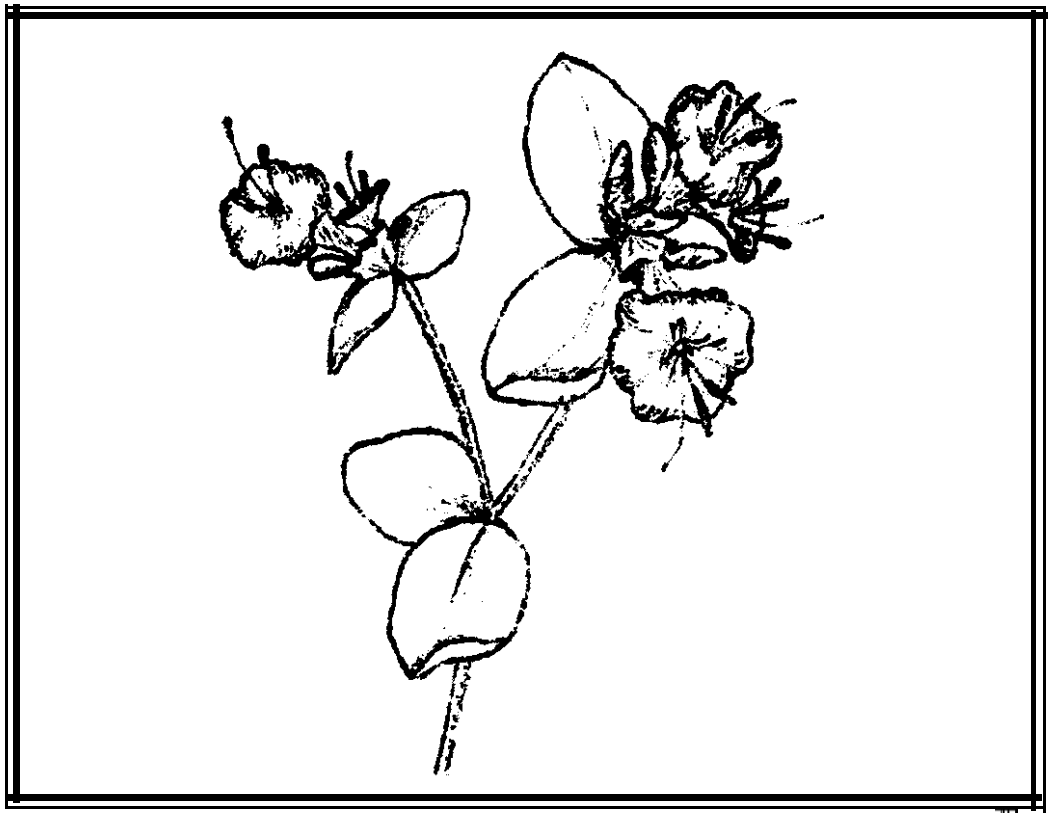
U.S. Fish & Wildlife Service

Revised Recovery Plan for **Macfarlane's Four-O'Clock** *(Mirabilis macfarlanei)*



Cover illustration of *Mirabilis macfarlanei* contributed by Edna Rey-Vizgirdas.

REVISED RECOVERY PLAN

For

MACFARLANE'S FOUR-O'CLOCK

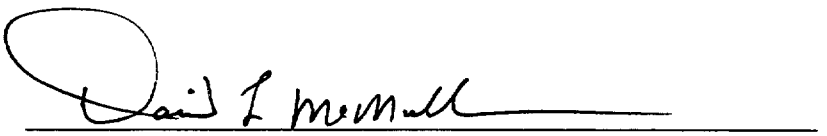
(*Mirabilis macfarlanei*)

(Original approved March 27, 1985)

Region 1

U.S. Fish and Wildlife Service

Portland, Oregon

Approved: 

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

Date: June 30, 2000

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Acknowledgments

The MacFarlane's Four-o'clock Revised Recovery Plan was prepared by Edna Rey-Vizgirdas, U.S. Fish and Wildlife Service, Snake River Basin Office, Boise, Idaho. Invaluable assistance was provided by Craig Johnson and Mark Lowry of the Bureau of Land Management and Paula Brooks and Jerry Hustafa of the Wallowa-Whitman National Forest.

Executive Summary

Current Species Status: *Mirabilis macfarlanei* (MacFarlane's four-o'clock) was originally listed as endangered in 1979 (44 FR 61912). Since that time, additional populations have been discovered and some populations on Federal lands are being actively managed and monitored. As a result of ongoing recovery efforts, *M. macfarlanei* was downlisted to threatened in March 1996 (61 FR 10693).

Mirabilis macfarlanei is endemic to portions of the Snake, Salmon, and Imnaha River canyons in Wallowa County in northeast Oregon, and adjacent Idaho County in Idaho. It is currently found in 11 populations in Idaho and Oregon.

Habitat Requirements and Limiting Factors: *Mirabilis macfarlanei* is endemic to low to mid-elevation canyon grassland habitats in west-central Idaho and northeastern Oregon. Plants are found on gravelly to loamy and sandy soils between approximately 300 and 900 meters (1,000 to 3,000 feet) elevation. Grazing by domestic livestock and the invasion of exotic (non-native) plants are the greatest threats to this species. Other threats include human trampling, off-road vehicle use, construction and maintenance of roads and trails, and herbicide spraying.

Recovery Objective: To recover the species to the point where delisting is warranted.

Recovery Priority Number: This species has a recovery priority number of 2 on a scale of 1 to 18, reflecting a high degree of threat, a high potential for recovery, and that this plant's taxonomic rank is a full species, which has a higher priority than a subspecies.

Recovery Criteria: Delisting of this species will be considered when:

1. A minimum of 11 populations are secure from threats and naturally reproducing with stable or increasing population trends for at least 15 consecutive years.

2. Population sizes are above the minimum necessary to maintain the viability of the species. Because the minimum viable population size for *M. macfarlanei* is currently unknown, population viability analyses will be conducted to support the recovery criteria.

3. Populations of this species occur throughout its current range in each of three geographic areas (i.e., Imnaha, Snake, and Salmon River areas).

4. Management practices reduce and control threats. On Federal land, habitat management plans are in place and monitoring is used to ensure implementation and effectiveness of conservation management practices. On non-Federal lands, *M. macfarlanei* populations are managed and conserved.

5. A post-delisting monitoring program for the species is developed and implemented. This program will be developed through coordination with the Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, and other interested parties.

Actions Needed:

1. Protect essential habitat and implement actions that may be necessary to eliminate or control threats. Manage habitat to maintain or enhance viable populations of *M. macfarlanei*.

2. Monitor *M. macfarlanei* population trends and habitat conditions.

3. Conduct research essential to the conservation of the species.

4. Conduct surveys in potential habitat areas. Manage and protect any newly discovered *M. macfarlanei* populations.

5. Establish propagule (seed, cutting, or spore) banks, including a long-term seed storage facility, for *M. macfarlanei*.

6. If warranted, establish and maintain new populations in areas where *M. macfarlanei* has been extirpated after intensive surveys have confirmed extirpation.

7. Validate and revise recovery objectives as needed.

Recovery Actions to Date: Surveys for *M. macfarlanei* have been conducted in Idaho and Oregon, which resulted in the discovery of several new populations of this species. One new (transplant) population was established by the Bureau of Land Management near Lucile in Idaho County, Idaho. Management plans for *M. macfarlanei* habitat have been developed by the Bureau of Land Management for three sites in the Salmon River drainage, Idaho County, Idaho. In addition, monitoring of *M. macfarlanei* populations has been conducted by the Bureau of Land Management and the Wallowa-Whitman National Forest. *Mirabilis macfarlanei* seed collection and long-term storage at Berry Botanic Garden has also been initiated.

Date of Recovery: If recovery actions are prompt and effective, delisting might be possible as early as 2015. Because *M. macfarlanei* is a long-lived perennial species and annual stem counts and cover vary significantly in response to climatic events (i.e., precipitation, temperature), a minimum of 15 years will be needed to determine long-term population trends.

Estimated Cost of Recovery: $1,207,500 - $1,667,500, some costs are yet to be determined.

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I. INTRODUCTION

A. BRIEF OVERVIEW

Mirabilis macfarlanei (MacFarlane's four-o'clock) was originally listed as endangered by the U.S. Fish and Wildlife Service in 1979. At the time of listing, only 3 populations were known, with a total of 20 to 25 individual plants. The species was threatened by several factors, including trampling, collecting, livestock grazing, disease, and insect damage (U.S. Fish and Wildlife Service 1979). Listing did not include critical habitat.

We developed a recovery plan for this species in 1985 (U.S. Fish and Wildlife Service 1985). In summary, the 1985 recovery plan called for: 1) conducting additional field surveys, 2) protecting *M. macfarlanei* sites and developing management plans, 3) conducting baseline studies to identify limiting factors and determine threats, 4) establishing new colonies, and 5) maintaining a propagule bank.

Since this species was first listed, seven additional *M. macfarlanei* populations[1] have been discovered in Idaho and Oregon (Johnson 1983, 1995; Mancuso and Moseley 1991; Paula Brooks, Wallowa-Whitman National Forest, *in litt.* 1999). These populations are located along the Snake River Canyon (Idaho County, Idaho and Wallowa County, Oregon), Imnaha River Canyon (Wallowa County, Oregon), and Salmon River Canyon (Idaho County, Idaho) (Figure 1). All currently known populations of *M. macfarlanei* occur in only two counties: Idaho County, Idaho, and Wallowa County, Oregon.

Some populations on Federal lands are being actively monitored (refer to the "Conservation Efforts" section of this recovery plan for more information on conservation activities for this species).

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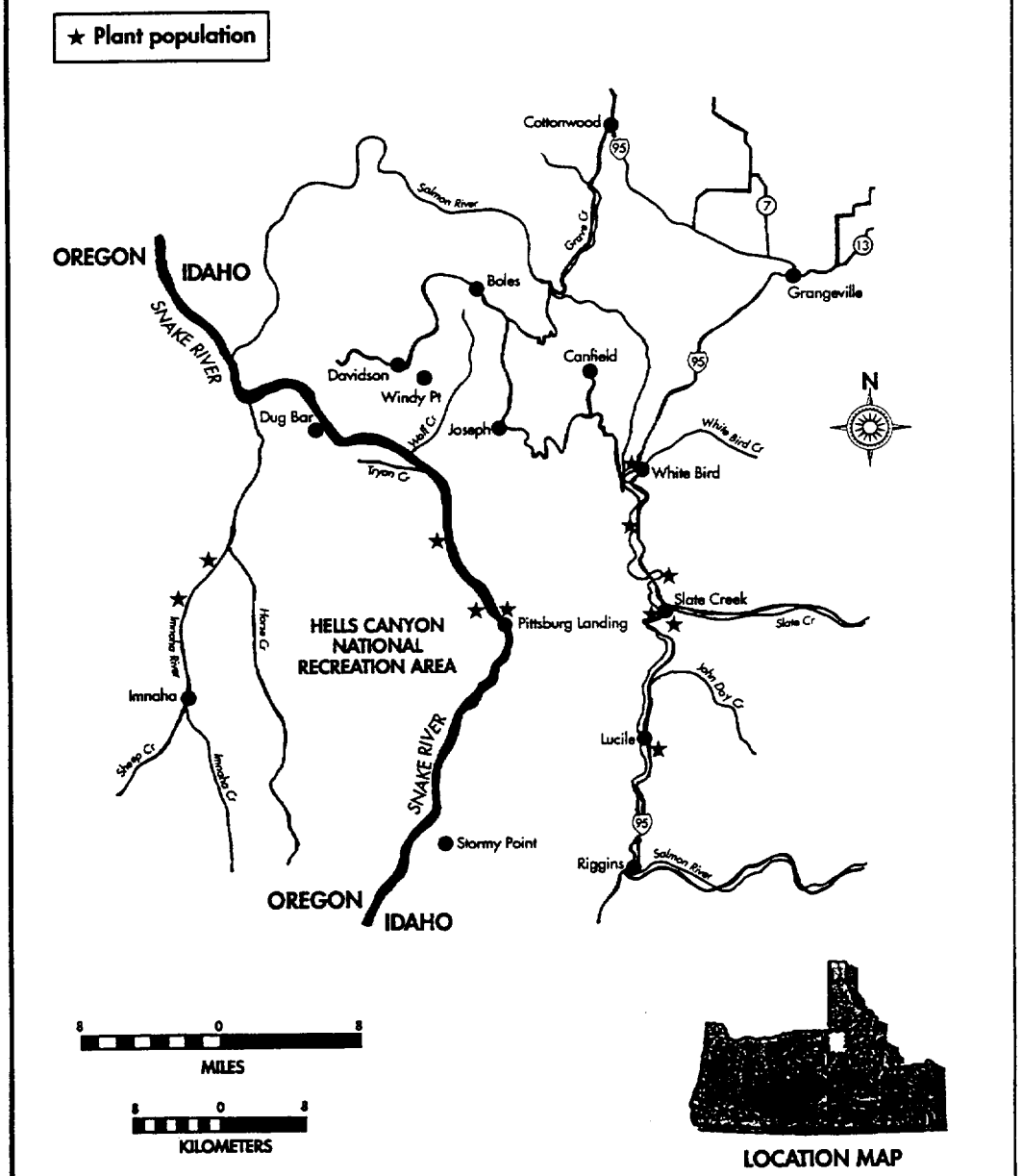
[1] In this recovery plan, "population" refers to all *M. macfarlanei* plants that occur within a specific geographic area. A population can be made up of one or more "colonies" (i.e., groups of *M. macfarlanei* plants) generally located within 1 mile of each other. The terms "colony" and "site" are used interchangeably in this document.

Figure 1: Distribution of MacFarlane's four-o'clock



As part of the 1985 recovery plan objectives, one new population was established at Lucile Caves along the Salmon River Canyon. This population is managed by the Bureau of Land Management (Cottonwood Field Office). In 1988, approximately 60 rhizomes were transplanted to suitable, unoccupied habitat at Lucile Caves within an 8-hectare (20-acre) fenced exclosure maintained by the Bureau of Land Management. In 1998 and 1999, approximately 400 additional rhizomes were transplanted to the site. This colony appears to be stable.

In Hell's Canyon National Recreation Area, three *M. macfarlanei* sites monitored from 1990 to 1995 appear to be stable (Kaye 1995). Improved livestock management by the Forest Service and the Bureau of Land Management has reduced impacts to *M. macfarlanei* from livestock grazing on Federal lands (Johnson 1995). As a result of recovery efforts and the discovery of additional populations, *M. macfarlanei* was downlisted to threatened on March 15, 1996 (U.S. Fish and Wildlife Service 1996).

B. TAXONOMY

Mirabilis macfarlanei is a member of the four-o'clock family (Nyctaginaceae). It was first described in 1936 (Constance and Rollins 1936) from specimens collected along the Snake River Canyon. *Mirabilis macfarlanei* is morphologically similar to *Mirabilis greenei*, found in the Klamath region of California and Oregon. In contrast to *M. greenei*, *M. macfarlanei* has broader leaves and shorter, nearly round bracts (Constance and Rollins 1936). At least two other species of *Mirabilis* occur in the Pacific Northwest (*M. linearis* and *M. bigelovii* var. *retrorsa*), but these species do not overlap in distribution with *M. macfarlanei* (Hitchcock and Cronquist 1973).

C. SPECIES DESCRIPTION AND LIFE HISTORY

Mirabilis macfarlanei is a long-lived herbaceous perennial with a deep-seated, thickened root. This species typically blooms from May through June. The bright pink flowers are conspicuous, up to 25 millimeters (1 inch) long by 25 millimeters (1 inch) wide. The flowers occur in inflorescences, which consist of a group of three to seven flowers subtended by a five-lobed involucre (saucer-shaped bract). The flowers are funnel-shaped with a widely expanding limb. Leaves are

opposite, somewhat succulent, and broadly lanceolate to ovate. Each flower has the potential to produce one fruit and one seed (Kaye *et al.* 1990). Individual plants have been observed to live over 20 years, based on limited monitoring conducted by the Bureau of Land Management (Craig Johnson, Bureau of Land Management, in litt. 1999).

Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring. Seeds apparently fall near the parent plant and are transported by gravity and rain water (Kaye 1992). It is possible that *M. macfarlanei* seeds may be dispersed by birds or mammals (Barnes 1996), but seed dispersal has not been studied for this species. No information exists on whether *M. macfarlanei* maintains a soil seed bank (Kaye *et al.* 1990).

Similar to other perennial species, seed germination and establishment may be infrequent in *M. macfarlanei* populations, and may be dependent upon a specific suite of environmental conditions. It is likely that seedling recruitment in this species is extremely variable from year to year. Specific conditions required for germination and seedling survival are unknown.

Apparently conflicting information exists on the frequency of seedling establishment in *M. macfarlanei*. For example, although researchers from the Oregon Department of Agriculture (Kaye *et al.* 1990, Kaye 1992) observed numerous seedlings in *M. macfarlanei* populations, others (Barnes *et al.* 1994, Johnson 1995, and Barnes 1996) have reported that seedling establishment appears to be rare. In one study, Kaye (1995) found that nearly 90 percent of *M. macfarlanei* seedlings die by their second year.

In addition to reproducing by seed, plants reproduce clonally from a thick woody tuber that sends out many shoots (collectively called a genet). Daughter plants produced in this manner are known as ramets. Some *M. macfarlanei* populations comprise several clones (genets). However, small populations of *M. macfarlanei* may comprise only one clone (one genet) (Barnes *et al.* 1994, 1995; Barnes 1996). The size of a ramet can vary greatly, from a single stem with no flowers to ramets with over 200 inflorescences present (Barnes 1996).

Even if seedling inputs are rare in *M. macfarlanei* populations, they may contribute to the long-term genetic stability of this species. For example, Soane and Watkinson (1979) found that even small seedling inputs may be significant in maintaining genetic diversity in clonal plant species. Some clonal species, such as *Solidago canadensis*, may experience increased seedling recruitment after a disturbance episode (Hartnett and Bazzaz 1985a). Kaye (1992) suggested that natural downslope soil movement may maintain *M. macfarlanei* habitat by creating openings and possibly reducing competition from neighboring plant species. However, Forest Service botanists have not observed seedling recruitment of *M. macfarlanei* in areas of soil disturbance since these areas are subsequently invaded by weedy species (Jerry Hustafa, Wallowa-Whitman National Forest, *in litt.* 1999).

Established *M. macfarlanei* plants generally start growth in early April. The timing and duration of flowering may be linked to annual temperature and precipitation levels (Kaye 1992, Johnson 1995). Drought may cause plants to be stunted, and may adversely affect reproduction. During wet years, plants are generally larger and flower abundantly (Kaye 1992, 1995).

For some *M. macfarlanei* populations, sexual reproduction may be more important than vegetative (i.e., clonal) reproduction (Kaye 1992). However, the relative contribution of sexual versus vegetative reproduction in *M. macfarlanei* is unknown, and may differ from site to site (Kaye 1992). From studies of clonal diversity in selected *M. macfarlanei* populations, Barnes (1996) speculated that recruitment of sexual propagules must have occurred in the past, based on the high number of genets at some sites.

Asexual reproduction may contribute to population stability by reducing the variation in annual recruitment (Kingsolver 1986). For some plant species, clonal growth can provide a means of escaping adverse biotic or abiotic conditions such as interference from neighboring species or other clones (Hartnett and Bazzaz 1985a, 1985b; Slade and Hutchings 1987). In addition, clonal growth can result in the dispersal of ramets to favorable microsites near the parent plant, which is particularly important if seedling establishment is rare or difficult (Huenneke 1985).

Salzman and Parker (1985) found that ramets in a locally inferior environment (e.g., high salinity) can benefit from neighboring ramets, apparently due to the transport of water and photosynthate. For *M. macfarlanei*, it is unknown whether daughter ramets receive water or nutrients from parent ramets. Currently, no data exists on the longevity of connections between *M. macfarlanei* ramets.

Clonal reproduction may have important genetic consequences for *M. macfarlanei*. Since individual ramets within a clone are genetically identical, extensive clonal reproduction can result in reduced genetic diversity in *M. macfarlanei* populations. Although small populations may consist of only one or a few individuals (genets), the extent of genetic variation in *M. macfarlanei* populations differs from site to site (Barnes *et al.* 1994, 1995; Barnes 1996). Barnes (1996) found high population differentiation in this species, which may be the result of isolation and limited gene flow among populations.

Mirabilis macfarlanei has been found to be self-compatible (Barnes 1996). In addition to clonal reproduction, the degree of selfing that occurs in *M. macfarlanei* populations could also contribute to low genetic diversity. Plant species that rely on selfing may have lower population viability, apparently due to lower heterozygosity (Menges 1991). Inbreeding depression may be detrimental to all but entirely selfing plant species (Huenneke 1991).

Studies on its genetic structure have shown that *M. macfarlanei* has lower genetic diversity than species with a similar life history (Barnes *et al.* 1994, 1995; Wolf *et al.* 1994). The greatest level of gene flow (pollen or seed dispersal) occurred between populations that were less than 2.0 kilometers (about 1 mile) apart (Barnes *et al.* 1994). The level of gene flow decreased as the distance between populations increased. *Mirabilis macfarlanei* was found to have relatively high levels of genetic differentiation among populations (Barnes *et al.* 1994, Barnes 1996). Barnes *et al.* (1994) also found that small populations of *M. macfarlanei* contained alleles that were apparently absent from other, larger populations, which stresses the need to protect even small populations of this species.

Several researchers have observed insect visitors to *M. macfarlanei* plants that may act as potential pollinators for this species, including bumblebees (*Bombus* spp.) and solitary bees (*Anthophora* spp. and *Tetralonia* sp.) (Kaye and Meinke

1992, Barnes *et al.* 1995). Common floral visitors to *M. macfarlanei* include long-tongued bees of several genera, such as *Anthophora*, *Bombus*, *Synhalonia*, and *Melecta* (Barnes 1996). These insects are vital to successful sexual reproduction in this species (Barnes 1996). Although *M. macfarlanei* is self-compatible, it apparently requires a vector for pollination (Barnes 1996).

It is difficult to determine the extent of a particular *M. macfarlanei* clone since different clones (genotypes) can overlap in distribution and vary greatly in size (Barnes *et al.* 1995). The root system of some *M. macfarlanei* clones extends beyond the presence of ramets by at least 1 to 3 meters (about 1 to 3 yards) (Craig Johnson, *in litt.* 1999). Conceivably, an extensive root system could allow populations to expand into adjacent areas. Such areas may contain suitable habitat, or habitat that, under appropriate circumstances, could be suitable for this species in the future.

Another clonal species, quaking aspen (*Populus tremuloides*), apparently has an extensive root system that allows rapid expansion into cleared areas (e.g., by fire or avalanche), even though aboveground ramets may not have been visible in these areas prior to disturbance (Mitton and Grant 1980). Mitton and Grant (1980) also found a positive correlation between growth rate and heterozygosity in aspen. Environmental and genetic factors that may affect the growth rate of *M. macfarlanei* clones have not been specifically studied.

Monitoring conducted by the Bureau of Land Management from 1981 to 1998 has documented significant annual fluctuation in *M. macfarlanei* stem counts (ramets) and foliar cover, which are influenced by annual climatic conditions such as temperature and precipitation. Population estimates for this species are further complicated by the fact that seedlings (new individuals produced by sexual reproduction) are very difficult to distinguish from new ramet shoots in the field (Craig Johnson, Bureau of Land Management, *in litt.* 1999). The source for small ramets may be one large woody tuber with numerous shoots. Long term monitoring by the Bureau of Land Management has documented what appears to be a die-off of "seedlings"; however, this is due to annual variability in stem counts attributed to climatic conditions and does not represent actual seedling survivorship (Craig Johnson, *in litt.* 1999).

D. HABITAT DESCRIPTION

Mirabilis macfarlanei occurs in river canyon grassland habitats that are characterized by regionally warm and dry conditions. Precipitation occurs mostly as rain during winter and spring. Sites are dry and generally open, although scattered shrubs may be present. Plants can be found on all aspects, but often occur on southeast to western exposures. Slopes may be steep or nearly flat. Soils vary from sandy to talus (consisting of gravel and cobbles) substrate. *Mirabilis macfarlanei* populations range from approximately 300 to 900 meters (1,000 to 3,000 feet) in elevation.

Habitat for *M. macfarlanei* generally consists of bunchgrass communities dominated by *Agropyron spicatum* (bluebunch wheatgrass). Associated grass species include *Sporobolus cryptandrus* (sand dropseed), *Aristida longiseta* (red threeawn), and *Poa secunda* (Sandberg's bluegrass). Additional species that may be found in *M. macfarlanei* habitat include *Achillea millefolium* (yarrow), *Alyssum alyssoides* (pale alyssum), *Bromus mollis* (soft brome), *B. tectorum* (cheatgrass), *Celtis reticulata* (hackberry), *Chrysothamnus nauseosus* (rabbitbrush), and *Rhus glabra* (smooth sumac).

A habitat analysis study conducted in Oregon showed that the distribution of *M. macfarlanei* appeared to be influenced by slope aspect, soil development, topographic position, and the density of non-native species (Kaye 1992). Apparently suitable but unoccupied habitat tended to have a greater density of exotic species than adjacent occupied habitat (Kaye 1992).

Throughout much of the Pacific Northwest, native bunchgrass (i.e., steppe) communities have been altered by the invasion of non-native annual grasses such as *Poa pratensis* (Kentucky bluegrass) and *Bromus tectorum* (cheatgrass). Disturbances such as fire and livestock grazing tend to favor the spread of *Bromus tectorum*, and eliminate native species such as *Agropyron spicatum* and *Festuca idahoensis* (Franklin and Dyrness 1988). Nearly all sites occupied by *M. macfarlanei* contain at least some *Bromus tectorum*.

During the past two decades, the invasion of noxious weeds has increased within canyon grassland habitats in the Salmon and Snake River Canyons. *Centaurea*

solstitialis (Yellow starthistle), *Linaria genistifolia* (toadflax), and *Centaurea maculosa* (spotted knapweed) have encroached on poor and fair quality grassland habitats, and have invaded high quality sites to a lesser extent. These three exotic species have invaded *M. macfarlanei* populations in the Salmon River drainage. *Centaurea solstitialis* is the number one noxious weed threat to *M. macfarlanei* habitat within the Salmon River Canyon (Craig Johnson, *in litt.* 1999).

Because the existence of high quality grassland habitat is important for the long-term survival of this species, management actions should focus on maintaining the native plant community in areas of occupied or potentially suitable habitat. This should include maintaining ecological processes such as natural fire regimes and preserving populations of native invertebrates (e.g., pollinators).

The effects of grazing, exotic plant species, and other factors on *M. macfarlanei* are discussed further in the "Reasons for Decline and Current Threats" section of this recovery plan.

E. HISTORIC RANGE AND POPULATION STATUS

At the time of the original listing (U.S. Fish and Wildlife Service 1979), *M. macfarlanei* was known from only three populations along the Snake River Canyon in Oregon (Hell's Canyon National Recreation Area) and the Salmon River Canyon in Idaho (Cottonwood Field Office area, Bureau of Land Management), totaling approximately 25 plants on 10 hectares (25 acres).

F. CURRENT RANGE AND POPULATION STATUS

Eleven populations of *M. macfarlanei* are currently known – three of these populations are found in the Snake River Canyon area (Idaho County, Idaho and Wallowa County, Oregon), six in the Salmon River area (Idaho County, Idaho), and two in the Imnaha River area (Wallowa County, Oregon). The total geographic range of the species occupies an area of approximately 46 by 29 kilometers (29 by 18 miles) (Kaye 1992).

Estimates of population size for *M. macfarlanei* are complicated by its clonal nature. The number of stems (or ramets) does not accurately reflect the number of genetic individuals (genets) in the population (Barnes *et al.* 1994). Although the number of ramets per genet varies considerably for this species, Barnes (1996) estimated a mean of 4.88 ramets per genet.

Some previous estimates for *M. macfarlanei* were based on the number of stems, not the number of individuals. For example, the Final Rule for downlisting this species from endangered to threatened status (U.S. Fish and Wildlife Service 1996) stated that roughly 7,000 individuals of *M. macfarlanei* existed; however, this number was based on an estimated total number of stems, not individuals of the species. In addition, the number of ramets visible from year to year can fluctuate dramatically, and may be dependant on local environmental conditions such as the amount of March and April precipitation (Johnson 1995).

The population size for all *M. macfarlanei* populations in Idaho and Oregon was previously considered to range from 1,500 to 3,000 individuals (7,500 to 15,000 stems), based on estimates of clonal size (Barnes 1996) and on population estimates for *M. macfarlanei* sites in Idaho and Oregon (summarized in Johnson 1995). However, recent information and survey data suggest that the total population size for *M. macfarlanei* is approximately 8,000 to 9,000 individuals (39,000 to 44,000 stems) (Craig Johnson, *in litt.* 1999).

G. REASONS FOR DECLINE AND CURRENT THREATS

Herbicide and pesticide spraying. Spraying vegetation in areas where *M. macfarlanei* occurs could potentially have an adverse effect on this species if weed control activities are not carefully implemented and monitored. One population is directly adjacent to a major highway along the Salmon River in Idaho, where roadside vegetation spraying is routinely conducted. It is also possible that insect control activities (i.e., pesticide spraying) may adversely affect pollinators of *M. macfarlanei* such as bumblebees (*Bombus* spp.).

An unauthorized aerial herbicide spraying incident in May 1997 affected *M. macfarlanei* in the vicinity of the Salmon River in Idaho County, Idaho. *Mirabilis macfarlanei* plants on both Federal and privately owned lands were affected by

the herbicide spraying, which was conducted by the county weed management board. At least 2,750 stems on Federal land managed by the Bureau of Land Management (known as the Blackhawk site) exhibited foliar kill as a result of the spraying, based on monitoring conducted in June 1997 (Craig Johnson, personal communication, 1997). The Blackhawk site is part of the Long Gulch-John Day population. Subsequent monitoring in 1998 found that most of the *M. macfarlanei* plants survived (Craig Johnson, personal communication, 1998), although long-term effects on *M. macfarlanei* are unknown.

Mirabilis macfarlanei plants on private land in the vicinity were also affected by the May 1997 herbicide spraying (Craig Johnson, personal communication, 1997). At least 10 to 14 hectares (25 to 35 acres) of *M. macfarlanei* habitat on private land may have been affected by this herbicide application, although specific effects on *M. macfarlanei* on private land are unknown.

Landslides and flood damage. In 1996 and 1997, significant damage from landslides and flooding occurred throughout northern and central Idaho, and in the Hell's Canyon area in Idaho and Oregon. Activities associated with flood damage repair, including maintaining roads, trails, and facilities damaged by landslides or flooding should be considered as a potential threat to *M. macfarlanei* habitat.

For example, in November 1996 and May 1997, landslides occurred approximately 24 kilometers (15 miles) north of Riggins in Idaho County, Idaho, within an area containing occupied *M. macfarlanei* habitat. As a result of these landslides, Highway 95, the only major north-south transportation route in west-central Idaho, was completely blocked by debris and a temporary detour route was constructed. A road was constructed by the Idaho Transportation Department adjacent to the slide within *M. macfarlanei* habitat to evaluate the landslide.

To compensate for the loss of *M. macfarlanei* plants associated with highway repair and landslide stabilization activities, the Bureau of Land Management in cooperation with the Idaho Transportation Department, transplanted approximately 400 *M. macfarlanei* rhizomes to the Lucile Caves Research Natural Area in 1998 and 1999.

In the Hell's Canyon National Recreation Area, the development or expansion of borrow pits to repair damaged roads or trails could also potentially impact habitat for *M. macfarlanei* (Jerry Hustafa, Wallowa-Whitman National Forest, personal communication, 1997).

Insect damage and disease. Some *M. macfarlanei* plants have been damaged by insects, including lepidopterans and spittle bugs (Baker 1983, 1985; Kaye *et al.* 1990). A type of fungal disease was also previously noted from *M. macfarlanei* plants (U.S. Fish and Wildlife Service 1985). Because of connections between ramets, diseases may spread rapidly through clonal plant populations (Hartnett and Bazzaz 1985b). Although damage from insects and disease do not currently appear to be significant in *M. macfarlanei* populations, these threats should be monitored.

Exotic plant species. Exotic (non-native) plant species pose a serious threat to *M. macfarlanei* and other native plants since they compete with native species for space, light, water, and nutrients. Two of the most serious exotic species are *Bromus tectorum* (cheatgrass) and *Centaurea solstitialis* (yellow star-thistle). *Centaurea solstitialis* infestations have increased significantly in the Snake River Canyon over the past decade (Johnson 1995). Efforts to control *Centaurea solstitialis* have been initiated at a few sites containing *M. macfarlanei.*

No control efforts are being conducted for *Bromus tectorum* in *M. macfarlanei* habitat, however. Cheatgrass has contributed to the widespread degradation of native rangelands throughout the western United States. Due to its ability to germinate readily under a wide variety of environmental conditions, cheatgrass is extremely difficult to eradicate once established in native plant communities (Franklin and Dyrness 1988). In rangelands that are dominated by cheatgrass, seedling establishment of native perennial species may be limited by cheatgrass competition for moisture (Young 1994). It is also possible that *Bromus tectorum* may exude allelopathic substances toxic to native species (Owen 1984).

Many rare plants are threatened by competition with exotic plant species. For example, nonnative annual grasses (including *Bromus* spp.) significantly increased mortality and decreased survivorship, plant size, and reproductive output in an endangered annual herb (*Amsinckia grandiflora*) (Pavlik *et al.* 1993).

When competition was reduced, *A. grandiflora* grew vigorously without supplemental water or nutrients. The population of the endangered annual appeared to be limited by the availability of high quality habitat without the presence of introduced species (Pavlik *et al.* 1993). In another study of a threatened plant species (*Cirsium vinaceum*), Huenneke and Thomson (1995) found that competition from *Dipsacus sylvestris* (teasel), an invasive nonnative species, can negatively affect growth and seedling recruitment in *C. vinaceum*.

Exotic species may be partially responsible for limiting the expansion of *M. macfarlanei* populations, especially in marginal habitat areas that are dominated by weeds. In addition to *Bromus tectorum* and *Centaurea solstitialis,* other weedy species that occur in *M. macfarlanei* habitat include teasel, *Melilotus* spp. (sweet clover), and exotic mustards (Paula Brooks, Wallowa-Whitman National Forest, *in litt.* 1999).

Livestock grazing. Although it is uncertain whether most or all *M. macfarlanei* populations have been grazed by domestic livestock in the past, livestock grazing still occurs at some sites. Livestock impact this species directly by trampling or consuming plants (Kaye 1995), and can result in reduced reproduction (i.e., seed set) for *M. macfarlanei* plants.

Because *M. macfarlanei* occurs in grassland habitats favored for livestock grazing, some degree of soil erosion and soil compaction is likely to occur, especially under heavy grazing or during wet periods. Grazing by domestic livestock can change the community composition of grassland habitats by decreasing the frequency of native species, allowing the invasion and proliferation of undesirable and unpalatable exotic species (Franklin and Dyrness 1988). In addition, livestock grazing can adversely affect soil cryptogams (non-vascular plants that form a crust on the soil surface) in semiarid rangelands (Bethlenfalvay and Dakessian 1984), and may impact native pollinators, particularly ground-nesting bees (Sugden 1985).

Grazing by wildlife species. Native and introduced ungulate species, including Rocky Mountain bighorn sheep (*Ovis canadensis*), Rocky Mountain elk (*Cervus elaphus*), and mountain goats (*Oreamnos americanus*), are found in the vicinity of *M. macfarlanei* habitat in Hell's Canyon National Recreation Area and the Salmon

River Canyon. Although evidence of herbivory by rabbits and deer has been observed (Mancuso and Moseley 1991), native wildlife species do not appear to significantly threaten this species. However, the potential introduction of additional Rocky Mountain bighorn sheep or mountain goats by State or Federal agencies could threaten *M. macfarlanei* habitat. Mountain goats and other ungulate species can impact rare plant habitat by trampling or consuming plants and by exposing mineral soil (Houston et al. 1994).

Fire history. Specific effects of historic and current fire regimes on *M. macfarlanei* are unknown. Fire suppression activities and rehabilitation efforts, including seeding with nonnative species, are a potential threat to this species.

It is possible that *M. macfarlanei* habitat has burned less frequently in the past 100 years due to fire suppression. Sites where fire has been excluded are vulnerable to accelerated succession, e.g., the invasion of shrubs or trees into grassland or meadow communities. However, the invasion of cheatgrass alters natural community dynamics by producing greater fine fuel levels, which may result in frequent, large-scale range fires. In areas where cheatgrass has invaded sagebrush-grass communities, altered fire dynamics have converted formerly productive, perennial communities to annual-dominated communities with increased fire management problems (Tausch et al. 1994).

Wildfires that occur during summer and fall months when *M. macfarlanei* plants are dormant may have minimal direct effects on this species since the underground rhizomes will be largely insulated from fire (Craig Johnson, *in litt.* 1999). However, fires may result in adverse changes in the ecological condition of sites and lead to the subsequent invasion of exotic species. Burning may also result in concentrations of ungulates grazing within the burned areas, which might cause increased trampling of *M. macfarlanei* plants. The primary concern from wildfires appears to be during the active growing period (typically April through June) when the aboveground plants would be susceptible to fire kill or injury (Craig Johnson, *in litt.* 1999).

Trampling. Since some populations of *M. macfarlanei* are located near hiking or recreational trails, trampling by humans is a threat to this species. Repeat

monitoring of *M. macfarlanei* sites on steep slopes can also result in localized trampling impacts.

Off-road vehicles. Several *M. macfarlanei* colonies are found within ½ kilometer (1/4 mile) of existing roads or highways in Idaho and Oregon. In addition, many *M. macfarlanei* colonies are on steep slopes that are particularly vulnerable to erosion. Uncontrolled off-road vehicle use is a potential threat to this species on both public and private lands. In the Hell's Canyon National Recreation Area, vehicular travel is restricted to open roads although this has not been actively enforced (Paula Brooks, *in litt.* 1999).

Road and trail construction and maintenance. Some *M. macfarlanei* populations in Idaho and Oregon are located near existing roads and trails, and could be adversely impacted by road or trail maintenance activities (refer to the "Landslides and flood damage" section above for more information). The construction of new roads or trails is also a threat to this species.

Collecting. *Mirabilis macfarlanei* is an attractive plant that could be sought by amateur or professional botanists for scientific or horticultural purposes. Because some colonies are readily accessible, collection of *M. macfarlanei* should be considered a potential threat to this species.

Mining. Although no populations are currently known to be impacted by mining, one *M. macfarlanei* population is located near an existing gravel mining operation along the Salmon River in Idaho County, Idaho. In addition, road construction is often associated with mining activity. The Hell's Canyon National Recreation Area is closed to any new mining claims (Paula Brooks, *in litt.* 1999). However, expansion of existing mining operations and development of future mining operations (e.g., borrow pits) should be considered a potential threat to *M. macfarlanei*.

Competition for pollinators. Preliminary observations have shown that successful pollination of *M. macfarlanei* may be hindered by competition from adjacent plant species. For example, researchers have noted the presence of mixed pollen loads on solitary bees, which are considered to be potential pollinators of *M. macfarlanei* (Jerry Hustafa, personal communication 1996). No data currently

exists on the natural history (e.g., biotic and abiotic requirements) of the primary pollinators of *M. macfarlanei*. It is unknown whether pollinator populations are adequate for the successful reproduction of *M. macfarlanei* at all sites, although one study (Barnes 1996) found that seed set in *M. macfarlanei* does not appear to be pollen limited.

Inbreeding depression. Some observers have noted that seedling recruitment is apparently rare in populations of *M. macfarlanei* (e.g., Barnes *et al.* 1994). This could be influenced by extrinsic factors such as competition, inadequate pollination, nutrient levels, or annual precipitation. Inbreeding depression could result in poor seed viability, reduced germination success, or poor seedling survivorship. If new individuals are not successfully added to the population, the population viability of *M. macfarlanei* may decrease over time.

Barnes (1996) believed that gene flow (i.e., by pollen or seed dispersal) among *M. macfarlanei* populations is limited, based on the high degree of population differentiation. In populations that lose genets with time, dominance by one or a few clones is likely unless new genets are recruited into the population (Hartnett and Bazzaz 1985a). Although the effects of inbreeding depression have not been specified for *M. macfarlanei*, inbreeding depression should be considered as a potential threat to this species. Genetic variability is important in influencing a plant species' response to stochastic (random naturally occurring) events, herbivory, and adverse environmental conditions (Huenneke 1991).

H. CONSERVATION EFFORTS

Previous Recovery Efforts

As part of the recovery tasks described in the original recovery plan for this species (U.S. Fish and Wildlife Service 1985), surveys for *M. macfarlanei* have been conducted in Idaho and Oregon, which resulted in the discovery of several new populations of this species. *Mirabilis macfarlanei* seed collection and long-term storage at the Berry Botanic Garden has also been initiated. One new (transplant) population was established by the Bureau of Land Management near Lucile in Idaho County, Idaho.

Management plans for three *M. macfarlanei* colonies on Federal land in Idaho were developed by the Bureau of Land Management. These three sites are located at Long Gulch (Bureau of Land Management 1981), Skookumchuck (Bureau of Land Management 1983), and Lucile Caves (Bureau of Land Management 1985), all within the Cottonwood Field Office area (Idaho County, Idaho). The implementation of these management plans has reduced threats to some *M. macfarlanei* sites from livestock grazing and herbicide spraying along the Salmon River corridor (Johnson 1995). However, increased coordination is still needed with private, State, and county agencies to ensure protection of *M. macfarlanei* sites on Federal lands. Specific coordination is needed regarding noxious weed control, livestock and wildlife management, Highway 95 construction and maintenance projects, and conservation planning.

Monitoring efforts for *M. macfarlanei* populations on Federal land managed by the Bureau of Land Management (Cottonwood Field Office) and the Wallowa-Whitman National Forest (Hell's Canyon National Recreation Area) are ongoing at several sites (see agency and site information below). Ongoing monitoring efforts help to identify threats to *M. macfarlanei* and provide information on population status (e.g., whether populations are increasing, decreasing, or stable). Monitoring also provides feedback on the effectiveness of management actions (e.g., fencing populations to reduce impacts from livestock grazing) and the effects of fire on populations.

These conservation actions contributed to the downlisting of *M. macfarlanei* from endangered to threatened in 1996. In addition to the conservation efforts described below, several studies on the habitat, ecology, and genetic structure of *M. macfarlanei* have been conducted (see "Species Description and Life History" section of this recovery plan for more information).

State and Federal Designations

Mirabilis macfarlanei is listed as endangered by the Oregon Department of Agriculture (Oregon Administrative Rule 603-73-070). Plants listed as threatened or endangered under the Oregon Endangered Species Act are protected by law only on State lands. No *M. macfarlanei* plants are currently found on State lands in Oregon.

Mirabilis macfarlanei is on the sensitive species list (federally listed threatened) for the Bureau of Land Management (Cottonwood Field Office area) and the Forest Service (Regions 1, 4, and 6).

Conservation Efforts By Agency and Site: (This section includes only those sites where efforts such as habitat protection measures or monitoring have been implemented by the Bureau of Land Management or Forest Service.)

Bureau of Land Management[2]:

1. Skookumchuck - Monitoring was established at this site in 1981, and a habitat management plan was developed in 1983 (Bureau of Land Management 1983). The site is designated as a Research Natural Area and Area of Critical Environmental Concern. No livestock grazing is authorized. Bureau of Land Management staff have coordinated with the highway department to restrict herbicide spraying in the highway right-of-way adjacent to *M. macfarlanei* habitat (Johnson 1995). The estimated number of *M. macfarlanei* ramets (stems) is 50 to 100.

2. McKinzie Creek - *Mirabilis macfarlanei* was discovered at this site in 1994; monitoring was initiated in 1994 (Johnson 1995). The estimated number of *M. macfarlanei* ramets (stems) is 300 to 400.

3. Long Gulch[3] - Monitoring efforts were initiated and a habitat management plan was developed for this site in 1981 (Bureau of Land Management 1981). Long Gulch is within a Research Natural Area/Area of Critical Environmental Concern, and contains an 18-hectare (45-acre) fenced exclosure (constructed in 1981). No livestock grazing is authorized (Johnson 1995). The estimated number of *M. macfarlanei* ramets (stems) is 7,000.

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[2]All sites where conservation efforts have been implemented by the Bureau of Land Management are located in the Salmon River Canyon, Idaho County, Idaho.

[3]The Long Gulch, John Day, Blackhawk, and Henry's Gulch sites are part of the Long Gulch-John Day population.

4. John Day - Monitoring was established by the Bureau of Land Management at John Day in 1983 (Johnson 1995). The site is on private land that is not protected or managed specifically for *M. macfarlanei*. The estimated number of *M. macfarlanei* ramets (stems) is 3,000 (Craig Johnson, *in litt.* 1995).

5. Blackhawk - *Mirabilis macfarlanei* was discovered at this site in 1994; monitoring was established in 1995 (Johnson 1995). The estimated number of *M. macfarlanei* ramets (stems) is 1,500 to 2,500 (Craig Johnson, *in litt.* 1999).

6. Henry's Gulch - Monitoring was established in 1993 by the Bureau of Land Management (Johnson 1995). The site is privately owned, and is not protected or managed specifically for *M. macfarlanei*. The estimated number of *M. macfarlanei* ramets (stems) is 100.

7. Giants Nose - Monitoring was established by the Bureau of Land Management in 1997. The site is on private land that is not protected or specifically managed for *M. macfarlanei*. This area is presently infested by *Centaurea solstitialis*, which could potentially spread throughout the entire site. The estimated number of *M. macfarlanei* ramets (stems) is 2,000 to 2,700 (Craig Johnson, *in litt.* 1999).

8. Slicker Bar - Monitoring was established in 1999 by the Bureau of Land Management. This site is on private land that is not protected or specifically managed for *M. macfarlanei*. The estimated number of *M. macfarlanei* ramets (stems) is 250.

9. Lucile Cave - In 1988, 60 *M. macfarlanei* rhizomes from John Day were transplanted to this site within an 8-hectare (20-acre) fenced exclosure. In 1998 and 1999, approximately 400 rhizomes were transplanted to this site as mitigation for a federally funded project (Highway 95 slide stabilization) that impacted *M. macfarlanei* on private lands (part of the Long Gulch-John Day population). The site is designated as a Research Natural Area/Area of Critical Environmental Concern, and a habitat

management plan was developed in 1985 (Bureau of Land Management 1985). The estimated number of *M. macfarlanei* genets (individuals) is 460.

Forest Service:

1. Pittsburg Landing/Kurry Creek (Hell's Canyon, Snake River Canyon, Idaho County, Idaho) - This site is fenced to exclude livestock grazing. The estimated number of *M. macfarlanei* ramets (stems) is 20.

2. Tryon Bar (Hell's Canyon, Snake River Canyon, Wallowa County, Oregon) - Monitoring was established in 1991 (Kaye 1995). No livestock grazing is authorized. The estimated number of *M. macfarlanei* ramets (stems) is 2,500.

3. West Creek (Hell's Canyon, Snake River Canyon, Idaho County, Idaho) - This site is fenced to exclude livestock grazing. Monitoring was established in 1991 (Kaye 1995). The estimated number of *M. macfarlanei* ramets (stems) is 270.

4. Fall Creek (Imnaha River Canyon, Wallowa County, Oregon) - *Mirabilis macfarlanei* plants occur on both Forest Service and private land at this site, although conservation efforts are currently limited to the portion of the population on Forest Service land. Monitoring was established at Fall Creek in 1990 (Kaye 1995). However, intensive monitoring was discontinued in 1995 due to increased erosion caused by researchers conducting the monitoring. The Forest Service has plans to construct fencing to exclude livestock grazing, possibly in 2000 (Paula Brooks, *in litt.* 1999). Forest Service staff continue to visit the site at least once a year to document threats and note any significant changes in habitat conditions (Jerry Hustafa, personal communication, 1997). The estimated number of *M. macfarlanei* ramets (stems) is 350.

II. RECOVERY

A. RECOVERY OBJECTIVES AND STRATEGIES

The objective of the recovery program is to delist the species, i.e. to remove *Mirabilis macfarlanei* from threatened status by protecting and maintaining reproducing, self-sustaining populations in each of three distinct geographic areas along the Snake, Salmon, and Imnaha River Canyons (Figure 1).

Since the original recovery plan (U.S. Fish and Wildlife Service 1985) was published, additional information on the habitat, distribution, and life history of *M. macfarlanei* has been obtained (refer to the "Species Description and Life History" section of this recovery plan for more information). Furthermore, the study of population viability and its implications for the preservation of rare plant species has expanded considerably in the past decade (see, e.g., Falk and Holsinger 1991, Menges 1991, and Pavlik 1994). The recovery criteria and actions outlined in this revision reflect the information currently available on this species, and identify information needs that are pertinent to the long-term conservation and management of *M. macfarlanei*.

Until additional information on the population viability of *M. macfarlanei* is available, all existing habitat supporting *M. macfarlanei* should be protected and managed for the long-term conservation of this species.

Populations of *M. macfarlanei* should be closely monitored: 1) to determine population trends, reproductive success, and habitat conditions, and 2) to assess the effects of existing or potential threats on *M. macfarlanei* and its essential habitat. As discussed in the "Species Description and Life History" section of this recovery plan, the clonal nature, longevity, and genetic structure of *M. macfarlanei* contribute to the need for long-term studies and monitoring. Additional populations of *M. macfarlanei* that may be discovered in the future should also be protected and monitored.

B. RECOVERY CRITERIA

Delisting will be considered when all the following conditions are met:

1. A minimum of 11 populations are secure from threats and naturally reproducing with stable or increasing population trends for at least 15 consecutive years.

2. Population sizes are above the minimum necessary to maintain the viability of the species. Because the minimum viable population size for *M. macfarlanei* is currently unknown, population viability analyses will be conducted to support the recovery criteria.

3. Populations of this species occur throughout its current range in each of three geographic areas (i.e., Imnaha, Snake, and Salmon River areas).

4. Management practices reduce and control threats. On Federal land, habitat management plans are in place and monitoring is used to ensure implementation and effectiveness of conservation management practices. On non-Federal lands, *M. macfarlanei* populations are managed and conserved.

5. A post-delisting monitoring program for the species is developed and implemented. This program will be developed through coordination with the Bureau of Land Management, Forest Service, Fish and Wildlife Service, and other interested parties.

III. STEPDOWN NARRATIVE OUTLINE OF RECOVERY ACTIONS

1 Protect essential habitat and control threats.

Protect essential (occupied and potentially suitable) habitat and implement actions that may be necessary to eliminate or control threats. Manage habitat to maintain or enhance viable populations of *M. macfarlanei*. Habitat should be managed to allow for the maintenance of natural ecosystem functions and processes and contribute to the long-term preservation of this species. Because *M. macfarlanei* populations are genetically distinct (Barnes 1996), all populations should be protected in order to maintain the genetic variability of this species.

1.1 Revise, develop, and implement habitat management plans on Federal lands.

Responsible agencies should develop and implement habitat management plans (or conservation strategies) for *M. macfarlanei* populations on Federal lands. A primary objective of the management plans should be to maintain habitat for *M. macfarlanei* in a condition optimal for its persistence and reproduction. Three habitat management plans have been prepared for *M. macfarlanei* at Skookumchuck (Bureau of Land Management 1983), Long Gulch (Bureau of Land Management 1981), and Lucile Caves (Bureau of Land Management 1985). However, these management plans have not been updated for several years. To date, no formal management plans are in place for any *M. macfarlanei* populations on lands managed by the Forest Service. Management plans or conservation strategies should be updated at least once every 5 years, or as needed.

1.1.1 The Bureau of Land Management should update existing management plans, and develop management plans for *M. macfarlanei* populations not included in existing management plans.

Two *Mirabilis macfarlanei* colonies not currently included in existing management plans are located in Idaho County, Idaho, in the vicinity of McKinzie Creek and Long Gulch.

1.1.2 The Forest Service should develop and implement management plans.

Forest Service should develop and implement management plans or conservation strategies for three *M. macfarlanei* populations within the Hell's Canyon National Recreation Area in Idaho and Oregon.

1.1.3 Management plans should include provisions to identify and control threats to *M. macfarlanei* habitat.

Management plans should include provisions to identify and control factors that may degrade habitat quality for this species, such as livestock grazing, noxious weeds, herbicide or pesticide use, and off-road vehicle traffic. Management plans should specify how ongoing coordination between Federal agencies (Bureau of Land Management and the Forest Service) and county agencies or others that have responsibility for activities such as weed control or herbicide use will be accomplished.

1.1.3.1 Effectively manage livestock grazing in *M. macfarlanei* habitat.

Effective grazing management may include the construction and maintenance of fencing, and revising allotment plans, grazing schedules, and stocking levels to address *M. macfarlanei* habitat. Surveys should be conducted in all allotments where grazing is authorized in areas containing suitable habitat for *M. macfarlanei*. Consultation under section 7 of the Endangered Species Act should be completed by 2001 for all allotments with suitable habitat for *M. macfarlanei*.

1.1.3.2 Coordinate with county agencies or local organizations that have responsibility for activities that could affect *M. macfarlanei* habitat.

County agencies or local organizations (e.g., weed management boards) should be aware of *M. macfarlanei* colonies on public and private lands so that activities they fund, implement, or authorize will not inadvertently affect *M. macfarlanei* habitat. Such activities may include, but are not limited to, weed control, or herbicide and pesticide use. Close coordination between Federal land management agencies (Bureau of Land Management and the Forest Service) and county agencies or local organizations is necessary to protect *M. macfarlanei* habitat on public land. Counties that contain *M. macfarlanei* sites include Idaho County, Idaho, and Wallowa County, Oregon.

1.1.3.3 Implement weed control measures.

Weed control should be conducted within a 1 kilometer (about 0.5 mile) radius of all populations. Weed control efforts should be coordinated with the Fish and Wildlife Service, private landowners, county, and State agencies to ensure the protection of *M. macfarlanei* individuals and habitat.

1.1.3.4 Manage herbicide and pesticide use.

Herbicide or pesticide use in the vicinity of *M. macfarlanei* habitat should be managed to avoid adverse impacts to this species or potential pollinators of *M. macfarlanei*. In some cases, selective herbicide use may be desirable to enhance *M. macfarlanei* habitat or control invasive plant species.

Appropriate methods for application of pesticides and herbicides within the vicinity of *M. macfarlanei* sites

should be implemented. For example, carefully controlled hand application rather than aerial spraying could be used adjacent to *M. macfarlanei* habitat. Frequent coordination should occur between responsible Federal agencies and all county agencies or other entities that fund, implement, or authorize herbicide or pesticide use in the vicinity of *M. macfarlanei* sites.

1.1.3.5 Implement effective off-road vehicle use control measures.

Off-road vehicle use should be effectively controlled in all areas containing *M. macfarlanei* habitat. This may involve the use of fencing or other barriers, and developing signs to restrict vehicle use to existing, designated roads.

1.1.3.6 Develop fire management plans for all sites containing *M. macfarlanei* populations on public lands.

Fire management plans should clearly describe strategies to protect *M. macfarlanei* populations and habitat in the event of a wildfire, both during fire-fighting activities and post-fire rehabilitation efforts. Fire management plans should be incorporated into habitat management plans. The potential for using prescribed or wild fire to enhance *M. macfarlanei* habitat, if appropriate, could also be included in fire management plans.

1.1.3.7 Monitor and manage wildlife populations and associated management activities to avoid impacts to *M. macfarlanei* and its essential habitat.

Analyze potential effects of wildlife management activities on *M. macfarlanei* populations and habitat. The Forest Service and Bureau of Land Management should monitor

and evaluate effects of wildlife populations and associated activities on *M. macfarlanei*. Monitoring may require additional coordination with the Fish and Wildlife Service and State fish and game agencies if adverse impacts to *M. macfarlanei* are occurring from wildlife.

1.2 Pursue special management designations for *M. macfarlanei* on public lands.

The Forest Service and the Bureau of Land Management should consider designating essential *M. macfarlanei* habitat areas on public land as special management areas (e.g., as Areas of Critical Environmental Concern, Botanical Special Interest Areas, or Research Natural Areas). Protected habitat areas should include occupied habitat and potentially suitable, currently unoccupied habitat to allow for population expansion. The Forest Service and Bureau of Land Management should coordinate closely with county or other agencies whose activities could directly or indirectly impact *M. macfarlanei* habitat on public lands. Recommendations for special management designations may be incorporated into *M. macfarlanei* habitat management plans.

1.3 Protect *M. macfarlanei* habitat on private lands.

Populations of *M. macfarlanei* on private land should be protected by conservation easements, deed restrictions, or possibly direct acquisition. At a minimum, the Fish and Wildlife Service, working through appropriate State, local, or county agencies, should seek voluntary cooperation to protect *M. macfarlanei* habitat on private lands.

2 Monitor population trends and habitat conditions.

Achieving recovery will require monitoring of both *M. macfarlanei* individuals and habitat throughout its range in Idaho and Oregon. Monitoring will provide information on threats to *M. macfarlanei* habitat, and will also provide feedback on the effectiveness of management and conservation activities.

2.1 Monitor *M. macfarlanei* populations/sites annually.

Responsible agencies should ensure that long-term monitoring is conducted for *M. macfarlanei* populations in order to determine population trends and evaluate habitat conditions. The effects of adjacent land uses, such as recreation, grazing, and herbicide spraying on this species should be monitored annually. Monitoring programs should be designed to evaluate the effects of nonnative species and other threats on *M. macfarlanei*. Use of global positioning equipment may be helpful.

2.2 Conduct demographic monitoring.

Demographic monitoring (which typically involves tracking the fates of individual plants) should be employed if populations or subpopulations decline by more than 25 percent over a 3-year period, and if the causes of the declines are not readily apparent (see Kaye 1995). Demographic studies of *M. macfarlanei* may be complicated by the species' longevity and clonal nature, and the fact that seedlings are difficult to locate and identify.

Demographic data allow researchers to predict short-term trends, and analyze factors that limit population growth and establishment (Pavlik 1994). Information gained from such studies can be used to guide management of *M. macfarlanei* habitat.

2.3 Monitor and evaluate the response of *M. macfarlanei* to fire.

In the event that any *M. macfarlanei* populations are burned by wildfire or prescribed burning, annual monitoring will be conducted to evaluate the response of *M. macfarlanei* and its habitat to fire. If habitat rehabilitation or enhancement measures are needed (e.g., to control exotic species or erosion), these measures should be developed in conjunction with the Fish and Wildlife Service, and should be described in site-specific fire management plans (task 1.1.3.6).

2.4 Obtain permission from private landowners to conduct monitoring for *M. macfarlanei* on private lands.

Mirabilis macfarlanei colonies on private lands should be monitored to determine population trends and habitat conditions. Prior to conducting monitoring on private lands, permission will be requested and obtained from appropriate landowners.

3 Conduct research essential to the conservation of the species.

Additional research on the reproductive biology and life history of *M. macfarlanei* needs to be conducted to ascertain whether these recovery objectives are valid. Information on life history, population characteristics, and habitat requirements should be obtained to allow specification of management and population goals.

Partnerships with other State, Federal, or private agencies and individuals should be developed where possible in order to meet these objectives. The Fish and Wildlife Service will work with appropriate agencies to ensure that adequate funding can be obtained to conduct essential research on *M. macfarlanei*.

3.1 Determine population viability of *M. macfarlanei*.

Conduct essential research to determine the long-term population viability of *M. macfarlanei*. Estimates of population viability for this species will need to consider factors such as mortality, dispersal, and recruitment (both sexual and asexual). In addition, habitat availability and threats, including manmade or anthropogenic threats, natural catastrophes, and genetic and demographic stochasticity (see Menges 1991) should also be evaluated.

3.2 Conduct research on pollinators of *M. macfarlanei*.

Additional information on the requirements of pollinators for *M. macfarlanei* is needed. Because pollinators are required for full seed set in *M. macfarlanei* (Barnes 1996), conservation measures for this species should also protect nearby pollinator populations.

3.3 Conduct habitat enhancement studies.

Habitat enhancement studies (e.g., reducing competition from non-native species such as cheatgrass) should be conducted to determine the biotic and abiotic conditions that may enhance habitat quality and increase reproduction and survivorship in *M. macfarlanei*. The effects of prescribed burning, mowing, and using specific herbicides to reduce competition from alien plant species and improve habitat for *M. macfarlanei* should be investigated.

4 Conduct surveys in potential habitat areas. Manage and protect any newly discovered *M. macfarlanei* populations.

Intensive field work should be conducted to locate additional populations of this species in each of the three geographic areas in which it is currently known (i.e., along the Imnaha, Salmon, and Snake River corridors in Idaho and Oregon). The habitat of any newly discovered populations should be protected and managed as necessary and appropriate following the protocol given in Task 1.

4.1 Conduct surveys on Federal lands where activities may affect *M. macfarlanei* habitat.

Intensive surveys for *M. macfarlanei* should be conducted prior to approving and implementing activities that may affect habitat (occupied or potentially suitable habitat) for this species in canyon grassland habitats within the Hell's Canyon National Recreation Area in Idaho and Oregon, and the Bureau of Land Management's Cottonwood Field Office area (Idaho). Surveys should also be conducted in all areas where ongoing activities may affect known or potentially suitable habitat for *M. macfarlanei* within the Hell's Canyon National Recreation Area and the Cottonwood Field Office area. In addition to the Hell's Canyon National Recreation Area and Cottonwood Field Office area, surveys should be conducted on lands containing potential habitat for this species in Idaho (Idaho, Lewis, and Nez Perce Counties); Oregon (Baker, Union, and Wallowa Counties); and Washington (Asotin County).

4.2 Obtain permission from private landowners to conduct surveys for *M. macfarlanei* on private lands.

Prior to conducting surveys on private lands, permission should be requested and obtained from appropriate landowners.

4.3 Protect newly discovered *M. macfarlanei* populations.

Include any newly discovered populations of *M. macfarlanei* in management plans (see Task 1.1).

5 Establish propagule banks, including a long-term seed storage facility for *M. macfarlanei*.

Seeds of *M. macfarlanei* should be collected according to currently accepted protocol, and stored at a long-term seed storage facility such as the Berry Botanic Garden (Portland, Oregon). Seeds from many *M. macfarlanei* sites are currently being stored at the Berry Botanic Garden. Additional seeds will be collected to capture as much of the species' genetic variability as possible. Berry Botanic Garden staff will also be conducting germination and propagation studies for *M. macfarlanei* (Andrea Raven, Berry Botanic Garden, personal communication, 1999). The Fish and Wildlife Service will assist with securing permits for activities as appropriate.

6 If warranted, establish and maintain new populations.

If *M. macfarlanei* is extirpated from formerly occupied areas, or if population viability analyses suggest that additional populations are needed for full recovery, new populations of *M. macfarlanei* may be established as necessary and appropriate.

6.1 Develop and implement a reintroduction plan for *M. macfarlanei*, if reintroduction is warranted.

Evaluate the appropriateness and feasibility of reintroducing *M. macfarlanei* into previously occupied areas of its range, in consultation with all appropriate parties, after intensive surveys have confirmed extirpation. If reintroduction is found to be appropriate and feasible, develop and implement a reintroduction plan. Any new colonies, if they are deemed to be necessary, will be established into protected areas. Population viability analyses may be used to evaluate the need for additional *M. macfarlanei* populations.

6.2 Protect and monitor the *M. macfarlanei* population at Lucile Cave.

Monitor and protect the population of *M. macfarlanei* at Lucile Cave. Plants were transplanted to the area in 1988, 1998, and 1999 by the Bureau of Land Management. This population may provide valuable information to guide potential future reintroduction efforts for this species.

7 Validate and revise recovery objectives, as needed.

This recovery plan should be modified to incorporate any new information as it becomes available. In particular, the results of any population viability analyses conducted for *M. macfarlanei* will be considered in future recovery plan revisions. This recovery plan should be reviewed every 5 years, and updated if necessary.

IV. IMPLEMENTATION SCHEDULE

The implementation schedule that follows outlines actions and estimated costs for this recovery plan. It is a guide for meeting the objectives discussed in this plan. This schedule describes and prioritizes tasks, provides an estimated time table for performance of tasks, indicates responsible agencies, and estimates costs of performing tasks. These actions, when accomplished, should recover *Mirabilis macfarlanei*.

Priorities in column 1 of the following implementation schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species' population or habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Definition of task durations:

Continual - A task that will be implemented on a routine basis once begun.

Ongoing - A task that is currently being implemented and will continue until action is no longer necessary.

Responsible parties: An asterisk (*) in the implementation schedule indicates lead responsible party.

BG -	Berry Botanic Garden
BLM -	Bureau of Land Management, Cottonwood Field Office
CDC -	Idaho Conservation Data Center
FS -	U.S. Forest Service, Wallowa-Whitman National Forest, Hell's Canyon National Recreation Area
FWS -	U.S. Fish and Wildlife Service, Snake River Basin Office, Boise, Idaho
ODA -	Oregon Department of Agriculture
OHP -	Oregon Natural Heritage Program
OSU -	Oregon State University (or other university)
PVT -	private landowners
TNC -	The Nature Conservancy

Implementation schedule for the revised *Mirabilis macfarlanei* (MIMA) recovery plan

Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimate (in $1,000 units)					Comments
					Total Costs	FY 2001	FY 2002	FY 2003	FY 2004	
1	1.1.1	BLM should update existing management plans, and develop management plans for MIMA populations not included in existing management plans	Ongoing	BLM	32.5	1.5	1.5	1.5	1.5	Initial cost ($10,000) to develop plans; $1,500 required annually thereafter to review/ revise plans
1	1.1.2	Forest Service should develop and implement management plans	Ongoing	FS	19	2	1	1	1	Plans will be completed by 2001
1	1.1.3.1	Effectively manage livestock grazing in MIMA habitat	Continual	BLM*, FS*	140	14	14	14	14	Costs may include fence construction and maintenance
1	1.1.3.2	Coordinate with county agencies or local organizations that have responsibility for activities that could affect MIMA habitat	Continual	BLM*, FS*	32	2	2	2	2	BLM/FS will meet with county agencies at least annually to review planned activities

Implementation schedule for the revised *Mirabilis macfarlanei* (MIMA) recovery plan

Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimate (in $1,000 units)					Comments
					Total Costs	FY 2001	FY 2002	FY 2003	FY 2004	
1	1.1.3.3	Implement weed control measures	Continuous	BLM*, FS*	160-288	10-18	10-18	10-18	10-18	BLM/FS will implement appropriate weed control measures annually
1	1.1.3.4	Manage herbicide and pesticide use	Continual	BLM*, FS*, County	32	2	2	2	2	BLM/FS will evaluate county spray programs annually
1	1.1.3.5	Implement effective ORV use control measures	Continual	BLM*, FS*	34	2	2	2	2	BLM/FS will maintain/ monitor control measures annually
1	1.1.3.6	Develop fire management plans for all sites containing MIMA populations on public lands	3	BLM*, FS*	6	2	2	2	0	Plans may be completed as part of tasks 1.1.1 and 1.1.2
1	1.1.3.7	Manage wildlife populations and associated activities to avoid impacts to MIMA and its essential habitat	Ongoing	BLM*, FS*	32	2	2	2	2	This task will be coordinated with state fish and game agencies

Implementation schedule for the revised *Mirabilis macfarlanei* (MIMA) recovery plan

Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimate (in $1,000 units)					Comments
					Total Costs	FY 2001	FY 2002	FY 2003	FY 2004	
1	1.3	Protect MIMA habitat on private lands	Ongoing	FWS*, TNC, PVT, others	64	4	4	4	4	
1	2.1	Monitor MIMA populations/sites annually	Ongoing	BLM*, FS*, FWS, CDC, ODA, OHP	192	10.8	10.8	10.8	10.8	FS costs = $4,500 per yr. (field work only); BLM costs = $6,300 per yr. (field work and data entry)
1	2.3	Monitor and evaluate MIMA response to fire	Ongoing	BLM*, FS*, FWS, CDC, ODA, OHP	0-32	0-2	0-2	0-2	0-2	This task will only be implemented if fire occurs in MIMA habitat
2	1.2	Pursue special management designations for MIMA on public lands	3	BLM*, FS*	12	3	3	6	0	May be completed as part of tasks 1.1.1 and 1.1.2
2	2.2	Conduct demographic monitoring	10	BLM*, FS*, FWS, CDC, ODA, OHP	0-30	0-3	0-3	0-3	0-3	This task will be implemented if MIMA populations decline by more than 25 percent

Implementation schedule for the revised *Mirabilis macfarlanei* (MIMA) recovery plan

Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimate (in $1,000 units)					Comments
					Total Costs	FY 2001	FY 2002	FY 2003	FY 2004	
2	2.4	Obtain permission from private landowners to conduct monitoring for MIMA on private lands	Ongoing	BLM, FS, FWS*, PVT	27	1	1	1	1	
2	3.1	Determine population viability of MIMA	10	BLM*, FS*, FWS, CDC, ODA, OHP, OSU	25-55	2-5	2-5	2-5	2-5	
2	3.2	Conduct research on pollinators of MIMA	10	BLM*, FS*, FWS, CDC, ODA, OHP, OSU	48	3	5	5	5	
2	3.3	Conduct habitat enhancement studies	10	BLM*, FS*, FWS, CDC, ODA, OHP, OSU	58	8	8	5	5	
2	4.1	Conduct surveys on Federal lands where activities may affect MIMA habitat	Continual	BLM*, FS*, FWS, CDC, ODA, OHP	200	16	16	16	16	

Implementation schedule for the revised *Mirabilis macfarlanei* (MIMA) recovery plan

Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimate (in $1,000 units)					Comments
					Total Costs	FY 2001	FY 2002	FY 2003	FY 2004	
2	4.3	Protect newly discovered MIMA populations	Ongoing	BLM*, FS*	0-80	0-5	0-5	0-5	0-5	
2	5	Establish propagule banks, including a long-term seed storage facility for MIMA	Ongoing	BLM*, FS*, BG	10.5	.5	.5	.5	.5	Costs are for seed storage and seed collection
2	6.2	Monitor MIMA population at Lucile Caves	Ongoing	BLM	13.5	.5	.5	.5	.5	2 days (field work) per yr.
3	4.2	Obtain permission from private landowners to conduct surveys for MIMA on private lands	Continual	BLM, FS, FWS*, CDC, ODA, OHP	42	5	5	5	5	
3	6.1	Develop and implement a reintroduction plan for MIMA, if reintroduction is warranted	10	BLM, FS, FWS*, CDC, ODA, OHP	0-160	0-25	0-15	0-15	0-15	This task will be implemented if MIMA has been extirpated in formerly occupied habitat

Implementation schedule for the revised *Mirabilis macfarlanei* (MIMA) recovery plan										
Task Priority	**Task Number**	**Task Description**	**Task Duration (years)**	**Responsible Parties**	**Cost Estimate (in $1,000 units)**					**Comments**
					Total Costs	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	
3	7	Validate and revise recovery objectives	5	FWS*, BLM, FS	28	1	1	1	5	Review recovery progress annually (2 days); revise plan in 2005
Total estimated cost of Recovery: 1,207.5 - 1,667.5										

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VI. APPENDIX. Summary of the Agency and Public Comments received on the Draft Revised Recovery Plan for MacFarlane's Four-o'clock (*Mirabilis macfarlanei*)

On April 5, 1999, we released the Draft Revised Recovery Plan for MacFarlane's Four-o'clock (*Mirabilis macfarlanei*) for a 60-day public comment period that ended June 4, 1999 (64 FR 16478).

Three responses were received. All comments either provided additional information or corrections. We sent letters to three people considered experts on this species to solicit comments on the Draft Revised Recovery Plan. All three of these experts provided comments and recommendations. We reviewed all of the comments received during the comment period. Comments provided were positive, favorable, and in support of the goal and approach taken. The comments provided recommendations for research and conservation strategies, and corrected and updated specific locality descriptions and information. All applicable comments have been addressed in, or incorporated into, the body of this final revised Recovery Plan.

The number of letters received by affiliation:

Federal agencies:	2 letters
State agencies:	1 letter

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