatened status or delisting when the following criteria are met:

- (1) **To consider reclassification to threatened status:** Each recovery unit shall maintain at least 750 flowering plants. **To consider delisting:** Each recovery unit shall maintain at least 1,000 flowering plants. For delisting

purposes, these 1,000 flowering plants should occur in protected *Fritillaria* management areas and should have exhibited net demographic stability or growth for a minimum of 15 years, as determined through at least biennial demographic monitoring. For the purposes of this plan, measurements of population size and structure are based on counts of flowering individuals because non-flowering *Fritillaria* species are not easily distinguished.

- (2) To avoid the threat of habitat loss, the *Fritillaria* management areas within the recovery units should be located on public land, or private land subject to permanent conservation easement or other permanently binding agreements. Because populations elsewhere on public land continue to experience loss and degradation of habitat, each agency involved in land ownership or management in association with a *Fritillaria* management area should take appropriate steps to ensure the long term conservation of this species by outlining their specific responsibilities for site protection and maintenance in general land management plans, conservation agreements, and the like.
- (3) To reduce vulnerability to adverse random events inherent to small populations composed of too few and too widely scattered individuals, maximize and maintain potential genetic, ecological, and geographical variation in the species, and maintain current distributional patterns, 2 of the *Fritillaria* management areas within each recovery unit must consist of populations of at least 100 flowering individuals each within an 0.8-kilometer (0.5-mile) radius of each other. Recovery units may include additional management areas of various sizes, as necessary, to meet the requirement of 750 flowering individuals for downlisting or 1,000 flowering individuals for delisting. If necessary, *Fritillaria* management areas may be subject to augmentation using genetically appropriate (originating from the same recovery unit) cultivated individuals to meet the minimum size criterion (Recovery Action 2.43). *Fritillaria* management areas should contain ample habitat to provide a spatial buffer around each population, and allow room for population shifts and expansion over time.
- (4) To avoid population vulnerability arising from the inordinate concentration of individuals within a very small area, potentially subject to extirpation from unpredictable catastrophic events, flowering

individuals should be distributed over a minimum of 50,000 square meters (5 hectares or 12.4 acres) of occupied habitat within each recovery unit.

- (5) To maintain favorable habitat conditions, a site-specific management and monitoring plan should be developed, approved and implemented for each *Fritillaria* management area to prevent degradation of sites, to assess effects of management actions, and to allow for adaptive management to assure the recovery of the species. Survival of the species and removal of threats should be identified as primary objectives for these plans.
- (6) To protect plants from bulb collecting and herbivory by deer or livestock, each *Fritillaria* management area could be subject to fencing, change of grazing season or other measures if population monitoring identifies these threats.
- (7) To ensure the continuing recovery of the species and adequacy of management actions undertaken, a post-delisting monitoring plan must be developed and ready for implementation at the time of delisting.

**Actions Needed:** (Refer to Part II of this plan for more detailed descriptions of recovery actions)

1. Provide private landowners with information on identification and management of their habitat to maintain *Fritillaria gentneri*.
2. Establish, manage, and maintain a minimum of eight *Fritillaria* management areas, distributed within four recovery units, where the species will be secure from all threats described in the Reasons for Listing in Part I of this plan (see Part II of this plan for *Fritillaria* management area size and structure requirements).
3. Conduct surveys and research essential to conservation and recovery.
4. Develop off-site germplasm banks to maintain reproductive materials.
5. Review and revise recovery plan as warranted by new data.



**Estimated Total Cost Necessary to Recover this Species (in \$1,000's):**

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
FY 1	10	0	141	10	0	161
FY 2	5	0	141	10	0	156
FY 3	5	53	131	10	0	199
FY 4	5	205	20	10	0	240
FY 5	5	215	20	10	0	250
FY 6	5	255	0	10	15	285
FY 7	5	255	0	10	15	285
FY 8	5	255	0	10	0	270
FY 9	5	175	0	10	0	190
FY 10	5	175	0	10	0	190
FY 11	5	135	0	10	0	150
FY 12	5	135	0	10	0	150
FY 13	5	135	0	10	0	150
FY 14	5	135	0	10	0	150
FY 15	5	135	0	10	0	150
FY 16	5	135	0	10	0	150
Total	85	2,398	453	160	30	3,126

**Estimated Total Cost of Recovery: \$3,126,000**

**Estimated Date of Recovery: 2018**

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## PART I. INTRODUCTION

### A. BRIEF OVERVIEW

*Fritillaria gentneri* (Gentner's fritillary) was listed as an endangered species on December 10, 1999 (U.S. Fish and Wildlife Service [USFWS] 1999), under the authority of the Endangered Species Act of 1973, as amended (16 United States code [U.S.C. 1531] *et seq.*). This rare, red-flowered lily is known primarily from Jackson and Josephine Counties in southwestern Oregon, where it generally occurs in very small, widely scattered patches of plants comprising an estimated 1,696 flowering individuals. One additional small population has just recently been found in northern California, very close to the Oregon border. *Fritillaria gentneri* has a recovery priority ranking of 2 on a scale of 1 (highest) to 18 (lowest), reflecting its status as a full species with a high degree of threat and a high potential for recovery (USFWS 1983a,b).

*Fritillaria gentneri*, like many plants known to science, may be of hybrid origin. However, all evidence suggests that it is a self-sustaining, naturally occurring population, and it is considered a valid species by the scientific community (Guerrant 1992; E. Guerrant, *in litt.* 1998). We, the U.S. Fish and Wildlife Service (Service), are responsible for preparing a recovery plan for this species that guides its conservation so that it can be downlisted from endangered to threatened status, and eventually be delisted. The designation of critical habitat for *Fritillaria gentneri* has not yet been decided (USFWS 1999).

### B. SPECIES DESCRIPTION

*Fritillaria gentneri*, also known as Gentner's fritillary or Gentner's mission-bells (cover photo and Figure 1), is a member of the lily family (Liliaceae) with showy, deep red to maroon flowers. The species was originally described in 1951 by Helen M. Gilkey. The following description of the species is after that of Gilkey's original publication (Gilkey 1951) and observations by local *Fritillaria* experts (Brock and Callagan 2001; Amsberry and Meinke 2002).

*Fritillaria gentneri* is a perennial herb arising from a fleshy bulb. Non-flowering individuals vastly outnumber flowering plants in natural populations, and are recognizable only by their single basal leaves, which appear virtually identical to those of other co-occurring *Fritillaria* species. Flowering individuals produce single, erect flowering stems (and no basal leaves) 50 to 70 centimeters



**FIGURE 1.** (a) Line drawing of *Fritillaria gentneri* (Gentner's fritillary), (b) gynoecium showing deeply cleft style, a diagnostic feature of this species. Drawing by Steven D. Gisler, used with permission.

(20 to 28 inches) tall, with groups of narrow leaves arranged in several whorls (groups of 3 or more at the same level) around the stems. The leaves and stems are glaucous (having a blue-grey waxy coating) and are sometimes tinged with purple coloration, especially early in their development. The basal leaf width of non-flowering individuals ranges in size from only 0.2 centimeter (0.08 inch) for young plants arising from small “rice-grain” bulblets to 7 centimeters (2.8 inches) or more for mature plants with larger bulbs.

The blooming season for *Fritillaria gentneri* generally extends from April through June. Flowers are composed of six tepals (petal-like structures) colored deep red to maroon, usually streaked or mottled with pale yellow, campanulate (bell-shaped), 3.5 to 4 centimeters (1.4 to 1.6 inches) long, with overlapping segments keeled beneath by long, conspicuous nectar-producing glands. These glands range in length from 12 to 18 millimeters (0.47 to 0.71 inches) long with gland to petal length ratios ranging from 39 to 56 percent (Brock and Callagan 2001). Flowers can be solitary or may occur in bracted racemes (simply branched flowering stems, with a small leaf at the base of each branch) on long, slender pedicels (the stalks supporting a single flower). Stamens (pollen-producing reproductive organs) are included within the flower, rather than exerted beyond the opening as in some other lilies, and the style (the slender, elongated portion of the pistil connecting the stigma to the ovary, all of which comprise the female reproductive organ) is deeply split about half its length. Stigma lobes range in length from 6 to 10 millimeters (0.24 to 0.39 inches), with stigma to style length ratios ranging from 32 to 50 percent (Brock and Callagan 2001). The fruit is a capsule (a dry fruit that splits open to release the seeds within when mature) truncate (squared off) or rounded at the apex, truncate to slightly cordate (heart-shaped) at the base, reaching 2 to 2.5 centimeters (0.8 to 1.0 inch) in length, 2.5 to 3.5 centimeters (1.0 to 1.4 inches) in width, broadly winged, with wings dentate (toothed along the margin) (Gilkey 1951). Additional descriptions and illustrations of *Fritillaria gentneri* can be found in Peck (1961), Turrill and Sealy (1980), and Meinke (1982).

*Fritillaria gentneri* co-occurs with, and may originally have been derived from, two other more common and geographically widespread *Fritillaria* species: *Fritillaria recurva* (scarlet fritillary) and *Fritillaria affinis* (= *F. lanceolata*) (chocolate lily). *Fritillaria gentneri* can be distinguished from these related taxa in several ways (Table 1). Although flowers of *Fritillaria gentneri* and *Fritillaria affinis* both exhibit yellow mottling, the base color of *Fritillaria gentneri* flowers is deep red to maroon, whereas that of *Fritillaria affinis* is plainly brown to purple-brown (Figure 2). Like those of *Fritillaria gentneri*, flowers of *Fritillaria*

**TABLE 1.** Morphological characteristics that differentiate sympatric (co-occurring) *Fritillaria* species in southwestern Oregon.

<b>Character</b>	<b><i>F. affinis</i> (chocolate lily)</b>	<b><i>F. gentneri</i> (Gentner's fritillary)</b>	<b><i>F. recurva</i> (scarlet fritillary)</b>
flower shape	broadly bell-shaped with petals flared at the tips but not recurved	broadly bell-shaped with petals spreading at the tips but not recurved	narrowly bell-shaped to funnellform with petals strongly recurved at the tips
flower color	brown to purplish brown with yellow mottling	carmine, ox-blood red, or dark maroon purple; all 'bluish' shades of red; checkered, mottled, or streaked with yellow	jasper or scarlet red to pale orange; all 'yellowish' shades of red; with yellow inside flower
style	divided $\frac{1}{2}$ to $\frac{2}{3}$ of its length and spreading	divided $\frac{1}{2}$ of its length and spreading	divided $\frac{1}{4}$ to $\frac{1}{3}$ its length and not widely spreading
stamens	not exerted beyond floral tube	generally equaling the pistil in length; not exerted beyond floral tube	generally exceeding the pistil in length; exerted beyond floral tube
nectary gland	extending $\frac{1}{2}$ to $\frac{2}{3}$ the length of the flower	length 12 to 18 mm (0.47 to 0.71 inches); extending $\frac{1}{2}$ the length of the flower and forming a keel on the dorsal surface	length 6 to 12 mm (0.24 to 0.47 inches); extending $\frac{1}{5}$ to $\frac{1}{3}$ the length of the flower



**FIGURE 2.** Photograph showing comparative floral features of three co-occurring *Fritillaria* species: *Fritillaria gentneri* (center), *F. affinis* (left), and *F. recurva* (right) (photo provided by Medford Bureau of Land Management, used with permission).

*recurva* are also red, but they are a noticeably brighter, yellowish shade of red, verging to pale orange.

Color differences aside, *Fritillaria gentneri* and *Fritillaria recurva* can also be distinguished by several other floral characteristics. Living up to the specific name, *Fritillaria recurva*, this species possesses flowers that recurve (bend backwards) strongly at the tips, whereas *Fritillaria gentneri* flowers simply flare at the tips, or very weakly reflex (bend backwards or upwards) (see Figure 2). Flowers of *Fritillaria recurva* are typically narrower, and less bell-shaped, than those of *Fritillaria gentneri*, though this character can be variable. The nectary glands of *Fritillaria recurva* are shorter, ranging in length from 6 to 12 millimeters (0.24 to 0.47 inches), with gland to petal length ratios ranging from 22 to 44 percent (Brock and Callagan 2001). In addition the style is not as deeply cleft in *Fritillaria recurva*; stigma lobes in this species range in length from 1 to 9 millimeters (0.04 to 0.35 inches), with stigma to style length ratios ranging from 10 to 37 percent (Brock and Callagan 2001). The style proves to be one of the most useful diagnostic floral features for distinguishing these species, as the style is split about half its length in *Fritillaria gentneri* but only one-fourth to one-third



its length in *Fritillaria recurva*. Ultimately, due to morphological variability within *Fritillaria gentneri*, it is often necessary to examine all of the aforementioned traits together to accurately identify the species.

Although numerous traits appear to intergrade between *Fritillaria recurva* and *Fritillaria affinis*, observers have generally found *Fritillaria gentneri* plants distinctive in morphology with few true intermediate forms (Gilkey 1951; Knight 1991a; Guerrant 1992; W. Rolle *in litt.* 1998a; Amsberry and Meinke 2002). Confirmed crosses between *Fritillaria recurva* and *Fritillaria affinis* do not resemble *Fritillaria gentneri*, thus *Fritillaria gentneri* is not thought to be a F1 (first generation) hybrid. Furthermore, the evidence suggests that *Fritillaria gentneri* likely arose only once, rather than through multiple, independent hybridization episodes where each population occurs (Guerrant 1992). Taking these factors into account, Guerrant (1992) contends that *Fritillaria gentneri* is a valid taxon, probably of hybrid origin and of the F2 (second generation) or later generation, resulting from backcrossing to one of the putative parents.

### C. REPRODUCTIVE ECOLOGY

*Fritillaria gentneri* is a perennial species that reproduces clonally, or asexually, by means of numerous small “rice-grain” bulblets that break off larger bulbs and form new plants. It is common in nature to observe as many as 40 to 60, or more, individuals arising from these bulblets, with their narrow leaves densely clustered around the base of a single mature plant (Figure 3).

The lifetime output of bulblets from a single mature bulb is unknown, as is the life span of individuals and how many growing seasons are required for young plants to reach reproductive maturity. In some other *Fritillaria* species, rice-grain bulblets require 3 to 5 years to reach maturity (Pratt and Jefferson-Brown 1997). When these young bulblet individuals are considered, along with other, larger, non-reproductive plants, the number of individuals actually in flower generally makes up only a small fraction of the total population size at any given site. Observations in the field suggest some mature plants may remain reproductive over many consecutive years, whereas others may periodically return to a vegetative condition (each producing a single leaf rather than a flowering stem), or a dormant condition under the soil surface, producing no leaves at all.

This species, like most lilies, produces one vegetative leaf in each growing season for several years before storing enough resources to produce a flower (Amsberry and Meinke 2002). Monitoring studies indicate that plants of



**FIGURE 3.** Mature *Fritillaria gentneri* bulbs produce dozens of rice-grain bulblets, resulting in dense clusters of young individuals that vastly outnumber flowering plants in populations. As discussed later in this plan, such bulblets could prove instrumental in future off-site cultivation and population augmentation projects. Photo by Dr. Robert Meinke, used with permission.

*Fritillaria gentneri* must reach a minimum size before flowering. Demographic study plots were established in the Jacksonville Woodlands, a natural area in Jacksonville, Oregon, in 1999 (Brock and Knapp 2000). Small plots (0.5 meter by 2.0 meters [1.6 feet by 6.6 feet]) were centered around flowering *Fritillaria gentneri* and all *Fritillaria* plants present were counted and presumed to be *Fritillaria gentneri*. Monitoring in 1999 identified 228 individual *Fritillaria gentneri*, 76 of which were considered large (leaf width 2 centimeters [0.78 inch] or greater). This study found 14 flowering *Fritillaria gentneri* plants and 21 non-flowering *Fritillaria gentneri* plants that had a leaf width of 4.5 centimeters (1.8 inches) or greater in 1999. No plants with a leaf width of less than 4.5 centimeters (1.8 inches) in 1999 flowered in 2000. Based on these results, plants with a leaf width of 4.5 centimeters (1.8 inches) are considered ‘mature’ vegetative plants for the purposes of further calculations developed in this recovery plan.

Sexual reproduction (production of fruits and seeds from flowers) appears to be a sporadic or episodic event for *Fritillaria gentneri*. The original description of *Fritillaria gentneri* by Gilkey in 1951 includes information on fruit characteristics, which implies that some fruits must have been formed, although the presence and viability of any seeds that may have been contained therein is unknown. Likewise, over the years since its description there have been numerous reports of both fruit and seed production in *Fritillaria gentneri* (W. Rolle *in litt.* 1988a; Guerrant 1992; Amsberry and Meinke 2002). However, the lack of consistent seed production, and failed attempts to produce fruit through pollination studies, combined with *Fritillaria gentneri*'s morphological similarity to both *Fritillaria recurva* and *Fritillaria affinis*, has prompted speculation among local botanists that this taxon may be a near-sterile hybrid of recent descent (Guerrant 1992; Amsberry and Meinke 2002). Within species crosses of *Fritillaria gentneri* produced a fruit and evidently viable seed in 2002, however, *Fritillaria gentneri* produced more fruits (and seeds) when cross-pollinated with either *Fritillaria recurva* or *Fritillaria affinis* than when pollinated with *Fritillaria gentneri* pollen (Amsberry and Meinke 2002). Crosses between *Fritillaria gentneri* and *Fritillaria recurva* resulted in fruit production at 3 of 4 sites and over 50 percent of flowers that were crossed. This study also indicated that *Fritillaria gentneri* fertility levels were variable across different sites: some sites showed high levels of fruit set while other sites produced almost no fruit.

Recent results of these ongoing reproductive studies indicate that nine positively identified seedlings grew from seed produced by *Fritillaria gentneri* plants (seedlings were either grown in isolation at Oregon State University, or if in the field, still had a portion of the obvious *Fritillaria gentneri* seed coat attached). Seven of the nine were seeds produced by *Fritillaria gentneri* plants in response to pollination with *Fritillaria recurva* pollen, one after pollination with *Fritillaria affinis* pollen, and one was from an open-pollinated plant (pollen source unknown) (K. Amsberry, *in litt.* 2003). Further information from this investigation shows that 10 other seedlings were established in field plots, including 1 that grew from a *Fritillaria gentneri* × *Fritillaria gentneri* seed. Further observation will be needed to determine the viability (past the seedling stage) of all of the seedlings.

These studies suggest that interspecific sterility barriers do not exist between *Fritillaria gentneri*, *Fritillaria recurva*, and *Fritillaria affinis*. However, the ability of these species to interbreed on occasion does not negate the validity of these taxa or their taxonomic or conservation status (Amsberry and Meinke

2002). Even if *Fritillaria gentneri* proves to be of recent hybrid origin, our proposed policy indicates that a species that has developed outside of confinement, is considered a self-sustaining, naturally-occurring entity and that continues to be recognized as a taxonomic species by the scientific community is protected by the Endangered Species Act (USFWS 1996).

Studies conducted by Dr. Darlene Southworth of Southern Oregon University indicated low germinability of *Fritillaria gentneri* pollen in the laboratory, which may account for low fruit and seed production for this species (D. Southworth, pers. comm. 2001). However, these findings may not reflect actual pollen germination rates under natural conditions, and may not accurately reflect pollen viability *per se*. Pollen inviability could explain the results of reproductive studies carried out by the Oregon Department of Agriculture in 2000 and 2001, where hundreds of flowers at three different sites were subjected to a variety of experimental pollination treatments (including within-plant, between-plant, between-population, and between-species crosses). All of these plants failed to produce even a single fruit or seed (Amsberry and Meinke 2002). These results suggest that seed production is probably limited by high levels of sterility, rather than by self-incompatibility mechanisms or severe inbreeding depression arising from matings between genetically uniform clones within sites.

Like many species recently derived from hybridization, *Fritillaria gentneri* may produce pollen which is largely incapable of germination (Amsberry and Meinke 2002). However, the lack of seed production could be due to other environmental or genetic causes. Borgias (*in litt.* 2003) suggested that sporadic sexual reproduction may historically have been associated with natural fire regimes or other disturbance events that would have occurred more consistently in the past but are now largely absent from the modern landscape. For example, fire may have stimulated post-fire flowering, resulting in more frequent episodes of sexual reproduction in this species.

During April, 2002, Donham (2003) made observations on insects and other pollinators visiting *Fritillaria gentneri* flowers (spanning 16 hours). Hummingbirds were noted visiting *Fritillaria gentneri* on four separate occasions. Hummingbirds are documented pollinators of *Fritillaria recurva* in California, and its bright yellow pollen is a likely floral cue for hummingbirds. The one visit that was photographed in this study confirms a male Anna's hummingbird (*Calypte anna*) visiting *Fritillaria gentneri* after having visited *Fritillaria recurva*. Although bumblebees (*Bombus vosneskii*) were commonly seen at

*Fritillaria gentneri* sites, none were ever noted visiting *Fritillaria gentneri* and they are not thought to be significant pollinators of *Fritillaria gentneri*. A halictid bee, *Lasioglossum* spp., was captured inside *Fritillaria gentneri* covered with pollen. Andrenid bees were captured visiting *Fritillaria affinis* and *Fritillaria recurva* during the same time period. Andrenids and halictids are both "miner bees," which require pollen for provisioning eggs and larvae in underground nests. Such nests are tunnels dug in bare patches of soil in early spring. Therefore, some species of bees may pollinate the plant as they forage early in the season. Patches of bare soil, such as exist in the disturbed areas near old mining sites in Jacksonville, may be potential nesting habitat for bees. To attract pollinators and increase the likelihood of successful pollination of *Fritillaria gentneri*, Donham (2003) suggested that additional pollen and nectar sources should be available in areas established for recovery of the species. The author recommends including plantings of *Fritillaria recurva* as well as other nectar sources that are native to the area and that bloom at the same time as *Fritillaria* species, such as various manzanita (*Arctostaphylos*) species, when enhancing habitat for *Fritillaria gentneri*.

In summary, what is currently known about reproduction in *Fritillaria gentneri* strongly suggests that vegetative reproduction is the primary means of population establishment and growth. However, restoration strategies should include provisions to ensure successful pollination and sexual reproduction to allow at least sporadic or occasional gene flow events.

Further research is needed, as identified in this recovery plan, and is currently being conducted to further determine the circumstances (*i.e.*, in certain parental crosses or within certain populations) under which *Fritillaria gentneri* reproduces sexually (Recovery Action 3.7).

#### **D. HABITAT DESCRIPTION**

*Fritillaria gentneri* occurs in the rural foothills of the Rogue and Illinois River valleys in Jackson and Josephine Counties, Oregon. Recent mapping of both current and historical locations using more refined methods shows that this species occurs at elevations ranging from approximately 306 to 1,544 meters (1,004 to 5,064 feet) above sea level. The species is often found in grassland and chaparral habitats within, or on the edge of, dry, open woodlands. *Fritillaria gentneri* is often associated with shrubs where it is somewhat protected from the effects of wind and sun. Although it often occupies ridgelines, it is not found on fully exposed sites or extremely dry sites (USFWS 1999; R. Brock *in litt.* 2002).

The plant appears to have specific moisture and light requirements that may be provided by a variety of habitat types or successional stages, and has been reported in association with 16 habitat types (Brock and Callagan 2001; R. Brock, *in litt.* 2002; see Table 2). Site specific habitat features depend upon the location within the species' range, and a variety of features occur at occupied sites throughout the distribution of the species (R. Brock, *in litt.* 2002).

The overstory is variably dominated by the following trees: *Quercus garryana* (Oregon white oak), *Quercus kelloggii* (California black oak), *Arbutus menziesii* (madrone), *Pseudotsuga menziesii* (douglas fir), and *Pinus ponderosa* (ponderosa pine).

Commonly associated understory shrubs may include *Arctostaphylos viscida* (white-leaved manzanita), *Ceanothus cuneatus* (buckbrush), *Ceanothus velutinus* (snowbrush), *Cercocarpus betuloides* (mountain mahogany), and *Toxicodendron diversiloba* (poison oak).

*Fritillaria gentneri* is associated with a spectacular diversity of understory herbaceous species, commonly including *Arabis subpinnatifida* (ashy rock cress), *Astragalus accidens* var. *hendersoni* (Rogue River milkvetch), *Bromus ciliatus* (fringed brome), *Calochortus tolmiei* (cat's-ear), *Cynoglossum grande* (hound's tongue), *Delphinium decorum* (larkspur), *Dodecatheon hendersoni* (Henderson's shootingstar), *Erythronium hendersonii* (pink fawn lily), *Festuca californica* (California fescue), *Festuca idahoensis* (Idaho fescue), *Fragaria vesca* var. *bracteata* (woods strawberry), *Lomatium utriculatum* (fineleaf biscuit-root), *Poa sandbergii* (Sandberg's bluegrass), *Ranunculus occidentalis* (western buttercup), *Sidalcea malvaeflora* (checkermallow), *Stipa lemmonii* (Lemmon's needle grass), *Senecio integerrimus* (tower butterweed), *Vicia americana* (American vetch), and the two other co-occurring *Fritillaria* species, *Fritillaria affinis* (chocolate lily) and *Fritillaria recurva* (scarlet fritillary) (USFWS 1999; S. Gisler, pers. comm. 2001; R. Meinke, pers. comm. 2001).

*Fritillaria gentneri* is sometimes found in areas that experience infrequent human disturbance, including roadsides, edges of trails, bulldozer routes, vineyards, and mounds left from past mining activities (W. Rolle, *in litt.* 1988b). Expert opinions vary widely on the importance of historical disturbance regimes such as the recurrence of natural fire across the landscape where *Fritillaria*

**TABLE 2.** Habitat types associated with *Fritillaria gentneri* occurrences (from Brock and Callagan 2001). Fire frequency data for each habitat type is provided where available (Frost and Sweeney 2000).

Habitat type	Number of macroplots (percentage)	Fire Return Intervals range in years (range of reported means)
Oregon white oak woodland	13 (19 %)	1-5 (11)
Oregon white oak - Douglas fir ecotone	12 (17 %)	
Dry Douglas fir forest	8 (11 %)	3-90 (13-22)
Moist riparian Douglas fir - white fir forest	6 (9 %)	
Mixed hardwood / conifer with black oak, Oregon white oak, Douglas fir, ponderosa pine, and wedgeleaf ceanothus - whiteleaf manzanita in shrub layer	5 (7 %)	
Oregon white oak / birchleaf mahogany - wedgeleaf ceanothus ecotonal chaparral	4 (6 %)	
Ponderosa pine - Douglas fir forest	3 (4 %)	3-55 (11)
Oregon white oak / wedgeleaf ceanothus dry chaparral	3 (4 %)	
Black oak forest with silktassle, poison oak, mountain mahogany; serpentine influence	3 (4 %)	
Grassland / meadow	3 (4 %)	
Moist riparian shrub community	3 (4 %)	
Moist chaparral with black oak, silktassle, birchleaf mountain mahogany, whiteleaf manzanita; serpentine influence	2 (3 %)	
Jeffrey pine - whiteleaf manzanita serpentine site	1 (1 %)	(7-50)
Ecotone between Oregon white oak / serviceberry chaparral and white fir - Douglas fir forest	1 (1 %)	
Oregon white oak / Klamath plum woodland	1 (1 %)	
Opening in white fir - Douglas fir forest	1 (1 %)	12-161 (25-64)

*gentneri* is known to occur. Brock and Knapp (2000) theorize that some level of disturbance may assist in dispersal of the species by moving bulblets across the landscape. Some experts suggest that the species benefits from shading and protection afforded from shrub cover (escape from herbivory) and that populations may be stable without historical disturbance regimes (R. Brock, *in litt.* 2000, 2002). Others suggest that the species would benefit from some overstory and shrub removal through thinning or prescribed burning (D. Borgias, *in litt.* 2003; R. Brock, *in litt.* 2000). *Fritillaria gentneri* may require infrequent but regular disturbance (such as the historic pattern of fires in the Rogue and Illinois River valleys) to create openings or edges for colonization. Although not documented, the often mid-successional nature of this species suggests that the loss of openings and subsequent encroachment of habitat by dense shrubs and trees will lead to the loss and extirpation of *Fritillaria gentneri* and associated understory species. Conversely, there is great concern that prescribed burning and mechanical thinning treatments may result in vulnerability of *Fritillaria gentneri* sites to invasive grasses and noxious weeds, species that were not present under historical disturbance regimes (R. Brock, *in litt.* 2002). In sum, due to the variability in factors such as plant species composition, habitat structure, and proximity to residential areas across the range of sites where *Fritillaria gentneri* is found, potential management actions will have to be evaluated on a case-by-case basis.

Since *Fritillaria gentneri* inhabits such a wide range of plant communities and successional stages, the periodicity of historically occurring fires experienced by this species has varied widely (Atzet and Martin 1992; Frost and Sweeney 2000; Table 2). Fires may have occurred relatively frequently, in cycles of less than every 11 years, in the vicinity of Medford, Oregon, while areas of higher elevation and in the northern range of the species are estimated to have burned every 20 years or so (T. Atzet, pers. comm. 2003). Many plant species are known to increase in abundance and/or flowering in the post-fire environment, including members of the lily family, of which *Fritillaria gentneri* is a member (Vogl 1974; Kucera 1981; Pendergrass 1995). Fire and the structure and composition of habitat are important factors to consider in determining management strategies for maintaining and enhancing conditions for this species. Therefore, research on the effects of fire and mechanical thinning has been identified as a recovery action for this species (Recovery Action 3.4). Extreme care should be taken to prevent and/or minimize the extent and spread of invasive grasses and noxious weeds into *Fritillaria gentneri* habitats.



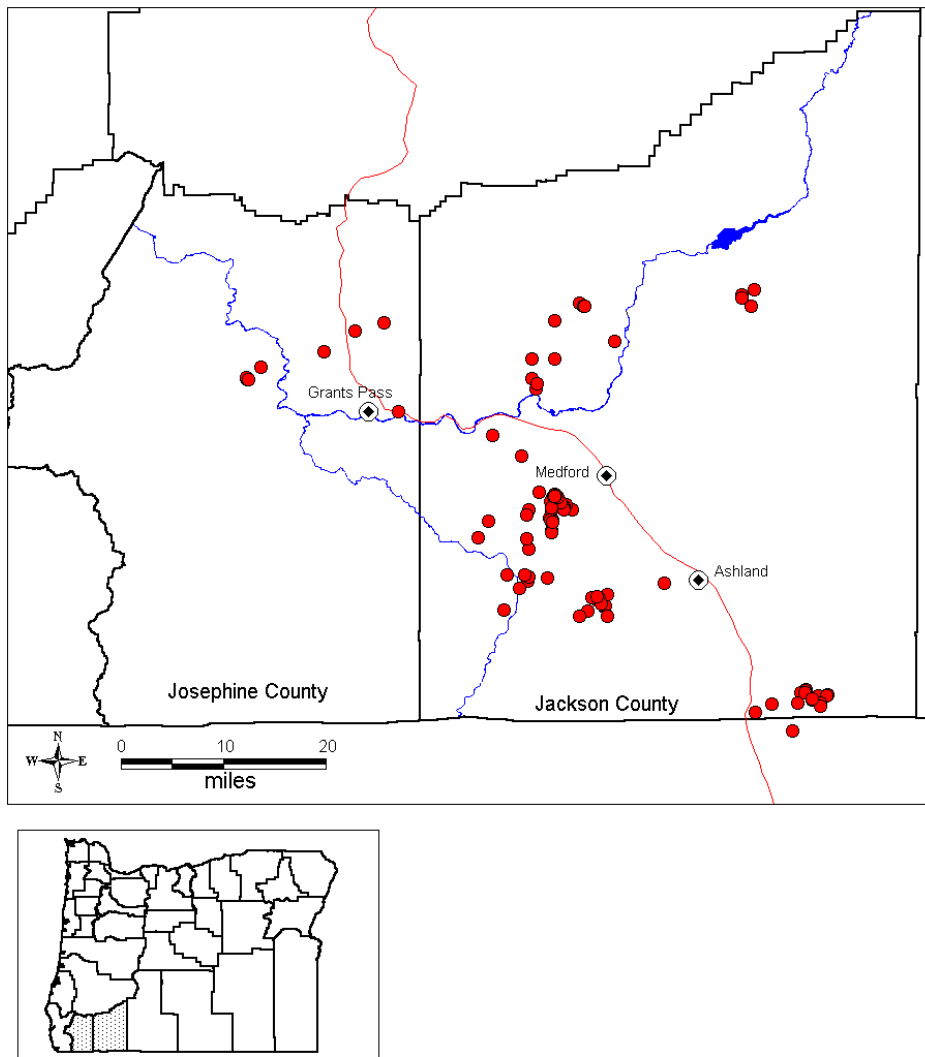
*Fritillaria gentneri* occurrences are known from 25 different soil types. Of these 25, *Fritillaria gentneri* shows a significant association with Vannoy soils. A table of these soils and the frequency of *Fritillaria gentneri* occurrences on them is provided in Appendix D.

Additional research into *Fritillaria gentneri* habitat requirements and soil affinities is identified in this recovery plan (Recovery Action 3.2), which may shed more light on the ecological factors contributing to the species' decline, help target future surveys for new occurrences, and assist land managers in developing effective habitat management plans as well as choosing appropriate sites for new introductions.

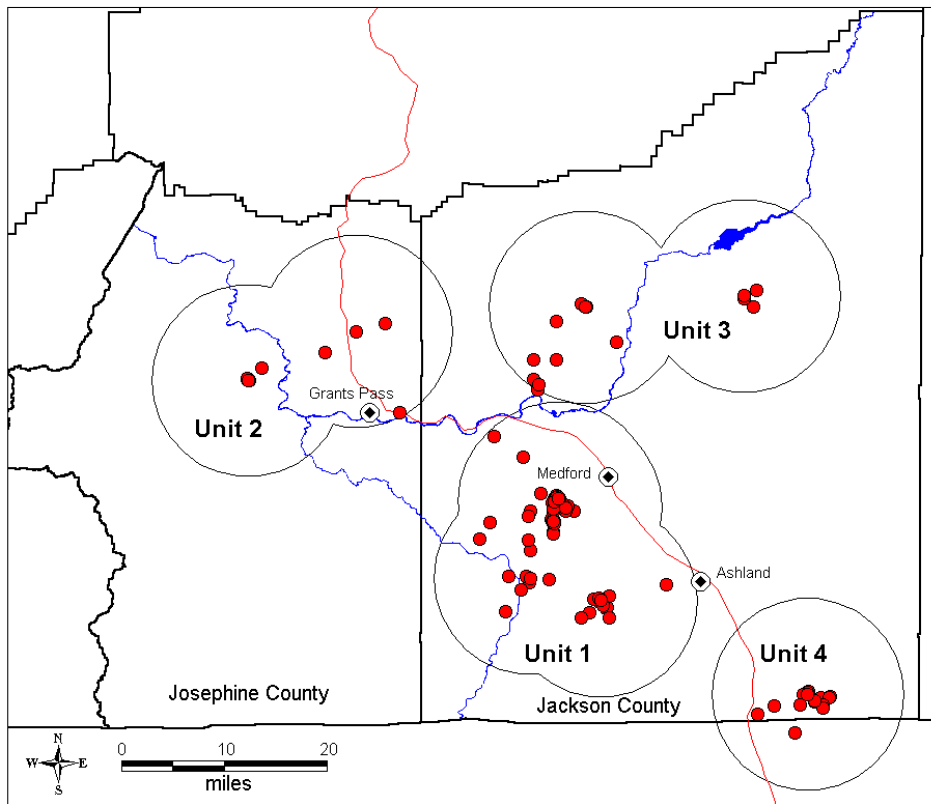
## **E. DISTRIBUTION AND ABUNDANCE**

*Fritillaria gentneri* occurs predominantly in southwestern Oregon, where it is known from scattered localities in the Rogue and Illinois River drainages in Jackson and Josephine Counties (Figure 4). A small population has just been found in northern California, close to the Oregon border (J. Molter, *in litt.* 2003). The species is highly localized within about a 48-kilometer (30-mile) radius of the Jacksonville Cemetery in Jacksonville, Oregon (Jacksonville Cemetery harbors one of the largest known *Fritillaria gentneri* occurrences and incidentally serves as a convenient center reference point for the range of this species).

The majority of known individuals (about 73 percent) occur within an 11-kilometer (7-mile) radius of the Jacksonville Cemetery. As seen in Figure 4, *Fritillaria gentneri* has a distribution characterized by several distinct clusters of occurrences concentrated in western Jackson County, as well as three outlying clusters of occurrences, two in the northeast and southeast corners of its range in Jackson County and one scattered grouping in Josephine County. These geographic clusters were taken into consideration during the designation of recovery units in Part II of this plan. It is unknown to what extent individual occurrences, or groups of occurrences, comprise distinct biological populations (*i.e.*, groups of interbreeding individuals mutually separated by lack of gene flow). Some observers suggest that individuals of this species appear morphologically different in two of these outlying population centers (Recovery Units 2 and 4; see Figure 5) from those in the core area populations around Jacksonville (Recovery Unit 1); Amsberry and Meinke 2002; M. Mousseaux *in litt.* 2003; W. Rolle, pers. comm. 2003). It is hoped that future research identified in this plan (Recovery Action 3.5) will help resolve these issues and shed light on the extent and distribution of genetic diversity within the species.



**FIGURE 4.** Geographic distribution of known extant *Fritillaria gentneri* occurrences (indicated by dots) in Jackson and Josephine Counties, Oregon, reflecting sites known as of 2001. Also shown is a small population that was recently discovered on private land in Siskiyou County, California (J. Molter, *in litt.* 2003). This is the only known occurrence of *Fritillaria gentneri* in the State of California.



**FIGURE 5.** Recovery units for *Fritillaria gentneri*. These four units are delineated with the intent of capturing existing geographic distribution patterns and maximizing the preservation of ecological and genetic variability in the species. The distribution of recovery units, and the allocation of populations within them, may change as new information is gained about the extent and distribution of genetic diversity between populations.

To help document and analyze the distribution of *Fritillaria gentneri* occurrences, the entire known geographic range of the species (including all current and historical species occurrence records) was divided into a longitude-latitude grid of macroplots 0.1 minute of longitude by 0.1 minute of latitude in size (each macroplot therefore comprising an area of about 2.56 hectares or 6.3 acres). These macroplots are used for tracking the data on the *Fritillaria gentneri* occurrences found within them. Using this methodology, further described in the

Final Rule (Final Endangered Status for the Plant *Fritillaria gentneri* [Gentner's Fritillary]; USFWS 1999), *Fritillaria gentneri* was historically reported from 53 macroplots, although 8 of these have since been extirpated. The number of known flowering plants as of 1998 within the extant 45 macroplots at that time was estimated at 340 (USFWS 1999).

Since the publication of the Final Rule, numerous additional occurrences of *Fritillaria gentneri* have been discovered, resulting in a current total of 109 occupied macroplots based on 2001 data (Appendix A). The largest single documented occurrence to date for *Fritillaria gentneri* (Pickett Creek, in the Bureau of Land Management Grants Pass Resource Area) contained 306 flowering plants in 2000 (Brock and Callagan 2000; see Appendix C). The smallest occurrence known is one plant (Brock and Callagan 2000). Very small populations make up the vast majority of *Fritillaria gentneri* occurrences known today. Of the 46 macroplots surveyed in 2001, nearly half (22 macroplots, or 48 percent) had between 1 and 5 flowering individuals, and 20 (43 percent) had between 6 and 50 flowering plants. Only 4 populations, representing 9 percent of the known occurrences, had a count of more than 50 flowering plants (Appendix A).

A population census of all known occurrences on Bureau of Land Management lands in 2000 documented a total of 569 flowering plants and 3,334 vegetative (non-flowering *Fritillaria* species) plants (Brock and Callagan 2000; Appendix C). Based on these data, current estimates are that for every flowering *Fritillaria gentneri* individual there are on average 7.0 vegetative plants of *Fritillaria gentneri* and/or *Fritillaria recurva* (vegetative plants may be of either species, since the plants are indistinguishable when not flowering; 95 percent confidence interval range is from 4.8 to 9.2 vegetative plants); these numbers are used as multipliers to project the expected range of numbers of mature plants as presented in Appendix E and explained in the following section "Methodology for Estimation of Population Sizes."

Twenty-two new occurrences were found during the field season of 2001 on Medford District Bureau of Land Management lands, bringing the current total to 775 flowering plants (Brock and Callagan 2001). In addition, nine potential new occurrences on private lands reported in response to information requests printed in area newspapers were investigated in 2001. Only one of these sites proved to harbor *Fritillaria gentneri*; the others either contained *Fritillaria recurva*, or no plants were found at all. This new *Fritillaria gentneri* occurrence

contained 50 flowering individuals and was located within a macroplot already occupied by the species near Grants Pass, Oregon. In addition to the aforementioned new occurrences, an extension of an existing occurrence near Grants Pass was also reported in 2001 (approximately 200 additional plants scattered up the hillside on private land opposite the previously reported roadside patch) (V. Harris, pers. comm. 2001).

Since many occurrences are located on private lands, no complete count of the total population in any one year has been possible. A total population size was estimated using the highest density recorded for each occurrence between 1941, when the first records were kept for sites, through 2001 (records for occurrences prior to 1951, when the species was first described, are based upon herbarium specimens). The highest numbers recorded were used for this estimate to compensate for the extreme variability in the numbers of plants that may be counted in any one year, as described below. This tally resulted in an estimate of approximately 1,696 flowering *Fritillaria gentneri* across all ownerships (private, State, and Federal; see Appendix A).

The number of known flowering plants, and our current ability to census flowering individuals, would be expected to fluctuate somewhat between years depending on annual variability in population demography, climate, and levels of herbivory by deer and livestock. The total number of *Fritillaria gentneri* individuals in existence is difficult to confidently ascertain because non-flowering plants cannot be distinguished from other co-occurring *Fritillaria* species. Censuses may be further complicated by the fact that many flowering plants are grazed by deer before identification and counting can be performed, and also because individuals can remain dormant for one or more years underground.

It is hoped that research identified in this recovery plan (Recovery Action 3.3) will assist in making more accurate counts of non-flowering *Fritillaria gentneri* possible through the development of chemical, anatomical, or other tests to differentiate between the co-occurring *Fritillaria* species by their leaves.

Ownership information is known for the 109 macroplots occupied by the species in 2001: 59 macroplots (54 percent) are on lands managed by the Medford District of the Bureau of Land Management; 2 (2 percent) are on lands managed by the U.S. Forest Service; 1 (1 percent) is on a right-of-way managed by the Oregon Department of Transportation; 1 (1 percent) occurs on a mixture of

private, county parks, and Oregon Department of Transportation lands; 6 (6 percent) occur on lands managed by Southern Oregon University; 8 (7 percent) are on lands managed by the City of Jacksonville and/or the Jacksonville Woodlands Association; and the remaining 32 (29 percent) are on privately owned lands (Appendix A). In summary, 77 macroplots (71 percent) are located on publicly managed lands with a high probability for management of *Fritillaria gentneri* while 32 macroplots (29 percent) on private lands have a lower probability of conservation of the species.

The specific amount of area that is actually occupied by the species at each site is not well documented. Most sites are generally mapped as point occurrences in existing geographic information system (GIS) databases. One high density population containing 86 flowering plants (Pickett Creek 1) was mapped fairly closely around actual occupied habitat using global positioning system (GPS) equipment and determined to encompass 3,488 square meters (37,545 square feet). This translates to 0.025 plants per square meter (0.0023 plants per square foot), or roughly 40 square meters (430.6 square feet) per plant. Since this is an unusually dense population, and a detailed range of densities is not available, a minimum area of 50 square meters (538.2 square feet) per flowering plant is recommended when considering establishment of new *Fritillaria gentneri* populations and as a guide for augmentation of sites.

Surprisingly, despite its showy appearance and the fact that botanists have been actively searching for this species for many years, new *Fritillaria gentneri* locations continue to be discovered, even in areas plainly evident from roads and highways. It is hoped that future surveys and new methods of targeting potential habitats, both identified in this recovery plan (Recovery Actions 3.1 and 3.2, respectively), will further increase the number of known *Fritillaria gentneri* plants and occurrences, and enhance our knowledge of its geographic range and habitat requirements.

### **Methodology for Estimation of Population Sizes**

Demographic study plots established in the Jacksonville Woodlands in 1999 identified 14 flowering *Fritillaria gentneri* plants and 21 non-flowering *Fritillaria gentneri* plants that had a leaf width of 4.5 centimeters (1.8 inches) or greater (therefore considered mature, as explained earlier; Brock and Knapp 2000). This resulted in a ratio of 1.5 mature vegetative plants for every flowering *Fritillaria gentneri* (ratio 21:14). This ratio, determined from plants of known identity, has been used to help estimate the population size of mature vegetative

*Fritillaria gentneri*, extrapolating from counts of flowering individuals in a population (Appendix E).

In other studies, the positive identification of the species of *Fritillaria* has not been possible, since within populations of *Fritillaria gentneri* there are isolated mature vegetative plants or plants that have had their buds eaten that are found away from the immediate base of flowering plants. Without the flowers present, accurate identification of the species cannot be made. Therefore at the locations studied, these mature vegetative plants may be either *Fritillaria gentneri* or *Fritillaria recurva*. Brock and Callagan (2000) surveyed Bureau of Land Management land and found 569 flowering *Fritillaria gentneri* and 3,334 mature vegetative *Fritillaria* species. Based on this work, on average approximately 7.0 mature vegetative plants (which may be either *Fritillaria gentneri* or *Fritillaria recurva*) are present for every flowering *Fritillaria gentneri* located, with a 95 percent confidence interval of 2.2 (range 4.8 to 9.2; Appendix C). Based on the information gained from the demographic studies cited above, that there will be an estimated 1.5 mature vegetative *Fritillaria gentneri* present for every one flowering *Fritillaria gentneri*, it was assumed that on average 1.5 out of these 7.0 mature, vegetative *Fritillaria* plants should be *Fritillaria gentneri* (21 percent).

Using data from tagged plants at various sites, Brock and Callagan (2000) found there were on average 14.8 vegetative plants (both large and small leaved individuals; henceforth referred to as bulblet plants) within close proximity of the base of every flowering *Fritillaria gentneri* (95 percent confidence interval is 5.15, range from 9.6 to 19.9 vegetative plants; Appendix B). Our calculations are based on the assumption that there are a similar number of bulblet plants associated with mature vegetative *Fritillaria gentneri*. This ratio (14.8 bulblet plants for every 1 flowering individual or mature vegetative plant) forms the basis for estimating the number of vegetative bulblet plants in a population. The total population size is then estimated based on the number of flowering *Fritillaria gentneri* plants by calculating the number of vegetative mature plants assumed to be present, as well as the number of bulblet plants associated with both the flowering individuals and the mature vegetative individuals. Based upon the stated assumptions and the results of the studies cited above, the total population sizes presented in Appendix E have been calculated according to the formulas in Box 1 below; an example of how we arrived at these population estimates follows.

**BOX 1.** Formula for estimating population sizes of *Fritillaria gentneri* based on the number of flowering individuals.

F = number of flowering plants (e.g., 500, 750 or 1,000)

	<u>Expected Mean</u>	<u>Expected Range</u>
Bulblets associated with flowering plants	$(F \times 14.8)$	$(F \times 9.6)$ to $(F \times 19.9)$
Mature vegetative plants	$(F \times 1.5)$	$(F \times 4.8 \times 0.21)$ to $(F \times 9.2 \times 0.21)$
Bulblets associated with mature vegetative plants	$(F \times 1.5 \times 14.8)$	$(F \times 1.5 \times 9.6)$ to $(F \times 1.5 \times 19.9)$

**Example.** -- Table A in Appendix E presents the total estimated population size for *Fritillaria gentneri* based on a count of 500 flowering individuals. Calculations are as follows: if there were 500 flowering plants, we would expect 7,400 ( $500 \times 14.8$ ) bulblet plants at the base of these flowering plants, with a 95 percent confidence interval range of 4,800 ( $500 \times 9.6$ ) to 9,950 ( $500 \times 19.9$ ) bulblet plants. We would also expect 750 mature vegetative plants ( $500 \times 1.5$ ) with a 95 percent confidence interval range of 504 ( $500 \times 4.8 \times 0.21$ ) to 966 ( $500 \times 9.2 \times 0.21$ ) plants. At the base of mature, vegetative plants we would expect to see 11,100 ( $500 \times 1.5 \times 14.8$ ) bulblet plants with a 95 percent confidence interval range of 7,200 ( $500 \times 1.5 \times 9.6$ ) to 14,925 ( $500 \times 1.5 \times 19.9$ ) bulblet plants. Thus the projected population total would tally to 19,750 plants (flowering individuals and their associated bulblet plants, as well as mature vegetative individuals and their associated bulblet plants) with a 95 percent confidence interval range of between 13,004 and 26,341 plants.

Total population estimates for populations with 750 and 1,000 flowering plants were determined using the same methodology (Tables B and C in Appendix E). Another way of approaching this method of population estimation is to assume that for every flowering individual observed at a site, there are a total of approximately 39.5 plants present ([1 flowering plant + 14.8 associated bulblet plants] + [1.5 mature, vegetative plants + 22.2 {=  $1.5 \times 14.8$ } associated bulblet plants] = 39.5 plants).



A recent report completed for the Medford District of the Bureau of Land Management by the Oregon Department of Agriculture's Plant Conservation Program provides additional data on the relative numbers of flowering plants and bulblet production (Amsberry and Meinke 2002). At three study sites, the average number of bulblets associated with the bulbs of 76 tagged *Fritillaria gentneri* plants ranged from 44.9 to 54.2. Using these latest numbers, a more accurate count of plants per flowering individual may be much higher than the 39.5 plants that we used. For example, using the average number of bulblets from the lower end of the range: (1 flowering plant + 44.9 bulblet plants) + (1.5 mature, vegetative plants + 67 [= 1.5 × 45] bulblet plants) = 114.4 plants present for every single flowering plant observed. As these numbers are considerably higher than those we used to estimate our numbers of vegetative plants in a population, the results of this recent study confirm that our recovery objectives as calculated may be conservative.

## F. REASONS FOR LISTING

Section 4(a)(1) of the Endangered Species Act specifies that species may be determined to be threatened or endangered due to one or more of the reasons listed below, all of which apply to *Fritillaria gentneri*. Removal of these reasons for listing is the ultimate criterion for recovery and delisting, as described in Part II of this plan. Additional details about the reasons for listing can be found in the Final Rule (USFWS 1999).

### 1. The present or threatened destruction, modification, or curtailment of its habitat or range

Loss of habitat is the core threat to *Fritillaria gentneri*. As stated previously, this species has a very narrow geographic range, and the vast majority of its few remaining occurrences consist mainly of lone plants or small clusters of plants. Because of their small size, individual occurrences are vulnerable to extirpation due to even small-scale losses of habitat.

Since 1982, *Fritillaria gentneri* has been extirpated from at least eight of its known historical locations due to agricultural development and construction of homes, schools, roads, and driveways. Vehicle use of logging roads on Federal lands for recreational purposes destroys habitat, particularly at the end of roads where large turn-around areas may be created. This is especially detrimental on ridgeline ecotones, which are typically occupied habitat for *Fritillaria gentneri*.

Although some habitat loss and disturbance continues to occur on Federal lands, primarily from timber harvest activities that include road construction, heavy-equipment trails, and landing decks, the areas most threatened are those on private lands where State and Federal laws do not regulate listed plants or their habitat.

Of the 109 known occupied macroplots as of 2001 (Appendix A), 32 (29 percent) occur wholly or partially on private lands and are unlikely to persist over the long-term, as residential development and detrimental land uses continue to expand. One of the most notable examples is the Jacksonville Cemetery site, where at least half of the occupied habitat was severely disturbed by bulldozing and road construction in 2001. *Fritillaria gentneri* has been impacted by trail construction in the Jacksonville Woodlands, although efforts are now being made to include the species in project plans to avoid such impacts in the future (General Management Plan, undated). One of the largest known occurrences, recently discovered on private land near Grants Pass, occupies habitat containing numerous soil test pits for septic tanks, indicating an imminent threat of development that will likely reduce or extirpate this occurrence.

2. Overutilization for commercial, recreational, scientific, or educational purposes

Given its extreme rarity and striking beauty, *Fritillaria gentneri* may attract horticulturists and bulb fanciers seeking to dig up plants from the wild for cultivation. The fact that this species does not appear to readily reproduce by seeds provides added incentive for collectors to dig the bulbs, since cultivation by seeds is rarely possible. Unfortunately, lack of seed production also renders the species more susceptible to the threat of bulb collecting, given the lack of soil seed banks to replenish populations after bulb removal.

Collection of bulbs has already been documented at the Britt Grounds site along trails. It is estimated that 40 percent of the total number of *Fritillaria gentneri* plants have high potential for collection given their close proximity to roadsides, where they are plainly visible (USFWS 1999). Because the majority of known *Fritillaria gentneri* sites consist of only a few individuals, a single collector could seriously reduce, if not extirpate, an entire macroplot occurrence.

### 3. Disease or predation

*Fritillaria gentneri* suffers from predation, which may reduce the health and vigor of plants. Although disease (fungal infection) was identified to be a threat to the species at the time of listing (USFWS 1999), only sporadic fungal infections have been noted, and these do not appear to pose an imminent threat to the species (W. Rolle, *in litt.* 1988b; D. Borgias, *in litt.* 2003; M. Mousseaux *in litt.* 2003; W. Rolle, pers. comm. 2003). An action (Recovery Action 2.44) to monitor fungal infections and other diseases has been included in this plan.

The species appears to be highly palatable to deer, resulting in high levels of herbivory, especially among flowering individuals (W. Rolle, *in litt.* 1988b; Brock and Knapp 2000). Reproductive studies conducted by the Oregon Department of Agriculture in 2000 and 2001 necessitated the use of heavy-gauge wire mesh cages for the explicit purpose of protecting study plants from herbivory by deer.

The long-term impact of herbivory on *Fritillaria gentneri* is unknown. In a study of the related species, *Fritillaria imperialis* (Crown Imperial fritillary), Van Die *et al.* (1976) found that lower stem leaves supply resources to the bulb, whereas upper leaves supply resources to flowers and fruits. If this pattern can be generalized to *Fritillaria gentneri*, then herbivory of flowering stems by deer (which typically occurs at or above mid-stem) may have little lasting consequences for bulbs. Likewise, since the species does not appear to produce viable seeds, floral and/or upper stem herbivory may yield little impact aside from depriving human spectators of colorful floral displays. Intensive grazing (including trampling) by livestock at some sites (*e.g.*, Pelton Lane) may pose a much greater threat than browsing by deer. Mousseaux (*in litt.* 2003) indicates that a population on private land with a history of heavy grazing had a count of 100 plants in 1990, but is now estimated at only 9 flowering plants. Cattle grazing may potentially pose a significant threat to the species, depending on factors such as season of use and accessibility of the plants to herbivory and trampling in cattle allotments (and other areas exposed to cattle grazing). The Medford Bureau of Land Management has recently begun conducting surveys in their grazing allotments within the range of *Fritillaria gentneri* to determine how extensive the threat of livestock grazing may be to the species and to reduce these impacts as much as possible (M. Mousseaux, pers. comm. 2003).

#### 4. The inadequacy of existing regulatory mechanisms

Although *Fritillaria gentneri* already falls under the jurisdiction of several existing State and Federal regulatory mechanisms, the protection it receives is inadequate to maintain even the current imperiled status of the species, much less bring about its recovery and long-term stability.

There are several regulations that have been enacted by the State of Oregon that provide some protective measures for *Fritillaria gentneri*. Under the Oregon Wildflower Law (Oregon Revised Statutes [ORS] 564.010-040), picking or digging of the species is prohibited within 60.9 meters (200 feet) of any State highway. Considering this law only applies to two macroplot occurrences of *Fritillaria gentneri*, only regulates collecting activities, carries minimal penalties, and is difficult to enforce, the protection provided by this law is considered negligible.

Of greater conservation importance is the listing of *Fritillaria gentneri* as endangered by the State of Oregon, as authorized by Senate Bill 533, commonly known as the Oregon Endangered Species Act (ORS 564.100). Under this law, the Oregon Department of Agriculture is responsible for regulating commercial trafficking of the species and developing rules for its protection on all State-owned or State-leased lands, which include all non-Federal public lands. State rules for listed plants stipulate that land managers must conduct surveys prior to implementation of land actions and consult with the Oregon Department of Agriculture if they could impact populations of listed species.

As these State rules do not apply to Federal lands or private lands, the only *Fritillaria gentneri* sites that fall under their protection are lands managed by the Oregon Department of Transportation, Southern Oregon University, Jackson and Josephine Counties, and the City of Jacksonville (*i.e.*, the Jacksonville Cemetery and Jacksonville Woodlands). The efficacy of these rules to reliably protect the species on these lands is by no means absolute, as demonstrated by the recent inadvertent destruction of *Fritillaria gentneri* plants and habitat at the Jacksonville Cemetery (R. Meinke, pers. comm. 2001), and other periodic incursions involving other listed taxa throughout the State. Implementation of an outreach program to increase awareness at local governmental agencies about their responsibilities under State law may reduce the potential for future inadvertent disturbances involving *Fritillaria gentneri*.

Additional State regulations that apply to *Fritillaria gentneri* include Oregon Administrative Rules (OAR) 340-094-0030 and OAR 340-095-0010, which protect federally listed species and their critical habitat from landfill establishment, operation, or expansion. Five of the 109 known macroplots (at least 27 flowering plants) would fall under these protective measures. OAR 141-089-0015 provides protective measures to federally listed species by stating that road construction and maintenance activities shall not adversely affect them or their critical habitat, which would overlap protection already afforded to two State highway populations under the Oregon Endangered Species Act.

*Fritillaria gentneri* receives protection where it occurs on Federal lands managed by the Bureau of Land Management and the U.S. Forest Service. Although no formal conservation agreement has yet been developed between us, the Bureau of Land Management, and the Forest Service that specifically applies to *Fritillaria gentneri*, the species is afforded some protection through its Federal listing as an endangered species, which requires the Bureau of Land Management and the Forest Service to enter into consultation with us prior to implementing any actions that may affect the species.

Lastly, *Fritillaria gentneri* is classified by the Oregon Natural Heritage Information Center as a "G1" category species, which identifies the species as one that is threatened with extinction throughout its entire range. Under this classification, *Fritillaria gentneri* receives general recognition as an imperiled species, but it conveys no formal protection.

In summary, although *Fritillaria gentneri* does receive some limited protection where it occurs on Federal and State lands, the species still faces serious and imminent threats on private lands, which constitute a significant portion of its range and will play an instrumental role in its continued survival.

##### 5. Other natural or manmade factors affecting its continued existence

Although habitat loss due to development and other land actions represents the most serious threat to *Fritillaria gentneri*, other processes, primarily fire suppression accompanied by ecological succession, are also at work to reduce the quality and quantity of habitat for the species. The typical oak woodlands occupied by *Fritillaria gentneri* once experienced a natural fire frequency of between 11 years or less to around 20 years (T. Atzet, pers. comm.

2003), which likely helped maintain the species' preferred open woodland/grassy understory habitat. Due to 50 to 60 years of fire suppression, these habitats have presumably become more thickly wooded, with closed canopies and development of shrubby understories, resulting in the gradual shading out and displacement of *Fritillaria gentneri*.

Although mechanical thinning of overstory shrubs and trees will not mimic all of the effects of fire, it could be used as an alternative management tool. The best management practices for each particular site must be evaluated carefully, as use of prescribed burns or mechanical thinning at some sites might have the negative result of releasing non native understory species, which could then proliferate and negatively impact *Fritillaria gentneri* through competitive exclusion. Proliferation of weeds, such as non native grasses and *Centaurea solstitialis* (yellow star-thistle), is already developing into a serious problem at numerous *Fritillaria gentneri* sites, especially those occurring in oak woodland habitats around the City of Jacksonville (R. Brock, *in litt.* 2000).

The development of sound management strategies for *Fritillaria gentneri* is a fundamental objective of this recovery plan and will be carried out on a site-specific basis. The results of identified research needs regarding *Fritillaria gentneri*'s habitat requirements (Recovery Action 3.2) and responses to experimental management treatments such as burning and overstory thinning (Recovery Action 3.4) will assist in developing plans that are most beneficial to the species.

*Fritillaria gentneri* is also endangered by the nature of its remaining populations, which are small in number and in size, and widely scattered in isolated patches. Generally, such small patches are at much higher risk of decline or extirpation than larger populations because they simply lack the demographic reserves needed to maintain them against random losses of individual plants. Such losses could result from diseases, herbivory, natural disturbances, unfavorable climatic events, successional changes, or innumerable potential human impacts. Moreover, because of their limited size, and due to the clonal nature of *Fritillaria gentneri*, these small populations may be additionally disadvantaged due to a paucity of genetically diverse individuals. Genetic uniformity may render populations more vulnerable to pest and disease pressures. The species may also lack the breadth of tolerances, or flexibility, that would be afforded by greater genetic variability and enable populations to respond to environmental changes with adaptation of subsequent generations (though the

species is less susceptible to inbreeding depression experienced among most sexually reproducing species). As such, if populations contain any genetic diversity at all, it is probably due to founder effects, or possibly the gradual accumulation of mutations over time, which are then maintained in cloned lineages. Unfortunately, such mutations tend more often to be mildly deleterious, rather than adaptive (Lande 1995), and their accumulation and fixation over time could pose a serious threat to *Fritillaria gentneri*.

The use of herbicides in forestry practice may pose a threat to *Fritillaria gentneri*. Boise Cascade Corporation regularly uses herbicides (unknown to type) on its land that occurs within the range of *Fritillaria gentneri* (D. Kendig, pers. comm. 2001). The City of Jacksonville uses Crossbow™ (Triclopyr) herbicide on *Toxicodendron diversilobum* (poison oak) and has not observed a noticeable loss of *Fritillaria gentneri* plants in areas sprayed (B. Schroeder, pers. comm. 2001). The season of use and type of herbicide used are critical factors in determining whether *Fritillaria gentneri* would be impacted by a particular herbicide. Triclopyr is a chemical that has most effect on broad-leaf plants with little effect on grasses and other monocots, such as *Fritillaria* spp. A dicot-specific or general herbicide used outside of the growing season of the plant would be expected to have limited impacts to the species. We need to further investigate the type and timing of herbicides being used in *Fritillaria gentneri* habitat to determine the potential impacts and possible approaches to reducing those impacts.

## **G. CURRENT CONSERVATION MEASURES**

Given its State and Federal status as an endangered species, and its high public profile as a rare and attractive native lily, public agencies, organizations, and individuals have already undertaken numerous conservation measures on behalf of *Fritillaria gentneri*. These include the provision of limited protection afforded by State and Federal regulations, performance of large-scale habitat surveys and multi-year demographic monitoring of populations, inclusion of the species in land development plans, and undertaking of various research projects. These measures are discussed in greater detail below.

### **1. Regulatory measures**

We listed *Fritillaria gentneri* as an endangered species in 1999, under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). This designation requires all Federal

agencies to actively pursue efforts to conserve listed species (section 7 of the Act) and to consult with us when any Federal action may affect these species. The Act states that Federal agencies will ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or adversely modify its critical habitat. The Endangered Species Act also regulates interstate and foreign trade of listed species.

*Fritillaria gentneri* is also regulated under Oregon's State Endangered Species Act, where it is listed as an endangered species (OAR 603-73-070). Regulations under State law are similar to those under the Federal Endangered Species Act, requiring all State agencies (including all county, city, and public school and university subdivisions of the State) to ensure that activities they authorize, fund, or carry out on State-owned or State-leased land are not likely to "take" (defined as "kill or maintain possession") (ORS 496.004) any State-listed species. State laws also regulate within-State commercial trade in listed species, and their transport on public roads.

Additional State laws, as well as the inadequacy of current regulatory mechanisms to effectively protect *Fritillaria gentneri*, are discussed above in the Reasons for Listing.

## 2. Surveys

Over the last 4 years, various individuals, organizations, and government agencies have conducted extensive surveys for *Fritillaria gentneri*, resulting in the discovery of many previously unknown occurrences and the relocation of historical occurrences. Since publication of the Final Rule in 1999 (USFWS 1999), the Medford District of the Bureau of Land Management has moved beyond conducting the habitat surveys regularly associated with individual project clearances, and has undertaken more proactive measures by sponsoring landscape-level surveys for *Fritillaria gentneri* in areas of suitable habitat. In 2001, surveys were conducted on over 3,846 hectares (9,500 acres) of Bureau of Land Management land, resulting in the discovery of 21 new occurrences. Of these, 1,821 hectares (4,500 acres) were surveyed within the Cascade/Siskiyou National Monument, near the existing Soda Mountain population. The Bureau of Land Management intends to continue proactive surveys of this nature in the future, provided there is



adequate funding (M. Mousseaux, pers. comm. 2001). Also in 2001, Josephine County conducted surveys on approximately 208 hectares (515 acres) of suitable habitat on county lands, though these efforts revealed no new occurrences.

Continuation of surveys in the future, as identified in this recovery plan (Recovery Action 3.1), will be important in solidifying our understanding of the species' geographic range, distributional patterns, abundance, habitat preferences, and conservation status.

### 3. Population monitoring

Population monitoring can be a very useful tool for gaining information on the structure of populations, levels of plant reproduction, longevity of individuals, demographic changes in response to time and environmental variables, and the general conservation status of populations. Monitoring of *Fritillaria gentneri* has been ongoing, in one form or another, for at least the last 13 years. Such efforts were first initiated by Wayne Rolle with the Siskiyou National Forest in 1988, and in 1990 a monitoring plan that tracked the fates of individual flowering plants was implemented for a single site on Bureau of Land Management land (Knight 1991b). Since 1998, the scope of population monitoring on Bureau of Land Management land has broadened to include many more sites (Brock and Callagan 2000). In 1999 and 2000, population monitoring was also carried out in demographic study plots located on land managed by the Jacksonville Woodlands Association (Brock and Knapp 2000). To date, these population monitoring efforts have helped reveal important information about *Fritillaria gentneri*, including the presence and extent of plant dormancy, levels of herbivory and disease, phenological responses to climate, changes in numbers of flowering plants over time, transitions of individuals from flowering to non-flowering stages (and vice versa), and indicated management needs of the species at different sites.

### 4. Habitat management

To our knowledge, little or no active measures have been taken to manage or improve habitat for *Fritillaria gentneri*. Currently, however, land managers are beginning to take such actions into serious consideration. The Medford District of the Bureau of Land Management

has initiated planning for reduction of fuels and thinning of overstory vegetation at one population site. Likewise, the Jacksonville Woodlands Association has submitted a proposal to conduct similar habitat management treatments on populations located in the Jacksonville Woodlands (M. Mousseaux, pers. comm. 2001). These populations are already subject to annual demographic monitoring by the Bureau of Land Management, which would provide a means of assessing the efficacy of different management techniques. Currently, the Oregon Department of Agriculture-Plant Conservation Program has proposed a challenge cost-share agreement with the Medford District of the Bureau of Land Management to conduct preliminary research into the effects of burning on *Fritillaria gentneri* within experimental plots, which may reveal important information useful in larger-scale habitat management applications.

The development and implementation of site-specific habitat management plans for *Fritillaria gentneri* is a key requirement in the recovery criteria outlined in this plan.

##### 5. Inclusion in land development plans

*Fritillaria gentneri* has been included in the General Management Plan for the Historic Natural Park and Trail System within the Jacksonville Woodlands (General Management Plan, undated). The lands within the Jacksonville Woodlands are owned by the Bureau of Land Management, Southern Oregon University, and the City of Jacksonville. As stated in the General Management Plan, protection of *Fritillaria gentneri* habitat is one of the primary purposes of the Jacksonville Woodlands. The General Management Plan (page 17) goes on to recognize several key responsibilities associated with the management of *Fritillaria gentneri*:

- "The species should in no way be harmed, picked, or have its habitat altered.
- Management of the Woodlands must identify and respect the areas where this species occurs.
- The location of habitat and individual plants should not be disclosed to the public.
- Any use of habitat will be strictly prohibited, except for the purpose of research.

- All actions (trail building, bench placement, etc.) on Bureau of Land Management land will have surveys for the presence of *Fritillaria gentneri* and appropriate actions taken to avoid adverse impacts if the plants are present."

If these responsibilities are carried out as stated, they should provide significant protection for *Fritillaria gentneri* in the Jacksonville Woodlands and alleviate threats directly arising through anthropogenic disturbances.

## 6. Research

Numerous research projects have been conducted to increase our knowledge about *Fritillaria gentneri*. Sponsored by the Oregon Department of Agriculture-Plant Conservation Program and Bureau of Land Management, Guerrant (1992) used electrophoretic techniques to assess the potential hybrid origin of *Fritillaria gentneri* and evaluate its validity as a legitimate species. Results of this study were not definitive, but Guerrant concluded that although *Fritillaria gentneri* is probably of hybrid origin (as are the majority of plant species known to science), it likely arose only once, rather than through multiple, independent hybridization episodes where each population occurs. Accordingly, to the best of our knowledge, *Fritillaria gentneri* should be considered a valid species. Additional research into this issue, using DNA fingerprinting techniques, is currently being initiated at Southern Oregon University under the supervision of Dr. Steven Jessup.

In response to the limited evidence of successful sexual reproduction in *Fritillaria gentneri*, the Oregon Department of Agriculture-Plant Conservation Program (in 2000, 2001, and 2002) carried out research that we sponsored to shed additional light on this aspect of the species' biology. As described in the previous section on reproductive ecology, these studies entailed various types of self-, open- and cross-pollination treatments, carried out among several populations. Few treatments have yielded successful seed production, indicating either a high level of sterility in the species, or inexplicable problems associated with the methodology of hand-pollinating *Fritillaria gentneri* flowers (Amsberry and Meinke 2002). Sexual reproduction (production of fruits and seeds from flowers) appears to be a sporadic or episodic event for *Fritillaria gentneri*. Plants of *Fritillaria gentneri* produced fruits and seeds in 2002, although at low and erratic rates, and produced more fruits

when cross-pollinated with either of the supposed parent species than when pollinated with pollen of its own species (Amsberry and Meinke 2002). Additional studies are needed to confirm the taxonomic validity of this species and to determine the conditions that lead to optimal sexual reproduction.

To help gain a better understanding of potential sterility in *Fritillaria gentneri*, Dr. Darlene Southworth at Southern Oregon University conducted research into the viability of *Fritillaria gentneri* pollen. This research indicated that: (1) pollen of this species appeared viable (non-shrunken) under microscopic examination; (2) pollen grains of *Fritillaria gentneri* were intermediate in size between *Fritillaria recurva* (scarlet fritillary) and *Fritillaria affinis* (chocolate lily); and (3) germination of *Fritillaria gentneri* pollen on an artificial medium was low (just a few percent) compared to that of *Fritillaria recurva* (10 to 20 percent) (D. Southworth, pers. comm. 2001). This research suggests that *Fritillaria gentneri* may be largely male-sterile, though the level of pollen germination under natural environmental and stigmatic conditions remains unknown, as does the extent of sterility among individuals and across populations. Additional research into the potential for viable seed production in *Fritillaria gentneri* is identified as a need in this recovery plan (Recovery Action 3.7).

Preliminary research is currently underway by the Oregon Department of Agriculture-Plant Conservation Program to investigate the cultivation requirements of *Fritillaria gentneri* in the greenhouse, using wild-collected bulbs and rice-grain bulblets salvaged from the site of ground disturbance at the Jacksonville Cemetery. The potential use of bulblets for off-site cultivation will be instrumental in augmenting existing populations in the wild, mitigating population declines due to habitat loss and disturbance, and enhancing *Fritillaria* populations to meet the minimum size requirements specified in Part II of this recovery plan. Additional research into *Fritillaria gentneri* cultivation requirements is currently being conducted by the Oregon Department of Agriculture-Plant Conservation Program as a challenge cost-share project with Medford Bureau of Land Management. This research will evaluate the effectiveness of different methods of cultivation and outplanting for successful establishment in the wild, thus potentially providing the

knowledge needed to develop an effective reintroduction and augmentation strategy for the species.

## H. RECOVERY STRATEGY

Four recovery units are identified for *Fritillaria gentneri*. Recovery units are geographic or otherwise identifiable subunits that are considered individually necessary to the long-term viability of the species through the preservation of factors such as genetic or demographic robustness that are essential to the species' survival and recovery.

The recovery units for *Fritillaria gentneri* were delineated by plotting known locations of the species on a map, and any area where four or more known locations occurred within 0.5-kilometer (0.3-mile) of each other was considered a "population center." Through this analysis, 11 population centers were identified. A circle 15.0 kilometers (9.3 miles) in radius was then created around each population center. Where the concentric circles around one population center intersect with concentric circles around another population center, the circles join to form "bands" that may continue around from two to six population centers. These intersecting circles are then combined to form a single recovery unit. This approach resulted in the delineation of 4 recovery units for *Fritillaria gentneri*, identified around each of these 11 population centers (Figure 5).

A distance of 15.0 kilometers (9.3 miles) was chosen to delineate the recovery units for this species based on the distribution of plant clusters across the landscape. No individuals of *Fritillaria gentneri* are known to occur beyond a distance of 15.0 kilometers (9.3 miles) of any of the 11 identified populations. Plants within this radius (*i.e.*, within a recovery unit) were therefore assumed to represent a deme, a scattered population of individuals with the potential to exchange genetic material on occasion. It is also theorized that the populations in different recovery units would only rarely interbreed, and thus each recovery unit may constitute a collection of relatively discrete populations. Some physical evidence supports this theory, as experts have noted apparent differences in populations at the extremes of the species' distribution (Units 2 and 4) in comparison with the populations at the core of the range (Units 1 and 3) (Amsberry and Meinke 2002; M. Mousseaux, *in litt.* 2003; W. Rolle, pers. comm. 2003). Thus, source material for augmentation and reintroduction at sites should come from populations within the same recovery unit. The two recovery units that are the closest to each other are Recovery Units 1 and 3, but these are

separated by the Rogue River. The importance of these individual recovery units to the long-term persistence of the species is discussed further below.

The recovery strategy for this species will be framed around the four identified recovery units. Within these recovery units, *Fritillaria gentneri* will be conserved by establishing a network of protected populations in natural habitat distributed in natural densities throughout its native range. Recovery of this species will focus on these protected populations, henceforth referred to as “*Fritillaria* management areas.” The strategy for each recovery unit will include rehabilitation of habitat, restoration of sites of historical occurrence, and augmentation of existing populations (through expansion of the geographic extent of present populations, while simultaneously maintaining natural densities, as detailed below).

The sizes of the populations needed for long-term persistence of *Fritillaria gentneri* were determined based on the research of Yonezawa *et al.* (2000). Based on studies of the related clonal species *Fritillaria camtschatcensis* (Kamchatka fritillary), these authors indicate that a minimum of 20,000 individuals (both flowering and non-flowering) would be needed to conserve normal levels of adaptive genetic variation under a balance of mutation and random genetic drift. If these findings can be generalized to *Fritillaria gentneri*, then conservation of approximately 20,000 *Fritillaria gentneri* plants within each of these recovery units should be adequate to maintain sufficient adaptive genetic variability for the long-term survival of this species. Flowering individuals are typically vastly outnumbered by accompanying non-flowering plants, such that a population with a count of 1,000 flowering *Fritillaria gentneri* plants is actually estimated to range in size from 26,008 to 52,682 total plants (Appendix E; see also “Methodology for Estimation of Population Sizes” in Section E). Based on this information, a recovery target of 1,000 flowering plants in each of the 4 recovery units has been established for this species. Furthermore, to ensure the conservation of any currently existing genetic variability, and to prevent stochastic and demographic collapse, the plan requires that a minimum of 2 *Fritillaria* management areas, each with a population of at least 100 flowering plants, must occur within an 0.8-kilometer (0.5-mile) radius of each other in each of the 4 recovery units.

The establishment of *Fritillaria* management areas should be based upon existing natural populations as much as possible. When augmenting sites, augmented population densities should reflect the natural densities representative

of the population being augmented or that of the nearest neighbor population. Furthermore, rather than augmenting an existing population to make it more dense, it is recommended to augment by expanding into new adjacent suitable habitat mirroring the natural density for the site. Where possible, the inclusion of higher elevation habitat is desired when determining boundaries for *Fritillaria* management areas to allow for the potential of shifting populations in response to global warming trends.

*Fritillaria gentneri*, a primarily clonal species, often occurs in very low densities. Based on averages from macroplot occurrences, densities range from a low of 3.3 flowering plants per 0.4 hectare (1 acre) to a high of 48 flowering plants per 0.4 hectare (1 acre) at Pickett Creek 3. One extant natural site with high densities of plants (Pickett Creek 1) was counted and mapped using global positioning systems equipment in 2001. As described earlier, this method identified a density of 0.025 flowering plants per square meter (0.0023 plants per square foot), or approximately 40 square meters (430.6 square feet) for each individual flowering plant. Since this is an unusually dense population and a range of densities is not available, a minimal limit of 50 square meters (538.2 square feet) per flowering plant is recommended in establishing a *Fritillaria* management area to allow room for population shifts and expansion over time. A *Fritillaria* management area should also minimally include a demographic population size of at least 50 individuals; this translates to approximately 5 flowering or mature plants. It is further recommended that the smallest *Fritillaria* management area established should encompass no less than 500 square meters (5,382 square feet) to allow some room for population expansion at a site.

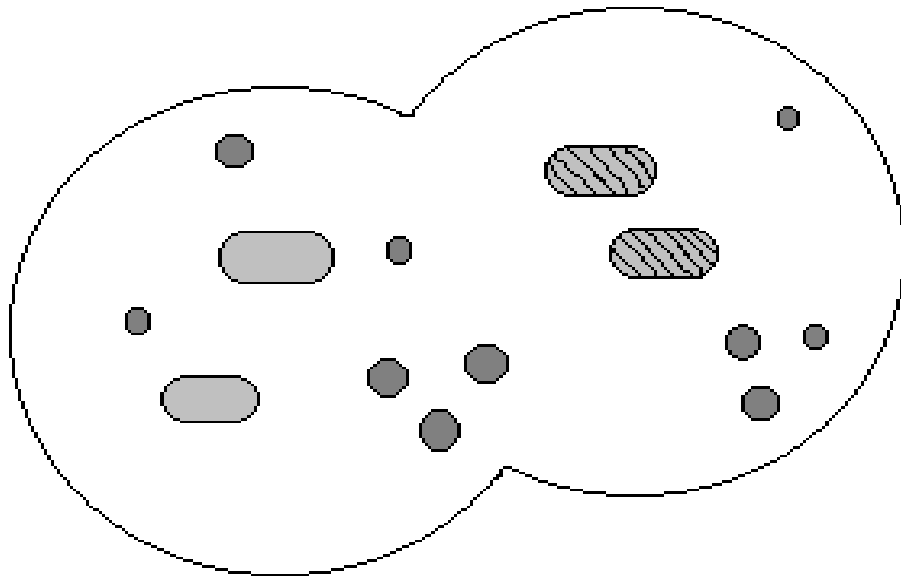
An innumerable combination of different sized *Fritillaria* management areas are possible to meet the recovery target of a total population based on 1,000 flowering plants encompassed within each of the 4 recovery units. In addition to the minimum 2 populations of 100 flowering plants each that must occur within 0.8-kilometer (0.5-mile) of each other, a recovery unit could encompass many additional small *Fritillaria* management areas (each with at least 5 flowering plants, and encompassing a minimum of 500 square meters [5,382 square feet]) or several, larger management areas. At one end of the spectrum, 2 *Fritillaria* management areas, each with at least 500 flowering plants (and with at least 100 individuals located within 0.8-kilometer [0.5-mile] of each other) could be established within a recovery unit. If only two large *Fritillaria* management areas were established for a recovery unit, we would expect them to be very large and to encompass a broad distribution of patches of plants at varying densities,

reflective of natural conditions. At the other end of the spectrum, in addition to the minimum 2 *Fritillaria* management areas of 100 flowering plants, a recovery unit could encompass up to 160 individual *Fritillaria* management areas that each consist of at least 5 flowering plants. Figure 6 offers a hypothetical example of this recovery unit/management area concept. These management areas should be established to mimic the range of natural densities (natural clustering) of *Fritillaria gentneri* observed across the landscape and should encompass the complete historical distribution of the species. Wherever possible, existing naturally occurring sites should be incorporated into *Fritillaria* management areas rather than emphasizing the establishment of new populations or augmentation of already dense populations.




New populations found outside of the existing identified recovery units may change recovery unit boundaries in the future. We will update recovery unit boundaries as necessary with future revisions of the recovery plan for the species (review of the plan should occur at least once every 5 years). As an interim approach, new populations found outside of the boundaries of the identified recovery units should generally be included in the nearest recovery unit until such time as the recovery plan can be revised. We request that we be contacted when new populations are discovered outside of the current recovery unit boundaries identified in this plan.

The importance of these four individual recovery units to *Fritillaria gentneri* relies on providing for the distribution of *Fritillaria gentneri* across its native range, preserving the full range of genetic diversity within the species to ensure its long-term viability through the maintenance of adaptive flexibility, and reducing the vulnerability of the species to extirpation from random catastrophic events by creating redundancy in the system. In a species such as *Fritillaria gentneri*, where essentially all of the representatives of the species occur in small, isolated populations within a small geographic area, the presence of numerous populations well-distributed across the natural range of the species provides additional assurance that a random event, such as a wildfire, will not eliminate all of the known occurrences of the species. When total population numbers within the recovery unit fall below 500 individual flowering *Fritillaria gentneri* plants, these populations become susceptible to the accumulation of deleterious alleles which may ultimately result in population declines and extirpation (Soulé 1987; Yonezawa *et al.* 2000). Furthermore, in order for the species to survive and recover in the future, all of the genetic diversity across the total range of the species should be conserved in order to provide the species with adaptive capacity





**FIGURE 6.** Example illustrating the *Fritillaria* management area concept (for conceptual purposes only; drawing not to scale). To meet the recovery criteria of 1,000 flowering plants per recovery unit, this hypothetical representation of Recovery Unit 2 might contain the following *Fritillaria* management areas (populations that are counted as contributing toward recovery):

- 
 2 large management areas within 0.8-kilometer (0.5-mile) of each other, 1 with approximately 300 flowering individuals and the other with 250 flowering plants
- 
 2 additional large management areas, 1 with 200 flowering plants and the other with 100 flowering individuals
- 
 10 additional smaller management areas, ranging in size from 5 to 25 flowering plants each, for a total of approximately 150 additional flowering plants

All of the management areas together support a total population of 1,000 flowering *Fritillaria gentneri* within this recovery unit. Depending on the number of vegetative individuals growing in association with these flowering individuals, a recovery unit containing 1,000 flowering *Fritillaria gentneri* would be conservatively estimated to support a total population of from 26,008 to 52,682 plants (see “Methodology for Estimation of Population Sizes” in Section E of the text and also Appendix E for an explanation of total population size estimates).

This would be only one of any number of possible combinations of numbers of management areas and management area sizes to meet the minimum population size delisting criteria for a single *Fritillaria gentneri* recovery unit.

when environments change in the future. Although there is some indication that the genetic variability of these populations may be somewhat reduced due to the primarily clonal nature of reproduction in the species, this merely underscores the need to preserve whatever reservoir of diversity currently exists within these populations, as there is little opportunity for genetic recombination events through sexual reproduction in *Fritillaria gentneri*. Although the array of genetic diversity across the range of the species is not known, there is some evidence of morphological variation between representatives of the species occupying the different recovery units, implying a possible genetic basis for those differences.

Researching the extent and distribution of genetic diversity within the species, and evaluating the delineation of recovery units accordingly, is one of the needed actions identified in this plan (Recovery Action 3.5). Not knowing what the nature of these underlying genetic differences may be at this point in time, the only prudent course of action is to act conservatively and preserve whatever genetic variability may be present, as 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. Since each of the recovery units are based upon preserving the existing genetic differentiation across the distribution of the species, as well as buffering the very small populations of *Fritillaria gentneri* against extirpation or extinction from its limited range, all of these recovery units are deemed essential for both the survival and recovery of the species.

Having reached this conclusion, that these recovery units are essential for both the survival and recovery of the species, we shall consider the effects of proposed Federal actions undergoing section 7 (of the Endangered Species Act) consultation at the level of 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 single recovery unit, and not to the species across its entire range.

To be counted toward the recovery objective, *Fritillaria* management areas within recovery units should consistently maintain adequate numbers of *Fritillaria gentneri* plants. Population size is calculated by counting the number of flowering plants present in *Fritillaria* management areas. Because this species spreads through vegetative reproduction (bulblets), individual, independent plants may not represent genetically distinct individuals.

Measures of occupied habitat, combined with counts of flowering plants, provide a practical method for evaluating the viability of extant, re-established, and augmented populations. All populations of *Fritillaria gentneri* will require management. Encroaching vegetation should be controlled, and populations may require periodic augmentation. Through an adaptive management approach, various techniques should be evaluated for their effect on *Fritillaria gentneri* and its associated habitat, and adjusted accordingly.

## **PART II. RECOVERY**

### **A. OBJECTIVES AND CRITERIA**

**Objectives.** -- The objective of this recovery plan is to outline recovery actions that, when implemented, will remove threats to *Fritillaria gentneri* to the extent that it is no longer in danger of extinction, at which point it may be warranted to downlist the species to threatened status or to remove it from the Federal List of Endangered and Threatened Wildlife and Plants. In the Final Rule to list *Fritillaria gentneri* as an endangered species (USFWS 1999), we identified several key threats (Reasons for Listing) that must be adequately addressed before reclassification of the species to threatened status or delisting can be considered. Appendix F links these listing factors to the recovery criteria and the recovery actions identified in this plan. These Reasons for Listing are also discussed in Part I of this recovery plan, and in descending order of magnitude are:

- Ongoing loss of habitat to development and other activities
- Vulnerability associated with small population sizes
- Lack of habitat management needed to maintain favorable, mid-successional conditions
- Inadequacy of existing regulatory mechanisms to conserve the species
- Potential for bulb collecting
- Herbivory and fungal disease

**Criteria.** -- Reclassification and delisting requires the establishment, management, and maintenance of a minimum of eight *Fritillaria* management areas, with at least two distributed within each of four recovery units as described below, where the species will be secure from all threats described in the Reasons for Listing in Part I, Section F of this plan.

- (1) **To consider reclassification to threatened status:** Each recovery unit shall maintain at least 750 flowering plants. **To consider delisting:** Each recovery unit shall maintain at least 1,000 flowering plants. For delisting purposes, these 1,000 flowering plants should occur in protected *Fritillaria* management areas and should have exhibited net demographic stability or growth for a minimum of 15 years, as determined through at least biennial demographic monitoring. For the purposes of this plan, measurements of population size and structure are based on counts of flowering individuals because non-flowering *Fritillaria* species are not easily distinguished. A population with a count of 1,000 flowering plants would be estimated to range in size from 26,008 to 52,682 individuals altogether.

The designation of additional recovery units, and/or changes to the boundaries of the existing units (Figure 5), may be warranted if additional population centers are discovered, and/or if future research into the distribution of genetic diversity (Recovery Action 3.5) suggests other, more appropriate, boundaries.

The populations of *Fritillaria gentneri* within each recovery unit will be considered secure from the threats identified in Reasons for Listing when all of these additional criteria are met:

- (2) To avoid the threat of habitat loss, the *Fritillaria* management areas within the recovery units should be located on public land, or private land subject to permanent conservation easement or other permanently binding agreements. Because populations elsewhere on public land continue to experience loss and degradation of habitat, each agency involved in land ownership or management in association with a *Fritillaria* management area should take appropriate steps to ensure the long-term conservation of this species by outlining their specific responsibilities for site protection and maintenance in general land management plans, conservation agreements, and the like.
- (3) To reduce vulnerability to adverse random events inherent to small populations composed of too few and too widely scattered individuals, maximize and maintain potential genetic, ecological, and geographical variation in the species, and maintain current distributional patterns, 2 of the *Fritillaria* management areas within each recovery unit must consist of populations of at least 100 flowering individuals each within an 0.8-

kilometer (0.5-mile) radius of each other. Recovery units may include additional management areas of various sizes, as necessary, to meet the requirement of 750 flowering individuals for downlisting or 1,000 flowering individuals for delisting. If necessary, *Fritillaria* management areas may be subject to augmentation using genetically appropriate (originating from the same recovery unit) cultivated individuals to meet the minimum size criterion (Recovery Action 2.43). *Fritillaria* management areas should contain ample habitat to provide a spatial buffer around each population, and allow room for population shifts and expansion over time.

- (4) To avoid population vulnerability arising from the inordinate concentration of individuals within a very small area, potentially subject to extirpation from unpredictable catastrophic events, flowering individuals should be distributed over a minimum of 50,000 square meters (5 hectares or 12.4 acres) of occupied habitat within each recovery unit.
- (5) To maintain favorable habitat conditions, a site-specific management and monitoring plan should be developed, approved and implemented for each *Fritillaria* management area to prevent degradation of sites, to assess effects of management actions, and to allow for adaptive management to assure the recovery of the species. Survival of the species and removal of threats should be identified as primary objectives for these plans.
- (6) To protect plants from bulb collecting and herbivory by deer or livestock, each *Fritillaria* management area could be subject to fencing, change of grazing season or other measures if population monitoring identifies these threats.
- (7) To ensure the continuing recovery of the species and adequacy of management actions undertaken, a post-delisting monitoring plan must be developed and ready for implementation at the time of delisting.

## **B. STEPDOWN OUTLINE OF RECOVERY ACTIONS**

1. Provide private landowners with information on identification and management of habitat to maintain *Fritillaria gentneri*
  - 1.1 Develop identification guide for *Fritillaria gentneri*
  - 1.2 Provide technical assistance to private landowners
  
2. Establish a minimum of eight *Fritillaria* management areas (allocated among recovery units as detailed in Objectives and Criteria)
  - 2.1 Select *Fritillaria* management areas
  - 2.2 Delineate management area boundaries
  - 2.3 Secure protection of habitat within *Fritillaria* management areas
  - 2.4 Meet minimum population size, structure, and stability criteria
    - 2.41 Conduct baseline demographic monitoring and map plant locations with global positioning systems equipment
    - 2.42 Assess population augmentation needs
    - 2.43 Augment populations as necessary
      - 2.431 Collect rice-grain bulblets from genetically suitable sources
      - 2.432 Cultivate bulblets into larger plants and outplant into *Fritillaria* management areas
    - 2.44 Conduct at least biennial monitoring to evaluate compliance with criteria for size, structure and stability of the population, to determine effectiveness of management techniques, and to evaluate impacts of illegal bulb collecting, disease, and herbivory by deer and livestock
  - 2.5 Manage each *Fritillaria* management area
    - 2.51 Develop habitat management and monitoring plans for each *Fritillaria* management area
    - 2.52 Implement habitat management plans for each *Fritillaria* management area
  
3. Conduct surveys and research essential to conservation and recovery
  - 3.1 Continue surveys for undiscovered populations
  - 3.2 Research habitat requirements

- 3.3 Develop chemical, anatomical, or other methods to distinguish non-flowering plants
  - 3.4 Research population responses to experimental habitat management treatments
  - 3.5 Research the extent and distribution of genetic diversity within the species (within and between populations)
  - 3.6 Research optimal cultivation and outplanting techniques
  - 3.7 Research potential for sexual reproduction
  - 3.8 Determine if *Fritillaria gentneri* is a hybrid
  - 3.9 Determine feasibility of bulb salvaging
4. Develop off-site germplasm banks to maintain reproductive materials
    - 4.1 Develop off-site storage methods
    - 4.2 Establish off-site germplasm banks
5. Review and revise recovery plan as needed, based on accumulation of new data

## C. NARRATIVE OUTLINE OF RECOVERY ACTIONS

1. Provide private landowners with information on identification and management of habitat to maintain *Fritillaria gentneri*

Although the primary focus of recovery efforts will lie in the establishment of secure *Fritillaria* management areas, conservation of all extant occurrences, even those in private ownership that only contain a few individuals, remains an elemental goal of this plan. These populations contribute to the overall abundance and distribution of the species and may harbor genetic variability important for conservation and recovery efforts.

1.1 Develop identification guide for *Fritillaria gentneri*

Because of the closely related *Fritillaria recurva* (scarlet fritillary), identification is challenging for the professional if not almost impossible for the amateur. An identification guide with a key identifying characters in both diagrams and photographs, and providing comparisons with closely related species, is needed to assist with the accurate identification of *Fritillaria gentneri*. Once this guide is developed and published, it should be made available to the general public. This guide will allow landowners to determine if they have *Fritillaria gentneri* on their property, and will provide some basic management guidelines should they desire to protect the species on their land.

1.2 Provide technical assistance to private landowners

We will take steps to prevent further habitat loss on these private lands by providing information on identification and management so that private landowners who wish to protect *Fritillaria gentneri* may be able to do so. This outreach effort could lead to establishment of conservation agreements, conservation easements, land acquisition from willing sellers, or other types of agreements. Conservation agreements should outline specific steps necessary to conserve the species, and encourage habitat improvement through programs such as the Partners for Fish and Wildlife Program, a restoration program administered by us, or other conservation programs.



2. Establish a minimum of eight *Fritillaria* management areas (allocated among four recovery units as detailed in Objectives and Criteria)

The core of recovery efforts for *Fritillaria gentneri* will lie in the establishment of at least eight *Fritillaria* management areas in four recovery units where the species will be secure from all threats identified in Reasons for Listing. The distribution of these *Fritillaria* management areas within the specified recovery units, minimum population size criteria, and other specifications are detailed in the preceding Recovery Strategy, Objectives and Criteria sections.

2.1 Select *Fritillaria* management area sites

Locations of *Fritillaria* management areas within each of the four recovery units will be selected in consultation with individual private landowners, public land management agencies, and other knowledgeable and interested parties.

The most suitable sites will be selected based upon factors including land ownership, extent and quality of habitat, health and size of existing populations, threats from current or projected land uses, site management needs, feasibility of providing habitat management in light of surrounding land uses, and security of sites from vandalism and trespass.

2.2 Delineate *Fritillaria* management area boundaries

Boundaries of selected populations for inclusion in *Fritillaria* management areas should be accurately mapped to ensure precision and efficiency in habitat acquisition and/or development of conservation agreements and easements, and to help avoid unintentional habitat disturbance resulting from management of adjacent lands. Adjacent landowners should be notified of *Fritillaria* management area boundaries to avoid inadvertent trespass.

Factors to consider when delineating *Fritillaria* management area boundaries include provision of adequate unoccupied habitat to allow for population expansion (particularly into higher elevations in the face of global warming), provision of buffers around the

population to diminish impacts from surrounding land uses and edge effects, natural distributional patterns of plants and habitat, patterns of historical natural disturbances such as fire, and patterns of land ownership. Once *Fritillaria* management area boundaries have been identified, they should be accurately recorded in formats useful to *Fritillaria* management area land managers (e.g., geographic information systems data and maps).

2.3 Secure protection of habitat within *Fritillaria* management areas

Populations of *Fritillaria gentneri* on private lands are not legally protected against habitat loss. Likewise, the occurrence of *Fritillaria gentneri* populations on public lands has not historically guaranteed their protection against inadvertent disturbance. As such, wherever *Fritillaria* management areas are established, they should be reliably protected through recognition and protection in Federal land management plans or through formation of permanent, legally binding agreements between us and the landowners. Conservation agreements should outline the specific steps needed to conserve *Fritillaria* management areas, and the liabilities of failing to carry out specified protection measures. The establishment of conservation agreements should be coupled with the development of site-specific habitat management plans, discussed below (Recovery Action 2.5), to provide for long-term maintenance or improvement of habitat.

2.4 Meet minimum population size, stability, and structure criteria

In order to meet the criteria for recovery, each recovery unit should consist of at least 750 flowering plants for reclassification to threatened status and 1,000 plants for delisting. A minimum of 5.0 hectares (12.4 acres) of occupied habitat is needed for each recovery unit to meet recovery goals (see Recovery Criteria). The steps needed to meet these criteria are discussed below.

2.41 Conduct baseline demographic monitoring and map plant locations with global positioning systems equipment

*Fritillaria* management areas should undergo baseline monitoring to determine their initial size (number of individuals), distribution of individuals within the habitat (including assessment of occupied habitat), and the frequency of individuals within different age (size) classes.

In order to better understand population densities and juxtaposition across the landscape, better mapping of populations using global positioning systems equipment is needed. All plant locations should be mapped using global positioning systems for use in geographic information systems mapping. This, coupled with counts of plants, will help in determining appropriate densities of plants for augmentation at different sites and in determining appropriate patch sizes for augmentation. This information will be useful in assessing augmentation needs and provide baseline information for use in determining management strategies.

2.42 Assess population augmentation needs

Once baseline demographic information has been collected, augmentation needs should be assessed to achieve, within each recovery unit, the recovery criterion of 1,000 flowering plants. Little is known about how long it takes to cultivate mature, reproductive *Fritillaria gentneri* plants from rice-grain bulblets, though other *Fritillaria* species typically require 3 to 5 years (Pratt and Jefferson-Brown 1997), so the process of attaining 1,000 flowering plants may take several years. To buffer against demographic stochasticity over time, efforts should be made at the outset to exceed the minimum number of 1,000 flowering plants.

2.43 Augment populations as necessary

The following steps are recommended as protocols for population augmentation, and are based upon information

gained from preliminary cultivation efforts currently underway at the Oregon Department of Agriculture-Plant Conservation Program. It may be useful to update these recommendations if and when this recovery plan is revised, as additional experience and information is gained from continued cultivation and outplanting research (Recovery Action 3.6).

2.431 Collect rice-grain bulblets from genetically suitable sources

To maintain the genetic integrity of *Fritillaria gentneri* populations, and maximize potential genetic diversity among *Fritillaria* management areas and recovery units, all augmentation activities should be limited to the use of genetically appropriate, local bulb stock, preferably from the existing population(s) within each *Fritillaria* management area (unless future data provide evidence that these populations are suffering the negative consequences of genetic uniformity, or there is no diversity among certain populations). In the unlikely event that a designated *Fritillaria* management area does not already harbor a *Fritillaria gentneri* population, then the nearest neighboring population should be used as the source of cultivation and augmentation stock; these should be within the same recovery unit for that area.

As competition between bulblets is probably extremely intense at the base of parent plants in natural populations due to crowding (*i.e.*, Figure 3), careful collection of a few bulblets from mature plants should have little, if any, impact on population dynamics while simultaneously providing valuable cultivation stock. Efforts should be made to collect bulblets from a range of individuals within each population, to maximize the potential genetic diversity of augmentation stock.

Additional study is needed in determining the effects of bulblet collection and associated disturbance on *Fritillaria gentneri*.

2.432 Cultivate bulblets into larger plants and transplant into *Fritillaria* management areas

Once bulblets are collected from natural populations, they should be cultivated in the greenhouse until they reach the desired size/age class for transplanting into *Fritillaria* management areas. Additional research is needed to determine optimal cultivation techniques, the length of time needed to cultivate small plants to reproductive maturity, and to evaluate optimal methods (and seasonal timing) of transplanting mature bulbs into the field. Preliminary research into cultivation techniques is currently underway by the Oregon Department of Agriculture-Plant Conservation Program, and additional cultivation and augmentation research is under proposal as a challenge cost-share project between the Oregon Department of Agriculture-Plant Conservation Program and the Medford District of the Bureau of Land Management. Once protocols are developed, Forest Service, Bureau of Land Management, or private nurseries could be used to increase propagation materials to allow for competitive costs when progressing into the population augmentation phase of recovery.

2.44 Conduct at least biennial monitoring to evaluate compliance with criteria for size, structure, and stability of the population, to determine effectiveness of management techniques, and to evaluate impacts of illegal bulb collecting, disease, and herbivory by deer and livestock

*Fritillaria* management areas should undergo at least biennial monitoring to determine if populations are stable, project long-term population trends in population growth or

decline, learn more about the life history of the species (*i.e.*, plant longevity, frequency of dormancy, and rate of transitions between age/size classes), measure spatial changes in populations, evaluate compliance with minimum size and structure (occupied habitat) criteria, and assess future augmentation needs.

Biennial monitoring of all sites was thought to be frequent enough to detect population trends and general management needs on sites that are reasonably stable and not subject to unpredictable human-related impacts. More frequent monitoring (at least site review for disturbance and management intervention, if necessary) would be desired when implementing new management techniques or when a site is vulnerable to various human impacts (off-road vehicles, weed encroachment, etc.).

Implementation of management plans should be conducted in concert with population monitoring, as a means of evaluating the response of populations to management actions. In instances when the outcome of a particular management strategy is uncertain, it may be wise to exercise caution and implement such strategies on a small-scale, experimental basis, prior to large-scale implementation.

Monitoring of *Fritillaria* management areas should be conducted at least biennially to evaluate the impacts of herbivory by deer and livestock and the potential loss of bulbs to collectors. If these factors become problematic, occurring at levels considered to be detrimental to the long-term health of populations, then actions should be taken to reduce their levels through fencing, repellants, or other means. Additionally, such monitoring can be designed to help determine the severity of fungal infections and other diseases. Research should be conducted to determine the identity of pathogens and any environmental factors that may be exacerbating their severity.

## 2.5 Manage each *Fritillaria* management area

Passive protection of *Fritillaria gentneri* from human disturbance will likely be inadequate to maintain the species in perpetuity in its presently degraded and changing environment. In addition to protection, comprehensive habitat management will be needed to encourage natural population recruitment and sustain *Fritillaria* management areas in the long-term.

### 2.51 Develop habitat management plans for each *Fritillaria* management area

Management strategies should be developed for each management area on an individual basis, determined by the needs and habitat characteristics at each site, as assessed by us, affected landowners, and consulted knowledgeable individuals. Management strategies may include, but are not limited to:

- (a) Reduction of successional encroachment and shading by means of prescribed fire, mowing, pruning, selective removal of trees and shrubs, or other means.
- (b) Curtailment of additional new roads in habitat to reduce direct and indirect impacts such as weed expansion into habitats.
- (c) Control and prevention of invasive weed colonization through annual monitoring, manual removal, biocontrol, herbicide application, mowing, or other means.
- (d) Reduction of herbivory by deer and livestock through fencing, repellants, and curtailments of livestock allotments such as timing of use or reduction in area.
- (e) Prevention of bulb collecting through public education, fencing, or other means.
- (f) Monitoring, fire management, and fire suppression plans.

- (g) If conditions that promote sexual reproduction are discovered through future research (Recovery Action 3.7), these conditions should be enhanced to facilitate increased seed production.

2.52 Implement habitat management plans for each *Fritillaria* management area

Once developed, management strategies should be incorporated into a written plan (which includes a fire management and fire suppression plan, where appropriate) with a detailed implementation schedule.

3. Conduct surveys and research essential to conservation and recovery

The following actions are identified as necessary to increase our knowledge of *Fritillaria gentneri* and assist in developing effective recovery strategies for the species.

3.1 Continue surveys for undiscovered populations

New populations of *Fritillaria gentneri* continue to be discovered, even though botanists and amateurs alike have searched for this showy species for several decades. This is in part due to large-scale surveys recently conducted on Bureau of Land Management and other lands, as well as information requests we publicized in area newspapers. Discovery of new *Fritillaria gentneri* populations increases the prospects for its recovery not only by elevating the number of known plants and providing new opportunities for their conservation, but also by enhancing our knowledge of the species' habitat requirements, geographical distribution, and response to various land use regimes.

When considering priorities for future surveys, emphasis should be given to private lands (with voluntary landowner cooperation), where the threat of land development and habitat loss is most immediate. Priority should also be given to surveying suitable habitats (as determined by Recovery Action 3.2) in areas immediately beyond the perimeter of known populations, so that we may become more confident about the limits of the species'



geographic range and provide land managers with more precise information about where project clearance surveys are warranted.

If chemical, anatomical, or other diagnostic methods are successfully developed for distinguishing *Fritillaria* species when in the vegetative stage (Recovery Action 3.3), these methods should be utilized in all future surveys to assist in accurate identification of non-flowering plants in the field. These techniques should also be used to reevaluate the identity of non-flowering plants, and extent of occupied habitat, in known populations and previously surveyed areas. Targeting of surveys may be assisted in the future by completion of research into *Fritillaria gentneri* habitat requirements and soil affinities (Recovery Action 3.2).

### 3.2 Research habitat requirements

To assist in the efficient implementation of targeted surveys for new *Fritillaria gentneri* populations, it would be helpful to develop a means of identifying and prioritizing the most suitable and promising sites. One way of doing this would be to collect detailed habitat information (including soils, associated species, elevation, etc.) from all known *Fritillaria gentneri* populations, and then use statistical analysis and geographic information systems to predict the areas with the highest potential of harboring the species. Preliminary information on soils occupied by known *Fritillaria gentneri* populations is summarized in Appendix D.

Collection of comprehensive habitat information would also be useful in selecting *Fritillaria* management area locations, defining *Fritillaria* management area boundaries, identifying augmentation areas within *Fritillaria* management areas, and refining management strategies and goals for *Fritillaria* management area (and non-management area) populations.

3.3 Develop chemical, anatomical, or other methods to identify non-flowering plants

Because their basal leaves appear virtually identical, it is currently considered impossible to distinguish *Fritillaria gentneri* from *Fritillaria affinis* and *Fritillaria recurva* when not in flower. As non-flowering plants predominate populations of these co-occurring species, a means of confidently differentiating their leaves is greatly needed to accurately determine their abundance and distribution, and to assist land managers in protecting *Fritillaria gentneri* from potentially destructive land actions. Efforts should be made to develop methods for distinguishing *Fritillaria* leaves, preferably using chemical, anatomical, or other techniques that are more practical, portable, and expedient than molecular analysis.

3.4 Research population responses to experimental habitat management treatments

Currently, habitat management recommendations for *Fritillaria gentneri* are based only on best estimates of habitat requirements. Nothing is known about how this species, and its various life history stages and population dynamics, respond to different management strategies. Topics needing further investigation and experimentation include, but are not limited to the following:

- (a) Response of the species to shading, or release from shading.
- (b) Effects of manual removal of shrubs and trees on the species; also evaluate the potential impacts of inadvertent proliferation of invasive weeds.
- (c) Determine conditions for and the potential effectiveness of burning as a tool for enhancing *Fritillaria gentneri* populations and reducing fuels (preliminary investigations into this question are currently under proposal as a challenge cost-share project between the Oregon Department of Agriculture-Plant Conservation Program and Medford District of the Bureau of Land Management).

- (d) Determine effects to *Fritillaria gentneri* from ground disturbance and bulblet collection, as suggested by its occurrence along old roadbeds, bulldozer grades, and trails.
- (e) Determine requisite frequency and intensity of implementation of management techniques.

Understanding of the most fundamental management-related questions should be sought to promote successful establishment of *Fritillaria* management areas and ensure development of strategies that will benefit, and not further jeopardize, *Fritillaria gentneri*.

3.5 Research the extent and distribution of genetic diversity within the species (within and between populations)

Little is currently known about the level of genetic diversity within and between populations of *Fritillaria gentneri*. There is quite a bit of morphological variation within the species, but the degree to which this is influenced by genetic factors versus environmental interactions is unknown. Since conservation of adaptive genetic variability in *Fritillaria gentneri* is a fundamental goal of this plan, resolving this issue would provide important information needed to evaluate the current delineation of recovery units, and assist in the selection of optimal *Fritillaria* management areas. This information would also be useful in determining the extent to which populations consist of genetically uniform clones, and hint at the history of founder effects, sexual reproduction, and accumulation of mutations experienced by different populations.

3.6 Research optimal cultivation and outplanting techniques

Successful augmentation of *Fritillaria* management areas, for purposes of increasing the number of flowering plants and achieving stable population sizes and spatial structures, will hinge on developing effective methods of cultivation and reintroduction. To date, the Oregon Department of Agriculture-Plant Conservation Program has had preliminary success cultivating plants in the greenhouse using small bulblets and mature bulbs, but it is still unknown how long it will take these plants to reach reproductive

maturity. Likewise, the optimal size, method, and timing of bulb transplanting (*i.e.*, fall, winter, or spring) remain unknown. As existing populations are far too small to meet the *Fritillaria* management area requirements in this plan, it will be very important to resolve these questions. Preliminary research into cultivation and outplanting methods is currently under proposal as a challenge cost-share project between the Oregon Department of Agriculture-Plant Conservation Program and the Medford District of the Bureau of Land Management.

### 3.7 Research potential for sexual reproduction

Very low levels of seed production have been observed, despite years of formal and informal pollination investigations into seed production in *Fritillaria gentneri* (Amsberry and Meinke 2002). Seed production may occur under infrequent or ecologically unique circumstances such as unusual climatic events or in response to disturbance events such as fire.

Understanding the nature of the circumstances required for successful seed production, if they exist, would be significant for *Fritillaria gentneri* conservation and recovery, as it might enable land managers to enhance population or environmental attributes that promote seed production. In turn, increased sexual reproduction could enhance levels of adaptive genetic variation within populations, encourage formation of seed banks, and provide additional stock for cultivation and off-site seed banking projects. Conversely, if *Fritillaria gentneri* is found to only rarely reproduce sexually, through study we will have a better understanding of the mechanisms and obstacles that function to prohibit seed production.

### 3.8 Determine if *Fritillaria gentneri* is a hybrid

Initial studies by Guerrant (1992) indicated that *Fritillaria gentneri* was not a hybrid, although it may have arisen through hybrid origins. However, the low levels of seed production and possible sterile pollen are indicators that the plant may be a hybrid.

Additional research should be conducted to confirm the taxonomic status of *Fritillaria gentneri* as a species.

### 3.9 Determine feasibility of bulb salvaging

There may be opportunities to salvage mature bulbs of *Fritillaria gentneri* from private lands that are slated for development. Currently there are three lots in Jacksonville Cemetery that would be prime salvage spots (B. Schroeder, pers. comm. 2001). Among the questions to be answered are: When is the best time of the year to salvage the bulbs? How should the bulbs be stored until needed? When is the best time to outplant? Should bulbs be marked when in flower if transplant is planned for after they have gone dormant? Experimentation with various techniques will help improve strategies for successful bulb relocation.

## 4. Develop off-site germplasm banks to maintain reproductive materials

One of the fundamental goals of establishing large *Fritillaria* management areas is to reduce the threat of extirpation by random catastrophic events, such as pest and disease outbreaks, vandalism, intense wildfires, unfavorable climatic events, etc. However, as *Fritillaria gentneri* apparently only rarely produces seeds, and therefore probably lacks a significant seed bank, this species lacks resiliency in the face of catastrophic events. Such events may be crippling and irreversible for a plant species that does not produce seeds as a rule. Not only are seed-producing plants capable of forming natural soil seed banks, but their seeds can also be used to develop artificial (off-site) seed banks, thus providing additional security against threats in their environment.

### 4.1 Develop off-site storage methods

Since seed is not reliably produced, another method of germplasm storage needs to be developed. Investigations into the feasibility of preserving bulblets in cold storage for prolonged periods versus outplanting of bulbs in gardens should be investigated. The danger of outplanting in gardens is possible genetic “contamination” from cross pollination with other *Fritillaria* species that may be present. If the only way to preserve germplasm of *Fritillaria gentneri* is in

“gardens,” protocols on how to establish these “gardens” so as not to have contamination problems need to be developed.

4.2 Establish off-site germplasm banks

To provide added security for *Fritillaria gentneri*, an off-site germplasm bank should be established where a representative number of individuals from each *Fritillaria* management area (and additional populations, if possible) are maintained in cultivation. This could be done in concert with the cultivation efforts that take place to provide stock for *Fritillaria* management area augmentation. In the event *Fritillaria gentneri* eventually proves capable of producing viable seeds, a seed collection and off-site banking program should be initiated, and cultivated individuals in the germplasm bank should be kept reproductively isolated (by population) to prevent the potential for unintentional cross-pollinations.

5. Review and revise recovery plan as needed, based on accumulation of new data

As new information about *Fritillaria gentneri* becomes available through additional surveys, research, and management experience, the objectives, criteria, and recovery actions in this recovery plan should be reviewed and revised, as necessary. Of specific importance may be evaluations of recovery unit delineations, allocation of *Fritillaria* management areas within recovery units, the size and structure criteria of *Fritillaria* management areas, and future research and management needs.

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## **PART IV. IMPLEMENTATION SCHEDULE**

The following Implementation Schedule is a guide for meeting the objectives discussed in Part II of this recovery plan. This schedule indicates action priorities, action numbers, brief action descriptions, duration of actions, the responsible agencies, and lastly, estimated costs. Initiation of the actions identified in the Implementation Schedule are subject to availability of funds. These actions, when accomplished, should bring about a level of species conservation and habitat protection such that delisting is merited. Priorities in 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, symbols and terms used in the Implementation Schedule:**

Annual	costs occur annually until species is recovered
Ongoing	once a project starts, costs will occur annually until species is recovered
BLM	Bureau of Land Management
CITY	City of Jacksonville and Jacksonville Woodlands Association
FS	U.S. Forest Service
FWS	U.S. Fish and Wildlife Service, Oregon State Office
ODA	Oregon Department of Agriculture - Plant Conservation Program

\* An asterisk denotes the proposed lead or predominant agency(ies) that will be involved with this activity. The listing of a party in the Implementation Schedule does not require, nor imply a requirement, that the identified party has agreed to implement the action(s) or to secure funding for implementing the action(s). However, parties willing to participate may benefit by being able to show in their own budgets that their funding request is for a recovery action identified in an approved recovery plan and is therefore considered a necessary action for the overall coordinated effort to recover *Fritillaria gentneri*.

**Implementation Schedule for the *Fritillaria gentneri* Recovery Plan.** Detailed cost estimates are provided for the first 10 years of the estimated time to recovery; the Total Cost reflects cost estimates for the entire 16 year period projected to recovery of the species.

Action Priority	Action Number	Action Description	Action Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year									
						FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
1	1.1	Develop identification guide	1	FWS*, ODA, BLM	5	5									
1	1.2	Provide technical assistance	Annual	FWS*, ODA, BLM, CITY	80	5	5	5	5	5	5	5	5	5	5
1	2.1	Select <i>Fritillaria</i> management areas	1	FWS*, ODA, BLM*, CITY	3			3							
1	2.2	Delineate boundaries	1	FWS*, ODA, BLM*, CITY	10			10							
1	2.3	Secure habitat	8	FWS*, ODA, BLM*	320			40	40	40	40	40	40	40	40
2	2.41	Conduct baseline demographic monitoring and map populations with GPS	5	FWS*, ODA, BLM*, CITY, FS	400				80	80	80	80	80		
2	2.42	Assess population augmentation needs	Ongoing	FWS, ODA*, BLM*, CITY, FS	65				5	5	5	5	5	5	5

**Implementation Schedule for the *Fritillaria gentneri* Recovery Plan.** Detailed cost estimates are provided for the first 10 years of the estimated time to recovery; the Total Cost reflects cost estimates for the entire 16 year period projected to recovery of the species.

Action Priority	Action Number	Action Description	Action Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year									
						FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
2	2.431	Collect rice-grain bulblets	Ongoing	FWS ,ODA*, BLM, CITY, FS	120					10	10	10	10	10	10
2	2.432	Cultivate bulblets into larger plants and outplant	Ongoing	FWS, ODA*, BLM*, CITY, FS	440						40	40	40	40	40
2	2.44	Conduct at least biennial monitoring	Ongoing	FWS, ODA, BLM*, CITY, FS	520				40	40	40	40	40	40	40
2	2.51	Develop habitat management plans and conservation agreements	2	FWS*, ODA, BLM*, CITY, FS	80				40	40					
2	2.52	Implement habitat management plans	Ongoing	FWS, ODA, BLM*, CITY, FS	440						40	40	40	40	40
2	3.1	Survey for undiscovered populations	5	FWS*, ODA, BLM*, CITY, FS	100	20	20	20	20	20					

**Implementation Schedule for the *Fritillaria gentneri* Recovery Plan.** Detailed cost estimates are provided for the first 10 years of the estimated time to recovery; the Total Cost reflects cost estimates for the entire 16 year period projected to recovery of the species.

Action Priority	Action Number	Action Description	Action Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year									
						FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
2	3.2	Research habitat requirements	3	FWS ,ODA*, BLM, CITY, FS	60	20	20	20							
2	3.3	Develop methods to distinguish non-flowering plants	3	FWS, ODA*, BLM, CITY, FS	60	20	20	20							
2	3.4	Research response to habitat management treatments	3	FWS, ODA*, BLM*, CITY, FS	60	20	20	20							
2	3.5	Research the extent and distribution of genetic diversity	3	FWS ,ODA*, BLM, CITY, FS	45	15	15	15							
2	3.6	Research off-site cultivation from bulblets	3	FWS, ODA*, BLM, CITY, FS	48	16	16	16							



**Implementation Schedule for the *Fritillaria gentneri* Recovery Plan.** Detailed cost estimates are provided for the first 10 years of the estimated time to recovery; the Total Cost reflects cost estimates for the entire 16 year period projected to recovery of the species.

Action Priority	Action Number	Action Description	Action Duration (Years)	Responsible Party	Total Cost	Cost Estimates, in thousands of dollars per fiscal year										
						FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10	
3	3.7	Research potential for sexual reproduction	3	FWS, ODA*, BLM, CITY, FS	30	10	10	10								
3	3.8	Determine if hybrid	3	FWS, ODA*, BLM, CITY, FS	30	10	10	10								
3	3.9	Determine feasibility of bulb salvage	2	FWS, ODA*, BLM, CITY, FS	20	10	10									
3	4.1	Develop off-site storage methods	3	FWS, ODA*, BLM, CITY, FS	30	10	10	10								
3	4.2	Establish off-site germplasm banks	Ongoing	FWS, ODA*, BLM, CITY, FS	130				10	10	10	10	10	10	10	10
3	5.0	Review and revise plan	2	FWS*, ODA, BLM, CITY, FS	30						15	15				
Totals					3,126	161	156	199	240	250	285	285	270	190	190	

## APPENDIX A

Censuses of *Fritillaria gentneri* macroplots showing highest number of flowering plants recorded at a site for any year since records begin in 1941. Survey data from 2001 is presented for comparison. Population trend was determined from the full data set including observances over all years for a site. All data is based on 2.56 hectare (6.3 acre) macroplots as explained in Part I, Section E of the plan.

Macroplot name	Highest number recorded	Population trend	2001 survey data	Land-owner <sup>1</sup>
Antioch Road 1	3	Stable	3	BLM
Antioch Road 2	2	Stable	2	BLM
Antioch Road 3	1	Declining	0	BLM
Bear Gulch	5	Stable	5	BLM
Bellinger Hill	8	Unknown	*	PRIV
Bishop Creek	11	Increasing	11	PRIV
Blacksmith Creek 1	1	Stable	0	BLM
Blacksmith Creek 2	2	Stable	1	BLM
Britt Grounds 1	27	Unknown	*	SOU
Britt Grounds 2	1	Unknown	*	SOU
Britt Grounds 3	1	Unknown	*	SOU
Britt Grounds 4/ Jacksonville Woodlands	5	Stable	*	SOU
Britt Grounds 5	34	Unknown	*	SOU
Britt Grounds 6	8	Unknown	*	SOU
Cady Road	4	Unknown	*	PRIV
Cobleigh Road	1	Stable	*	PRIV
Colestine	4	Unknown	4	BLM
Dog Creek	2	Unknown	2	USFS
Dutch Oven Creek 1A	1	Unknown	*	BLM
Dutch Oven Creek 1B	87	Stable	87	BLM
Dutch Oven Creek 2 & 4	30	Unknown	30	BLM
Dutch Oven Creek 3	2	Unknown	2	BLM
Dutch Oven Creek 5	3	Unknown	3	BLM
Dutch Oven Creek 6	6	Unknown	6	BLM
Dutch Oven Creek 7	12	Unknown	12	BLM
Eagle Canyon	12	Stable	5	BLM
East Camp Creek 1	15	Unknown	15	BLM
East Camp Creek 2	15	Unknown	15	BLM
East Scotch Creek/Lone Pine Ridge	50	Unknown	50	BLM
Galls Creek 1	1	Unknown	1	PRIV
Galls Creek 2	6	Unknown	6	BLM
Goat Cabin Ridge 1/Muddy Gluch 5	19	Increasing	19	BLM
Goat Cabin Ridge 2	2	Stable	0	BLM
Gray Creek 1	2	Unknown	2	BLM
Gray Creek 2	1	Unknown	1	BLM
Holcomb Spring 1	8	Unknown	*	PRIV

<b>Macroplot name</b>	<b>Highest number recorded</b>	<b>Population trend</b>	<b>2001 survey data</b>	<b>Land-owner<sup>1</sup></b>
Jackson County Landfill 3	5	Unknown	*	PRIV
Jackson County Landfill 4	1	Unknown	*	PRIV
Jackson County Landfill 5	1	Unknown	*	PRIV
Jackson Creek Road	3	Unknown	*	PRIV
Jacksonville 1	5	Unknown	*	PRIV
Jacksonville Cemetery 1 & 2	57	Unknown	*	CITY
Jacksonville Cemetery 3	3	Unknown	*	CITY
Jacksonville Cemetery 4	15	Unknown	*	CITY
Jacksonville Cemetery 5	4	Unknown	*	CITY
Jacksonville Cemetery 6	15	Unknown	*	CITY
Jacksonville Cemetery 7	1	Unknown	*	CITY
Jacksonville Cemetery 8	15	Unknown	*	CITY
Jacksonville Cemetery 9	2	Unknown	*	CITY
Jacksonville Woodlands 1	108	Stable	81	BLM
Jacksonville Woodlands 3	40	Stable	41	BLM
Laurel Wood Drive	3	Unknown	*	PRIV
Leafwood Drive	1	Stable	1	BLM
Lick Gulch	3	Declining	0	BLM
Little Applegate (Lower)	1	Stable	1	BLM
Little Applegate 2	1	Declining	0	BLM
Log Town Cemetery	2	Unknown	*	ODOT
Lomas Road	1	Stable	1	BLM
Lyman Mountain	*	Extirpated	*	PRIV
Merlin	*	Extirpated	*	PRIV
Muddy Gulch 1 A & 3	19	Stable	10	BLM
Muddy Gulch 1 B	10	Stable	9	BLM
Muddy Gulch 2	58	Stable	28	BLM
Muddy Gulch 4	2	Stable	1	BLM
Muddy Gulch 6	9	Increasing	9	BLM
Murphy	1	Unknown	*	BLM
Oregon Belle	22	Increasing	22	BLM
Paradise Ranch Road	1	Unknown	*	PRIV
Pelton Road	60	Unknown	*	PRIV
Pickett Creek 1	86	Increasing	86	BLM
Pickett Creek 2	153	Declining	46	BLM
Pickett Creek 3	153	Declining	45	BLM
Pickett Creek 4	41	Increasing	41	BLM
Pickett Creek 5	1	Unknown	*	BLM
Pilot Rock	45	Unknown	45	BLM
Placer Hill Drive	6	Unknown	*	PRIV
Poorman's Gulch 1	1	Unknown	*	PRIV
Poorman's Gulch 2	1	Unknown	*	PRIV
Poorman's Gulch 3	2	Unknown	*	PRIV
Poorman's Creek 1	1	Declining	0	PRIV

Macroplot name	Highest number recorded	Population trend	2001 survey data	Land-owner <sup>1</sup>
Ramsey Road	2	Unknown	*	PRIV
Red Mountain	1	Unknown	1	BLM
Rush Creek	4	Declining	0	BLM
Sailor Gulch	5	Unknown	*	PRIV
Sam's Creek 1	1	Declining	0	PRIV
Sam's Creek 2	2	Declining	0	BLM
Sexton Mountain	2	Unknown	*	BLM
Spencer Gulch 1	1	Declining	0	BLM
Spencer Gulch 2	1	Declining	0	BLM
Star Gulch	1	Declining	0	BLM
Sterling Creek Road 1	1	Unknown	*	PRIV
Sterling Creek Road 2	3	Unknown	*	PRIV
Sterling Creek Road 3	1	Unknown	*	PRIV
Sterling Creek Road 4	1	Unknown	*	PRIV
Tom Pierce County Park	250	Unknown	250	COUNTY/ ODOT/ PRIV
Wagner Creek	1	Unknown	1	BLM
Wagon Trail Road 1	4	Declining	0	BLM
Wagon Trail Road 2	4	Stable	1	BLM
Waters Creek	4	Unknown	*	USFS
Wellington Butte	3	Stable	0	BLM
West Camp Creek 1	15	Unknown	15	BLM
West Camp Creek 2	4	Unknown	4	BLM
Winona	*	Extirpated	*	PRIV
West Fork Muddy Gulch 1	6	Declining	2	BLM
West Fork Muddy Gulch 2	10	Declining	2	BLM
<hr/>				
Total number of flowering plants	1,696		1,025	
Mean number of flowering plants per macroplot	16.00		16.26	

<sup>1</sup>Key to acronyms used in LANDOWNER column:

BLM - Bureau of Land Management

CITY - City of Jacksonville and Jacksonville Woodlands Association

COUNTY - Josephine County (park)

ODOT - Oregon Department of Transportation

PRIV - Private

SOU - Southern Oregon University

USFS - U.S. Forest Service

\* Indicates macroplots where *Fritillaria gentneri* were historically located, however, no survey was conducted in 2001.

## APPENDIX B

Data from individually staked *Fritillaria gentneri* plants (Brock and Callagan 2000). Each basal leaf represents one juvenile (bulblet) plant.

Site Name	Plant identification number	Total number leaves at base of tagged flowering plant
Bear Gulch	1	2
Eagle Canyon	1	3
	2	49
	3	29
	4	22
	5	66
	6	27
	7	28
	8	40
	9	15
	10	8
Goat Cabin Ridge #1	1	20
	2	1
	3	11
	4	0
	5	17
	6	1
Goat Cabin Ridge #2	1	7
	2	8
East of Muddy Gulch	1	6
	2	3
	3	12
	4	1
	5	20
	6	0
Oregon Belle #2469	1	15
	2	10
	3	6
	4	25
Bishop Creek #2727	1	9
	2	3
	3	0
	4	29
	5	18
	6	6
Total number of basal leaves		517
Number of flowering plants		35
Mean number of bulblets per flowering plant		14.77
Standard error of means		2.54
Standard deviation		14.79
95% confidence interval (range)		± 5.15 (9.6 - 19.9)

## APPENDIX C

Census data providing ratio of flowering *Fritillaria gentneri* to mature vegetative *F. gentneri* and/or *F. recurva* plants<sup>1</sup>; from Bureau of Land Management lands, indeterminate areas in censuses (Brock and Callagan 2000).

<b>Macroplot Name</b>	<b>Flowering</b>	<b>Vegetative</b>	<b>Ratio Veg:Flowering</b>
Antioch Road 1	1	6	6
Antioch Road 2	2	0	0
Antioch Road 3	0	3	0
Bear Gulch	1	2	2
Bishop Creek	6	65	10.8
Blacksmith Creek 1	1	8	8
Blacksmith Creek 2	1	6	6
Dutch Oven Creek 1	17	321	18.9
Eagle Canyon	12	287	23.9
Goat Cabin Ridge 1	14	106	7.6
Goat Cabin Ridge 2	2	15	7.5
Leafwood Drive	0	2	0
Lick Gulch	3	27	9
Little Applegate 1	1	3	3
Little Applegate 2	1	7	7
Lomas Road	0	12	0
Muddy Gulch 1A	27	393	14.6
Muddy Gulch 1B	0	0	0
Muddy Gulch 2	58	679	11.7
Muddy Gulch 3	2	3	1
Muddy Gulch 4	2	6	3
Muddy Gulch 5	2	25	12.5
Muddy Gulch 6	6	37	6.2
Oregon Belle	11	70	6.4
Pickett Creek 1	53	255	4.8
Pickett Creek 2	306	878	2.9
Pickett Creek 4	24	33	1.4
Poormans Creek 1	0	1	0
Ramsey Canyon	0	0	0
Rush Creek	0	*	*
Sam's Creek 1	0	0	*
Sam's Creek 2	1	1	1
Spencer Gulch 1	0	1	0
Spencer Gulch 2	0	*	*
Wagon Trail Road 1	0	0	0
Wagon Trail Road 2	0	1	0
Waters Creek	*	*	*
Wellington Butte	3	7	2.3
West Fork Muddy Gulch 1	3	18	6
West Fork Muddy Gulch 2	10	57	5.7
<hr/>			
Number of ratios	27		
Number of flowering plants	569		
Number of vegetative plants	3,334		
Mean ratio of flowering to vegetative plants	7.0		
Standard error of means	1.08		
Standard deviation	5.5		
95% confidence interval (range)	± 2.2 (4.8 - 9.2)		

<sup>1</sup> A count of 108 flowering individuals reported from Jacksonville Woodlands was not included since associated vegetative plants were not also counted. An asterisk (\*) indicates no survey.

## APPENDIX D

Soils associated with known occurrences of *Fritillaria gentneri* (prepared by Andy Robinson, USFWS). A chi square test shows that the species is found significantly more often on Vannoy soils than on other soil types (\*chi square at n-1, 0.1% = 51.18).

Soil Type	Occurrences of <i>F. gentneri</i>	Chi Square	Jackson County <sup>1</sup>	Josephine County <sup>1</sup>
Abegg	1	2.36		1b
Beckman-Colestine complex	2	1.09		6f, 7f
Brader-Debenger complex	2	1.09	17c, 44c	
Caris-Offennbacher complex	9	5.78	25g, 26g	
Cornutt-Dubakelia complex	1	2.36		19e
Dubakella-Pearsoll complex	3	0.30		29f
Farva	2	1.09	57g, 58g	
Heppsie	1	2.36	81g	
Heppsie-McMullin complex	1	2.36	82g	
Holland	1	2.36		42c
Langellain	1	2.36	101e	
Langellain-Brader	3	0.30	102d, 103e	
Manita	4	0.003	108d,e,f	
McMullin-Medco complex	1	2.36	125f	
McMullin-Rockoutcrop complex	9	5.78	113e,g	
McNull	1	2.36	114e, 115e	
McNull-Medco complex	2	1.09	119f, 126f	
McNull-McMullin complex	6	0.86	116e, g	
Ruch	3	0.30	157b, 158d	67b
Tallowbox	1	2.36	189g	
Tatouche	1	2.36	191g	
Vannoy*	34	216.7	195e, 196e	
Vannoy-Voorhies complex	12	15.07	197f	
Woodseye Rockoutcrop complex	1	2.36	207g	
Xerorthents-Dumps complex	1	2.36	208c	

Total number of soil types is 25

Total number of occurrences is 103

Expected frequency of occurrence, given null hypothesis of equal distribution, is  $103/25 = 4.12$

<sup>1</sup>County soil codes are provided; shading indicates soil type is present in that county.

## APPENDIX E

Expected total numbers of plants based on counts of 500, 750, and 1,000 flowering individuals of *Fritillaria gentneri*. For an explanation of how these estimates were derived, see Part I, Section E of this plan.

<b>A) Minimum Viable Population (<i>sensu</i> Soulé 1987)</b>	<b>Expected mean</b>	<b>Expected range</b>
Flowering plants	500	500
Juveniles (bulblets associated with the base of flowering plants)	7,400	4,800 to 9,950
Mature vegetative plants (plants with leaves $\geq$ 4.5 cm [1.8 inches] wide)	750	504 to 966
Juveniles (bulblets associated with the base of mature vegetative plants with leaves $\geq$ 4.5 cm [1.8 inches] wide)	11,100	7,200 to 14,925
<b>Total</b>	<b>19,750</b>	<b>13,004 to 26,341</b>

<b>B) Reclassification (downlisting)</b>	<b>Expected mean</b>	<b>Expected range</b>
Flowering plants	750	750
Juveniles (bulblets associated with the base of flowering plants)	11,100	7,200 to 14,925
Mature vegetative plants (plants with leaves $\geq$ 4.5 cm [1.8 inches] wide)	1,125	756 to 1,449
Juveniles (bulblets associated with the base of mature vegetative plants with leaves $\geq$ 4.5 cm [1.8 inches] wide)	16,650	10,800 to 22,388
<b>Total</b>	<b>29,625</b>	<b>19,506 to 39,512</b>

<b>C) Full Recovery (delist)</b>	<b>Expected mean</b>	<b>Expected range</b>
Flowering plants	1,000	1,000
Juveniles (bulblets associated with the base of flowering plants)	14,800	9,600 to 19,900
Mature vegetative plants (plants with leaves $\geq$ 4.5 cm [1.8 inches] wide)	1,500	1,008 to 1,932
Juveniles (bulblets associated with the base of mature vegetative plants with leaves $\geq$ 4.5 cm [1.8 inches] wide)	22,200	14,400 to 29,850
<b>Total</b>	<b>39,500</b>	<b>26,008 to 52,682</b>



## APPENDIX F

Recovery criteria and actions within this recovery plan designed to reduce or eliminate the threats to *Fritillaria gentneri* as identified in the Reasons for Listing (“listing factors”; see Section F of this plan).

LISTING FACTOR*	THREAT	ACTION NUMBERS†	RECOVERY CRITERIA‡
A	Destruction of habitat through residential or commercial development	2.1, 2.2, 2.3, 2.5	1, 2
A	Destruction of habitat resulting from timber harvest activities	2.1, 2.2, 2.3, 2.5	1, 2, 5
A	Off road vehicle use	2.1, 2.2, 2.3, 2.44, 2.5	1, 2, 5
B	Commercial collecting of bulbs	2.44, 2.5	6
C	Grazing by livestock and deer	2.1, 2.2, 2.3, 2.4, 2.44, 2.51, 2.52	1, 2, 5, 6
D	No legal protection on private lands	1.1, 1.2	2
E	Fire suppression	2.44, 2.5, 3.2, 3.4	5
E	Herbicide spraying	1.1, 1.2, 2.44	2, 5
E	Genetic drift, inbreeding depression	2.4, 2.5, 3.5, 3.6, 3.7, 3.8, 3.9	1, 2, 3, 4
E	Habitat fragmentation	2, 3.1, 3.2, 3.3, 3.4	1, 2, 3, 4
E	Catastrophic events	2, 4	1, 2, 3, 4

\*Listing Factors:

- A. The present or threatened destruction, modification, or curtailment of its habitat or range
- B. Overutilization for commercial, recreational, scientific, educational purposes
- C. Disease or predation
- D. The inadequacy of existing regulatory mechanisms
- E. Other natural or manmade factors affecting its continued existence

†From Part II, Section C of this plan; recovery action numbers identified are intended to be inclusive of all subtasks included under that action as well

‡For recovery criteria refer to Part II, Section A of this plan

## APPENDIX G

### Summary of Agency and Public Comments on the Draft Recovery Plan for *Fritillaria gentneri*

#### I. Summary of the Agency and Public Comment Process

On November 22, 2002, the U.S. Fish and Wildlife Service (Service) released the Draft Recovery Plan for *Fritillaria gentneri* (draft plan) for a 90-day comment period for Federal agencies, State and local governments, and members of the public (Federal Register/Vol. 67, No. 226). The comment period ended on January 21, 2003. Steven Jessup, Ed Guarrant, Richard Brock, and Kelly Amsberry were asked to provide peer review of the Draft Plan. Comments were received from only one of our peer reviewers, Kelly Amsberry.

This section provides a summary of general information about the comments we received, including the number of letters from various sources. A complete index of those who commented, including their affiliations, is available from the U.S. Fish and Wildlife Service, Ecological Services, Oregon Fish and Wildlife Office, 2600 SE. 98<sup>th</sup> Avenue, Suite 100, Portland, Oregon 97266. All comment letters are kept on file in the Oregon Fish and Wildlife Office.

The following is a breakdown of the number of comment letters received from various sources:

Federal agencies–2  
State agencies– 2  
Local governments–0  
Business/industry–0  
Environmental/conservation organizations– 5  
Individual citizens–0

A total of nine letters or e-mails were received. Each contained one or more issues with some issues raised in more than one letter. In preparing this final plan, we have attempted to clarify points that were indicated to be vague or needing more definition. Some letters provided new information or suggestions for clarity; these were included in the final plan where germane. The remainder of comments were considered, noted, and principal comments were included for response. The following section is a summary of the principal comments and our responses to those comments. We thank all of those who provided comments. If we have not answered your question or addressed your comment in this section or within this recovery plan, please feel free to contact us for further clarification.

## II. Summary of Comments and Service Responses

### *General*

**Comment:** A number of comments came in asking that new information from various studies be included, or asking for clarification on various points in the text and how we developed the recovery strategy, objectives and criteria sections including determination of plant numbers, plant spacing, requirements on reserve sizes, etc.

**Response:** We have edited all sections to include and update the data and rationale and have provided examples in the text to try to make the rationale as clear as possible regarding the development of the Recovery Strategy and Objectives and Criteria sections of the document.

**Comment:** One comment questioned whether *Fritillaria gentneri* is a legitimate species due to evidence that suggests that it may be a hybrid.

**Response:** Research indicates that *Fritillaria gentneri* may be a species of recent hybrid origin. Numerous plant species considered to be valid taxa today have originated through hybridization events of the past. Guerrant's 1992 report indicated that *Fritillaria gentneri* could be consistently separated by morphological characteristics from its suspected congenitors, *Fritillaria recurva* and *Fritillaria affinis*, an observation substantiated by other *Fritillaria* experts (Amsberry and Meinke 2002). Therefore, he contends that *Fritillaria gentneri* is a valid taxon, probably of hybrid origin and of the F2 (second generation) or later generation, resulting from backcrossing to one of the putative parents. Guerrant (1992) theorized that *Fritillaria gentneri* likely arose only once, rather than through multiple, independent hybridization episodes where each population occurs. If *Fritillaria gentneri* were a true F1 hybrid, one should observe a broad array of phenotypes (hybrid swarms) between the suspected parents; this is not the case. Confirmed crosses between *Fritillaria recurva* and *Fritillaria affinis* do not resemble *Fritillaria gentneri*, thus *Fritillaria gentneri* is not thought to be a F1 (first generation) hybrid (Amsberry and Meinke 2002). As such, based on the best available scientific and commercial data available at this time, *Fritillaria gentneri* should be considered a valid species. Additional research into this issue, using DNA fingerprinting techniques, is currently being initiated at Southern Oregon University under the supervision of Dr. Steven Jessup. Further research work looking at the progeny of *Fritillaria gentneri* × *Fritillaria gentneri* (conspecific crosses) would be informative; if all progeny were to mirror the parent, these findings would indicate that *Fritillaria gentneri* is not a hybrid. Conspecific pollination studies have been conducted by the Oregon Department of Agriculture - Plant

Conservation Program (in 2000, 2001, and 2002) and seed was produced in 2002; these seedlings are now establishing and growing.

The ability of these species to interbreed on occasion does not negate the validity of a species' taxonomic status (Amsberry and Meinke 2002). Furthermore, proposed Service policy provides guidance that the Endangered Species Act does provide protections for taxa that "have developed outside of confinement, are self-sustaining, naturally-occurring taxonomic species" and "that continue to be recognized as taxonomic species by the scientific community"(USFWS 1996). Based on available scientific information, we consider *Fritillaria gentneri* to be a valid taxon deserving full protection under the provisions of the Endangered Species Act. Confirmation of *Fritillaria gentneri*'s taxonomic status as a species in its own right is identified as an action in this final recovery plan (Recovery Action 3.8).

**Comment:** The Bureau of Land Management was concerned about changes in how they conduct surveys, determine effects and conduct consultation for *Fritillaria gentneri*.

**Response:** The Bureau of Land Management (and other Federal agencies) should continue to conduct surveys for *Fritillaria gentneri* throughout the entire potential range of the species, not just within the recovery units identified in this plan. This will allow us to locate new populations, including those outside of the identified recovery units, and will improve our predictive models for where the species is likely to be found. Effects analysis and consultation will continue to be based on the best available data and information. New populations found outside of the existing identified recovery units may change recovery unit boundaries and the Service would update these with future revisions of the recovery plan for the species (Recovery Action 5; revision evaluation should occur every 5 years). As an interim approach, new populations found outside of the boundaries of the identified recovery units should be included in the nearest recovery unit until such time as the recovery plan can be revised. We request that we be contacted if new populations are located outside of the recovery unit boundaries.

### ***Monitoring***

**Comment:** One comment indicated a concern with the requirement for monitoring all sites on an annual basis. This agency could only commit to a biennial schedule of monitoring.

**Response:** Biennial monitoring of all sites was thought to be frequent enough to detect population trends and general management needs on sites that are reasonably stable and not subject to unpredictable human-related

impacts. The final recovery plan reflects this change from annual to at least biennial monitoring. More frequent monitoring (at least site review for disturbance and management intervention, if necessary) would be desired when implementing new management techniques or when a site is vulnerable to various human impacts (off-road vehicles, weed encroachment, etc.). The underlying expectation is that responsible agencies will ensure monitoring occurs at appropriate intervals at sites under their management.

**Comment:** The Bureau of Land Management provided a comment that they would prefer that the State (Oregon Department of Agriculture and Oregon State University) have the lead on monitoring, and the Bureau of Land Management will either provide funds or explore additional grants or cost-shares with the State or non-profit groups to assist with the funding.

**Response:** The Oregon agencies clearly have the expertise to carry out the monitoring but should not be shouldered with the financial responsibility to monitor populations on Federal lands. If it is the Bureau of Land Management's preference to arrange for the State to do the monitoring on Bureau of Land Management land, then we encourage the Bureau of Land Management to secure necessary funding to enable State personnel to monitor the species. But it should remain a primary responsibility of Federal agencies to assure completion of necessary monitoring of populations on Federal lands under their management per section 7(a)(1) of the Endangered Species Act, where Federal agencies are required to conduct activities to help recover species listed under this Act.

### ***Fire History***

**Comment:** There was an interest in having more information on the historical fire regimes included in the plan and to connect this to the potential management needs of the species. It was also pointed out that the discussion of protected areas required further development regarding the selection and design of these areas at appropriate scales and in multiplicity to reflect understanding of natural fire patterns, use of prescribed fire, and suppression of wildland fire. We were also asked to consider connectivity to habitat at higher elevations and provisions for habitat connectivity between protected areas to provide for long term viability in the face of climate change.

**Response:** More information on fire regimes is provided under the Habitat Description section in this final plan. We recognize the potential importance of ecological processes, such as fire, in relation to management activities needed to assure the perpetuation of this species and the habitat upon which it depends. Further research into the response

of *Fritillaria gentneri* to experimental habitat manipulations, such as the use of prescribed fire, is included in this plan (Recovery Action 3.4). In addition, where possible we incorporated concepts for *Fritillaria* management area planning in the face of global warming.

### ***Surveys***

**Comment:** One comment indicated that individuals of *Fritillaria gentneri* may not flower every year and that it may require at least 5 years to properly survey for its presence.

**Response:** Adequate surveys (during the flowering season) should be conducted within areas where proposed activities will occur on Federal lands or where Federal funds are used or Federal permits are necessary to conduct an action on other public or private lands. Currently, a single year survey within the appropriate season is considered adequate by Federal land management agencies to detect the presence of vascular plant species such as *Fritillaria gentneri* (Federal protocols are available online at <<http://www.or.blm.gov/surveyandmanage/SP/VascularPlants/imor99-26.htm>>). In any given year, at least a few flowering individuals are expected to occur within an area that would allow for detection of populations, although it is possible that some very small patches of non-flowering individuals could be overlooked in any one year of survey. Surveying sites in successive years is not likely to significantly increase the probability of finding every plant or every small population patch of *Fritillaria gentneri*. The number of sites that may be missed with a single year of survey and whether these small sites are important to recovery of the species are unknown. In the future, if methods can be developed to differentiate vegetative individuals of *Fritillaria* plants effectively and economically in the field, additional small sites might be determined during surveys.

### ***Roads and Invasive Non-native Plants***

**Comment:** A specific comment was provided concerning the Bureau of Land Management's Bald Lick project, which could involve road construction with potential spread of noxious weeds in Recovery Unit 2.

**Response:** We have forwarded these specific comments to the Bureau of Land Management's Medford District Botanist for their consideration during development of alternatives for this project.

### ***Herbivory***

**Comment:** A comment indicated that the plan needed to include more discussion on the potential significance of predation of flowering individuals by deer and what impact this predation may have on the species' observed distribution and demographic composition. There was

concern that recovery of the species based on the number of flowering plants may not accurately reflect the dynamics of a species that reproduces predominantly through vegetative means, especially in response to high levels of flower predation.

**Response:** As stated in the text, deer herbivory generally results in the removal of the upper part of the plant, allowing the lower leaves to continue accumulation of carbohydrates and thus not significantly reducing the vigor of plants. Due to over-hunting and extirpation by humans, the natural predators of deer have been removed, resulting in unknown effects on current deer abundance and distribution, and thus having unknown repercussions for the distribution and demographics of this plant. We assume that deer have always been a natural part of the environment of *Fritillaria gentneri* and will continue to be so.

Because the species is impossible to identify from other *Fritillaria* species while in the vegetative state, basing recovery on the number of flowering plants has evolved as a practical solution. We assume that at least some relative number of plants will be flowering in a given year of monitoring. We further expect to be able to more precisely determine the numerical relationship of flowering to non-flowering plants in the future and thus improve this predictor of total population size, even if the primary reproductive scheme of this species is through vegetative means.

**Comment:** One comment indicated an interest in seeing a study on the correlation of deer abundance over the last 15 years within the historical range of this plant and observed levels of deer herbivory and flowering individuals over the same time.

**Response:** Data are currently not available for such a study. This could prove to be a good research subject for a graduate student. Actions to determine current levels of herbivory and associated management needs (to reduce herbivory levels) and implementation have been included in the plan (Recovery Actions 2.44 and 2.5)

### ***Fungal Issues***

**Comment:** A number of comments were received that questioned the level of threat from fungal infections on *Fritillaria gentneri* and the potential detrimental ecological affects of fungicide application to *Fritillaria gentneri*.

**Response:** Only sporadic fungal infections have been noted, and these do not appear to pose an imminent threat to the species. Considering the lack of concrete evidence for fungal problems for this species, we agree that

the use of fungicides is not warranted without clear evidence of a problem. An action to identify fungal agents and their impact on plants has been included in the research actions in this final recovery plan. An action proposing the use of fungicide has been dropped.

### ***Herbicide Issue***

**Comment:** A comment was received asking for clarification on the effects of an herbicide used on private lands where the species is known to occur.

**Response:** Some information is available concerning potential effects of this herbicide and has been added in the text in Section F - Reasons for Listing.

### ***Budget***

**Comment:** One comment indicated that they thought that the estimated budget for the species recovery might be over-estimated.

**Response:** The proposed budget is only an approximation of costs expected. Funding that will be needed for many potential projects, including costs of associated planning and regulatory requirements, are unknown at this time and cannot be well defined. For example, as the Bureau of Land Management pointed out, fencing of areas could result in the need for a significant amount of funding. However, it is unknown whether fencing will be necessary at this point in the recovery process. The budget is also intended to include costs associated with staffing to accomplish all of the identified tasks. Some of the project work has already occurred and costs associated with these projects have been used as estimators of costs for future years in the budget table. Many unknowns are evident in preparing this budget, but it is our best estimate based on actual costs experienced with the actions implemented for this and other species.

### ***Conservation Issues***

**Comment:** It was recommended that the Service needs to prevent take of this species by ensuring that private entities and Federal land managers are properly protecting populations, especially in light that the main threat to this species is destruction of habitat.

**Response:** We concur with the comment that the main threat to the species is present or threatened destruction, modification, or curtailment of its habitat or range. However, protection of this species under the Endangered Species Act only applies to Federal lands, Federal actions or where Federal permits are required. Federal agencies are required to minimize impacts and consult with us on all activities on Federal lands or



if Federal activities will occur on other public or private lands that might affect *Fritillaria gentneri*. Federal actions cannot result in jeopardy to the species.

Unfortunately, *Fritillaria gentneri* is not protected on private lands. Non-Federal actions are only regulated to the extent there is Federal funding, permitting, or approval involved (e.g., a Federal permit is required for the action). Neither does the State Endangered Species Act of Oregon protect populations of State or federally-listed species on private lands. We can work with landowners interested in voluntarily conserving this species on private lands.

**Comment:** It was “strongly urged” that we promptly designate critical habitat for *Fritillaria gentneri*.

**Response:** While section 4(6)(C) of the Endangered Species Act does require us to designate critical habitat for this species, we are unable to do so at this time. We are currently required to complete a significant number of court ordered critical habitat actions and do not have the funds available to designate critical habitat for this species.

**Comment:** One comment suggested that fencing of sites be used as a preventative measure against deer and livestock grazing and not just “a wait and see measure.”

**Response:** Deer are a natural element in the habitat of *Fritillaria gentneri*. It seems prudent to determine whether this very expensive “fix” is needed at all sites, especially in light of limited Federal budgets for carrying out such work. Furthermore, fencing can further complicate actions (such as prescribed thinning or burning) that may be desired for management of this species at various sites. This action is included in Recovery Action 2.5, and should be assessed as a management tool on a site-specific basis, in conjunction with other management options.

#### ***Recovery Strategy, Objectives and Criteria***

**Comment:** A comment questioned if the recovery priority number for *Fritillaria gentneri* had changed from the time that the draft recovery plan was published.

**Response:** Yes. The current recovery priority number is a "2" (it was identified as a "5" in the draft plan) and has been changed in the final recovery plan to reflect a change in the perception of a higher recovery potential than was previously thought possible (e.g. it appears reasonable to augment populations via vegetative/bulblet means). This recovery number is based on the degree of threat (high for *Fritillaria gentneri*),

recovery potential (high for *Fritillaria gentneri*; updated from low as rated previously), and taxonomy of the species (full species for *Fritillaria gentneri*, versus a subspecies or lower) to arrive at a recovery priority of 2 on a scale from 1C (highest) to 18 (lowest). An overview of the guidance in setting a recovery priority number for a species can be found in the Federal Register (USFWS 1983a,b).

**Comment:** Concern was expressed that 1,000 individuals per recovery unit may be too low of a threshold for recovery of this species and to ultimately ensure survival of the species over the long-term.

**Response:** The threshold for recovery is set at 1,000 flowering individuals per recovery unit. For every flowering individual present, it is estimated that there are actually, on average, about 39.5 total plants (flowering, mature, and juveniles or bulblets), thus a population based on a count of 1,000 flowering plants actually represents an estimated total average population size of around 39,500 plants. New preliminary data suggests that this may be a conservative estimate of population size, as this recent investigation shows between 44.9 to 54.2 bulblets (versus, on average, an earlier estimate of 14.8 juvenile plants) per plant associated with the bulbs of 76 tagged *Fritillaria gentneri* plants (Amsberry and Meinke 2002). Based on modeling studies of a closely related *Fritillaria* species, *Fritillaria camtschatcensis*, the minimum viable population size was estimated to be 20,000 individuals (Yonezawa et. al 2000). Setting a minimum of 1,000 flowering individuals per recovery unit with, on average, approximately 39,500 total individuals seems a reasonably conservative approach for recovery of *Fritillaria gentneri*, particularly when one considers that this species is presumed to have historically been relatively rare across the landscape.

**Comment:** The Bureau of Land Management commented that once the Oregon Department of Agriculture develops the protocols and methods to produce greenhouse grown fritillaries, responsibility for the “bulb production” phase of recovery should be shifted to the Bureau of Land Management and other Federal facilities or managed through contracts with private nurseries to produce large quantities of *Fritillaria gentneri* bulbs at competitive costs.

**Response:** We recognize this important economic recommendation and concur that this is the reasonable way to proceed with the bulb production program. This is noted in the final recovery plan.

**Comment:** The Bureau of Land Management voiced concern that management areas established for *Fritillaria gentneri* recovery should not be designated a special land management unit in Federal management

plans. Most populations currently fall within the Matrix lands identified in the Medford Bureau of Land Management Resource Management Plan and populations will likely require management actions to recover the species.

**Response:** We are not suggesting a plan amendment to designate *Fritillaria* management areas out of the Matrix Land Use Allocation, where most populations of *Fritillaria gentneri* currently occur. Special attention to and care of these areas relative to management is clearly needed. We also concur that the variety of management actions allowed for under the matrix designation be permitted to the extent they not only do not adversely affect the species, but they should also include actions that will actually facilitate recovery. Simply remaining neutral to the conservation needs of the species is not consistent with the conservation obligations of Federal agencies.

**Comment:** A comment was received that indicated a concern that recovery of this species would be expected to occur without active management of sites.

**Response:** This implication (of no management of sites) was not intended. Rather the management of sites should be on a site-by-site basis, taking into account locations of weed populations, off-road vehicle uses, etc. Experimentation with prescribed burns is included as an action to determine effects on *Fritillaria gentneri* and may prove to be an important management tool for at least some populations.

**Comment:** A comment was received that indicated that we had not included an objective and measurable criterion for recovery of the species in relation to the threats that led to the listing of the species. Specifically, the comment stated that the Service had not included objective and measurable criterion for ongoing habitat loss, lack of habitat management (habitat quantity and quality and provisions for site management plans that would be developed in the future) and inadequate regulatory mechanisms (*i.e.*, we should list critical habitat for the species).

**Response:** The provisions of the Endangered Species Act are not likely to stop all habitat loss from occurring, but it is the intent of this plan to reserve adequate habitat to provide for the long-term survival of the species. This would be measured through attainment of at least 1,000 flowering plants (with population numbers stable or increasing over a 15 year period) secured in at least 8 management areas in each of 4 recovery units. Recovery actions (2.0) to designate and manage *Fritillaria* management areas have been included in this recovery plan. The quantity of habitat necessary to meet full recovery goals will ultimately be determined during management area development. A goal specifically

addressing quality of habitat has not been determined in this plan; since the habitat structure and site conditions are so varied across the landscapes where this species is known to occur, no discrete habitat structure or management approach could be set. Actions to determine habitat needs (3.2) and management of protected areas (*Fritillaria* management areas) (2.5) have been included in this plan. The development of site-specific management plans for each *Fritillaria* management area is necessary for recovery of the species. These plans would take into account specific site conditions such as population size, juxtaposition on the landscape, relation to weed populations or human disturbances, etc. The habitat quality may be indexed according to monitoring of population numbers at sites. If population numbers are observed to be stable or increasing over a 15-year time frame, habitat quality and management would be deemed adequate to ensure the survival of the species at the site. In this plan the management areas established for *Fritillaria gentneri* recovery are to be managed specifically for the species and should not allow for incompatible uses (such as grazing, recreational vehicle use, or other public uses that prove to be threats to this species and its habitat). Actions (3.4) have been identified in this plan to study the effects of management actions such as overstory thinning and prescribed burning on *Fritillaria gentneri* and its habitat.

We have added language to make it clear that recovery would not be reached until site-specific management plans were approved and being implemented for reserve areas, including survival of the species and removal of threats as objectives for these plans. Development of site management plans without active implementation is inadequate to conserve the species.