U.S. Fish & Wildlife Service

Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems

Vernal pool photograph used with permission.
Sam Friedman/U.S. Fish and Wildlife Service

Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems

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

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

Date: Nov. 6, 2012

U.S. FISH AND WILDLIFE SERVICE'S MISSION IN RECOVERY PLANNING

Section 4(f) of the Endangered Species Act of 1973, as amended, directs the Secretary of the Interior and the Secretary of Commerce to develop and implement recovery plans for species of animals and plants federally listed as endangered or threatened unless such plans will not promote the conservation of the species. The U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration-Fisheries have been delegated the responsibility of administering the Endangered Species Act. Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of species with the minimum necessary investment of resources. A recovery plan delineates, justifies, and schedules the research and management actions necessary to support the survival and recovery of a listed species. Species of conservation concern are not federally listed but have a critical degree of threats and/or rarity and could potentially become federally listed in the future. These species are not required to have recovery plans; however, some are included in this recovery plan because a community-level strategy provides opportunities for pre-listing conservation of species with needs similar to those of listed species.

Recovery plans do not, of themselves, commit staff time or funds, but are used in setting regional and national funding priorities and providing direction to local, regional, and state planning efforts. Means within the Endangered Species Act to achieve recovery goals include the responsibility of all Federal agencies to seek to conserve endangered and threatened species (section 7), and the Secretary's ability to designate critical habitat (section 4), to enter into cooperative agreements with the states (section 6), to provide financial assistance to the respective state agencies (section 6), to acquire land, and to develop habitat conservation plans with applicants (section 10).

We are committed to applying an ecosystem approach to conservation to allow for efficient and effective conservation of our Nation's biological diversity (U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration 1994). In terms of recovery plans, ecosystem considerations are incorporated through the development and implementation of recovery plans for communities or ecosystems where multiple listed species and species of conservation concern occur, in a manner that restores,

reconstructs, or rehabilitates the structure, distribution, connectivity, and function upon which those listed species depend. In particular, these recovery plans shall be developed and implemented in a manner that conserves the biotic diversity of the ecosystems upon which the listed species depend. Recovery plans detail the actions necessary to achieve self-sustaining, wild populations of listed species so they will no longer require protection under the Endangered Species Act.

Disclaimer

Recovery plans delineate actions that the best available science indicates are necessary to recover and protect listed species. We, the U.S. Fish and Wildlife Service (Service), publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, state agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery actions in this plan should not be construed as a commitment or requirement that a Federal agency or other party obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation other than the U.S. Fish and Wildlife Service. They represent our official position only after they have been signed by the Director or Regional Director as approved. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions.

NOTICE OF COPYRIGHTED MATERIAL

Permission to use copyrighted illustrations and images in this recovery plan has been granted by the copyright holders. These illustrations are not placed in the public domain by their appearance herein. They may not be copied or otherwise reproduced, except in their printed context within this document, without the written consent of the copyright holder.

Literature Citation:

U.S. Fish and Wildlife Service. 2012. Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems. Region 1, Portland, Oregon. xvii + 240 pages.

An electronic version of this recovery plan will also be made available at http://www.fws.gov/pacific/ecoservices/endangered/recovery/plans.html and http://www.fws.gov/endangered/species/recovery-plans.html. Please check for updates or revisions to this recovery plan at these web addresses before using.

Acknowledgments

In addition to Service personnel, the following individuals provided contributions to this final recovery plan:

Linda Hale
Former Ecologist
Medford District
Bureau of Land Management
Medford, Oregon

Mark Mousseaux
Oregon/Washington State Botanist
Bureau of Land Management
Medford, Oregon

Darren Borgias
Stewardship Ecologist
The Nature Conservancy
Southwest Oregon Office
Medford, Oregon

Executive Summary

INTRODUCTION

This recovery plan addresses ten species of plants and animals of seasonally wet habitats in southern Oregon. Two federally endangered plant species that are endemic to southern Oregon are the primary focus of the plan: *Limnanthes pumila* ssp. *grandiflora* (large-flowered woolly meadowfoam; also known as big-flowered woolly meadowfoam or Agate Desert meadowfoam) and *Lomatium cookii* (Cook's desert-parsley; also known as Cook's lomatium or Agate Desert lomatium). Site-specific information and recovery actions are also provided for one federally threatened invertebrate, the vernal pool fairy shrimp (*Branchinecta lynchi*). In addition, site-specific information and provisions for long-term conservation are provided for seven species of conservation concern, including six plants (*Agrostis hendersonii* [Henderson's bentgrass], *Callitriche marginata* [winged water-starwort], *Limnanthes pumila* ssp. *pumila* [dwarf woolly meadowfoam], *Limnanthes gracilis* spp. *gracilis* [slender meadowfoam], *Plagiobothrys austiniae* [Austin's popcornflower], and *Plagiobothrys greenei* [Greene's popcornflower]) and a newly discovered aquatic invertebrate species, *Dumontia oregonensis*.

The nine species addressed in this recovery plan occur in vernal pool, swale, or seasonal wet meadow habitats within southern Oregon and are largely confined to limited areas by topographic constraints, soil types, and climatic conditions. Surrounding and associated upland habitat is critical to the proper ecological function of these seasonally moist meadow and vernal pool habitats. Most of the plants and animals addressed in the recovery plan have life histories adapted to the short period for growth and reproduction within inundated or drying pools and meadows interspersed with long dormant periods and extreme year-to-year variation in rainfall.

CURRENT SPECIES STATUS

Limnanthes pumila ssp. *grandiflora* is known from 18 extant populations in the Rogue Valley in Jackson County, Oregon. *Lomatium cookii* is known from 13 occurrences in the Rogue Valley in Jackson County, Oregon and 24 occurrences in the Illinois Valley of Josephine County, Oregon. The vernal pool fairy shrimp occurs in vernal pools in the Agate Desert, White City, and Table Rocks areas in the Rogue Valley of Jackson County, Oregon, as well as various localities in the Central Valley and Coast Ranges of California. In southern Oregon, occurrences of all three species often overlap administrative boundaries and property lines.

Recovery Priority Numbers: *Limnanthes pumila* ssp. *grandiflora*: 3C
Lomatium cookii: 2C
vernal pool fairy shrimp: 2C

Priority rankings, on a scale from 1C (highest) to 18 (lowest), are determined in accordance with Service guidelines for assigning recovery priorities (U.S. Fish and Wildlife Service 1983; see also Appendix C) and are based upon a high degree of threat, a high potential for recovery, and taxonomic level (classification as a species for *Lomatium cookii* and vernal pool fairy shrimp, and as a subspecies for *Limnanthes pumila* ssp. *grandiflora*). The "C" indicates the potential for conflict with construction, development, or other economic activities.

SCOPE OF THE RECOVERY PLAN

This plan addresses *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp of the Rogue River Valley (Rogue Valley) of Jackson and Josephine Counties in southwest Oregon. It also addresses *Lomatium cookii* where the species occurs in the Illinois River Valley (Illinois Valley) of Josephine County, Oregon, a major tributary of the Rogue River. This plan also provides site-specific information regarding seven species of concern: six plant taxa and *Dumontia oregonensis*, an aquatic invertebrate.

The recovery strategy is oriented to adaptive management of vernal pool and wet meadow habitat, consistent with the Service's Strategic Habitat Conservation process, which calls for an iterative process of biological planning, conservation design, conservation delivery, and monitoring and research. The biological planning and conservation design set forth in this recovery plan lay out the criteria for recovery and identify localities for implementing actions, while the recovery actions describe a process for implementing conservation on the ground, outcome-based monitoring to assess success, and ongoing assumption-driven research to test biological hypotheses important to management.

The recovery of the vernal pool fairy shrimp is primarily guided by the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a), which outlines recovery actions and criteria for the vernal pool fairy shrimp and 19 other listed species endemic to vernal pool habitats across a broad geographic range in California and Oregon. The Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems provides recovery actions specific to

the Oregon range of the vernal pool fairy shrimp, which refine and step down the actions identified in the broader Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a).

The seven species of concern are included in this recovery plan because they are closely associated with seasonal wetland ecosystems and may co-occur with the three listed species in southwestern Oregon. Proactive implementation of conservation measures for these species may avoid the need for listing them in the future.

HABITAT REQUIREMENTS AND LIMITING FACTORS

All species addressed in the plan occur, or historically occurred, in vernal pools, seasonally wet meadows, sloped mixed-conifer forest openings, and shrubby habitat in southwestern Oregon. Both federally listed plant species occur within the Agate Desert of the Rogue Valley in Jackson County, where they are associated with vernal pools. *Lomatium cookii* also occurs in the Illinois Valley of neighboring Josephine County, in serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and shrub dominated plant communities. The majority of the extant and historical sites for the two federally listed plant species within the Rogue Valley occur on soil formations characterized by Agate-Winlo silty clay loam series (deep, poorly drained soils present in depressions in alluvial stream terraces). *Lomatium cookii* additionally occurs on seasonally wet serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and along roadside edges in shrub dominated plant communities on soil formations characterized by Brockman clay loam, Abegg clay loam, Eightlar extremely stony clay, Josephine gravelly loam, Pollard loam, Takilma cobbly loam, and Newberg loam in the Illinois Valley (Natural Resources Conservation Service 1999).

Most of the listed plant and fairy shrimp occupied sites are moderately to highly disturbed due to expanding commercial and residential development and agricultural activities in the area. Urban development, incompatible agricultural practices, mining, habitat alteration due to invasion of nonnative species, habitat fragmentation and degradation, and other human-caused disturbances have resulted in substantial losses of seasonal wet meadow habitat throughout the species' historical ranges. Conservation needs include establishing a network of protected populations in natural habitat distributed throughout their native range and responding to potential threats posed by changing climate conditions in the region.

RECOVERY GOALS

The goals of this recovery plan are as follows:

- **Delist *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii***

When self-sustaining, protected *Limnanthes pumila* ssp. g*randiflora* and *Lomatium cookii* populations are achieved as described in this plan, we will consider the removal of these species from the Federal List of Endangered and Threatened Wildlife and Plants.

- **Contribute to the recovery of the vernal pool fairy shrimp as stated in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a).**

This goal will be accomplished by identifying and implementing site-specific recovery actions for vernal pool fairy shrimp within the Klamath Mountains Vernal Pool Region.

INTERIM GOALS

- **Reclassify *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* to threatened (*i.e.*, downlist).**

RECOVERY OBJECTIVES

- Stabilize and protect populations of the three listed species in core areas so further decline in species status and range are prevented.
- Minimize or eliminate the threats that caused the species to be listed, and any other newly identified threats, in order to be able to delist these species.
- Conduct research necessary to refine reclassification (*i.e.*, downlisting) and recovery criteria.
- Promote natural ecosystem processes and functions by protecting and conserving, in identified core areas, intact vernal pool-mounded prairie complexes and seasonally wet serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and shrub dominated plant communities within the recovery planning area.

These objectives will be accomplished through implementation of a variety of recovery measures including habitat protection and enhancement; management and restoration; monitoring; augmentation and reintroduction; research and status surveys; and public participation, outreach, and education.

OBJECTIVES FOR SPECIES OF CONSERVATION CONCERN

- Provide for the long-term conservation of the seven nonlisted species of conservation concern so as to avoid future listing.
- Confirm the status of *Agrostis hendersonii*, a species of concern that is currently presumed extirpated from Oregon. If extant populations are discovered, the goal would be to ensure the long-term conservation of this species.

RECOVERY CRITERIA

Individual recovery criteria are presented for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* in the recovery plan to provide for their genetic diversity, distribution across their historic range, and demographic stability. We recommend monitoring of species populations and habitat to determine appropriate management techniques and track progress toward recovery. The downlisting and delisting criteria for the two plant species, summarized below, constitute our best estimate of the conditions that would allow us to conclude in a five-factor threats analysis that the species no longer meet the definition of endangered or threatened under the Endangered Species Act. Actual delisting or downlisting requires formal publication of a final rule in the Federal Register with a threats analysis that justifies the determination; in some circumstances delisting may be accomplished without precisely meeting all of the recovery criteria if an alternative set of conditions exists that supports such a threats analysis.

Delisting Criteria Specific to *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii*:

- At least 17 of 18 occurrences for *Limnanthes pumila* ssp. *grandiflora*; or 33 of 36 occurrences for *Lomatium cookii* (approximately 95 percent of documented/extant occurrences) should be protected in conservation-oriented ownership (*i.e.*, land that is formally secured from habitat loss and degradation by way of conservation easements, formal agreements, conservation banks, or public or conservation group ownership). For occurrences that have become extirpated, reintroduced or introduced

populations may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if the Service deems them equivalent in their contribution to recovery.

- At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area for the species and at least 90 percent of suitable vernal pool habitat acreage within each Priority 2 core area for the species has been protected from development. All suitable habitat must include soils and hydrology that support the plant species.
- Conservation oriented management plans for each protected core area are developed to guide protection and conservation following establishment of protected status such as a conservation easement or transfer of ownership to land trusts or government entities. Each management plan should be operational as soon as possible, as funding and staff time allow.
- Additional species occurrences identified through future site assessments, GIS, other analyses, or status surveys, and that are determined essential to recovery, are protected.
- Status surveys, 5-year status reviews, and population monitoring show achievement of self-sustaining species populations as confirmed through species monitoring and status surveys in each protected occurrence.
- Seeds from each core area of the two species are in storage as insurance against the risk of extirpations and to ensure that genetic lines are preserved. Seed banking is also necessary in order to complete the reintroductions or introductions that can contribute to meeting recovery criteria.

Delisting Criteria for Vernal Pool Fairy Shrimp Specific to the Klamath Mountain Vernal Pool Region:

- At least 80 percent (9 of 11) of the occurrences within the Klamath Mountain Region (Rogue Valley) have been protected.
- At least 85 percent of suitable vernal pool habitat within the Klamath Mountain Vernal Pool Region has been protected.
- Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all protected habitat.
- Cyst banking actions have been completed for the vernal pool fairy shrimp.

- Status surveys, 5-year status reviews, and population monitoring show vernal pool fairy shrimp populations within the Klamath Mountain Vernal Pool Region are viable (self-sustaining) and have been maintained (stable, increasing, or showing only minor declines from high population levels) for a 10-year monitoring period.

Recommended Actions:

1. Protect vernal pool, wet meadow, and sloped mixed-conifer forest habitats.
2. Manage, restore, and monitor vernal pool and wet meadow habitat.
3. Conduct rangewide population status surveys.
4. Conduct research essential to the conservation and recovery of the species.
5. Enhance public awareness and participation in the recovery of the species.
6. Develop a post-delisting monitoring plan.

TOTAL ESTIMATED COST OF RECOVERY

The Implementation Schedule provides the estimated costs of implementing recovery actions for the first 5 years after the release of the recovery plan. Estimated total costs of recovery are based on cost estimates for ongoing and recurring actions projected forward to recovery and delisting timeframes for each species.

The estimated cost to implement this plan for the first 5 years is $3,230,700 plus additional costs that cannot be determined at this time. Estimated total cost projected over 20 years is $6,971,000 plus additional costs that cannot be determined at this time.

Estimated Date of Delisting: If this plan is fully implemented as described and recovery criteria are met, we anticipate that delisting of *Limnanthes pumila* ssp. g*randiflora* and *Lomatium cookii* (as well as accomplishment of vernal pool fairy shrimp recovery targets within the Rogue Valley) may be considered as soon as 2032.

Table 1. Cost Estimates through First 5 Years of Plan (in $1,000 units). Actions refer to the primary recovery actions identified in this plan (see "Recommended Actions" above).

	Year				
Action	1	2	3	4	5
1. Protect vernal pool and wet meadow habitat	157.8	157.8	57.8	57.8	57.8
2. Manage, restore and monitor habitat	546.7	418.7	258.7	174	164
3. Conduct rangewide population status surveys	87	132	32	42	2
4. Conduct research essential to conservation and recovery	225	260	235	40	40
5 Enhance public awareness and recovery participation	45	10	10	10	10
6. Develop a post-delisting monitoring plan	0	0	0	0	0
Annual Estimate	1,061.4	978.4	593.4	323.8	273.8
Estimate for first 5 years	**$3,230.7**				

TABLE OF CONTENTS

I. Background I-1
A. Overview I-1
B. Biotic Communities Represented I-5
1. Rogue Valley Vernal Pool-Mounded Prairie Complex I-6
2. Illinois Valley Habitats I-14
II. Species Accounts II-1
A. *Limnanthes pumila* ssp. *grandiflora* (large-flowered woolly meadowfoam) II-1
1. Distribution II-4
2. Population Status II-6
3. Habitat Description II-8
4. Life History II-8
5. Reasons for Decline and Threats to Survival II-10
6. Conservation Efforts II-11
B. *Lomatium cookii* (Cook's desert parsley) II-13
1. Distribution II-16
2. Population Status II-20
3. Habitat Description II-21
4. Life History II-22
5. Reasons for Decline and Threats to Survival II-25
6. Conservation Efforts II-25
C. Vernal Pool Fairy Shrimp II-28
1. Population Status II-30
2. Habitat Description II-31
3. Community Associations II-33
4. Life History II-34
5. Reasons for Decline and Threats to Survival II-35
6. Conservation Efforts II-37
D. Associated Species of Conservation Concern II-42
1. *Agrostis hendersonii* (Henderson's bentgrass) II-42
2. *Callitriche marginata* (winged water-starwort) II-45
3. *Limnanthes pumila* ssp. *pumila* (dwarf meadowfoam) II-49
4. *Limnanthes gracilis* ssp. *gracilis* (slender meadowfoam) II-52
5. *Plagiobothrys austiniae* (Austin's popcornflower) II-54
6. *Plagiobothrys greenei* (Greene's popcornflower) II-56
7. *Dumontia oregonensis* II-59
8. Additional Species II-61
III. Reasons For Listing III-1
A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range III-1
B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes III-2
C. Disease or Predation III-3
D. The Inadequacy of Existing Regulatory Mechanisms III-3
E. Other Natural or Manmade Factors Affecting its Continued Existence III-5

IV. Recovery IV-1
A. Recovery Strategy IV-1
1. Habitat Protection IV-3
2. Habitat Management IV-5
3. Status Surveys IV-6
4. Research IV-7
5. Public Participation and Outreach IV-8
B. Recovery Zones and Core Areas IV-9
1. Recovery Zones IV-9
2. Core Areas IV-10
3. *Limnanthes pumila* ssp. *grandiflora* IV-18
4. *Lomatium cookii* IV-18
5. Vernal Pool Fairy Shrimp IV-19
C. Recovery Goals IV-20
D. Recovery Objectives IV-20
E. Recovery Criteria IV-21
1. Downlisting Criteria for *Limnanthes pumila* ssp. *grandiflora* IV-26
2. Downlisting Criteria for *Lomatium cookii* IV-27
3. Delisting criteria for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* IV-29
4. Delisting Criteria for the Vernal Pool Fairy Shrimp IV-30
5. Recovery Criteria Rationale IV-34
F. Narrative Outline of Recovery Actions IV-36
V. Implementation Schedule V-1
VI. References VI-1
A. Literature Cited VI-1
B. Personal Communications VI-15
VII. Appendices VII-1
Appendix A. Glossary of Technical Terms VII-1
Appendix B. Plant and Animal Species Referenced in this Recovery Plan VII-4
Appendix C. Recovery Priorities for Recovery of Threatened and Endangered Species VII-7
Appendix D. Recovery Core Areas VII-8
Appendix E. Threats Identified for the Vernal Pool and Wet Meadow Species and Recovery Plan Recommended Management Actions VII-28
Appendix F. Conservation Tools and Strategies VII-30
Appendix G. Agency and Public Comment on the Draft Recovery Plan for Listed Species of the Rogue Valley Vernal Pool and Illinois Valley Wet Meadow Ecosystems VII-38
Appendix H. Conservation and Regulatory Measures VII-45

LIST OF FIGURES

Figure I-1 Map of recovery plan area, showing the Rogue Valley and Illinois Valley in Jackson and Josephine Counties I-2
Figure II-1 *Limnanthes pumila* ssp. *grandiflora* II-2
Figure II-2. Occurrences of *Limnanthes pumila* ssp. *grandiflora* in Jackson County, Oregon II-3
Figure II-3. Photographs of *Lomatium cookii* II-14
Figure II-4. Occurrences of *Lomatium cookii* in the Agate Desert, Jackson County, Oregon II-18
Figure II-5. Occurrences of *Lomatium cookii* in the Illinois Valley, Josephine County, Oregon II-19
Figure II-6 Vernal Pool Fairy Shrimp (male) II-29
Figure II-7 Distribution of vernal pool fairy shrimp (*Branchinecta lynchi*) II-32
Figure II-8. Illustration of *Agrostis hendersonii* (Henderson's bentgrass) II-43
Figure II-9. *Callitriche marginata* (winged water-starwort) II-47
Figure II-10. *Limnanthes pumila* ssp. *pumila* (dwarf woolly meadowfoam) II-50
Figure II-11. *Limnanthes gracilis* ssp. *gracilis* (slender meadowfoam) II-53
Figure II-12 Illustration of *Plagiobothrys austiniae* (Austin's popcornflower) II-55
Figure II-13. Illustration of *Plagiobothrys greenei* (Greene's popcorn flower); plant and nutlet II-57
Figure II-14. *Dumontia oregonensis* II-60
Figure IV-1 Rogue Valley core areas for vernal pool fairy shrimp, *Lomatium cookii*, and *Limnanthes pumila* ssp. *grandiflora* IV-12
Figure IV-2. Illinois Valley Core Areas for *Lomatium cookii* IV-13
Figure IV-3. Vernal pool fairy shrimp core areas within the Klamath Mountain Vernal Pool Region IV-14

LIST OF TABLES

Table I-1. Species addressed in Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems I-4

Table I-2. Summary of Vernal Pool Habitat Integrity Classes in the Agate Desert .. I-7

Table II-1. Distribution of *Limnanthes pumila* ssp. *grandiflora* across land ownership in the Rogue Valley, Jackson County II-5

Table II-2. Habitat acreage by critical habitat unit and ownership, providing habitat protection for *Limnanthes pumila* ssp. *grandiflora* II-7

Table II-3. Distribution of *Lomatium cookii* across land ownership in the Rogue Valley, Jackson County II-20

Table II-4. Distribution of *Lomatium cookii* across land ownership in the Illinois Valley, Josephine County II-20

Table II-5. Habitat acreage by critical habitat unit and ownership, providing habitat protection for *Lomatium cookii* II-27

Table II-6. Amount of vernal pool fairy shrimp habitat receiving protective measures, by critical habitat unit and type of protective measure II-40

Table IV-1. Core Areas in the Illinois Valley Recovery Zone for *Lomatium cookii* IV-15

Table IV-2. Core Areas in the Rogue Valley Recovery Zone for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* IV-16

Table IV-3. Core Areas in the Klamath Mountains Region for vernal pool fairy shrimp IV-17

Table IV-4. Species-specific recovery criteria for species occurrence and habitat protection, reintroduction, and seed banking IV-24

I. Background

A. OVERVIEW

Jackson and Josephine Counties, in the Klamath/Siskiyou region of southwestern Oregon (Figure I-1), host unique assemblages of plant communities. In a rare plant population assessment, Kaye *et al*. (1997) identified this area as the largest "hot spot" in Oregon for high density of rare plants. Smith and Sawyer (1988) also identified the Klamath/Siskiyou region as having high concentrations of species diversity, disjunct distribution, and endemism.

This recovery plan addresses two federally endangered plant species that are endemic to seasonal wetlands* in southwestern Oregon, as well as Oregon populations of the federally threatened vernal pool fairy shrimp and seven nonlisted species of conservation concern that co-occur with these listed species in southwestern Oregon†.

Listed species. *Limnanthes pumila* ssp. *grandiflora* (large-flowered woolly meadowfoam; also known as big-flowered woolly meadowfoam or Agate Desert meadowfoam) and *Lomatium cookii* (Cook's desert-parsley; also known as Cook's lomatium or Agate Desert lomatium) are plant species that were both listed as endangered on November 7, 2002 (U.S. Fish and Wildlife Service 2002a), under authority of the Endangered Species Act of 1973, as amended (16 United States Code [U.S.C.] 1531 *et seq*.). (*Limnanthes pumila* ssp. *grandiflora* was originally listed under the scientific name *Limnanthes floccosa* ssp. *grandiflora*, but recent research has modified the taxonomic classification of this subspecies. Both names refer to the same taxonomic entity, but in this document we use the current classification; see section II.A below.) Critical habitat was designated for the two plants on July 21, 2010 (U.S. Fish and Wildlife Service 2010). The two plants are also listed as endangered by the State of Oregon. The vernal pool fairy shrimp (*Branchinecta lynchi*) was listed as threatened on September 19, 1994 (U.S. Fish and Wildlife Service 1994). Critical habitat was

---

* Certain technical or scientific terms are defined in the Glossary (Appendix A).

† Scientific and common names of species referred to in this recovery plan are summarized in Appendix B.

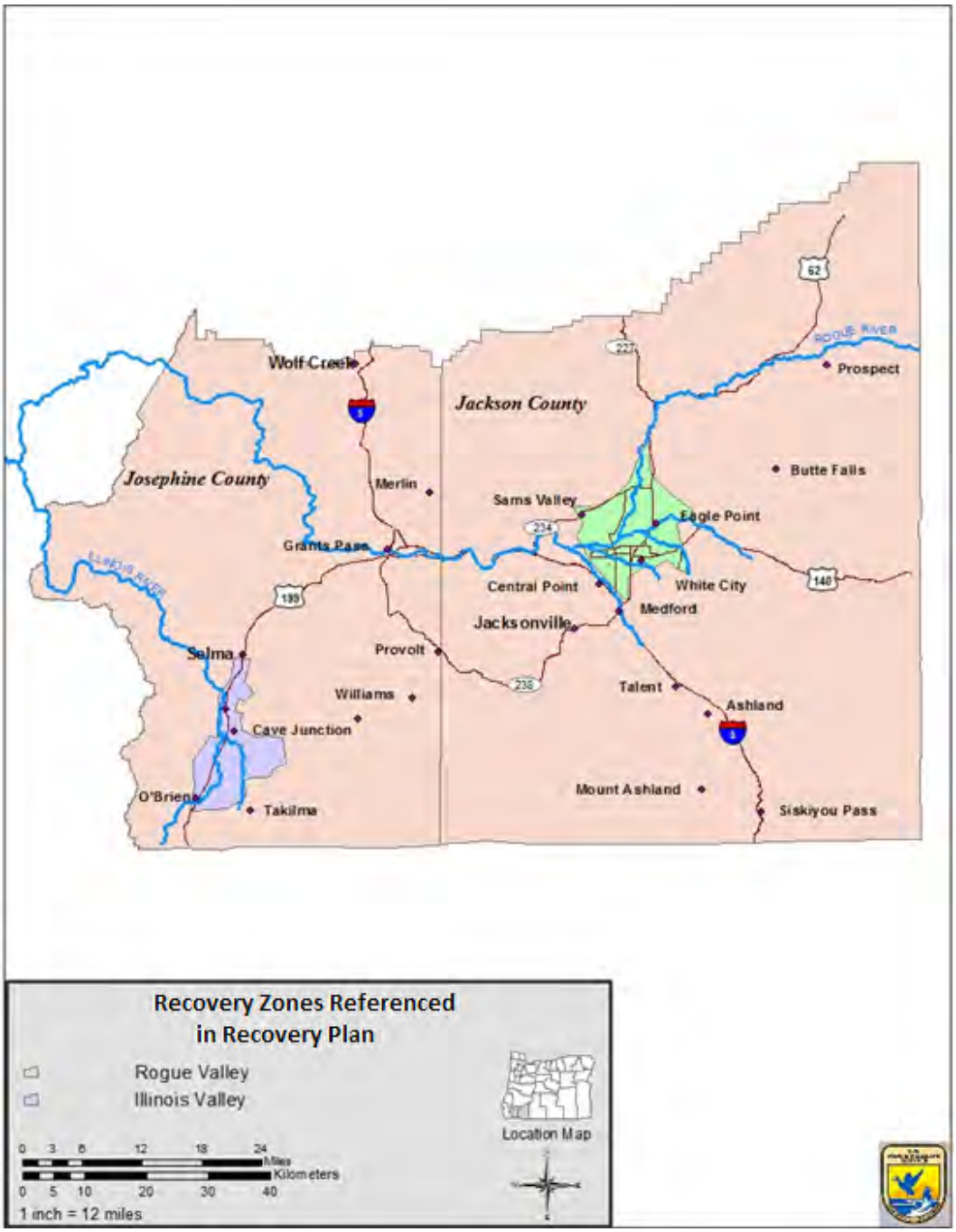

Figure I-1. Map of recovery plan area, showing the Rogue and Illinois Valleys in Jackson and Josephine Counties, Oregon.

designated for the vernal pool fairy shrimp on August 11, 2005 (U.S. Fish and Wildlife Service 2005b). The vernal pool fairy shrimp and the two listed plants occur in seasonally wet vernal pools, with *Lomatium cookii* also occurring in wet meadows in oak and pine forests, sloped mixed-conifer openings, and shrub dominated plant communities. This recovery plan provides a strategy to guide the recovery of the two federally listed plant species and aid in the recovery of the vernal pool fairy shrimp in southwest Oregon using an ecosystem approach (Table I-1).

Extant populations of *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and the vernal pool fairy shrimp occur in the vernal pool-mounded prairie complex of the Rogue Valley of Jackson County, Oregon. *Lomatium cookii* populations also occur in the Illinois Valley of Josephine County, Oregon (Figure I-1).

The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a), developed by our Sacramento Fish and Wildlife Office, presents broad recovery goals, objectives, and strategies for 20 listed species associated with vernal pool habitats in California and Oregon, including the vernal pool fairy shrimp. Recovery criteria for the vernal pool fairy shrimp are presented for 13 vernal pool regions throughout the range of the species, from the Western Riverside Vernal Pool Region in southern California to the Klamath Mountains Vernal Pool Region in southwestern Oregon. This Recovery Plan for the Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems complements the broader vernal pool ecosystems recovery plan in that it steps down and provides more detailed site-specific recovery actions specific to the vernal pool fairy shrimp within its range in the Rogue Valley of Jackson County, Oregon (corresponding to the Klamath Mountains Vernal Pool Region as described in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon).

Selected habitat areas in the Rogue Valley have been designated as critical habitat for vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora*, and *Lomatium cookii* (U.S. Fish and Wildlife Service 2003, U.S. Fish and Wildlife Service 2010). In Jackson County, a significant portion of the critical habitat units overlap for all three species; however, in Josephine County only *Lomatium cookii* critical habitat occurs.

Table I-1. Species addressed in the Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems.

Species	Status [1]	Recovery Priority [2]	Threats [3]	Federal Listing Date
***Limnanthes pumila* ssp. *grandiflora* (large-flowered woolly meadowfoam)**	E with critical habitat, SE , OR1	2C	A, B, H, I, L, M, P	11/07/02
***Lomatium cookii* (Cook's lomatium)**	E with critical habitat, SE, OR1	3C	A, B, H, I, L, M, P, S	11/07/02
Vernal pool fairy shrimp (*Branchinecta lynchi*)	T with critical habitat, OR1	2C	A, B, I, L	9/19/94
***Agrostis hendersonii* (Henderson's bentgrass)**	OR1-ex	Not Applicable	A, B, I, L, M, P	Not Applicable
***Callitriche marginata* (winged water-starwort)**	OR2	Not Applicable	A, B, I, L, P	Not Applicable
***Limnanthes pumila* ssp. *pumila* (dwarf woolly meadowfoam)**	ST, OR1	Not Applicable	A, B, I, L, P	Not Applicable
***Limnanthes gracilis* ssp. *gracilis* (slender meadowfoam)**	SC, OR1	Not Applicable	A, B, H, I, M, S	Not Applicable
***Plagiobothrys austiniae* (Austin's popcornflower)**	OR2	Not Applicable	A, B, I, L	Not Applicable
***Plagiobothrys greenei* (Green's popcornflower)**	OR2	Not Applicable	A, B, I, L	Not Applicable
Dumontia oregonensis	Newly discovered	Not Applicable	A, B, I, L, P	Not Applicable

[1] E: federally endangered. T: federally threatened. SE: State endangered. ST: State threatened. SC: State Candidate. OR1: Oregon Biodiversity Information Center List 1 – Taxa threatened with extinction or presumed extinct through their entire range. OR2: Oregon Biodiversity Information Center List 2 – Taxa threatened with extirpation or presumed extirpated within Oregon. OR1-ex: Oregon Biodiversity Information Center List 1-extirpated – Taxa on OR1 that are presumed extirpated from Oregon.
[2] Recovery Priority: See Appendix C for description of how recovery priorities are established for listed species. Only federally listed species are assigned a recovery priority number.
[3]Threats: A = Historic management, B = Habitat loss, H = Habitat vandalism, I = Invasive species, L = Livestock grazing, M = Maintenance activities, P = Small population size, S= Succession to native woody plants.

Species of conservation concern. This recovery plan addresses six plants and one aquatic invertebrate that are not federally listed but have been previous candidates for Federal listing, are currently State listed, and/or are recognized by the Oregon Biodiversity Information Center as rare (Table I-1). These species share similar habitats and ranges with the three listed species described in the scope of this recovery plan. The six nonlisted plant species are *Agrostis hendersonii* (Henderson's bentgrass), *Callitriche marginata* (winged water-starwort), *Limnanthes pumila* ssp. *pumila* (dwarf woolly meadowfoam), *Limnanthes gracilis* ssp. *gracilis* (slender meadowfoam), *Plagiobothrys austiniae* (Austin's popcornflower), and *P. greenei* (Green's popcornflower). The aquatic invertebrate *Dumontia oregonensis* is a newly described species recently identified at the Agate Desert that potentially faces the threat of habitat loss.

Efforts to recover and stabilize *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp populations and their habitat may likely directly benefit these currently unlisted but rare species, as well as other associated species of vernal pools, seasonally wet serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and shrub dominated plant communities.

B. BIOTIC COMMUNITIES REPRESENTED

The biotic ecosystems featured in this recovery plan are the vernal pool-mounded prairie complex of the middle Rogue River Valley (Rogue Valley) and the seasonally wet meadows in oak and pine forests, sloped mixed-conifer openings, and shrub-dominated plant communities of the Illinois River Valley (Illinois Valley), a tributary to the Rogue River (Figure I-1). While *Limnanthes pumila* ssp. *grandiflora* is associated only with the Rogue Valley vernal pool-mounded prairie complex, *Lomatium cookii* inhabits both the Rogue Valley vernal pool-mounded prairie complex and the Illinois Valley wet meadow habitats.

The Rogue and Illinois Valleys of southwest Oregon are part of the Klamath Mountains Ecoregion, which supports a variety of plant assemblages that are derived from the merging of larger floristic provinces and adapted to unique geologic features (Oregon Biodiversity Project 1998). Both valleys support grasslands that historically represented a small component of the

vegetation of the Klamath Mountain Ecoregion. Grasslands are now becoming rare due to accelerated urban, industrial, and agricultural conversion. Moreover, natural grassland habitat has been permanently altered due to the spread of aggressive, nonnative plants, which now dominate much of the remaining undeveloped areas in the Rogue and Illinois Valleys.

1. Rogue Valley Vernal Pool-Mounded Prairie Complex

The vernal pool-mounded prairie complex is the dominant natural landscape feature of the Rogue Valley's Agate Desert. The complex is characterized by small irregularly shaped mounds and depressions with agriculturally unproductive, Agate-Winlo complex soils, abundant agates, sparse prairie vegetation, and a relative scarcity of trees (Oregon Natural Heritage Program 1997). The Agate Desert landscape consists of gentle mound-swale topography with a characteristic appearance in aerial photographs that is sometimes referred to as patterned ground. The Agate Desert is actually an extensive Pleistocene alluvial fan terrace, where a duripan soil layer allows formation of shallow, often interconnected vernal pools (Oregon Natural Heritage Program 1999). Vernal pools host important links in the food chain for migrating waterfowl (ducks and geese), shorebirds (plovers, sandpipers), birds of prey (hawks and owls), frogs, toads, salamanders, pollinating insects, and a variety of invertebrates. Animals common to the Agate Desert vernal pool-mounded prairie complex include such species as Botta's pocket gopher (*Thomomys bottae*), black-tailed jackrabbit (*Lepus californicus*), California vole (*Microtus californicus*), creeping vole (*Microtus oregoni*), deer mouse (*Peromyscus maniculatus*), harvest mouse (*Reithrodontomys megalotis*), western meadowlark (*Sturnella neglecta*), and the Savannah sparrow (*Passerculus sandwichensis*).

Vernal pools are a unique type of wetland ecosystem characterized by seasonal ponding during the winter and early spring. They are wet long enough to be different in character and species composition from the surrounding upland habitats, yet their prolonged annual dry phase prevents the establishment of species typical of more permanent wetlands. Unique animal and plant species have become specially adapted to the unusual ephemeral conditions existing in these vernal pool habitats. Associated with vernal pools are upland prairie mounds which support plant communities that cannot tolerate extended wet conditions and animals that depend on seasonal pools for forage, temporary

shelter, spawning grounds, or water. Vernal pools are renowned for their showy displays of spring wildflowers which bloom in concentric rings around the drying pools.

Vernal pool habitat in the Agate Desert historically occupied approximately 8,000 hectares (20,000 acres) (Oregon Natural Heritage Program 1999). A study of Agate Desert vernal pool ecosystem hydrology and vegetation conducted by the Oregon Natural Heritage Program (now the Oregon Biodiversity Information Center) and funded by the Oregon Department of State Lands provided a preliminary mapping and assessment of the integrity of the topography and vegetation of the vernal pools located in the Agate Desert (Oregon Natural Heritage Program 1997, 1999). No fully intact vernal pool habitat remained, and the highest quality habitat type (hydrology/topography intact but vegetation altered) was present on approximately 17.6 percent of the original vernal pool topography in the Agate Desert (Table I-2). Vernal pool topography and hydrology had been lost on over 60 percent of the historic range of the Agate Desert landform; this alteration is attributed to residential, commercial, and industrial development, along with land leveling (primarily for agriculture). The remainder of the habitat was either severely altered by historic and continuing (permitted and unpermitted) land uses, or occurred along the fringes of the landform where vernal pools are weakly expressed (Oregon Natural Heritage Program 1999) (Table I-2) (D. Borgias, pers. comm. 2007).

Table I-2. Summary of Vernal Pool Habitat Integrity Classes in the Agate Desert (Oregon Natural Heritage Program 1999).

Topography/Hydrology	Vegetation	Acres	% of Total Acres
Intact	Intact	0.0	0.0
Intact	Altered	3,621	17.6
Intact	Severely altered	945	4.6
Weakly expressed	Altered	2,118	10.3
Altered or weak	Severely altered	1,215	5.9
Undetermined		289	1.4
Leveled		3,933	19.1
Developed		8,428	41.0
Total		20,548.0	100.0

a) Climate and Soils.

Specialized soils are necessary for the formation of vernal pools (Bauder and McMillan 1998). Vernal pools form over a layer of impervious soils where the rate of inundation exceeds the rate of evapotranspiration. Vernal pools are often found in Mediterranean climates, where winters are cool and wet and an early spring rainy season is followed by a hot, dry summer, but these climates are not necessary for their formation (Keely and Zedler 1998). In the Medford area, average high air temperatures reach 32 degrees Celsius (90.1 degrees Fahrenheit) in July, and average low air temperatures reach -1 degree Celsius (30.6 degrees Fahrenheit) in January (Western Regional Climate Center 2012).

Vernal pools form where a soil layer below or at the surface, known as a hardpan, duripan, or claypan, is partially to completely impermeable to water. Precipitation and surface runoff become trapped or "perched" above this layer. Agate-Winlo soils maintain perched water from fall and winter rains that collects in shallow depressions where downward percolation of water is prevented by the hardpan. The soil hardpan layer in the Agate-Desert developed gradually over thousands of years, and ranges from 43 to 61 centimeters (17 to 24 inches) in depth (Natural Resources Conservation Service 2007).

The average annual precipitation in the Medford area (period of record 1928 to 2005) is 48 centimeters (19 inches), primarily falling from November through March (Western Regional Climate Center 2012). Later in the spring, when rains decrease and the weather warms, the water evaporates and the pools are generally dry by May. The shallow depressions remain relatively dry until late fall and early winter when greater precipitation and cooler temperatures allow soil recharge to begin again. Claypans are formed by the transportation and accumulation of fine clay particles to the B horizon (soil formation beneath the surface soil layer) and accumulate there. The claypans may be augmented by redeposition of saline or alkaline compounds (Keely and Zedler 1998).

Vernal pools typically occur in landscapes that, on a broad scale, have a shallow slope or are nearly level, but on a fine scale may be quite bumpy. Vernal pool landscapes are dotted with numerous, rounded soil mounds, which have been attributed to burrowing and disturbance by gophers over millennia or to soil swelling and shrinkage during wetting and drying cycles (U.S. Fish and Wildlife Service 2002b, Huddleston 2001, Elliott and Sammons 1995).

b) Vegetation and Ecology.

Vegetation Associations. Seven different vegetation associations have been classified in the vernal pool-mounded prairie complex in the Agate Desert landform (Borgias 2004). These associations express the effects of varied pool depths, duration of inundation, and proximity to upland vegetation from the surrounding mounds. The upland vegetation across the range of the two listed plant species may vary significantly between locations, depending on local soil composition, past land use, local topography, and hydrology (D. Borgias, pers. comm. 2004). Although native bunchgrasses have been largely displaced by the nonnative annual *Bromus* (cheat grass) species, *Hordeum marinum* ssp. *gussoneanum* (Mediterranean barley), *Poa bulbosa* (bulbous bluegrass), *Taeniantherum caput-medusae* (medusahead), and *Vulpia myuros* (rat-tail fescue), remnant populations of native plants still exist in portions of the Rogue Valley as described below.

Spring-blooming plants common to the vernal pool mounded prairie complex include *Achyrachaena mollis* (blow wives), *Camassia quamash* (common camas), *Clarkia purpuria* (purple clarkia), *Collinsia sparsiflora* (few-flowered collinsia), *Eryngium petiolatum* (coyote thistle), *Hemizonia fitchii* (Fitch's tarweed), *Lasthenia californica* (California goldfields), *Lasthenia glaberrima* (smooth goldfields), *Myosurus minimus* (least mousetail), *Navarretia leucocephala* ssp. *leucocephala* (white-flowered navarretia), *Plagiobothrys fulvus* (fulvous popcornflower), *P. nothofulvus* (rusty popcornflower), *P. stipitatus* (stipitate popcornflower), and *Wyethia angustifolia* (mule's ears). A summer-blooming plant common to vernal pool-mounded prairie uplands is *Eremocarpus setigerus* (turkey mullein). *Navarretia leucocephala* ssp. *leucocephala* is an important component of vernal pool habitat in the Rogue Valley and in California's vernal pools. The plant is favorably adapted to withstand seasonal inundation and only occurs at pool bottoms in the Rogue Valley vernal pools. It ranges into the Willamette Valley and eastern and southeastern Oregon, growing in a variety of seasonally moist habitat types, including alkaline flats.

One characteristic adaptation of vernal pool plants to their environment is their ability to remain dormant in the soil seedbank for years or even decades. While dormant, these seeds must resist extreme heat, drought, and repeated wetting and drying, and then be able to reactivate their metabolism and life cycle

when conditions are appropriate. The cues that vernal pool plants use to emerge from dormancy are probably complex, but ultimately linked to spring rainfall and inundation time. Studies and models of other seed banks in highly variable environments suggest that dormancy is a strategy to spread offspring across many years. In this way, not all seeds are lost in a climatically unfavorable year and at least some encounter more favorable conditions in future years (Jain 1978).

Biological soil crusts. Unique soil communities, often referred to as biological soil crusts, or cryptogamic, cryptobiotic, microbiotic, or microphytic soil crusts, commonly occur within the inundated portions of vernal pools in the Rogue Valley (Belnap *et al*. 2001). These communities of highly specialized autotrophic organisms occupy open spaces between higher plants in arid and semi-arid lands throughout the world. Biological soil crust communities are a complex mosaic of cyanobacteria, green algae, lichens, mosses, microfungi, and other bacteria. In these communities, cyanobacterial and microfungal filaments weave through the top few millimeters of soil, gluing loose particles together and forming a matrix that stabilizes and protects soil surfaces from erosive forces (Friedman and Ocampu-Paus 1976, Belnap and Gardner 1993). Although these crusts commonly occur, and may constitute up to 70 percent of the living cover in some plant communities (Belnap 1994), they have only recently been recognized as having a major influence on terrestrial systems. The crust morphology can determine its ecological function relative to water infiltration, erosion, water retention, and resistance and resiliency to disturbance.

Biological soil crusts function as living mulch by retaining soil moisture and discouraging annual weed growth. Biological crusts can also reduce wind and water erosion, fix atmospheric nitrogen, and contribute to soil organic matter. All crustal species are capable of drying out and temporarily suspending respiration without negative effects, unlike vascular plants, but can become photosynthetically active again very quickly after wetting. Because they lack a waxy epidermis, crustal organisms also tend to leak nutrients into the surrounding soil upon wetting and drying (Pendleton *et al*. 2004).

On the Agate Desert, cyanobacterial, green algal, and moss seem to be the most common crust groups. Populations of *Nostoc* sp. cyanobacteria containing ultraviolet-screening pigments are commonly found directly on the Agate Desert soil surface. Liverworts and mosses have also been encountered within the plant

crust mosaic, and a variety of lichens may be present on undisturbed cobble surfaces (S. Wille, pers. comm. 2004). Non-biotic soil surface crusts are thought to potentially be an important structural component on the Agate Desert because they can reduce water infiltration and prevent the emergence of vascular plant seedlings (Belnap *et al*. 2001). Continuing research on Agate Desert cryptobiotic crusts may shed more light on vernal pool ecosystem dynamics.

c) Past Land Practices.

Historically fires are likely to have been a frequent occurrence in the Agate Desert region of the Rogue Valley, and evidence of annual lightning-caused fires in the region and on surrounding hillsides supports this view (Oregon Blue Book 2012). However, modern fire suppression policy and practice have altered the fire cycles in recent decades. The report of the United States Exploring Expedition in 1841 (Wilkes 1844) suggests that widespread grazing in southwest Oregon by black-tailed jackrabbits (*Lepus californicus*), rabbits (*Sylvilagus* sp.), deer (*Odocoileus* sp.), and pronghorn (*Antilocapra americana*), along with smaller vertebrates and invertebrates, historically created disturbance across the prairie. Borgias (2004) also suggested that elk likely used the mounded prairie in the winter as well.

Grasslands in the Agate Desert landform are most likely limited primarily by the moisture-holding capacity of the soil. Lightning- and Native American-ignited fires are assumed to have also influenced the grassland (Oregon Blue Book 2012). Early accounts of fire from the pre-settlement period to the mid-1800s document the prevalence of fire and account in part for the pattern of grassland savanna and woodland on the landscape. The Takelma Indians frequently visited the Agate Desert area and likely utilized fire to assist in hunting and gathering (LaLande 2004, Tveskov *et al*. 2002).

For the Takelma Indians, fire was utilized for maintaining healthy food sources. For example, fire was used as a tool to facilitate tarweed seed gathering, grasshopper gathering, and to assist with deer drives. With regular fire on the landscape, brush and small tree growth were maintained as an open oak savanna habitat. The use of fire by the Takelma Indians not only provided them with sustainable food resources, but also maintained a habitat for large game animals, encouraged biological diversity, minimized fuels and, subsequently, decreased the probability of catastrophic wildfires (LaLande 2004). In some instances, the

Takelma Indians used fire during warfare to scare away or hinder travel of competing tribes or to use the smoke to cover up an escape. They also used fire to burn potential enemy hiding places and to signal war activity to nearby groups (Tveskov 2002).

The present condition of vernal pool vegetation has been largely shaped by historical agricultural practices, past and current development, and both intentional and non-intentional introduction of invasive non-native plant species. In 1851, soon after gold was discovered in California, miners came into the Rogue and Illinois Valleys. Jacksonville, the first town in southern Oregon, was founded at this time. Agricultural possibilities were recognized, and permanent settlers located along the small streams of the valley, bringing with them herds of livestock. Early settlers raised common field crops, attempted dryland crops on marginal soils, and let loose herds of livestock into the surrounding grasslands, hills, and mountains for rangeland.

Undeveloped land in the Agate Desert, near what is now White City, was subdivided around 1910. A system of irrigation ditches across the landform was planned and parcels offered to agrarians and speculators for orchard tracts. The pear industry was booming, and undeveloped orchard land was selling for over $400 an acre. As irrigation began to divert water from the Rogue River and its tributaries, portions of vernal pool mounded prairie complexes within the Agate Desert area were manipulated for water impoundments, leveled for planting, and irrigated for improved pasture. On the Agate Desert landform, orchards failed on the poorly drained soils, and most of the irrigation ditches were abandoned (Elliot and Sammons 1996).

Livestock were also introduced and given free range of the area when the first settlers colonized the Rogue Valley. Sheep were very common in the unrestricted open ranges in western Oregon and in the late 19th century are thought to have supplied a considerable portion of wool to the Ashland Woolen Mills, the largest wool mill in southern Oregon operating at that time (Oregon History Project 2003). Today, cattle are the primary livestock grazed throughout the area, but sheep are still present (Oregon Blue Book 2012).

In the wake of extensive grazing throughout the region, much of the upland vegetation has become dominated by exotic grasses such as *Taeniatherum*

caput-medusae, *Bromus hordeaceus* (soft brome), *Bromus japonicus* (Japanese brome), *Poa bulbosa*, *P. myuros*, *Hordeum marinum*, *Erodium cicutarium* (filaree, crane's bill), and *Centaurea solstitialis* (yellow star-thistle), which were spread through contaminated livestock feed, on vehicles, and along roads. In a few areas, *Thinopyrum ponticum* (=*Agropyron elongatum*) ('largo' tall wheatgrass) was introduced for recreational game-bird hunting.

The Nature Conservancy evaluated the effects of cattle grazing on a variety of sites in the Agate Desert and found mixed results for indicators of prairie condition, including endangered plant population trends (Borgias 2004). Similarly, grazing studies have been conducted on vernal pool habitat in California by The Nature Conservancy (Marty 2005). Grazing affects water permeability in upland soils and also appears to create more vernal pool complexity. In California, native plant species richness appears to benefit from grazing while ungrazed vernal pool areas have demonstrated lower native plant species richness (Marty 2005). However, concerns persist that improper grazing regimes could be detrimental to the viability of the species covered in this recovery plan (Kagan 1986, Brock 1987). Overall, short-term grazing has been shown to be neutral to beneficial for the two listed plant species (Borgias 2004).

The Rogue Valley in the vicinity of Medford and White City is a rapidly developing area. Medford's population has grown from 47,021 in 1990 to 77,240 in 2009 (Oregon Blue Book 2012). White City has a population of 10,476 people, but industrial development is rapidly expanding within an Urban Containment Boundary nearly equal in size to Medford's Urban Growth Boundary (ESRI data 2012). Population growth has been greater in Medford and White City than in Jackson County as a whole, indicating that these areas are experiencing greater development pressure than rural areas in the county. Specifically, the populations of White City and the City of Medford increased at an average annual growth rate of 2.2 and 2.34 percent, respectively, between 1980 and 2005, as compared to the population of Jackson County which increased at an average annual growth rate of 1.55 percent over the same period (Industrial Economics, Inc. 2010). From 1990 to 2009, over 74 percent of Jackson County's population growth has taken place in Medford, Ashland, and Central Point (Oregon Blue Book 2012), and Medford continues to expand northward toward White City.

There is an ongoing trend in the Rogue Valley for conversion from agricultural land to housing, commercial, and industrial development. From 1982 to 2007, farmland in Jackson County decreased from 301,871 acres to 244,055 acres (U.S. Department of Agriculture 2007); a large portion of this conversion occurred in the Rogue Valley.

Residential, commercial, and industrial developments, along with land leveling, have claimed at least 77 percent of the historical range of this Agate Desert landform (Oregon Natural Heritage Program 1999). The remainder has become wholly or partially occupied by non-native invasive annual plant species such as *Centaurea solstitialis*, *Hordeum marinum* ssp. *gussoneanum*, and *Taeniantherum caput-medusae* (U.S. Fish and Wildlife Service 2002a).

2. Illinois Valley Habitats

The seasonally wet serpentine-derived grassland meadows and mixed-conifer forest openings in the Illinois Valley are underlain by patches of impermeable hardpan soils, creating pockets of differing mesic plant communities that flower and seed later in the year than the surrounding grasslands. The soils beneath these forested wet meadows, sloped mixed-conifer openings, and brushy roadside habitats are formed by alluvial wash from a variety of geologic sources. For this reason the Illinois Valley habitats lack vernal pool-mounded prairie topography. In spite of this, many unique and distinct plant associations can be found in the Illinois Valley.

a) Climate and Soils.

The climate of the Illinois Valley is characterized as Mediterranean with a pronounced cool-wet yet mild winter and spring and a hot-dry summer. The average annual precipitation at Cave Junction (period of record 1962 to 2012) is 154 centimeters (60.5 inches) (Western Regional Climate Center 2012). In response to these conditions, the vegetation responds with rapid growth in the warming weather of spring that will carry on until the arrival of hotter weather in summer. Characteristic vegetation of the valley has adapted to extended periods of drought and vulnerability to fire.

The soils of the Illinois Valley habitats are largely derived from a mixture of serpentine and non-serpentine alluvium parent material of the surrounding

hills. Typical soils occurring in the Illinois Valley include Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam. Brockman clay loam soils in the French Flat area average 60 to 90 centimeters (24 to 35 inches) in depth (Natural Resources Conservation Service 2007). Serpentine soils, derived from serpentinite, are mineral producing, dry, nutrient-poor soils toxic to plants that are not specially adapted to its unusual chemistry. High levels of magnesium in the soil block a plant's ability to take in soil nutrients, especially calcium. Because the serpentine soils are shallow and low in organic material and clay, they also cannot hold water or nutrients well.

Serpentine soils are normally acidic near the surface, but less so in deeper layers. As wind and water erode the soil, nonacidic layers are exposed, creating varied habitat for plants. Although serpentine soils underlie the Illinois Valley habitats, their distribution, depth, and degree of decomposition varies greatly throughout the valley, creating an unusual and varied distribution of plant communities and associations (Silvernail and Meinke 2008).

The Illinois Valley slopes and plains occur on floodplain bench deposits that contain sufficient clay to form a clay pan at 60 to 90 centimeters (24 to 35 inches) below the soil surface (Soil Conservation Service 1983). The claypan creates seasonally wet areas similar to the vernal pools of the Agate Desert, but often lacks the latter area's distinctive mound-swale topography. These soils are responsible for the seasonally wet patches along hill slopes and valley bottoms that may support occurrences of *Lomatium cookii*.

b) Vegetation and Ecology.

The plant community type that occupies flats and gentle slopes in the Illinois Valley was designated *Danthonia californica* (California oatgrass)-*Deschampsia cespitosa* (tufted hairgrass) grassland by Kaye and Blakely-Smith (2002). Populations of *Lomatium cookii* are also found in the Illinois Valley in grass-dominated gaps within oak woodland, especially in the Reeves Creek area. These habitats are on hillsides with upland soils and are substantially different in character than the wet sites in the Illinois Valley lowlands. These grasslands feature only a few *Pinus jeffreyi* (Jeffrey pine) and *Pinus ponderosa* (ponderosa pine) trees scattered within the dominant *Danthonia californica* and *Deschampsia cespitosa* grasslands. Moisture levels in the soils of this community-type

generally range from mesic to hydric. *Danthonia californica* tends to dominate in more mesic soils, while *Deschampsia cespitosa* is more common on hydric soils. The drier sites also host more grass species such as *Melica geyeri* (oniongrass) and *Festuca roemeri*, and are transitional to Jeffrey pine savannah. The diverse forb community includes *Achillea millefolium* (yarrow), *Aira caryophyllea* (silver hairgrass), *Calochortus uniflorus* (large-flowered tulip star), *Camassia quamash*, *Hesperochiron californica* (California hesperochiron), *Horkelia daucifolia* (carrot-leaved horkelia), *Isoetes nuttallii* (quillwort), *Microseris howellii* (Howell's microseris), *Micropus californicus* (slender cottonweed), *Prunella vulgaris* (self-heal), *Packera hesperia* (western ragwort), and *Viola hallii* (Hall's violet) (Kaye and Blakely-Smith 2002).

Fire has played a significant role in shaping the grassland habitat of the Illinois Valley. The occurrence of fire in this area is extremely variable. A 30-year average fire cycle for the mixed conifer forest type was determined by Agee (1993) from forest survey work done in the 1940s by Andrews and Cowlin.

Native American use of fire as a management tool is considered to have had a profound influence on the ecology of most of the forest land in southwest Oregon, the west coast, and the nation. In the absence of Native American burning, natural lightning fires in many forested landscapes have become less common yet more intense. Native American burning is assumed to have reduced the numbers of high intensity fires that would have been caused by lightning. As Native American-initiated burning ceased in North America during the 19th Century a rapid change took place in forest ecology: prairies became woodlands, savannas became dense forests, and open forests became choked with dense undergrowth (MacCleery 1994).

In 1939, a 40-man crew was assigned to fight fires in the Siskiyou National Forest and in the early 1940s a smokejumper base became established in Cave Junction, Oregon. Since then fire exclusion has significantly affected vegetation in the Illinois Valley by disrupting the current disturbance-dependent cycle of southwest Oregon wildland areas (U. S. Forest Service 2004). Many former grassland areas in the Illinois Valley are overgrown with such plants as *Ceanothus cuneatus* (wedge-leaf buckbrush), *Arctostaphylos viscida* (white-leaf manzanita), *Toxicodendron diversiloba* (poison oak), *Pseudotsuga menziesii* (Douglas fir), and *Rubus armeniacus* (Armenian or Himalayan blackberry). The

existing natural grassland communities of the Illinois Valley are often disjunct, highly fragmented, and marginal habitats due to agricultural development, mining, and fire exclusion.

c) Past Land Practices.

By 1880, the Illinois Valley had become home to a vigorous gold mining industry. By 1920, mining claims were still producing gold ore, and timber was becoming an established industry, but agriculture and grazing were only minor industries. In recent years, agriculture, particularly grape production, has become a prominent part of the commerce in the area, although mining and timber harvests continue to exist. Tourist attractions such as outdoor recreation, a wild animal park, and the Oregon Caves National Monument have recently begun to support the community in earnest (Cave Junction.com 2007, Oregon Blue Book 2012).

II. Species Accounts

A. *LIMNANTHES PUMILA* SSP. *GRANDIFLORA* (LARGE-FLOWERED WOOLLY MEADOWFOAM)

Overview. *Limnanthes pumila* ssp. *grandiflora* (Figure II-1) is an annual herbaceous forb that belongs to the meadowfoam family (Limnanthaceae), a family of wetland plants found primarily along the Pacific coast of North America. *Limnanthes pumila* ssp. *grandiflora* is endemic to the Rogue Valley Plains of Jackson County at elevations between 366 to 400 meters (1,200 to 1,310 feet), within an 8,300-hectare (20,510-acre) landform within the Agate Desert, in the vicinity of Eagle Point and White City, Oregon (Figure II-2). The plant has never been documented outside of this range (Oregon Natural Heritage Information Center 2008). The plants grow 5 to 15 centimeters (2 to 6 inches) tall, and have 1- to 5-centimeter (0.4- to 2-inch) leaves divided into five to nine segments. The leaves, stems, and lower sepals (flower segments below the petals) are sparsely covered with short, white, fuzzy hairs.

In his monograph of the genus *Limnanthes*, Mason (1952) described three varieties of *Limnanthes floccosa*, but did not recognize ssp. *grandiflora* as distinct. Arroyo (1973) elevated Mason's varieties to subspecies based on her study of specimens grown under controlled conditions from field-collected seed and described two additional subspecies, *californica* and *grandiflora*. A genetic study conducted at Oregon State University focused on inbreeding systematics and gene flow within previously named *Limnanthes floccosa* subspecies (Meyers 2010, Chambers and Meyers 2011). This research used hybridization trials and molecular data to evaluate genetic relationships of the various *Limnanthes* subspecies in the Rogue Valley. They determined that ssp. *grandiflora* is reproductively isolated from *L. floccosa* ssp. *floccosa* and is more closely aligned with ssp. *pumila*, and therefore proposed transferring ssp. *grandiflora* from *L. floccosa* to *L. pumila* under the more accurate scientific name *Limnanthes pumila* ssp. *grandiflora* (Meyers 2010; Chambers and Meyers 2011), which we adopt in this recovery plan.

Limnanthes pumila ssp. *grandiflora* (=*Limnanthes floccosa* ssp. *grandiflora*) was listed as an endangered species on November 7, 2002 (U.S. Fish and Wildlife Service 2002a), under the authority of the Endangered Species Act

a.

b.

Figure II-1. ***Limnanthes pumila* ssp. *grandiflora***
a) Growth form (Photograph by Jeff Dillon, USFWS)
b) Close-up of flower (Photograph by Sam Friedman, USFWS).

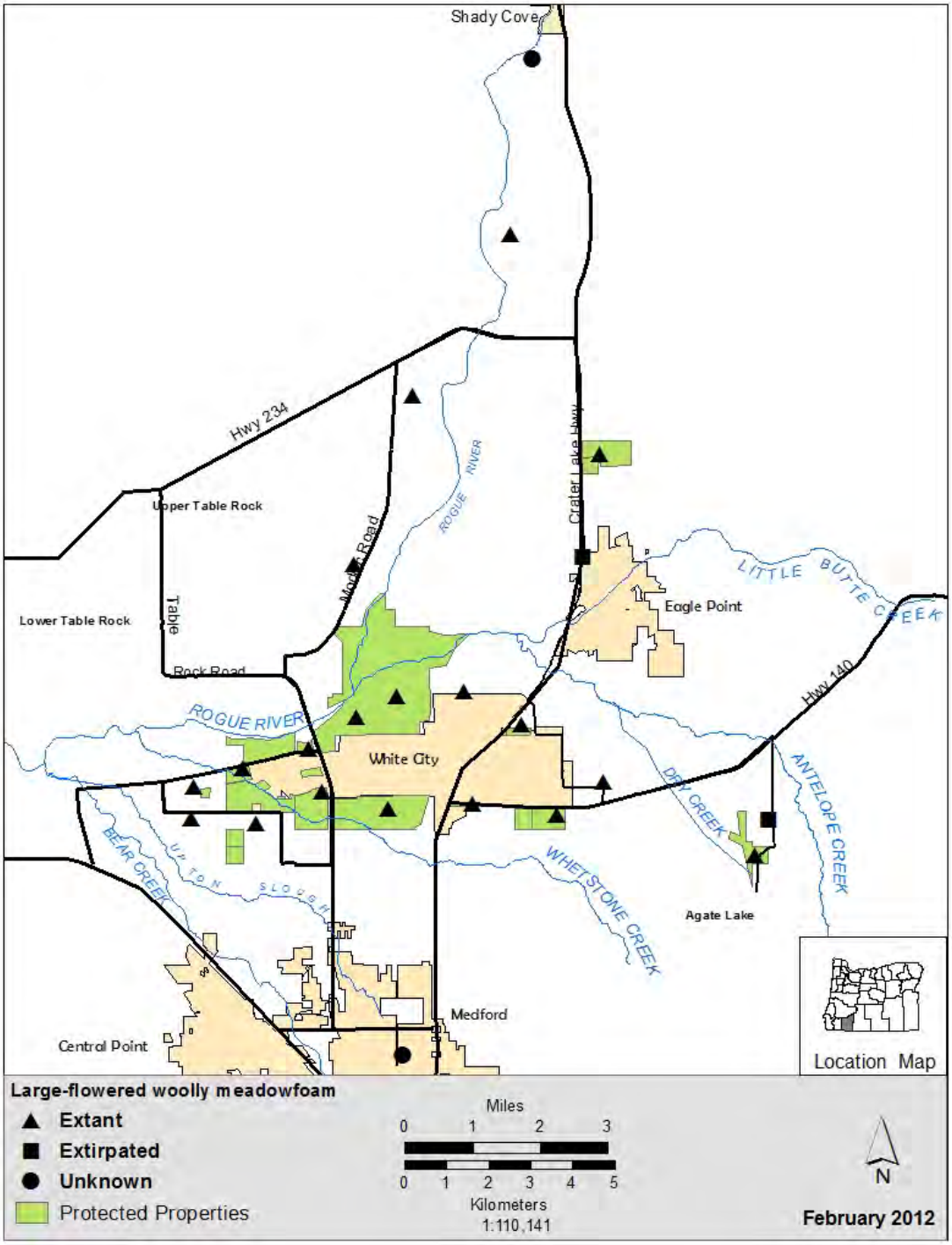

Figure II-2. Occurrences of *Limnanthes pumila* ssp. *grandiflora* in Jackson County, Oregon.

of 1973, as amended. Critical habitat was designated on July 21, 2010, including eight critical habitat units in Jackson County totaling 2,363 hectares (5,840 acres) (U.S. Fish and Wildlife Service 2010). The primary constituent elements for *L. pumila* ssp. *grandiflora* critical habitat include vernal pool habitat, the dominant native plant association of this habitat, and intact hydrology and soils that provides for adequate soil moisture. Enhancement and protection of these elements will significantly contribute to the recovery of the species.

Recovery priority. *Limnanthes pumila* ssp. *grandiflora* has a recovery priority number of 3C. Recovery priority rankings, on a scale from 1C (highest) to 18 (lowest), are determined in accordance with our guidelines for assigning recovery priorities (Appendix C, U.S. Fish and Wildlife Service 1983). This ranking is based upon a high degree of threat, a high potential for recovery, and a taxonomic classification as a subspecies for *Limnanthes pumila* ssp. *grandiflora*. The "C" indicates the potential for conflict between the species and construction, development, or other economic activities.

1. Distribution

Limnanthes pumila ssp. *grandiflora* occupies a limited portion of the Rogue Valley. The plant typically occurs in areas mapped with Agate-Winlo soils. There are no significant ecological, genetic, or geographic barriers separating the 21 extant and historical *L. pumila* ssp. *grandiflora* occurrences, apart from agricultural and rural development and road systems. All known populations of *L. pumila* ssp. *grandiflora* comprise approximately 177 hectares (440 acres), and are grouped into nine core areas that are separated by at least 1 kilometer (0.7 miles). Core areas are described below in section IV.B and correspond to designated critical habitat units. The Rogue Plains, Shady Cove, Hammel Road, Table Rock Terrace, and North Eagle Point core areas have one occurrence each. The status of *L. pumila* ssp. *grandiflora* occurrences at Shady Cove has not been revisited since it was first observed in the 1980s. An additional population was recorded near Eagle Point in 1927, but the approximate site location has been developed and suitable vernal pool habitat in the approximate area does not appear to be present. In the south Rogue Valley, eight populations of *L. pumila* ssp. *grandiflora* occur in the central White City core area, four populations occur at the Whetstone Creek core area, and the Rogue

Valley Airport and Agate Lake core areas include one population each (Figure II-2).

The species has been historically documented from 7 occurrences in the north Rogue Valley and 14 occurrences in the south Rogue Valley in populations ranging from approximately under 100 to 100,000 (Oregon Natural Heritage Information Center 2008). Only 18 *L. pumila* ssp. *grandiflora* occurrences have been observed in the last 5 years. Three occurrences have not been confirmed after range-wide surveys were completed in 2008, and the Eagle Point and Dry Creek populations are considered to be extirpated.

In the Agate Desert, the 18 extant *Limnanthes pumila* ssp. *grandiflora* occurrences are found on private, State, and federally owned lands (Table II-1). The following estimates represent data provided by the Oregon Natural Heritage Information Center (2008) and U.S. Fish and Wildlife Service records.
One *L. pumila* ssp. *grandiflora* occurrence, occupying 6.7 hectares (33 acres) occurs on Federal land managed by the Bureau of Reclamation. Five known *L. pumila* ssp. *grandiflora* occurrences, occupying 67 hectares (166 acres), occur on State lands managed by the Oregon Department of Fish and Wildlife and the Oregon Department of Transportation (Table II-1).

Table II-1. Distribution of extant *Limnanthes pumila* ssp. *grandiflora* across land ownership in the Rogue Valley, Jackson County.

	Federal	State	County	Municipal	Private	Total
Occurrences	1	5 (3 shared with private)	3 (1 shared with city and private)	2 (shared with private)	7 (2 shared with county, city and state)	18
Acres	33	166	11	10	253	473
Hectares	13	67	4	4	102	190
Percentage	7	35	2	2	54	100

Throughout its range, *Limnanthes pumila* ssp. *grandiflora* occurrences occupy 102 hectares (253 acres) of privately owned lands. Within the privately owned parcels, three populations of *L. pumila* ssp. *grandiflora*, occupying a total of 38 hectares (95 acres), occur on two preserves owned by The Nature Conservancy and one parcel with a conservation easement managed by The Nature Conservancy. The suitable habitat on this land comprises 197 acres on The Nature Conservancy preserves (designated as critical habitat units R6 and R8) and an additional 150 acres under the conservation easement (RV4) (Table II-2). The two preserves and the conservation easement contain the only large populations on private land specifically managed for the protection of these endangered plants. Several populations of *L. pumila* ssp. *grandiflora* overlap State, county, municipally, and privately owned lands.

2. Population Status

Limnanthes pumila ssp. *grandiflora* numbers fluctuate annually depending on the seasonal precipitation and temperature; therefore the species population estimate will vary from year to year as well. In grazed prairies, sudden increases or declines in population density may be linked to the intensity, seasonality, and duration of grazing. In general, numbers of annual plants, such as *L. pumila* ssp. g*randiflora*, tend to fluctuate more widely than those of perennial plants, such as *Lomatium cookii*. For example, in the year 2000, a wet spring, The Nature Conservancy counted 68,111 *L. pumila* ssp. g*randiflora* plants on their preserves. In 2001, a dry spring, population numbers had declined to 39,031. In 2002, rainfall was still below normal but the population increased to 63,752 plants (D. Borgias, pers. comm. 2003). A more recent census in 2008 counted 64,268 *L. pumila* ssp. *grandiflora* plants at the Agate Desert Preserve, indicating that population numbers fluctuate but are fairly stable (M. Morison, pers. comm. 2012). Year-to-year changes of this magnitude may be within the normal range of variation for this annual plant. However, a population on City of Medford administered land contained some 10,000 *L. pumila* ssp. *grandiflora* individuals in the year 2000, while only 112 individuals were noted at this site in 2001 (D. Borgias, pers. comm. 2001). As of 2008, the population had decreased to 55 plants (Meyers 2008). The reason for the decrease of plants on City of Medford property is not known, but may be attributed to high stocking rates of cattle and improperly timed grazing. Grazing occurs on other areas within the Agate Desert without documented decreases of *L. pumila* ssp. *grandiflora*.

In general, if a patch of habitat occupied by *L. pumila* ssp. *grandiflora* is reasonably protected from degradation or fragmentation, pollinators are present,

Table II-2. Habitat acreage by critical habitat unit and ownership, providing habitat protection for *Limnanthes pumila* ssp. *grandiflora*.

Land Parcel	Critical Habitat Unit Number*	Ownership	Acres Of Critical Habitat
Wildlands Bank	RV3	Wildlands, Inc.	100
Parson's Easement	RV3	Private	40
Rogue River Plains Preserve	RV4	Private conservation easement held by The Nature Conservancy	150
Agate Reservoir	RV7	Bureau of Reclamation	154
Highway 140 SMA	RV6	Oregon Department of Transportation	20
Jackson County School District #9	RV6	Jackson County School District #9	25
Hornecker	RV6	Private	5
ODOT Dutton road mitigation area	RV6	Oregon Department of Transportation	4
Agate Desert Preserve	RV6	The Nature Conservancy	53
Denman Wildlife Area[1]	RV6	Oregon Department of Fish & Wildlife	720
Whetstone Preserve	RV8	The Nature Conservancy	144
ODOT Conservation Bank	RV8	Oregon Department of Transportation	80
City of Medford	RV6	City of Medford	3
Bear Creek Valley Sanitary Authority	RV8	City of Medford	5
Total			1,503

[1]. This Area is composed of the Military Slough Tract (1,178 acres) and the Hall Tract (620 acres). A 12-acre wetland mitigation site is also located within the Military Slough Tract for impacts associated with the filling of 3 acres of wetlands at the Medford Airport. A 19-acre wetland mitigation site on the Hall tract was completed in 2009 (K. Perchemlides, pers. comm. 2009).

* See also critical habitat maps as designated in USFWS (2010). RV indicates critical habitat units within Rogue Valley.

and the seed source is protected and allowed to disperse, then we expect that the population should be able to persist, with moderate annual fluctuations related to climatic conditions.

3. Habitat Description

Limnanthes pumila ssp. *grandiflora* is typically associated with vernal pools. According to Arroyo (1973), the plant occurs generally near the wetter, inner edges of pools, as opposed to the drier outer fringes, which harbor the slightly more common *L. floccosa* ssp. *floccosa*. However, on many occasions, *L. pumila* ssp. *grandiflora* has been observed on the outside edges of vernal pools, sympatric with *L. floccosa* ssp. *floccosa*, and has even been observed in some areas on low upland mounds (S. Meyers, pers. comm. 2007). The deeper basins are dominated by *Plagiobothrys stipitatus*, *Eryngium petiolatum*, *Navarretia leucocephala* ssp. *leucocephala*, and *Myosurus minimus*. *Alopecurus saccatus* (Pacific foxtail), and *Deschampsia danthonioides* are also common plant associates. The inner vernal pool edges occupied by *L. pumila* ssp. *grandiflora* often have up to 10 to 15 percent exposed soil, due partly to gopher or vole foraging activity.

Mounded prairie habitat in the Rogue Valley is currently characterized by the presence of invasive exotic herbs and grasses. On much of the vernal pool-mounded prairie habitat in Jackson County, five exotic plant species (*Centaurea solstitialis*, *Hordeum marinum* ssp. *gussoneanum*, *Taeniatherum caput-medusae*, *Poa bulbosa*, and *Erodium cicutarium*) are often found on uplands surrounding vernal pool edges.

4. Life History

Various species in the genus *Limnanthes* have been studied extensively because meadowfoam seeds produce an oil product that is potentially valuable for many industrial and pharmaceutical uses. Research has been underway for at least three decades to identify the taxa with the most desirable features for commercial use and to cross-breed them (Pierce and Jain 1977, Brown and Jain 1979).

Limnanthes pumila is an annual plant that is self-compatible (capable of self-fertilization) and capable of autogamy (self-pollination). The structural adaptation to self-pollination is the placement of anthers above the stigmas. Self-compatibility and autogamy, along with relatively few visits from pollinators, suggest that reproduction in *L. pumila* and *L. floccosa* involve high levels of inbreeding. Arroyo (1973) however, saw evidence that *L. pumila* ssp. *grandiflora* had only modest levels of autogamy due to observations of insect activity and the presence of a larger flower size and nectar guides to facilitate pollination. Therefore presence of pollinators is likely an important requirement for the species.

Limnanthes pumila ssp. *grandiflora* typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable. Nutlets are produced in late April, and the plants begin to die back by mid-May or when the soil becomes dry (D. Borgias, pers. comm. 2004). *Limnanthes pumila* ssp. *grandiflora* flowers at approximately the same time as *L. floccosa* ssp. *floccosa*, from March to early May. The plant produces one to three flowers per peduncle (flower stalk) in April, unlike *L. floccosa* ssp. *floccosa*, which often produces more than three peduncle flowers. Each flower will produce a cluster of four to five hard nutlets by mid-May, which will quickly drop in the drying mud. Conversely, *L. floccosa* ssp. *floccosa* more often produces one to two nutlets. Nutlets of *L. pumila* ssp. *grandiflora* apparently are dispersed by water; they can remain afloat for up to 3 days; however, the nutlets of the plant are normally dispersed only short distances (Jain 1978). Thus, *L. pumila* ssp. *grandiflora* nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978). It is likely that *Limnanthes pumila* ssp. *grandiflora* has always been confined to the Rogue Valley Plains.

Limnanthes pumila ssp. *grandiflora* is associated exclusively with the margins around shallow vernal pools. Plants adapted to these ephemeral wetlands, such as *Plagiobothrys* spp., *Navarretia leucocephala* ssp. *leucocephala*, and *Downingia yina* (Cascade calicoflower) are capable of growing, flowering, and setting seed during the short time that water is available in the spring, and finish their life cycle before the dry hot summer. *Limnanthes pumila* ssp.

grandiflora requires adequate hydrology, adequate room for seed dispersal, and specific pollinators.

5. Reasons for Decline and Threats to Survival

Nearly 50 percent of *Limnanthes pumila* ssp. *grandiflora* sites have been severely altered (Meyers 2008). In 1999, a function and value assessment of vernal pool quality, abundance, and distribution determined that habitat with intact hydrology and only moderately altered vegetation accounted for just 1,457 hectares (3,600 acres) or 17.6 percent of the original landform; approximately 850 hectares (2,104 acres) of this contained well-distributed and abundant vernal pools (Oregon Natural Heritage Program 1999).

Specific threats to *Limnanthes pumila* ssp. *grandiflora* are road construction, housing, commercial, and industrial development, fragmentation, invasion of nonnative annual grasses and herbs, off-road vehicle damage, fill and contaminant dumping, herbicide spraying, and poorly managed livestock grazing (U.S. Fish and Wildlife Service 2002a). A 0.3-hectare (0.75-acre) portion of vernal pool near a *L. pumila* ssp. *grandiflora* population in the Agate Desert was contaminated by an unknown substance, eliminating all vernal pool plants in the area (D. Borgias, pers. comm. 2005, D. Hanson, pers. comm. 2005). Recreational off-road vehicle activities have impacted two *L. pumila* ssp. *grandiflora* populations in the White City area.

In addition there is a potential threat of predation by meadowfoam fly (*Scaptomyza apicalis*) larvae. The meadowfoam fly, which occurs in northern California and Southern Oregon, is the only insect pest of significance on meadowfoam. The larvae of the meadowfoam fly have been known to cause severe damage to both vegetative and reproductive tissue in *Limnanthes alba* and may be present on *L. pumila* ssp. *grandiflora* in the Agate Desert, though the fly has not been observed yet within *L. pumila* ssp. *grandiflora* populations (Ehrensing *et al*. 1990; S. Meyers, pers. comm. 2006). Heavy infestations of the fly can result in mortality in young plants or severe stunting, loss of vigor and reduced flower production in mature plants. Later in the season meadowfoam fly damage may result in destroyed stems and flower buds. A significant loss of seed in experimental plots damaged by the meadowfoam fly has been reported in

literature (Fiez *et al*. 1991 and Jolliff *et al*. 1981). Threats are described further in section III of this recovery plan.

6. Conservation Efforts

Included in *Limnanthes pumila* ssp. *grandiflora* critical habitat are approximately 603 hectares (1,503 acres) of habitat secured through conservation easements, conservation banks, and agreements (Table II-2). The Southern Oregon Land Conservancy has a conservation easement on 16 hectares (40 acres) of vernal pool habitat occupied by *Limnanthes pumila* ssp. *grandiflora*. The Nature Conservancy owns and manages three preserves in the Agate Desert area: the Agate Desert Preserve, the Whetstone Savanna Preserve, and the Rogue River Plains Preserve total 140 hectares (346 acres), of which 102 hectares (252 acres) are vernal pool habitat (D. Borgias, pers. comm. 2002). Within these preserves and conservation easements are four populations of *Limnanthes pumila* ssp. *grandiflora* totaling 20 hectares (48 acres).

Wildlands, Inc. has finalized plans for a 255-acre bank containing approximately 100 acres where there is opportunity for vernal pool conservation and restoration. This bank proposal is located adjacent to the Southern Oregon Land Conservancy conservation easement within *Limnanthes pumila* ssp. *grandiflora* Critical Habitat Unit RV3 (Table II-2).

Species and habitat surveys, wetland function and value assessments, and restoration efforts will be conducted on these land parcels as part of efforts to conserve and protect critical habitat and the associated primary constituent elements.

A 5-year programmatic section 7 consultation, finalized in 2011 and with the expressed purpose of implementing a vernal pool conservation strategy, provides Endangered Species Act coverage to the U.S. Army Corps of Engineers, other agencies, and private entities for a broad range of projects associated with vernal pool habitat in the Rogue Valley (U.S. Fish and Wildlife Service 2011a). The Conservation Strategy includes the following:

- Targets for vernal pool complex habitat protection, restoration and enhancement;

- Guidance, best management practices, and performance standards for vernal pool complex and vernal pool species restoration and management;
- Prioritized use of credits available from conservation banks, mitigation banks, or equivalent conservation or mitigation projects (in conjunction with on-site best management practices and performance standards) as the most credible method to minimize the effects and significance of unavoidable impacts to listed vernal pool species that might result from otherwise lawful development activities in vernal pool complexes;
- Thresholds, criteria, ratios, and other factors that will determine establishment of appropriate credits and credit allocation to banks or equivalent conservation or mitigation projects and appropriate and effective use of these credits to address the adverse impacts of development projects, enabling U.S. Army Corps of Engineers and/or Oregon Department of State Land-approved wetland banks and credits established consistent with the above factors to also serve as species conservation banks and credits under the Endangered Species Act;
- Streamlined regulatory review and approval of certain conservation and development activities within vernal pool complexes via use of a single suite of standards and processes by the U.S. Army Corps of Engineers, Oregon Department of State Land, and the U.S. Fish and Wildlife Service, and programmatic permitting and compliance products by each agency, including a programmatic Biological Opinion produced by U.S. Fish and Wildlife Service, and a Regional General Permit and General Permit produced by the U.S. Army Corps of Engineers and Oregon Department of State Lands, respectively; and
- Common expectations and reasonable certainty about the standards and requirements for engaging in vernal pool complex development and conservation activities for landowners, developers, habitat managers, and others.

The programmatic Biological Opinion coupled with the recovery plan is anticipated to provide long-term conservation benefits not only to *Limnanthes pumila* ssp. *grandiflora*, but also Jackson County populations of *Lomatium cookii* and vernal pool fairy shrimp, while facilitating Endangered Species Act consultation and coordination with the U.S. Fish and Wildlife Service. The

consultation will also streamline projects with the principal purposes of protecting, preserving, restoring, enhancing, or maintaining the habitat and listed species attributes of the vernal pool complex.

Limnanthes pumila ssp. *grandiflora* seed collected from several areas in the Agate Desert is currently stored at the Rae Selling Berry Seed Bank in Portland, Oregon. However, the plant is not yet a sponsored species and is not fully funded for germination trials or augmented seed collection (E. Guerrant, pers. comm. 2004, 2012).

B. *LOMATIUM COOKII* (COOK'S DESERT PARSLEY)

Overview. *Lomatium cookii* is a perennial herb in the parsley family (Apiaceae) that grows 15 to 50 centimeters (6 to 20 inches) tall with a slender, twisted taproot (Figure II-3). The base often branches at or below ground level, forming multiple stems. The leaves are glossy bluish-green, minutely inter-divided, and strictly basal (growing directly from the root crown, out of the ground, not along the stems). The pale yellow flowers are clustered into 5-centimeter (2-inch) umbels (umbrella-like formation of flower clusters). Each flowering stalk produces either primarily male or female umbels. Through one flowering season, *L. cookii* may produce up to eight male or female (sometimes both) flowering stalks. The bracts found below the umbels are thin, lance-shaped and have an entire margin. An umbel of female flowers will develop boat-shaped fruits 8 to 13 millimeters (0.3 to 0.5 inch) long with thickened margins. The flowering stalk very rarely forms leaves, unlike the closely associated *L. utriculatum* (foothills desert parsley). The single umbel bracts best distinguish *L. cookii* from *L. bradshawii* (Bradshaw's lomatium), indigenous to wet prairies from the southern Willamette Valley in Oregon to southwest Washington, and *L. humile* (alkali desert parsley), found in vernal pools in northern California (Kagan 1986). The umbel bracts can be used to distinguish *L. cookii* from the much wider, toothed, and overlapping umbel bracts of *L. utriculatum*.

L. utriculatum, a similar plant found commonly on mounds adjacent to pools in the Agate Desert, is distinguished from *L. cookii* by its more brilliant yellow flowers, the different shape of its involucel bractlets (leaf-like structures below the flowers), thin-winged fruits, and the broader leaf petiole base (Kagan 1986). *L. tracyi* (Tracy's desert parsley), occurring in California and the Illinois

a.

b **c.**

d.

Figure II-3. Photographs of *Lomatium cookii.*

a) growth form, b) bracts of fruiting umbel, c) first year seedling, and d) flowering umbel.

Photographs courtesy of (a) Sam Friedman (USFWS), (b-c) Norm Jensen (private photographer), and (d) Ken Cannon (Oregon Department of Transportation).

Valley, has a similar appearance to *L. cookii*, but *L. tracyi* has slender-margined fruits and can grow on dry sites. *Lomatium cookii* has boat- or pumpkin-shaped fruits and grows on seasonally wet sites (U.S. Fish and Wildlife Service 2002a). Recent genetic research has shown *L. cookii* to be most closely related to *L. bradshawii*. *Lomatium marginatum* and probably *L. tracyi* are likely the next closely related species (M. Gitzendanner, pers. comm. 2003).

Lomatium cookii appears to generally have different growth forms in two areas in southwest Oregon (Silvernail and Meinke 2008). The results from a nursery study suggested that growth form is a reflection of both seed and substrate, and that a unique genotype by environment interaction exists (Silvernail and Meinke 2008). *L. cookii* in the Illinois Valley is slightly more diminutive in growth form than *L. cookii* in the Rogue Valley. Growth and seed survival for *L. cookii* from the Illinois Valley also responded to differences in soil medium, with Rogue Valley soils producing the taller and more robust plants. Conversely, plants from the Rogue Valley that were grown on Illinois Valley soils were more diminutive and had poorer seedling survival (Silvernail and Meinke 2008).

Lomatium cookii was listed as an endangered species on November 7, 2002 (U.S. Fish and Wildlife Service 2002a), under the authority of the Endangered Species Act of 1973, as amended. We designated critical habitat for *L. cookii* on July 21, 2010, including three critical habitat units in Jackson County, totaling 924 hectares (2,282 acres), and 13 critical habitat units in Josephine County, totaling 1,621 hectares (4,007 acres) (U.S. Fish and Wildlife Service 2010).

The primary constituent elements for *L. cookii* critical habitat include vernal pools, seasonally wet meadows within oak and pine forests, sloped mixed-conifer openings, and shrubby plant habitats, the dominant native plant association of these habitats, and intact hydrology and soils that provides for adequate soil moisture. Enhancement and protection of these elements is critical to recovering the species.

Recovery priority. *Lomatium cookii* has a recovery priority number of 2C, based upon a high degree of threat, a high potential for recovery, and a taxonomic classification as a species (Appendix C, U.S. Fish and Wildlife Service

1983). The "C" indicates the potential for conflict between the species and construction, development, or other economic activities.

1. Distribution

Lomatium cookii was first collected in 1981 and subsequently described from vernal pools in the Agate Desert, Jackson County, Oregon (Kagan 1986). Additional populations were found at French Flat in the Illinois Valley, Josephine County, Oregon in 1988 (Oregon Natural Heritage Information Center 2008). Slight morphological differences exist between *L. cookii* populations in the Agate Desert and French Flat, but these differences are not considered significant enough to separate the species into subspecies (M. Gitzendanner, pers. comm. 2002).

The distribution of *Lomatium cookii* ranges from the Agate Desert area of the Rogue Valley in Jackson County to the Illinois Valley in Josephine County. The following estimates are based on data provided by the Oregon Natural Heritage Information Center database (Oregon Natural Heritage Information Center 2008) and U.S. Fish and Wildlife Service data. All reported population areas may or may not have been recently revised depending upon accessibility for inventory and monitoring, especially on private lands.

In the Rogue Valley of Jackson County, *Lomatium cookii* is known from six extant, six unknown, and one extirpated populations, mostly east, west and south of White City, Oregon, and in northern Medford (Table II-3, Figure II-4). The populations occur within or adjacent to vernal pool-mounded prairie habitat on Agate-Winlo mapped soils.

Lomatium cookii occupies 59 hectares (146.5 acres) in the Rogue Valley's Agate Desert (Table II-3). An estimated 1,654 hectares (4,086 acres) of potential *L. cookii* habitat is present within the area. Approximately 40 percent of the population occurs on publicly owned land and 60 percent occurs on privately owned land. In the Rogue Valley *L. cookii* has four populations on State lands, covering 6.5 hectares (15 acres). Two populations of *L. cookii* comprising 2 hectares (5 acres) occur on City of Medford land. Five populations of *L. cookii* comprising 3 hectares (7 acres) occur on Jackson County managed lands. A population of *L. cookii* comprising 5 hectares (12 acres) overlaps both county and

private land. Seven populations of *L. cookii* occur on 45 hectares (111 acres) on private lands (Oregon Natural Heritage Information Center 2008). A 7-hectare (17-acre) population of *L. cookii* occurs on the Agate Desert Preserve and a 19-hectare (47-acre) population occurs at the Whetstone Savanna Preserve, both of which are managed and owned by The Nature Conservancy (Table II-3).

In the Illinois Valley, the 24 occurrences of *Lomatium cookii* cover 12 hectares (29.5 acres) (Table II-4, Figure II-5), with an estimated 3,143 hectares (7,766 acres) of potential *L. cookii* habitat present. Occurrences range from areas north of Selma, Oregon, south to the French Flat area. Throughout the Illinois Valley range of *L. cookii*, 16 occurrences exist on Bureau of Land Management administered land, covering 6.5 hectares (16 acres). Eight of these populations occur at the French Flat Area of Critical Environmental Concern, four near Selma, and four near the Rough and Ready Botanical Area (Table II-4, Figure II-5).

Three populations of *Lomatium cookii* occur on State lands, comprising 1 hectare (2.47 acres). Two populations overlap both Bureau of Land Management and State lands comprising 1 hectare (2.47 acres). Four populations of *L. cookii* overlap both Bureau of Land Management and private lands comprising 12 hectares (30 acres) (Table II-4).

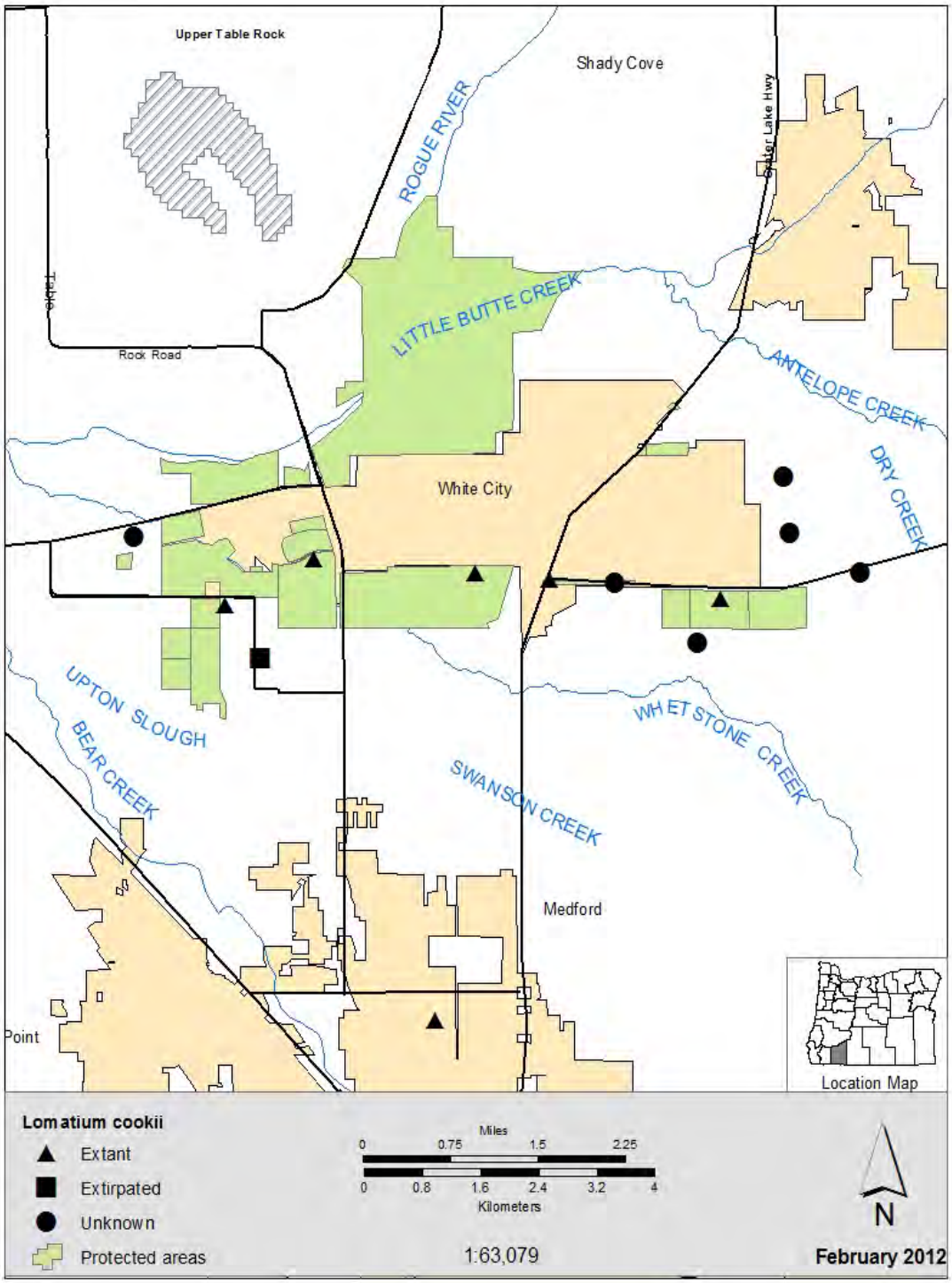

Figure II-4. Occurrences of *Lomatium cookii* in the Agate Desert, Jackson County, Oregon.

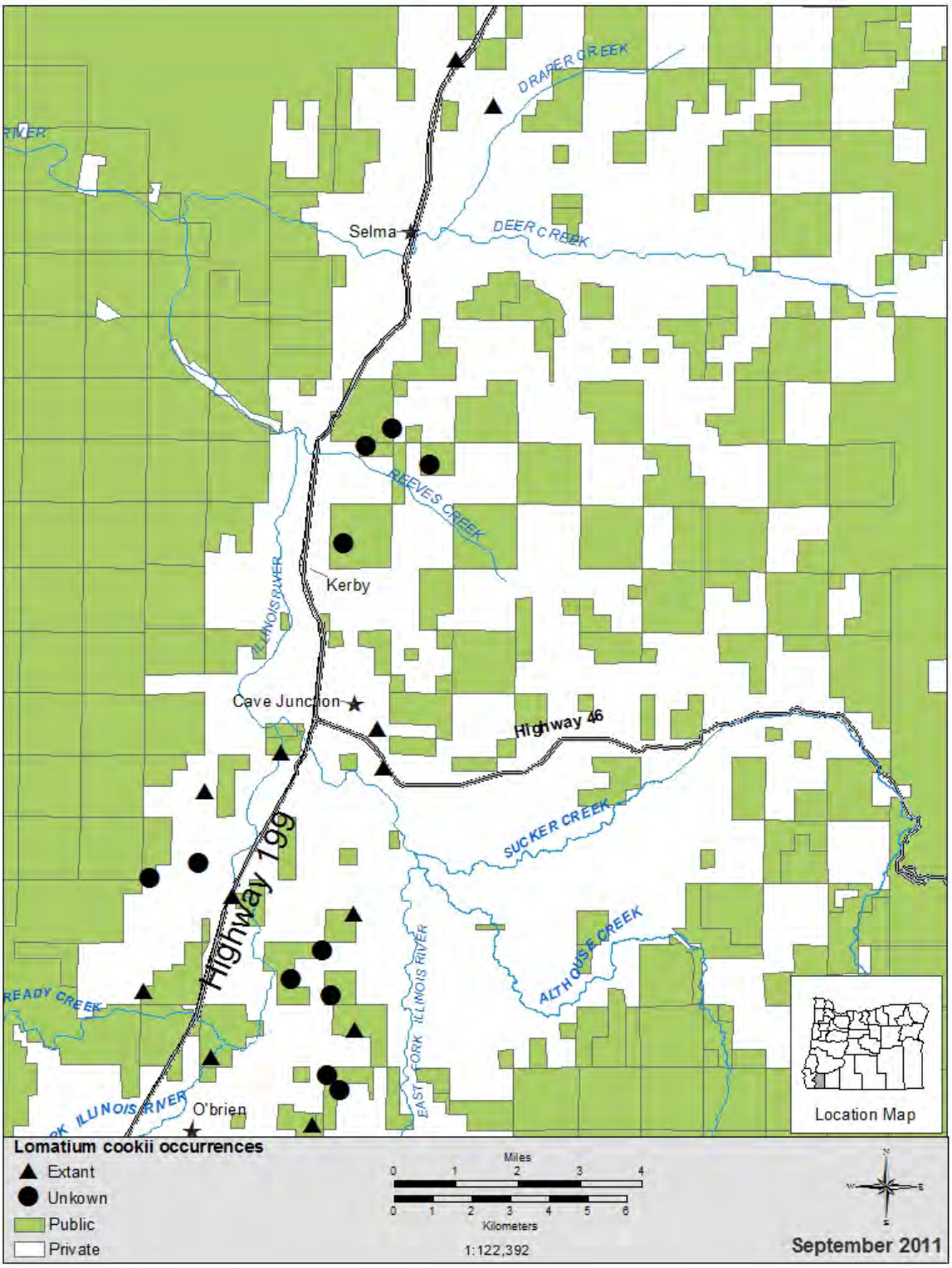

Figure II-5. Occurrences of *Lomatium cookii* in the Illinois Valley, Josephine County, Oregon.

Table II-3. Distribution of *Lomatium cookii* across land ownership in the Rogue Valley, Jackson County.

	Federal	State	County	Municipal	Private	Total
Occurrences	0	4*	4*	1*	10*	13
Acres	0	15	34	10	87.5	146.5
Hectares	0	6.5	14	4	34.5	59
Percentage	0	10	23	7	60	100

* Populations overlap with multiple land ownerships.

Table II-4. Distribution of *Lomatium cookii* across land ownership in the Illinois Valley, Josephine County.

	Federal	State	County	Municipal	Private	Total
Occurrences	16*	3*	0	0	7*	24
Acres	16	2.5	0	0	11	29.5
Hectares	6.5	1	0	0	4.5	12
Percentage	54	9	0	0	37	100

* Populations overlap with multiple land ownerships.

2. Population Status

Lomatium cookii in the Rogue Valley is known from 13 occurrences, of which 6 are extant, 6 are unknown in current status, and 1 is extirpated. Population census results at the Agate Desert Preserve between 1997 and 2007 indicate a fluctuating but gradual decline in *Lomatium cookii* numbers, ranging from a high of 5,000 in 1997 to a low of 1,800 in 2002 (M. Morison, pers. comm. 2012). The most recent *L. cookii* census, in 2011, estimated only 1,710 plants. Surveys at an Oregon Department of Transportation Special Management Area along Highway 140 have found fluctuating populations: 200 plants observed in 1992, decreasing to 26 plants in 2000 and 60 plants in 2004, and most recently increasing to 160 plants in 2009 (D. Sharp, pers. comm. 2009, 2010, 2012). On private land in central White City, a population numbering 2,000 individuals was documented in 1992 but was partially extirpated due to development (Oregon Natural Heritage Information Center 2008). Several populations on the Hall Tract of the Denman Wildlife Area decreased in size from an original estimate of 700 to 1,000 plants in 1992 to an estimate of 500 plants in 2000, but were estimated to contain 3,000 plants in 2008. During 2001, roughly 500,000 individuals were observed in a single population of *L. cookii* on private property in White City

(Oregon Natural Heritage Information Center 2008). The current estimated population size at the Rogue Valley International-Medford Airport is approximately 5,000 plants (U.S. Fish and Wildlife Service 2008).

In the Illinois Valley, *Lomatium cookii* numbers at Bureau of Land Management monitoring sites in Rough and Ready Creek and French Flat have fluctuated due to environmental conditions, but typically fall within a range of acceptable variation (Kaye 2006; T. Kaye, pers. comm. 2004). At least 5 significant *Lomatium cookii* populations, respectively numbering approximately 12,000, 92,500, 57,700, 200, and 50 plants, occur in the French Flat area. A survey along an Oregon Department of Transportation Special Management Area along Highway 46 in 2005 reported approximately 1,095 plants, which was up from the 1,035 plants observed in 2003 (K. Cannon, pers. comm. 2005).

3. Habitat Description

Lomatium cookii grows on seasonally wet soils in both the Rogue Valley and the Illinois Valley. For much of its range in the Rogue Valley, the plant occurs on upland mounds, at the bottom of vernal pools, and on flanks of vernal pools in rocky or fine-grained soils. It occurs in either strongly expressed or weakly expressed vernal pool formations. At one location it grows through roadside gravel.

In the Rogue Valley, *Lomatium cookii* occurrences are found in shallow Agate-Winlo complex soils in sparse prairie vegetation. Common plant associates include *Lupinus bicolor* (bicolor lupine), *Collinsia sparsiflora*, *Clarkia purpurea*, *Erodium cicutarium*, *Lomatium utriculatum*, *Achnatherum lemmonii* (Lemmon's needle-grass), *Poa bulbosa*, *Brodiaea elegans* (elegant brodiaea), *Madia* spp. (tarweed), *Lasthenia californica*, *Hemizonia fitchii*, and *Plagiobothrys* spp.

In the Illinois Valley, *Lomatium cookii* occurs on Abegg gravelly loam, Brockman clay loam, Copsey clay, Cornutt–Dubakel complex, Dumps, Eightlar extremely stony clay, Evans loam, Foehlin gravelly loam, Josephine gravelly loam, Kerby loam, Newberg fine sandy loam, Pearsoll–Rock outcrop complex, Pollard loam, Riverwash, Speaker–Josephine gravelly loam, Takilma cobbly loam, or Takilma Variant extremely cobbly loam. The majority of *Lomatium*

cookii occurrences in the Illinois Valley are found on Brockman clay loam, Josephine gravelly loam, and Pollard loam (USDA 2012). At several occurrences, *Lomatium cookii* emerges from roadside gravel and mine tailings (K. Cannon, pers. comm. 2004; T. Kaye, pers. comm. 2004). Brockman clay loam soils in the French Flat area average 60 to 90 centimeters (24 to 35 inches) in depth. These seasonally wet soils have the ability to block water permeability through the soil, similar to the Agate Desert vernal pools, but lack that region's distinctive mound and swale topography.

Some soils in the Illinois Valley occupied by *Lomatium cookii* are partially derived from serpentine formations that occur on surrounding slopes and hilltops. Common species in the Illinois Valley associated with *Lomatium cookii* include *Danthonia californica* (California oatgrass), *Chlorogalum pomeridianum* (soap plant), *Plagiobothrys bracteatus* (bracted popcornflower), *Hesperochiron* sp. (hesperochiron), *Horkelia californica* (California horkelia), *Calochortus uniflorus* (short-stemmed mariposa lily), and *Ceanothus cuneatus*. Two plants that may occasionally occur with *L. cookii* in the Illinois Valley are *Packera hesparia* (western ragwort) and *Microseris howellii* (Howell's microseris). Both species were recently removed from an Oregon species of concern list. New information indicates that these plant populations are stable and are not significantly threatened.

4. Life History

Lomatium cookii is an herbaceous perennial with a thickened taproot reaching up to 30 centimeters. The plant flowers from late March to May and is pollinated entirely by insects. The first umbels (grouping of flowers) produced are on shorter pedicels (umbel stalks) and composed entirely of male flowers. The second umbels produced are a combination of both male and female flowers that extend beyond the withering male umbel. Third and fourth flower sets will alternate between predominantly male and female umbels. This flowering strategy promotes plant-to-plant intercrossing by visiting insects and hinders self-crossing.

Lomatium cookii produces abundant viable seeds that will often drop within close proximity to the parent plant. A single large adult plant has occasionally been found with up to 100 seedlings growing within 30 centimeters

(12 inches) of its leaf base (M. Morison, pers. comm. 2004). As seeds are buoyant, a probable mode of seed dispersion is via surface water flow. Other possible modes of dispersal are through gopher and mole subsurface excavations, ingestion by birds, insects, and small mammals, and human-associated transportation of seeds via muddy shoes, tires, and farm equipment. A long-term *L. cookii* transition study conducted on Bureau of Land Management administered lands indicated that populations experience substantial dynamics with high rates of seedling mortality (Kaye and Cramer 2005).

Lomatium cookii appears to tolerate disturbance to some degree. *L. cookii* populations may decline when fire or grazing are excluded. At French Flat, the populations that have more competition from grasses and encroaching native shrubs have reduced germination trends. At The Nature Conservancy's Agate Desert Preserve, the *L. cookii* population is in long-term decline, possibly due to lack of seasonal grazing and the accumulation of thatch (Borgias 2004; K. Perchemlides, pers. comm. 2012). At the Rogue Valley International-Medford Airport, *L. cookii* responds very well to regular spring mowing, historic grazing, and mulching (S. Wille, pers. comm. 2002). Although plants at the airport grow to a short height, they appear to exhibit high fecundity and grow in dense clusters.

Lomatium cookii is closely related to the endangered *L. bradshawii* (Bradshaw's lomatium) of the Willamette Valley in central Oregon. Because these species share many life history parameters and needs, population models are likely to perform similarly for both. A demographic model of *L. bradshawii* based on field calculated data suggested that 2,000 flowering plants associated in a native plant community, which is managed with prescribed burning, would have a greater than 90 percent probability of survival for 100 years (U.S. Fish and Wildlife Service 1993a).

Fire has played a significant historical role in the shaping of Klamath Mountain grassland habitats. It is likely that fire plays a role in the maintenance of *Lomatium cookii* habitat. Such woody early successional shrubs as *Ceanothus cuneatus, Arctostaphylos* spp. (manzanita), and the exotic *Cytisus* spp. (broom) compete for space and sunlight with *Lomatium cookii* in the Illinois Valley. Eventually these shrubs will completely shade out populations of *L. cookii* and effectively fragment habitat or displace the plant entirely. The historical fire

cycle had most likely prevented such shrubs from colonizing the majority of the species' habitat in the past.

a) Long-term monitoring.

The Medford Bureau of Land Management has funded long-term demographic monitoring for three populations of *Lomatium cookii* in the Illinois Valley. Ten to 14 years of monitoring life-stage data were analyzed using transitional matrices. At each population (French Flat, Rough and Ready, and Indian Hill), plots were established. All individual *L. cookii* plants were mapped to their approximate location, given unique numbers, and assigned to one of six categories: seedling, vegetative with one or two leaves, vegetative with three or more leaves, reproductive with one umbel, reproductive with two umbels, and reproductive with three or more umbels. Where data were lacking, an average of transition probabilities were used from the years when these data were available. Based on multiple model iterations, the study concluded that the risk of a 50 percent decline at one sub-population over a 20-year period was 98.3 percent, with a 0.46 percent chance of 99 percent decline (Kaye and Cramer 2005). The specific stochastic factors that accounted for the reduced viability at the population were precipitation and vole herbivory. The other two *L. cookii* populations that have been monitored appear to be mostly stable or increasing.

The Nature Conservancy has monitored demographics of the *Lomatium cookii* population at the Agate Desert Preserve since 1993 using permanent plots. During these 19 years, elimination of grazing, burning, native plant seeding, and weed eradication has been employed to restore vernal pool-mounded prairie habitat. Unfortunately, *Lomatium cookii* has not shown long-term increases in plant numbers or density. In fact, for the last 19 years, the population has experienced periodic surges after prescribed burns, but overall, seems to be steadily declining (K. Perchemlides, pers. comm. 2012). The exact reason for the decline is not completely understood, but is partly owed to competing vegetation, abundance of thatch left by non-native annual grass, and perhaps lack of disturbance (K. Perchemlides, pers. comm. 2012). The Nature Conservancy will be utilizing periodic mowing and perhaps re-institute grazing to help bolster the *Lomatium cookii* population at the preserve.

5. Reasons for Decline and Threats to Survival

Specific threats to *Lomatium cookii* are off-road vehicle use, mining, road construction, logging in surrounding forests, inappropriate livestock grazing regimes, animal herbivory, woody plant encroachment due to fire exclusion, invasion of nonnative annual grasses and herbs, herbicide spraying, and mining for gold in surrounding hills (U.S. Fish and Wildlife Service 2002a). When driven in moist areas, off-road vehicle tires create large ruts and can fracture the clay hardpan layer, which allows water to drain and affects plant survival. It is estimated that off-road vehicle use had caused the drainage of 6 hectares (15 acres) at French Flat in 2000 (U.S. Fish and Wildlife Service 2002a) and by 2004 had drained an additional 4 hectares (10 acres) (M. Mousseaux, pers. comm. 2004). Threats are described in more detail below in section III of this recovery plan.

6. Conservation Efforts

a) Education and Outreach.

Efforts in the Illinois Valley community to prevent or reduce impacts to native habitat in the surrounding forests, seasonal wet meadows, and serpentine plant communities has recently become intensified and expanded by a multi-group effort. Off-road vehicle shop owners, off-road vehicle club members, U.S. Forest Service staff, local schools and educational institutions, local law enforcement, lumber mill staff, and concerned members of the community have formed a group called the Illinois Round Table and are developing a communication network in the community to discuss and solve local problems. One potential problem facing the group is the loss of native plant habitat (*i.e.*, populations of *Lomatium cookii)* and the introduction of noxious weeds that can result from unrestricted off-road vehicle use in forests and meadows. The Round Table is working to proactively stop damages caused by off-road vehicles to natural plant communities in the area. This includes speaking at public schools, engaging in outreach to off-road vehicle clubs and shop owners, and reporting license plates of vehicles to prevent unrestricted and illegal off-road vehicle use in some of these botanically rich wet meadows (C. Shohet, pers. comm. 2004).

b) Conservation.

Where *Lomatium cookii* occurs on public lands, it receives some form of protection (Table II-5). The Bureau of Land Management protects 16 populations of *Lomatium cookii* in the Illinois Valley by restricting off-road vehicle access, maintaining a long-term population inventory program, and monitoring existing populations (Tables II-4 and II-5). Additionally, the U.S. Fish and Wildlife Service signed a Conservation Agreement with the Bureau of Land Management in January 2003. The Conservation Agreement further enables protection of the species on Federal lands by cooperatively spending on fencing and staff time for monitoring and other technical assistance (Bureau of Land Management and U.S. Fish and Wildlife Service 2003). Although some trespass and damage problems still exist, the agencies are working cooperatively to address these issues.

The Oregon Department of Transportation maintains *Lomatium cookii* populations in both Jackson and Josephine Counties within three roadside Special Management Areas by limiting destructive maintenance activities during the growing season, restricting herbicide use, and performing restorative practices that benefit the plants (K. Cannon, pers. comm. 2002). The Oregon Department of Parks and Recreation is planning to enhance vegetation conditions near a *L. cookii* population at the Illinois State Park (N. Bacheller, pers. comm. 2007).

The *Lomatium cookii* population that occurs on Jackson County land at the Rogue Valley International-Medford Airport appears to be in good condition. Seasonal mowing of the airport fields during dry weather, when grasses reach 32 centimeters (14 inches) tall and protection from vehicular disturbance has benefitted *L. cookii*. At the property, the plants appear prolific, relatively densely spaced, and exhibit a high degree of germination (S. Wille, pers. comm. 2003; R. Russell, pers. comm. 2004). Although more detailed studies need to be conducted at the airport property to determine population trends and the long-term health of the population, the current management of the population appears to be successful.

Table II-5. Habitat acreage by critical habitat unit and ownership, providing habitat protection for *Lomatium cookii*.

Land Parcel	Critical Habitat Unit Number*	Ownership	Acres Of Critical Habitat
Highway 140 SMA	RV6	Oregon Department of Transportation	20
Agate Desert Preserve	RV6	The Nature Conservancy	53
Denman Wildlife Area[2]	RV6	Oregon Department of Fish & Wildlife	283
Jackson County Sports Park	RV6	Jackson County Sports Park	10
Whetstone Preserve	RV8	The Nature Conservancy	144
ODOT Conservation Bank	RV8	Oregon Department of Transportation	80
City of Medford	RV6	City of Medford	3
Bear Creek Valley Sanitary Authority	RV8	City of Medford	5
Anderson Creek	IV1	Bureau of Land Management	37
Reeves Creek North	IV3	Bureau of Land Management	277
Reeves Creek Middle	IV4	Bureau of Land Management	143
Reeves Creek South	IV5	Bureau of Land Management/State	387
Laurel Road	IV6	State	4
Illinois River Forks Park	IV7	Bureau of Land Management	94
Woodcock Mountain	IV8	Bureau of Land Management	86
Riverwash	IV9	Bureau of Land Management/State	12
French Flat North	IV10	Bureau of Land Management	24
Rough and Ready Creek	IV11	Bureau of Land Management	216
French Flat Middle	IV12	Bureau of Land Management	584
Indian Hill	IV13	Bureau of Land Management	46
Total			2,504

[2] This Area is composed of the Military Slough Tract (1,178 acres) and the Hall Tract (620 acres). A 12-acre wetland mitigation site is also located within the Military Slough Tract for impacts associated with the filling of 3 acres of wetlands at the Medford Airport. A 19-acre wetland mitigation site is also proposed for the Hall tract, with implementation scheduled for summer of 2009.

* See also critical habitat maps as designated in USFWS (2010). RV indicates critical habitat units within Rogue Valley; IV indicates those within Illinois Valley.

The Nature Conservancy has managed two populations of *Lomatium cookii* at two preserves for over 20 years. Although the two populations are protected from development and grazing was eliminated from the preserves, the populations are not very large or robust. Noxious weeds have been greatly reduced from both preserves and prescribed burning has been conducted, but the *L. cookii* population has not responded well. Mowing, grazing, and reintroduction are now being utilized to maintain or restore vernal pool-mounded prairie habitat at the Agate Desert and the Whetstone Savanna preserves in an attempt to bring the populations back to their former robust size (M. Morison, pers. comm. 2011).

Seeds from three *Lomatium cookii* populations in the Rogue Valley and two locations in Josephine County (French Flat) are stored at the Rae Selling Berry Seed Bank in Portland, Oregon (E. Guerrant, pers. comm. 2005). In 2006, the U.S. Fish and Wildlife Service funded the Oregon Department of Agriculture to develop detailed propagation and reintroduction protocols for the species.

Also as previously mentioned, the 5-year 2011 programmatic consultation, will provide facilitated conservation benefit to *Lomatium cookii* in Jackson County's Rogue Valley (U.S. Fish and Wildlife Service 2011a).

C. VERNAL POOL FAIRY SHRIMP

(*This section is, in part, adapted from the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon [U.S. Fish and Wildlife Service 2005a]).*

Overview. The vernal pool fairy shrimp is included in this recovery plan because it is sympatric with several populations of the two listed plants in the Rogue Valley. For more information regarding vernal pool fairy shrimp please refer to the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a).

The vernal pool fairy shrimp (Order Anostraca) ranges from 11 to 25 millimeters (0.4 to 1.0 inch) in length (Eng *et al.* 1990) (Figure II-6). Vernal pool fairy shrimp is distinguished from other fairy shrimp by the shape of a small mound-like feature located at the base of the male's antennae, called the pulvillus. The vernal pool fairy shrimp can also be identified by the shape of a bulge on the distal, or more distant, end of the antennae. Vernal pool fairy shrimp have paired dorsolateral thoracic protuberances on the third thoracic segment that are lacking

Figure II-6. V**ernal Pool Fairy Shrimp (male).**
(Photo courtesy of Oregon Department of Fish and Wildlife)

in the midvalley fairy shrimp (*Branchinecta mesovallensis*) (Belk and Fugate 2000). The Oregon fairy shrimp (*Eubranchipus oregoni*) is common throughout Oregon and in the Agate Desert of the Rogue Valley and is distinguished from the vernal pool fairy shrimp by a shorter secondary antenna (looking through hand lens or dissecting scope), reddish-orange eyes, a shorter midsection, and reddish-orange coloration in the tail (K. Perchemlides, pers. comm. 2011).

The vernal pool fairy shrimp (*Branchinecta lynchi*) was first described by Eng, Belk, and Eriksen (Eng *et al*. 1990). The type specimen was collected in 1982 at Souza Ranch, Contra Costa County, California.

The vernal pool fairy shrimp was federally listed as threatened in California on September 19, 1994 (U.S. Fish and Wildlife Service 1994), and was discovered in Oregon in 1998. In 2003, critical habitat was designated for vernal pool fairy shrimp and several other vernal pool species (U.S. Fish and Wildlife Service 2003). The primary constituent elements for vernal pool fairy shrimp critical habitat include the vernal pools, the surrounding uplands, shelter, and food sources. Enhancement and protection of these critical elements will significantly aid in the species recovery.

Recovery priority. The vernal pool fairy shrimp has a recovery priority number of 2C, based upon a high degree of threat, a high potential for recovery, and a taxonomic classification as a species (Appendix C, U.S. Fish and Wildlife Service 1983). The “C” indicates the potential for conflict between the species and construction, development, or other economic activities.

1. Population Status

a) Historical Distribution.

Vernal pool fairy shrimp were identified relatively recently and there is little information on the historical range of the species. However, the vernal pool fairy shrimp is currently known to occur in a wide range of vernal pool habitats in the southern and Central Valley areas of California and in vernal pool habitats within the Agate Desert area of Jackson County, Oregon. The vegetation and land use are similar to those of northern California's inland valleys (Pater *et al.* 1998).

The historical and current distribution of vernal pool fairy shrimp in the Rogue Valley can only be inferred from the loss of vernal pool habitat. Habitat loss estimates by the Oregon Natural Heritage Program (1997) suggest that the range of vernal pool fairy shrimp in Oregon has most likely declined by 75 percent from its historical extent. However, because the presence of vernal pool fairy shrimp was first documented in 1998, it is possible that additional locations for the species will be found in Oregon in the future.

b) Current Distribution.

Vernal pool fairy shrimp are currently found in 27 counties across the Central Valley and Coast Ranges of California, and in Jackson County in southern Oregon (Figure II-7). The species occupies a variety of vernal pool habitats and occurs in 12 of the 17 vernal pool regions identified in California. Although the vernal pool fairy shrimp is distributed more widely than most other fairy shrimp species, it is generally uncommon throughout its range and rarely abundant where it does occur (Eng *et al.* 1990, Eriksen and Belk 1999). In California, Helm (1998) found vernal pool fairy shrimp in only 16 percent of pools sampled across 27 counties, and Sugnet (1993) found this species in only 5 percent of 3,092 locations sampled. In Oregon, surveys conducted by The Nature Conservancy have shown a variable range in occurrence, with vernal pool fairy shrimp occurring in 50 percent of the pools sampled at the Agate Desert Preserve and 8 percent of the pools sampled at the Denman Wildlife Management Area.

The Agate Desert and nearby Table Rocks area of Jackson County, Oregon, comprises the northern extent of the range of the vernal pool fairy shrimp (Figure

II-7). In the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon, Oregon's vernal pool fairy shrimp area in the Rogue Valley was denoted as the Klamath Mountains Vernal Pool Region (U.S. Fish and Wildlife Service 2005a). In Oregon, vernal pool fairy shrimp are known from the vernal pools within the Agate-Winlo soils of the Agate Desert landform and the Randcore-Shoat soils underlain by lava bedrock on top of Upper and Lower Table Rock (Helm and Fields 1998). In California, the vernal pool fairy shrimp occurs in the Northwestern Sacramento Valley, Northeastern Sacramento Valley, Southeastern Sacramento Valley, Solano-Colusa, San Joaquin Valley, Southern Sierra Foothills, Livermore, Central Coast, Santa Rosa, Carrizo, Santa Barbara, and Western Riverside Vernal Pool Regions (see U.S. Fish and Wildlife Service [2005a] for details).

2. Habitat Description

Vernal pool fairy shrimp exist only in vernal pools or vernal pool-like habitats. Individuals have never been found in riverine, marine, or other permanent bodies of water. Vernal pool habitats form in depressions above an impervious soil layer or duripan. Due to local topography and geology, the depressions are part of an undulating landscape, where soil mounds are interspersed with basins, swales, and drainages. Water movement within complexes allows vernal pool fairy shrimp to move between individual pools. These movement patterns, as well as genetic evidence, indicate that vernal pool fairy shrimp populations exist within and are defined by entire vernal pool complexes, rather than individual vernal pools (Simovich *et al.* 1992, King *et al.* 1996).

The vernal pool fairy shrimp occupies a variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools (Eng *et al*. 1990, Helm 1998). Although the vernal pool fairy shrimp has been collected from large vernal pools, including one exceeding 10 hectares (25 acres) in area (Eriksen and Belk 1999), it tends to occur in smaller pools (Platenkamp 1998), and is most frequently found in pools measuring less than 0.02 hectare (0.05 acre) in area (Gallagher 1996, Helm 1998). The vernal pool fairy shrimp occurs at elevations from 10 meters (33 feet) to

Figure II-7. Distribution of vernal pool fairy shrimp (*Branchinecta lynchi*). (Reproduced from the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon [U.S. Fish and Wildlife Service 2005a]).

1,220 meters (4,003 feet) (Eng *et al.* 1990), although two sites in the Los Padres National Forest have been found to contain the species at an elevation of 1,700 meters (5,600 feet). The vernal pool fairy shrimp has been collected at water temperatures as low as 4.5 degrees Celsius (40 degrees Fahrenheit), however, the species has not been found in water temperatures above about 23 degrees Celsius (73 degrees Fahrenheit) (Helm 1998, Eriksen and Belk 1999). The species is typically found in pools with low to moderate amounts of salinity or total dissolved solids (Collie and Lathrop 1976, Keeley 1984, Syrdahl 1993).

Vernal pools are mostly rain fed, resulting in low nutrient levels and dramatic daily fluctuations in pH, dissolved oxygen, and carbon dioxide (Keeley and Zedler 1998). Although there are many observations of the environmental conditions where vernal pool fairy shrimp have been found, there have been no experimental studies investigating the specific habitat requirements of this species. Platenkamp (1998) found no significant differences in vernal pool fairy shrimp distribution between four different geomorphic surfaces studied at Beale Air Force Base.

In Oregon, the vernal pool fairy shrimp is found on two distinct vernal pool habitats (Helm and Fields 1998). The species occurs on alluvial fan terraces associated with Agate-Winlo soils on the Agate Desert, and in the Table Rocks area on Randcore-Shoat soils underlain by lava bedrock.

3. Community Associations

In California, the vernal pool fairy shrimp occupies the same vernal pool habitats as many of the plant species addressed in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a). In Oregon, the vernal pool fairy shrimp is found in the same vernal pool habitats as *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii*. However, vernal pool fairy shrimp do not occur in the wet meadow habitat of the Illinois Valley in Josephine County.

The vernal pool fairy shrimp has rarely been collected from the same pools as other fairy shrimp species (Eng *et al.* 1990, Maeda-Martinez *et al.* 1997, Eriksen and Belk 1999). When the species do coexist, the vernal pool fairy shrimp are often less abundant than other fairy shrimp species (Eng *et al.* 1990,

Gallagher 1996, Eriksen and Belk 1999). Given the apparently wide distribution of this species and its tolerance for a wide range of conditions, it is possible that the absence of the vernal pool fairy shrimp in certain habitats is explained by competitive exclusion by other fairy shrimp (Helm 1998, Eriksen and Belk 1999). Vernal pool tadpole shrimp (*Lepidurus packardi*), are predators of vernal pool fairy shrimp, whereas vernal pool fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus.

Vernal pool fairy shrimp are also a key prey item for waterfowl, such as ducks (Proctor and Malone 1965, Krapu 1974, Swanson 1974). In turn, waterfowl and other migratory birds are important dispersal agents for this and other vernal pool species.

4. Life History

Vernal pool fairy shrimp are uniquely adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of the vernal pool fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. Another important adaptation is that the vernal pool fairy shrimp has a relatively short life span, allowing it to hatch, mature to adulthood, and reproduce during the short time period when vernal pools contain water. The vernal pool fairy shrimp can reach sexual maturity in as few as 18 days at optimal conditions of 20 degrees Celsius (68 degrees Fahrenheit), and can complete its life cycle in as little as 9 weeks (Gallagher 1996, Helm 1998). However, maturation and reproduction rates of vernal pool crustaceans are controlled by water temperature and can vary greatly (Eriksen and Brown 1980, Helm 1998). Helm (1998) observed that vernal pool fairy shrimp did not reach maturity until 41 days at water temperatures of 15 degrees Celsius (59 degrees Fahrenheit) and observed six separate hatches of vernal pool fairy shrimp in a single pool within a single wet season.

Gallagher (1996) observed three separate hatches of vernal pool fairy shrimp in vernal pools in Butte County, California. Helm (1998) found the mean life span of the vernal pool fairy shrimp was significantly shorter than the California fairy shrimp (*Linderiella occidentalis*), but not significantly different from mid-valley (*Branchinecta mesovallensis*), longhorn (*B. longiantenna*), or Conservancy fairy shrimp (*B. conservatio*) observed under the same conditions.

In larger pools that hold water for longer durations, vernal pool fairy shrimp are capable of hatching multiple times if water temperatures drop below 10 degrees Celsius (50 degrees Fahrenheit), a necessary environmental cue for vernal pool fairy shrimp cyst hatching (Gallagher 1996, Helm 1998). Helm (1998) observed vernal pool fairy shrimp living for as long as 147 days.

5. Reasons for Decline and Threats to Survival

In Oregon, vernal pool fairy shrimp occurring on the Agate Desert are threatened by commercial and industrial development, agricultural conversion, and utility projects (Oregon Natural Heritage Program 1997, U.S. Fish and Wildlife Service 2002a). Over 40 percent of the vernal pool habitats remaining in Oregon have been degraded (Oregon Natural Heritage Program 1999).

Although habitat loss is the principal danger to vernal pool fairy shrimp, water supply conditions can be a disturbance factor that may affect a substantial portion of the populations. Introduction of water during summer can disrupt the life cycles of vernal pool crustaceans by subjecting them to greater levels of predation by animals such as bullfrogs and predatory fish that require more permanent sources of water.

Vernal pool crustaceans are very sensitive to the water chemistry of their habitats. Pools where fairy shrimp have been found have low total dissolved solids, low conductivity, low alkalinity, and low chloride concentrations (U.S. Fish and Wildlife Service 1994).

Contamination of vernal pools from adjacent areas may injure or kill vernal pool crustaceans. Certain pesticides are registered by the Environmental Protection Agency for use on rangelands and these may be sprayed directly on vernal pools. Mosquito abatement activities in the Rogue Valley mainly occur during the summer months, but do not include application of pesticides to vernal pools. The primary tools used by Jackson County Vector Control District to control mosquitos in Jackson County are a non-pesticidal, biodegradable surfactant, mosquito fish application, and a bacterial (*Bacillus thuringiensis israelensis*) product, that specifically targets mosquitos and black flies. The surfactant product produces a surface sheen to prevent mosquito larvae from

accessing the surface, degrades within a couple of hours, and contains no chemicals that harm invertebrates (Eugene Papineau, pers. comm. 2012).

Some fertilizer and pesticide compounds do not degrade in a season, resulting in long-term accumulation. Fertilizer runoff may lead to eutrophication of vernal pools, which can kill fairy shrimp by reducing the concentration of dissolved oxygen. Fairy shrimp breathe through lobes similar to gills. Fairy shrimp living in pools with a high amount of siltation may suffocate (U.S. Fish and Wildlife Service 1994, 2003).

The timing, frequency, and length of inundation of the vernal pool habitat are critical to survival of vernal pool fairy shrimp. Any substantial hydrologic change in these factors adversely affects this species (U.S. Fish and Wildlife Service 1994). Diversion (or blockage) of surface runoff feeding the pools can result in premature dry-down before the life cycle of these animals is completed. Supplemental water from outside the natural watershed into vernal pools can change the habitat into a marsh-dominated or a permanent aquatic community that is unsuitable for the vernal pool fairy shrimp.

Physical barriers such as roads and canals fragment vernal pools and can isolate a fairy shrimp population from a portion of its aquatic habitat. Surface runoff is altered by disturbance from trenching and other activities that change amounts, patterns, and direction of surface runoff to ephemeral drainages.

Human activities, such as urban development and conversion of land to agricultural use, eliminated much of the original vernal pool habitat and threaten remaining habitat (U.S. Fish and Wildlife Service 1994, Belk 1998). Vernal pool habitats that are protected on the Agate Desert by The Nature Conservancy are threatened by the indirect effects of adjacent land use, including alteration of hydrology (David Evans and Associates 2001).

Some of the vernal pool fairy shrimp populations in the Table Rocks area, managed by the Bureau of Land Management, are also threatened by recreation activities. Because the portion of Table Rocks managed by the Bureau of Land Management is designated as an Area of Critical Environmental Concern, the pools are in an area that is not available for resource extraction and closed to off-road vehicle use. The current population trend for vernal pool fairy shrimp on

Bureau of Land Management land is believed to be stable. Portions of the Upper and Lower Table Rock summits have been owned by The Nature Conservancy but are currently being donated to the Bureau of Land Management. The area is open to mineral entry; however no claims are currently active. In addition, no grazing leases are active within the areas. There is a single access road to the summit of each of the Table Rocks from adjacent private lands, and an old airplane landing strip is present on Lower Table Rock. The tops of the Table Rocks are closed to motorized vehicles, including aircraft. Threats to the vernal pools on the Table Rocks are primarily a result of recreation use: human trampling in the wet areas near pools and potential change in subsurface or surface flow runoff patterns due to trail construction and/or improvement. The Bureau of Land Management conducted preliminary vernal pool surveys of Upper and Lower Table Rock in 2005. A formal management plan has been in development and is slated for completion in 2012 (M. Wineteer, pers. comm. 2012).

6. Conservation Efforts

Conservation efforts for the vernal pool fairy shrimp are divided into the following five broad categories: regulatory and legal protections, education and outreach, research, conservation planning and habitat protection, and species specific management and monitoring. A brief description of each type of conservation action is provided below.

a) Education and Outreach.

Vernal pool regional working groups will be important for tracking the progress of recovery efforts, including monitoring the status of occurrences of this species, particularly on private lands that are not currently monitored. The Service is currently working on organizing a recovery implementation team and multiple working groups for the vernal pool fairy shrimp throughout its range (U.S. Fish and Wildlife Service 2007a). The diverse composition of these groups will enable communication to a broader public of interested parties in vernal pool conservation. In Oregon, stakeholders meet periodically, facilitated by the Rogue Valley Council of Governments, to discuss vernal pool related issues for vernal pool fairy shrimp and other species within the Agate Desert.

b) Conservation.

The vernal pool fairy shrimp is protected as a threatened species under the Endangered Species Act. The International Union for the Conservation of Nature and Natural Resources listed the vernal pool fairy shrimp as vulnerable in the 2007 Red List of Threatened Species (http://www.redlist.org/).

Created by The Nature Conservancy in 1974, the Oregon Natural Heritage Program (now the Oregon Biodiversity Information Center) was incorporated into the State of Oregon in 1979 with the passage of the Natural Heritage Act (ORS 273.563-273.591). The program was managed cooperatively, first by the Nature Conservancy and then by Oregon State University, for the Oregon Department of State Lands. With the passage of the Natural Heritage Act and the Oregon Endangered Species Act of 1987, the Oregon Natural Heritage Advisory Council of the Department of State Lands became the State agency responsible for rare and endangered invertebrates in Oregon. The Oregon Biodiversity Information Center provides staff to manage this program, and as such, the U.S. Fish and Wildlife Service has granted the program limited authority to administer and manage a program for federally threatened and endangered invertebrate species, as provided under section 6 of the Endangered Species Act (Oregon Biodiversity Information Center 2012). The Oregon Natural Heritage Advisory Council and Biodiversity Information Center have three objectives for the rare and endangered invertebrate program:

1) To gather as much information as possible on those invertebrates currently considered rare, threatened or endangered in order to enable managers to protect critical habitat or populations;

2) To promote inventory and taxonomic work on undescribed or poorly known species that may face significant threats; and

3) To assist in the U.S. Fish and Wildlife Service recovery efforts for the three invertebrates already protected under the Endangered Species Act. This includes coordination, inventory, management, and research projects for the Oregon silverspot butterfly (*Speyeria zerene hippolyta*), the Fender's blue butterfly (*Icaricia icarioides fenderi*), and the vernal pool fairy shrimp.

c) Research.

Vernal pool habitats have been the focus of much research, and scientific interest in this unique habitat type has continued to grow (U.S. Fish and Wildlife Service 2005a). Research programs that would be valuable for recovery of vernal pool fairy shrimp include study of genetics, dispersal mechanisms, environmental tolerances, preserve design, and habitat management methods.

d) Conservation Planning and Habitat Protection.

The Service published the Final Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon in 2005 (U.S. Fish and Wildlife Service 2005a). The recovery plan set out specific goals, objectives, and tasks to direct recovery efforts for vernal pool fairy shrimp. The Jackson County vernal pool area, known as the Klamath Mountains Vernal Pool Region, was divided into three core areas (Agate Desert, White City, and Table Rocks) (U.S. Fish and Wildlife Service 2005a). The priority level of the core areas within this vernal pool region was classified as Zone 2 because vernal pool fairy shrimp are relatively widely distributed, rather as Zone 1 which indicates core areas occupied by narrowly endemic listed species. Recovery recommendations within Zone 2 are considered more flexible than Zone 1 and recovery criteria specific to Zone 2 core areas may be modified on a case-by-case basis as information becomes available.

Throughout the species' range in Oregon, approximately 944 hectares (2,333 acres) of vernal pool habitats, including mitigation banks, and sites in government and land trust ownership, have been specifically set aside for the vernal pool fairy shrimp as terms and conditions of U.S. Fish and Wildlife Biological Opinions (Table II-6). These acres represent important building blocks toward recovery of the species.

In May 2009, The Nature Conservancy announced the purchase of 692 hectares (1,710 acres) on and adjacent to Table Rocks. This large acquisition includes approximately 186 hectares (460 acres) of vernal pool habitat on Upper and Lower Table Rock. All of this vernal pool habitat was included within Critical Habitat Unit number 4. This acquisition has resulted in the protection of the entire area of Critical Habitat Unit number 4 (361 hectares [892 acres]). The U.S. Fish and Wildlife Service acknowledges The Nature Conservancy as an entity that primarily protects environmentally sensitive or unique lands and

Table II-6. **Amount of vernal pool fairy shrimp habitat receiving protective measures, by critical habitat unit (CHU) and type of protective measure.**

Unit	Acres Protected	Type of Protection
CHU 1	200	• 100 acres in a Nature Conservancy conservation easement • 100 acres in the Wildlands Conservation Bank (No credits have been sold yet, but area is now protected)
CHU 2	196	• 34 acres protected as compensatory mitigation under section 404 of the Clean Water Act • 154 acres managed by Bureau of Reclamation • 8 acres managed by Oregon Dept. of Transportation
CHU 3	1,005	• 197 acres owned by The Nature Conservancy • 720 acres managed by Oregon Dept. of Fish and Wildlife with final management plan • 8 acres protected as compensatory mitigation under section 404 of the Clean Water Act • 80 acres in an Oregon Dept. of Transporation bank (Three credits have been utilized to date, compensating for non-vernal pool impacts outside the Rogue Valley)*
CHU 4	892	• 432 acres managed by Bureau of Land Management, management plan being implemented • 460 acres purchased by The Nature Conservancy. To be transferred to Bureau of Land Management
Total	2,333	

*Net gains are anticipated to increase due to several conservation mitigation banks coming on line in the near future. Vernal pool losses are anticipated but gains will occur due to the banks.

provides conservation easements on lands which they manage (See Table II-6). The Bureau of Land Management is anticipated to receive the Upper and Lower Table Rock properties from The Nature Conservancy in the near future (M. Wineteer, pers. comm. 2012).

Vernal pool habitats supporting populations of vernal pool fairy shrimp have been protected through a variety of other means. In Oregon, vernal pool fairy shrimp populations are protected on The Nature Conservancy's Agate Desert and Whetstone Savanna preserves, containing approximately 80 hectares (197 acres) of vernal pool habitats. Habitat is also protected from development on property administered by the Bureau of Land Management (129 hectares [320 acres] of vernal pool habitat) and the Bureau of Reclamation (62 hectares [154

acres] of vernal pool habitat). The Bureau of Land Management is developing a management plan for Upper and Lower Table Rock (M. Wineteer, pers. comm. 2012).

We are working with the following agencies to conserve vernal pool habitat:

- the Bureau of Land Management, to implement a management plan to restore and preserve 175 hectares (432 acres) of Bureau-owned vernal pool habitat (as well as 186 hectares [460 acres] currently being transferred from The Nature Conservancy to Bureau ownership) on top of the Table Rocks;
- the Bureau of Reclamation, to implement a management plan for 62 hectares (154 acres) of vernal pool habitat near Agate Reservoir;
- the Oregon Department of Transportation, to implement a management plan for a 3-hectare (8-acre) special management area along Highway 140 and a long-term management plan for a 32-hectare (80-acre) conservation bank adjacent to The Nature Conservancy's Whetstone Savannah Preserve; and
- the Oregon Department of Fish and Wildlife, to implement a management plan for the 291 hectares (720 acres) of vernal pool habitat within the Denman Wildlife Area.

Also as previously mentioned, the 5-year 2011 programmatic section 7 consultation will provide facilitated conservation benefit to vernal pool fairy shrimp in the Rogue Valley by providing Endangered Species Act coverage for parties working on vernal pool related projects and especially projects with the specific intent to protect, preserve, restore, enhance, or maintain the habitat and listed species associated with vernal pool habitats (U.S. Fish and Wildlife Service 2011a).

D. ASSOCIATED SPECIES OF CONSERVATION CONCERN

Several other species of conservation concern (Table I-1) share seasonally wet habitats occupied by *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and the vernal pool fairy shrimp. *Agrostis hendersonii*, *Limnanthes pumila* ssp. *pumila*, *Plagiobothrys austiniae*, and *P. greenei* are nonlisted species that are of special conservation interest to the U.S. Fish and Wildlife Service because they occur within vernal pool habitat in the vicinity of the Agate Desert and have a global or state elevated imperiled or rarity status (Table I-1). *Dumontia oregonensis* is a newly described arthropod species that is of elevated conservation interest due to its taxonomic distinctness and apparently endemic occurrence in vernal pools. *Limnanthes gracilis* ssp. *gracilis* is a plant species of concern that co-occurs with *Lomatium cookii* in the seasonally wet meadows of the Illinois Valley.

1. *Agrostis hendersonii* (Henderson's bentgrass)

This species was previously a Category 2 candidate for Federal listing (U.S. Fish and Wildlife Service 1993b). The Oregon Biodiversity Information Center has identified *Agrostis hendersonii* as a List 1 taxon (threatened with extinction or presumed extinct throughout its range), and it is considered extirpated (locally extinct) from Oregon (Oregon Biodiversity Information Center 2010). In California, the taxon has been assigned a Rare Plant Rank of 3.2 (Fairly threatened in California: 20-80% occurrences threatened / moderate degree and immediacy of threat, but taxonomically problematic or lacking necessary information to assign species to one of the other ranks) (California Native Plant Society 2012).

a) Taxonomy and Description.

Agrostis hendersonii (*Agrostis microphylla* var. *hendersonii*) was first collected in Sam's Valley near Gold Hill, Jackson County in 1930 (Hitchcock 1930). In 1945, Alan Beetle treated the taxon as a variety of *Agrostis microphylla* var. *hendersonii* (Beetle 1945) due to its similarity to *A. microphylla* and *A. microphylla* var. *intermedia*. Most recently, Harvey (1993) has treated the taxon as a full species, *Agrostis hendersonii* (Harvey 1993).

Agrostis hendersonii is a small annual grass in the family Poaceae. It is tufted, forms several slender culms between 6 to 70 centimeters (3 to 40 inches) tall, and has flat, smooth leaf blades to 4 centimeters (1.6 inches) long. The plant forms spikelets that are purplish tinged, but become straw-colored with age. A 1-centimeter (0.4-inch), reddish awn (terminal hair) rises from the middle of the lemmas (outer flower bracts) (Figure II-8).

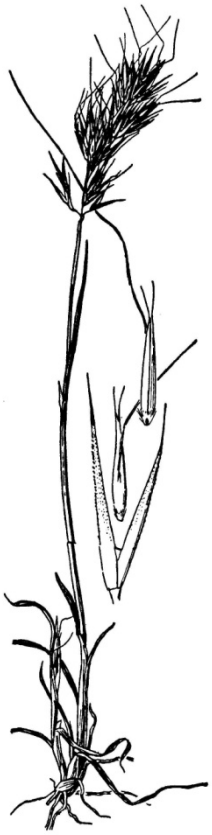

Figure II-8. **Illustration of *Agrostis hendersonii* (Henderson's bentgrass). Reprinted from Hitchcock (1971).**

b) Distribution and Population Status.

Agrostis hendersonii was only collected once in the Sam's Valley area of the Agate Desert in 1930, and its former or current distribution within Oregon, anticipated to be very limited, is unknown. In California, the species has a relatively broader distribution, being known from vernal pools of California's Cascade Range, Sierra Nevada Foothills, and Sacramento and San Joaquin Valleys in the Central Valley.

c) Life History and Habitat Description.

Agrostis hendersonii is an annual grass that inhabits damp sites near vernal pool margins at elevations less than 425 meters (1,400 feet).

d) Reasons for Decline and Threats to Survival.

Threats to *Agrostis hendersonii* are mainly loss or degradation of habitat by activities such as grazing, agricultural production, displacement by un-managed native and non-native vegetation (especially the aggressive non-native grasses), and loss of hydrology. These threats are likely to have caused its apparent disappearance in Oregon for the last 80 years. The plant lacks formal research on the specific habitat requirements for its continued viability.

e) Conservation Efforts.

Agrostis hendersonii does not receive protection from either Federal or State law. No conservation efforts have yet been initiated for *A. hendersonii* in Oregon. Botanical surveys conducted in the Rogue Valley vernal pools should attempt to re-discover this rare grass in Oregon. Prior to considering re-introduction of this species to Oregon, a survey for the plant in earnest should be conducted in the proposed re-introduction areas.

f) Conservation Actions for Rediscovered Plants.

In the event of rediscovery of *Agrostis hendersonii* in Oregon, both immediate and long-term actions will be needed. Including these actions in this recovery plan is intended to increase the potential for participation by both State and Federal agencies in conservation efforts and for funding to carry out needed actions. Three actions–status review, plant stabilization, and protection of plants and habitat–would be needed concurrently.

First, a status review of existing records should be conducted to determine if remnant populations occur. When possible, this review should be followed by surveying appropriate habitat types or historic sighting locations in the Rogue Valley. If no plants are located after the review and survey, but potential habitat is identified, a reintroduction plan for this species may be considered.

Second, if plants are located in the Rogue Valley, stabilizing plant populations and alleviating threats to short-term survival should be conducted as

resources allow. Such stabilization efforts may include controlling invasive nonnative or native vegetation, erosion, destructive rodents and/or insects, and providing insurance for the population by collecting and storing seed (if such collection would not further imperil the population's survival).

Third, securing and protecting the habitat and the existing plants, if any, would be essential. If the plant is rediscovered on public lands, it would be important to work with the land manager to develop a site-specific management plan that would include yearly monitoring measures to minimize any threats. If the plant is rediscovered on private lands, the willingness of the land owner to participate in recovery efforts would need to be assessed and encouraged. If the landowner (and land manager or lessee) were amenable, an agreement could be developed to formalize plant protection. This agreement could be temporary or long-term, depending on the willingness of the landowner and the needs of the species.

Long-term management options could include reintroduction to historical sites, propagation in greenhouses and/or botanical gardens, and seed collection and storage. Other necessary actions would include the alleviation of threats, securing sites, maintaining or enhancing abundance, developing and implementing a monitoring plan, conducting essential research (*e.g.*, demography, genetics, reproductive biology, and propagation techniques), and coordinating efforts with conservation and recovery actions for other species covered in this recovery plan or throughout the recovery plan area.

2. *Callitriche marginata* (winged water-starwort)

The Oregon Biodiversity Information Center has identified *Callitriche marginata* as a List 2 taxon (taxa that are threatened with extirpation or presumed to be extirpated from the state of Oregon; List 2 taxa are often peripheral or disjunct species which are of concern when considering species diversity within Oregon's borders) (Oregon Biodiversity Information Center 2010). This species has a Bureau of Land Management Bureau Sensitive ranking for Oregon. Bureau Sensitive Species are restricted in range and have natural or human-caused threats to survival. The Bureau of Land Management considers these species eligible for Federal or State listing or candidate status. *C. marginata* has no California Native Plant Society rare plant designation.

a) Taxonomy and Description

Callitriche marginata is an annual aquatic plant in the plantain family (Plantaginaceae). Until recently the genus *Callitriche* was classified in the water-starwort family (Callitrichaceae). This taxon was first described by Dr. John Torrey in 1857 from an 1853 collection by John Milton Bigelow and Asa Fitch near Sonoma County, California (Smithsonian Institution 2012).

Callitriche species are typically mat-forming, have floating and submerged leaf types, and occur in habitats that support shallow water or wetlands. In most species, the submerged leaves grow in pairs along the stems and vary in size from less than 0.5 centimeters (about 0.25 inches) to 2.5 centimeters (about 1 inch). Often the floating leaves are less than 1.0 centimeter (about 0.4 inch) wide and may be oval or roundish in shape, resembling duckweed (Brockmann 2012). The floating mat of *C. marginata* is formed of tiny leaf rosettes attached by long, hairlike stems to its roots in the mud substrate (Figure II-9). The stems, each up to about 10 centimeters (4 inches) long, form a tangle when the plant grows outside of the water. The inflorescence sometimes has two inflated whitish bracts alongside the tiny flowers. These flowers occur on slender, pedicled, branched stems that tend to float on the water's surface. *C. marginata* has black seeds which remain dormant in the soil during the dry season (Lansdown and Preston 2012; Miller 2001).

Callitriche marginata differs from similar related species that occur in the Agate Desert area (*Callitriche stagnalis* [pond water-starwort] and *Callitriche trochlearis* [effluent water-starwort]) in having fruits that are clearly on long pedicels (stalks) from 2 to 25 millimeters (0.02 to 1 inch). *C. stagnalis* and *C. trochlearis* have fruit pedicels that are 0.5 millimeter (0.08 inch) or less (Lansdown and Preston 2012).

b) Distribution and Population Status

Callitriche marginata is native to the west coast of North America (from British Columbia to Baja California) and to Wisconsin. It is more common in the southern part of its range, occurring widely in California, but is rare in the Pacific Northwest. It is documented from three sites in Jackson County, Oregon;

Figure II-9. ***Callitriche marginata*** **(winged water-starwort).**
Photograph by Mary Ellen (Mel) Harte, Bugwood.org.

one site in Josephine County, Oregon; one site in Wasco County, Oregon; 5 sites in British Columbia; and a few disjunct sites in northern Wisconsin (Miller 2001). Historically it also occurred in Washington.

In southwest Oregon, it is known to occur on Bureau of Land Management administered lands at the summits of both Upper and Lower Table Rocks in Jackson County, and at one location in the Applegate River Valley in Josephine County (Oregon Flora Project 2012).

c) Life History and Habitat Description

Callitriche marginata occurs in vernal pools and depressional areas in vernal pool-mounded prairies, but it is occasionally found in ponds, sloughs with stagnant or intermittently flowing water, or mud of recently dried pools. The species will often colonize disturbed areas such as cattle hoofprints, shallow ditches, and dirt road depressions (M. Wineteer, pers. comm. 2012).

Callitriche marginata is found in well-lighted vernal pools and other temporary wetlands (e.g., rocky depressions) that are formed by winter rains and dry by late spring or early summer, and also in draining wetlands, seeps and springs (Muth *et al*. 2001). *Callitriche marginata* exists only as seed in summer

and autumn (McGlaughlin 1974). Classified by federal agencies in the US as an obligate wetland species and a wetland indicator (USFWS 1988, USDA-NRCS 2012), it occurs either on dried mud at the edge of pools or, less commonly, as mats in the water (Fassett 1951).

d) Threats to Survival

The primary threats to *Callitriche marginata* are recreational disturbance and displacement by seral and invasive plant species. Research to understand the biology of the species, its genetic similarity to associated *Callitriche* spp., seed germination, and propagation needs would be beneficial. Although development is not likely to occur on top of Table Rocks, the increasing recreational pressure from hiking activities on the two summits may have a potential to impact a small number of plants during their growing season, due to trampling.

Callitriche marginata populations may also be threatened by invasive annual grass thatch build-up. Additional threats to *C. marginata* if populations are located in the valley, are road construction, fragmentation, off-road vehicle damage, fill and contaminant dumping, herbicide spraying, and the threat of small population size vulnerability to extirpation.

Because populations of annual plants living in unpredictable and variable habitats such as vernal pools are naturally subject to high fluctuations in density and area of coverage (Venable and Lawlor 1980), high population turnover may be a fundamental characteristic of *C. marginata* ecology (Miller 2001).

e) Conservation Efforts

Callitriche marginata does not have any formal protection under Federal or State law. The known populations in the Agate Desert area occur on Bureau of Land Management lands on top of Upper and Lower Table Rocks, where they may receive protection as a Bureau Sensitive Species.

The designation of land on the Table Rocks summits as an Area of Critical Environmental Concern by the Medford Bureau of Land Management is a conservation initiative that has benefitted the plant. A management plan is being drafted by the Medford Bureau of Land Management for the entire Table Rocks areas. Management activities will include determining the necessary or optimal

growth conditions for the plant, performing annual or biennial surveys, and ensuring that hiking trails avoid the plant populations.

3. *Limnanthes pumila* ssp. *pumila* (dwarf meadowfoam)

Limnanthes pumila ssp. *pumila* (=*L. floccosa* ssp. *pumila*) was previously a Category 1 candidate for Federal listing (U.S. Fish and Wildlife Service 1993b), but was removed from candidate status in 1996 (U.S. Fish and Wildlife Service 1996). The plant is also a State of Oregon Threatened species. The Oregon Biodiversity Information Center has identified *L. pumila* ssp. *pumila* as a List 1 taxon (threatened with extinction or presumed extinct throughout its range) (Oregon Biodiversity Information Center 2010).

a) Taxonomy and Description.

Limnanthes pumila ssp. *pumila*, a member of the false mermaid family (Limnanthaceae), was first collected from the top of Table Rock, Jackson County, Oregon, and then described by Howell in 1897 as *Limnanthes pumila*. M.E. Peck revised the name to *Limnanthes bellingeriana* in 1937 (Abrams 1951), but C. T. Mason reassigned the name to *Limnanthes pumila* (Mason 1952). Arroyo (1973) treated the taxon as a subspecies within *Limnanthes floccosa*, but it is currently assigned to *Limnanthes pumila* ssp. *pumila* based on hybridization trials and molecular data (Chambers and Meyers 2011).

Limnanthes pumila ssp. *pumila* is an upright annual herb with simple stems that occasionally branch near the base. The plants reach 5 to 10 centimeters (2 to 4 inches) high, are mostly glabrous throughout, and have pinnate leaves which are divided into five to nine divisions. The plant's petals are 7.5 to 8 millimeters (0.30 to 0.31 inches) long and equal the sepal length (Figure II-10). The petals are glabrous with the exception of two rows of inside hairs. Each flower produces three to five nutlets. The flowers are white in color with an occasional slight yellow tinge at the base of the petals.

Figure II-10. ***Limnanthes pumila* ssp. *pumila* (dwarf woolly meadowfoam).**
Photograph courtesy of Norm Jensen (private photographer).

b) Distribution and Population Status.

Limnanthes pumila ssp. *pumila* is a narrow endemic, known only from the summits of Upper and Lower Table Rocks in Jackson County, Oregon. The species is likely limited to only these two areas. The status of the species is unknown, but does not appear to be on a declining trend based on the best available information (Newton *et al*. 2010). Annual monitoring suggests that population numbers fluctuate from year to year depending on seasonal rainfall and temperature patterns. The species is concentrated within vernal pools and in slight depressions on the summits. The plant patches are scattered in distribution and fluctuate yearly. A 2002 Upper Table Rock survey found approximately 70 percent of the vernally wet areas occupied by *L. pumila* ssp. *pumila* (Newton *et al*. 2010).

c) Life History and Habitat Description.

Limnanthes pumila ssp. *pumila* begins to germinate on Lower and Upper Table Rocks in the early spring (Arroyo 1973). The plant flowers from late March to April and produces mature nutlets by mid-May. *L. pumila* ssp. *pumila* occurs on vernal pools and shallow ditches underlain by shallow soils with a volcanic-

derived duripan layer. The plant community on Table Rocks is open short prairie. The Table Rock vernal pool plant community consists of *Allium* spp. *(*onion), *Callitriche marginata* (winged waterstarwort), *Deschampsia danthonioides*, *Downingia yina*, *Lasthenia californica*, *Minuartia californica* (California sandwort), *Plagiobothrys* spp., *Trifolium depauperatum* (poverty clover). Common exotic species include *Poa bulbosa* and *Taeniatherum caput-medusae*.

d) Threats to Survival.

The primary threats to this plant are recreational disturbance and displacement by seral and invasive plant species. Research would be beneficial to understand its biology, genetic similarity to associated *Limnanthes* spp., seed germination, and propagation needs. Although development is not likely to occur on top of Table Rocks, the increasing recreational pressure from hiking activities on Upper and Lower Table Rock may have a potential to impact a small amount of plants during their growing season due to trampling.

e) Conservation Efforts.

While little conservation efforts have occurred for this plant in Oregon, a key effort by the Medford Bureau of Land Management has designated land on the Table Rocks summits as an Area of Critical Environmental Concern. Property owned by The Nature Conservancy on the Table Rocks summits is being donated to the Bureau of Land Management. A management plan has been drafted by the Medford Bureau of Land Management for the entire Table Rocks area and is planned to be finalized in 2012. Management activities will include determining the necessary or optimal growth conditions for the plant, performing annual or biennial surveys, and ensuring that hiking trails go around the plant populations. Augmentation or re-introduction of this species to suitable habitat is not likely to be greatly beneficial because this plant has such a limited range and is distributed well throughout the available suitable habitat.

4. *Limnanthes gracilis* ssp. *gracilis* (slender meadowfoam)

This subspecies was previously a Category 2 candidate for Federal listing (U.S. Fish and Wildlife Service 1993b). The Oregon Biodiversity Information Center has identified the species as a List 1 taxon (threatened with extinction or presumed extinct throughout its range) (Oregon Biodiversity Information Center 2010). It is also a State of Oregon candidate species. This species has a Bureau of Land Management Bureau Sensitive ranking for Oregon. Bureau Sensitive Species are restricted in range and have natural or human-caused threats to survival. The Bureau of Land Management considers these species eligible for Federal or State listing or candidate status.

a) Taxonomy and Description.

Limnanthes gracilis ssp. *gracilis* (slender meadowfoam) is in the false mermaid family (Limnanthaceae). It was described in 1897 by Howell from a collection in the Rogue Valley, Oregon, as *L. gracilis* (Abrams 1951). A related subspecies collected from southern California was described as *Limnanthes versicolor* var. *parishii* (Parish's meadowfoam) by Jepson (1936); however Mason (1952) recognized var. *parishii* as a variety of *L. gracilis*, based on flower and fruit morphology. Beauchamp (1986) elevated the plant to a subspecies, consistent with other treatments of this genus, noting the geographic separation of over 1,200 kilometers (744 miles) between *L. gracilis* ssp. *parishii* and *L. gracilis* ssp. *gracilis*.

Limnanthes gracilis ssp. *gracilis* is a glabrous annual herb that reaches 10 centimeters (4 inches) tall (Figure II-11). It has large, somewhat showy white cup-shaped flowers with 10 to 14 millimeter (0.39 to 0.55 inch) long petals. The petals curve over the fruit as it matures. The leaves are fern-like, 3 to 5 centimeter (1.2 to 2.0 inch) long and are deeply divided into 5 to 9 segments. The primary leaf segments are entire or three-parted.

Figure II-11. *Limnanthes gracilis* ssp. *gracilis* (slender meadowfoam).
Photograph courtesy of Norm Jensen (private photographer).

b) Distribution and Population Status.

Limnanthes gracilis ssp. *gracilis* ranges across Josephine County from Takilma, in the southern portion of the county, to northeast of Grants Pass, and in a few areas in Douglas County, Oregon. Only 40 documented occurrences of this plant are recorded within the Illinois Valley landform, but plant populations have been recorded as small as 51 plants and as large as 50,000 plants. The estimated number of plants throughout its range may be as high as 200,000 (Oregon Natural Heritage Information Center 2008). At least two populations occur on Bureau of Land Management administered lands.

c) Life History and Habitat Description.

Limnanthes gracilis ssp. *gracilis* is a short lived annual herb that flowers from March until May. The fruits form on the stalks from May to early June. The plant occurs in gravely seepages, wet slopes, intermittent streams, or small pond edges in moist meadows along with *Deschampsia cespitosa*, *Danthonia*

californica, and *Ranunculus occidentalis* (western buttercup). *Limnanthes gracilis* ssp. *gracilis* often occurs near *Lomatium cookii* in seasonally wet meadows of the Illinois Valley.

d) Reasons for Decline and Threats to Survival.

The primary threats to this plant are urban and rural development, road construction, aggregate and mineral mining, and recreational disturbance. Sixteen populations are known to have been extirpated since this species was first discovered in Oregon.

e) Conservation Efforts.

Limnanthes gracilis ssp. *gracilis* receives no protection from Federal or State law. The species receives protection where it occurs on land managed by the Bureau of Land Management in the Illinois Valley by virtue of its Bureau Sensitive Species ranking.

Research on this plant has been primarily conducted by the commercial meadowfoam oil seed industry. Hybrid crosses between this plant and several other *Limnanthes* sp. were conducted to determine optimal characteristics for hardiness, oil seed quality, and seed set.

5. *Plagiobothrys austiniae* (Austin's popcornflower)

The Oregon Biodiversity Information Center has identified *Plagiobothrys austiniae* as a List 2 taxon (threatened with extirpation or presumed extirpated in Oregon) (Oregon Biodiversity Information Center 2010). The plant has no Federal or State listing status.

a) Taxonomy and Description.

Greene first recognized *Plagiobothrys austiniae* as a new species in 1887, assigning the name *Allocarya austiniae* to the plant from a collection in Butte County, California (Abrams 1951). After a revision to *Allocarya cristata* by Piper in 1920, *Echinoglochin austiniae* by Brand in 1925, and *Allocarya austiniae* var. *cristata* by Jepson in 1925, I. M. Johnston in his 1932 monograph on *Plagiobothrys* assigned the name by which Austin's popcorn-flower is known currently, *P. austiniae* (Johnston 1932, Abrams 1951).

Plagiobothrys austiniae is an annual forb with hairy linear leaves and stems (Figure II-12). Its flowers are white with yellow centers. This species may reach 40 centimeters (16 inches), but averages about 15 centimeters (6 inches). This species is best identified by the midrib prickles on the lateral ribs of the nutlets. The prickles are stouter than the other species of *Plagiobothrys* in vernal pool mounded prairie habitat.

b) Distribution and Population Status.

Plagiobothrys austiniae is known from 10 counties in California's central valley, ranging from Fresno County north to Shasta County. Although the plant is fairly common in California, *Plagiobothrys austiniae* has only been documented in 12 sites in Jackson County, Oregon. The plant occurs on both Lower and Upper Table Rock land formations and in several vernal pools in the Rogue Valley.

The species occurs in scattered patches among vernal pool margins. The number of plants in a given vernal pool area are similar to *Plagiobothrys greenei*, which ranges from 50 plants in a 400-square-meter (4300-square-foot) area to over 1000 plants in a 100-square-meter (1080-square-foot) area.

Figure II-12. Illustration of *Plagiobothrys austiniae* (Austin's popcornflower).
Reprinted from Abrams and Ferris (1960).

c) Life History and Habitat Description.

Plagiobothrys austiniae is an herbaceous annual that occurs in vernal pools and wet areas throughout its range. The plant germinates in early February while under water, flowers from late March to May, produces mature seed from May to June, and goes dormant in July. As the plant goes dormant, it withers, turning gray. Seed has dropped by late July, when the plants are barely discernible. The plants are pollinated by a wide assortment of insects common to the vernal pool-mounded prairie complexes in the Rogue Valley.

The species is limited to vernal pool margins and dry grassland depressions that occur within a matrix of annual grassland on shallow clay loam soils underlain by a volcanic- or clay-derived duripan layer. *Plagiobothrys austiniae* is often associated with *Allium* spp., *Downingia yina, Lasthenia californica, Limnanthes pumila* spp., *Plagiobothrys greenei, Minuartia californica, Myosurus minimus, Trifolium depauperatum,* and *Triteleia hyacinthina* (white brodiaea).

d) Threats to Survival.

Plagiobothrys austiniae is primarily threatened by development and habitat degradation that impacts or removes vernal pools. At all populations, *P. austiniae* is threatened by invasive annual grass thatch build-up. Additional threats to *P. austiniae* are road construction, building and home development, commercial and industrial development, fragmentation of habitats, off-road vehicle damage, fill and contaminant dumping, and herbicide spraying.

e) Conservation Efforts.

Although this plant is not federally or State listed, this species often occurs in designated vernal pool fairy shrimp critical habitat where it may receive protection where Federal actions take place. This plant is known to occur in the Bureau of Land Management's Area of Critical Environmental Concern on both Upper and Lower Table Rock and in The Nature Conservancy's Agate Desert Preserve.

6. *Plagiobothrys greenei* (Greene's popcornflower)

The Oregon Biodiversity Information Center has identified *P. greenei* as a List 2 taxon (threatened with extirpation or presumed extirpated in Oregon)

(Oregon Biodiversity Information Center 2010). The species is also considered a sensitive species by the Bureau of Land Management.

a) Taxonomy and Description.

Plagiobothrys greenei (Greene's popcornflower) is in the borage family (Boraginaceae). This species was first collected in Yreka, California and described in 1877 by Asa Gray as *Echinospermum greenei*. Greene changed its name in 1887 to *Allocarya echinoglochin* and again in 1894 to *Allocarya greenei*. I.M. Johnston gave the species its current name, *Plagiobothrys greenei*, in his 1932 *Plagiobothrys* monograph (Abrams 1951).

Plagiobothrys greenei is an annual herb with hairy stems and leaves in the borage family (Boraginaceae) (Figure II-13). This species may reach 40 centimeters (16 inches) tall but averages a height of approximately 15 centimeters (6 inches). *P. greenei* is distinguished from other *Plagiobothrys* spp. in the vernal pool-mounded prairie complex of the Agate Desert by the presence of numerous thin bristles on the nutlets. The nutlets are more or less smooth, lacking the lateral- and cross-ribs of most other *Plagiobothrys* species. The ovate or triangular scar is located near the base of the nutlet and is concave. The flower is white, sometimes with a yellow center, and is 1 to 2.5 millimeters (0.04 to 0.1 inch) wide.

Figure II-13. **Illustration of *Plagiobothrys greenei* (Greene's popcornflower); plant and nutlet.**
Reprinted from Abrams and Ferris (1960).

b) Distribution and Population Status.

Although common in California, *Plagiobothrys greenei* is only known from 16 populations in Oregon, of which 11 occur in the Agate Desert. There are three populations known from Josephine County and one occurrence each in Douglas and Klamath counties. *Plagiobothrys greenei* has similar population and distribution patterns as *P. austiniae* and ranges from 50 plants in a 400 square meter (4,306 square foot) area to over 1,000 plants in a 100 square meter (1,076 square foot) area.

c) Life History and Habitat Description.

Plagiobothrys greenei germinates in late winter, flowers in April and begins to fruit in May. From late May to June the nutlet-seeds will be mature enough to fall to the ground. By July the plants wither to a whitish-gray color and slowly decompose. The plants usually will disappear entirely by October.

Habitat for *Plagiobothrys greenei* occurs in small seasonally wet gravelly areas in openings of white oak/manzanita woodland or vernal pool-mounded prairie on gentle slopes with sandstone substrates and vernally wet edges of seasonal creeks, generally on very shallow soils, often underlain by a volcanic or clay duripan layer. Plants often associated with *P. greenei* include *Allium* spp., *Achyrachaena mollis, Downingia yina, Lasthenia californica, Limnanthes floccosa* spp. *floccosa, Limnanthes pumila* spp. *grandiflora, Minuartia californica, Myosurus minimus, Plagiobothrys austiniae, Trifolium depauperatum*, and *Triteleia hyacinchina*.

d) Threats to Survival.

Plagiobothrys greenei is threatened by development or habitat fragmentation that impacts or degrades vernal pool habitat. The plant receives no protection from the Endangered Species Act, however, within vernal pool fairy shrimp critical habitat areas, it can receive incidental protection derived from protection of the primary constituent elements of vernal pool fairy shrimp critical habitat, which include vernal pools and the upland habitat that contributes to vernal pool function. At all populations, *P. greenei* is threatened by thatch build-up of invasive annual grass and forb species. Additional threats to *P. greenei* are

road construction, residential and commercial development, fragmentation, off-road vehicle damage, fill and contaminant dumping, and herbicide spraying.

e) Conservation Efforts.

Plagiobothrys greenei is not protected under Federal or State law. The plant receives protection at The Nature Conservancy's Agate Desert Preserve and on Bureau of Land Management land on the top of both Upper and Lower Table Rock. No specific conservation efforts have been directed to preserve this species.

7. *Dumontia oregonensis*

Dumontia oregonensis is a minute multi-cellular aquatic crustacean. These organisms play critically important roles in their environments and are part of the ecological dynamics of freshwater ponds and lakes. They help maintain water quality because they consume algae and limit its spread in a small aquatic environment. They are also an important source of food for birds and larger organisms. *Dumontia oregonensis* has neither a Federal nor State listing status. Because the species is a relatively new discovery, we are continuing to discover new information about its biology and distribution.

a) Taxonomy and Description.

Dumontia oregonensis is in the order Cladocera (water fleas) and in the suborder Anomopoda. *D. oregonensis* was first described in 2003 (Santos-Flores and Dodsen 2003). The species was collected from two vernal pools in The Nature Conservancy's Agate Desert Preserve in January 1998 and March 2001. The collected specimens were mature and immature females. *D. oregonensis* is morphologically unique within Anomopoda, and is believed to represent a previously undescribed family, Dumontiidae. The limb morphology of this family suggests a closer relation to the family Daphniidae. Dumontiidae appears to be a 'missing' link between the suborders Radopoda and Anomopoda. The families Daphniidae, Ilyocryptidae, Bosminidae, Moinidae, and the new Dumontiidae are similar in that they lack typical setae (bristles) on the second pair of trunk limbs.

Dumontia oregonensis is an aquatic invertebrate less than 3 millimeters (0.12 inch) long (Figure II-14). Due to the recent discovery, very little

information exists regarding the species' habitat or life history requirements (Santos-Flores and Dodsen 2003).

b) Distribution and Population Status.

Dumontia oregonensis has only been collected in a few localities in southwest Oregon and northern California. Several populations have been found in vernal pools in Jackson County, Oregon and in northern California (Santos-Flores and Dodsen 2003).

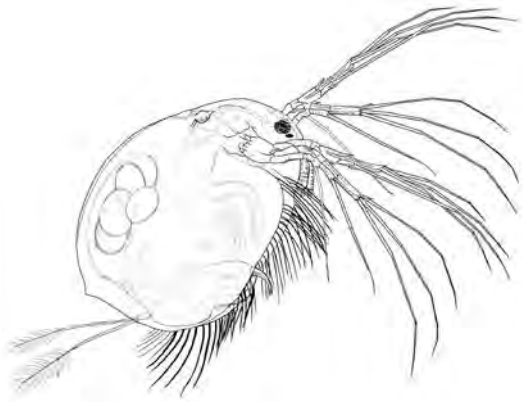

Figure II-14. ***Dumontia oregonensis*.**
Illustration by Kandis Elliot, Botany, University of Wisconsin, February 2004; used with permission.

c) Life History and Habitat Description.

Dumontia oregonensis perhaps has a very short life cycle. At this time only females have been observed through collections in a few vernal pools and drainage ditches in Jackson County.

d) Threats to Survival.

Santos-Flores and Dodsen (2003) suggested that *Dumontia oregonensis* occupies a particular, but limited, habitat type. The extent of additional threats is unclear, but is likely to correspond to threats facing the vernal pool fairy shrimp, such as commercial and industrial development, agricultural conversion, and utility projects.

e) Conservation Efforts.

One of the primary goals of the Oregon Natural Heritage Information Center's Rare and Endangered Invertebrate Program is to promote inventory and

taxonomic work on undescribed or poorly known invertebrate species which may face significant threats, such as the newly discovered *D. oregonensis*. To better understand the species, it is necessary to determine the full distribution and range of the species.

8. Additional Species

Microseris howellii (Howell's microseris) and *Packera hesperia* (western ragwort) are two plant species that are often located adjacent to *Lomatium cookii* habitat near the French Flat, Rough and Ready Creek, and Reeves Creek areas in the Illinois Valley. These species are State-listed as threatened and candidate species, respectively. These two plant species have restricted ranges, but now have more documented occurrences than previously thought and are no longer on the U.S. Fish and Wildlife Service's species of concern list for Oregon.

Two plant species that were discussed as species of concern in the draft of this recovery plan (*Navarretia heterandra* [Tehama navarretia] and *Plagiobothrys glyptocarpus* var. *glyptocarpus* [rough-seeded popcornflower]) occur more widely in California; the Oregon Biodiversity Information Center has recently moved them from List 2 to the less threatened List 4 (Oregon Biodiversity Information Center 2010), and these species are no longer on the U.S. Fish and Wildlife Service's species of concern list for Oregon. *Plagiobothrys figuratus* ssp. *corallicarpus* (coral-seeded popcornflower) was also discussed as a species of concern in the draft recovery plan, but we have removed it from this final recovery plan because its typical habitat is in intermittent streams rather than in vernal pools.

III. Reasons For Listing

A. THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT OR RANGE

The primary threat to *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and the vernal pool fairy shrimp is habitat loss and degradation. Vernal pool habitat, formerly widespread south of the Rogue River, has been almost completely eliminated (Brock 1987, Oregon Natural Heritage Program 1999). In the Agate Desert, recent studies of vernal pool hydrology and vegetation indicate that no undisturbed vernal pool habitat remains (Oregon Natural Heritage Program 1999). The ranges of all species have declined by roughly 50 percent in this area, and while the majority of vernal pool wetlands were likely altered prior to the 1980s, habitat alterations are continuing (C. Tuss, pers. comm. 2002). Based on aerial cover observation and site evaluation, it is estimated that over 60 percent of the vernal pool habitat in the Rogue Valley has been removed. In the remaining Rogue Valley vernal pool habitat, nonnative plants have largely become established (Environmental Science Associates 2007a).

The Agate Desert occurs in the second most rapidly developing area of Oregon and its relatively flat topography makes it highly desirable for development. Much of the area, particularly around White City, is subject to ongoing urbanization as the population of the City of Medford and its environs expand. Remaining vernal pool habitat is highly vulnerable to destruction, degradation, and isolation as a result of this growth. For this reason, Agate Desert vernal pools are recognized as a wetland resource of heightened concern and have been designated as "Wetlands of Special Interest for Protection" by the Oregon Department of State Lands.

Since the Oregon Natural Heritage Program survey was conducted in 1999, there has been no comprehensive, quantitative assessment of vernal pool habitat changes in the Agate Desert; however, some losses of vernal pool habitat to hydrological alterations and residential and commercial development have continued to occur, particularly within the urbanizing area around White City.

The primary threats to the vernal pool habitat of *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* in the Agate Desert are industrial,

commercial, and residential development. Related road and utilities construction and maintenance activities including mowing, herbicide spraying, and firebreak construction, as well as altered hydrology, particularly through the conversion of undeveloped land to irrigated agricultural use, all contribute to the deterioration of habitat quality for these plants (D. Borgias, pers. comm. 2001). Nonnative annual grasses also pose a threat, as *Lomatium cookii* tends to decrease over time if these nonnative competitors are not controlled through mowing, managed grazing, or prescribed burns (Borgias 2004). Any activities that result in altered hydrology, either inundation of the normally shallow vernal pools, or conversely, draining of these pools, will adversely impact the habitat for these species.

Many of the same threats occur at the *Lomatium cookii* populations in the Illinois Valley. In addition to threats at the Rogue Valley, habitats in the Illinois Valley have been altered by surface gold mining operations, the uncontrolled use of off-road vehicles, timber sale-associated activities, inappropriate grazing practices, garbage dumping, tree and shrub encroachment as a result of fire suppression, and the potential direct impacts of fire management activities. As an example, off-road vehicle use is estimated to have destroyed at least 20 percent of the remaining *L. cookii* habitat on federally managed land in the Illinois Valley, and gold mining operations threaten populations at French Flat (S. Fritts, pers. comm. 2011).

B. OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Lomatium cookii and vernal pool fairy shrimp have no known commercial, recreational, or scientific use at this time. However, *Limnanthes pumila* ssp. *grandiflora* may be of interest to collectors and researchers since some members of the genus possess seed oil with potential for industrial applications (Knapp and Crane 1999, Oelke *et al*. 2004). Although both of these threats are expected to be quite minor, the following two threats could potentially occur: One threat is related to the proximity of agricultural plots to extant *Limnanthes pumila* ssp. *grandiflora* populations. The threat for outbreeding depression and hybridization would be accelerated if intentional agriculturally-related crossings of various *Limnanthes* species were to take place near a known *Limnanthes pumila* ssp. *grandiflora* population. Currently there are no known outdoor cultivation plots of *Limnanthes* ssp. in the upper Rogue Valley. Second is the over-collection of

Limnanthes seed. The over-collection of seed at one or several populations compounded with a season of poor seed production could allow a population to become genetically unviable. However, today such seed collection would require associated Federal or State permits on public lands, and over-collection would be unlikely. The potential for both of these threats is low at this time.

C. DISEASE OR PREDATION

Although disease (fungus) and herbivory have been identified as potential problems, no data other than casual observations exist to suggest that these factors pose a substantial threat to either species at this point in time. Brock (1987) observed several mature *Lomatium cookii* roots in the Rogue Valley that were infested with beetle larvae. No further examples of plant mortality resulting from beetle larvae have been observed. Frequently, gopher excavations appear near *Lomatium cookii* patches. These excavations appear to destroy both young and older plants. The plants that do survive tend to grow within the vernal pool margins and bottoms, occasionally growing among large rocks at the bottom of pools. The extent to which gophers destroy *Lomatium cookii* plants should be more thoroughly analyzed.

Meadowfoam fly (*Scaptomyza apicalis*) larvae pose a potential predation threat to *Limnanthes pumila* ssp. *grandiflora*. The fly has been found to be a serious pest on commercial *Limnanthes* plots (Ehrensing *et al*. 1990). Although there have been no reports of damage caused by larvae of the meadowfoam fly to *Limnanthes* in the Rogue Valley, all occurrences of *L. pumila* ssp. *grandiflora* should be carefully monitored for incidents of meadowfoam fly predation.

D. THE INADEQUACY OF EXISTING REGULATORY MECHANISMS

The Endangered Species 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. The vernal pool fairy shrimp is protected under the Endangered Species Act by the section 9 take prohibition. The U.S. Fish and Wildlife Service and

other law enforcement agencies are responsible for investigating suspected violations of the take prohibition, whether by collection or other means. Generally, except for certain circumstances, removal to possession or direct harm of this species is prohibited under the Endangered Species Act. Reducing plants to possession on Federal lands is also generally prohibited under the Endangered Species Act, except for certain circumstances.

Lomatium cookii and *Limnanthes pumila* ssp. *grandiflora* are listed as endangered species under the State of Oregon Endangered Species Act (Oregon Administrative Rules 603-73-070, Oregon Senate Bill 533, and its corresponding Oregon Revised Statute 564). In addition, State law recognizes federally designated critical habitat.

In accordance with the Clean Water Act of 1977 (91 Statutes At Large 1566; 33 U.S.C. 1251 *et seq.*), the Agate Desert vernal pools are classified as jurisdictional wetlands. The Clean Water Act does not regulate drainage of wetlands unless that action results in the discharge of dredged or fill material into a wetland. Normal farming, silviculture, and ranching activities do not require permits for discharge or fill activities (see 33 Code of Federal Regulations § 323.4), all of which could potentially damage vernal pool habitats. Furthermore, the Nationwide Permit Program (33 Code of Federal Regulations § 330) allows the discharge of fill in nontidal wetlands up to 0.2 hectare (0.5 acre) in size; however, there are discretionary Federal actions that require section 7 consultation. Since many of the vernal pools are very small in size, such an activity could have a measurable impact on these systems. A similar problem arises under State of Oregon wetland laws. In light of the Supreme Court decisions in Solid Waste Agency of Northern Cook County versus U.S. Army Corps of Engineers, 531 U.S. 159 (2001) (SWANCC), and the consolidated cases Rapanos versus United States, and Carabell versus United States, 126 S. Ct. 2208 (2006), the Portland District Office has continued to consider most vernal pools in the Agate Desert area as jurisdictional (J. Goudsward, pers. comm. 2007).

The Removal-Fill Law of 1989 (Oregon Revised Statutes 196.800-196.990), administered by the Oregon Department of State Lands, does not regulate activities that involve less than 38 cubic meters (50 cubic yards) of fill. Such an amount of fill could seriously impact many smaller vernal pool wetlands

in which *Lomatium cookii*, *Limnanthes pumila* ssp. *grandiflora*, and vernal pool fairy shrimp occur.

E. OTHER NATURAL OR MANMADE FACTORS AFFECTING ITS CONTINUED EXISTENCE

Poorly managed grazing of livestock appears to be a significant factor in vernal pool and wet meadow degradation. In some cases historic sheep grazing may have resulted in the widespread destruction of native plant communities by intense grazing and the introduction of non-native annual grasses and herbs (Borgias 2004, Brock 1987). The largest contributors to the loss of listed species and degradation of vernal pool and wet meadow habitat could have been the site preparation activities that took place prior to grazing. Associated management actions such as non-native seeding, ditching, leveling, or other associated activities are likely to have compromised vernal pool-mounded prairie topography and hydrology, the integrity of the vernal pool duripan soil layer, or degraded vernal pool or wet meadow plant communities prior to grazing and agricultural use.

Herbicide spraying, mowing, grading, and other road maintenance activities may threaten small *Lomatium cookii* sites adjacent to roads on private lands near Cave Junction in the Illinois Valley. In the Agate Desert, *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* individuals in road or powerline rights-of-ways could be accidentally destroyed by local public works departments, highway districts, fire departments, or private citizens carrying out maintenance activities (K. Cannon, pers. comm. 2004).

Fire suppression may affect the species in two ways. First, fire suppression activities may cause trampling of plants or habitat degradation when equipment is mobilized or fire lines are created. Second, the ongoing suppression and exclusion of fire may allow succession of woodland habitats and render formerly open areas unsuitable for growth of *Lomatium cookii* or *Limnanthes pumila* ssp. *grandiflora* due to the encroachment of trees and shrubs.

The invasion of nonnative annual plants in the Agate Desert has altered the native perennial plant communities (Brock 1987). Native bunch grasses on mounds between vernal pools have been replaced by introduced Eurasian herbs

and grasses. The dense thatch produced by these introduced annuals prevents the germination of *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* seed. *Alyssum murale* (yellowtuft), *A. corsicum* (Corsicum yellowtuft), and *Isatis tinctoria* (dyer's woad) are highly invasive plants that can encroach on serpentine soils. All three plants have been found in the Illinois Valley and could potentially threaten *Lomatium cookii*.

Catastrophic events, such as severe fire, could eliminate the large patches of *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* located on the Agate Desert Preserve (J. Kagan, pers. comm. 1998). Nine patches of *Lomatium cookii* in the Illinois Valley are vulnerable to demographic extinction because of their small size (fewer than 100 plants).

Industrial, commercial, and residential development, road and power-line construction and maintenance, livestock grazing, agricultural conversion, weed competition, mowing, and roadside spraying have all contributed to the decline of these plant species. In Josephine County, *Lomatium cookii* is also threatened by habitat alteration or destruction caused by gold mining, logging, fire suppression, and uncontrolled off-road vehicle use. Indirect effects stemming from off-road vehicle use, road maintenance, utility construction, or mining can disrupt the hydrology of an area and redirect natural water sources away from small *Lomatium cookii* populations and introduce, scatter and bury noxious weed seed. Similarly, vernal pool fairy shrimp can be adversely affected by fragmentation of habitat, introduction of pesticides and other contaminants into vernal pools, and disruption of hydrological patterns.

This habitat loss directly causes mortality and injury to the plants, their seeds, and fairy shrimp adults and cysts, as well as impairing or destroying a site's potential to support future reproduction. Moreover, development in upland areas surrounding wetlands can further affect these species through increased runoff of sediment and fertilizer and reduced availability of pollinating insects for flowering plants. Fragmentation of habitat into smaller disconnected blocks also impedes these species' dispersal and recolonization of habitat patches, increasing the probability of local extirpation.

While the development and degradation of the southwestern Oregon ecosystems treated in this plan has been a primary factor responsible for the

decline of the plant and invertebrate species associated with these communities, changing climate will place a greater stress on the region's habitats and the species that depend on them. The Intergovernmental Panel on Climate Change (IPCC) has concluded that recent warming is already strongly affecting terrestrial biological systems (IPCC 2007); this is evident in seasonal timing, changing migration events, and in glacial and upward shifts in plant and animal distribution. Evidence of global climate change includes widespread increases in average air and ocean temperatures, accelerated melting of glaciers, and rising sea level. The IPCC has further concluded that the resilience of many ecosystems is likely to be compromised this century by an unprecedented combination of climate change, associated disturbances (*e.g.*, flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (IPCC 2007). In Oregon, climate changes projected for the 21st century include a general increase in annual mean temperature (at a rate of 0.1 to 0.6 degree Celsius [0.2 to 1.0 degree Fahrenheit] per decade) and a trend toward hotter, drier summers; the direction of changes in annual precipitation remains unclear (Oregon Climate Change Research Institute 2010).

Although climate change is almost certain to affect vernal pool, wet meadow, and mixed conifer habitats, there is uncertainty about the direction and specific effects of climate change on listed species. The U.S. Fish and Wildlife Service has developed a strategic plan to address the threat of climate change to vulnerable species and ecosystems. Goals of this plan include maintaining ecosystem integrity by protecting and restoring key ecological processes such as pollination, seed dispersal, nutrient cycling, natural disturbance cycles, and predator-prey relationships (U.S. Fish and Wildlife Service 2009). Our recovery program will implement these goals by attempting to establish conditions that allow populations of target species to be resilient to changing environmental conditions and to persist as viable populations into the future. The recovery goals for the listed species covered by this recovery plan will stress maintaining large populations distributed across their entire historical range, with management plans focusing on protecting sites with high habitat heterogeneity and a range of elevations. Maintenance of large populations is essential to buffering environmental variation and ensuring the continuation of evolutionary processes (Traill *et al*. 2010); habitat heterogeneity and elevational gradients within reserves will provide a large range of microhabitats, and therefore will allow for the greatest amount of internal species movement under changing environmental

conditions (Halpin 1997). Additional recovery actions to address climate change will focus on monitoring species status and response to changing conditions, and seeking expert input and consensus on recommendations to prepare for future environmental change.

IV. Recovery

A. RECOVERY STRATEGY

An endangered species is "any species which is in danger of extinction throughout all or a significant portion of its range," and a threatened species is "any species which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range" (Endangered Species Act, Section 3). Any recovery strategy must therefore be focused on reducing extinction risk and ensuring persistence of the species. One of the first steps in this process is identifying the possible sources of risk as well as the factors that influence the long-term viability of a species.

The primary threat to *Limnanthes floccosa* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp, as discussed above, is the loss of vernal pool and wet meadow habitat, including grading and filling for commercial and residential development, and associated road and infrastructure construction. This habitat loss directly causes mortality and injury to the plants, their seeds, and fairy shrimp adults and cysts, as well as impairing or destroying a site's potential to support future reproduction. Moreover, development in upland areas surrounding wetlands can further affect these species through increased runoff of sediment and fertilizer and reduced availability of pollinating insects for flowering plants. Fragmentation of habitat into smaller disconnected blocks also impedes these species' dispersal and recolonization of habitat patches, increasing the probability of local extirpation. Therefore, protecting vernal pool and wet meadow habitat from development (particularly in larger continuous patches) is critical to recovery of these species. Habitat protection can be achieved through cooperative partnerships with Federal, State, and local agencies and land trust organizations that manage habitat, land acquisitions for preserves, and development of conservation agreements and easements with private landowners.

Various secondary land management impacts associated with development can adversely affect listed plants and vernal pool fairy shrimp and degrade their habitat: drift or runoff of herbicide spray can damage listed plants; mowing at the wrong time may cut plants back before their seeds have fully developed; and hydrological changes in the timing and duration of inundation (either to dry or

year-round wet conditions) can render habitat unsuitable for these species adapted to seasonal hydrology regimes. Invasion by nonnative grasses and accumulation of thatch impairs germination and survival of the listed plants. Mosquito abatement programs could adversely affect vernal pool fairy shrimp through pesticide impacts or predation by stocked mosquitofish. In the Illinois Valley, land management practices can also affect *Lomatium cookii* populations by their consequences for grazing, off-road vehicle use, mining, and gold dredging (with potential for direct damage to plants and erosion impacts) and fire suppression (including direct impacts of fireline construction and competitive effects of woody plant encroachment due to fire suppression). Therefore, for protected habitat patches to remain viable they must be managed appropriately to minimize these adverse impacts, if necessary coordinating with neighboring landowners within the watershed and agencies responsible for infrastructure maintenance to implement management practices that do not adversely affect seasonal wetland habitat.

Where vernal pool habitats have been degraded, management to enhance or restore them (active removal of nonnative grasses and encroaching woody plants, restoring seasonal hydrology, fill removal, etc.) may be necessary to improve survival and reproduction of listed plants and vernal pool fairy shrimp; if necessary these measures may be supplemented by experimental creation of new vernal pool habitat beyond existing vernal pool complexes. Long-term habitat management plans should be developed for protected sites, incorporating management methods that are appropriate to address the major threats to listed species at each site. To be effective, management plans must be adequately funded, and should adaptively evaluate and modify management techniques as appropriate to optimize the site's value for listed species habitat.

In addition to the direct population effects of habitat loss, extirpation of local populations may destroy local genetic variants that are adapted to local conditions and could benefit long-term viability of the species. Thus, retaining in perpetuity the full current and historic range of site diversity and genetic diversity maximizes the likelihood of species persistence in stochastic conditions (*e.g.*, climate change, drought, fire), and conservation planning should provide for protection of a broad range of occupied sites. To preserve as much genetic diversity as possible against the threat of local population extirpation, seeds and vernal pool fairy shrimp cysts should be collected from each known occurrence

and banked at multiple locations for long-term storage. If the population at a site has become very small or extirpated, these stored seeds and cysts should be used, in conjunction with habitat protection and management, for reintroduction or augmentation with appropriate genetic varieties.

Because our information on the biology, ecology, and distribution of these species remains incomplete, status surveys, research, and population monitoring are necessary to effectively manage them. Status surveys with standardized protocols to fully assess their distribution and population trends within the Rogue and Illinois Valleys should help to identify additional occurrences or potential reintroduction sites and assess progress toward meeting recovery criteria. After species are delisted these surveys should be continued under post-delisting monitoring plans to document whether the improvement in status continues to be maintained. We expect research into habitat management techniques, vernal pool restoration, reserve design, ecological interactions, genetics, and controlled propagation to provide useful data for adaptively improving management methods. Genetic studies should help to identify populations with unique genotypes that could be prioritized for habitat protection and banking of seeds and cysts.

Because these species occur on land managed by private landowners and a variety of State, Federal, and local governmental agencies, successfully implementing this recovery strategy across the Rogue and Illinois Valleys depends on public support and effective coordination among stakeholders. Therefore, a recovery implementation team with local working groups should involve stakeholders in implementing recovery actions and provide outreach information about vernal pool conservation to the public.

These major elements of the recovery strategy are described in further detail below. The Stepdown Narrative in section IV.F lays out a series of specific recovery actions that will implement this recovery strategy. The recovery strategy, criteria and actions proposed in this recovery plan are based on the following fundamental concepts for reducing the risk of extinctions and ensuring, to the extent possible, the persistence of the species into the foreseeable future.

1. Habitat Protection

Habitat protection includes the preservation of the geographic, topographic, and edaphic features that support complexes of hydrologically interconnected vernal pools, seasonally wet meadow systems, and other ephemeral wetlands and depressions within a matrix of surrounding uplands. These areas together form hydrologically and ecologically functional ecosystem complexes.

a. Amounts and locations of habitat.

The recovery criteria and actions recommend the protection of a diverse range of vernal pool and wet meadow habitats (maintaining a diversity of vernal pool types, soil types, geographic distribution, and species diversity) and protection of habitat in blocks as large as possible, including the associated uplands, buffers, and contributing local watershed. Although we have identified the highest priority areas for focused conservation, additional research and ground-truthing are needed to evaluate the appropriate reserve and buffer sizes necessary to fulfill the biological needs of the species in this recovery plan. Habitat and buffer size should afford the following protections to the listed species from adjacent incompatible land uses:

1. Allow for protection of current and historical species occurrences;

2. Provide basic biological needs for the species;

3. Provide upland habitat requirements of pollinators of vernal pool and wet meadow plants;

4. Provide upland habitat (*i.e.*, watersheds) contributing to and necessary for the maintenance of, vernal pool and wet meadow hydrological function; and

5. Provide for distribution of vernal pool and wet meadow complexes needed for dispersal and genetic exchange across the landscape.

We recommend targeting habitat protection within specific core areas, identified and discussed in detail in section IV.B below and Table IV-1. Protection of the majority of suitable habitat within core areas is recommended to provide corridors and dispersal habitat, support their metapopulation dynamics,

and to provide for reintroduction or introduction sites for species under this plan. Identification and prioritization of core areas is intended to assist in protecting species and their distribution and supports the recovery strategy.

2. Habitat Management

Protection from development alone cannot be considered sufficient to recover *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp and conserve the species of concern in this recovery plan. Because the ecosystems have been altered by historic land uses, careful management must be performed to bring the habitat to a more stable and functioning condition. Habitat that is protected yet not managed well could become overgrown with both invasive non-native and native plants that outcompete listed species, causing them to decline; in addition, layers of non-native plant thatch can accumulate in vernal pool/mounded prairie habitat, restricting or preventing germination and growth of native grasses, herbs, and shrubs. Without a natural disturbance cycle, unmanaged habitat typically undergoes seral succession, becoming overgrown with native species that outcompete or eliminate the listed plant species.

Until site- and species-specific research is completed, habitat management, restoration, and monitoring techniques for vernal pool-mounded prairie, seasonally wet meadow, and sloped mixed conifer forest ecosystems must remain adaptive while new information about the focal listed species becomes available and management techniques are refined. The objective of core area habitat protection is to safeguard that listed plant populations are self-sustaining. Declines in species populations must be halted, by way of management actions, and likely reversed, if populations are to be self-sustaining. If listed plant populations continue to be stable or increasing, existing habitat management should be continued if possible. If such populations begin to decline, changes in management should be considered.

The recovery actions and criteria recommend completing standardized habitat site assessments to identify site-specific threats, conduct interim management and monitoring, conduct reviews and revisions of existing management plans, and develop and implement comprehensive long-term management plans for vernal pool habitats and species. Actions intended to improve our understanding of appropriate management of habitat include

conducting monitoring and incorporating results into habitat management plans (*i.e.*, adaptive management), and research on habitat management, restoration, monitoring techniques, and basic species biology and ecology. Thus, our strategy is to base management on existing information and observed outcomes of ongoing management, but also to incorporate new information resulting from research and monitoring.

3. Status Surveys

Status surveys for recovery purposes are necessary to determine species presence, abundance and population across the species' range. The intent of the status surveys is to determine whether species warrant reclassification or delisting, and to identify locations within appropriate habitat that could be suitable for population augmentation or reintroduction efforts. Status surveys are recommended for all taxa featured in this recovery plan to update distribution information and assess local threats. A status survey may include a combination of review of historic information (such as Oregon Biodiversity Information Center data), taxa occurrence documentation, and examination of herbarium or museum specimens, as well as field surveys to measure population trend through statistically reliable monitoring efforts. Historical and predicted sites should be visited at the appropriate time of year to evaluate if populations have persisted. Population size and threats at those sites should be evaluated, and recommendations for conservation should be made. Moreover, status surveys can be used to identify additional sites for protection and to identify additional management actions necessary to minimize or eliminate remaining threats to the species.

Changes in weather patterns (*e.g.*, type, frequency, and duration) can influence the distribution and site occupation probability of listed plant and invertebrate species. Thus, the ability of a population assessment to detect a status change is limited without a multi-year monitoring process to account for annual climatic variability. Therefore, we recommend that status surveys use a 10-year monitoring period, which should provide sufficient time to interpret plant or invertebrate status in terms of natural year-to-year variability and increasing or decreasing population trends. To contribute to meeting recovery criteria the population trend must not be declining. Plant populations must also show evidence of reproduction by seed set or presence of seedlings.

Appropriate monitoring techniques for plants or vernal pool fairy shrimp may vary depending on the species distribution within an area. A plant census or vernal pool fairy shrimp survey would be the most thorough form of a species assessment, in particular for relatively smaller populations. However, for larger population sizes this may not be appropriate or feasible, and subsampling may be necessary. The monitoring method should balance sufficient statistical precision with reasonable implementation cost and time requirements. Monitoring techniques already in use by the Bureau of Land Management and The Nature Conservancy in the Rogue and Illinois Valleys could serve as a template for monitoring populations elsewhere.

4. Research

Development of specific recovery criteria and prescriptive recovery actions in this recovery plan is complicated by a lack of specific and quantitative information about the biology and ecology of the species. While many threats to these species are well known, methods to reduce or eliminate those threats are not. Thus, research to further understand the effects of threats and the effectiveness of our measures to reduce or eliminate those threats is necessary to recover and conserve the taxa featured in this recovery plan. Research needed to develop effective habitat management techniques includes: 1) studies related to habitat protection (*e.g.*, appropriate preserve size and location), 2) habitat management and restoration techniques (*e.g.*, appropriate levels of burning, grazing, or mowing), 3) habitat mapping and analysis to better define distribution of seasonal wetland habitats, and 4) species ecology and biology (*e.g.*, genetic relatedness, species interactions, and controlled propagation methods). These research needs must be assessed and prioritized periodically by the Service, with assistance from a technical work group, to ensure that research carried out will contribute directly to recovery of the species.

For certain species, long-term population analyses can be useful in developing and refining recovery criteria and adaptive management. However, this method may be difficult to apply effectively for annual plants with large year-to-year population fluctuations, or for organisms with complicated life histories involving long-lived seed and cyst stages where demographic characteristics may be very difficult to adequately measure and characterize. Additionally, year-to-

year environmental variability and the ephemeral nature of habitats and populations may add to the difficulty of measuring population sizes, demographic characteristics, and metapopulation dynamics necessary to model population viability.

5. Public Participation and Outreach

Public participation and outreach are critical to the survival and recovery of the listed species and species of concern addressed in this recovery plan because these vernal pool mounded prairie and seasonally wet grassland species occur on multiple properties owned and/or managed by a variety of stakeholders (private landowners, Federal and State agencies, and local governments). Landowners and land managers should be informed and enlisted early in the recovery implementation process so they can become effective and engaged participants. Many private landowners and local agencies are willing to participate in recovery efforts but may not have the information necessary to make informed decisions. Developing working relationships with all stakeholders is essential to secure and recover the ecosystems covered under this recovery plan. Information on the ecological requirements of the species and possible incentives to compensate landowners for conservation efforts should also be provided.

Various conservation tools to assist landowners to manage and protect their lands are included in Appendix F. The U.S. Fish and Wildlife Service offers several programs (*e.g.* the Partners for Fish and Wildlife Program) that can assist landowners to restore habitat on their lands.

Outreach and awareness programs should be developed and implemented to enhance compliance with existing regulations and to take advantage of opportunities within existing Federal, State, and local laws, regulations, and policies to conserve vernal pool resources.

In the Rogue and Illinois Valley, locally led multi-stakeholder groups that have an interest in conservation of vernal pool and wet prairie ecosystems currently exist. We recommend continued engagement of these local stakeholder and technical work groups, as appropriate, to implement effective outreach, education, landowner participation, and recovery actions. For example, a vernal

pool stakeholder group in Jackson County is already in place, comprised of Federal, State, and county agencies and private land owners and non-governmental organizations who have effectively implemented vernal pool conservation actions. During the process of critical habitat designation stakeholders met, facilitated by the Rogue Valley Council of Governments, to discuss issues related to critical habitat and the region-wide Army Corps of Engineers general permit. Meetings of agency botanists are currently being planned. We recommend that these groups continue their valuable work with Service assistance as appropriate; we are supporting continued stakeholder meetings and finalization of the Rogue Valley Vernal Pool Assessment Methodology through the Rogue Valley Council of Governments (J. Dillon, pers. comm. 2012).

B. RECOVERY ZONES AND CORE AREAS

1. Recovery Zones

If appropriate, recovery plans may subdivide the range of a listed species into two or more recovery zones. In this recovery plan, advantages of identifying recovery zones include encouraging implementation of recovery tasks by local interests, allowing for management of different threats in different areas (*e.g.*, ranching, development, seral succession), helping in the design of management actions, placing widely distributed species on smaller spatial scales for easier management and planning, and allowing for evaluation of impacts at different scales.

For *Lomatium cookii*, we have divided the geographic area covered by this recovery plan into two recovery zones (previously referred to as recovery units in USFWS 2006): the Rogue Valley and Illinois Valley. These recovery zones will provide a framework for establishing populations of listed species across their historical ranges. The two recovery zones are geographically, climatically, and politically distinct, and have unique soil formations, vegetation structure, and plant associations. Research has shown that *Lomatium cookii* has become uniquely adapted to these two areas (Silvernail and Meinke 2008).

Lomatium cookii is the only listed species that occurs in the Illinois Valley Recovery Zone. *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and the vernal pool fairy shrimp all occur within the Rogue Valley Recovery Zone.

2. Core Areas[3]

Core areas, as identified in this recovery plan, are smaller geographic areas that occur within recovery zones, representing specific wetland complexes where recovery actions are focused (Figures IV-1, 2, and 3). The identification of recovery core areas does not have Federal regulatory requirements or imply any additional legal responsibility for recovery actions, but functions as a planning aid to guide recovery of the species covered by this recovery plan. However, core areas in the Rogue and Illinois Valleys are based on designated critical habitat units for *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp, and were selected for focused restoration, protection, research, and monitoring efforts for species covered in this recovery plan (Tables IV-1, IV-2, and IV-3). Protection of all core areas is recommended to provide corridors and dispersal habitat, support metapopulation dynamics, provide for reintroduction or introduction sites, and to protect currently undiscovered populations of vernal pool and wet meadow species. Core areas will also have unique site specific management needs which can be identified through work group discussion. This plan provides provisional recommendations specific to each recovery core area (Tables IV-1, IV-2, and IV-3). The specific delineation of core area boundaries is based on listed species occurrences and the presence of suitable habitat according to: a) distribution of vernal pool and wet meadow habitat from aerial photo interpretation; b) topography; and c) presence of Agate-Winlo or Provig-Winlo soils, in the Agate Desert region; or presence of Brockman, Pollard, Josephine, and Eightlar or Kerby soils in the Illinois Valley region. Appendix D provides additional narrative information about each core area.

---

[3] Core area names as delineated in this current recovery plan differ somewhat from those in the 2005 Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon, which identified broader groups of core areas; compare Figures IV-1 and IV-3. The Agate Desert core area group from the 2005 recovery plan corresponds to the Rogue Plains, North Eagle Point, and Hammel Road core areas in the current plan; the Table Rocks group corresponds to the Upper Table Rock, Lower Table Rock, and Table Rock Terrace core areas; and the White City group corresponds to the White City, Agate Lake, and Whetstone Creek core areas.

Each core area has been assigned an overall priority for recovery (ranked 1 or 2) based on the number of listed taxa present, population size of each taxon, size of vernal pool-mounded prairie complex or wet meadow suitable habitat, level of threat, and condition of suitable habitat. Core areas were designated as Priority 1 if two or more listed species occur in the core area, the core area includes multiple populations of one listed species, the population is exceptionally large or densely populated, or the core area acts as is a corridor or stepping stone between two other core areas. Core areas were designated as Priority 2 if at least one listed species occurs; in Priority 2 core areas, the status of the listed species population typically has not been recently documented and it may be extirpated or suitable habitat may occur in isolated pockets or be sparsely scattered in the core area. Core areas that included less protected land or were subject to greater threats were assigned higher priorities.

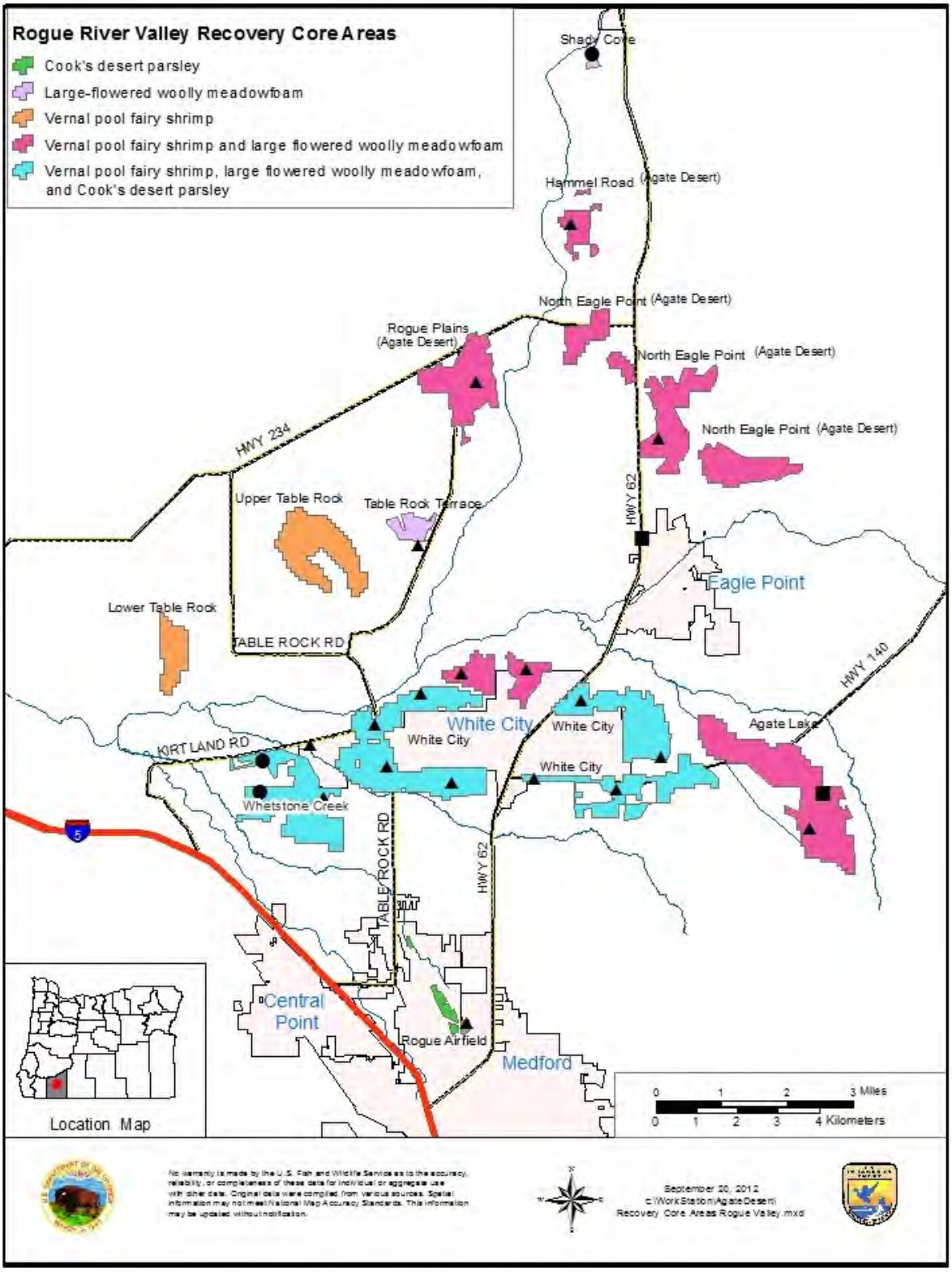

Figure IV-1. Rogue Valley core areas for vernal pool fairy shrimp, *Lomatium cookii*, and *Limnanthes pumila* ssp. *grandiflora*.

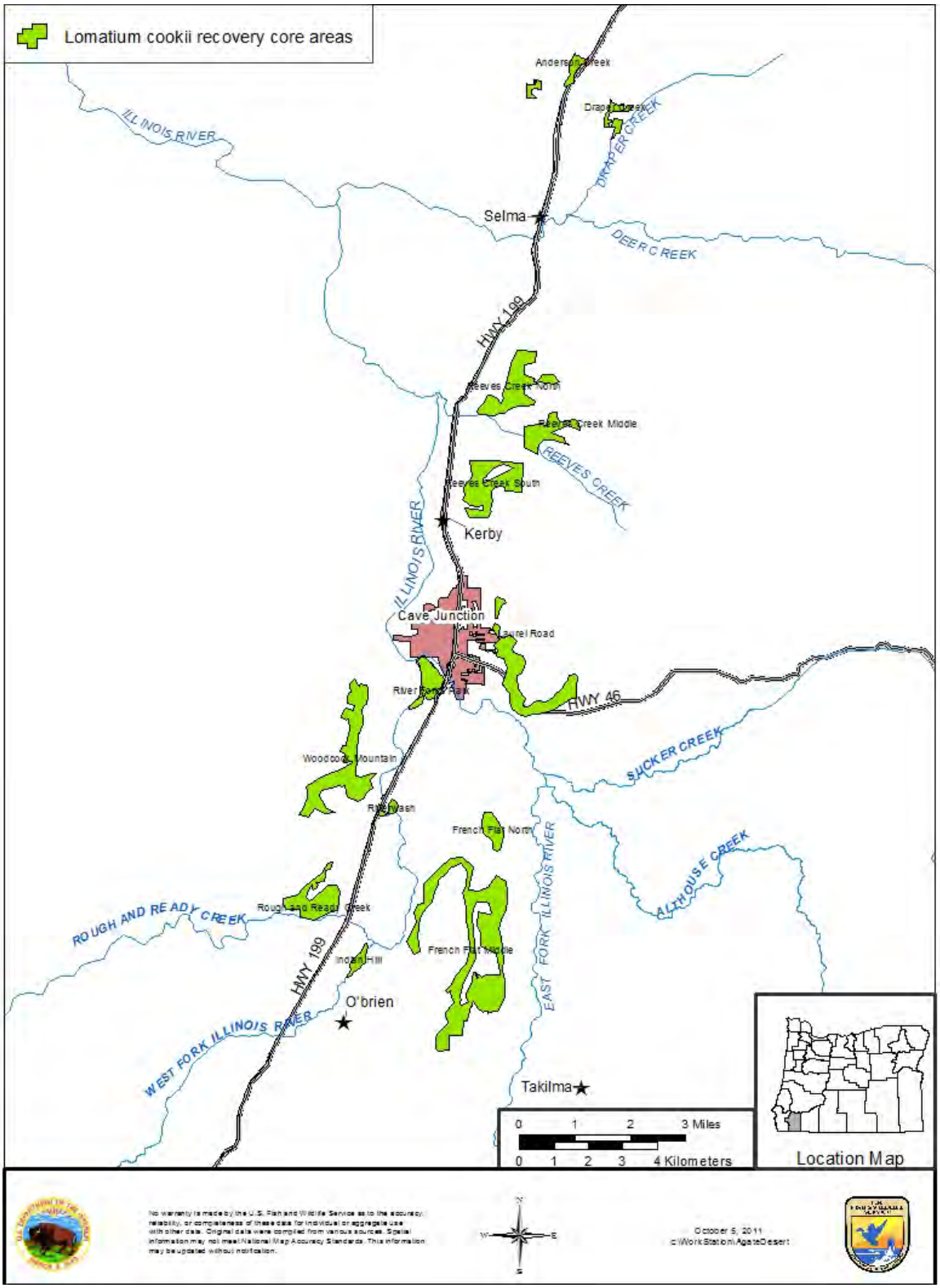

Figure IV-2. Illinois Valley Core Areas for *Lomatium cookii.*

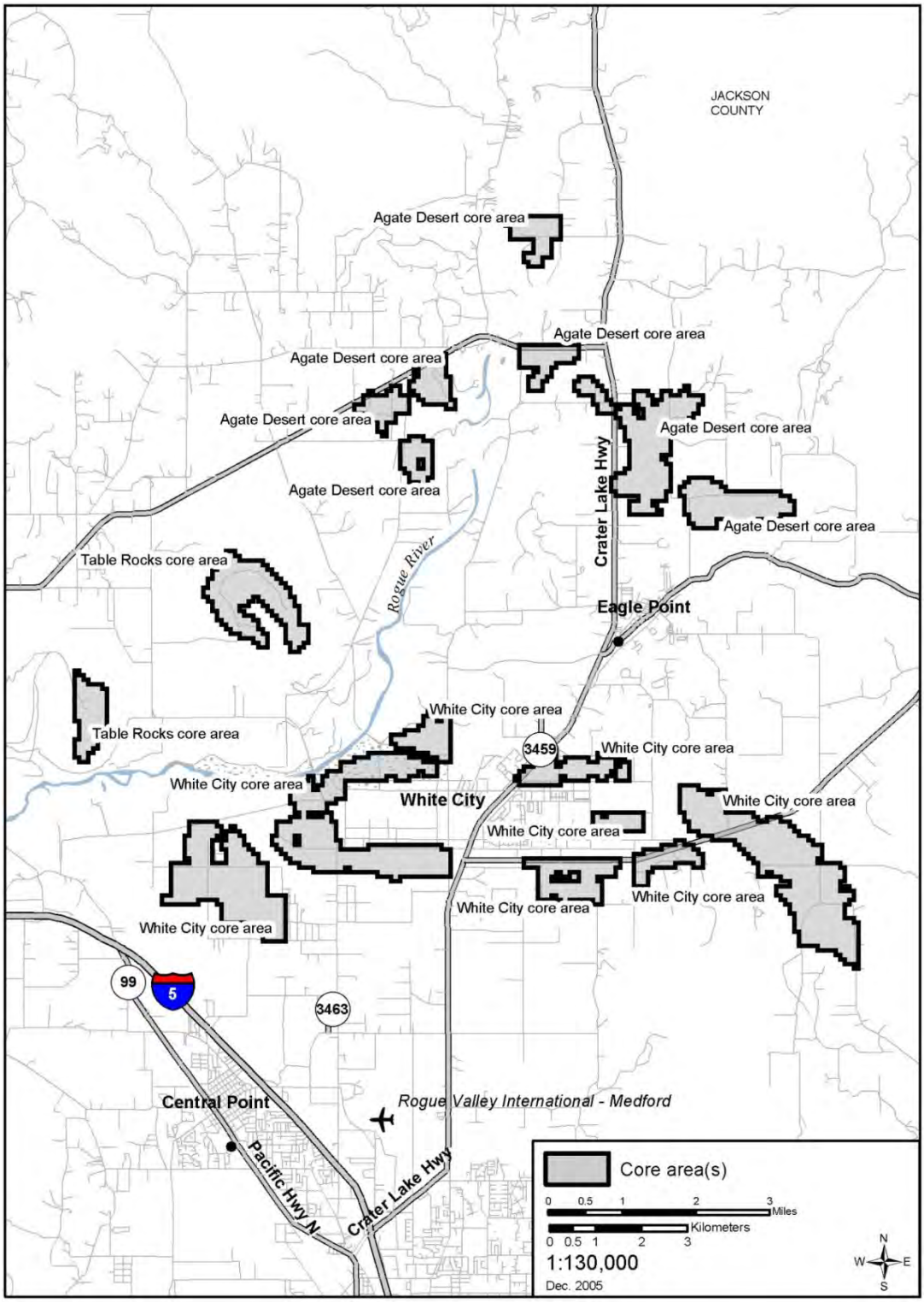

Figure IV-3. Vernal pool fairy shrimp core areas within the Klamath Mountain Vernal Pool Region.

(Reproduced from the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon [U.S. Fish and Wildlife Service 2005a]). Core areas identified in this map refer to vernal pool fairy shrimp only, not to listed plant species addressed in this recovery plan.

Table IV-1. Core Areas in the Illinois Valley Recovery Zone for *Lomatium cookii.*

Core Area Sites	Priority	Threats	Recommendations	Ownership	Area of Suitable Habitat	Listed or rare species documented at site
Anderson Creek	1	Succession, development	Agreement, easement	35% Federal 65% private	35 ha (85 ac)	*Lomatium cookii*
Draper Creek	1	Succession, development	Agreement, easement	100% private	28 ha (70 ac)	*Lomatium cookii*
French Flat North	1	Succession		22% Federal 78% private	45 ha (110 ac)	*Lomatium cookii*
French Flat Middle	2	Succession/mining, off-road vehicle disturbance	Finalize mgt. plan, Agreement, easement, Deter off-road vehicle traffic	48% Federal 52% private	492 ha (1,215 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Illinois River Forks State Park	2	Succession, development	Prepare mgt. plan, mech. or natural shrub removal	25% Federal 45% state 30% private	55 ha (136 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Indian Hill	2	Succession	Agreement, easement	86% Federal 14% private	22 ha (54 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Laurel Road	2	Succession, development	Agreement, easement	2% State 98% private	182 ha (449 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Reeves Creek North	1	Succession, development	Mech. or natural shrub removal, agreement, easement	74% Federal 26% private	152 ha (374 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Reeves Creek South	1	Succession, development	Mech. or natural shrub removal, agreement, easement	95% Federal 5% private	165 ha (407 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Reeves Creek East	1	Succession	Mech. or natural shrub removal, agreement, easement	70% Federal 30% private	83 ha (204 ac)	*Lomatium cookii*
Riverwash	1	Succession	Mech. or natural shrub removal, agreement, easement	38% Federal 4% State 58% private	12 ha (30 ac)	*Lomatium cookii*
Rough and Ready Creek	2	Succession, mining, off-road vehicle disturbance	Mech. or natural shrub removal, management plan, agreement, easement, deter off-road vehicle traffic	74% Federal 26% private	118 ha (292 ac)	*Limnanthes gracilis* ssp. *gracilis*, *Lomatium cookii*
Woodcock Mountain	2	Succession, development, mining	Agreement, easement	5% Federal 95% private	234 ha (579 ac)	*Lomatium cookii*

Table IV-2. Core Areas in the Rogue Valley Recovery Zone for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii.*

Core Area Sites	Priority	Threats	Recommendations	Ownership	Area of Suitable Habitat	Listed or rare species documented at site
White City (previously Agate Desert)	2[a,b]	Succession/ Invasive weeds	Monitoring, weed control, native plant introduction, Lease/easement	32% State 8% County 10% city 50% private	740 ha (1,829 ac)[a] 546 ha (1,349 ac)[b]	*Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, vernal pool fairy shrimp, *Dumontia oregonensis*, *Plagiobothrys greenei*, *Plagiobothrys austiniae*
Agate Lake	1[a,b]	Development/ invasive weeds	Management plan	10% Federal 2% County 88% private	421 ha (1,039 ac)	*Limnanthes pumila* ssp. *grandiflora*, vernal pool fairy shrimp
North Eagle Point	2[a]	Development	Lease/Easement	100% private	490 ha (1,210 ac)	*Limnanthes pumila* ssp. *grandiflora*, vernal pool fairy shrimp, *Plagiobothrys greenei*, *Plagiobothrys austiniae*
Rogue Airfield	2[b] 1[a]	Airport development – fragmentation	Management plan development	1% State 80% County 19% private	34 ha (83 ac)	*Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*
Rogue Plains	2[a]	Grazing, invasive weeds	Monitoring, weed control, native plant introduction	100% private	318 ha (786 ac)	*Limnanthes pumila* ssp. *grandiflora*, vernal pool fairy shrimp
Shady Cove	1[a]	Unknown	Monitoring	100% private	8 ha (20 ac)	*Limnanthes pumila* ssp. *grandiflora*
Hammel Road (previously Staley Rd)	2[a]	Unknown	Monitoring	100% private	69 ha (169 ac)	*Limnanthes pumila* ssp. *grandiflora*,, vernal pool fairy shrimp
Table Rock Terrace	1[a]	Grazing	Monitoring, weed control, native plant introduction	100% private	51 ha (125 ac)	*Limnanthes pumila* ssp. *pumila*, *Plagiobothrys austiniae*, *Plagiobothrys greenei*, vernal pool fairy shrimp
Whetstone Creek	2[a,b]	Invasive weeds	Monitoring, weed control	13% city 87% private	344 ha (850 ac)	*Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, vernal pool fairy shrimp

(a = *Limnanthes pumila* ssp. *grandiflora*, b = *Lomatium cookii*)

Table IV-3. Core Area Groups in the Klamath Mountain Region for vernal pool fairy shrimp.

Core Area Sites	Priority	Threats	Recommendations	Ownership	Area of Suitable Habitat	Listed or rare species documented at site
Agate Desert (includes Rogue Plains, North Eagle Point, and Hammel Road core areas)	2	Invasive weeds, grazing regime, development	Monitoring, weed control, lease/easement	1% County 99% private	862 ha (2,130 ac)	vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora*, *Plagiobothrys greenei*, *Plagiobothrys austiniae*
Upper and Lower Table Rocks (includes Upper Table Rock, Lower Table Rock, and Table Rock Terrace core areas)	2	Invasive weeds	Monitoring, weed control	40% Federal 60% private	361 ha (892 ac)	vernal pool fairy shrimp, *Callitriche marginata*, *Limnanthes pumila* ssp. *pumila*, *Plagiobothrys greenei*, *Plagiobothrys austiniae*
White City East (includes Agate Lake and White City core areas)	2	Invasive weeds, grazing regime, development	Monitoring, weed control, management plan	3% Federal 7% County 90% private	911 ha (2,251 ac)	vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, *Plagiobothrys greenei*, *Plagiobothrys austiniae*
White City West (includes Whetstone Creek and White City core areas)	2	Invasive weeds, grazing regime, development	Monitoring, weed control	27% State 12% municipal 61% private	931 ha (2,301 ac)	vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, *Plagiobothrys greenei*, *Plagiobothrys austiniae*

3. *Limnanthes pumila* ssp. *grandiflora*

The distribution of *Limnanthes pumila* ssp. *grandiflora* is restricted to the Agate Desert area of the Rogue Valley without significant geographic or distance barriers between populations. Consequently, designation of recovery zones is not necessary for this species. Four Priority 1 core areas and five Priority 2 core areas, each with known occurrences of this species, have been identified for protection and concentrated recovery efforts in the Rogue Valley (Figure IV-1). These core areas are defined by size and presence of populations, vernal pool function and value, and placement and distance of known populations within the range of the species. A strategic focus to protect and restore these areas will be crucial in the recovery of the species.

4. *Lomatium cookii*

The distribution of *Lomatium cookii* is disjunct and ranges from the Agate Desert area of the Rogue Valley to the Illinois Valley in Josephine County. The Illinois Valley area is roughly 60 kilometers (37 miles) west of the Rogue Valley. Dividing the two valleys are the Applegate Mountain Range, cresting at 1,370 meters (4,494 feet) at Mt. Isabelle, and the northern extent of the Siskiyou Mountain Range, cresting at 1,388 meters (4,555 feet) at Mungers Butte (Figure I-1). Besides the wide geographical separation, the ecological habitat of each valley is unique in microclimate, soils, and plant associations. For example, *Lomatium cookii* populations in the Illinois Valley are distinct from Rogue Valley populations because the plant occurs in seasonally wet meadows within oak and pine forests, sloped mixed-conifer openings, and shrubby plant communities on deeper Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam soils averaging 60 to 90 centimeters (24 to 35 inches) in depth. Whereas, the Rogue Valley populations are unique in that they occur on Agate-Winlo soils averaging 25 to 36 centimeters (10 to 14 inches) deep, in vernal pool mounded prairie, which is also seasonally moist. *L. cookii* habitat in the Illinois Valley is not distinguished by vernal pool-mounded prairie and has a different vegetation association. It is likely that *L. cookii* populations within the two recovery zones are genetically adapted to disparate environmental conditions in the distinct habitats, such that conservation of populations within both recovery zones may be necessary to full recovery of the species.

Three core areas in the Rogue Valley Recovery Zone for *Lomatium cookii* were identified based on presence of populations, vernal pool or wet meadow function and value, connectivity, aerial photo interpretation, and distribution of known populations (Table IV-1, Figure IV-1). In the Illinois Valley Recovery Zone, 13 core areas were identified (Table IV-1, Figure IV-2). Protection and restoration of these core areas will be the focus of preliminary recovery efforts of the species.

5. Vernal Pool Fairy Shrimp

The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a) prioritized the vernal pool regions currently occupied by listed species as either Zone 1 (occupied by one of the narrowly endemic species addressed in that recovery plan) or Zone 2 (not qualifying as Zone 1, but occupied by one or more of the more widely distributed listed species such as vernal pool fairy shrimp). These zones correspond respectively to regions where that recovery plan identified Priority 1 and Priority 2 recovery actions for habitat protection. All vernal pool habitat in Oregon occurring in in the Rogue Valley was designated as the Klamath Mountains Vernal Pool region (classified as Zone 2, because the only listed species addressed in that recovery plan that occurred in Oregon was the vernal pool fairy shrimp). No Zone 1 core areas were identified in Oregon. For vernal pool fairy shrimp, the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon stated that "protection of Zone 2 core areas will significantly contribute to recovery, and if sufficient might offset the need to protect some lands within the Zone 1 core areas." Although all core areas occupied by vernal pool fairy shrimp in Oregon were designated as Zone 2, vernal pool fairy shrimp occur at several sites that this recovery plan identifies as Priority 1 core areas for *Limnanthes pumila* ssp. *grandiflora* or *Lomatium cookii*.

Vernal pool fairy shrimp are known to occur in five Priority 1 core areas and four Priority 2 core areas that have been identified for protection and concentrated recovery efforts in the Rogue Valley (Table IV-1, Figure IV-1). These core areas generally correspond with vernal pool areas (Figure IV-3) that have been previously identified as core habitat for vernal pool fairy shrimp in the Klamath Mountain Vernal Pools Region by the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a), but differ slightly due to more accurate delineation of habitat areas and differing habitat needs of

Limnanthes pumila ssp. *grandiflora* and *Lomatium cookii*. Vernal pool fairy shrimp are not known to occur in the Illinois Valley.

C. RECOVERY GOALS

The goals of this recovery plan are to:

- Recover *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* and remove them from the Federal List of Endangered and Threatened Wildlife and Plants;
- Recover the vernal pool fairy shrimp within its Klamath Mountains Recovery Zone, as described in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a); and
- Enable the long-term conservation of the species of concern *Agrostis hendersonii*, *Callitriche marginata*, *Limnanthes pumila* ssp. *pumila*, *Limnanthes gracilis* spp. *gracilis*, *Plagiobothrys austiniae*, *Plagiobothrys greenei*, and *Dumontia oregonensis*.

The interim goal of this recovery plan is to:

- Reclassify *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* to threatened (*i.e.*, downlist). Reclassification will be appropriate when each species is no longer in danger of extinction throughout a significant portion of its range.

D. RECOVERY OBJECTIVES

The objectives of this recovery plan are to:

- Stabilize and protect populations of *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* in core areas, so that further declines in species status and range are prevented, by minimizing or eliminating the threats that caused the species to be listed as endangered.
- Stabilize and protect populations of the vernal pool fairy shrimp within its Klamath Mountains Vernal Pool Region, so that further declines in species status and range are prevented, by minimizing or eliminating the threats

that caused it to be listed as threatened and minimizing any other newly identified threats.

- Conduct research necessary to refine reclassification (*i.e.*, downlisting) and recovery criteria for the three listed species.
- Confirm the status of *Agrostis hendersonii*, a species of concern that is currently presumed extirpated from Oregon.
- Stabilize and protect populations of the seven nonlisted species of conservation concern sufficiently to conserve them and avoid the necessity of listing them under the Endangered Species Act.
- Promote natural ecosystem processes and functions by protecting and conserving, in identified core areas, intact vernal pools, vernal pool-mounded prairie complexes, and seasonally wet meadows in oak and pine forests, sloped mixed-conifer openings, and shrubby plant communities within the recovery planning area (Figure I-1) to maintain viable populations of listed species and species of concern, and prevent additional threats from emerging over time.

E. RECOVERY CRITERIA

Downlisting or delisting is warranted when a listed species no longer meets the definition of threatened or endangered under the Endangered Species Act (see definitions below). Recovery criteria are set to serve as objective, measurable guidelines to assist us in determining when a species has recovered to the point that the protections afforded by the Endangered Species Act are no longer necessary. However, a change in listing status requires a formal rulemaking process based upon an analysis of the five factors considered in the listing of a species (see section III above, Reasons for Listing). Thus the recovery criteria presented in this recovery plan represent our best assessment of the conditions that would support a five factor analysis determining that downlisting or delisting of *Limnanthes pumila ssp. grandiflora* and *Lomatium cookii* is warranted. Alternatively, due to unforeseen changes in threats or advances in our knowledge of the species, a future analysis of the five listing factors may lead to a recommendation to downlist or delist, even though precise compliance with the recovery criteria defined in the recovery plan has not been achieved. Recovery criteria for vernal pool fairy shrimp have previously been identified in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a); the present recovery plan does not alter those rangewide criteria, but provides more locally specific information

about the conditions that would be necessary to meet those criteria within the Klamath Mountains Vernal Pool Region.

Recovery criteria presented for species included in this recovery plan are based on the most current information concerning needs and requirements for the species. To achieve downlisting and delisting, the threats to the listed species in each core area should be reduced or eliminated. Because empirical data is often lacking on minimum requirements for assured survival of these vernal pool and wet meadow species, elimination and reduction of threats are recommended through securing the extant listed species populations covered in this recovery plan, adaptive management, monitoring to guide management, species re-introductions and introductions, species status surveys, and research. Monitoring and research are recommended to assist in the development of appropriate management plans. Criteria for downlisting or delisting may be revised as necessary, if additional information provided by the recommended research projects, new modeling, status survey and monitoring programs indicates that a change in any of the criteria is appropriate.

Table IV-4 includes species-specific recommendations regarding the protection of suitable habitat and species occurrences, where reintroductions could occur, and numbers of populations from which seeds or cysts could be banked. Criteria for downlisting or delisting may be revised, as necessary, if additional information provided by the recommended research projects, new modeling, status surveys and monitoring programs indicates that a change in any of the criteria is appropriate.

Because this recovery plan addresses multiple listed species and species of conservation concern, emphasis is placed on strategies that will benefit several species within the same locality (*e.g.*, an ecosystem approach). This approach is most feasible since many of these species co-occur at a number of sites. In most cases, core areas attempt to the fullest extent possible, to represent the full range of vernal pool sizes and types, soils, and within species genetic diversity for each taxon. Core areas, which are the focus for habitat protection efforts, have been defined and prioritized based on the known distribution of vernal pool species and plant species. To provide for consistency in recovery efforts, this Rogue and Illinois Valley Recovery Plan utilizes protection criteria from and tiers to the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005a), which provides the rationale for protection values. The recovery criteria generally

recommend protection of 90 to 95 percent of suitable habitat within Zone 1 core areas and 85 to 90 percent suitable habitat within Zone 2 core areas. Suitable habitat includes vernal pool wetland area as well as adjacent buffer areas of upland habitat (see USFWS 2011); however, depending on the density and configuration of vernal pool habitat within a core area, not all acreage within a core area will necessarily be suitable vernal pool habitat. These percentages are presented as general targets, recognizing that site-specific conditions such as Service approved conservation plans, variation in habitat quality, and other factors will help determine achievement of protection for the core areas, and in some cases the full percentage may not be achievable.

Table IV-4. Species-specific recovery criteria for species occurrence and habitat protection, reintroduction, and seed banking.

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat, by recovery core area, to be protected, listed by Rogue or Illinois Valley (Priority ranking of core area for species in parentheses)	Augmentations/ reintroductions recommended within vernal pool regions or core area[2]	Collection sources for seed / cyst banking [3]
Listed Plant Species				
Large-flowered woolly meadowfoam *Limnanthes pumila* ssp. *grandiflora* (E) Downlist	90% of occurrences; may include newly discovered or reintroduced populations	**Rogue Valley** White City (2) 85% Agate Lake (1) 90% North Eagle Point (2) 85% Rogue Airfield (1) 90% Rogue Plains (2) 85% Hammel Road (1) 90% Shady Cove (1) 90% Table Rock Terrace (1) 90% Whetstone Creek (2) 85%	North Eagle Point Rogue Airfield Whetstone Creek White City Agate Lake	Collect and store seed from all known locations.
Delist	95% of occurrences; may include newly discovered or reintroduced populations	White City (2) 90% Agate Lake (1) 95% North Eagle Point (1) 95% Rogue Airfield (1) 95% Rogue Plains (2) 90% Hammel Road (1) 95% Shady Cove (1) 95% Table Rock Terrace (1) 95% Whetstone Creek (2) 90%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	
Cook's lomatium *Lomatium cookii* (E) Downlist	90% of occurrences; may include newly discovered or reintroduced populations	**Rogue Valley** Agate Lake (1) (90%) White City (2) 85% Rogue Airfield (2) 85% Whetstone Creek (2) 85% **Illinois Valley** Anderson Creek (1) 90% Draper Creek (1) 90% French Flat North (1) 90% French Flat Middle (2) 85% Illinois River Forks State Park (2) 85% Indian Hill (2) 85% Laurel Road (2) 85% Reeves Creek North (1) 90% Reeves Creek Middle (1) 90% Reeves Creek South (1) 90% Riverwash (1) 90% Rough and Ready Creek (2) 85% Woodcock Mountain (2) 85%	Rogue Airfield Whetstone Creek White City Agate Lake	Collect and store seed from all known locations.

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat, by recovery core area, to be protected, listed by Rogue or Illinois Valley (Priority ranking of core area for species in parentheses)	Augmentations/ reintroductions recommended within vernal pool regions or core area[2]	Collection sources for seed / cyst banking [3]
Cook's lomatium *Lomatium cookii* (E) Delist	95% of occurrences; may include newly discovered or reintroduced populations	**Rogue Valley** White City (2) 90% Rogue Airfield (2) 90% Whetstone Creek (2) 90% **Illinois Valley** Anderson Creek (1) 95% Draper Creek (1) 95% French Flat North (1) 90% French Flat Middle (2) 90% Illinois River State Park (2) 90% Indian Hill (2) 90% Laurel Road (2) 90% Reeves Creek North (1) 90% Reeves Creek Middle (1) 90% Reeves Creek South (1) 90% Riverwash (1) 95% Rough and Ready Creek (2) 90% Woodcock Mountain (2) 90%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	
Listed Animal Species				
vernal pool fairy shrimp *Branchinecta lynchi* (T) Delist	80%	**Rogue Valley (Klamath Mountain Region)** Agate Desert (2) 85% Table Rocks (2) 85% White City (2) 85%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	Collect and bank cysts from Agate Desert, Table Rocks, White City, and any genetically unique populations

[1] Percent occurrences to protect, unless additional occurrences are found.
[2] Where populations are not known to occur. Ability to reintroduce may depend on amount and condition of suitable habitat and on success criteria that must be met to demonstrate for successful reintroductions.
[3] Store seeds (plants) in at least two Center for Plant Conservation certified facilities.

1. Downlisting Criteria for *Limnanthes pumila* ssp. *grandiflora*

Reclassification from Endangered to Threatened status may be considered for *Limnanthes pumila* ssp. *grandiflora* when the following criteria are met:

a. At least 16 of the 18 documented and extant occurrences (approximately 90 percent) have been protected from development (Figure II-2). If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery.

b. At least 90 percent of suitable vernal pool habitat acreage within the four Rogue Valley Priority 1 core areas has been protected, and at least 85 percent of suitable vernal pool habitat acreage within the five Rogue Valley Priority 2 core areas has been protected (see Tables IV-2 and IV-4). All suitable vernal pool habitat must include soils and hydrology that support *Limnanthes pumila* ssp. *grandiflora*.

   This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations.

c. Management plans for each protected area are developed for species protection and conservation and implemented as soon as feasible. The management plans should address vegetation control, include a set of methods to reduce thatch buildup and noxious weed control, set a monitoring schedule to assess population levels to quantitatively determine trends, include a set of methods to maintain hydrological functions, outline an outreach plan for neighboring landowners, and set a plan to deter garbage dumping. Management plans should take an ecosystem approach to management, conserving associated wetland and upland species.

d. Additional *Limnanthes pumila* ssp. *grandiflora* occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined necessary to recovery are protected.

e. Achievement of self-sustaining *Limnanthes pumila* ssp. *grandiflora* populations within core areas will be determined through species monitoring and status surveys in each protected occurrence. In order to be considered self-sustaining, populations should demonstrate evidence of reproduction by seed set or presence of seedlings and exhibit population trends that are stable, increasing or show only minor declines from high population levels for 10 years prior to consideration for reclassification.

f. Seed collection is accomplished within each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4).

2. Downlisting Criteria for *Lomatium cookii*

Reclassification from Endangered to Threatened status may be considered for *Lomatium cookii* when the following criteria are met:

a. At least 32 of 36 documented/extant *Lomatium cookii* occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery.

b. At least 90 percent of suitable habitat acreage within each Priority 1 core area (one core area in the Rogue Valley and seven core areas in the Illinois Valley) has been protected from development. At least 85 percent of suitable habitat acreage within Priority 2 core areas (three core areas in the Rogue Valley and six core areas in the Illinois Valley) has been protected from development. (See Tables IV-1, IV-2, and IV-4). All suitable vernal pool and wet meadow habitat must include soils and hydrology that

support *Lomatium cookii*.

This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations.

c. Management plans for each protected core area are developed and implemented as soon as feasible for *Lomatium cookii* protection and conservation. The management plans should address vegetation control, including thatch buildup and noxious weeds; monitoring of threats and population levels in detail sufficient to quantitatively assess population trends; maintaining hydrological functions; and outreach to neighboring landowners. Management plans should take an ecosystem approach to management by ensuring the long-term maintenance of wetland and adjacent upland plant associates.

d. Additional *Lomatium cookii* occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected.

e. Achievement of self-sustaining *Lomatium cookii* populations will be determined through species monitoring and status surveys in each protected occurrence. Population trends must be shown to be stable, increasing or showing only minor declines from high population levels for 10 years prior to consideration for reclassification.

f. Seed collection is accomplished at each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4).

g. Reintroductions and introductions must be carried out as described in Table IV-4. Introductions may replace extirpated occurrences that cannot be restored to the same site as the original occurrence.

3. Delisting criteria for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii*

Delisting may be considered for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* when all downlisting criteria plus the following criteria are met:

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (*e.g.*, evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats.

b. At least 34 of 36 *Lomatium cookii* occurrences, or 17 of 18 *Limnanthes pumila* ssp. *grandiflora* occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery.

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support *Limnanthes pumila* ssp. *grandiflora* or *Lomatium cookii*, as appropriate.

   Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4).

d. A post-delisting monitoring plan has been developed for these plant species.

4. Delisting Criteria for the Vernal Pool Fairy Shrimp

The following outline describes criteria that should be met for vernal pool fairy shrimp within the Rogue Valley. These criteria are based on the delisting criteria that were identified for vernal pool fairy shrimp in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a), in general throughout the full range of the species in California and Oregon, and specifically for the Klamath Mountains Vernal Pool Region. As noted in that recovery plan, recovery criteria relating to Zone 2 core areas may be modified on a case-by-case basis as information becomes available. Thus, these criteria have been modified to incorporate details specific to recovery within the Rogue Valley. Delisting of the vernal pool fairy shrimp requires broad-based recovery across its range, and thus cannot be accomplished solely through recovery efforts in Oregon, but meeting these criteria should allow the Klamath Mountains Vernal Pool Region to fully contribute to delisting the vernal pool fairy shrimp. Table IV-4 includes guidance specific to the vernal pool fairy shrimp regarding the percentage of suitable habitat that should be protected, the percentage of occurrences that should be protected for the Klamath Mountain Vernal Pool Region, where reintroductions should occur, and numbers of populations from which cysts should be banked.

1) Habitat Protection.
   a. At least 80 percent of all known vernal pool fairy shrimp occurrences (9 of the 11 documented by Oregon Biodiversity Information Center) in the Klamath Mountain Vernal Pool Region have been protected from development.
   b. At least 85 percent of suitable vernal pool habitat acreage within each core area group in the Klamath Mountain Vernal Pool Region (Agate Desert, Table Rocks, and White City) has been protected from development. (See core area delineations in Figures IV-1 and IV-3 above, and core area discussion under section IV.B.2. Also see discussion below regarding guidance for acreages of protected lands and conservation banks within the Rogue Valley.)
   c. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery by the recovery team. Any locations occupied by vernal pool

fairy shrimp could contribute to meeting recovery criteria. Other populations will contribute to recovery as discovered.

d. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one 10-year monitoring period to ensure self-sustaining populations are achieved. We anticipate this time period will be sufficient to assess hydrological conditions across a variety of wet and dry years.

2) Adaptive Habitat Management and Monitoring.

a. Plans must be developed and implementation begun within 5 years after a conservation easement or other form of protection is established on a newly protected area. Plans must include provisions for managing nonnative and native competitors, appropriate grazing, fire or other management regimes, adaptive habitat management, incorporation of new information resulting from implementation of research actions, and addressing site-specific threats. Management plans for specific parcels are being developed as described under Recovery Action 2.7 in this recovery plan. Timely implementation of plans should ensure vernal pool fairy shrimp populations are maintained, as necessary, and threats due to lack of management are minimized.

b. Mechanisms are in place to provide for management into the foreseeable future and long-term monitoring of the Habitat Protection section above (*e.g.* funding, personnel, etc.).

c. Monitoring, utilizing the most current vernal pool assessment methodology, indicates ecosystem function has been maintained in the protected areas.

d. Cyst banking actions have been completed. Cyst-bearing soils should be banked from at least one population in each of the three major core area groups (Agate Desert, Table Rocks, and White City), as well as any populations found to have unique genotypes (see Table IV-4).

3) Status Surveys.

a. Status surveys, 5-year status reviews, and population monitoring show vernal pool fairy shrimp populations within the Klamath Mountain Vernal Pool Region are viable (self-sustaining) and have been maintained (stable, increasing or showing only minor declines from high population levels) for at least one 10-year period. We anticipate this time period will be

sufficient to assess population trends across a variety of wet and dry years. (Determining when this criterion is met may rely partly on development of standardized monitoring and survey protocols to determine appropriate parameters to measure during status surveys.)

b. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. As appropriate and feasible, threats should be ameliorated or eliminated on lands managed by government agencies and land trusts or protected by conservation easements.

4) Research.

a. Research actions (see Recovery Action 4) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and results have been incorporated into habitat protection, habitat management and monitoring, and species monitoring plans as appropriate.

b. Research on genetic structure has been completed for reintroduction and introduction, and the results have been incorporated into habitat protection plans to ensure that genetic variation within and among populations is fully represented by protected populations.

c. Research necessary to determine appropriate parameters to measure population viability for the vernal pool fairy shrimp has been completed.

5) Participation and Outreach.

a. A working group of vernal pool stakeholders is assisting in recovery implementation within the Klamath Mountain Vernal Pool Region. (A subset of this group should be identified to coordinate with the rangewide team covering the entire range of vernal pool fairy shrimp in California and Oregon.)

b. The Klamath Mountain Vernal Pool Region working group has developed and implemented an outreach program that enables partnerships contributing to recovery criteria under the Habitat Protection section.

c. Participation plan for the Klamath Mountain Vernal Pool Region has been completed and implemented.

Recovery Criterion 1(b) above recommends protecting 85 percent of suitable vernal pool habitat in the Klamath Mountain Vernal Pool Region for vernal pool fairy shrimp. Thus, of approximately 2,200 hectares (5,000 acres) of vernal pool habitat

within the Rogue Valley, at least 1,720 hectares (4,250 acres) should be protected. As such we have developed the following guidance for vernal pool conservation in this area (U.S. Fish and Wildlife Service 2011a):

- A minimum of 1,720 hectares (4,250 acres) of vernal pool habitat should be protected through ownership, management, or conservation easement or agreement.

- A minimum of 200 hectares (500 acres) should be protected in the form of conservation banks.

    - Conservation banks should be a minimum of 70 acres. Banks can be composed of discontinuous parcels, with a core parcel of a minimum of 50 acres. Banks smaller than 70 acres can be approved on a case-by-case basis.

    - Conservation banks or bank parcels should be located within the historical range of the Agate-Winlo soil type. Existing vernal pool habitat can be conserved, restored and enhanced. Re-creation of vernal pool habitat (re-creation of surface topography where the underlying duripan layer is intact), may be considered on a case-by-case basis.

    - Creation of vernal pools (making vernal pool habitat in upland area) is considered a possible option at this time. Consideration of creating vernal pools will be on a case-by-case basis.

- A minimum of 400 hectares (1,000 acres) should be protected in the form of conservation easements or agreements.

- This conservation effort should be distributed throughout the Agate Desert, Table Rocks, and White City vernal pool fairy shrimp Recovery Core Areas. The arrangement of the protected parcels will allow for a network of protected parcels with a maximum distance between parcels of 2 miles or less.

Approximately 943 hectares (2,330 acres) are currently protected (Table II-6), and approximately 800 hectares (2,000 acres) still need to be protected to meet the recovery objective for the Klamath Mountain Vernal Pool region. Management plans

for several of the protected areas also need to be finalized and implemented. The protected areas include approximately:

- 72 hectares (180 acres) of conservation banks in various stages of establishment,
- 57 hectares (140 acres) in conservation easements,
- 223 hectares (550 acres) administered by Federal agencies,
- 324 hectares (800 acres) in State ownership, and
- 267 hectares (660 acres) owned by The Nature Conservancy.

5. Recovery Criteria Rationale

Suitable Habitat. Suitable habitat is the habitat that can be occupied by some or all of the listed plant species and/or the fairy shrimp. Suitable habitat occurs in only specific areas of Jackson and Josephine Counties and is composed of specific soil types (namely Agate-Winlo soils in the Agate Desert), is characterized by an intact hydrology, and often lacks soil disturbance. In addition to vernal pool wetland area, suitable habitat also includes adjacent buffer areas of upland habitat (see USFWS 2011), which provide ecosystem functions necessary to listed vernal pool species (*e.g.* upland habitat for pollinators, regulating hydrological processes, filtering of water-borne sediment and contaminants). In the Agate Desert, aerial photo interpretation is a method to quickly identify patterned ground indicative of vernal pool-mounded prairie habitat. However, not all patterned ground indicates properly functioning vernal pool-mounded prairie habitat. Protection of suitable habitat will be based on status surveys and habitat assessments for successful reintroduction.

Percent of suitable habitat within core areas to protect. Table IV-4 lists the percentages of suitable vernal pool habitat recommended to be protected for each core area. Most core areas in the Rogue Valley contain populations of more than one vernal pool species, so percentages of suitable habitat to protect within core areas are based on the number of species that occur in that core area and the relative rarity of species within that core area. These percentages also correspond with the recovery priority of the core area. Based on the threats the species face, and consistent with the recovery criteria set forth for the vernal pool fairy shrimp in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife

Service 2005a), recovery criteria recommend protection of 90 to 95 percent of suitable habitat within Priority 1 core areas and 85 to 90 percent of suitable habitat within Priority 2 core areas. In general Priority 1 core areas are subject to more significant threats and include less protected land, and may contain occurrences of more than one listed species, populations at the extreme edges of the range, and narrow or disjunct distributions that are known to be, or are likely to be, genetically or ecologically distinct; Priority 2 core areas are relatively less subject to threats, and may contain occurrences of more widespread species (such as vernal pool fairy shrimp) or have only one listed species present. The amount and location of habitat to be protected must be determined through standardized assessment of available habitat, status surveys, and development of captive propagation and reintroduction plans. However, as stated elsewhere in this plan, it may be possible to downlist or delist a species without specifically meeting all recovery criteria, if threats to the species have been sufficiently reduced that a five-factor analysis would support such a determination.

Reintroductions and introductions. Reintroductions are recommended for species with very few occurrences or for species that have experienced multiple extirpations. Reintroductions also are recommended if status surveys indicate a species has been extirpated from a particular vernal pool area or soil type. At this time, the current status of many populations and occurrences are unknown, so it is not possible to accurately define the numbers and locations of all reintroductions necessary to achieve recovery. Reintroductions are intended to reduce the risk of extinction due to stochastic events and/or to ensure that the species is distributed across its geographic and ecological range such that a species' adaptive potential and population dynamics can be maintained. These actions will require protection of the habitat on which reintroductions or introductions will occur and may require restoration of habitat as well.

Seed and cyst banking. Seed or cyst banking is recommended for species addressed in this recovery plan as insurance against risk of random extirpations, or for species that will require reintroductions or introductions to contribute to meeting recovery criteria. Seed banking is one means to ensure that genetic variation can be restored if extirpations or extinctions from random events occur. Seed banking is recommended at each population for the two listed plant species because they have few occurrences and are narrowly distributed.

F. NARRATIVE OUTLINE OF RECOVERY ACTIONS

This narrative outline of recovery actions follows the format of the recovery strategy. Within the recovery strategy format, component actions are presented in sequential order. In the Implementation Schedule (Section IV below), these actions are sorted by priority number, and the agencies and/or entities to whom these tasks apply are identified.

Action priorities are defined 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 or conservation objectives.

1 Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses.

Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery core areas, while lower priority

actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions.

The recovery strategy, actions, and criteria recommend protection of populations over the entire geographic and ecological distribution of each species in order to ensure representation of genetic variation. Priority core areas have been provisionally identified for the listed species for this recovery plan to protect species across their full geographic and ecological distributions and thus ensure preservation of the range of genetic variation.

1.1 Complete regional site assessments for the affected areas.

In 2007, the final draft of the Agate Desert Vernal Pool Function and Values Assessment Methodology was completed for the White City area in the Rogue Valley to assist with a region-wide conservation initiative (Environmental Science Associates 2007b). The Assessment Methodology identified which functions and values best determine highest priority habitats for vernal pool conservation. Vernal pool, wet meadow, and mixed forested habitat site assessments utilizing the Assessment Methodology can be used to identify preferred sites for protection. The network of conservation areas within the identified recovery core areas will include small, large, and intermediate-sized reserves. Large reserves are preferred because they minimize per-acre management costs, make it possible to preserve historic management regimes, where appropriate, for listed and special status species, reduce edge effect, and increase the likelihood of survival for their resident species by maintaining more ecosystem functions. However, small reserves also can contribute to recovery because they may contain the necessary genetic components of a species to maintain self-sustainability or function as stepping-stone populations to preserve pollination corridors.

Often, small areas are all that remain of formerly large ecosystems and represent unique genotypes or ecological conditions. Results of research into habitat needs will help determine minimum reserve size and optimal buffer size.

1.1.1 **Complete a habitat site assessment for the greater Illinois Valley region.** (Priority 2)

This action serves to identify prioritized sites for protection within the Illinois Valley. This action will better determine which functions and values best determine highest priority habitats. Aspects of this action includes an evaluation of habitat function, number of target species, presence of listed species (priority will be given to rarest species found), connectivity to other listed species populations, condition of habitat for function and value, and level of threats. The action will focus on core areas initially and then work beyond core areas into the wider Illinois Valley region.

1.1.2 **Complete the habitat site assessment methodology for the greater Agate Desert region** (Priority 2)

A draft of the Agate Desert vernal pool habitat assessment methodology (Environmental Science Associates 2007b) needs to be finalized to support Endangered Species Act consultation and recovery efforts.

1.2 Protect known or newly identified species occurrences, potential species occurrences, and their vernal pool, wet meadow, sloped mixed conifer forest, or shrub dominated habitat.

Much of the habitat that contains species covered in this recovery plan need to be protected over the long term. Protection of these lands includes the permanent reduction or elimination of the threats and application of appropriate and adaptive management to ensure species survival and recovery. In other cases, there may be lands that can contribute to the recovery or long-term conservation of vernal pool species. For example, for some vernal pool plant species, including some plants and shrimp, lands that occur within modern urban areas may need to be preserved only until species occurring in

those areas can be translocated, providing that scientifically collected data have shown that translocation of these species is successful and will benefit the species, appropriate habitat is available, and that strict success criteria have been developed.

Long-term protection of these lands includes the reduction or elimination of the threats, and application of appropriate management to ensure species survival and recovery. For example, Safe Harbor Agreements can provide private and non-Federal property owners' incentives to restore, enhance, and maintain habitats for listed species by providing assurances that their activities will not adversely impact listed species. Net conservation benefits from these voluntary agreements can establish or maintain connectivity between listed species' populations, can buffer existing populations, or can provide other net conservation benefits. Please see Appendix F for further discussion of Safe Harbor Agreements. Priority rankings for habitat protection in each core area are summarized in Tables IV-1 through IV-3 above. Appendix F describes numerous tools available to assist in the protection of habitat for vernal pool species.

1.2.1 Encourage Federal agencies managing land to use their authorities to protect habitat and promote the recovery and conservation of the species addressed in this recovery plan.

Under the authority of section 7(a)(1) of the Endangered Species Act, Federal agencies have a responsibility to implement habitat protective measures, minimize and avoid habitat loss (often through section 7(a)(2) consultations) and otherwise conserve listed species. Federal agencies can enter into cooperative partnerships, ensure adequate management plans are developed and implemented, and develop conservation agreements. When possible, Federal agencies should ensure that easements and agreements allow periodic site visits by Federal, State, and local agencies on protected lands to assess habitat condition, conduct status surveys, and perform research, where appropriate.

1.2.1.1 **Protect species occurrences and their habitat in Priority 1 core areas**. (Priority 1)

We consider protection of Priority 1 core areas to be essential to prevent extinction or irreversible decline of at least one species covered by this plan. If sufficient species occurrences and suitable habitat of each species are protected in Priority 1 core areas throughout the range of each species, it is anticipated that some of the species covered by this plan may be recovered.

1.2.1.2 **Protect species occurrences and their habitat in Priority 2 core areas.** (Priority 2)

This action is designated as a Priority 2 action because we consider the protection of species occurrences and their suitable habitat in Priority 2 core areas is necessary to prevent a significant decline in the species population or habitat quality or some other significant negative impact for at least one species covered under this plan. Protection of suitable habitat in Priority 2 core areas will contribute to recovery.

1.2.1.3 **Protect species occurrences and their habitat that occur outside of a core area, but within the Rogue Valley or Illinois Valley Regions.** (Priority 3)

If habitat and species occurrence protection in Priority 1 and 2 recovery core areas is not sufficient to recover or conserve the recovery plan's covered species, habitat and species occurrences should be protected elsewhere within the regions until sufficient suitable habitat and species occurrences have been protected.

1.2.2 **Encourage State and non-Federal public agencies managing land use their authorities to protect habitat and promote the recovery and conservation of the species addressed in this recovery plan.**

For example, State and local agencies can enter into cooperative partnerships, ensure adequate management plans are developed and implemented, or develop conservation programs consistent with the Oregon Endangered Species Act regulations.

1.2.2.1 **Protect species occurrences and their habitat in Priority 1 core areas.** (Priority 1)

1.2.2.2 **Protect species occurrences and their habitat in Priority 2 core areas.** (Priority 2)

1.2.2.3 **Protect species occurrences and their habitat that occur outside of a core area, but within the Rogue Valley or Illinois Valley Regions.** (Priority 3)

1.2.3 Assist in the establishment of new preserves, conservation easements, and land acquisitions onto existing preserves for local land trust organizations for listed species occurrences and their habitat through coordination with local, county and state agencies.

Many of these occurrences contain numerous discrete sub-occurrences scattered over a few square kilometers in an area of mixed ownership. The land supporting these occurrences is owned and managed by various parties, including commercial businesses, industrial timber companies, and ranch owners (with larger acreages), and relatively small-property residential owners (approximately 2 to 8 hectares [5 to 20 acres]). Protection agreements and strategies (*e.g.*, Habitat Conservation Plans, Safe Harbor Agreements, etc.) will likely vary depending on the particular owner or manager and the specific location of the species occurrence or sub-occurrence. See Tables IV-1 through IV-3 for priority levels of specific core areas.

1.2.3.1 **Protect species occurrences and their habitat in Priority 1 core areas.** (Priority 1)

1.2.3.2 **Protect species occurrences and their habitat in Priority 2 core areas.** (Priority 2)

1.2.3.3 **Protect species occurrences and their habitat that do not occur within a core area, but do occur within in the Rogue Valley or Illinois Valley Regions.** (Priority 3)

2. Manage, monitor, and restore vernal pool and wet meadow habitat.

Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation; monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known *Lomatium cookii*, *Limnanthes pumila* ssp. *grandiflora*, and vernal pool fairy shrimp populations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species.

2.1 Encourage Federal agencies managing land to use their authorities to conduct interim management to promote the recovery of listed species and the long-term conservation of the species of concern addressed in this recovery plan.

Long-term, comprehensive habitat management and monitoring plans are necessary to ensure that protected lands are managed to reduce and eliminate the threats that caused the species addressed in this recovery plan to become listed or species of concern. Long-term, comprehensive habitat management and monitoring plans should be developed and implemented to address habitat management

activities (*e.g.*, prescriptions for control or removal of invasive species), existing threats (*e.g.*, habitat degradation due to inappropriate levels of recreational use), species and habitat responses to habitat management activities, incorporation of monitoring results into habitat management plans, and schedule for the completion of operations and maintenance of ongoing routine tasks and one-time tasks. Currently the Medford District of the Bureau of Land Management is developing long-term management plans for the Table Rocks and French Flat Areas of Critical Environmental Concern. The Bureau of Reclamation has developed the long-term Agate Lake Vernal Pools Area Management Plan (Bureau of Reclamation 2006).

Often interim resource assessments conducted prior to plan development are necessary to prepare management plans that more realistically address threat reduction and management activities. The Nature Conservancy and Bureau of Land Management conduct habitat and species assessments that qualify as interim management.

2.1.1 **Conduct interim management on Federal lands in Priority 1 core areas**. (Priority 1)

2.1.2 **Conduct interim management on Federal lands in Priority 2 core areas**. (Priority 2)

2.1.3 **Conduct interim management on Federal lands that do not occur in a core area, but occur within Rogue Valley or Illinois Valley Regions**. (Priority 3)

2.2 Encourage non-Federal public agencies managing land use their authorities to conduct interim management to promote the recovery of listed species and the long-term conservation of the species of concern addressed in this recovery plan.

2.2.1 **Conduct interim management on non-Federal public lands in Priority 1 core areas**. (Priority 1)

2.2.2 **Conduct interim management on non-Federal public lands in Priority 2 core areas**. (Priority 2)

2.2.3 **Conduct interim management on non-Federal public lands that do not occur in a core area, but do occur within Rogue Valley or Illinois Valley Regions**. (Priority 3)

2.2.4 **Conduct interim management on non-Federal public lands that do not occur within a vernal pool region, but do contribute to recovery and long-term conservation of the species addressed in this recovery plan**. (Priority 3)

2.3 Encourage private landowners with existing conservation agreements are conducting interim management to promote the recovery of listed species and long-term conservation of the species of concern addressed in this recovery plan.

2.3.1 **Conduct interim management on lands in Priority 1 core areas.** (Priority 1)

2.3.2 **Conduct interim management on lands in Priority 2 core areas**. (Priority 2)

2.3.3 **Conduct interim management on lands that do not occur in a core area, but do occur within Rogue Valley or Illinois Valley Regions.** (Priority 3)

2.3.4 **Conduct interim management on lands that do not occur within a vernal pool region, but do contribute to recovery and long-term conservation of the species addressed in this recovery plan.** (Priority 3)

2.4 Develop and implement standardized monitoring techniques to evaluate ecosystem function and response, species response, and threat response to interim management activities. (Priority 1)

Standardized monitoring techniques need to be developed to ensure consistency and continuity of data between observers and over time and sufficient precision to detect changes. Standardized monitoring must be based on multiple criteria, but must be consistent and not unduly costly to implement. No single criterion will reliably measure trends consistently over time. Standardized monitoring techniques may also include, where applicable, notes on the degree of habitat fragmentation, degree of threat, shifts in vegetation type, establishment and loss of plant and animal occurrences, number of individuals, photopoints, estimates of acreage occupied, listed plant species density, co-occurring species including nonnative plants, time since last disturbance, and some estimate of seedbank or cystbank abundance.

The Nature Conservancy and Bureau of Land Management monitoring techniques employed to census listed species are an example of monitoring techniques that could be utilized at other conservation areas so that data can be consistent.

2.5 Enhance, restore, and create vernal pool habitats, as necessary, to promote the recovery and long-term conservation of the species addressed in this recovery plan.

Enhancement, restoration, and creation of vernal pool habitat may be necessary when natural vernal pools representing certain ecological conditions have been degraded or destroyed. In all cases practicable, existing pools should be used as a model for enhancement, restoration, and creation. Vernal pools should only be created when enhancement and restoration activities are not sufficient, and where creation is ecologically appropriate. Pools should not be created within existing vernal pool landscapes because of the risk of disrupting hydrologic function and the surrounding upland habitat that is important to many vernal pool species.

2.5.1 **Establish scientifically-based and site-specific appropriate, mechanisms and success criteria for the enhancement, restoration, and creation of vernal pool habitat.** (Priority 3)

Both the actual mechanisms and the success criteria for enhancement, restoration, and creation of vernal pool habitat may differ from one vernal pool region to another based on geographic, topographic and edaphic characteristics of the individual pools. However, we have begun developing a set of performance standards to minimize ambiguity between vernal pool areas. Also, mechanisms and success criteria should have both Federal and State interagency endorsement to ensure they are regionally applicable and accepted.

2.5.1.1 **Review and revise as necessary existing enhancement, restoration, and creation mechanisms and success criteria**. (Priority 3)

2.5.1.2 D**evelop scientifically-based and site-specific success criteria based on review of existing mechanisms for enhancement, restoration, and creation of vernal pool habitat.** (Priority 3)

2.5.2 **Identify and prioritize areas of historically occupied habitat with potentially suitable habitat for restoration and management for *Lomatium cookii, Limnanthes pumila* ssp. *grandiflora*, and vernal pool fairy shrimp.** (Priority 1)

Historical plant and vernal pool fairy shrimp populations that are currently declining or extirpated can potentially be restored or enhanced using wetland restoration techniques currently in the process of development.

2.5.3 **Develop an augmentation plan to collect and propagate seed that can later be utilized for population restoration, augmentation, and introduction**.

2.5.3.1 **Identify and prioritize appropriate seed collection sites with the permission and cooperation from both public and private landowners.** (Priority 1)

Range wide population surveys for federally listed species coupled with outreach may be necessary to identify appropriate seed collection sites.

Ideally, seeds should be banked from at least one population in each core area and from every known occurrence. After genetic studies are completed, additional collections should be made from each population that contains unique genotypes. Repeated, small collections of seed may be necessary over several years to avoid contributing to the decline of very small populations. The Center for Plant Conservation (1991) detailed the considerations for seed collection in its "Genetic Sampling Guidelines for Conservation Collections of Endangered Plants." Seed collections from each population of each taxon should be stored in at least two sites, including the National Center for Genetic Resources Preservation in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation such as the Rae Selling Berry Seed Bank in Portland, Oregon.

2.5.3.2 **Secure seed source at offsite locations and nurseries through land leases, partnerships, or agreements.** (Priority 1)

An available supply of seeds retained through conservation easements, partnerships, and agreements will facilitate introductions and population augmentations for the listed and conservation species in protected areas. Conservation agreements and easements will also promote partnerships and sharing of conservation goals.

2.5.3.3 **Collect and store seeds from listed plant occurrences on Priority 1 core areas**. (Priority 1)

2.5.3.4 **Collect and store seeds from listed plant occurrences Priority 2 core areas**. (Priority 2)

2.5.4 **Establish scientifically based and site-appropriate mechanisms and success criteria for the collection, storage, and use of soil containing vernal pool fairy shrimp cysts for the purpose of inoculating restored or created vernal pool habitat.**

Both the actual mechanisms and the success criteria for collection, storage, and use of vernal pool soils containing vernal pool fairy shrimp cysts may differ from one vernal pool region to another based on topographic and edaphic characteristics of the individual pools and the biological needs of the target species. However, the mechanisms and success criteria should be developed as uniformly as possible (*i.e.*, standardized) to minimize ambiguity between regions. Also, mechanisms and success criteria should have both Federal and State interagency endorsement to ensure they are regionally applicable and accepted.

2.5.4.1 **Review history of collection of cyst-bearing soils, as needed, to determine need to collect cysts and the number of cysts necessary.** (Priority 1)

Cyst collections for shrimp taxa should be representative of both population and species-level genetic diversity.

2.5.4.2 **Review existing mechanisms of collection of soils bearing vernal pool fairy shrimp cysts, storage, and application and success criteria.** (Priority 3).

2.5.4.3 **Develop a prioritized list of sites from which vernal pool fairy shrimp cysts need to be collected**

to further the recovery and long-term conservation of vernal pool species. (Priority 3)

2.5.4.4 **Conduct collection of soil containing cysts for use in inoculation of created or restored vernal pool habitat, as necessary, for vernal pool fairy shrimp.** (Priority 2)

Initially, cyst-bearing soils should be collected from at least one population in each core area. After genetic studies are completed, additional collections should be made from each population that contains unique genotypes.

2.6 Develop and implement augmentation and reintroduction programs, as needed, to restore extirpated populations and protect individual species from the threat of extirpation due to random environmental and/or genetic events.

When necessary, species augmentation and reintroductions have utility as part of a sound recovery strategy. Conservation of vernal pool plants and animals requires increasing their survival prospects, despite foreseeable events. Off-site or ex-situ methods can make the difference between survival and extinction, by preventing unique genotypes from disappearing altogether. While accession of seeds or cysts can be an important component of a comprehensive recovery strategy, it is by no means meant to replace conservation of populations in their natural habitat. Ex-situ work is intended to support in-situ conservation. Collection, storage, and propagation of seeds and cysts should only be conducted where necessary to preserve rare or unique genotypes or occurrences in danger of extirpation.

2.6.1 Reintroduce or augment listed species populations as needed to suitable habitat.

Introductions into suitable protected localities may be considered for specific sites following assessment of feasibility and likely population survival.

2.6.1.1 **Conduct research into techniques and determination of success criteria for enhancement, restoration, and creation, including feasibility of reintroductions and introductions.** (Priority 1)

2.6.1.2 **Develop reintroduction plans for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* that will identify and prioritize appropriate outplanting locations, augmentation and reintroduction techniques, and outplanting strategies.** (Priority 1)

2.6.1.3 **Reintroduce or introduce *Limnanthes pumila* ssp. *grandiflora* to Federal lands in the Rogue Valley according to Table IV-4.** (Priority 1)

2.6.1.4 **Reintroduce or introduce *Lomatium cookii* to Federal lands in the Rogue Valley and additional Federal lands in the Illinois Valley according to Table IV-4.** (Priority 1)

2.6.2 **Implement introduction of cyst-bearing soils to restored or created habitat based on scientifically sound and site-appropriate, mechanisms.**

2.6.2.1 **Reintroduce or introduce vernal pool fairy shrimp cyst-bearing soils to core areas in the Rogue Valley according to Table IV-4.** (Priority 2)

2.6.3 **Adaptively manage the cyst monitoring as necessary to provide for changes to data collection and management of vernal pool species.** (Priority 3)

It may be necessary to modify cyst-bearing soil collection, storage, or application mechanisms and success criteria, as necessary, to achieve recovery and long-term conservation of the species addressed in this recovery plan. This "adaptive" approach is essential to the recovery and long-term conservation of vernal pool species as new information becomes available.

2.7 Confirm that public agencies are developing and implementing long-term management plans directed to conserve vernal pool and wet meadow habitats within the southwest Oregon region.

2.7.1 **Assist in the implementation of species management actions for the Oregon Department of Fish and Wildlife Denman Wildlife Area.** (Priority 1)

The Denman Wildlife Area is currently implementing conservation actions for vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii*. Under a contract funded by a section 6 grant to the Oregon Department of Fish and Wildlife, The Nature Conservancy has assessed wetland habitat status within the Denman Wildlife Area and identified major restoration priorities for listed species (Borgias *et al.* 2009). These priority actions are being implemented as funding is available.

2.7.2 **Encourage the finalization of the management plan for the Bureau of Land Management Table Rock Area of Critical Environmental Concern.** (Priority 2)

A management plan has been under preparation for the Table Rock core areas by the Bureau of Land Management. The plan, expected to be finalized in 2012, will establish vernal pool habitat protection for threats from grazing and pedestrian usage. Site assessments are underway to evaluate vernal pool quality, presence of vernal pool fairy shrimp to prioritize management actions and determine focal areas.

The Table Rock core areas are identified as Priority 2 because they only support one listed species, the vernal pool fairy shrimp. However the core areas also support *Limnanthes pumila* ssp. *pumila*, *Plagiobothrys austiniae*, and *P. greenei*.

2.7.3 **Encourage implementation of the Bureau of Reclamation Agate Lake Area management plan.** (Priority 1)

The Bureau of Reclamation has prepared the Agate Lake Management Plan (Bureau of Reclamation 2006) to conserve and better protect vernal pool habitats. Management actions include restoration of vernal pool habitat, reduction of nonnative weed threats by grazing, burning, or mowing prescriptions, habitat assessments, and procedures to reduce impacts from maintenance activities. The plan proposes to seed burned areas with native seed. Monitoring efforts will determine if *Lomatium cookii* occurs at the area and will attempt to relocate a historical record of *Limnanthes pumila* ssp. *grandiflora*. This core area provides good potential for expanding the distribution of *Limnanthes pumila* ssp. *grandiflora* or *Lomatium cookii*; if warranted, populations may be introduced or augmented.

2.7.4 **Provide technical assistance to Oregon Parks and Recreation Department with implementation of *L. cookii* species management actions at the Illinois River Forks State Park.**

Illinois River Forks State Park has identified management actions that will reduce or eliminate threats to *Lomatium cookii* in the park. Such threats include succession of native woody vegetation, noxious weeds, or impacts unauthorized off-road vehicle use.

2.7.5 **Encourage use of and/or enter into a conservation agreement with Oregon Department of Transportation**

Special Management Areas in Jackson and Josephine Counties. (Priority 1)

A management plan for the Oregon Department of Transportation Special Management Areas would include site habitat assessments, threat reduction practices, population monitoring, and conservation measures to reduce or eliminate impacts from road maintenance actions.

2.7.6 **Assist with the Rogue Valley Regional General Permit and conservation banking plan**. (Priority 1)

An initiative to coordinate between the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency to direct conservation of the highest quality vernal pool habitat in the White City area has commenced. Intraservice consultation has been completed by the U.S. Fish and Wildlife Service for a forthcoming U.S. Army Corps of Engineers regional general permit, which is currently in the final stages of preparation. The Oregon Department of State Lands has also recently finalized their General Permit for the Rogue Valley region. Conservation banking in compensation for wetland impacts can be streamlined and could result in protection for approximately 1,477 hectares (3,650 acres) of vernal pool fairy shrimp habitat in the White City area, but in anticipation of losses of lower quality, isolated vernal pool habitat and non-vernal pool wetlands Under the consultation, loss of up to 45 hectares (110 acres) of vernal pool wetland is covered, with compensation ratios averaging 3 acres of protection or 2 acres of restoration to 1 acre lost (U.S. Fish and Wildlife Service 2011a).

2.8 Revise existing management plans, as necessary, to reflect new research findings or information as it becomes available. (Priority 2)

This recovery action should be coordinated with State and Federal agencies, city managers, landowners, and private land trust organizations. As sufficient data are gathered, management plans should be updated as appropriate to apply refined management techniques and actions.

3. Conduct rangewide population status surveys.

A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site.

3.1 Conduct strategic, region wide monitoring efforts for listed taxa in this recovery plan.

In order to develop and update the statuses of listed species covered in this recovery plan and refine recovery actions, continuing survey efforts of known listed species occurrences used in concert with Geographic Information Systems mapping is recommended. Data sets collected from previous listed species surveys in the Rogue and Illinois Valleys will be utilized for comparison with current surveys to establish population trends.

3.1.1 **Identify and prioritize areas within each vernal pool region, starting with core areas, to conduct standardized status surveys.** (Priority 1)

The status survey must be adequate to assess whether a species is stable or declining. Areas to be surveyed within vernal pool regions that contribute to the recovery of a species should be determined based on the following parameters: 1) core areas; 2) known and newly identified localities of each species within each vernal pool region; 3) historic localities of each species within each vernal pool region; 4) potential

habitat locations identified through implementation of Action 1.2; 5) species statuses within each vernal pool region (*e.g.*, surveying a subset of localities for wide-ranging species versus all known localities for narrowly distributed species); 6) recovery criteria/goals for each species, and 7) standardized survey guidance as developed above in Action 2.4.

3.1.2 **Conduct standardized species status surveys within each core area.** (Priority 1)

Known and newly identified locations are surveyed to determine species population sizes and status of threats, and recommendations for improving conservation efforts are made for each locality. This action is linked to Action 2.4 so it should be completed and implemented concurrently.

3.2 Survey for additional occurrences of the listed species. (Priority 1)

Potential suitable habitat within core areas for *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp remain unsurveyed, particularly on private land. Recently identified occurrences (Jackson School District and Commerce Street) on county and private lands indicate the potential for discovering additional occurrences.

3.3 Perform standardized, periodic core area site assessments for the 28 core areas. (Priority 1)

The core areas identified in this recovery plan are based on historical and currently known listed plant occurrences, aerial photo interpretation, soil Geographical Information System layers and represent the full range and distribution of the species. Within these core areas, focused site assessment surveys should be conducted to refine and prioritize recovery actions to be consistent with the changing landscape.

3.4 Periodically review progress toward listed species recovery and long-term conservation of nonlisted species and identify those species warranting a change in status (downlisting, delisting, uplisting, or listing).

These reviews should be based on results of standardized status surveys and other information from research, habitat protection, management, and monitoring actions.

3.4.1 **Revise suitable species habitat maps and core area boundaries as new information becomes available.** (Priority 2)

3.4.1 **Conduct status reviews of listed species in this recovery plan and identify those species warranting a change in status.** (Priority 2)

3.4.2 **Conduct status reviews of nonlisted species in this recovery plan**. (Priority 3)

3.5 Conduct post-delisting monitoring of recovered species. (Priority 3)

As species are recovered, post-delisting monitoring is required for a specified number of years, depending on the species, until a continued stability or improvement in the species status has been documented.

4. Conduct research essential to the conservation of these species.

In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. The following are areas for critical research needed for effective management of these species:

4.1 **Study pollination vectors between and among populations.** (Priority 2)

Pollination vectors are often used to define how populations are linked as pollinators establish a genetic link between populations. Genetically isolated and stepping stone populations may be considered to be a higher conservation priority.

To refine protection in core areas and conservation measures, managers may utilize pollination information, along with habitat management information.

4.2 **Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors.** (Priority 3)

The cyst and seed dispersal mechanisms and vectors for species treated in this recovery plan require further investigation. Study of the rate and distance with which animals and wind distribute seed or cysts may lead to an entirely new understanding of how populations become distributed and why they persist only in localized areas. For plants, this entails studying the dispersal of seeds and pollen and for animals, cyst dispersal vectors. Data regarding dispersal mechanisms for vernal pool species are critical to ensuring that decisions about reserve size and location, habitat management activities, and corridor establishment between reserves allow for properly functioning metapopulations. Public land managers and private landowners should be able to provide for adequate gene flow among populations to promote and ensure viability.

4.3 **Evaluate techniques to reduce impacts from encroachment of native woody plant succession.** (Priority 2)

Lomatium cookii populations in the Illinois Valley are largely threatened by succession of woody plants due to fire exclusion. Restoration techniques need to be studied to determine the most feasible methods of habitat restoration. Thinning, brushing, burning or combinations of these should be evaluated for cost effectiveness, efficiency, and greatest benefit to species long-term viability.

4.4 **Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses.** (Priority 2)

In the Rogue Valley, exotic grasses such as *Taeniatherum caput-medusae* have infested extensive tracts of vernal pools. The success of techniques such as prescribed burning, mowing, native grass and forb cultivation, and combinations thereof to achieve pre-grazing conditions should be evaluated to formulate an exotic grass reduction protocol that can be readily available to land managers and landowners.

4.5 **Refine research on appropriate grazing practices**. (Priority 2)

Appropriate grazing can be a surrogate for historical fires that periodically reduced the grass cover to enable germination of listed plants. Appropriate grazing may facilitate seed distribution and stimulate ecosystem health. This information will provide a tool to area managers to aid in conservation and promote ecosystem health.

If thoughtfully timed and managed, grazing may potentially benefit the species covered in this recovery plan by reducing competition with introduced grasses and problems with accumulated thatch. Early fall grazing and proper rotation may be particularly beneficial by reducing the populations of nonnative competitors and creating additional microdiversity within the vernal pools (Borgias 2004, Marty 2005).

4.6 **Research genetic and morphologic traits among individuals and populations.** (Priority 1)

Priorities for genetics studies are as follows: 1) species that require reintroduction and/or introduction; 2) species that will require seed or cyst banking because of high risk of extirpations due to random events; and 3) species/populations that have experienced extreme reductions in range and/or population numbers that may now require genetic management to offset deleterious effects of genetic drift, bottlenecks and inbreeding depression, etc.

4.7 **Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill.** (Priority 2)

Restoration of historical vernal pool habitat is being pursued in the Rogue Valley on habitat that was partially leveled, filled with woody debris or biosolids. Research can assess various techniques to achieve faster restoration of vernal pool and wet meadow habitats while stimulating ecosystem health. This information can also provide a tool to area managers to aid in conservation and promote ecosystem health.

4.8 **Determine incidence of herbivory or predation on *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* populations.** (Priority 3)

Although incidence of herbivory or predation has not been repeatedly observed, it is possible that declining populations could be attributed to below-ground predation by insects or mammals. If the threat of herbivory or predation is determined to present a serious obstacle to the recovery of the two species, then appropriate measures should be undertaken to minimize or avoid these threats. At this time disease or predation are not known to seriously impact the two listed plants.

4.9 **Develop offsite and onsite cultivation and propagation techniques for *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora*.** (Priority 1)

A necessary step to restore and recover populations for the two listed plants is to evaluate cultivation and propagation techniques to establish standardized procedures and protocols. Success criteria should be established prior to commencing cultivation and propagation studies. A standardized protocol will enable a larger number of nurseries to participate in recovery so that species genetics can be better preserved.

4.10 **Research associated soil crusts as indicators for vernal pool health and function.** (Priority 3)

Understanding of the relationship between soil crusts and vernal pool ecosystem health will enable managers to establish additional success criteria in vernal pool restoration and enhancement evaluations. The research may provide clues to better understand ecosystem dynamics of vernal pools.

5. Enhance public awareness and participation in recovery of the species.

Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the three listed species.

5.1 Continue engagement and use of locally led groups implementing conservation oriented efforts for vernal pool and wet meadow systems in the Rogue Valley and Illinois Valley. (Priority 1)

In the Rogue and Illinois Valley, we are aware of existing locally led multi-stakeholder groups with an interest in conservation of vernal pool and wet prairie ecosystems. We recommend continued engagement of these local stakeholder and technical work groups, as appropriate, to implement effective outreach, education, landowner participation, and recovery actions. For example, a vernal pool stakeholder group in Jackson County is already in place and is comprised of federal, state, and county agencies and private land owners and non-governmental organizations who have effectively implemented vernal pool conservation actions. We recommend this group continue its valuable work with Service assistance as appropriate.

Establishing a technical work group to provide technical advice may also be necessary to assist in recovery. This group could

be comprised of invertebrate zoologists, botanists, ecologists, range scientists, fire effects experts, and other experts to participate as appropriate. Their role could be to review and provide input on habitat protection and management (Actions under 1.2), species and habitat monitoring (Action 2.4), completion of a reintroduction plan for each species (Action 2.6.1.2), completion of a habitat assessment methodology (Action 1.1.2) completion of research actions (Actions under 4.0), revising suitable species habitat maps and core area boundaries as new information becomes available (Action 3.4.1), and develop a strong public participation and outreach program (Actions under 5.3).

5.2 Form individual recovery zone work groups, as needed, that engage participation from for private landowners, nongovernmental target audiences, and Federal, State, and local agencies to promote the recovery of listed species and long-term conservation of the species of concern addressed in this recovery plan.

5.2.1 **Form individual working groups for the Rogue Valley and Illinois Valley regions.** (Priority 1)

The regional work groups would cooperatively implement specific actions necessary to recover the listed species and conserve the species of concern addressed in this recovery plan. Additionally, a role of the work groups could be to track progress of recovery efforts and provide annual progress reports of activities including recommendations for future recovery actions or changes to existing actions to benefit species.

5.3 Prepare and implement an outreach strategy for enlisting stakeholder involvement in the implementation of the recovery plan. (Priority 2)

An outreach strategy with success criteria should be prepared, for example by the regional work groups, to better focus outreach

efforts. Options for outreach should be pursued so that all possible sources and assistance can be utilized for creating outreach opportunities and with a goal to enlist stakeholder involvement and participation in the recovery plan.

5.3.1 **Establish contacts with the public to provide information about species covered under the recovery plan.** (Priority 1)

Participation in public community or municipal planning events will enable the public to understand our mission towards forming partnerships to conserve and protect threatened and endangered species and their habitat. In turn, conservation opportunities with willing landowners may result from these public contacts.

5.3.2 **Create and distribute plant and animal identification and habitat restoration guides to landowners and the general public regarding plant and animal species included in this recovery plan**. (Priority 2)

The general public will be provided a colored identification guide to help them learn to identify the listed species. Circulation of these guides will help the local public to recognize plant species. As vernal pool fairy shrimp are difficult to identify and view during most of the year, the guide will describe intact vernal pool mounded prairie complexes and what kinds of factors enable functioning habitats.

5.3.3 **Participate at local outdoor shows and other public events.** (Priority 3)

In order to better communicate with the public, vernal pool displays at county outdoor shows in Oregon should be continued. When feasible, staff from various regulatory and management agencies (U.S. Fish and Wildlife Service, Oregon Department of Fish and Game, Bureau of Land Management, etc.) should be available to discuss vernal pool ecosystems with

interested attendees of the show. In addition to the general information contained in the display, updated information on conservation activities should also be included as recovery efforts continue. Through participation in outdoor events, identification of potential stakeholders with interests in recovery implementation for species covered in this recovery plan can be accomplished.

5.3.4 **Invite the public to assist in long-term monitoring.** (Priority 3)

To the extent feasible, interested members of the public should be invited to participate in long-term monitoring of *Lomatium cookii*, *Limnanthes pumila* ssp. *grandiflora* and vernal pool fairy shrimp populations. Training of volunteers will foster public awareness of local listed species and local environmental changes, as well as provide a relatively low-cost labor pool to contribute to monitoring efforts.

5.3.5 **Provide schools within the area covered by the recovery plan with information about the species and recovery efforts.** (Priority 3)

To foster interest about special status species among young people, schools within the area covered by the recovery plan should be provided with information about all of the covered species and recovery efforts.

6. Develop post-delisting monitoring plans.

Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved.

6.1 **Complete post-delisting monitoring plan for *Limnanthes pumila* ssp. *grandiflora*.** (Priority 3)

6.2 **Complete post-delisting monitoring plan for *Lomatium cookii*.** (Priority 3)

6.3 **Complete post-delisting monitoring plan for vernal pool fairy shrimp.** (Priority 3)

V. Implementation Schedule

The following Implementation Schedule is a guide for meeting the objectives discussed in Part IV of this plan. This schedule indicates recovery action priorities, action numbers, brief action descriptions, duration of actions, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* and protect their habitat, as well as benefiting the conservation of the nonlisted species of concern and allowing the Agate Desert area to fully contribute to the rangewide recovery of vernal pool fairy shrimp.

Priority. The priority for each recovery action is given in the first column of the implementation schedule. Priorities are defined 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 or conservation objectives.

Action Number and Description. The action number and description are extracted from the Step-down Narrative found in Part IV of this recovery plan. Please refer back to this narrative for a more detailed description of each action.

Definition of action durations:

Continual:	An action that will be implemented on a routine basis once begun.
Ongoing:	An action that is currently being implemented and will continue until action is no longer necessary.
TBD:	To be determined.
Unknown:	Either action duration or associated costs are not known at this time.

Threats Addressed. This column addresses the five listing factors that the particular recovery action will eliminate or reduce. The listing factors, represented by A through E in the implementation schedule, are presented in the Reasons for Listing section (page III-1-III-5) and reflect the threats found in section 4(a) of the Endangered Species Act.

Responsible Parties. In the implementation schedule, we have identified agencies and other parties that are or may become primary stakeholders in the recovery process. The list of potential stakeholders is not limited to the list below; other stakeholders are invited to participate. The most logical lead agency or agencies from the list of responsible parties (based on authorities, mandates, and capabilities) has been identified with an asterisk (*). The following abbreviations are used to indicate the responsible party for each recovery action:

Key to Acronyms used in the Implementation Schedule:

Berry	Rae Selling Berry Seed Bank
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CITY	Cities of Cave Junction, Medford, and White City
COE	Army Corps of Engineers
DSL	Oregon Department of State Lands
EPA	Environmental Protection Agency
EDU	University and college institutions
FAA	Federal Aviation Administration
FWS	U.S. Fish and Wildlife Service
COS	County Governments
ODA	Oregon Department of Agriculture
ODOT	Oregon Department of Transportation
ORBIC	Oregon Biodiversity Information Center
OPRD	Oregon Parks and Recreations Department
RVCOG	Rogue Valley Council of Governments
PLT	Private Land Trust Organizations
Total Cost	Projected cost of each action from start to completion

* - Lead Agency

Cost Estimates. Estimated total and annual cost for each recovery action for the first 5 years after release of the recovery plan are shown. Total costs for continual and ongoing

actions are based on the estimated time to recovery. The costs include estimated salaries for individuals who will carry out identified actions. However, these costs are approximate and based primarily on estimates agreed on by various State, Federal and local government agencies and nongovernmental organizations. In most cases these costs were estimated without the benefit of a scope-of-work or any other type of bid process. Typically, the responsible party (or lead agency) bears the largest share of the cost, with other stakeholders as contributors. The inclusion of estimated costs in this recovery plan does not commit any agency or party to an expenditure of funds. Therefore, initiation and completion of these actions is subject to the availability of funds as well as other constraints affecting the stakeholders involved.

Note: See the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005a) for implementation schedule requirements for vernal pool fairy shrimp.

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
1	1.2.1.1	A,E	Ensure Federal agencies managing land use their authorities to protect habitat in Priority 1 core areas.	Every year until delisting or downlisting	FWS*, BLM, BOR, COE, EPA, FAA, FTA	100	5	5	5	5	5
1	1.2.2.1	A,E	Ensure non-Federal public agencies managing land use their authorities to protect habitat and promote the recovery and conservation of listed species in Priority 1 core areas.	Every year until delisting or downlisting	ODA*, ODOT, ODFW, FWS	100	5	5	5	5	5
1	1.2.3.1	A,E	Ensure land trust organizations preserve listed species occurrences and habitat and promote recovery in Priority 1 core areas.	Every year until delisting or downlisting	FWS*, PLT, ODA	20	1	1	1	1	1
1	2.1.1	A, E	Conduct interim management on Federal lands in Priority 1 core areas.	5 years	BLM, BOR, FWS*	50	10	10	10	10	10
1	2.2.1	A,E	Conduct interim management on non-Federal public lands in Priority 1 core areas.	5 years	PLT, FWS*, ODA	50	10	10	10	10	10

[1] Based on recovery achieved in 20 years; * Lead agency

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
1	2.3.1	A,E	Ensure private landowners with existing conservation agreements are conducting interim management on lands in Priority 1 core areas.	5 years	PLT, FWS*, ODA	250	50	50	50	50	50
1	2.4	A,B,E	Develop and implement standardized monitoring techniques to evaluate ecosystem function and response, species response, and threat response to interim management activities	1 year	FWS*, ODA, PLT, BLM, ORBIC	40		40			
1	2.5.2	A,E	Identify and prioritize areas of historically occupied habitat with potentially suitable habitat for restoration and management for *Lomatium cookii*, *Limnanthes pumila* ssp. *grandiflora*, and vernal pool fairy shrimp.	Every 5 years	FWS*, ODA, BLM, ODOT, PLT	800	200				
1	2.5.3.2	A,E	Secure seed source at offsite locations and nurseries through land leases, partnerships, or agreements.	Every year until delisting or downlisting	FWS*, ODA, Berry	500	25	25	25	25	25

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
1	2.5.3.3	A, E	Collect and store seeds from listed plant occurrences on Priority 1 core areas.	8 years	FWS*, ODA, Berry	16	2	2	2	2	2
1	2.5.4.1	A,E	Review history of collection of cyst-bearing soils, as needed, to determine need to collect cysts and the number of cysts necessary.	6 months	FWS*, ODFW	10		10			
1	2.6.1.1	E	Conduct research into techniques and determination of success criteria for enhancement, restoration, and creation, including feasibility of reintroductions and introductions.	2 years	ODA, FWS*, PLT	80		40	40		
1	2.6.1.2	E	Develop Reintroduction Plans for the two listed plant species that will identify and prioritize appropriate outplanting locations, augmentation and reintroduction techniques, and outplanting strategies	5 years	ODA, FWS*, PLT, Berry	TBD					

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
1	2.6.1.3	A,E	Reintroduce or introduce *Limnanthes pumila* ssp. *grandiflora* to Federal lands in the Rogue Valley.	Every year until delisting or downlisting	FWS*, ODA, BOR	500	25	25	25	25	25
1	2.6.1.4	A,D,E	Reintroduce or introduce *Lomatium cookii* to Federal lands in the Rogue Valley and additional Federal lands in the Illinois Valley.	Every year until delisting or downlisting	FWS*, ODA, BLM	500	25	25	25	25	25
1	2.6.2.1	A,D,E	Reintroduce or introduce vernal pool fairy shrimp cyst-bearing inoculum to core areas in the Rogue Valley.	As needed until delisting or downlisting	FWS*, ODFW, BLM	TBD					
1	2.7.1	A, E	Assist in the implementation of species management actions for the Oregon Department of Fish and Wildlife Denman Wildlife Area	2 years	FWS, ODFW*, PLT	20	10	10			
1	4.7	E	Research genetic and morphologic traits among individuals and populations.	1 year	FWS*, ODA	45			45		

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
1	4.10	A, E	Develop offsite and onsite cultivation and propagation techniques for *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora.*	3 years	FWS*, ODA, BLM	270	90	90	90		
1	5.1	A, E	Form a single Rogue Valley and Illinois Valley recovery implementation team.	3 months	FWS, ODA, BLM, PLT, SOU, Berry	10	10				
1	5.2.1	A, E	Form individual working groups for the Rogue and Illinois Valley regions.	TBD	FWS*, ODA, PLT, ODOT, Berry						
1	5.3.1	A,E	Establish contacts with the public to provide information about species covered under the recovery plan.	Ongoing	FWS*, PLT, RVCOG	60	3	3	3	3	3
1	5.7.1.2	A,E	Develop agreements with landowners or land managers in Priority 1 core areas.	Every year until delisting or downlisting	FWS, PLT*,	40	2	2	2	2	2

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
2	1.1.1	A,E	Complete a vernal pool site assessment for the greater Agate Desert region.	2 years	DSL*, FWS*, COE, RVCOG	80	40	40			
2	1.1.2	A, E	Complete a wet meadow site assessment for the greater Illinois Valley wet meadow region.	2 years	DSL, FWS*, COE	120	60	60			
2	1.2.1.2	A, E	Ensure Federal agencies use their authorities to protect species occurrences and their habitat in Priority 2 core areas.	Every year until delisting or downlisting	FWS*, BLM, COE, BOR	500	25	25	25	25	25
2	1.2.2.2	A, E	Ensure State and non-Federal agencies use their authorities to protect species occurrences and their habitat in Priority 2 core areas.	Every year until delisting or downlisting	FWS, ODA*, ODFW, ODOT, OPRD	200	10	10	10	10	10
2	1.2.3.2	A, E	Assist in the establishment of new preserves on private lands to protect listed species occurrences and their habitat in Priority 2 core areas.	Every year until delisting or downlisting	FWS, PLT*	200	10	10	10	10	10
2	2.1.2	E	Conduct interim management on Federal lands in Priority 2 core areas.	3 years	FWS, BOR*, BLM*	30	10	10	10		

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
2	2.2.2	E	Conduct interim management on non-Federal public lands in Priority 2 core areas.	As needed	FWS, ODOT, ODWF	10	2	2	2	2	2
2	2.3.2	E	Conduct interim management on private lands in Priority 2 core areas.	As needed	FWS, PLT	10	2	2	2	2	2
2	2.5.3.1	E	Identify and prioritize appropriate seed collection sites with the permission and cooperation from both public and private landowners.	Every year until delisting or downlisting	FWS, Berry*, ODA	40	2	2	2	2	2
2	2.5.3.4	A,E	Collect and store seeds from extant sites in Priority 2 core areas.	3 years	FWS, Berry	30	10	10	10		
2	2.5.4.4	A, E	Conduct collection of soil containing cysts for use in inoculation of created or restored vernal pool habitat, as necessary, for vernal pool fairy shrimp.	TBD	FWS, ODFW, PLT						
2	2.7.2	E	Finalize the management plan for the Bureau of Land Management Table Rock Area of Critical Environmental Concern.	3 years	FWS, BLM*	6	2	2	2		

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
2	2.7.3	A, E	Ensure the management plan for the Bureau of Reclamation Agate Lake Area is implemented.	Every year until delisting or downlisting	FWS, BOR*	100	5	5	5	5	5
2	2.7.4	E	Provide technical assistance to Oregon Parks and Recreation Department's Illinois River Forks State Park.	3 years	FWS, OPRD*, ODA	3	1	1	1		
2	2.7.5	A, E	Develop a management plan for or enter into a conservation agreement with Oregon Department of Transportation in Jackson and Josephine Counties.	3 years	FWS, ODOT*, ODA	30		10	10	10	
2	2.7.6	A, E	Assist with the Agate Desert Wetland Conservation Plan/White City Regional General Permit and conservation banking plan.	Every year until delisting or downlisting	FWS, DSL*, COE, RVCOG, ODOT	100	5	5	5	5	5
2	2.8	A,E	Revise existing management plans to reflect new research findings or information as it becomes available.	As needed	FWS*, BOR, BLM, OPRD, ODFW, PLT	5	1	1	1	1	1

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
2	3.1	E	Conduct strategic, region wide monitoring efforts for listed taxa in this recovery plan.	Every 3 years	FWS*, ODA, BLM, PLT, ORNHICORBIC	320	40			40	
2	3.2	E	Survey for additional occurrences of the listed plant species.	Every 5 years	FWS*, ODA, BLM, PLT, ORNHICORBIC	200	40				
2	3.3	A	Perform periodic core area site assessments for the 22 core areas.	Every 5 years	FWS*, DSL, ODA, BLM, PLT, ORNHICORBIC	400		100			
2	3.4.1	A,E	Revise suitable species habitat maps and core area boundaries as new information becomes available.	As Needed	FWS, ODA, PLT	10	2	2	2	2	2

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
2	3.4.2	A,E	Conduct status reviews of listed species in this recovery plan and identify those species warranting a change in status.	Every 5 years	FWS*	20	5				
2	4.1	A	Implement standardized monitoring to document ecosystem and species responses to interim habitat management activities.	1 year	FWS*, PLT, BLM	10	10				
2	4.2	E	Study pollination vectors between and among populations	1 year	FWS, ODA	40		40			
2	4.4	E	Evaluate techniques to reduce impacts from encroachment of native woody plant succession.	3 years	FWS, BLM*, ODA, PLT	120	40	40	40		
2	4.5	E	Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses.	5 years	FWS, BLM*, ODFW, BOR, PLT	100	20	20	20	20	20
2	4.6	A, E	Refine research on appropriate grazing practices.	5 years	FWS, BLM*, ODFW, BOR, PLT	100	20	20	20	20	20

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
2	4.8	E	Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill.	3 years	FWS*, ODFW, BOR, PLT	60	20	20	20		
2	5.3.2	A	Create and distribute plant and animal identification and habitat restoration guides to landowners and the general public regarding plant and animal species included in this recovery plan.	1 year	FWS*, BLM, RVCOG, ODFW	25	25				
3	1.3.1.4	A	Protect species occurrences and their habitat that do not occur within a core area, but do occur within in the Rogue Valley or Illinois Valley Regions.	Every year until delisting or downlisting	FWS, BLM, BOR, COE	10	0.5	0.5	0.5	0.5	0.5
3	1.2.2.4	A	Protect species occurrences and their habitat that do not occur within a core area, but do occur within in the Rogue Valley or Illinois Valley Regions.	Every year until delisting or downlisting	FWS, ODA*, ODFW, ODOT, OPRD	5	0.25	0.25	0.25	0.25	0.25
3	1.2.3.4	A	Protect species occurrences and their habitat that do not occur within a core area, but do occur within in the Rogue Valley or Illinois Valley Regions.	Every year until delisting or downlisting	FWS*, PLT	20	1	1	1	1	1

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
3	2.1.3	A, E	Conduct interim management on Federal lands that do not occur in a core area, but do occur within a vernal pool region.	3 years	FWS, BOR, BLM	10	3.33	3.33	3.33		
3	2.1.4	A, E	Conduct interim management on Federal lands that do not occur within a vernal pool region, but do contribute to recovery and long-term conservation of the species addressed in this recovery plan.	3 years	FWS*, BOR, BLM	10	3.33	3.33	3.33		
3	2.2.3	A	Conduct interim management on non-Federal public lands that do not occur in a core area, but do occur within a vernal pool region.	3 years	FWS, ODA*, ODOT, OPRD, ODFW	6	2	2	2		
3	2.2.4	A	Conduct interim management on non-Federal public lands that do not occur within a vernal pool region, but do contribute to recovery and long-term conservation of the species addressed in this recovery plan.	3 years	FWS, ODA*, ODOT, OPRD, ODFW	6	2	2	2		

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
3	2.3.3	A	Conduct interim management on lands that do not occur in a core area, but do occur within a vernal pool region.	3 years	FWS*, ODA*, RVCOG	12	4	4	4		
3	2.3.4	A	Conduct interim management on private lands that do not occur within a vernal pool region, but do contribute to recovery and long-term conservation of the species addressed in this recovery plan.	3 years	FWS, PLT, RVCOG	6	2	2	2		
3	2.5.1.1	A	Review existing enhancement, restoration, and creation mechanisms and success criteria.	Every 5 years	FWS, DSL, COE	4	1				
3	2.5.1.2	A	In coordination with the Oregon Fish and Wildlife Office, develop scientifically-based and site-specific appropriate success criteria based on vernal pool enhancement, restoration and creation efforts.	1 year	FWS, ODFW, COE, SAC	20	20				

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
3	2.5.4.2	A	Review existing mechanisms of collection of soils bearing vernal pool fairy shrimp cysts, storage, and application and success criteria.	1 year	FWS*, ODFW, PLT, COE	2	2				
3	2.5.4.3	A	In coordination with the Roseburg Field Office, develop a prioritized list of sites from which vernal pool fairy shrimp cysts need to be collected to further the recovery and long-term conservation of vernal pool species.	1 year	FWS*, ODFW, BLM, PLT	10	10				
3	2.6.3	A	Apply success criteria in a monitoring program to determine if vernal pool fairy shrimp cysts hatch and complete a full life cycle.	2 years	FWS*, ODFW, ORNHICORBIC	200	100	100			
3	3.4.2	A	Conduct status reviews of nonlisted species in this recovery plan	2 years	FWS*, BLM, ODA	60		30	30		
3	3.5	A	Conduct post-delisting monitoring of recovered species.	Not in next 5 years	FWS*, ODA, ODFW	50					

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
3	4.3	A	Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors.	2 years	FWS, ODFW, SOU	40	20	20			
3	4.9	A	Determine incidence of herbivory or predation on *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* populations.	1 year	FWS, ODA, PLT	5	5				
3	4.11	A	Research associated micro and macro flora and fauna (crypto-biotic crusts) as indicators for vernal pool health and function.	1 year	FWS*, EDU	10		10			
3	5.3.3	A	Participate at local wildflower and outdoor shows and other public events.	Every year until delisting or downlisting	FWS*, ODA*	20	1	1	1	1	1
3	5.3.4	A	Invite the public to assist in long termlong-term monitoring.	Every year until delisting or downlisting	FWS, ODFW, PLT*	20	1	1	1	1	1

Implementation Schedule for Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems											
Recovery Priority Number	Recovery Action Number	Threats Addressed	Recovery Action Description	Recovery Action Duration [1] (Years)	Responsible Party	Total Cost	**Cost Estimates, in thousands of dollars per fiscal year**				
							FY13	FY14	FY15	FY16	FY17
3	5.3.5	A	Provide schools within the area covered by the recovery plan with information about the species and recovery efforts.	Every year until delisting or downlisting	FWS, BLM, ODFW, ODOT, OPRD	20	1	1	1	1	1
3	5.7.2	A	Assist lead agencies and districts in incorporating provisions of this recovery plan in local decision-making (e.g.*e.g.*, General/ Specific Plans, mosquito- and flood-control districts).	Every year until delisting or downlisting	FWS, RVCOG, CITY, COS	40	2	2	2	2	2
3	6.1	A	Complete post-delisting monitoring plan for *Limnanthes pumila* ssp. *grandiflora*.	Not in next 5 years	FWS*, ODFW	15					
3	6.2	A	Complete post-delisting monitoring plan for *Lomatium cookii*.	Not in next 5 years	FWS, ODA, BLM	15					
3	6.3	A	Complete post-delisting monitoring plan for vernal pool fairy shrimp.	Not in next 5 years	FWS, ODA	15					
Total estimated cost to time of recovery: $6,961,000 plus additional costs that cannot be estimated at this time.						6,961	1,061	973	588	324	274

VI. References

A. LITERATURE CITED

Abrams, L. 1951. Illustrated flora of the Pacific states: Washington, Oregon, and California. Vol. III. Geraniaceae to Scrophulariaceae: geraniums to figworts. Stanford University Press, Stanford, California. 866 pages.

Abrams, L., and R. S. Ferris. 1960. Illustrated flora of the Pacific States. Vol. III. Stanford University Press, Stanford, California. 866 pages.

Agee, J. K. 1993. Fire ecology of Pacific Northwest forests. Washington, D.C. Island Press. 490 pages.

Arroyo, M. T. K. 1973. A taximetric study of infraspecific variation in autogamous *Limnanthes floccosa* (Limnanthaceae). Brittonia 25:177-191.

Atzet, T., and D. Wheeler. 1982. Historical and ecological perspectives on fire activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests. USDA -Forest Service, Pacific Northwest Region, Portland, OR.

Bauder, E., and S. McMillan. 1998. Current distribution and historical extent of vernal pools in southern California and northern Baja California, Mexico. Pages 56-70 *in:* C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren, and R. Ornduff (editors). Ecology, Conservation, and Management of Vernal Pool Ecosystems - Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, California.

Beauchamp, R. M. 1986. A flora of San Diego County, California. Sweetwater River Press, National City, California.

Beetle, A. A. 1945. A new section Microphyllae in *Agrostis*. Bulletin of the Torrey Botanical Club 72:541-549.

Belk, D. 1998. Global status and trends in ephemeral pool invertebrate conservation: implications for Californian fairy shrimp. Pages 147-150 *in*: C. W. Witham, E. T.

Bauder, D. Belk, W. R. Ferren, and R. Ornduff (editors). Ecology, conservation, and management of vernal pool ecosystems - Proceedings from a 1996 conference. California Native Plant Society, Sacramento, California.

Belk, D., and M. Fugate. 2000. Two new Branchinecta (Crustacea: Anostraca) from the southwestern United States. Southwestern Naturalist 45:111-117.

Belnap, J. 1994. Potential role of cryptobiotic soil crust in semiarid rangelands. Pages 179-185 *in*: S. B. Monsen and S. G. Kitchen, eds. Proceedings: Ecology and Management of Annual Rangelands. General Technical Report INT-GTR-313. USDA Forest Service, Intermountain Research Station, Ogden, Utah. 416 pages.

Belnap, J., and J. S. Gardner. 1993. Soil microstructure of the Colorado Plateau: the role of the cyanobacterium *Microcoleus vaginatus*. Great Basin Naturalist 53:40-47.

Belnap, J., J. H. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard and D. Eldridge. 2001. Biological soil crusts: Ecology and management. Produced by U.S. Department of the Interior Bureau of Land Management. Technical Reference 1730-2. Denver, Colorado. 119 pages.

Borgias, D. 2004. Effects of livestock grazing and the development of grazing best management practices for the vernal pool-mounded prairies of the Agate Desert, Jackson County, Oregon. Report prepared for the U.S. Fish and Wildlife Service. Portland, Oregon.

Borgias, D., K. Perchemlides, L. Hammer, and A. Jones. 2009. Restoration priorities and recovery implementation planning for *Branchinecta lynchi* and other listed vernal pool species on the Ken Denman Wildlife Area, Jackson County, Oregon. Report submitted to Oregon Department of Fish and Wildlife. The Nature Conservancy, Medford, Oregon. 43 pages.

Brock, R. 1987. The ecology of *Lomatium cookii*, an endangered species of the Rogue Valley, Oregon. Unpublished report submitted to the Oregon Field Office of The Nature Conservancy. 32 pages.

Brockmann, T. 2012. What is *Callitriche*? Available online at http://www.wisegeek.com/what-is-callitriche.htm. Accessed on August 15, 2012.

Brown, C. R., and S. K. Jain. 1979. Reproductive system and pattern of genetic variation in two *Limnanthes* species. Theoretical and Applied Genetics 54:181-190.

Bureau of Land Management and U.S. Fish and Wildlife Service. 2003. Conservation agreement for Cook's lomatium (*Lomatium cookii*) in the Illinois Valley, Medford District. Available online at <http://ecos.fws.gov/docs/plan_documents/tcca/tcca_249.pdf>. 31 pages. Accessed 10 May, 2004.

Bureau of Reclamation. 2000. Agate Lake Resource Management Plan. Lower Columbia Area Office, Pacific Northwest Region. Portland, Oregon.

Bureau of Reclamation. 2006. Final report - Agate Lake Vernal Pools Area Management Plan. Lower Columbia Area Office, Pacific Northwest Region. Portland, Oregon.

California Native Plant Society. 2012. Inventory of rare and endangered plants (online edition, v8-01a). Sacramento, California. Available online at <http://www.rareplants.cnps.org>. Accessed 7 June, 2012.

Cave Junction.com. 2007. Cave Junction and the Illinois Valley. Available online at <http://www.cavejunction.com/cavejunction/history.shtml>. Accessed 19 November, 2007.

Center for Plant Conservation. 1991. Appendix. Genetic sampling guidelines for conservation collections of endangered plants. Pages 225-238 *in*: D. A. Falk and K. E. Holsinger, editors. Genetics and conservation of rare plants. Oxford University Press, New York.

Chambers, K. L., and S.C. Meyers. 2011. Nomenclatural changes for some taxa in the Oregon flora. Journal of the Botanical Research Institute of Texas 5(2):619-623.

Collie, N. and E. W. Lathrop. 1976. Chemical characteristics of the standing water of a vernal pool on the Santa Rosa Plateau, Riverside County, California. Pages 27-32 *in*: S. Jain (editor). Vernal pools: their ecology and conservation. U.C. Davis, Institute of Ecology Publications, Davis, California.

Crampton, B. 1954. Morphological and ecological considerations in the classification of *Navarretia* (Polemoniaceae). Madroño 12: 225-238.

David Evans and Associates. 2001. Agate Desert vernal pool surveys. Prepared for Rogue Valley Council of Governments, Jackson County, Oregon. 16+ pages.

Day, A. G. 1993. *Navarretia*. Pages 844-849 *in*: J.C. Hickman, editor. The Jepson manual: higher plants of California. University of California Press, Berkeley, California. 1,400 pages.

Ehrensing, D.T., F. E. Bolton, D. F. Grabe, J. M. Crane, and C. Garbacik. 1990. Response of meadowfoam to nitrogen fertility and seeding rate. 27-29. *In* W.C. Young III (ed.) Seed production research at Oregon State University USDA-ARS. Department of Crop and Soil Science Ext./CrS 83.

Elliott, M., and D. Sammons. 1996. Characterization of the Rogue River Plains. Unpublished report on file with Oregon Department of State Lands, Salem, Oregon.

Eng, L. L., D. Belk, and C. H. Eriksen. 1990. Californian Anostraca: distribution, habitat, and status. Journal of Crustacean Biology 10:247-277.

Environmental Science Associates. 2007a. Agate Desert final draft wetland conservation plan inventory and functional assessment. Prepared for the Agate Desert Technical Advisory Committee. 62 pages + appendices.

Environmental Science Associates. 2007b. Agate Desert vernal pool functional assessment methodology. Prepared for the Agate Desert Technical Advisory Committee. Sacramento, California. 58 pages + appendices.

Eriksen, C. H., and D. H. Belk. 1999. Fairy shrimps of California's puddles, pools, and playas. Mad River Press, Inc., Eureka, California.

ESRI. 2012. Tapestry segmentation. Data available online at <http://redlandsarcweb .esri.com/services/servlet/EBIS_Reports?serviceName=FreeZip&errorURL=http:/

/www.esribis.com/reports/ziplookup-error.html&zipcode=97503>. Accessed on 22 February, 2012.

Fasset, N. C. 1951. *Callitriche* in the New World. Rhodora 53:137-222.

Fiez, T.E., O.S. Norberg, and G.D. Jolliff. 1991. Yield components in three meadowfoam lines. Agron. J. 83: 598-602.

Friedman, E. I., and R. Ocampo-Paus. 1976. Endolithic blue-green algae in the Dry Valley: primary producers in the Antarctic Desert ecosystem. Science 193:1247-1249.

Gallagher, S. P. 1996. Seasonal occurrence and habitat characteristics of some vernal pool branchiopoda in Northern California, U.S.A. Journal of Crustacean Biology 16:323-329.

Halpin, P. N. 1997. Global climate change and natural area protection: management responses and research directions. Ecological Applications 7:828-843.

Harvey, M. J. 1993. *Agrostis*, Bent grass. Pages 1227-1231, 1237, 1360 *in* J.C. Hickman, editor. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley. 1,400 pages.

Helm, B. P. 1998. Biogeography of eight large branchiopods endemic to California. Pages 124-139 *in*: C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren, and R. Ornduff, eds. Ecology, conservation, and management of vernal pool ecosystems - Proceedings from a 1996 conference. California Native Plant Society, Sacramento, California.

Helm, B. P., and W. Fields. 1998. Aquatic macro-invertebrate assemblages occurring in selected vernal pools on the Agate Desert and nearby sites in Jackson County, Oregon. Oregon Natural Heritage Program, Portland, Oregon.

Hickman, J. C. (Editor). 1993. The Jepson Manual. University of California Press. Berkeley, California. 1,400 pages.

Hitchcock, A. S. 1930. Botany - Four new grasses. Journal of Washington Academy of Sciences 20:381-384.

Hitchcock, A. S. 1971. Manual of the grasses of the United States. Volume I. Dover Publications. New York, New York. 569 pages.

Huddleston, R. 2001. Native prairie restoration of The Nature Conservancy's Agate Desert Preserve in southwest Oregon. Masters Thesis. University of California, Davis, California.

Industrial Economics, Inc. 2010. Economic analysis of critical habitat designation for the large-flowered woolly meadowfoam and Cook's lomatium. Final report prepared for the U.S. Fish and Wildlife Service. Cambridge, Massachusetts. 131 pages.

Intergovernmental Panel on Climate Change. 2007. Summary for policymakers. *In*: Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.

Jain, S. K. 1978. Local dispersal of *Limnanthes* nutlets: an experiment with artificial vernal pools. Canadian Journal of Botany 56:1995-1997.

Jepson, W. L. 1936. Limnanthes. Pages 409-412 in: A flora of California. Volume II. Capparidaceae to Cornaceae. University of California, Berkeley, California.

Johnston, I. M. 1932. Studies in the Boraginaceae. IX. The *Allocarya* section of *Plagiobothrys* in the western United States. Contributions of the Arnold Arboretum 3: 5-82.

Jolliff, G. D., I. J. Tinsley, W. Calhoun, and J. M. Crane. 1981. Meadowfoam (*Limnanthes alba*): Its research and development as a potential new oilseed crop for the Willamette Valley of Oregon. Agricultural Experiment Station, Oregon State University, Corvallis. Station Bulletin 648. 17 pages.

Kagan, J. 1986. A new species of *Lomatium* (Apiaceae), from southwestern Oregon. Madroño 33:71-75.

Kagan, J. 1994. Habitat management plan for *Lomatium cookii* (Cook's desert-parsley) in the Illinois Valley, Josephine County, OR. Oregon Natural Heritage Data Base.

Kaye, T. N., and M. Blakely-Smith. 2002. Vegetation survey of French Flat ACEC. Report for Medford District Bureau of Land Management. 21 pages.

Kaye, T. N., and J. R. Cramer. 2005. *Lomatium cookii* population monitoring in the Illinois Valley, Josephine County, Oregon. Report for Medford District BLM. 44 pages.

Kaye, T. N., R. J. Meinke, J. Kagan, S. Vrilakas, K. L. Chambers, P. F. Zika and J. K. Nelson. 1997. Patterns of rarity in the Oregon flora: implications for conservation and management. *In*: Kaye, T. N., A. Liston, R. M. Love, D. Luoma, R. J. Meinke, and M. V. Wilson (editors). Conservation and management of native plants and fungi. Native Plant Society of Oregon, Corvallis, Oregon.

Keeley, J. E. 1984. Photosynthetic characteristics of certain vernal pool species. Pages 218-222 *in*: S. Jain and P. Moyle (editors), Vernal pools and intermittent streams. Institute of Ecology, Davis, California.

Keeley, J. E., and P. H. Zedler. 1998. Characterization and global distribution of vernal pools. Pages 1-14 *in*: C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren, Jr., and R. Ornduff (editors). Ecology, conservation, and management of vernal pool ecosystems. California Native Plant Society, Sacramento, California. 285 pages.

King, J. L., M. A. Simovich, and R. C. Brusca. 1996. Species richness, endemism and ecology of crustacean assemblages in northern California vernal pools. Hydrobiologia 328:85-116.

Knapp, S. J. and J. M. Crane. 1999. Breeding advances and germplasm resources in meadowfoam: A novel very long chain oilseed. Pages 225–233 *in*: J. Janick (editor). Perspectives on new crops and new uses. American Society for Horticultural Science Press, Alexandria, Virginia.

Krapu, G. L. 1974. Foods of breeding pintails in North Dakota. Journal of Wildlife Management 38(3):408-417.

LaLande, J. 2004. So, just how extensive was anthropogenic fire in the Pacific Northwest? Southwestern Oregon as a case study. Eugene, Oregon. Paper presented at the Northwest Anthropological Conference. Copy on file at Medford District, Bureau of Land Management.

Lansdown, R. V. and R. E. Preston. 2012. Callitriche. Pages 1006-1007 *in*: Baldwin, B. G., D. H. Goldman, D. J. Keil, R. Patterson, T. J. Rosatti, and D. H. Wilken, editors. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, California. 1,568 pages.

MacCleery, D. 1994. Understanding the role that humans have played in shaping America's forest and grassland landscapes: Is there a landscape archaeologist in the house? USDA-Forest Service. Available online at < http://www.fs.fed.us /eco/eco-watch/ew940210.htm >. Accessed 29 June, 2012.

McLaughlin, E. G. 1974. Autecological studies of three species of *Callitriche* native in California. Ecological Monographs 44:1-16.

Marty, J. 2005. Effects of cattle grazing on diversity in ephemeral wetlands. Conservation Biology 19:1626-1632.

Mason, H. L. 1946. Five new species of *Navarretia*. Madroño 8:196-200.

Mason, C. T. 1952. A systematic study of the genus *Limnanthes*. University of California Publications in Botany 25:455–512. Berkeley, California.

Maeda-Martinez, A. M., D. Belk, H. Obregon-Barboza, and H. J. Dumont. 1997. Large branchiopod assemblages common to Mexico and the United States. Hydrobiologia 359:45-62.

Meyers. S. A. 2008. A survey and seed bulking of historic and known populations of *Limnanthes floccosa* ssp. *grandiflora*. Report prepared for the U.S. Fish and Wildlife Service, Roseburg, Oregon. 65 pages.

Meyers, S. A. 2010. Evolutionary relationships and an investigation of sympatric speciation within Limnanthaceae. Dissertation submitted to Oregon State University for the partial fulfillment of the requirements for the Degree of Doctor of Philosophy. Presented April 29, 2010. Oregon State University. Corvallis, Oregon. 131 pages.

Miller, M. 2001. Stewardship account for winged water starwort (*Callitriche marginata*). Prepared for the BC Conservation Data Centre and the Garry Oak Ecosystems Recovery Team. Available online at http://www.goert.ca /documents/SA_callmarg.pdf. Accessed on August 15, 2012. 26 pages.

Muth, G., J. Callizo, and J. Ruyget. 2001. Napa County Flora. Pacific Union College. Accessed online at <http://www.puc.edu/Faculty/Gilbert_Muth/napa.htm> on August 15, 2012.

Natural Resources Conservation Service. 1999. Soil survey of Josephine County. U.S. Department of Agriculture.

Natural Resources Conservation Service. 2007. Agate and Winlow Soil survey. Available online at <http://ortho.ftw.nrcs.usda.gov/>. Accessed 22 August, 2007.

Newton, R. E., A. S. Thorpe and A. G. Stanley. 2010. Threat assessment for *Limnanthes floccosa* ssp. *pumila* and *Callitriche marginata* on Table Rocks ACEC, Medford District BLM. 2010 progress report. Institute for Applied Ecology. Corvallis, Oregon. 42 pages. Available online at<http://appliedeco.org/reports/Table Rocks Report 2010.pdf>. Accessed 13 April, 2012.

Oelke, E. A, E. S. Oplinger, C. V. Hanson, and K. A. Kelling. 2004. Alternative field crops manual: Meadowfoam. University of Wisconsin. Available online at <http://www.hort.purdue.edu/newcrop/afcm/meadowfoam.html>. Accessed 10 May, 2004.

Oregon Biodiversity Information Center. 2010. Rare, threatened, and endangered species of Oregon. Available online at <http://orbic.pdx.edu/documents/2010-rte-book.pdf >. Accessed June 5, 2012.

Oregon Biodiversity Information Center. 2012. Endangered invertebrate program. Available online at < http://orbic.pdx.edu/>. Accessed June 5, 2012.

Oregon Biodiversity Project. 1998. Oregon's living landscape - Strategies and opportunities to conserve biodiversity. Defenders of Wildlife. 218 pages.

Oregon Blue Book. 2012. Available online at <http://bluebook.state.or.us >. Accessed 6 June, 2012.

Oregon Climate Change Research Institute. 2010. Oregon climate assessment report. K. D. Dello and P. W. Mote, editors. College of Oceanic and Atmospheric Sciences, Oregon State University. Corvallis, Oregon. Available online at http://occri.net/ocar.

Oregon Department of State Lands. 2003. Newsroom. Federal grant will fund wetland plan for White City area. Available online at <http://www.leds.state.or.us/DSL/news/pr0336_whitecitywetland.shtml>. Accessed 22 August, 2007.

Oregon Department of Fish and Wildlife. 2006. Ken Denman Wildlife Area Management Plan. Prepared by Vince Oredson, Ken Denman Wildlife Area Manager, and Nancy Breuner, Habitat Biologist.

Oregon Flora Project. 2012. Oregon Plant Atlas for *Callitriche marginata*. Accessed online at <http://www.oregonflora.org/atlas.php> on August 15, 2012.

Oregon History Project. 2003. Ashland Woolen Mills. Cain Allen, Oregon Historical Society. <http://www.ohs.org/education/oregonhistory/historical_records/dspDocument.cfm?doc_ID=4EB41CBA-BB92-40DF-490231D5518789C9>. Accessed June 5, 2012.

Oregon Natural Heritage Information Center. 2008. Element Occurrence Records for *Lomatium cookii* and *Limnanthes floccosa* ssp. *grandiflora*. Database. Oregon Natural Heritage Information Center, Portland, Oregon.

Oregon Natural Heritage Program. 1997. Agate Desert vernal pool habitat: Preliminary mapping and assessment. Report prepared for the Oregon Department of State Lands under Contract No. 10738-369. 23+ pages.

Oregon Natural Heritage Program. 1999. Assessment and map of the Agate Desert vernal pool ecosystem in Jackson County, Oregon: March 1998 imagery revision. Report to the U.S. Fish and Wildlife Service, December 6, 1999. 15+ pages.

Pater, D. E., S. A. Bryce, T. D. Thorson, J. S. Kagan, C. Chappell, J. M. Omernik, S. H. Azavedo, and A. J. Woods. 1997. Ecoregions of western Washington and Oregon. Environmental Protection Agency, Corvallis, OR. Map with appendices.

Pendleton, R. L., B. K. Pendleton, G. L. Howard, and S. D. Warren. 2004. Effects of biological soil crusts on seedling growth and mineral content of four semiarid herbaceous plant species. Pages 131-133 *in*: Hild, A. L., N. L. Shaw, S. E. Meyer, D. T. Booth, and E. D. McArthur. Seeds and soil dynamics in shrubland ecosystems: Proceedings; 2002 August 12-16, Laramie, Wyoming. U.S. Department of Agriculture, Forest Service. RMRS-P-31. Ogden, Utah. 216 pages.

Pierce, R. O., and S. K. Jain. 1977. Variation in some plant and seed oil characteristics of meadowfoam. Crop Science 17:521-526.

Platenkamp, G. 1998. Patterns of vernal pool biodiversity at Beale Air Force Base. Pages 151-160 *in*: C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren Jr., and R. Ornduff (Editors). Ecology, conservation, and management of vernal pool ecosystems - Proceedings from a 1996 conference. California Native Plant Society, Sacramento, California.

Proctor, V. W., and C. R. Malone. 1965. Further evidence of the passive dispersal of small aquatic organisms via the intestinal tract of birds. Ecology 46:728-729.

Santos-Flores, C. J., and S. I. Dodson. 2003. *Dumontia oregonensis* n. fam., n. gen., n. sp. A new family of water-fleas (*Crustacea*, *Anomopoda*) from U.S.A., and on the classification of the Order Anomopoda. Hydrobiologia 500:145-155.

Silvernail, I.S., and R. J. Meike. 2008. Patterns of ecotypic variation and the germination and cultivation requirements of *Lomatium cookii*. Prepared for the U.S. Fish and Wildlife Service, Region 1. Corvallis, Oregon. 91 pages.

Simovich, M., R. Brusca, and J. King. 1992. Invertebrate survey 1991-1993 PGT-PGE/Bechtel pipeline expansion project. University of San Diego, Alcala Park, San Diego, California.

Smith, J. P., and J. O. Sawyer. 1988. Endemic vascular plants of northwestern California and southwestern Oregon. Madroño 35:54-69.

Smithsonian Institution. 2012. Collections Search Center. *Callitriche marginata* Torr. & A. Gray. Accessed on-line at <http://collections.si.edu/search/results.htm?q=record_ID:nmnhbotany_2122590> on August 15, 2012.

Soil Conservation Service. 1983. Soil survey of Jackson County. U.S. Department of Agriculture.

Spencer, S. C. 1993. The evolution of vernal pool adaptation and restriction in Navarretia (Polemoniaceae) as inferred from anatomical, morphological, and palynological studies. American Journal of Botany 80(6) Supplement:177.

Sugnet, P. 1993. Preliminary compilation of documented distribution, fairy shrimp and tadpole shrimp proposed for listing. Sugnet and Associates, Sacramento, CA. 10 pages.

Swanson, G. A. 1974. Feeding ecology of breeding blue-winged teals. Journal of Wildlife Management. 38:396-407.

Syrdahl, R. L. 1993. Distribution patterns of some key macro-invertebrates in a series of vernal pools at Vina Plains Preserve, Tehama County, California. Biological Sciences. California State University, Chico, Chico, California. 83 pages.

Traill, L. W., M. L. M. Lim, N. S. Sodhi, and C. J. A. Bradshaw. 2010. Mechanisms driving change: altered species interactions and ecosystem function through global warming. Journal of Animal Ecology 79:937-947.

Tveskov, M., N. Norris, and A. Sobiech. 2002. The Windom site: A persistent place in the western Cascades of southwest Oregon. Ashland, Oregon: SOULA Research Report 2002-1.

U.S. Department of Agriculture. 2007. USDA Census of Agriculture – Historical publications. Available online at: <http://www.agcensus.usda.gov/Publications/Historical_Publications/index.php> Accessed June 6, 2012.

U.S. Department of Agriculture. 2012. Web soil survey. Natural Resources Conservation Service. Available online at: <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>.

U.S. Department of Agriculture - Natural Resource Conservation Service. 2012. The PLANTS Database. Version 3.1. National Plant Data Centre, US Dept. of Agriculture, Baton Rouge, LA70874-4490 USA. Available online at: <http://plants.usda.gov> [accessed August, 14 2012].

U.S. Fish and Wildlife Service. 1983. Endangered and threatened species listing and recovery priority guidelines. Federal Register 48:43098-43105. September 21, 1983.

U.S. Fish and Wildlife Service. 1993a. *Lomatium bradshawii* (Bradshaw's lomatium) recovery plan. Portland, Oregon. 47 pages.

U.S. Fish and Wildlife Service. 1993b. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Federal Register 58:51144-51190. September 30, 1993.

U.S. Fish and Wildlife Service. 1994. Determination of endangered status for the Conservancy fairy shrimp, longhorn fairy shrimp and the vernal pool tadpole shrimp; and threatened status for the vernal pool fairy shrimp. Federal Register 59:48136-48153. September 19, 1994.

U.S. Fish and Wildlife Service. 1996. Endangered and threatened wildlife and plants; Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Federal Register 61:7596-7613. February 28, 1996.

US Fish and Wildlife Service. 1988. National list of vascular plants that occur in wetlands. U.S. Fish and Wildlife Service Biological Report 88 (24).

U.S. Fish and Wildlife Service. 2002a. Endangered and threatened wildlife and plants; Determination of endangered status for *Lomatium cookii* (Cook's lomatium) and

Limnanthes floccosa ssp. *grandiflora* (large-flowered woolly meadowfoam) from southern Oregon. Final Rule. Federal Register 67:68004-68015. November 7, 2002.

U.S. Fish and Wildlife Service. 2002b. Endangered and threatened wildlife and plants; Critical habitat designation for four vernal pool crustaceans and eleven vernal pool plants in California and Southern Oregon. Proposed Rule. Federal Register 67:59883-59932. September 24, 2002.

U.S. Fish and Wildlife Service. 2003. Endangered and threatened wildlife and plants; Final designation of critical habitat for four vernal pool crustaceans and eleven vernal pool plants in California and southern Oregon. Final Rule. Federal Register 68:46683-46867. August 6, 2003.

U.S. Fish and Wildlife Service. 2005a. Recovery plan for vernal pool ecosystems of California and southern Oregon. Portland, Oregon. xxvi + 606 pages.

U.S. Fish and Wildlife Service. 2005b. Endangered and threatened wildlife and plants: Final designation of critical habitat for four vernal pool crustaceans and eleven vernal pool plants in California and southern Oregon; Evaluation of economic exclusions from August 2003 final designation; final rule. Federal Register 70:46924-46999. August 11, 2005.

U.S. Fish and Wildlife Service. 2006. Draft recovery plan for listed species of the Rogue Valley vernal pool and Illinois Valley wet meadow ecosystems. Region 1, Portland, Oregon. xiii + 136 pages.

U.S. Fish and Wildlife Service. 2007a. Vernal pool fairy shrimp (*Branchinecta lynchi*) 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office. Sacramento, California. 76 pages.

U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; Designation of critical habitat for *Limnanthes floccosa* ssp. *grandiflora* (large-flowered woolly meadowfoam) and *Lomatium cookii* (Cook's lomatium). Federal Register 75:42490-42569. July 21, 2010.

U.S. Fish and Wildlife Service. 2011a. Programmatic formal consultation on the U.S. Fish and Wildlife Service's vernal pool conservation strategy for Jackson County Oregon. January 26, 2011. Ref. #: 13420-2011-F-0064.

U.S. Fish and Wildlife Service. 2011b. Habitat conservation plans - Overview. Available online at <http://www.fws.gov/endangered/what-we-do/hcp-overview.html>. Accessed 29 June, 2012.

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration. 1994. Endangered and threatened wildlife and plants: Notice of interagency cooperative policy for the ecosystem approach to the Endangered Species Act. Federal Register 59:34273-34274. July 1, 1994.

U.S. Forest Service. 2004. Chapter Three - Affected environment and environmental consequences. Pages 111-1 to 111-36 *in*: Draft Environmental Impact Statement; the Biscuit Recovery Project. U.S. Department of Agriculture, Rogue River-Siskiyou National Forest. Medford, Oregon.

Venable, D. L., and L. Lawlor. 1980. Delayed germination and dispersal in desert annuals: escape in space and time. Oecologia 26:272-282.

Wilkes, C. U.S.N. 1844. Volume IV *in* U.S. Exploring Expedition. C. Sherman, publisher, Philadelphia, Pennsylvania. 500 pages.

Western Regional Climate Center. 2012. Station data for Medford WSO AP (355429). Available online at http://www.wrcc.dri.edu/ summary/climsmor.html. Accessed on 6 June, 2012.

B. PERSONAL COMMUNICATIONS

Bacheller, Noel. 2007. Parks Botanist, Oregon State Parks and Recreation Department, Salem, Oregon.

Borgias, Darren. 2001, 2002, 2003, 2004, 2005, 2006, 2007. Stewardship Ecologist, The Nature Conservancy, Medford, Oregon.

Cannon, Ken. 2002, 2004, 2005. Region 3 Biologist, Oregon Department of Transportation, Roseburg, Oregon.

Case, Bern. 2010. Airport Director, Rogue Valley International-Medford Airport. Medford, Oregon.

Friedman, Sam. 2004. U. S. Fish and Wildlife Service. Roseburg, Oregon.

Fritts, Susan. 2010, 2011. Bureau of Land Management, Medford District. Medford, Oregon.

Garcia, Diane. 2007. Executive Director, Southern Oregon Land Conservancy. Ashland, Oregon.

Gitzendanner, Matthew A. 2002, 2003. Department of Botany, University of Florida. Gainesville, Florida.

Goudsward, Jim. 2007. Wetland Specialist, Portland District Office, U.S. Army Corps of Engineers, Portland, Oregon.

Guerrant, Ed. 2004, 2005, 2012. Conservation Director, Rae Selling Berry Seed Bank, Portland, Oregon.

Hanson, Don. 2005. Western Region Cleanup Program, Oregon Department of Environmental Quality, Salem, Oregon.

Kagan, James. 1998. Director, Oregon Natural Heritage Program, Portland, Oregon.

Kaye, Thomas N. 2004. Director, Institute of Applied Ecology, Corvallis, Oregon.

Meinke, Robert. 2004. Assistant Professor, Oregon State University, and Plant Conservation Biology Program Leader, Oregon Department of Agriculture, Corvallis, Oregon.

Meyers, Stephen. 2006, 2007. Taxonomic Director, Oregon Flora Project. Department of Botany and Plant Pathology, Oregon State University. Corvallis, Oregon.

Michaud, Michelle. 2004. Oregon Parks and Recreation Department. Salem, Oregon.

Morison, Molly. 2004, 2011. Stewardship Coordinator, The Nature Conservancy, Medford, Oregon.

Mousseaux, Mark. 2004. District Botanist, Bureau of Land Management, Medford District. Medford, Oregon.

Papineau, Eugene. 2012. Manager. Jackson County Vector Control District, White City, Oregon.

Perchemlides, Keith. 2009, 2011, 2012. Conservancy Ecologist, The Nature Conservancy, Medford, Oregon.

Russell, Robert. 2004. Deputy Director-Operations, Rogue Valley International-Medford Airport, Medford, Oregon.

Schoening, Ken. 2006. Engineer, David Evans and Associates, Medford, Oregon.

Sharp, Doug. 2009, 2010, 2012. Oregon Department of Transportation, Roseburg, Oregon.

Shohet, Cecile. 2004. Former Zone Botanist, Rogue River-Siskiyou National Forest, Grants Pass, Oregon.

Tuss, Craig. 2002. Former Field Supervisor, currently retired, U.S. Fish and Wildlife Service, Roseburg, Oregon.

Wille, Stephen. 2002, 2003, 2004. Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Portland Oregon.

Wineteer, Marcia. 2007, 2012. Botanist, Bureau of Land Management, Medford District, Medford, Oregon.

Yballe, Dominick. 2004. Project Manager. Portland District, U.S. Army Corps of Engineers, Portland, Oregon.

VII. Appendices

APPENDIX A. GLOSSARY OF TECHNICAL TERMS

Alluvial:	Composed of clay, silt, or gravel sediments carried by rushing waters and deposited where the waters slow down.
Autogamy:	Self-fertilization, as in such plant species as *Limnanthes floccosa*.
Autotrophic:	Obtaining carbon and energy from nonliving sources (chemical elements and electromagnetic radiation), rather than from living organisms.
Awn:	A slender, bristle-like extension from the bracts of grasses.
Category 1 candidate:	A species for which sufficient information is on file with the Fish and Wildlife Service to list it as endangered or threatened, but which is awaiting publication of a formal listing proposal.
Category 2 candidate:	A species for which listing possibly may be appropriate, but for which insufficient information is available to make a determination; this category is no longer used by the Fish and Wildlife Service.
Claypan:	A layer of clay soil that prevents drainage of water.
Culm:	The stem of a grass or similar plant.
Cyanobacteria:	Photosynthetic bacteria, also called blue-green algae.
Demographic:	Pertaining to the size, growth, and vital statistics of populations.
Duripan:	A hard layer of soils (hardpan) that prevents drainage of water, especially one cemented by silica.
Ecoregion:	A region containing a geographically distinct assemblage of natural communities.

Ecosystem:	A system formed by the interaction of a community of organisms with their physical environment.
Edaphic:	Pertaining to the soil.
Endangered:	The classification provided to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.
Extant:	Still in existence; not extinct, destroyed, or lost.
Floristic:	Pertaining to flowers or a flora.
Glabrous:	Having no hairs, projections, or pubescence; smooth.
Habitat:	The type of environment in which an organism or group normally lives or occurs.
Hardpan:	A hard layer of soils (clay, volcanic, or caliche) that prevents drainage of water.
Hydric:	Characterized by excessive moisture.
Lemma:	The outer of the two bracts enclosing the flower in a grass spikelet.
Mesic:	Having or characterized by a moderate supply of water.
Nexus:	Involvement of the Federal government in an action through a governmental role in ownership, funding, licensing, permitting, or regulation.
Occurrence:	An occupied area at least 0.4 kilometers (0.25 mile) away from the next occupied area; usually recorded in a heritage database; see also element occurrence, population.
Photosynthetic:	Able to synthesize carbohydrates from carbon dioxide and water using light as an energy source.
Population:	A group of individuals of the same species that occupy an area small enough to permit interbreeding regularly (herein used interchangeably with occurrence or to represent a

	group of individuals that is not included in the Oregon Biodiversity Information Center database).
Protected:	Land that is formally secured from habitat loss and degradation by way of conservation easements, formal agreements, conservation banks, or public or conservation group ownership.
Pulvillus:	A small mound-like feature located at the base of the male fairy shrimp antennae.
Self-sustaining population:	A population that is capable of remaining stable or increasing without human intervention.
Sepals:	Outer flower bracts.
Setae:	Bristles, rough hairs.
Stochastic:	Random environmental variable.
Sympatric:	Occupying the same location; co-occurring.
Threatened:	The classification provided to an animal or plant likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
Viable:	Capable of life or normal growth and development.
Wetlands:	Areas that are inundated by surface or ground water with a frequency sufficient to support vegetation or aquatic life that requires saturated soil conditions for growth and reproduction.

APPENDIX B. PLANT AND ANIMAL SPECIES REFERENCED IN THIS RECOVERY PLAN

Scientific Name	Common Name
Rogue Valley	
Achyrachaena mollis	blow wives
Achnatherum lemmonii	Lemmon's needlegrass
Agrostis hendersonii	Henderson's bentgrass
Alopecurus saccatus	Pacific foxtail
Alyssum murale	yellowtuft
Alyssum corsicum	Corsicum yellowtuft
Branchinecta coloradensis	Colorado fairy shrimp
Branchinecta lynchi	vernal pool fairy shrimp
Branchinecta mesovallensis	midvalley fairy shrimp
Callitriche marginata	winged water-starwort
Callitriche stagnalis	pond water-starwort
Callitriche trochlearis	effluent water-starwort
Ceanothus cuneatus	wedge-leaf buckbrush
Centaurea solstitialis	yellow star-thistle
Clarkia purpurea	purple clarkia
Collinsia sparsiflora	few-flowered collinsia
Deschampsia danthonioides	annual hairgrass
Downingia yina	Cascade calicoflower
Erodium cicutarium	crane's bill, filaree
Eremocarpus setigerus	turkey mullein
Eryngium petiolatum	coyote thistle
Festuca roemeri	Roemer's fescue
Hesperochiron californicus	California hesperochiron
Hordeum marinum ssp. *gussoneanum*	Mediterranean barley
Isatis tinctoria	Dyer's woad
Isoetes nuttallii	quillwort
Lasthenia californica	California goldfields
Lasthenia glaberrima	smooth goldfields
Lepidurus packardi	vernal pool tadpole shrimp
Lepus californicus	black-tailed jackrabbit
Limnanthes floccosa ssp. *floccosa*	woolly meadowfoam
Limnanthes pumila ssp. *grandiflora*, *Limnanthes floccosa* ssp. *grandiflora*	large-flowered woolly meadowfoam
Lomatium cookii	Cook's lomatium, Cook's desert parsley
Lomatium humile	alkali desert parsley
Lomatium tracyi	Tracy's desert parsley

Lomatium utriculatum	foothills desert parsley
Lupinus bicolor	bicolored lupine
Microtus californicus	California vole
Microtus oregoni	creeping vole
Minuartia californica	California sandwort
Myosurus minimus	least mousetail
Navarretia heterandra	Tehama navarretia
Navarretia leucocephala ssp. *leucocephala*	white-flowered navarretia
Peromyscus maniculatus	deer mouse
Passerculus sandwichensis	Savannah sparrow
Plagiobothrys austiniae	Austin's popcornflower
Plagiobothrys bracteatus	bracted popcornflower
Plagiobothrys fulvus	single-flowered cat's ear
Plagiobothrys glyptocarpus var. *glyptocarpus*	rough-seeded popcornflower
Plagiobothrys greenei	Green's popcornflower
Plagiobothrys nothofulvus	rusty popcornflower
Plagiobothrys stipitatus	stipitate popcornflower
Poa bulbosa	bulbous bluegrass
Reithrodontomys megalotis	harvest mouse
Sturnella neglecta	western meadowlark
Taeniatherum caput-medusae	medusahead
Thinopyrum ponticum	tall wheatgrass
Thomomys bottae	Botta's pocket gopher
Trifolium depauperatum	poverty clover, cow's udder clover
Triteleia hyacinthina	white brodiaea
Vulpia myuros	rat-tail fescue

Illinois Valley Seasonally Wet Meadow

Achillea millefolium	yarrow
Aira caryophyllea	silver hairgrass
Calochortus uniflorus	large-flowered tulip-star
Camassia quamash	Common camas
Chlorogalum pomeridianum	soap plant
Danthonia californica	California oatgrass
Deschampsia cespitosa	tufted hairgrass
Festuca roemeri	Roemer's fescue
Hesperochiron californica	California hesperochiron
Horkelia californica	California horkelia
Horkelia daucifolia	carrot-leaved horkelia
Isoetes nuttallii	quillwort
Limnanthes gracilis ssp. *gracilis*	slender meadowfoam
Lomatium cookii	Cook's lomatium, Cook's desert parsley

Melica geyeri	oniongrass
Micropus californicus	slender cottonweed
Microseris howellii	Howell's microseris
Pinus jeffreyi	Jeffrey pine
Pinus ponderosa	ponderosa pine
Prunella vulgaris	self-heal
Packera hesperia	western ragwort
Viola hallii	Hall's violet
Ranunculus occidentalis	western buttercup

APPENDIX C. RECOVERY PRIORITIES FOR RECOVERY OF THREATENED AND ENDANGERED SPECIES

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
	High	Species	2	2C
	High	Subspecies	3	3C
	Low	Monotypic Genus	4	4C
	Low	Species	5	5C
	Low	Subspecies	6	6C
Moderate	High	Monotypic Genus	7	7C
	High	Species	8	8C
	High	Subspecies	9	9C
	Low	Monotypic Genus	10	10C
	Low	Species	11	11C
	Low	Subspecies	12	12C
Low	High	Monotypic Genus	13	13C
	High	Species	14	14C
	High	Subspecies	15	15C
	Low	Monotypic Genus	16	16C
	Low	Species	17	17C
	Low	Subspecies	18	18C

C = species that are or may be in conflict with construction, other development projects, or other forms of economic activity.

See U.S. Fish and Wildlife Service (1983) for further details of the recovery priority system.

APPENDIX D. RECOVERY CORE AREAS

The Rogue and Illinois Valley habitat areas presented in this section were evaluated based on functional and value mapping, on-site assessments, and information in the final critical habitat rule for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* (USFWS 2003, USFWS 2010, Oregon Natural Heritage Program 1999). For the sites selected and described below, the habitat is mostly intact with the exception of upland vegetation, which should be managed for invasive grasses and herbs.

A. ROGUE VALLEY RECOVERY CORE AREAS

Land owners for these core areas include The Nature Conservancy, the Oregon Department of Transportation, the Oregon Department of Fish and Wildlife, the U.S. Bureau of Reclamation, the U.S. Bureau of Land Management, Jackson County School District, Jackson County, the City of Medford, Medford Water Commission, private businesses, and private individuals. Species covered under this recovery plan that occur or are likely to occur in these core areas include *Agrostis hendersonii*, *Dumontia oregonensis*, *Callitriche marginata*, *Limnanthes pumila* ssp. *grandiflora*, *Limnanthes pumila* ssp. *pumila*, *Lomatium cookii*, *Plagiobothrys austiniae*, *P. greenei*, and vernal pool fairy shrimp.

1. White City Core Area

The White City Core area includes a cluster of variously-sized vernal pool habitats within a broad spectrum of ownerships that lie just outside the former Camp White Military Training Base. The 740-hectare (1,829-acre) area is 32 percent State, 8 percent County, 10 percent City of Medford, and 50 percent privately owned. *Agrostis hendersonii* and *Callitriche marginata* have never been observed, but could potentially occur within this core area.

Agate Desert Preserve

Description. This area includes approximately 21 hectares (53 acres) of land west of Table Rocks Road and north of Antelope Road, protected for long-term conservation of the listed species. The vernal pool habitat in this area is categorized as topographically intact vernal pools with altered vegetation.

History. This 21-hectare (53-acre) parcel was a livestock pasture when acquired by The Nature Conservancy in 1987 as a land trust. The Nature Conservancy has successfully restored and managed the habitat to benefit *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and the vernal pool fairy shrimp that occur there. Also occurring at the preserve are *Plagiobothrys austiniae*, *P. greenei*, and *Dumontia oregonensis*.
Management. The Nature Conservancy performs annual monitoring of the two endangered plants and vernal pool fairy shrimp. They perform periodic monitoring for listed plants and vernal pool fairy shrimp, periodic burning and mowing; plant native grasses and herbs; and hand remove nonnative weeds, as needed.

Objective. Add adjacent parcels to existing protected parcel, including privately owned lands and the City of Medford. Restore habitat on city and privately owned lands, reduce noxious weed threats, and eventually restore with native vegetation around key areas.

Dutton Creek and Avenue H Mitigation Area

Description. This area includes a 20-hectare (50-acre) tract of land south of Dutton Road, north of Avenue H and east of Highway 62 (Crater Lake Highway). The vernal pool habitat in this area has intact vernal pool-mounded prairie landform with altered vegetation. A 10-hectare (25-acre) Jackson County School District mitigation area occurs in the southern portion of the area and an approximately 4-hectare (10-acre) Oregon Department of Transportation mitigation area occurs in the northern portion of the site.

History. The land north of Avenue H Site was most likely grazed prior to becoming part of the Camp White military installation. After military operations were discontinued in this area after the 1940s, the land was mostly utilized for off-road recreation. In recent years portions of the land have been purchased by the Oregon Department of Transportation and Jackson County School District # 9 for mitigation credit. At the Jackson County School District property vernal pools were expanded, a ditch running across the site was filled by the old spoils berm, and a prescribed fire was performed (for restoration of natural plants) and native plant seeds were sown to restore vernal pool habitat and function. Only the Jackson County School District property supports *Limnanthes pumila* ssp. *grandiflora*, and vernal pool fairy shrimp, *Plagiobothrys austiniae,* and *P. greenei* have not been documented at the properties. Currently non-native invasive plants, including *Centaurea solstitialis* and *Taeniatherum caput-medusae*, are abundant throughout the site and encroach on native vernal pool plants.

Objective. Reduce or eliminate invasive plant encroachment and secure additional habitat in this area for long-term *Limnanthes pumila* ssp. *grandiflora* and vernal pool fairy shrimp protection. Add adjacent parcels to existing mitigation to promote connectivity between Jackson County School District and the Oregon Department of Transportation mitigation sites.

Kershaw (East of Atlantic Avenue between Avenues E and H)

Description. This area includes 90 hectares (223 acres) of privately owned vernal pool complex located east of Atlantic Avenue, south of Avenue H, and north of Avenue E. The area is divided into 7- to 12-acre taxlots. At least two of the taxlots have historic occurrences of *Limnanthes pumila* ssp. *grandiflora* or *Lomatium cookii* and are likely to have vernal pool fairy shrimp, *Plagiobothrys austiniae*, and *P. greenei*. One taxlot on private property was reported to have an estimated 500,000 *Lomatium cookii* plants growing on leveled and tilled vernal pool-mounded prairie habitat; however, this property has not been surveyed since 2005 and its current status is unknown (Oregon Natural Heritage Information Center 2008). The landowner has no intention of conserving the plant and could develop the property in the near future (D. Borgias, pers. comm. 2004).

Management. Portions of the property are unmanaged or grazed by livestock.

Objective. Temporarily protect areas in or adjacent to the parcels with vernal pool fairy shrimp critical habitat or with presence of *Lomatium cookii*. Lease the area for use as a seed bank, until a suitable reserve of seed is established to use in restoring populations to the east of White City in areas better situated for long-term habitat conservation and protection with larger intact habitat complex.

Denman Military Slough

Description. This area includes a State-administered parcel located north of Kirtland Road and Avenue G, south of the Rogue River, east of Table Rocks Road and west of Agate Road. The vernal pool-mounded prairie topography is variably altered by fill of log deck debris and by plantings of the non-native grass, *Thinopyrum ponticum*. Although the vegetation has been altered, vernal pool fairy shrimp and *Limnanthes pumila* ssp. *grandiflora* occur at the site on intact vernal pools and associated swale habitat.

History. Land was once military practice and storage grounds for Camp White. After the land was set aside as state wildlife refuge, nonnative grasses were seeded for game bird cover and recreational hunting. In 2002, a 1.6-hectare (4-acre) project designed to compensate for impacted vernal pools at the Rogue Valley International-Medford Airport was completed at this property on disturbed vernal pool habitat.

Management. Development of a management plan is currently underway for protection and conservation of vernal pools and the two endangered plants. We provided funding through section 6 grants for the completion of habitat restoration activities for the entire Denman Wildlife Area. In 2009, the restoration guide was completed. In fiscal year 2013 the management plan will be revised to incorporate the 2009 restoration guide and update old information.

Objective. Enhance current condition by removing fill and wood waste and restoring native prairie at least around high priority areas to be identified within the tract. Monitor listed species and utilize fire for control of thick thatch buildup.

Denman Hall Tract

Description. This area includes State-administered parcels located south of Antelope road, west of Agate Road, and north of Gregory Road. The vernal pool-mounded prairie topography is variably altered by fill of log deck debris and vegetation has been severely altered by plantings of *Thinopyrum ponticum*, but portions of the property is occupied by vernal pool fairy shrimp, *Lomatium cookii*, and *Limnanthes pumila* ssp. *grandiflora*.

History. Land was utilized for military practices during the early 1940s. After the land was set aside as a state wildlife refuge, nonnative grass was seeded for game bird cover and recreational hunting.

Management. A management plan was developed for the entire Denman Wildlife Area in 2006 for the purpose of hunting and fishing recreation and conservation of vernal pool habitat. The U. S. Fish and Wildlife Service provided funding in 2007 through section 6 grants for development of prioritized restoration guide, completed in 2009. In 2010, a mitigation project was initiated at the site, restoring 7.8 hectares (19.4 acres) of vernal pools that had been divided by an old road. There are opportunities to completely restore the old road and bring additional habitat improvement to the core area.

Objective. Enhance current condition by removing fill and wood waste, removing introduced grass, reducing noxious weeds, and restoring native prairie around high priority areas to be identified within the tract. Monitor listed species and utilize fire for control of thick thatch buildup. Augment current *Lomatium cookii* population to replace recently extirpated nearby populations.

Hoover Ponds

Description. The Hoover Ponds complex includes 323 hectares (777 acres) of vernal pool habitat principally owned by Jackson County. The complex is located south of Highway 140 and west of Kershaw Road. In this complex the vegetation community health is low and vernal pools show evidence of historic leveling. Vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora*, and *Lomatium cookii* critical habitat has been designated for this core area. Vernal pool fairy shrimp, *Limnanthes pumila ssp. grandiflora*, and *Lomatium cookii* all occur on the complex.

History. Land was utilized for military practices during the early 1940s. After the land was set aside as a state wildlife refuge, nonnative grass was seeded for game bird cover and recreational hunting. In 2011, 4.4 hectares (10.9 acres) were restored to vernal pool habitat as mitigation for lost vernal pool habitat in White City.

Management. Portions of the property are available for off-road recreation, while others are utilized for recreation. Some grazing occurs on the privately owned areas.

*Objective***.** On county lands, ensure that management is provided for the protection, enhancement, and restoration of vernal pool habitat occupied by vernal pool fairy shrimp, *Limnanthes pumila ssp. grandiflora*, and *Lomatium cookii*. On County owned lands, pursue additional restoration to improve vernal pool habitat. On private lands, pursue easements, leases, or enter into agreements with willing landowners in the area for land protection, compatible land use, or seed banking.

2. Agate Lake Core Area

Description. This area, south of Highway 140 along East Antelope Road, includes 363 hectares (896 acres) of both private and Federal lands. The vernal pool habitat in this area is categorized as topographically intact vernal pools with altered vegetation. The land is 10 percent federally owned, 2 percent county owned and 88 percent in private ownership.

Vernal pool fairy shrimp and *Limnanthes pumila* ssp. *grandiflora* occur within the federally managed land.

History. The land has historically been managed as pastureland. The Bureau of Reclamation manages 62 hectares (154 acres) of intact but altered vernal pool habitat as part of the Agate Reservoir. A management plan has been completed and implementation is underway for protection and conservation of vernal pool habitat.

Management. Vernal pool fairy shrimp monitoring, plant monitoring, road closures to preserve habitat from off-road vehicle intrusion, control of noxious weeds, and installation of public information signs have been carried out on the federally managed property surrounding the Agate Reservoir. Additional management actions in the plan that may occur in some later date include burning and mowing. The Bureau of Reclamation has played an active role in the recovery implementation team.

Objective. Pursue conservation agreements or leases with landowners of adjacent parcels within the core area. Utilize the best management techniques to restore habitat to benefit the vernal pool fairy shrimp and *Limnanthes pumila* ssp. *grandiflora*.

3. Hammel Road Core Area

Description. This area includes a 69-hectare (169-acre) area of privately owned properties west of Highway 62, in the vicinity of Hammel Road. These properties are categorized by the functional assessment as topographically intact vernal pools with altered vegetation.

History. Cattle grazing has occurred on the majority of the properties.

Management. Lands are primarily grazed.

Objective. The site affords opportunities for conservation easements, leases, and potentially mitigation credit opportunities. *Limnanthes pumila* ssp. *grandiflora* is known to occur on the property and can tolerate certain grazing practices, but a detailed species population assessment should be conducted to determine the species abundance and habitat quality.

4. North Eagle Point Core Area

North Eagle Point

Description. This core area is a priority 2 core area. It includes a 490-hectare (1,210-acre) area north of Eagle Point and east of Highway 62, categorized in the Agate Desert functional assessment as topographically intact vernal pools with altered vegetation. Several seasonal creeks and overland irrigation drainages flow through portions of vernal pool habitat within this area. Vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora, Plagiobothrys austiniae,* and *P. greenei* occur at this core area.

History. Livestock grazing occurs on the majority of the properties. There is no evidence of large scale leveling. In 2008, the 15-hectare (38-acre) historical Wood House property was brought into a conservation easement with the Southern Oregon Land Conservancy with the intention of historical and natural habitat preservation. In 2009, a 40-hectare (100-acre) property was purchased for a conservation bank to be managed primarily by grazing. In 2012, a survey yielded the presence of vernal pool fairy shrimp and over 2,000 *Limnanthes pumila* ssp. *grandiflora* plants.

Management. All properties are grazed in this core area, but with different degrees of livestock concentrations.

Objective. On the private properties, the site affords opportunities for conservation banking, easements, and leases with compatible livestock grazing.

5. Rogue Airfield Core Area

*Description***:** The greater 172-hectare (425-acre) area includes 34 hectares (83 acres) of variously disturbed to lightly impacted lands. The ownership of the area is 1 percent State, 80 percent County, and 19 percent private lands. The largest parcel is managed by Jackson County's Rogue Valley International-Medford Airport Authority.

History. A portion of this land was formerly a tree orchard and fairground prior to being an airport. In 1922, the City of Medford and Jackson County purchased the Medford field, known as Newell Barber field, and it became a public airport. In areas east of the airport, the land has been utilized for pasture or left vacant. In the past 10 years development has been increasing while the Oregon Department of Transportation has been planning to construct additional transportation corridors in the area.

Lomatium cookii occurs in localized sites within the airport boundary and east of the boundary within intact although partially leveled vernal pools. Although *Lomatium cookii* occurs principally within the airport property, a few *Limnanthes pumila* ssp. *grandiflora* plants occur on private land, just outside the airport property, in an area slated for development.

Prior to 2001, a 55-hectare (80-acre) patch of *Lomatium cookii* occurred on the airport property. In 2001, a new runway and access road were added to the airfield, dividing the population into three parts. A 25-year master plan on the airport calls for further runways to be built, to meet a growing air transportation demand, that could potentially conflict with the fragmented *Lomatium cookii* population (B. Case, pers. comm. 2010).

Management. Until recently, the airport authority practiced controlled burns at the airfield, but now maintains vegetation below 30 centimeters (12 inches) by periodic mowing. No herbicides, grazing, burning, or other management activities occur at the site. No management activity occurs on private lands where *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* occur and the area is anticipated to be developed for the realignment of the Highway 62 corridor.

*Objective***.** The site may provide opportunities for conservation easements and leases. A long-term conservation agreement with Jackson County for management of the *Lomatium cookii* population would benefit the species as well. It is uncertain if the area is large and secure enough to provide any long-term conservation benefit for *Limnanthes pumila* ssp. *grandiflora*.

6. Rogue Plains Core Area

Description. This area includes 318 hectares (786 acres) of land south of Sam's Valley Road and east of Modoc Road, as well as other surrounding habitat. The vernal pool habitat in this area is categorized as topographically intact vernal pools with altered vegetation. Vernal pools at this site are slightly sloped and are more weakly expressed than other areas.

History. The land has been managed as pastureland. The Nature Conservancy acquired the 63-hectare (155-acre) tract of land in 2000. Grazing was once practiced at the property under a conservation easement, but currently has stopped due to fencing expenses (D. Borgias, pers. comm 2012). *Limnanthes pumila* ssp. *grandiflora* and the vernal pool fairy shrimp occur at the property and are monitored regularly.

Management. In addition to managing cattle grazing with resting and rotation, The Nature Conservancy performs annual monitoring of *Limnanthes pumila* ssp. *grandiflora* and periodic monitoring of the vernal pool fairy shrimp. The Nature Conservancy has constructed experimental plot livestock exclosures to monitor native grass introduction using different methods, and is continuing to improve the habitat conditions with further native plant introduction.

Objective. Continue to graze, mow, or burn to improve habitat conditions at the preserve. Seek additional conservation easements or leases with adjacent property owners. The privately owned lands adjacent to the preserve afford opportunities for potential mitigation banking opportunities.

7. Shady Cove Core Area

Description. This area includes a 0.5-hectare (1-acre) area south of Shady Cove and west of Highway 62, categorized by the functional assessment as topographically intact vernal pools with altered vegetation. The habitat at this area is described as in good condition and vernal pool-mounded prairie habitat has been retained. Intact vernal pools occur on portions of the property.

History. Cattle grazing has occurred on the majority of the core area.

Management. Lands are primarily grazed.

Objective. The site affords opportunities for conservation easements, leases, and potentially mitigation banking opportunities.

8. Table Rock Terrace Core Area

Description. This area includes an 8-hectare (12-acre) area near Hammel Road and west of Highway 62, categorized by the functional assessment as topographically intact vernal pools with altered vegetation. The lands in the core area are under private ownership. Intact vernal pools occur on portions of the property.

History. Cattle grazing and agriculture have occurred on the majority of the properties.

Management. Lands are primarily grazed.

Objective. The site affords opportunities for conservation easements and potentially for mitigation banking opportunities. A detailed species population assessment should be conducted to locate the historical population of *Limnanthes pumila* ssp. *grandiflora*.

9. Whetstone Creek Core Area

Whetstone Savanna Preserve

Description. This area includes a 54-hectare (134-acre) area west of Table Rocks Road and south of Newland Road. The vernal pool habitat in this area is categorized as topographically intact vernal pools with altered vegetation.

History. This parcel was pasture when acquired by The Nature Conservancy as a land trust. The Nature Conservancy has successfully restored and managed the habitat to benefit endangered plants and the vernal pool fairy shrimp that occur there.

Management. The Nature Conservancy performs annual monitoring of the two endangered plants and vernal pool fairy shrimp. They also hand remove nonnative weeds.

Objective. Add adjacent parcels to the existing protected parcel, and restore hydrology by containing irrigation overflow to the site and enhance by managing for native vegetation around key areas of the site.

ODOT Vernal Pool Mitigation Bank

Description. This area includes a 32-hectare (80-acre) and a 40-hectare (100-acre) property west of and adjacent to the Whetstone Savanna Preserve. The vernal pool habitat in this area is categorized as marginally intact vernal pools with altered vegetation.

History. This parcel was pasture when acquired by the Oregon Department of Transportation for mitigation and conservation credit to compensate for planned projects that would likely impact vernal pool and wetland habitat. The Oregon Department of Transportation contracted The Nature Conservancy to manage and restore the habitat to benefit endangered plants and the vernal pool fairy shrimp that occur there.

Management. The Nature Conservancy has been performing annual monitoring of the two endangered plants and vernal pool fairy shrimp. They also have been removing nonnative invasive plants at site.

Objective. Restore hydrology by culverting irrigation ditch at the site to reconnect historic vernal pool systems, reintroduce listed plant species, and enhance native vegetation around key areas of the site.

10. Upper and Lower Table Rocks

Description. This area includes the summits of two disjunct, flat-topped hills that are volcanic in origin. The area is designated critical habitat for vernal pool fairy shrimp and is identified as recovery habitat for vernal pool fairy shrimp in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service 2005). No occurrences of *Limnanthes pumila* ssp. *grandiflora* or *Lomatium cookii* occur at this site, but *Callitriche marginata*, *Limnanthes pumila* ssp. *pumila*, *Plagiobothrys austiniae*, and *Plagiobothrys greenei* occur at the two Table Rock Summits. The site includes two remnant volcanic plateaus with topographically intact vernal pools with altered vegetation on top, encompassing 163 hectares (404 acres).

History. The Bureau of Land Management has managed the majority of the Table Rocks summits for many years. Recently the private properties on a portion of the summit of Lower Table rock and on some of the slopes were purchased by The Nature Conservancy. The Nature Conservancy has recently donated the land to the Bureau of Land Management. Lower Table Rock was grazed historically and included a landing strip for small aircraft. The landing strip is currently closed. Apart from the clearing and grading for the airstrip, the vernal pools are relatively intact.

Management. Medford Bureau of Land Management manages a trail system accessing the Table Rock summits and provides signs to inform visitors of the unique vernal pool ecology. The agency monitors daily use, influx of non-native invasive plants, and vernal pool habitat condition. Monitoring of the vernal pool fairy shrimp and other rare plant species occurs periodically. A Table Rocks Management Plan will soon be finalized. It provides a schedule and assortment of tools that will provide for conserving and protecting vernal pool fairy shrimp, the rare plants, and general habitat that occur on the summits.

Objective. Continue to monitor the area, improve habitat conditions as warranted, and implement the management plan.

B. ILLINOIS VALLEY RECOVERY CORE AREAS

The Illinois Valley Core Areas include the following soil types: Josephine gravelly loam, Brockman Clay loam, Pollard, Eightlar, and Kerby silt loam. Public land ownership for these core areas includes the U.S. Bureau of Land Management, the Oregon Department of Transportation, Oregon Parks and Recreation Department, and the City of Cave Junction. Species covered under this recovery plan that occur or are likely to occur in these core areas include *Lomatium cookii* and *Limnanthes gracilis* ssp. *gracilis*.

1. Anderson Creek Core Area

Description. This area includes 35 hectares (85 acres) north of Selma, Oregon. The site includes wet meadow habitat surrounded by forested areas. No detailed ground surveys have been performed in this area.

History. The core area has 35 percent Federal ownership and 65 percent private ownership. Much of this parcel has always been in private ownership and utilized for pasture, timber harvesting, or agriculture. A portion of this area is occupied by *Lomatium cookii*.

Management. Lands are unmanaged, harvested for timber, mowed annually, grazed, or cultivated.

Objective. The site affords opportunities for conservation easements and leases. With the cooperation of the landowners, a plant survey should be conducted to assess the status of the recently discovered *Lomatium cookii* population.

2. Draper Creek Core Area

Description. This area includes a 28-hectare (70-acre) area north of Selma, Oregon. The site includes wet meadow habitat surrounded by forested areas. No detailed ground surveys have been performed in this area.

History. The core area is all under private ownership. Much of this parcel has always been in private ownership and utilized for pasture, timber harvesting, or agriculture. A portion of this area is occupied by a small *Lomatium cookii* population on private lands.

Management. Lands are unmanaged, mowed annually, harvested for timber, grazed, or cultivated.

Objective. The site affords opportunities for conservation easements and leases. With the cooperation of the landowners, a plant survey should be conducted to assess the status of the recently discovered *Lomatium cookii* population.

3. French Flat North Core Area

*Description***.** The French Flat North Core Area occupies the portion of the Illinois Valley Basin south of Cave Junction, between the East Branch of the Illinois River and the west fork of the Illinois. It includes 45 hectares (110 acres). In this core area, 22 percent of the area is federally owned and 78 percent is in private ownership. The area is mostly outside of timber sales.

*History***.** *Lomatium cookii* occurs within the periphery of the core area, which is a designated Area of Critical Environmental Concern for the Medford Bureau of Land Management. There are two *Lomatium cookii* populations numbering up to 50 plants within the core area.

Management. The area is not utilized for timber, and off-road vehicles are not permitted to enter Bureau of Land Management sensitive areas. Due to difficulties with the private land boundaries, the area is not well protected from off-road vehicle usage.

Objectives. Perform restoration activities (through fire or mechanical thinning) to reduce woody plant encroachment to increase suitable habitat, develop an outreach program to communicate with adjacent landowners and local schools the importance of conserving the sensitive habitat occurring at this area, and monitor the population more closely. Pursue conservation easements, conservation banks, or leases on private lands.

4. French Flat Middle Core Area

*Description***.** The French Flat area occupies a large portion of the Illinois Valley Basin south of Cave Junction, east of the East Branch of the Illinois, north of Waldo that encompasses 492 hectares (1,215 acres). In this core area, 48 percent of the area is federally owned, and 52 percent is in private ownership. The area is mostly outside of timber harvest units.

The Bureau of Land Management performs occasional site visits to the area, but it is not closely monitored or managed. In the past 15 years the area has been vandalized by off-road vehicles that cause damage to the sensitive wet meadow soils. The Fish and Wildlife Service has entered into a Conservation Agreement with the Bureau of Land Management to help limit unlawful access to the property by motorized vehicles and to develop an outreach program to the local community. The Bureau of Land Management staff has attempted several entry deterrents, but access has not effectively been blocked. Currently a community based group, known as Friend of French Flat, has taken initiatives to clean up garbage dumped on property, monitor for illegal access, and has contacted adjacent landowners to assist in these endeavors. A proposal for a gold mine that could impact a small portion of the area is also undergoing review.

*History***.** *Lomatium cookii* and *Limnanthes gracilis* ssp. *gracilis* both occur within the periphery of the core area, which is a designated Area of Critical Environmental Concern for the Medford Bureau of Land Management. At least 5 significant *Lomatium cookii* populations (numbering approximately 12,000; 92,500 57,700; 200; and 50 plants) occur within the core area.

The Bureau of Land Management performs annual monitoring and a management plan is currently in development. In the past 15 years the area has been vandalized by off-road vehicles that cause damage to the sensitive wet meadow soils. The Fish and Wildlife Service has entered into a Conservation Agreement with the Bureau of Land Management to help limit unlawful access to the property by motorized vehicles and to develop an outreach program to the local community. The Bureau of Land Management staff has attempted several entry deterrents, but access has not effectively been blocked. Currently a community based group, known as Friend of French Flat, has taken initiatives to clean up garbage dumped on property, monitor for illegal access, and has contacted adjacent landowners to assist in these endeavors. A proposal for a gold mine is also undergoing review, that could impact a small portion of the area.

Management. The area is not utilized for timber, and off-road vehicles are not permitted to enter Bureau of Land Management sensitive areas. *Lomatium cookii* populations are annually monitored. Due to difficulties with the private land boundaries, the area is not well protected from off-road vehicle usage. Because populations appear to be steadily declining (Kaye et al. 2011), as a result of vegetation encroachment. The Bureau of Land Management

has begun clearing activities to reduce threats from vegetation encroachment and keep the meadow functioning in an early seral habitat.

Objectives. Support the current community effort to protect the habitat at this site, develop an outreach program to communicate with adjacent landowners and local schools the importance of conserving the sensitive habitat occurring at this area and monitor the effects of off-road vehicle damage to *Lomatium cookii*. Continue to monitor *Lomatium cookii* populations, augment existing populations, and increase suitable habitat through fire or mechanical thinning management. Pursue conservation easements, conservation banks, or leases on private lands.

5. Illinois River Forks Park Core Area

Description. This core area occurs west of Cave Junction, Oregon and includes wet meadow plant communities at margins of oak and fir woodlands area encompassing 55 hectares (136 acres). The Illinois River Forks Park core area is 25 percent federally owned, 45 percent State owned, and 30 percent privately owned.

History. In this core area, a *Lomatium cookii* population is located on State owned land managed by the Oregon Parks and Recreation Department. The department has been maintaining the area as a public park, while protecting the *Lomatium cookii* population and performing sporadic monitoring since 2002. Due to lack of fire, native vegetation has grown around *Lomatium cookii* populations, threatening them with encroachment and rendering otherwise suitable habitat unfavorable to *L. cookii* establishment. Vandalism and garbage dumping have been problems at the park as well. In addition, *Limnanthes gracilis* occurs within this core area, but its population status has not been evaluated. To save costs and to reduce threats of vandalism and excess garbage, the Oregon Parks and Recreation Department will begin focusing on the conservation of *Lomatium cookii* and its habitat and close public access to the park.

Management. The State Park plans to implement management actions to address natural resources occurring at the State owned lands, in lieu of a management plan. Such actions will include one or more of the following: periodic mowing, brush removal, prescribed fire, plant augmentation, and monitoring of the *Lomatium cookii* populations. Management actions will be carried out adaptively depending on the results (N. Bacheller, pers. comm. 2012).

Objective. Manage habitat, monitor *Lomatium cookii* and *Limnanthes gracilis* populations, augment existing populations as needed, and increase suitable habitat through fire or mechanical thinning management.

6. Indian Hill Core Area

Description. The Indian Hill core area is located along the West Fork of the Illinois River, approximately 7.5 kilometers (4.7 miles) south-southwest of Cave Junction, Oregon. The 22-hectare (54-acre) area includes oak and fir woodlands that are interspersed with wet meadows and drainages. In this core area, 86 percent of the land is on Federal lands mostly managed for non-timber, and 14 percent of the parcels are privately owned.

*History***.** One *Lomatium cookii* population occurs within this core area, numbering approximately 12,900 plants. The Bureau of Land Management has 11 years of monitoring data of the Indian Hill *Lomatium cookii* population.

Management. The area is not utilized for timber, and off-road vehicles are not permitted to enter Bureau of Land Management sensitive areas. The *Lomatium cookii* population is annually monitored.

Objectives. Continue to monitor *Lomatium cookii* populations, augment existing populations, and increase suitable habitat through fire or mechanical thinning management. Pursue conservation easements or conservation banks on private lands.

7. Laurel Road Core Area

*Description***.** This area encompasses 182 hectares (449 acres) and is located just east of Cave Junction, Oregon. This area is 2 percent State owned and, 98 percent privately owned. The Oregon Department of Transportation manages a Special Management Area within this core area that supports a vigorous *Lomatium cookii* population of approximately 20,000 individuals.

History. The Oregon Department of Transportation has been protecting this site and performing biennial monitoring for this population since 2003. *Lomatium cookii* and *Limnanthes gracilis* ssp. *gracilis* have occurrences within this core area. The largest population of *Lomatium cookii* on State owned land occurs along this managed highway right-of-way. Vegetation control has not been an issue for this population.

Management. The population is regularly monitored and is protected from inadvertent highway maintenance impacts with signs. Long-term maintenance of the road will be a concern as well as unpredicted traffic related disturbances.

Objective. Monitor *Lomatium cookii* populations, develop and refine maintenance guidelines, augment existing populations, and complete a long-term management plan or schedule for site. Pursue conservation easements, conservation banks, or leases on private lands.

8. Reeves Creek North Core Area

*Description***.** This area includes 152 hectares (374 acres) of mixed oak-pine woodlands and open meadows located 5 kilometers (3 miles) northeast of Kerby, Oregon. This area is 50 percent federally owned and 50 percent privately owned. The core area has 74 percent Federal ownership and 26 percent private ownership. The mesic plant communities that support *Lomatium cookii* occur at margins of oak and fir woodlands on slopes and within brushy plant communities. The area is mostly outside of timber sales.

History. Three large patches of *Lomatium cookii* occur at this site and contain approximately 100 to 200 plants. Due to lack of fire, native vegetation threatens portions of populations and renders otherwise suitable habitat unfavorable to *Lomatium cookii* establishment.

Management. The Bureau of Land Management manages the Federal land in this core area. *Lomatium cookii* populations are periodically monitored. Maintenance of the road will be a concern as well as traffic related disturbances.

Objective. Monitor *Lomatium cookii* populations, augment existing populations, and increase suitable habitat through fire or mechanical thinning management.

9. Reeves Creek South Core Area

Description. This area includes a 165-hectare (407-acre) area northeast of Cave Junction, Oregon. The site includes sloped mixed-conifer openings and shrubby plant communities surrounded by forested areas. No detailed ground surveys have been performed in this area.

History. The core area has 95 percent Federal ownership and 5 percent private ownership. It is utilized for pasture, timber harvesting, or agriculture. A portion of this area on Federal lands is occupied by a small *Lomatium cookii* population.

Management. Lands are primarily used for timber harvests and special forest products such as wood burls and mushrooms.

Objective. The site affords opportunities for restoration, population reintroduction conservation easements, and leases. A plant survey should be conducted on Federal lands to determine the status of the *Lomatium cookii* population.

10. Reeves Creek East Core Area

Description. This area includes an 83-hectare (204-acre) area northeast of Cave Junction, Oregon. The site includes sloped mixed-conifer openings and shrubby plant communities surrounded by forested areas. No detailed ground surveys have been performed in this area.

History. The core area has 70 percent Federal ownership and 30 percent private ownership. It is utilized for pasture and timber harvesting. A portion of this area is occupied by a small *Lomatium cookii* population on Federal lands.

Management. Lands are periodically harvested for timber and special forest products such as wood burls and mushrooms.

Objective. The site affords opportunities for restoration, population reintroduction, and conservation easements. A plant survey should be conducted on Federal lands to determine the status of the *Lomatium cookii* population.

11. Riverwash Core Area

Description. This core area is located along the east bend of the West Fork Illinois River, 0.7 km (0.43 mi) south upstream) of the confluence between Woodcock Creek and the West Fork Illinois River. The area includes 12 hectares (30 acres) of intact wet meadow and streambank habitat.

History. The core area has been monitored periodically since the time it was discovered (D. Sharp, pers. comm. 2009). A population within the core area occurs in wet meadow habitat alongside a stream on Oregon Department of Transportation managed land. The core area is 38 percent federally owned, 4 percent State owned, and 58 percent privately owned.

Management. The State will continue to monitor the population periodically while the remainder of the property is likely managed for timber production.

Objective. Because the primary threats to habitat in this unit are periodic roadside maintenance, garbage dumping, vegetative succession, occasional roadside disturbance, and rural development, the site affords opportunities for restoration, population reintroduction, and conservation easements.

12. Rough and Ready Creek Core Area

Description. The private lands encompass 118 hectares (292 acres). The land is under 74 percent Federal ownership and 26 percent private ownership. This area occurs west of the Illinois Valley airport on Bureau of Land Management land and includes oak and fir woodlands that are interspersed with wet meadows and drainages.

History. Protection of a significant *Lomatium cookii* population on private property has been achieved through the purchase of a 92-acre conservation easement. This population numbers approximately 2,000 plants. The land will be managed to benefit *L. cookii* and the habitat will be monitored annually. Although a portion of the *L. cookii* population has been extirpated by historic development, clearing activities, and road maintenance, the population has been maintained in other areas.

*Management***.** On the private land portion, the area is closed to off-road vehicle use, development, and the area is closed to mineral entry. The Bureau of Land Management will continue to monitor *Lomatium cookii* and the habitat conditions for invasive weeds, encroachment of native trees, garbage accumulation, and the general habitat condition. The agency will deter motorized vehicle from entry onto the habitat supporting this plant (S. Fritts, Pers. comm. 2010).

Objective. Continue to monitor the core area for *Lomatium cookii* population health and for site condition. Population may become necessary if suitable land becomes protected by conservation easements or changes in ownership. Continue to deter off-road vehicle use on property to preserve the habitat condition.

13. Woodcock Mountain Core Area

Description. The lands encompass 234 hectare (579 acres). This area occurs west of the Illinois Valley airport on Bureau of Land Management land and includes oak and fir woodlands that are interspersed with wet meadows and drainages. The area is five percent federally and 95 percent privately owned.

History. Protection of a significant *Lomatium cookii* population on private property has been achieved through the purchase of a 92-acre conservation easement. This population numbers approximately 2,000 plants. The land will be managed to benefit *Lomatium cookii* and the habitat will be monitored annually. Although a portion of the *L. cookii* population has been extirpated by historic development, clearing activities, and road maintenance, the population has been maintained in other areas.

*Management***.** On this private land, the area is closed to off-road vehicle use, development, and the area is closed to mineral entry. No formal monitoring schedule has been planned or implemented yet.

Objective. Continue to monitor the *Lomatium cookii* population when possible. Augment the population as necessary and maintain or increase suitable habitat through fire or mechanical thinning management.

APPENDIX E. THREATS IDENTIFIED FOR THE VERNAL POOL AND WET MEADOW SPECIES AND RECOVERY PLAN RECOMMENDED MANAGEMENT ACTIONS

SPECIES	LISTING FACTOR	THREAT	RECOVERY ACTION NUMBERS	RECOVERY CRITERIA
All listed species	A, D	Industrial, commercial, and residential development	1.1, 1.2, 2.1, 2.2, 2.3, 2.7, 5.1, 5.2, 5.3, 5.4	1a-d, 2a-d, 3b-c, 4(1)a, 4(1)b, 4(1)d
All listed species	A, D	Road and utilities construction and maintenance	2.7, 4.10	1a-d, 2a-d, 3b-c, 4(1)a, 4(1)b, 4(1)d
All listed species	A	Hydrological alteration and conversion to irrigated agricultural use	2.1, 2,2, 2.3, 2.7, 4.7	1a-e, 2a-e, 3b-c, 4(1)a, 4(1)b, 4(1)d
Both listed plant species	A	Competition from introduced annual grass species	2.7, 4.4	1c, 1e, 2c, 2e
All listed species	A	Fall and winter cattle grazing	2.1, 2.2, 2.3, 4.5, 4.8, 5.1, 5.2, 5.3, 5.4	1c, 1e, 2c, 2e, 3a, 4(1)d, 4(2)a-c,4(3) a-b
Lomatium cookii	A	Proposed gold mining operations	2.1, 2.2, 2.3, 2.7, 5.1, 5.2, 5.3, 5.4	2c, 2e
All listed species	A	Off-road vehicle disturbance	2.1, 2.2, 2.3, 2.7, 5.1, 5.2, 5.3, 5.4	1c, 1e, 2c, 2e, 3a, 4(1)d, 4(2)a-c,4(3) a-b
All listed species	A	Timber sale-associated activities	2.1, 2.2, 2.3, 2.7, 5.1, 5.2, 5.3, 5.4	1c, 1e, 2c, 2e, 3a, 4(1)d, 4(2)a-c,4(3) a-b
Lomatium cookii	A	Encroachment of woody vegetation due to fire suppression	2.1, 2.2, 2.3, 2.7, 4.4, 5.1, 5.2, 5.3, 5.4	2c, 2e
Limnanthes pumila ssp. *grandiflora*	B	Collection related to meadowfoam oil seed development	2.2, 2.3, 5.1, 5.2, 5.3, 5.4	1c, 1d, 1e, 1f
All listed species	C	Predation by insect larvae	4.8	1c, 1e, 2c, 2e, 3a, 4(2)a-c, 4(3)a, 4(4)a

SPECIES	LISTING FACTOR	THREAT	RECOVERY ACTION NUMBERS	RECOVERY CRITERIA
All listed species	D	Limitations of Clean Water Act protection of small, isolated wetlands	2.1, 5.1, 5.2, 5.3, 5.4	1a-c, 2a-c, 3b-c, 4(1)a-b, e, 4(5)a-b
All listed species	D	Limited protection under State of Oregon Endangered Species Act	2.2, 5.1, 5.2, 5.3, 5.4	1a-c, 2 a-c, 3b-c, 4(1)a-b, e, 4(5)a-b
All listed species	E	Vulnerability to stochastic (random) events due to isolation and small population size	1.1, 1.2, 2.1, 2.2,.2.3, 2.5, 2.6, 2.7, 4.6, 5.1, 5.2, 5.3, 5.4	1a-f, 2a-f, 3a-c, 4(1)a-d, 4(3)a-b

APPENDIX F. CONSERVATION TOOLS AND STRATEGIES

Rights and Interests in Land that Can be Acquired

Right or Interest	Explanation	Advantages	Disadvantages
Fee simple ownership	Full title to land and all rights associated with land.	Owner has full control of land. Allows for permanent protection and public access.	Most costly. Ownership responsibility includes liability and maintenance.
Conservation easement / development rights (Access to monitor species populations should be added to conservation easement)	A partial interest in property transferred to an appropriate non-profit or governmental entity either by gift or purchase. As ownership changes, the land remains subject to the easement restrictions.	Less expensive than fee simple. Landowner retains ownership and property is taxed at a lower rate. Easement may allow for some development. Potential income and estate tax benefits from donation.	Public access may not be guaranteed. Easement must be enforced. Restricted use may lower resale value. If the easement has a "sunset" then permanent protection is not guaranteed.
Fee simple / leaseback	Purchase of full title and leaseback to previous owner or other lessee. May impose land use restrictions.	Allows for comprehensive preservation program of land banking. Income through leaseback. Liability and management responsibilities assigned to lessee.	Public access is not guaranteed. Land must be appropriate for leaseback (*e.g.*, agricultural).
Lease	Short or long-term rental of land.	Low cost for use of land. Landowner receives income and retains control of property.	Does not provide equity and affords only limited control of property. Temporary.
Undivided Interest	Ownership is split between different owners, with each fractional interest extending over the whole parcel. Each owner has equal rights to entire property.	Prevents one owner from acting without the consent of the others.	Several landowners can complicate property management issues, especially payment of taxes, future sale, land uses, and access.
Deed Restriction	Voluntary or imposed restriction on land use placed on title by landowner.	Can prevent impacts to or protect habitat and/or open space values as long as landowner retains the restriction.	Is easily removed from property title by property owner without government knowledge. Does not guarantee even short-term protection.

Ways that Title Can Be Acquired

Technique	Explanation	Advantages	Disadvantages
Fair market value sale*	Land is sold at its highest and best use value.	Highest income (cash inflow) to seller.	Most expensive. Greatest capital gains.
Bargain Sale*	Part donation/part sale - property is sold at less than fair market value.*	Tax benefits to seller since difference between fair market value and sale price is considered a charitable contribution. Smaller capital gains tax.	Seller must be willing to sell at less than fair market value.
Charitable Gift	A donation by landowner of all interest in property.*	Allows for permanent protection without direct public expenditure. Tax benefits to seller since property's fair market value is considered a charitable contribution.	Seller must be willing to donate.
Bequest	Landowner retains ownership until death.*	Management responsibility usually deferred until donor's death.	Date of acquisition is uncertain. Donor does not benefit from income tax deductions. Landowner can change will, may contain land use conditions unfavorable to open space/ habitat use.
Donation with reserved life estate	Landowner donates during lifetime but has lifetime use.	Landowner retains use but receives tax benefits from donation.	Date of acquisition is uncertain.
Land exchange	Exchange of developable high habitat/open space land for land with equal development potential but less habitat/open space value.	Low-cost technique if trade parcel is donated. Reduces capital gains tax for original owner of protected land.	Properties must be of comparable value. Complicated and time consuming.
Agency transfer (government)	Certain government agencies may have surplus property inappropriate for their needs that could be transferred to a parks agency for park use.	Limited expenditure.	Time consuming with possible conflicts with local government.
Restricted auction (nonprofit)	Government restricts the future use of property to open space, and then sells.	Property sold to highest bidder but restriction lowers price and competition.	It may be difficult for a nonprofit to convince government that a restriction will serve to benefit the general public. Can be expensive.

* There are different ways of financing: *e.g.*, cash, mortgaged, owner financed, lease/option, etc. with some means having greater tax benefits than others for the seller and some means more easily financed by government than others. Conservation easements also can be acquired by these means.

Management and Ownership Options Following Purchase by Non-profit Organization

Technique	Explanation	Advantages	Disadvantages
Conveyance to public agency	Non-profit organization acquires and holds land until public agency is able to purchase.	A non-profit organization can enter the real estate market more easily than government, and can often facilitate a sale when the government agency would be unable.	Must have a public agency willing and able to buy within a reasonable time frame. Private fund raising can be difficult.
Conveyance to another non-profit organization	Non-profit organization acquires and holds land until another non-profit organization has been established or is able to finance acquisition.	Allows immediate acquisition even though acquiring group cannot or is not willing to hold property.	Requires existence or establishment of ultimate land holder that has solid support, funding and the ability to manage land.
Management by non-profit organization	Non-profit organization retains ownership and assumes management responsibilities.	Ownership remains within the community; local citizens can provide responsible care and management.	Land must fit criteria of acquiring organization. Organization must assume long-term management responsibilities and costs.
Saleback or leaseback	Non-profit organization purchases property, limits future development through restrictive easements or covenants, and resells or leases back part or all of property. May involve subdivision of property.	Acquisition is financed by resale or leaseback. Resale at less than fair market value (because of restrictions) makes land affordable for buyer. Sale can finance preservation of part of site.	Complex negotiations. A leaseback means the nonprofit organization retains responsibility for the land.

Financing Options for Government

Financing Option	Explanation	Advantages	Disadvantages
General fund appropriation	Appropriation from primary government funds.	Avoids interest and debt service cost.	Budget allocations unpredictable. Might not provide sufficient funds, and competes with other programs.
Bond act	Borrowing money through insurance of bonds. Usually approved through local or statewide referendum.	Distributes cost of acquisition. Does not impact general funds.	Requires approval of general public. Can be expensive - interest charges are tacked on to cost of project.
Land and Water Conservation Fund	Federal funds provided to local governments on a 50/50 matching basis for acquisition and development of land for public use.	Cost of acquisition for local government is lowered by subsidy.	Federal release of these funds is uncertain and has been extremely limited to date. Competition is extreme.
State grant/low interest loans	States provide matching grants or low interest loans for municipalities to acquire open space.	Encourages localities to preserve open space by leveraging local funds. Donated lands may be used as a match.	Localities must compete for limited funds and be able to match state funds.
Real estate transfer tax	Acquisition funds obtained from a tax on property transfers. Percentage and amount exempted varies with locality.	Growth creates a substantial fund for open space acquisition. Enables local communities to generate their own funds for open space protection.	Places greater burden on new residents than on existing residents. Can inflate real estate values. Effective only in growth situations.
Land gains tax	Capital gains tax on sale or exchange of undeveloped land held for a short period of time. Tax rate varies depending on holding period.	Discourages speculative development. Has a regulatory and revenue impact.	Can inflate real estate values and slow market.
Payment in lieu of dedication	Local government requires developers to pay an impact fee to a municipal trust fund for open space acquisition.	New construction pays for its impact on open space.	Acquisition funds depend on development. May be lack of accountability for funds. Legality of method depends on relationship of open space to new development.
Special assessment district	Special tax district for area benefitted by a public benefit project.	Users finance acquisition and management.	Increases taxes. Timely and costly to implement. Requires 2/3 voter approval in California.
Tax return check off	On state income tax forms, a filer may appropriate a small amount of taxes owed toward revenues for natural lands acquisitions.	Convenient and successful means of generating funds.	Vulnerable to competition from other worthwhile programs.
Other funds/taxes	Taxes on cigarettes, sales, gasoline, and natural resource exploitation; revenue from fees and licenses for boat, off-road vehicle, and snowmobile use, park entry, hunting, etc.	Income from fees and licenses pays for resources.	Revenues from taxes can be diverted for other uses unless dedicated to open space. Fees create pressures for money to be spent on special interest uses.
Sale or transfer of tax default property	Sale of tax default property can provide a fund for open space acquisition. Also, if site meets criteria, it can be transferred to appropriate agency for park use.	Funds for acquisition are acquired with little cost to taxpayers.	Need to assure that sale proceeds are specially allocated to open space acquisition. Might not provide a significant income. Very political process.

Financing Options for Non-Profit Organizations

Financing Option	Explanation	Advantages	Disadvantages
Loan from institutional or private lender	Conventional loan from bank or savings and loan or private source, such as a foundation or corporation.	Less time-consuming process than fund raising.	Long-term financial commitment for non-profit organization. Higher interest costs than owner financing. Mortgage lien.
Installment sale	Buyer pays for property over time.	If seller financed, can lower taxes for seller. Buyer can negotiate better sale terms (lower interest rates).	Long-term financial commitment for non-profit organization. Mortgage lien.
Fundraising	No- or low-interest loans are acquired through program related investments from foundations, non-standard investments from corporations, or charitable creditors (community members).	Community fundraising creates publicity and support.	A long, uncertain, and time consuming process.
Revolving fund/loans or grants	A public or private organization makes grants to localities or non-profit organizations for land acquisition based on a project's revenue generating potential.	Encourage projects with revenue generating potential.	Projects with low revenue-generating potential have lower priority.
Partial development/ saleback or lease	Non-profit organization purchases property, limits future development through restrictive covenants, and resells or leases back part or all of property.	Acquisition is financed by resale or leaseback. Sale can finance preservation of part of site.	Complex negotiations. If leaseback, non-profit organization retains responsibility for land. Finding buyer for restricted property may be difficult, and land value will be lowered by restrictions.

Government Financial Incentives for Conservation

Incentive	Explanation	Advantages	Disadvantages
Preferential assessment	Under state laws, agricultural and forest districts can be established to assess land as farmland or forestland rather than at its highest and best use.	Promotes resource conservation and management. Especially benefits landowners in areas with development pressure. Tax base loss can be partially reclaimed through penalty tax on landowners who terminate enrollment.	Voluntary participation. Does not provide long-term protection. Minimum acreage for entry. Strength of program depends on penalty from withdrawals. Local government bears burden of reduced tax base.
Purchase of development rights	Local or state government purchases development rights to maintain land in farm use.	Landowner can derive income from selling development rights and continue to own land. Lower property value should reduce property taxes.	Can be costly, particularly in a community with high real estate values.
Land conservation grants	State programs pay or otherwise enable landowners to preserve land, enhance wildlife, and provide public access.	Landowners derive revenues from preserving land without selling interests in land.	Provision of public expenditures.

Safe Harbor Agreements

Incentive	Explanation	Advantages	Disadvantages
Create incentives by removing restrictions under section 9 of Endangered Species Act. Allows "take" of listed species beyond baseline conditions (*i.e.*, those lands or animals protected at time of signing of agreement).	Private landowners and non-Federal property owners encouraged to restore, enhance and maintain habitats for listed species in return for assurances that additional land-use restrictions as a result of voluntary conservation actions will not be imposed.	Could garner non-Federal landowner's support for species conservation on non-Federal lands. By reducing fear of future additional property use restrictions under Endangered Species Act, landowners may enhance their lands for listed species. Could reduce habitat fragmentation and increase population numbers of listed species.	Could adversely affect populations by serving as biological sink for species attracted to enhanced habitat, only to have habitat later lost to development. May not be adequate incentives other than public relations value, and may not offer value over traditional Habitat Conservation Plans. Opportunities may be few in states with strong coastal protection regulations.

Regulatory Techniques - Growth Control

Technique	Explanation	Advantages	Disadvantages
Phased growth	Permits a limited amount of growth each year.	Effective as a comprehensive planning strategy.	There must be an equitable system to approve development. Future development pressures difficult to predict.
Moratorium	Legal postponement or delay of land development.	Useful as an interim measure during the formulation of a master development plan.	Provides only a temporary solution and can create a rush on land development prior to taking effect.
Transfer of development rights	An owner of publicly-designated land can sell development rights to other landowners whose property can support increased density.	Cost of preservation absorbed by property owner who purchases development rights.	Difficult to implement. Preservation and receiving areas must be identified.

Regulatory Techniques - Zoning and Subdivision Provisions

Technique	Explanation	Advantages	Disadvantages
Large lot zoning	Large minimum lot sizes restrict the density of the development.	An established land use control used as part of a comprehensive plan.	Since zoning is subject to change, not effective for permanent preservation. Can increase real estate values and infrastructure costs can foster urban sprawl.
Performance zoning	A zone is defined by a list of permitted impacts (based on natural resource data and design guide-lines) as opposed to permitted uses.	Directs development to appropriate places based on a comprehensive, environ-mentally-based plan. Can be implemented through cluster development.	Difficulties in implementation since environmental impacts can be hard to measure and criteria are hard to establish. Plan can be expensive to prepare.
Carrying capacity zoning	Based on the ability of an area to accommodate growth and development within the limits defined by existing infrastructure and natural resource capabilities. Often called Current Planning Capacity.	Zoning is based on an area's physical capacity to accommodate development. Can be implemented through cluster development.	Requires a comprehensive environmental inventory for implementation. Determining carrying capacity can be a difficult process, subject to differing opinions, quality-of-life assumptions, and changing technologies.
Cluster Zoning/planned unit development (PUD)	Maintains regular zoning's ratio of housing units to acreage but permits clustered development through undersized lots, thus allowing for open space preservation. A PUD provision allows clustering for a large, mixed-used development.	Flexibility in siting allows preservation of open space areas within development site. Can reduce construction and infrastructure costs.	Open space often preserved in small separate pieces, not necessarily linked to a comprehensive open space system. May increase processing time for development approval. Lack of infrastructure can inhibit technique.
Preservation overlay zoning	At discretion of municipality, overlay zones with development restrictions can be established to protect agricultural and natural areas, scenic views, and historic neighborhoods.	Special zones have regulations specific to the needs of a unique area and may be subject to mandatory clustering, performance standards, special permits, and site plan and architectural review.	Language in special district ordinance must be specific enough to avoid varying interpretations.
Exaction	As a condition of obtaining subdivision approval, local government requires developers to pay a fee or dedicate land to a municipal trust fund for open space. Also, states can require open space set-asides as part of environmental review.	New construction pays for its impact on open space.	Acquisition funds dependent on residential development. Commercial development often not subject to exaction fees. Difficult to calculate developer's fair share of costs. New case law restrictions.
Conservation density subdivisions	Permit developers an option of building roads to less expensive specifications in exchange for permanent restrictions in number of units built. Roads can be public or private.	Increases open space and reduces traffic. Discourages higher densities to pay for the higher cost of road building.	Requires enforcement of easements. Private roads limit public access and require homeowner association maintenance.

Regulatory Technique - Conservation/Mitigation Banks

Technique	Explanation	Advantages	Disadvantages
Conservation/ mitigation banks	Wildlife habitat areas are restored and permanently protected by selling credits to offset development impacts elsewhere.	Could advance regional habitat conservation by allowing mitigation credits at sites recognized to be high priority for regional conservation in exchange for areas of minimal habitat value.	If not carefully considered and development projects are not consistent with all Federal and state laws, could facilitate habitat loss. Environmentally controversial.

APPENDIX G. AGENCY AND PUBLIC COMMENT ON THE DRAFT RECOVERY PLAN FOR LISTED SPECIES OF THE ROGUE VALLEY VERNAL POOL AND ILLINOIS VALLEY WET MEADOW ECOSYSTEMS

I. Summary of Agency and Public Comment on the Draft Recovery Plan for Listed Species of the Rogue Valley Vernal Pool and Illinois Valley Wet Meadow Ecosystems

On September 22, 2006, we released the Draft Recovery Plan for Listed Species of the Rogue Valley Vernal Pool and Illinois Valley Wet Meadow Ecosystems for a 60-day comment period for Federal agencies, State and local governments, and members of the public. The public comment period ended on November 21, 2006. Robert Meinke, Darrin Borgias, Darlene Southworth, and Jimmy Kagan were asked to provide peer review comments for the draft plan. Three of the peer reviewers, Darrin Borgias, Darlene Southworth, and Jimmy Kagan, provided comments on the draft plan. Graduate students under Robert Meinke, Stephan Meyers, and Rebecca Currin provided review comments on the draft plan.

This section provides a summary of general information about the comments we received, including the numbers of letters from various sources. A complete index of comments by affiliation is available from the U.S. Fish and Wildlife Service, Roseburg Field Office, 2900 NW Stewart Parkway, Roseburg, Oregon 97470. All comment letters are kept on file in the Roseburg Field Office.

The following is a breakdown of the number of comment letters (including the peer reviewers) received from various sources:

Federal Agencies	3
State Agencies	3
Academia/Professional	2
Environmental/Conservation Organizations	1
Individuals	2

In general comments were supportive and offered helpful suggestions. Three peer reviewers provided comments and suggested edits on the draft recovery plan. In general their comments regarding the draft plan were generally supportive of the plan. Several main themes addressed by the peer reviewers were a) more detail in the associated species of conservation concern, b) more information about vernal pool fairy shrimp, and c) additional information about priority core areas.

Each letter contained comments that could be divided into the following categories:

II. Summary of Major public comments and Service Responses

GENERAL COMMENTS

1. *Comment*: One commenter suggested that the title of the recovery plan is too long and complicated and suggested changing the recovery plan name to *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* Recovery Plan.

Response: This Recovery Plan encompasses the entire vernal pool and wet meadow ecosystems in two areas of southern Oregon and includes site specific recovery actions for the vernal pool fairy shrimp. The current name, "Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems", better represents the broad perspective of the conservation material. The name also distinguishes it from the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon.

2. *Comment*: One commenter suggested that critical habitat designation be included in the recovery plan in place of recovery core areas.

Response: Critical habitat for the two listed plant species has now been designated in a final rule published on July 21, 2010 (U.S. Fish and Wildlife Service 2010). Critical habitat is not designated in recovery plans because critical habitat designation and recovery planning are two separate processes under the Endangered Species Act. The evaluation of the need for and designation of critical habitat is accomplished through the listing process under subsections 4(a)(3) and 4(b)(2) of the Endangered Species Act, while the development and implementation of a recovery plan is accomplished under section 4(f) of the Endangered Species Act. Critical habitat designations are regulatory documents that identify specific geographic areas within which consultation under section 7(a)(2) is required. Before designating critical habitat, careful consideration is given to the economic impacts, impacts on national security, and other relevant impacts of specifying any particular area as critical habitat, and areas may be excluded from critical habitat for these reasons. Recovery plans are guidance documents that broadly address conservation needs of the species by identifying habitat, protection and restoration, and management needs and all other actions that we anticipate will bring a species to a state in which it may be delisted or downlisted.

CONTENT

1. *Comment*: One commenter raised the question, "Has *Limnanthes pumila* ssp. *grandiflora* always been confined to Rogue Valley Plains?"

Response: Based on current and historic information, *Limnanthes pumila* ssp. *grandiflora* has always been a narrow endemic, only known to occur in vernal pool-mounded prairie habitat in the Agate Desert area of the Rogue Valley in Jackson County. Although the plant has been grown off-site as an experimental seed-crop, the genetic component of the plant has never become established outside of the Agate Desert.

2. *Comment*: One commenter asked the question, "Is *Limnanthes pumila* ssp. *grandiflora* rare due to rarity or due to human intervention?"

Response: Because *Limnanthes pumila* ssp. *grandiflora* is a narrow endemic that only occurs in Agate-Winlo soils, it would likely be considered rare, regardless of human intervention. The spread of human development in its core area has further restricted the range and distribution of this species. Human rural and industrial development has reduced the distribution of the species to small isolated fragments dispersed around the periphery of the historic population center.

3. *Comment*: Does the Army Corps of Engineers have jurisdiction for vernal pools after the June 19, 2006, U.S. Supreme Court of the United States decision (RAPANOS v. UNITED STATES [Nos. 04-1034 and 04-1384])?

Response: The Army Corps of Engineers evaluates Clean Water Act applications individually to determine if wetland features in Oregon meet jurisdictional "Waters of the United States" criteria. In most development projects in Oregon affecting vernal pools, the Corps has considered vernal pools to be jurisdictional wetlands. Their rationale is based on the fact that vernal pools can be proven to have above-ground connectivity to waters of the United States.

4. *Comment*: Is the lack of enforcement of take of plants in the Endangered Species Act a significant threat?

Response: There is no take prohibition for listed plants in the Endangered Species Act. However, federally funded or permitted actions are subject to consultation under section 7 of the Endangered Species Act, and Federal agencies must ensure that their actions are not likely to

jeopardize listed plants or destroy or adversely modify their critical habitat. Removal or reduction to possession of listed plants from Federal lands is also prohibited. However, because of the lack of a take prohibition for plants, the Endangered Species Act provides little legal protection for the two listed plant species on any private lands where no Federal action is involved; therefore, long-term protection of Priority 1 and 2 core areas is critical to recovery of the species.

5. *Comment*: The baseline condition of a population may not reflect that a population is viable. The current status of a species population in many cases may need to be improved, not maintained at current level. Evidence of reproduction and recruitment is not enough to determine that a population is viable.

Response: The goal of status surveys is to determine whether species populations are being maintained in stable or increasing levels and are viable. In this recovery plan, we consider a species population, no matter how small, as important to recovery of the species. At many sites data may be insufficient for a detailed analysis of population viability, but stable or increasing population trends, in combination with successful reproduction, protection of habitat, and successful implementation of management actions to reduce or eliminate likely threats, are evidence supporting viability of a population. This recovery plan recommends continued monitoring to determine effectiveness of management measures and evaluate population responses to confirm whether populations are viable over the long term.

6. *Comment*: The Endangered Species Act does not apply to non-Federal or non-state lands for plants, unlike animals, private lands are exempt from the Endangered Species Act. Only Federal lands should be included in the recovery core areas.

Response: Recovery plans are based on the biology of the species and are intended to provide direction so that listed species can be recovered throughout their range. While recovery plans do not impose a requirement on private landowners to implement recovery actions or necessarily ensure the availability of funding to do so, they do describe actions that conservation partners can voluntarily implement to help recover species. The lack of Endangered Species Act protection for plants on private lands makes those populations potentially the most vulnerable, increasing the importance of voluntary conservation by private landowners. Indeed, the majority of both plants' habitat is in private ownership, and for *Limnanthes pumila* ssp. *grandiflora* no populations are known to occur on Federal lands. Evaluation of whether a species should be delisted will be based on a full assessment of threats to its survival, and our understanding of

population status on both private and public lands will contribute to this assessment; thus we do not preemptively exclude private lands from recovery core areas.

7. *Comment*: One commenter suggested the Recovery Plan include actions to address un-discovered populations of *Lomatium cookii* east of the Illinois Valley.

Response: The recovery plan has identified core areas for where species occur and might occur in suitable habitat. Although it is possible that species will also occur outside of these core areas, it is unlikely. This final recovery plan does consider the possibility of undiscovered naturally occurring species populations outside of core areas, and provides measures for newly discovered populations to be protected.

RECOVERY STRATEGY

1. *Comment*: It would be unrealistic to wait for a long-term population viability analysis study to be completed before setting target population numbers for recovery.

Response: Recovery targets for populations should be determined using the best knowledge that we have at this time. We agree that it is unrealistic to wait an extended amount of time to develop a full population viability analysis. In addition, population viability modeling can be expensive and often does not apply to on-the-ground statistics. We have reduced the importance of population viability analyses in this recovery plan to determine how to manage and recover populations. We are still considering protection of habitat and listed species populations as the most crucial step towards recovery.

2. *Comment*: Include specific goals for number of populations or number of individuals in population.

Response: While careful species monitoring can allow managers to perform management with better precision, in the case of recovery criteria for *Lomatium cookii, Limnanthes pumila* ssp. *grandiflora*, and the vernal pool fairy shrimp our main goal is to establish protected areas with functional ecosystems. We identify targets for the number of occurrences and for overall population trends to be stable or increasing within an occurrence, but rather than identifying a specific numeric population target we focus on control of the major threats to the species. When the listed taxa covered in this recovery plan are removed from threats they are anticipated to become stable, to increase in area and to increase in population size. Should new threats be

identified in the near future we will coordinate with managers to respond to threats with effective conservation and restoration tactics.

DOWNLISTING/DELISTING CRITERIA.

1. *Comment*: One commenter raised the question about the utility of planning for private lands to meet recovery plan criteria. Plants do not receive Federal protection on private lands, therefore it would not be practical or realistic to require the lands are protected in order to achieve recovery.

Response: Recovery criteria describe our best estimate of conditions that would be necessary for a five-factor delisting analysis to conclude that threats to the species have been alleviated and the species is no longer threatened or endangered. Thus, they are based on the biology of the species rather than how its populations are distributed across land ownership boundaries. We cannot guarantee that the species covered under this recovery plan can achieve recovery without participation of various public agencies, land conservation groups, and private landowners. Focusing conservation efforts solely on public lands could lead to the loss of populations and genetic variability that are important to increase the likelihood of the species' persistence through unpredictable events (*e.g.*, climate change, drought, fire).

2. *Comment*: Would management be necessary for all populations or is protection enough to conserve a listed species population?

Response: Due to widespread presence of invasive non-native weeds, unlawful dumping and recreational activities, and the threat of fire, at least some form of limited management may be necessary for all populations of the listed species. For some listed species populations, if reasonably protected, leaving the land alone may be sufficient to ensure that threats are overcome enough to allow continued survival; however, this is not true for all populations. Because all habitats in the Rogue Valley have been invaded by non-native annual grasses and forbs, the threat of non-native plant proliferation in combination with unsustainably small population size could cause extirpation of some species populations without active management. In the Illinois Valley, the threat of fire is steadily increasing due to an ongoing and increasing degree of fire exclusion and lack of vegetation maintenance, so active management is needed to address this threat.

3. *Comment*: One commenter suggested that in the plant downlisting criteria, a threat assessment time period of 3 years was too short, and should be combined with the overall population

monitoring time period of 10 years, to ensure threats were controlled over the entire 10-year period.

Response: In this final recovery plan, we have removed the reference to a 3-year threat assessment period. The implementation of management plans should evaluate the degree and trend of threats on an ongoing basis, and any downlisting or delisting action initiated after 10 years of population monitoring should be able to document that appropriate management plans have been effective at controlling threats.

APPENDIX H. CONSERVATION AND REGULATORY MEASURES

1. Federal Lands and Regulations

The development of a federally administered project must be coordinated with the U.S. Fish and Wildlife Service for actions that may affect listed species or their critical habitat. By these regulatory measures, additional protection of *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, the vernal pool fairy shrimp, and their critical habitats can be achieved. Federally listed plants and animals and designated critical habitat are protected on all federally administered lands under the Endangered Species Act. Under the same act, Federal agencies are required to conduct conservation programs for federally listed species.

a) Federally Administered Lands.

Bureau of Land Management. The Bureau of Land Management manages several populations of *Lomatium cookii* on 723 hectares (1,781 acres) of *Lomatium cookii* critical habitat in the Illinois Valley by protecting the plant occurrences near roadside timber harvests, restricting off-road vehicle access, maintaining a long-term population inventory program, and monitoring existing populations. French Flat, a 320-hectare (792-acre) historic mining site that includes seasonally wet grassland meadows and forests in the Illinois Valley, is designated as an Area of Critical Environmental Concern on Bureau of Land Management land. This area receives special management for habitat conservation due to the outstanding botanical, ecological, and geological values in an area mostly undisturbed by roads or development.

French Flat is one of only a few population centers for *Lomatium cookii* on federally administered lands. The site also hosts a number of plant communities considered rare or vulnerable by the Oregon Biodiversity Program (Kagan 1994). Equally valuable is the very low abundance of nonnative, invasive plants at French Flat, and wetlands that cover much of the flat terrain.

French Flat has four documented and nine suspected special status wildlife species. In addition, it has potential habitat characteristics required by 12 other special status wildlife species not yet detected in the Area of Critical Environmental Concern.

Other important natural systems and processes include fire, succession, and evolution. Atzet and Wheeler (1982) indicated that fire has been a significant and important part of the environment, shaping plant communities in the region, and evidence of past fire is common on the landscape of the Area of Critical Environmental Concern. French Flat presents an array of plant communities which display successional processes. Evolutionary processes, in the form of species hybridization such as in the case of the *Triteleia howellii* (Howell's brodiaea) × *T. multiflora* (multiflowered brodiaea) complex, have been documented at the site.

The management objective for French Flat is to protect, conserve, and enhance the values for which it was designated, which includes ensuring that ecological processes can be maintained. Mining activities, recreation, and authorized land uses are required to be managed in such a way as to avoid negative impacts to designated Area of Critical Environmental Concern values.

The large patches of *Lomatium cookii* occurring at French Flat is the focus of a collaborative conservation effort between the U.S. Fish and Wildlife Service and Bureau of Land Management. A Conservation Agreement signed in January 2003 by both agencies facilitates protection for the species from illegal trespass and vandalism (Bureau of Land Management and U.S. Fish and Wildlife Service 2003). Action items on the agreement include plant population monitoring, seed collecting, blocking roads to deter off-road-vehicle damage, managing the area to enhance habitat suitability, seeking to acquire adjacent lands, and notifying the Fish and Wildlife Service of new mining claims.

Bureau of Reclamation. The Bureau of Reclamation administers approximately 174 hectares (430 acres) adjacent to Agate Lake. In 2000, the Bureau of Reclamation prepared a Resource Management Plan (Title 28 of Public Law 102-575 [106 Statute 4690]) for Agate Lake in cooperation with Jackson County Roads and Parks Services (Bureau of Reclamation 2000). The Resource Management Plan for Agate Lake was intended to direct the management of Agate Lake resources to maximize overall public and resource benefits for 10 years (2000 through 2010). The plan has not yet been renewed, but still provides a conceptual framework for conserving, protecting, developing, using, enhancing, and managing Agate Lake resources.

The overall objectives that guided the development of the Resource Management Plan include:

- Determine the most appropriate uses of all Bureau of Reclamation-administered and Jackson County Parks-managed recreation lands around Agate Lake, considering the use of adjacent private lands.
- Explore ways to enhance and protect the natural, recreational, aesthetic, and cultural resources.
- Identify long-term programs to address public health and safety, fish and wildlife, and recreation.
- Identify financially feasible opportunities or partnerships to assist Jackson County Parks in managing recreational facilities.

On pages 4-12 through 4-15 of the Resource Management Plan under Section D, Natural Resources, there are several goals and objectives focused on enhancing wildlife habitat that includes identification and protection of vernal pool habitat, while minimizing adverse impacts to wildlife when designing and constructing facilities. Specifically, goal D.3, Identify and protect vernal pool habitat, lists specific management actions (page 4-15 of Resource Management Plan). These include:

- Complete a regional vernal pool survey to determine the location, condition, and value of vernal pool habitat; and,

- As appropriate, the Bureau of Reclamation and Jackson County Parks will partner with the U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and the Oregon Natural Biodiversity (Heritage) Information Center to develop a management plan that protects and enhances vernal pool habitat. The Agate Lake Vernal Pool area Management Plan was completed in December of 2006.

The Agate Lake Vernal Pool area Management Plan prescribes the following:

- Performing a site assessment for current conditions of vernal pool-mounded prairie habitat. The management plan will utilize a similarity index calculated to a reference vegetation to assess vegetation condition. This method will determine where particularly severe noxious weed infestations occur and where the most intact vernal pool habitat occurs so that management actions can be prioritized.
- Determine the feasibility of using prescribed burns, mowing, or cattle grazing to improve vernal pool habitat value. Fire is essential to control vegetation at upland areas in the Agate Desert (Bureau of Land Management 2006). When fire is not available, grazing or mowing may function adequately as a surrogate. These actions will determine practicality of various treatments and implement techniques that are most appropriate to control both noxious weeds and non-native invasive grasses and forbs.
- Exploring feasibility of listed plant introductions. Both *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* may be able to become established in the Agate Lake area. This action will attempt to introduce the species to favorable habitat at the Agate Lake area and will monitor the success of establishment.

b) Critical Habitat.

Within the Rogue Valley, 3,065 hectares (7,574 acres) have been designated as critical habitat for the vernal pool fairy shrimp (U.S. Fish and Wildlife Service 2003). A total of 1,964 hectares (4,853 acres) of newly designated critical habitat for *Lomatium cookii* and *Limnanthes pumila* ssp. *grandiflora* overlap with existing vernal pool fairy shrimp critical habitat. Critical habitat requires Federal agencies to evaluate the effects of any activities they fund, authorize, or carry out on listed species. This designation will also provide protection for the two listed plants in the Rogue Valley. Federal actions that most often affect vernal pools are actions covered under issuances of Clean Water Act permits, administered by the U.S. Army Corps of Engineers.

Designation of critical habitat does not constitute a land management plan nor does it signal any intent by the government to acquire or control the land. Therefore, if there is no Federal involvement, activities of a private landowner, such as farming, grazing or constructing a home, generally are not affected by a critical habitat designation, even if the landowners' property is within the geographical boundaries of critical habitat. Without a Federal ***nexus*** to a proposed action, designation of critical habitat does not require that landowners of state or other

non-Federal lands do more than they would otherwise do to avoid harming, harassing, or removing listed species under section 9 provisions of the Endangered Species Act.

Federal agencies are required to ensure that their activities are not likely to jeopardize the survival of a listed species or adversely modify (*e.g*., damage or destroy) its critical habitat. By consulting with the U.S. Fish and Wildlife Service, Federal agencies can usually minimize or avoid any potential conflicts and, thus, activities usually proceed in some form. It should be noted that critical habitat designation does not create a wilderness area, preserve, or wildlife refuge. It applies only to activities sponsored at least in part by Federal agencies. Such federally-permitted land uses as grazing and recreation may take place if they do not adversely modify critical habitat.

c) Clean Water Act.

Some protection is afforded to the vernal pool fairy shrimp, *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* in vernal pool complexes on private and public lands through section 404 of the Clean Water Act (33 U.S.C. 1344) regulated by the Army Corps of Engineers. Clean Water Act permits for the discharge of dredged or fill materials into navigable waters of the U.S. require consultation with the U.S. Fish and Wildlife Service when threatened or endangered species may be affected. Clean Water Act permits are circulated though government agencies and the public for review and projects can be planned ahead of time to avoid impacts to threatened or endangered species.

In light of the Supreme Court decisions in Solid Waste Agency of Northern Cook County versus U.S. Army Corps of Engineers, 531 U.S. 159 (2001) (SWANCC), and the consolidated cases Rapanos versus United States, and Carabell versus United States, 126 S. Ct. 2208 (2006), the Portland District Office has continued to consider most vernal pools in the Agate Desert area as jurisdictional (J. Goudsward, pers. comm. 2007).

A general regulatory condition that accompanies all permits under the Clean Water Act requires that if at any time the applicant becomes aware of the presence of a listed species within the authorized project area that was not previously addressed in the permit application, all work activity must cease immediately. The Army Corps of Engineers must be notified and approve a plan before any other work can proceed. If an applicant discovers the presence of an endangered species after a Clean Water Act permit has been issued, they must cease work and notify the Army Corps of Engineers. The Army Corps of Engineers cannot require them to stop working but failure to do so may result in a violation of Federal law. Violators may be subject to enforcement action or civil and criminal penalties (D. Yballe, pers. comm. 2004).

In one example of compensatory mitigation for a county removal-fill activity and consultation with the U.S. Fish and Wildlife Service, a Jackson County Clean Water Act compensatory mitigation project burned 10 hectares (25 acres) of vernal pool habitat near a Jackson County School to reduce thatch buildup and control invasive plants. In 2003, topsoil

was added to one vernal pool at the site as an inoculum from a vernal pool containing *Limnanthes pumila* ssp. *grandiflora* at the adjacent development site. A robust population of *Limnanthes pumila* ssp. *grandiflora* occurs at site currently.

Compensatory mitigation in the form of restoration for permitted wetland development is appearing in several areas on municipal and private lands in the Rogue Valley. Several acres of poorly functioning and moderately degraded vernal pools have been restored to functioning systems by restoring leveled vernal pools to pool and mounded prairie formations utilizing historical aerial photos. Approximately 59 hectares (145 acres) of vernal pool habitat was recently protected as compensatory mitigation for wetland impacts associated with various developments and foreseen developments in the Agate Desert area. Although compensatory mitigation is typically performed in the form of restoration, enhancement and creation, a new category, conservation, is becoming a more acceptable form of mitigation to the Army Corps of Engineers and the U.S. Fish and Wildlife Service.

d) Grants.

The Oregon Department of State Lands received a $143,000 grant in 2003 through the U.S. Fish and Wildlife Service to assist in the development of a Wetland Conservation Plan/Habitat Conservation Plan for the vernal pool wetlands within the White City urban containment boundary of the Agate Desert (Oregon Department of State Lands 2003). Rather than develop a Habitat Management Plan, the US. Army Corps of Engineers, Oregon Department of State Lands, and the Vernal Pool Technical Committee decided that funds would go to developing a vernal pool assessment guide and wetland habitat conservation plan.

Under the draft Agate Desert Wetland Conservation Plan, the vernal pool habitat remaining in the White City area would be divided into three categories. Approximately 230 hectares (568 acres) (16 percent) of vernal pool habitat were in the development category, 536 hectares (1,325 acres) (36 percent) of vernal pool habitat were in the protection category, and 799 hectares (1,757 acres) (48 percent) of vernal pool habitat were in the conservation category. The 258 hectares (568 acres) slated for development would likely be permanently lost and the fate of the conservation category may depend on funding of conservation incentive programs. None of the 3,035 hectares (7,500 acres) of vernal pool fairy shrimp critical habitat is included in the development category.

The Oregon Department of State Lands applied for the grant on behalf of Jackson County, the Rogue Valley Council of Governments, and other local interests to help guide development and wetland conservation in the area. The benefit of this plan is to reduce time spent on section 7 consultations and direct development and conservation in the White City area to occur in pre-selected locations. Approximately 1,480 hectares (3,650 acres) of vernal pool fairy shrimp habitat was proposed for inclusion within the Wetland Conservation Plan/Habitat Conservation Plan study area.

The Oregon Department of State Lands used a portion of the funds to develop an inventory and functional assessment of the vernal pools in the White City study area. The assessment was completed in April 2007. The vernal pool assessment was intended to assist the Agate Desert Technical Advisory Committee and the Stakeholders group with development and finalization of the Wetland Conservation Plan. The vernal pool habitat study provided a detailed assessment of vernal pool habitat, restoration potential, flora and fauna characterization, and other functions for vernal pool areas within each land parcel (Environmental Science Associates 2007). A vernal pool habitat assessment effort focused on the greater Rogue Valley area would be greatly needed to identify the best vernal pool habitat for long-term protection or restoration.

In June, 2007, the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Oregon Department of State Lands, and Rogue Valley Council of Governments issued a joint public notice for the Agate Desert area for an upcoming Regional General Permit. The public notice included a proposal to establish guidelines and standards to improve conservation of vernal pool species and habitat in the Agate Desert study area by utilizing conservation banking. The guidelines will also streamline regulatory requirements of the State's Removal/Fill law, the Clean Water Act, and the Endangered Species Act between the agencies.

In 2011, The U.S. Fish and Wildlife Service completed consultation for a suite of conservation, restoration, and development activities and paved the way for conservation banking to occur in the Rogue River Valley. They also provided coverage for an anticipated General wetland fill permit by the Army Corps of Engineers and a Regional General Permit by the Oregon Department of State Lands. In 2012 The Oregon Department of State Lands finalized the Regional General Permit for the area. An Army Corps of Engineers General Permit is anticipating completion within one or two years (J. Linton, pers. Comm. 2012).

The goal of the regional permitting is to streamline Federal and State wetland permitting requirements, while steering conservation to larger blocks of land, which are anticipated to provide a large benefit to vernal pool habitat and enable easier management.

2. State Lands and Regulations

Under Oregon State law, any Federal or State listed plant species receives protection on State, County, and municipally administered lands (Oregon Administrative Rules 603.73-070). State, County, and municipal agencies and governments are required to protect, conserve, and develop management plans for plants occurring on State, County, and municipally owned lands. Any land action on Oregon non-federal public lands which results, or might result, in the taking of a threatened or endangered species requires either a permit or a consultation with staff at Oregon Department of Agriculture. Although federally listed and State endangered plants are protected from collection, harm, transportation, or 'take' on these lands under State law, enforcement is limited by lack of personnel, and is rarely enforced (R. Meinke, pers. comm. 2004).

a) Oregon Department of State Lands.

The Oregon Department of State Lands is responsible for ensuring that any wetlands impacted by fill and removal are compensated in function and value, usually through mitigation. Several wetland mitigation projects in White City and Medford are restoring old vernal pool systems to compensate for development and habitat degradation within known listed species populations. If habitat for the three listed species are impacted by development projects or habitat fragmentation, the Oregon Department of State Lands requires compensatory mitigation in the form of conservation, restoration, enhancement or creation to offset habitat loss. Finalization of a vernal pool assessment methodology is the short-term goal for this agency. The finalization of the Regional General Permit is anticipated to encourage protected, intact and functioning vernal pool-mounded prairie habitat with robust populations of listed species.

b) Oregon Department of Fish and Wildlife.

The Oregon Department of Fish and Wildlife manages the Denman Wildlife Area in the Rogue Valley. This wildlife area includes 291 hectares (720 acres) of relatively intact vernal pool-mounded prairie habitat. Several large populations of *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and vernal pool fairy shrimp occur at the wildlife area.

The Denman Wildlife Area was recently provided funding by the U.S. Fish and Wildlife Service through the section 6 grants program to develop a species management plan to carry out restoration actions for listed species in the wildlife area. The plan will likely include such actions as removal of log deck debris, mowing, burning, and periodic species and habitat condition monitoring to improve habitat for the two listed plants and the vernal pool fairy shrimp.

The management plan is expected to guide conservation of the three species for the 769-hectare (1,900-acre) wildlife management area. Conservation measures expected to be included in the plan are removal of log decking and debris, prescribed burns, restoration of local hydrologic connectivity, biological and mechanical weed control, removal of exotic grasses, and

native seed introduction. The southern tract of the Denman Wildlife Area is called the Hall Tract. This tract supports populations of the two listed plant species and the vernal pool fairy shrimp. The northern tract (Military Slough Tract) and the northeast tract (Creeks Tract) support the vernal pool fairy shrimp and *Limnanthes pumila* ssp. *grandiflora*. Vernal pool restoration actions including burning and native plant seeding were conducted on 4.9 hectares (12 acres) of the Military Slough tract as part of compensatory mitigation by the Rogue Valley International-Medford Airport in 2003.

c) Oregon Department of Transportation.

The Oregon Department of Transportation has developed a system of Special Management Areas on State managed roadside right-of-ways where State or federally listed species occur. Special Management Areas are managed for the protection of two of the listed plants that are covered in this recovery plan. Populations of these plants occurring on State right-of-ways receive special management through maintenance activity restrictions (no herbicides, delayed mowing), regular monitoring, and coordination between State staff and the U.S. Fish and Wildlife Service.

Annual or semi-annual monitoring is conducted in the Special Management Areas at the extant plant populations to evaluate population trends. Results of monitoring are intended to facilitate understanding of how maintenance actions can be improved to better protect and conserve the species while maintaining roadside safety conditions. Two Special Management Areas are designated in the Agate Desert area for *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii* and two Special Management Areas are designated in the Illinois Valley for *Lomatium cookii*.

In the Agate Desert, the Oregon Department of Transportation monitors two Special Management Areas. The Highway 62 site in White City has an extirpated occurrence of *Lomatium cookii*. The site has been monitored bi-yearly but the plant has not been observed for the past 5 years. The Highway 140 site has several dispersed populations of *Limnanthes pumila* ssp. *grandiflora* and *Lomatium cookii*. The population is fenced and situated several meters away from the highway so that is not directly affected by regular roadside maintenance.

In the Illinois Valley, the Oregon Department of Transportation monitors two populations of *Lomatium cookii* within State highway easements near Cave Junction. At one area, a *L. cookii* population occurs on both sides of the State highway and also extends onto private lands on either side of the right-of-way (K. Cannon, pers. comm. 2004). The site is monitored regularly and roadside signage directs maintenance crews to suspend herbicide application and to avoid mowing, disking, or blading. Heavy equipment on the site is restricted except for emergency situations (K. Cannon, pers. comm. 2004).

Conservation activities have not yet been implemented at these special management areas; however, the Oregon Department of Transportation is planning potential mowing and/or

prescribed burning to reduce buildup of competing vegetation. By burning or mowing the sites, excess thatch can be removed and the spread of invasive nonnative plants can be curtailed. These effects should provide more openings for the *Lomatium cookii* plants to grow and spread and permit more water to reach the roots.

d) Oregon Parks and Recreation Department.

The Oregon Parks and Recreation Department manages a population of *Lomatium cookii* at the Illinois River Forks State Park in the Illinois Valley. At the park, a *L. cookii* population is currently fenced off from the road and picnic areas. This fence appears to deter unintentional disturbance by park visitors. A park management plan for the plant is currently being developed (M. Michaud, pers. comm. 2004).

3. County and Municipal Lands and Regulations

Several populations of *Lomatium cookii* occur at the Rogue Valley International-Medford Airport. The airport is managed by Jackson County and administered by the Federal Aviation Authority. *Lomatium cookii* on the airport grounds occupies 7.34 hectares (17 acres) and contains over 5,000 flowering plants. Required security measures at the airport are stringent and restrict casual trespassing or vandalism. The entire airport runway grounds are fenced-off with 2.6 meter (8 foot) high steel fencing and are monitored with video cameras and vehicle patrols (R. Russell, pers. comm. 2004). The airport grounds are mowed regularly to meet airport safety regulations.

The City of Medford has ownership of several parcels near White City, Oregon which support several occurrences of *Limnanthes pumila* ssp. *grandiflora*, *Lomatium cookii*, and the vernal pool fairy shrimp. The amount of vernal pool-mounded prairie occupied by *L. pumila* ssp. *grandiflora*, *L. cookii*, and the vernal pool fairy shrimp habitat on City of Medford owned lands is approximately 140 acres (4 hectares). The city does not actively manage the habitat on their property for listed species, but does permit grazing during the late winter and spring months when pools are inundated by winter rains and grass and forbs are green and fresh. The city is required under the Oregon Revised Statute 564 to protect listed plant species found on their lands.

4. Private Lands

The private lands in the Rogue River Valley managed specifically for the benefit of the three listed species are managed voluntarily by The Nature Conservancy and the Southern Oregon Land Conservancy. The Nature Conservancy manages four preserves in the Agate Desert for scientific and conservation purposes (D. Borgias, pers. comm. 2004). All of the properties support extant or reintroduced populations of *Limnanthes pumila* ssp. *grandiflora*, three of which support *Lomatium cookii*. The vernal pool fairy shrimp occurs in abundance on all four. The Nature Conservancy monitors populations of the three species annually. The

Southern Oregon Land Conservancy manages two (16-hectare [40-acre] and 40-hectare [100-acre]) properties north of Eagle Point, known as the Wood House Property and the Rogue Valley Conservation and Mitigation Bank property. All properties are anticipated to be protected in perpetuity.

Region 1
U.S. Fish & Wildlife Service
Ecological Services
911 N.E. 11th Avenue
Portland, OR 97232-4181

http://www.fws.gov

November 2012