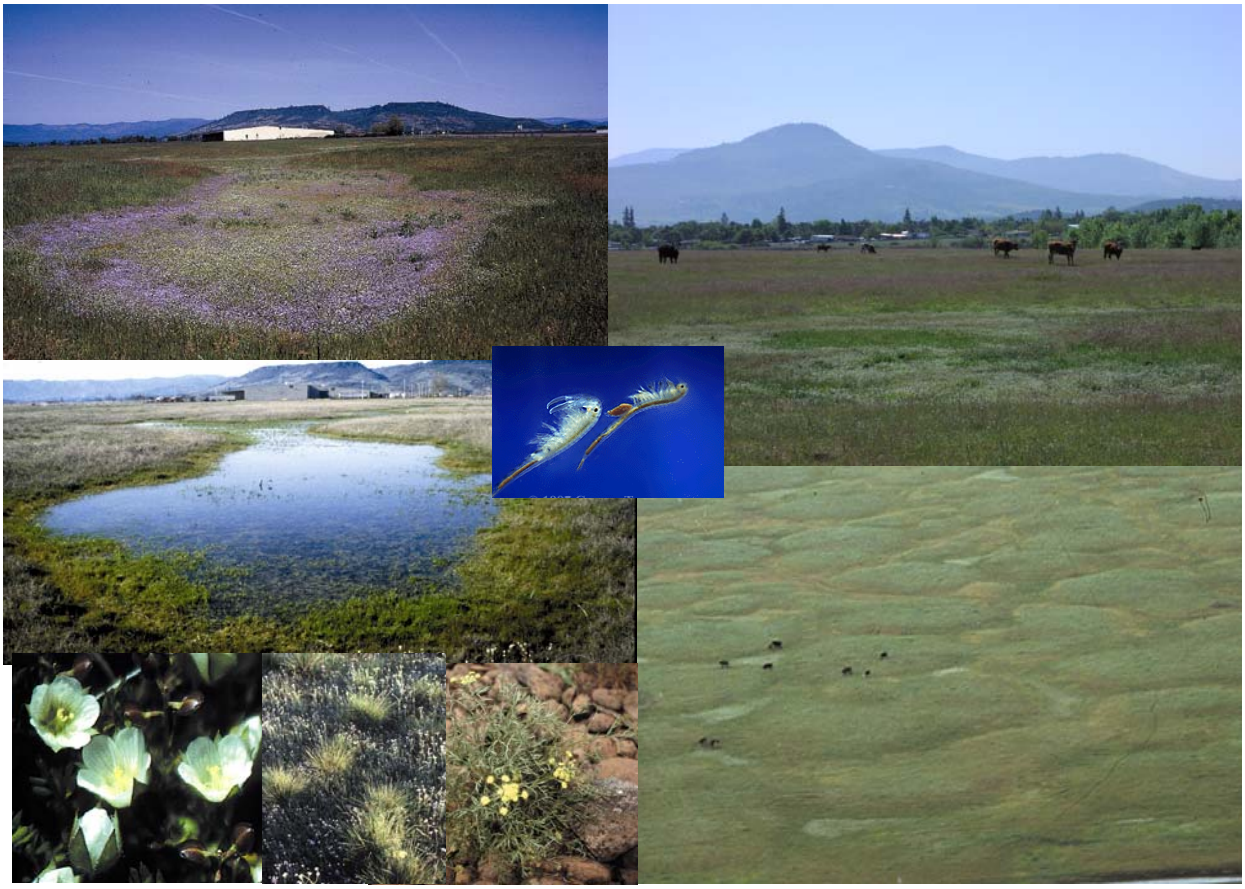
EFFECTS OF LIVESTOCK GRAZING AND THE DEVELOPMENT OF GRAZING BEST MANAGEMENT PRACTICES FOR THE VERNAL POOL -- MOUNDED PRAIRIES OF THE AGATE DESERT, JACKSON COUNTY, OREGON



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The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

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INTRODUCTION

The Agate Desert Vernal Pool-Mounded Prairie in Jackson County is a unique expression of a greater ecosystem that occurs in patches through the Central Valley of California to Baja Mexico[1], with disjunct occurrences in southern Oregon[2] and on the Columbia Plateau in Washington State[3]. The temporary winter-season pools that form in small depressions host an array of specially adapted biota, many endemic to subregions of the system, including species listed or proposed for listing under the Endangered Species Act (ESA). The Agate Desert pools on the Rogue River Plains in southern Oregon support populations of the vernal pool fairy shrimp (*Branchinecta lynchi*), a fairly wide-ranging species listed as threatened. Some pools and pool margins support two locally endemic plant species. The large-flowered woolly meadowfoam, sometimes called Agate Desert meadowfoam (*Limnanthes floccosa* ssp. *grandiflora*) (meadowfoam) and Cook's desert parsley (*Lomatium cookii*) were listed as endangered by the U.S. Fish and Wildlife Service (USFWS) on November 7, 2002. As development in and around the Agate Desert progresses, concern over the future of the vernal pool ecosystem and its' associated species has increased. In addition to loss of habitat due to wetland filling for development, concerns over other land uses, including agricultural practices, hydrologic alterations, and recreation have been stated.[4,5,6]

The vernal pools are jurisdictional wetlands regulated under the Oregon State Removal-Fill law and section 404 of the federal Clean Water Act. The Agate Desert vernal pools are considered "Wetlands of Special Interest for Protection" in Oregon[7], recognized for the unique natural functions and values they offer, and highlighted for the growing development pressure that fuels conflict between wetland protection and other resource values and uses. In response, the Rogue Valley Council of Governments has coordinated a community based, interagency effort to develop a comprehensive plan that balances conservation and development interests. The plan will guide the path of future development, and prioritize other areas for conservation and protection. The plan must also address ongoing management of the lands not committed to development, and the likelihood of novel changes such as newly introduced invasive species. The primary land use made of the vernal pool ecosystem in livestock grazing. Livestock grazing has been cited as a potential concern for the ongoing viability of the system and particularly the species listed or proposed for listing under the ESA. This analysis and report was requested by the USFWS to help understand how livestock grazing interacts with the system, and how livestock grazing practices might be managed to benefit the system. This report is offered as a

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[1] Witham, C., E. Bauder, D. Belk, W. Ferren Jr., R Ornduff. 1996. Ecology, Conservation and Management of Vernal Pool Ecosystems, Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, California.

[2] 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 U.S. Fish and Wildlife Service, December 6, 1999, 15+pp.

[3] Bjork, Curtis, R. 1997. Vernal Pools of the Columbia Plateau, Eastern Washington. Unpublished report to The Nature Conservancy, Seattle, Washington.

[4] USFWS 1994. Endangered and Threatened Wildlife and Plants; 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. 50 CFR Part 17.

[5] USFWS 2002. 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. 50 CFR Part 17. Federal Register Volume 67, number 216. Pages 68004-68015

[6] 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 U.S. Fish and Wildlife Service, December 6, 1999, 15+pp.

[7] Oregon Freshwater Assessment Methodology, pages 25-28, and Appendix G.

starting point for discussions aimed at reaching agreements on how landowners and concerned agencies and organizations can cooperate to produce optimal conditions for commodity production, conservation, and other community interests.

SOCIAL BACKGROUND

A place named "Agate Desert"

The Agate Desert is the open prairie on the floor of the Rogue River Basin, north of Medford, Oregon. The USGS 7.5 minute quadrangles for Sams Valley and Eagle Point stretch the label "Agate Desert" from the confluence of Bear Creek and the Rogue River, across White City, south of Little Butte Creek to Antelope Creek and Dry Creek. At least as early as 1885, the community referred to this area as "The Desert"[8] for the poor agricultural quality of the shallow soils, the sparse prairie vegetation, and relative lack of trees. For a few years after 1901, a post office with the name "Agate" was maintained there, presumably named for the abundant agates found in the soil[9]. A location so named was shown on the "Official Map of the County of Jackson" adopted in 1910[10]. Recent considerations of the geology, and ecology of the region extended the term Agate Desert to a wider array of landscapes, all having in common the distinctive patterned ground, with vernal pools[11,12]. A map of the Agate-Winlo complex soils map unit provided by the Natural Resources Conservation Service[13] is quite effective at describing this extent, encompassing an area of 32 square miles. These areas of patterned ground extend from Shady Cove south to Phoenix and from Central Point east to the town of Lake Creek. See photos in Appendix 8.

Historic land use on the Agate Desert

Prior to European American settlement, the Takelma Indians, who lived along the river and creeks, used the Agate Desert landscape for hunting and gathering. The United States Exploring Expedition, which rode through in 1841, reported extensive use of snares by the Takelma, strung across openings in buckbrush patches to catch black-tailed jackrabbits and deer, and the expedition observed and shot pronghorn there[14]. The Agate Desert Landform was ignored during early settlement. The US Cadastral Surveys between 1854 and 1859 map the cultivated fields and later the Donation Land Act claims blanketing the bottomland along "Stewart Creek" and "Gold River" (Bear Creek and Rogue River). The maps show the "rolling prairie", above,

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[8] Ashland Tidings Newspaper and Job Printing Office, 1885. The Rogue River Valley, Southern Oregon, Pamphlet with un-numbered pages, see "Soils".

[9] McArthur, Lewis A. 1992. Oregon Geographic Names. 6th edition, Oregon Historical Society Press.

[10] Jackson County Court, 1910. Official Map of the County of Jackson, Oregon, 1910. Jackson County Abstract Co. Available at the Southern Oregon Historical Society.

[11] 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 U.S. Fish and Wildlife Service, December 6, 1999, 15+pp.

[12] Elliott, M and D. Sammons 1996. Characterization of the Agate Desert. A report prepared for the Oregon Division of State Lands. On file at the Southern Oregon State College Geology Department.

[13] Johnson, D.R. [SCS] 1994. Soil Survey of Jackson County Area, Oregon USDA SCS in cooperation with the Oregon Agricultural Experiment Station (spring '93).

[14] Wilkes, C. 1849. Narrative of the United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842. Volume V pages 215-250.

was barren of claims-- the soils, described in the surveyor's notes were "2nd rate gravelly clay loam and stoney (sic)" on the western side of the landform[15,16]. To the east, the surveyors labeled the prairie "Clay and gravel prairie. Soil poor 2nd rate" The surveyor annotated the tracts with the owner's names. The farm families surrounding the west side of the Agate Desert included Newland, and Truax, among others (including Rankin, Sewell, Hall, Drew, Davis, and McDonough). On the east were Stow, Westgate, Tinkham and Linkswiten.

Wheat and livestock were the primary products of the land at the time. The records compiled for the U.S. Census of Agriculture, with data recorded every 10 years beginning in 1860 for the Rogue Valley, reveal the patterns of use, and growth of agriculture in the years since settlement. The 1860 and 1870 records report roughly 50,000 acres claimed in farms, with about 30,000 acres improved (plowed, or fenced as pasture). By the 1880 the number of farms tripled, the area in farms increasing to 284,000 acres with 187,000 acres considered improved. The land category of "improved" farm increased five-fold by 1880, but within 10 years farmer's improvement efforts declined and the acreage reported as improved was reduced by 80,000 acres by the year 1900. Dry land cultivation of wheat, particularly between the years of 1870 and 1900, may have been attempted on tracts of the Agate Desert where the soil was less stony. Because of physical limits on the cultivation of the soil (i.e. the hardpan, winter flooding, shallow droughty soils in the summer), crops likely proved unprofitable. Livestock grazing and foraging on open range surrounding the farms was widespread at the time[17], and similar use by nearby farms presumably occurred on the Agate Desert prairies.

Irrigation in the valley began in 1851, with 3,900 acres under irrigation by 1860 and 17,000 acres by 1890[18], but not likely extended to the Agate Desert at that time. The Fish Lake Water Company, organized in 1897, owned one of the largest blocks of the Agate Desert and attempted to promote its use by developing irrigation canals and delivering water to portions of the Agate Desert by 1902[14]. Plat maps from 1910 show much of the open prairie on the core of the Agate Desert owned by either S.J.I. Gore or the Jackson County Improvement Company. Shortly after, much of the undeveloped land was acquired and subdivided by the Roguelands Company, which promoted the "Roguelands Irrigated Orchard Tracts" to hopeful agrarians and speculators. The pear industry was booming, and prime undeveloped orchard land was selling for as much as $400/ac. Limited attempts to start orchards on the poorly drained soils failed, and the Roguelands irrigation system was abandoned. Some time after 1919, when the Eagle Point Irrigation District was established, several areas of the Agate Desert landform were converted to irrigated pasture. After the completion of the Lost Creek Reservoir in 1978, more mounded prairie was leveled and irrigated on the terraces above the Rogue River.

The US government purchased the core of Agate Desert in 1942 for the development of the Camp White Military Base. The short-lived training center was developed from Table Rock Road, eastward past Crater Lake Highway. Decommissioned in 1946, part of the camp was purchased by a consortium of timber industry businesses and they established an industrial

[15] US Surveyor General's Office. 1855. Survey maps and notes for Township No. 36 South Range No. 1 and 2 West of the Willamette Meridian (note these are two separate maps)

[16] US Surveyor General's Office. 1859. "the surveys of claims in Township No. 36 South Range No. 1 and 2 West of the Willamette Meridian (note these are two separate maps)

17 Walling A. G. 1884. History of Southern Oregon. A. G. Walling, Portland, OR,

18 Rogue River Valley Irrigation District website (http://rogueriverprojectirrigation.org/rrvid_history.htm)

center, focused on milling timber products. Residential development accelerated after the war, with subdivisions in the outlying oak savanna on the western and southern lobes of the Agate Desert core area, and the eastern portion of the abandoned grid of Camp White. As the timber economy boomed, industrial development expanded. The Southern Pacific Railroad brought in a rail spur to White City to transport mill products. Tax incentives and inexpensive land encouraged diverse industries to establish there. Around 1979, the City of Medford acquired a 720-acre tract west of Table Rock Road for the Whetstone Industrial Park.

There are a variety of other uses that occur on the Agate Desert, some of which overlap on a given site. Several areas have been used for the development of ponds. Recreational use of off-road vehicles occurs on some sites most noticeably east of White City on lands owned by Jackson County. The open grasslands are used for upland game-bird hunting, with quail and doves the native prey. Waterfowl and pheasant hunting is also promoted on the Oregon Department of Fish and Wildlife (ODFW) Ken Denman Wildlife Management Area. Rock hounding for agates is popular along the roads and where the soil has been more recently disturbed. In the last decade dried sewage sludge from the regional wastewater treatment plant, considered an agricultural amendment, has been applied to vernal pool mounded prairie in the Whetstone Industrial Park by the City of Medford.

A History of Livestock Grazing in Jackson County

The prairies of the Agate Desert were historically valued primarily for livestock grazing. The extent to which areas of the Agate Desert were used for grazing historically is not known. The intensity of use is surmised from broader assessments of livestock use in the County. The numbers of livestock reported at decade intervals, and estimated at 5 year intervals for the US Census of Agriculture provide this broad view (Figure 1). Livestock numbers are shown by species, revealing shifts in the markets, farmer's preferences, logistics, and other factors.

Early on, livestock ranching in the Rogue Valley was considered particularly viable if a ranch had access to summer range on the surrounding hills and mountains (Walling 1884). While no mention was made of wintering grounds, presumably most of these livestock were over-wintered in the valley to avoid exposure to more severe weather and for convenience for feeding when necessary. With the advent of irrigation districts and improved irrigated pastures after the turn of the century, the importance of high elevation summer range was somewhat reduced. From 1850 through at least 1900 there was a notable emphasis on swine production that subsequently diminished. The animals were allowed to range free and were later rounded up for butchering. Pigs foraged on acorns, particularly in the fall, and otherwise rooted through uncultivated soil for bulbs of native camas, brodiea, fawn lilies, and other species such as desert parsley and yampa. Swine production slowly tapered off after 1900. Accounts as late as 1885 describe ongoing open range herding[19], but it is not known how much longer, or how widespread that particular practice persisted.

[19]. Ashland Tidings Newspaper and Job Printing Office, 1885. The Rogue River Valley, Southern Oregon, Pamphlet with un-numbered pages.

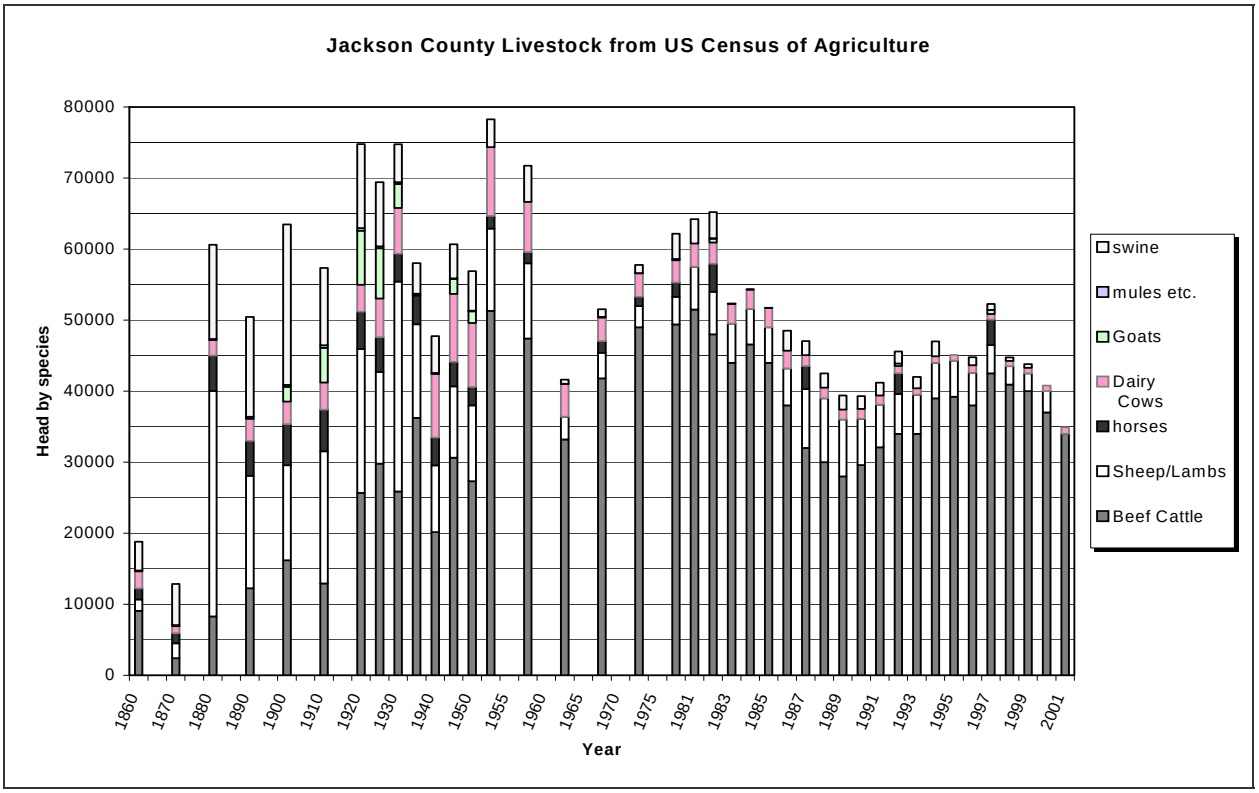

Figure 1. Number of livestock by type in Jackson County, 1860-2001

Production of sheep became the predominant range use after 1870 with peak numbers of 32 thousand animals reported in the year of 1880 and nearly that many again in 1930. Sheep were the dominant contributors to the total livestock numbers until 1920. After 1940, the importance of sheep production began to decline to its present minor role in the array of livestock.

During this early period of livestock use, Walling (1884) reported that livestock were well dispersed and healthy in the hills surrounding the valley. In 1900, John B. Leiberg, a botanist and forester with the US Geological Survey, reported productive meadows in some areas in the highlands and severe overgrazing in certain townships surrounding the valley. For the valley floor he reported a "scant growth of grass"[20]. Livestock number for the county was over 60,000 domestic animals of all species, including swine, of which some were foraging outside of pens or the split rail fences around cultivated crop fields.

The number of livestock in the county peaked between 1920 and 1930, near 80,000 animals of all species. Cattle for beef, and to a smaller extent for dairy, increased gradually from 1870 and then accelerated between 1910 and 1920, when cattle numbers significantly exceeded that for sheep. While beef cattle and sheep numbers declined through the 1940's, contributing to a decreased total number, beef became the dominant contributor to the number of livestock in the county, and have remained so since. The dairy herd continued to grow, exceeding 9000 cows

[20] Leiberg, J.B. 1900. Cascade Range and Ashland Forest Reserves and adjacent regions. in United States Geological Survey, 21st Annual Report, 1899 - 1900 Part 5, Forest Reserves, pp 211-498.

from 1945 through 1954. Livestock numbers overall spiked up in 1950 to near record levels, led by growth of the cattle herd. A sharp decline to 40,000 head of all species county-wide was reported in 1964, but the herd slowly increased again, reaching 65,000 animals by 1982. Another dip and recovery ensued with a peak of 50,000 animals in 1997.

Livestock ranching continues as the primary value and use on most private tracts that are not zoned for development. Livestock ranching is an important cultural and economic part of the community. Over 37,000 head of cattle and 3,000 head of sheep were pastured in Jackson County in 2000[21]. This level of ranch production approximates the 20-year average for cattle and about 50% of the average number for sheep (see figure). Roughly $8 to $12 million in farm gate sales of cattle in Jackson County, annually, are part of an industry that is estimated to generate roughly $19 million to $29 million in economic activity[22].

Current Livestock Grazing Practices on the Agate Desert

In 2002, there were 90 tax lots with relatively intact Agate Desert vernal pool complexes that appeared to be used for livestock grazing. These included tracts intersecting with at least 10 acres of complex with a function and value score of 26 or higher (Rogue Valley Council of Government (RVCOG) function and value scoring, and unpublished GIS analysis using Jackson County data, and various roadside surveys [vpranches.shp]). These tax lots are held by 50 owners. Several of the operators were interviewed about their management practice. The general practices described by those interviewed are recorded in Appendix 2, and summarized here. Photos of several sites are provided in Appendix 8.

The owners of most of the tax lots live in southern Oregon, and there are a half dozen owners with out-of-state addresses. The owners often run livestock on their own tracts, or others lease grazing privileges from them. The tax lots range up to 228 acres, with considerably larger aggregates of acreage under multiple tax lots but with a single owner or operator.

Ongoing livestock practices on the Agate Desert focus on wintering livestock. Cattle, the predominant species, are typically let out in the fall after green up begins or later. The timing of green up is tied to effective fall rains that arrive as early as late September or October in most years. Cattle feed on the growth of annual grasses and forbs that germinate and grow at that time. Herds are usually left for some part of the late fall, winter and early spring. Some operators only let out livestock in the spring.

The total annual forage production on Agate Desert soils amounts to 800 lbs per acre, as determined by the Natural Resources Conservation Service (NRCS)[23]. This amount of forage is just over the estimated requirements of for a cow and calf pair for a month (ie. 780 lbs [26 lbs./day] / “animal unit month” abbreviated as AUM)[24]. Additional production is likely as well, accounting for amounts consumed by gophers, voles, and invertebrates. The peak period for growth of the forage is from February through April.

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[21] USDA National Agricultural Statistical Service (http://www.nass.usda.gov:81/ipedb/)

[22] Randy White, Oregon State University Agricultural Extension Office, Jackson County, Personal communication.

[23] Johnson, D.R. [SCS] 1994. Soil Survey of Jackson County Area, Oregon USDA SCS in cooperation with the Oregon Agricultural Experiment Station (spring '93).

[24] NRCS. 1997. National Range and Pasture Handbook, p 6-9,9

The timing, duration, and intensity of grazing is determined by the ranchers' need for winter range, and the seasonal opportunity to take advantage of the rapid production of the annual grasses. Operators balance capitalizing on this opportunity with the desire to maintain site stability and productivity. Typical stocking rates on the Agate Desert are about 1 cow-calf pair for each 2.5 to 4 or more acres. Stocking rates as high as 1 animal (of varied age and species) per acre at times was reported by one rancher with access to several small adjoining tracts. Where cross fencing has been installed, ranchers move herds around through the winter and spring to limit the amount of bare soil exposure to retain forage production capacity and desirability of the forage species composition. In other cases, ranchers move feeding sites around a pasture, as available, to spread out the livestock use, and to keep hay out of the mud.

The requirements of a herd for supplemental winter feed depend on the stocking rate relative to operator assessment of the forage growth, and herd condition. Pastures with oak woodlands and stands of chaparral offer additional forage variety that has been described as beneficial to the nutrition of pregnant cows[25]. Patches of chaparral and oak woodlands also offer thermal cover, protection from wind in the winter, and provide shade in warmer months.

The vernal pools, or at least a reliable subset of them, typically have standing water to provide for the herd's needs from December through March with some extending into April. Supplemental water for the herd is unnecessary through the winter months on many tracts. Stock ponds have been constructed by deepening vernal pools to augment storage capacity and onsite ditches have been dug to increase delivery. In other pastures, natural drainage ways provide permanent or seasonal watercourses available to livestock. Distances to water greater that one mile becomes a constraint on stocking rates, and shorter distances are preferred[26]. On pastures without alternative natural water sources or other developed sources, the period of use by livestock is controlled by the natural period of availability of water in the vernal pools.

One of the distinct advantages of over-wintering livestock on the Agate Desert landform with its abundant vernal pools, paradoxically, is the firm soil. The Agate Desert winter range has been likened to a convenient “parking lot” for the cattle where access for feeding in the winter is less problematic than on other nearby soil types[27]. Much of the Agate Desert landform is comprised of gravelly loam soils that allow vehicular travel through much of the winter even though the vernal pools have standing water. In contrast, many of the low elevation foothill soils in the valley, particularly on the Cascade side, are clayey and do not support trucks used to deliver hay.

Livestock are typically moved off the Agate Desert and on to irrigated pastures or mountain ranges as summer approaches, typically as early as April to later in May. By June, the growth of the prairie forage has slowed, supplemental feed becomes necessary, and most operators have moved the herd to greener pastures. Owners of smaller lots, or those who have not sought access to alternate irrigated summer pastures have kept stock year round. There is little growth of palatable forage for livestock during the summer, and supplemental feeding typically is necessary.

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[25] Don Bradshaw, 1996. personal communication
[26] NRCS. 1997. National Range and Pasture Handbook p5.3-1 table 3-13
[27] Amy Wilson, 2000, personal communication

ECOLOGY OF GRASSLANDS AND GRAZING

Grassland Ecosystems

Grasslands are dynamic ecosystems that are set apart from other vegetation by an environment and natural processes that prevent establishment of woody vegetation or wetland obligate species. Grassland often occurs where innate limiting factors constrain successful growth or colonization of shrubs or trees. These innate factors can include insufficient annual precipitation, shallow soils with limited moisture reserve, heavy clay soils that are droughty in the summer or sandy soils with limited capacity to hold moisture, and severe shrink-swell action in certain clay soils that disturb roots. Sites exposed to prolonged severe winds or steep south facing slopes that receive high insolation can be desiccated, even though the regional precipitation regime is mesic. Secondary environmental factors or perturbations work in combination with the innate factors; for example, sites exposed to frequent fire or grazing and inadequate opportunity for woody species to establish.

Grasslands are further divided into "ecological sites"—a distinctive kind of land with specific physical characteristics and ability to produce a distinctive kind and amount of vegetation[28]. The potential composition and structure, or the current expressed condition of grassland is a result of all the environmental factors on a site. Part of that system is the historic pattern of colonization and extirpation through time, driven or drawn by fluctuations in the environment, including grazing. For example, the Agate Desert Mounded Prairie is an ecological site that differs from nearby foothill oak savanna.

Grazing in Grassland Ecosystems

Herbivory is a natural process influenced by the combination of herbivore species, their behaviors, and by the many facets of the plant community condition. Grazing contributes to the condition of a plant community directly through changes in the structure, nutrient pathways, through secondary interactions with soil moisture and successional processes, and ultimately fluctuations in composition. Likewise the community type and its condition influences grazing and other animal use—habitat selection and proportion of use by different animal groups. In many prairies the most important herbivores are small, including a variety of invertebrates and ranging up to small mammals such as voles and gophers. Large mammals, such as the deer, elk, and pronghorn that once occupied the presettlement Rogue Valley can also be important. For the purpose of further discussion about livestock grazing the factors described below address the influences specific to ungulate grazers, both native and domesticated, along with those in common with herbivores in general.

Primary (direct) effects of grazing on a prairie are readily observable. Grazers clip, tear, or uproot vegetation while foraging, modifying the structure of individual plants, as well as the structure of the community. By consuming vegetation, ungulates influence nutrient deposition and nutrient cycle pathways. In ranging for forage, ungulates incidentally compact and break both live and dead plant material on the surface with their hooves, and when bedding down. The

[28] National Range and Pasture Handbook 3.1-1.

shear forces from hooves also sever or break plant parts below the soil surface. Ungulate grazers are vehicles for moving soil and propagules (seeds, bulbs, rhizomes) of plants. Plant propagules in mud or simply clinging with barbs or other adaptations to hair on ungulates get delivered between patches of plants and mixed among grassland habitats. Hooves can compact soil, reducing the volume of pore space and the permeability, and can displace or churn the soil, particularly wet soils in waterways and wetlands, and mix sediments that have been sorted by other natural processes (e.g. alluvial, illuvial, colluvial). Turbidity of water bodies increase with this movement of soil.

These direct processes have secondary interactions that influence the grassland condition. Structural changes from herbivory can alter the penetration of sunlight and wind, generally reducing thermal insulation of the soil. Consumption of leaves reduces the photosynthetic surface and capacity of individual plants to produce sugars that fuel growth and reproduction. Clipping off flowers or the branches and buds that produce flowers further alters the reproductive capacity of plants. A prairie roughened by hoof churning has altered surface area and topographic diversity, modifying the differentiation of microsites that can support establishment or maintenance of species. Churning and compaction at the surface can increase the decomposition rate, and the amount of dead organic matter residue, or litter. Structural changes in the soil influence the soil's capacity to receive and hold moisture and air.

Ultimately, the primary and secondary interactions of grazing grassland influence the composition— the species growing there, and their abundance. Controls are set in part by the number and assortment of seeds deposited in combination with the available roots and stems of perennial plants that can re-sprout. Establishment and survivorship in turn are constrained by the number and variety of germination sites, the solar energy reaching plants, the amount of water penetrating the soil, nutrients, and also the drying caused by sun and wind. The remaining plants compete for resources, with the species best adapted to the primary and secondary effects of grazing, (and of those, the individuals best positioned) succeed. Dramatic shifts in the relative abundance of species on site can occur. New species colonize a site made suitable by such changes, while others are extirpated, resulting in additional modifications to the prairie community.

These changes can take many different turns, some ephemeral others long lasting, some predictable (e.g. succession), other not. Grassland systems with their herbivores vary, one to the next, in the amplitude of the changes, but often operate within a recognizable, repeating natural range of conditions or states, sometimes approaching a dynamic equilibrium. Often the types of communities found are observed to occur in a repeating pattern or cycle of recognizable states responding to cycles of natural processes such as fire. Other grasslands fluctuate more strongly or are changing in novel ways depending on the type of management or on relatively rare combinations of natural factors. Some grasslands have been observed to cross a threshold between conditions over which they do not return without expensive restoration work.

Grazing interactions with a plant community are affected by a number of factors relevant to the grazers themselves. The species of grazers vary in size of hoof, their weight, their consumption rates, and the way that they consume vegetation. Herbivores are typically selective consumers

with the patterns of selectivity dependent on their morphology and physiology[29]. The composition, season, phenology and other factors of the grassland condition influence the species of herbivores present, and the degree and direction of forage selection by animals.

Evaluating Grazing Interactions

The intent of this report is to provide a balanced perspective on livestock grazing impacts, positive and negative, and the ways in which those impacts can be managed to for the overall benefit of the natural resources of the Agate Desert ecological site. Decisions about management must be tied to goals and consider costs. With heightened concern about the species that use the Agate Desert, management goals must address ecological and economic systems and reflect the constraints and opportunities presented by each. The development of such goals will be addressed after a section describing the Agate Desert vernal pool mounded prairie, its ecological processes and the changes that have occurred and that may occur in the system. This somewhat detailed foundation is important to understanding the interactions with livestock grazing, both on a historic scale, and as an immediate return on ongoing practices.

[29] National Range and Pasture Handbook 8-5.

ECOLOGY OF THE AGATE DESERT VERNAL POOL MOUNDED PRAIRIE

The Agate Desert Landform occupies roughly 32 square miles at elevations ranging between 1200 and 1400 feet in the Rogue Basin. It is a fragmented alluvial terrace perched above the present floodplains of the streams that drain through the basin. The terrace is composed of gravel deposited during the middle Pleistocene by streams draining both the southern Cascade and the Siskiyou Mountain ranges (Elliot and Sammons 1996). With time, the apron has been eroded by streams, which dissected the terrace into multiple landscape fragments. The landform is outlined by the Rogue River and Little Butte Creek on the north and by Bear Creek on the west. The southern edge of the landform thins gradually and gives way to residual soils of the surrounding uplands. The landform is further characterized by a yellowish-red, well-oxidized surface; shallow, duripan near the surface; and development of patterned ground (Elliot and Sammons 1996). Where the pattern has not been leveled, mounds and depressions are present. These vary from circular in outline, often roughly 30 meters across, to more elongate shapes with circular lobes. Elongate patterns tend to be found on gently sloping parts of the landform, while more circular shapes are found on the flattest areas. Larger mounds are relatively flat topped, about 70 cm in height above the inter-mound, and typically have narrow side slopes. The proportion of mound and intermound varies between complexes and within a complex.

Vernal Pools

Vernal pools form on the Agate Desert in low ground or depressions between mounds. Precipitation collects in the inter-mounds, its downward percolation impeded by the impervious duripan several inches below the soil surface. Vernal pools fill during winter rains, which account for most of the annual precipitation (18.39 inches) in Medford (National Oceanic Atmospheric Administration (NOAA) 1995). Studies of vernal pool hydrology in California provide valuable insight into how the vernal pools of the Agate Desert likely function, and are summarized below.[30] Precipitation, the primary and most important direct source of water, falls directly onto intermound depressions, or swales. Vernal pools also receive overland flow from adjacent pools and mounds. Precipitation captured in pools also percolates through the soil above the impervious layer and then flows laterally through the soil of swales or under mounds to depressions down slope. Through-flow is controlled by the grade of the underlying hardpan, the impermeability and depth of the hardpan, and the permeability of soils for percolation. External contributions to pool hydrology occur on floodplains (e.g. along Whetstone Creek) and where the mounded prairie landform abuts the toe of a slope (e.g. the corner of Modoc and Sams Valley Highway). The degree to which pools recede between storms is affected by these secondary sources of water. The pools dry during the spring as winter storms decrease, and remain dry through the characteristically dry summers.

Vernal pools of the Agate Desert are expressed variably between sites and at a given site. Dramatic differences in initial date of ponding, duration, and thoroughness of ponding among vernal pool complexes and between pools have been noted (The Nature Conservancy (TNC),

[30] Hanes, T and L. Stomberg, 1998. Hydrology of vernal pool on non-volcanic soils in the Sacramento Valley. Pages 38-49 in C.W. Witham, E.T. Bauder, D. Belk, W.RR.Ferren Jr., and R. Orenduff (Editors). Ecology, Conservation, and Management of Vernal Pool Ecosystems – Prceeding from a 1996 Conference, California Native Plant Society, Sacramento, CA 1998.

unpublished data). Factors contributing to these differences include pool area, shape, drainage connectivity, density of pools within a given area, and soil depth over the hardpan.

The factors discussed above also appear to influence the water quality in a given pool and possibly influence the composition of the aquatic plants and invertebrates found in pools. The water in the vernal pools is typically clear; especially early in the season as rain and surface runoff accumulate. Some pools remain relatively clear, suggesting limited inputs of dissolved solids, especially nutrients, or efficient nutrient cycling that keep primary productivity in balance with consumption. Turbidity observed in some pools appears to be associated with waterfowl disturbance of the pool bottom. Water temperatures closely track ambient atmospheric temperatures, and dissolved gases respond to temperature and the diurnal metabolic patterns of the plants and animals that occur there. As water temperatures increase during the late winter and spring, primary productivity appears to increase, particularly visible in the form of filamentous algae. Recent observations suggest that pools receiving little overland flow from other pools tend to have the clearest water[31], while pools receiving spill over flows from other pools, or possibly soil through-flow from up slope, appear to have greater nutrient inputs, and greater primary productivity, at least during the aquatic stage.

While a few species are shared between pools and mounds, the species assemblages of vernal pools are quite distinct from that found on the mounds. Thirty of the vernal pool species found on the Agate Desert are classified as "obligate" wetland indicator plants[32]. The mounds above the pools are not seasonally inundated and support species that are less tolerant of flooding. Native forbs dominate the vernal pools, with up to a quarter of the species introduced, and as few as 10% in deeper pools. The two listed plant species are observed to occur in and near the margins of deep pools, or blanket the bottom of shallow pools with short duration ponding[32].

Vernal Pool Vegetation Communities

The variation within and among pool basins influence plant growth and ultimately the plant associations found there. Because of annual climatic variation, the suitability of each pool or location within a pool for a given species or plant assemblage can also vary somewhat annually. The vegetation of the Rogue Valley Vernal Pools has been classified into a complex array of 17 intergrading types[33]. Using an approach coordinated with an ongoing California statewide effort led by researchers from the University of California at Davis, The Nature Conservancy currently attributes six common plant associations to the pools. Individual pool basins generally contain two to three and sometimes four different plant associations. The most common association is Navarretia leucocephala[34] (whitehead navarretia) type. Pools with longer standing water support a Eryngium petiolatum - Navarretia leucocephala (coyote thistle– whitehead navarretia) type. With slightly shorter inundation, a Lasthenia glaberrima (smooth lasthenia) community may

[31] Darren Borgias, personal observation

[32] USFWS. National List of Plant Species that Occur in Wetlands, Region 9 (NW) 1988, and Region 10 (CA) 1996.

[33] Huddleston, Russell, and Darren Borgias 1999. Classification of the Rogue River Valley--Agate Desert Landform Vernal Pools, Jackson County, Oregon. Unpublished report submitted to the Environmental Protection Agency, Region 9, Sacramento CA, on file at The Nature Conservancy, Portland, OR.

[34] Following plant ecology convention, the Latin names of species used in the names of plant communities are not italicized.

form, often covering pool bottoms or forming a ring around Navarretia types. The Downingia yina (Cascade calico flower) type is spatially dynamic type from year to year, generally occurring peripheral to Navarretia and Lasthenia types, in a setting that suggests a shorter duration of inundation and annual variation. All four of the types above have important coverage from the dominant species cited in the name of the community. *Plagiobothrys stipitatus* and *Isoetes nutallii* are widespread in pools and important in all three communities. An array of secondary species also occurs, the most notable constituents are: *Myosurus minimus, Alopecurus saccatus, Psilocarphus brevissimus, Juncus uncialis, Gratiola ebracteata, Callitriche sp.* The composition on the margins of pools is relatively distinct in most sites. The width of the marginal band depends on the slope of the pool basin/mound, and on disturbance. The same vegetation type can also occur in swales where overland flow conveys water between pools. Currently the band supports a community type dominated by Mediterranean barley (*Hordeum marinum),* a non-native grass that replaces the annual hairgrass in the dryer elevations. This band appears to be broadened part way up the flank of surrounding mounds on sites under grazing. Finally, there is an uncommon pool plant association dominated by camus (*Camassia quamash*)

Historic Vernal Pool Vegetation Condition "reference site description"

The vernal pool vegetation is considered relatively intact, particularly in the deeper pools or those with longer duration ponding. Changes in the composition of the vernal pools since settlement include the establishment of several non-native species, and the possible reduction and elimination of natives. Two non-native species are of special concern in the vernal pools: *Lolium perenne* (perennial ryegrass*),* a spreading grass, and a tall forb, *Rumex crispus* (curly dock), These can form dense stands that appear to crowd out the native forbs. The interaction between another non-native forb, *Ranunculus arvensis* (field buttercup) and native vernal pool species is not known. *Eleocharis macrostachya,* a spikerush, is a fourth species of concern that spreads by rhizomes that allow it to crowd out the other plant communities if not controlled by disturbance such as grazing or burning. Finally, *Hordeum murinum* (Mediterranean barley) tends to dominate the pool edges and fill in more ephemeral pools in dry years.

Prior to settlement, *Danthonia californica* (California oatgrass) and *Poa secunda* (pine bluegrass) *Camassia quamash* (camus) may have occupied pool margins. The species composition in relatively ephemeral pools and pool margins are altered by a greater selection of introduced species. Vernal pool species from the Agate Desert are provided in Appendix 1. For a general description of the species composition and the range of plant communities see the section above: *Vernal Pool Vegetation,* and the Ecological Reference Site Description in Appendix 3.

Upland Prairie

The shallow impervious hardpan that causes the vernal ponding in winter set a limit on the soil depth available for rooting. With overall low rainfall (<20 inches annually), and little of that arriving in summer, the availability of water for much of the year is limited, creating xeric conditions. These conditions largely preclude the growth of shrubs and trees on most sites. More

xeric-tolerant plants, such as prairie grasses and forbs, therefore dominate the Agate Desert Upland Prairie community.

Current upland grassland

At least 93 non-native plant species have been introduced to the Agate Desert prairies, representing 30% of the flora, and a greater percent of the biomass, these species severely alter both the composition and structure of the surmised original community. Despite the incursion by non-natives, much of the pre-settlement native prairie flora has persisted-- including at least 215 native species. Some of the species are frequent in occurrence and important in terms of cover, while others are quite rare. Non-native species are prevalent on the mounds, where they comprise close to 75% of the species. The historic upland community, presumably a textured bunchgrass prairie, has been replaced by annual grassland, referred to as "Mediterranean" or "Californian"[35]. The annual grasses of Eurasian origin contribute the dominant cover. Non-native annual grasses, led by medusahead (*Taeniatherum caput-medusae*), several bromes (*Bromus)* species, annual fescue (*Vulpia*) species, and the perennial bulbous bluegrass (*Poa bulbosa*), currently dominate in most locations. The prairie still supports a relatively rich assemblage of native forbs, particularly those that grow and flower during the winter and spring (See Appendix 1 for a species flowering). Perennial summer flowering species are infrequent in the current grassland.

Non-native species of forbs typically dominate the forb component, including: starthistle (*Centauria solstitialis*), prickly lettuce (*Lactuca serriola*), crane's bill (*Erodium* spp.), and several species of non-native clover (*Trifolium*). Pasture and cover crop plantings are also found, such as at Oregon Department of Fish and Wildlife Denman Wildlife Management Area, which has extensive plantings of intermediate wheatgrass (*Agropyron intermedium*) cultivars. Other areas have been seeded to European perennial grasses for the purpose of improving livestock forage and hay crops. The composition of the community varies from year to year depending on the variable response of annual species to the timing and amount of annual rainfall, and the nature of management on the site.

Litter, or dead plant material, contributes to the stand structure and components of habitat for wildlife, and plays into the nutrient cycle for a site. The litter accumulates depending on rates of plant growth, herbivory, physical disturbance by animals (e.g. ungulates and gophers), and the occurrence of fire. Litter provides forms of habitat structure and material that are used for cover and nesting by wildlife. As the dead stems of plants accumulate and pile up at greater density they begin to interweave in a vertical or suspended horizontal structure called thatch. Thatch shades the soil surface and forms mulch that can control the types of plants that grow in and around it, depending on the relationship of their germination characteristics to the amount of soil shading, temperature, and moisture. The dead stems of medusahead ryegrass contribute to high rates of thatch accumulation because its stems are high in silica and poorly decomposed. Excessive accumulation of thatch is thought to limit the diversity of plant species on Agate Desert mounded prairie sites.

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[35] Heady, H. 1977. Valley Grassland. P 491-514. In Michael Barbour and Jack Major eds. Terrestrial vegetation of California. Wiley-Interscience Pupl., New York.

Soil disturbance by gophers is a key ecological factor of the prairie. The soil movement caused by gophers, represented in part by the small mounds of loose soil brought to the surface, is readily apparent on many sites. This soil movement is important for distributing nutrients and plant propagules above ground and below, for seed banking, mixing the soil, and creating friable bare soil at the surface throughout the year. Bare ground on the Agate Desert is an important substrate where competition is reduced, representing optimal substrate for some species for germination and growth (e.g. *Nemophylla pedunculata*, *Limnanthes floccosa*). Gopher use is also important for attracting larger scale digging by predators that further add micro-topography and structures that may be used by other species, such as the burrowing owl. Finally, the net effect of the soil movement is hypothesized to contribute to the maintenance of the mounded topography that defines the vernal pools[36].

The vegetation structure is an important expression of plant growth, energy storage, and reproductive capability that contribute to the long-term viability of species on a site. Short term events of herbivory and fire can negatively affect plant growth, and the availability of vegetation structure for wildlife, but are typically tolerated when within the natural (background) range of variation. Alteration of the long-term patterns of grazing and fire regimes (return interval, seasonality, duration, etc.) can reduce the long-term viability of species.

Historic Upland Prairie Condition "reference site description"

A reference site description for the Agate Desert Upland Prairie was written for this effort following recommendations of the NRCS[37], and a report summarizing the available information is presented in Appendix 3.

The historic plant community type for the mounds of the Agate Desert is the *Pseudoroegneria spicata - Festuca roemeri* type. Bluebunch wheatgrass and Roemer's fescue (formerly lumped with Idaho fescue [*F. idahoensis*]) were dominant species in this community. Lemmon's needlegrass *(Acnatherum lemmonii*) and squirreltail (*Elymus elymoides*) were secondary in cover. Other perennial grasses with low cover included pine bluegrass (*Poa scabrella* [*Poa secunda*]), and Junegrass (*Koeleria macrantha*). A wide variety of annual forbs occurred, especially those germinating in winter and flowering in spring. These occurred at high frequency with low cover, taking advantage of the ubiquitous soil disturbance by gophers and reduced vegetation cover from disturbance from grazing by deer, elk, and pronghorn. Important genera included; *Lupinus*, *Plagiobothrys*, *Collinsia*, and *Nemophylla*. Perennial forb species were generally subdominant, minor, or rare species, but diverse. These represented several functional groups. Spring flowering species included the bulbous species (*Brodiaea, Tritellia, Camus, and Zygadenus*), taprooted plants in the carrot family (*Lomatium* spp.), and fibrous rooted species such as Viola (*V. douglasii*), larkspur (*Delphinium menziesii*), and buttercups (*Ranunculus occidentalis* and *R. austro-oreganus*). Summer-flowering perennial forbs were an important base of the vegetation cover. Tap-rooted species included mule's ears (*Wyethia angustifolia*), yampa (*Perideridea*) and balsamroot (*Balsamorhiza deltoidea*). Fibrous rooted

[36]Elliott, M and D. Sammons 1996. Characterization of the Agate Desert. A report prepared for the Oregon Division of State Lands. On file at the Southern Oregon State College Geology Department.

[37]NRCS National Range and Pasture Handbook, revised. 1997.

perennials included penstemon *(Penstemon laetus)*, paintbrush (*Castilleja applegatei*), lupine (*Lupinus albicaulis*), cinquefoil (*Potentilla* sp. [*glandulosa* most likely]), yarrow (*Achillea millifolium*), Oregon sunshine [or Oregon sunflower] (*Eriophyllum lanatum)*, and phacelia (*Phacelia sp. [heterophylla*, most commonly]). A final group of subshrubs, represented by semi-woody species of buckwheat (*Eriogonum spp*.), may also have occurred. The potential role of a cryptobiotic crust (a low soil-surface growth of lichens and bryophytes) is not known.

The variety and abundance of species on any particular mound or in a complex of patterned ground depended on numerous factors, including the proximity to other plant communities, use by ungulate grazers and burrowing mammals, and the incidence of fire. Forb species, especially annuals, and bulb rooted species were abundant in the years following fire events. Fire was a major recurring factor on the Agate Desert, ignited both by lightning and through the cultural practices of the Native Americans[38]. Some perennial species and subshrubs are able to increase or establish within longer fire free intervals. Any mound typically had all of the dominant and subdominant species, but the frequency of occurrence and cover of other species was highly variable. Most vernal pool mounded prairie complexes would have had 90% of the species listed in the table (See Appendix 3). The two rare plants and the listed vernal pool fairy shrimp associated with the Agate Desert are among the native species remaining a part of the annual grassland. They are a focus for conservation efforts due to their rarity on a global scale, low abundance of occurrences and low numbers of individuals in some locations, along with their proximity to developing areas, which leaves the species roughly in the path of potential future development. The historic extent of the Agate Desert landform and the distributions of the occurrences of the remaining habitat and target species are shown in Figure 2.

[38] Davies, J. 1980. Douglas of the Forests: The North American Journals of David Douglas. University of Washington Press, Seattle.

Franklin, J. F., and C. T. Dyrness 1988. Natural Vegetation of Oregon and Washington. Oregon State University Press, Corvallis Oregon.

LaLande, J. and R. Pullen. 1999. Burning for a "Fine and Beautiful Open Country": Native uses of fire in southwestern Oregon. Pp. 255-276 in: R. Boyd, ed. Indians, fire and the land in the Pacific Northwest. Oregon State University Press, Corvallis, OR.

Whitlock, C., Shafer, S.H., and Marlon, J. 2003. The role of climate and vegetation change in shaping past and future fire regimes in the northwestern U.S., and the implications for ecosystem management. Forest Ecology and Management 178: 5-21.

Wilkes, C. 1849. Narrative of the United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842. Volume V pages 215-250.

Wright, H.A. and A.W. Bailey, 1982. Fire Ecology: United States and southern Canada. A Wiley Interscience publication, New York. 501 pp.

Focal Conservation Species

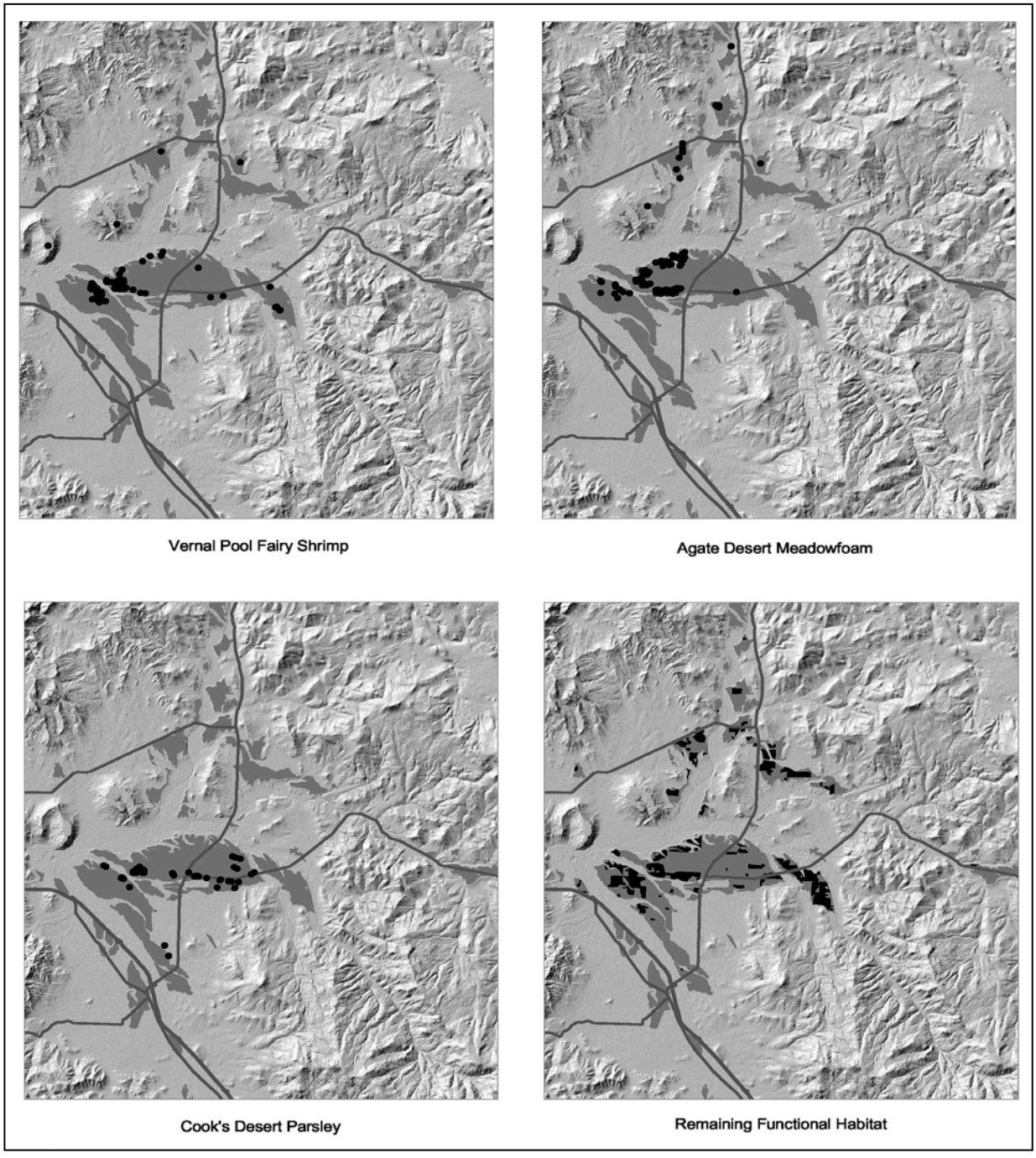

Figure 2. Occurrences of conservation targets on the Agate Desert landform (Siskiyou Resource Geographics and the Rogue Valley Council of Governments)

Cook's desert parsley, a perennial from the carrot family, occurs in shallow vernal pools and on the margins of deeper, longer duration pools. The species also occurs on mounds at lower densities. The known occurrences in the Rogue Valley are all limited to the core area of the

Agate Desert and the fragments of the habitat within and around the Jackson County Airport. The Oregon Natural Heritage Program database accounts for 15 occurrences comprised of 39 patches across the Agate Desert. A new patch recorded by David Evans & Associates (DEA) Inc at the Jackson County Airport has not been incorporated in the database.

A comprehensive condition assessment for all patches is not available. At least four patches have been recently covered over by development, along Highway 62. Several other patches have been partially impacted by development in and around White City. Two small known patches on the south tract of the Denman Wildlife Area have not been relocated in two recent searches, apparently extirpated while the habitat remains undeveloped.

The actual area of habitat occupied and the numbers of plants in each patch is quite variable. Adult Cook's desert parsley re-sprout in late fall or early winter (November or December) from a long, thin taproot. They grow slowly through winter and begin flowering as early as late February, and have been observed flowering under water. Seeds are produced through early July and typically fall near the mother plant. The plants dry down to the taproot a few centimeters below ground, and are dormant through summer. Seedlings germinate in March with a single leaf. In subsequent years, a plant gains additional leaves, and by the fourth year begins flowering with a single inflorescence[39]. Surviving plants continue to grow, gaining in number of leaves and infloresences. Typical life expectancies have not been determined, but based on size and number of flowers on some individuals; some plants live for 10 years or more.

The meadowfoam is endemic to the Agate Desert, known only from the vernal pools between Shady Cove and Medford. Twenty-one patches of the species comprising 13 occurrences across the Agate Desert are documented in the Oregon Natural Heritage Database. Three of these occurrences are associated only with general locations noted in 1971. Their current status is not known. One is located on a fragment of the landform along the Rogue River downstream from Long Branch Creek, one on Antioch Road near Modoc, and the third above Antelope Creek. Recent work by The Nature Conservancy and the RVCOG has documented 3 additional patches and extensions of known patches on and surrounding the Agate Desert Preserve, Whetstone Savanna Preserve, and the tracts of the Denman Wildlife Area. RVCOG efforts discovered a new patch on Reese Creek Road (north of Eagle Point) that would likely be counted as a 14th occurrence. Reductions have occurred at least south of the Rogue River Plains Preserve.

The meadowfoam is an annual plant typically found on pool margins and throughout shallower vernal pools with shorter duration inundation. The plants germinate in December and grow slowly through the winter. They typically flower in late March and April, but the rusty colored sepals enclosing the petals and seed can be seen later, dried down but standing. By June the dried flowers and seed have fallen to the ground. The abundance of this annual plant has been observed to vary drastically from year to year in response to the abundance of winter rain and the extent of pooling.

The existence of the vernal pool fairy shrimps have been less thoroughly surveyed than those of the plants. Although local residents recalled observing the animals in their childhood, the presence of the species on the Agate Desert, or in Oregon was not recorded by science until very

[39] TNC Seeding trial, 1995. Plantings at OSU experiment station began flowering in second year.

recently[40]. Adult *Branchinecta lynchi* are found in pools with a variety of depths, surface areas and duration of ponding[41]. Cysts may likely be carried by birds or mammals, which act as vectors for dispersal between vernal pools. Most of their life is spent in the cyst stage. The cyst stage enables fairy shrimp to tolerate the extreme environmental conditions found in their ephemeral environment, including extreme heat, cold, and extended drought. Cysts can survive desiccation and remain dormant until favorable conditions for adults reappear. Cysts typically hatch shortly after pools fill, and the individuals mature and reproduce in a matter of weeks. Multiple hatch events, or possibly "generations", have also been observed to occur in a given pool over a single wet season[42].

Such events enable the species to take advantage of the typically short but variable wet season. The Nature Conservancy observed that cysts apparently remained viable over the winter of 2000/2001, when a majority of pools occupied in previous years failed to fill. Shrimp were observed again at "normal" abundance levels the following winter of 2001/2002.

Focal Species conditions prior to presettlement

The condition of the target rare species under presettlement conditions is not known, yet remains a matter of some importance relative to setting goals and expectations for conservation. One of fundamental issues is the perception that the current distributions and abundance of the species is critically reduced from the supposed presettlement distributions. While the meadowfoam is relatively widespread, many of the known occurrences are small and isolated. The species has not been found, or adequately surveyed, on landscape fragments north of Eagle Point and east of the Rogue River. The Cook's desert parsley has only been found at the core of the Agate Desert; however, it is likely that it occurred more widely on other nearby fragments of the landform, particularly near Antelope Creek. The vernal pool fairy shrimp, which has been found on most of the larger fragments of the landform, was likely widespread.

Conservation on the Agate Desert

The original expanse of patterned ground on the Rogue Plains has been fragmented further by development, leaving as little as 17 percent of the original Agate Desert landform surface in relatively intact patterned ground[43] (see History). All of the remaining patterned ground has been altered through nonnative plant invasions. Most of the remaining habitat on the Agate Desert occurs on livestock ranches which, though modified by historic and ongoing use, support elements and functions of prairie and other habitats for native plants and wildlife, including rare

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[40] Helm, Brent, and Wayne Field, 1998. Aquatic macro-invertebrate assemblages occurring in selected vernal pools on the Agate Desert and nearby sites in Jackson County. A report prepared for the ORNHP, under a grant from the USFWS, Portland OR.

[41] Borgias, Darren, Jay Doino, and Susan Nyoka 1999. Vernal pool Fairy shrimp on public lands on the Agate Desert Landform, Jackson County, Oregon. Unpublished report on file with the USFWS, Portland OR..

[42] Jay Doino, SOU graduate student, personal communication.

[43] 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 U.S. Fish and Wildlife Service, December 6, 1999, 15+pp.

species. While these ranches provide modified habitats, the current practices provide greater benefit for the diversity of native grassland species than do cultivated fields, orchards, or lands converted to residential and industrial development. Ranches also maintain open space and aesthetic resource values by virtue of the low density of structures and pastoral setting, viewable from numerous roads. This report was designed to explore the management possibilities that ranchers could employ to best support viable prairie condition. Adoption of a set of "best management practices" designed for the site could become an important tool for improving the functions of the habitat and the diversity and viability of the species using it.

Other conservation efforts on the Agate Desert were initiated in 1954 when the US government conveyed undeveloped land to the Oregon Game Commission under the terms of a restrictive deed specifying that the area be used for wildlife management. The Denman Wildlife Management Area currently includes roughly 660 acres of Agate Desert vernal pool-mounded prairie complex, in various conditions. The current long-range management plan for the wildlife area identifies the need to protect or enhance unique habitats, special status plants, and sensitive wildlife (Coleman 1993).

Active conservation efforts focusing on the sensitive plants of the Agate Desert started with biological inventories initiated by Oregon Native Plant Society under the leadership of Wayne Rolle and Ron Kranz in 1982. These efforts were followed by further inventory by the Oregon Natural Heritage Program. Jimmy Kagen, a plant systematics graduate student at Oregon State University, studied and published the scientific description of the Cook's Desert Parsley in 1986. Concern over the continued viability of certain species was elevated (Table 1, following page) by these early inventories.

A year later, in 1987, The Nature Conservancy acquired the 50-acre patch of prime habitat for Cook's desert parsley occurring in the City of Medford Whetstone Industrial Park. A second habitat patch, the 144-acre Whetstone Savanna Preserve, was purchased by the Conservancy in 1996. The Conservancy is also developing a conservation easement over 120 acres of mounded prairie off the Sams Valley Highway. The Conservancy acquired the interests in these tracts to prevent future conversion or development of the mounded prairie habitat, and manages the sites to maintain the focal conservation targets there: the rare species, upland prairie, vernal pools, and an example of an oak savanna community. The primary activities on the preserves include: monitoring of the species and natural community, restoration in the form of prescribed burning, weed control, and reintroduction of the native perennial bunchgrasses, research, and educational use. The Nature Conservancy is also currently continuing the historic livestock grazing use at one of the sites where it will have the opportunity to explore the grazing interactions first hand.

Table 1. Species of concern in the Agate Desert vernal pool – mounded prairie system.

Species and Plant Association Common name	Scientific name	ORNHP rank[a], ESA listing	Agate Desert importance to subject in ecoregion[b]
	Plant Association		
Rogue-Umpqua upland grassland	*Pseudoroegneria spicata - Festuca idahoensis - Stipa lemmonii*	G2S2	1
Rogue Valley terrace- hardpan vernal pools	*Plagiobothrys stipitatus – Downingia yina vernal pools on terrace hardpan soils*	Not ranked	1
California oatgrass valley grassland	*Danthonia californica valley grassland*	G1S1	2
	Plants		
Large-flowered woolly meadowfoam	*Limnanthes floccosa spp. grandiflora*	G4T1, Endangered	1
Cook's desert parsley	*Lomatium cooki*	G1, Endangered	2
Henderson's bentgrass	*Agrostis hendersonii*	G1SH	1
Southern Oregon buttercup	*Ranunculus austro-oreganus*	G2	2
Tehama navarretia	*Navarretia heterandra*	G4	1
Coral seeded allocarya	*Plagiobothrys figuratus ssp carallicarpus*	G5T1S1	2
American pillwort	*Pilularia americana*	G5	1
	Invertebrates		
Vernal pool fairy shrimp	*Branchinecta lynchi*	G2, Threatened	1
	Birds		
Western Burrowing Owl	*Athene cunicularia hypugea*	G4	2
Peregrine Falcon	*Falco peregrinus anatum*	G4T3, de-listed	3
Western Meadowlark	*Sturnella neglecta*	G5	2
Oregon Vesper Sparrow	*Pooecetes gramineus affinis*	G5	2
Lark Sparrow	*Chondestes grammacus*	G5	2
Western Kingbird	*Tyrannus verticalis*	G5	2
Northern Harrier	*Circus cyaneus*	G5	2
White-tailed Kite	*Elanus leucurus*	G5	2
Horned Lark	*Eremophila alpestris*	G5	2
Grasshopper Sparrow	*Ammodramus savannarum*	G5S2?B	2
Savannah Sparrow	*Passerculus sandwichensis*	G5	2
American Kestrel	*Falco sparverious*	G5	3
Prairie Falcon	*Falco mexicanus*	G5	3
	Mammals		
Brazilian freetailed bat	*Tadirida brasiliensis*	G5	2

[a] ORNHP Ranks: G (Global) and S (state)—1 critically imperiled because of extreme rarity or because it is especially vulnerable to extinction or extirpation, 2 Imperiled because of rarity or because it is very vulnerable to extinction or extirpation, 3 rare, uncommon, or threatened, 4 not rare, apparently secure but with cause for long-term concern, 5 widespread, abundant, secure.
[b] 1=only site in ecoregion, 2= part of area in ecoregion at this site, 3= found throughout ecoregion.

ECOLOGY OF GRAZING ON THE AGATE DESERT

Presettlement Wildlife Herbivory on the Agate Desert

Historically, browsing and grazing animals, including: elk, deer, pronghorn, black-tailed jackrabbits, Botta's pocket gopher, and voles, were a significant part of the Agate Desert system. Bison were not known to have occurred in western Oregon prior to or during settlement[44]. The abundance of the native grazers is not known. A simple model for the extent of presettlement winter range for native ungulates could include the entire Rogue Basin floor and the surrounding hills to the upper extents of the mapped ODFW "winter range", amounting to roughly 1480 square miles. Based on the number of elk using the remaining winter ranges around the state, (9.5 - 28 animals per square mile[45]), between 14,000 and 41,440 elk may have ranged across the valley floor in winter. Presumably, settlement, hunting pressure, and conversion of grasslands pushed elk into more forested and less favorable habitats[46]. The current elk population around the Rogue Valley is estimated at several thousand[47]. The impacts of settlement were sufficient to extirpate pronghorn. The black-tailed deer herd has been less affected by settlement, and still use fragments of the Agate Desert near the Rogue River and elsewhere where sufficient cover is provided nearby.

The foraging and other behavior of wildlife are important considerations. Presumably the Agate Desert prairie systems varied within a repeating natural range of conditions in a cycle responding to grazing and recurrent fire, while responding to other combinations of natural factors. The species of herbivore vary in size of hoof, their weight, their consumption rates, and the way they select vegetation[48]. The composition, season, phenology and other grassland factors influence the species of herbivores present, the degree and direction of forage selection, and the effects of hoof impact by animals. Elk and deer are considered grazers primarily, preferring grass and forbs, while antelope prefer forbs. All of them browse shrubs and small trees in the winter relying on buds at the tips of twigs. The historic patterns in their movement within winter and summer ranges for thermal cover, shade, water, favorable forage and hiding cover relative to the Agate Desert is not known. These patterns in behavior were once an important ecological factor in the grassland condition. Grazers likely used the prairie primarily during the winter when the higher elevation habitats were covered in snow. Compaction may likely be a factor, depending on timing and intensity of herd use; however, abundant burrowing by pocket gophers served to break up compacted soils. Unlike some of the nearby common soils, such as Coker and Carney clays, the Agate-Winlo series soil is less prone to churning from hoof action.

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[44] Iten, C., T.O'Neil, K. Bettinger, and D. Johnson 2000. Extirpated species of Oregon and Washington. Pages 454-455. In Johns, D. and O'Neil, T. editors. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press.

[45] ODFW 2001. Environmental Assessment. Research on the effects of nutrition and predation on elk recruitment. Portland Oregon, p 42, http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/ODFWEA.pdf

[46] Altman, B., M. Cayes, S. Janes, and R. Forbes 2000. Wildlife of westside grassland and chaparral Habitats. Page 264. In Johns, D. and O'Neil, T. editors. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press

[47] Simon Wray, ODFW, 2001, personal communication.

[48] National Range and Pasture Handbook 8-5.

Livestock and the Conversion to Annual Grassland in the Rogue Valley

The current grassland is similar in many respects to the annual grassland systems widespread in the Central Valley and surrounding foothills in northern California. As described earlier, the Agate Desert Prairie was once dominated by perennial bunchgrasses. Harold Heady, who provides one of the best overviews of the California annual grassland, points to three primary factors contributing to the transition from the original bunchgrass prairie to the current state: 1) invasion by non-native plant species, 2) altered grazing regime, and 3) cultivation[49]. European-American settlement and land management practices led to introductions of invasive plant species, replacing native species through competitive interactions supported by the altered land management practices. Historic livestock grazing replaced native herds of elk, pronghorn, and deer, and Heady presumes that the grazing level increased and patterns were altered, but not necessarily outside the long-term capability of the prairie to sustain its ecological integrity. Instead, the profound changes in the prairie ecosystem and its viability should be viewed as resulting from the altered grazing regime along with the invasion of non-native annual plant species that spread on wagon roads, livestock trails, and from abandoned cultivated fields into the surrounding prairies managed as pasture and open range.

The dominant non-native annual species were introduced during early settlement. Some of the introduced species arrived prior to European American settlement of the Rogue Valley, with plants dispersing north from Spanish settlements in California (*Avena*, and *Erodium* spp.) [50]. Disruptive foraging by herds of settlement-era swine severely disturbed natural prairie conditions and facilitated spread of the invasive species[51]. Release of large herds of swine to range and forage was a common practice prior to 1900 with numbers of swine in the county reaching 22,500 animals in 1900 (US Agricultural Census, Ashland Tidings 1884).

A winter annual native to the Mediterranean region, medusahead, was introduced into the United States in the late 1880s, first collected near Roseburg, Oregon, in 1887[52]. Among the dominant grasses in the Agate Desert prairies, it is especially well adapted to soils with high clay content. It spread rapidly through California (and presumably southern Oregon) in the 1930's, dispersed in the coats of livestock, especially sheep (Furbish 1953)[53]. In Jackson County, sheep grazing was at peak levels between 1880 and 1940.

Significant change in the grassland system occurred within a few years of settlement. After 50 years of settlement, Leiberg, a forester who completed an inventory focused on timber resources in 1899, described meadows in various conditions in the surrounding hills and reported that the valley floor supported "scant growth of grass".

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[49] Heady, H. 1977. Valley Grassland. P 491-514. In Michael Barbour and Jack Major eds. Terrestrial vegetation of California. Wiley-Interscience Pupl., New York.

[50] Heady, H. 1977. Valley Grassland. P 491-514. In Michael Barbour and Jack Major eds. Terrestrial vegetation of California. Wiley-Interscience Pupl., New York.

[51] The role of ranging herds of swine was not discussed by Heady.

[52] The Nature Conservancy, 1988. Element Stewardship Abstract for *Taeniatherum caput-medusae*, Medusahead. Available at http://tncweeds.ucdavis.edu/esadocs/documnts/taencap.rtf.

[53] Furbish, P. 1953. Control of medusahead on California ranges. J. Forestry 51:118-121.

Albert Strauss, a Rogue Valley rancher who arrived around 1913 as a boy, talked with an intern for The Nature Conservancy in 1992, recalling the change in composition from perennial to annual grasses, particularly medusahead, known then as "foxtails"[54]:

> *"By the time I moved here, the valley floor was all annuals and foxtail. But there used to be lots and lots of bunchgrasses of all kinds, along the low hills between Eagle point and Sams Valley--until the sheep came, thousands of them, and grazed it down. It all changed to foxtail and never came back"*

An extended period of relative drought, beginning in 1914 and lasting until 1935 supported the transition from perennial bunchgrasses to annuals. Over this period, the 5-year averages of annual precipitation ranged from 3 to 4 inches below normal.

It is important to recognize that once present in a prairie, the non-native annual grasses have selective advantages as grazing pressure increases. As annuals, medusahead and soft-chess brome have intrinsic competitive advantages over perennial grasses, including a short life-cycle with rapid growth phase, and the ability to produce abundant seed under adverse conditions. Medusahead maintains its position when grazing pressure is removed—producing a dense shading thatch to which its seedlings are well adapted and germinate in profusion. The accumulated dead plants intertwine in a mat suspended over the soil, inhibiting its decomposition, and effectively shading out many species.

The Agate Desert prairie, as it is currently expressed, represents a new system developed since settlement of the valley. Along with changes in species have come changes in structure, the seasonality of primary production, accumulation of biomass, and pathways for nutrient cycles. Each of these changes serves to maintain the annual species. While relatively stable, the current grassland is subject to invasion by new non-native species. The presettlement system, with perennial bunchgrasses, appears unable to re-establish under the ongoing uses.

Differentiating effects of historic grazing from ongoing Livestock Grazing

While altered grazing regimes have been cited as a cause of species losses or habitat degradation, it is important to differentiate historic changes from the subsequent change that occurs in response to ongoing or future grazing management. In the case of the Agate Desert mounded prairie, historic damage to the native grassland following settlement was dramatic compared to the minor shifts in the annual grassland due to ongoing grazing practices. Annual variations in ongoing livestock operations result in modified litter accumulation, fluctuation in the abundance of individuals within species, and change in the structure of the community, but less so in the diversity of species[55]. European invasive species are not well adapted to the vernal pool environmental conditions, thus the winter aquatic stage affords a degree of protection from the invasives that might otherwise out compete the native species.

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[54] Albert Straus, 1992, personal communication, with Lewis Kroll of the The Nature Conservancy.

[55] The Nature Conservancy 2000. Effects of Prescribed Fire and Cattle Grazing on a Vernal Pool Grassland Landscape: Recommendations for Monitoring. A report to the Environmental Protection Agency, San Francisco, CA.

The remaining native species on the uplands have selective advantages, as annuals or geophytic perennials (plant that resprout from a bulb or tuber), over the perennial species that were historically lost under grazing. The above-ground buds, brittle stems, slower growth, and summer flowering habit, makes the native perennials more vulnerable to year-round herbivory. A careful approach to livestock grazing management is necessary to work with the tolerance ranges imparted by these adaptations and the refuge value of the vernal pool habitat, for the listed species, and the perennials that once comprised the uplands.

Studies on livestock grazing and biodiversity in California vernal pool systems

Similar questions about the influence of grazing on vernal pools, prairie, and rare species have been the topic of recent and ongoing research in related systems in California.[56,57,58] For example, ceasing grazing in annual grasslands has been cited for contributing to loss of species[59]. These studies provide useful insight, especially in comparison of effects on upland grassland, applicable to the Agate Desert. Comparisons between the critical species associated with vernal pools must be made more cautiously, due to the high degree of habitat specificity expressed by each species, and because the range of species studied do not overlap with the Agate Desert.

At Vina Plains, regardless of management treatment, grazing, rest, and burning, the species diversity of the upland prairie appears to be declining[60]. The measured response of the vernal pool rare plants and large branchiopod populations between treatments were inconclusive. Attempting to quantify the effects of ongoing livestock grazing on vernal pool-mounded prairie systems proved difficult due to the extreme variability in annual climate, soil conditions, and topography. The study was completed over a relatively short period that did not capture the full range of biotic variation due to climatic fluctuation.

The California Department of Fish and Game has begun evaluating short duration controlled grazing separately and in combination with prescribed burning in vernal pools systems at the Dales Lake Ecological Reserve and other vernal pools systems in Tehama County[61]. The department will determine, after the third year of data collection, if the management can improve upland habitat without impacting the rare and listed native species of plants and fairy shrimp. The sensitive species there are associated with deep long lasting pools, and the plants typically grow after the pools dry down, well after the grazing treatments in spring[62].

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[56] The Nature Conservancy 2000. Effects of Prescribed Fire and Cattle Grazing on a Vernal Pool Grassland Landscape: Recommendations for Monitoring. A report to the Environmental Protection Agency, San Francisco, CA.

[57] Lis Richard, and Eda Eggeman, 2000. Conservation and management of vernal pools through grazing and burning: updating the vernal pool project. Outdoor California, spring 2000, pp. 19-23.

[58] The Nature Conservancy 2000. Range Management in Threatened Habitats: Quantifying the effects of Cattle Grazing in vernal pools. A research proposal.

[59] The Nature Conservancy 2000. Effects of Prescribed Fire and Cattle Grazing on a Vernal Pool Grassland Landscape: Recommendations for Monitoring. A report to the Environmental Protection Agency, San Francisco, CA.

[60] The Nature Conservancy 2000. Effects of Prescribed Fire and Cattle Grazing on a Vernal Pool Grassland Landscape: Recommendations for Monitoring. A report to the Environmental Protection Agency, San Francisco, CA.

[61] Richard Lis, California Department of Fish and Game, personal communication, 2002.

[62] Richard Lis, California Department of Fish and Game, personal communication, 2002.

At the 12,000-acre Howard Ranch, in Sacramento County, the Conservancy has completed a 4-year replicated study of grazing effects on vernal pool systems[63, 64]. Jaymee Marty tested a variety of grazing regimes, including ungrazed, wet-season grazing (current management referred to as the control), grazing only fall and spring when pools are dry, and peak of winter grazing when vernal pools are hydrated. While the results have not yet been published, Jayme found:

- Reduced cover of exotic species, particularly annual grasses with cattle grazing
- Relative cover of native species was highest in continuously grazed plots
- Ratio of grass to forb cover was highest in ungrazed plots
- Species richness declined in ungrazed plots and increased in grazed plots
- Duration of inundation was longer and less intermittent in grazed pools in 2003
- Richness of aquatic taxa was lower in ungrazed pools in 2003

The results point out advantages of grazing in the highly altered prairie systems with vernal pools. It is important to consider some provisions and limitations to the applicability of the Conservancy's preliminary findings to the Agate Desert vernal pools[65]. The results are based on short term livestock exclosure and the dramatic differences between grazing and rest at Howard Ranch observed in 2003 followed two drought years during which upland species had greater opportunity to establish in the intermound "pool" setting. Second, the Howard Ranch pools were ponded for a relatively short period (from 50 to 105 days in 2003) compared to pools on the Agate Desert that would typically be ponded for 100 to 150 days. A longer duration inundation would confer on the Agate Desert pools a greater resistance to invasion by upland grasses. Additional insight will be gained as research at Howard Ranch is continued to look at longer term results. The Nature Conservancy's results there will be discussed further in the context of the observations taken from a mix of sites, both grazed and not, on the Agate Desert.

[63] Marty, Jaymee 2004. Vernal Pools are at Home on the Range. National Wetlands Newletter, volume 26, number 4, Environmental Law Institute.

[64] The Nature Conservancy 2000. Range Management in Threatened Habitats: Quantifying the effects of Cattle Grazing in vernal pools. A research proposal.

[65] Jaymee Marty, 2004, Cows Eat Grass: How Cattle Grazing Maintains Native Species Diversity in California Vernal Pool Grasslands. http://www.vernalpools.org/Marty/index_files/frame.htm

RANGELAND HEALTH GOALS FOR THE AGATE DESERT

A Rangeland health goal for the Agate Desert should be conditions that are sufficient to maintain or improve the viability of the focal conservation targets. Whether livestock grazing is practiced, or not, management practices should result in conditions that meet or exceed minimum acceptable ecological integrity thresholds for the viability of the focal conservation targets. Efforts to conserve species and systems and to maintain rangeland health will benefit from a focus on maintaining the key ecological factors within the natural range of variation. Understanding the functions of the Agate Desert, and the stresses on key factors caused by management, allows managers to abate the stresses or reduce them to tolerable limits by modifying management.

The indicators described below were developed by first considering characteristics of the minimum acceptable ecological integrity for each of the focal conservation targets. While careful consideration was given to the "optimal" ecological integrity in the putative Ecological Reference Area Site Description for vernal pool mounded prairie in developing the goals, such conditions exceed the minimum acceptable or tolerable condition, particularly in regard to the presence of introduced nonnative species.

The goals address the key ecological factors of the prairie system and the focal species of that system. Some of the factors are impacted by critical stresses, and goals were developed for these as well. Together seven goals for ecological integrity or rangeland condition are offered below. The goals are designed to elevate conditions at sites where targets are vulnerable to significant disturbances that exert degrading pressure, and to prevent the target from entering a condition where the restoration of the target or prevention of its extirpation become practically impossible. These goals represent hypotheses based on limited data, and remain open to refinement, yet are crucial to advancing management.

Minimum Acceptable Health Goals for Agate Desert Rangeland

1. ***Cook's desert parsley:*** Where it occurs, maintain an abundance of > 2,000 reproductive plants in 100 acres of vernal pool mounded prairie complex, with patches occupying > 10% of the complex.

2. ***Large-flowered woolly meadowfoam*****:** Maintain conditions to support >3,000 plants in 100 acres of vernal pool mounded prairie complex in an average year, and the occurrence with patches in > 50% of 10-acre grids in such a complex.

3. ***Vernal Pool Fairy Shrimp:*** Vernal pool fairy shrimp occupy >40% of pools typically hydrated in an average precipitation winter. Occupied pools occur in > 40% of 10-acre grids in a 100-ac complex. Fairy shrimp of both sexes found with at least moderate abundance in > 25% of occupied pools.

4. ***Thatch accumulation:*** Thatch is a minor feature of mixed sources—occurring with < 15% cover (typically < 30% of live vegetation cover), and typically less < 3 cm average maximum height.

5. ***Soil disturbance by pocket gophers:*** Fresh pocket gopher mounds common, generally observed on and around many mounds and intermounds, often with > 3% cover of the ground surface.

6. ***Vegetation structure:*** Average vegetation height >25 cm (grazed or not), with bunchgrasses contributing regularly to variability (texture). Many infloresences of most spring and summer-flowering perennial plants present and contributing to elevated litter with a cover of > 10% in most years, unless recently burned; thatch <40%. Nest and perch structure for grassland birds and other wildlife frequent in most years.

7. ***Status of functional groups of plants, including invasive plants:*** The similarity index for functional groups > 60% relative to the Ecological Reference Description. Stands with native perennial bunchgrasses an important component, and with diverse and abundant native annual, biennial, and perennial forb species present in a 100-acre complex. Non-native summer flowering forbs are infrequent and contribute low cover.

The maintenance of adequate size and distribution of the focal species populations is a recurring goal. Large well-distributed populations have greater ecological integrity for numerous reasons. Larger populations typically have greater useful genetic variation, potentially allowing them to subsist under natural environmental variations. Large populations are less vulnerable to being pushed outside the acceptable range of variation by chance events or human caused disturbances. Such populations are more easily judged as "secure", and appear to require less intervention to be maintained. Such populations more closely approximate what is best known as its "natural state" or functions within its "natural range of variation." As populations shrink they become increasingly susceptible to further collapse in abundance or range.

In excessive amounts, thatch limits species diversity, and alters ecosystem processes on the prairie. Thatch accumulation can become severe where medusahead or Mediterranean barley dominates in settings not periodically grazed, mowed, burned (or otherwise disturbed). Soil disturbance by gophers is a key ecological factor for creating friable bare soil throughout the year, maintaining the mound topography, and for distributing nutrients and plant propagules above ground and below. Vegetation structure is important to maintain the reproductive capabilities of the plants, and the conditions for successful nesting by birds, to provide wildlife forage and cover. The diversity of species on site is a major contributor to the ecosystem functions, structure, habitat differentiation, as well as forage quantity and quality.

Rangeland Health Assessment Tool for the Agate Desert

The purpose of an assessment tool for rangeland is to provide a basis for making comparisons between sites, desired outcomes, and for highlighting opportunities in management to enhance and restore prairies of the Agate Desert. The assessment is focused on the goals for the focal species and their ecosystem. In developing the assessment, key factors of ecological integrity for each conservation target and considered critical alterations to natural processes were considered. An assessment indicator was developed for each of the key ecological factors and their goals. Condition ranks for each indicator were described from interpretation of existing ecological data

relative to a reference description for the Agate Desert range type and further consideration of minimum acceptable ecological integrity.

These indicators were developed to address the features of the prairie system most important to the continued viability, or minimum acceptable conditions, for the critical conservation targets on the Agate Desert. The development of the indicators with ranks is described in Appendix 4. Careful consideration was given to the indicators developed by the US Department of Interior and Department of Agriculture in their recent document "Interpreting Indicators of Rangeland Health—Version 3"[66]. That assessment includes 17 indicators especially sensitive to detecting the signs of erosion and susceptibility to erosion. With clay rich soils and low slope gradients, the Agate Desert prairies are less prone to soil erosion due to rain impact, sheet flow, and wind. The Soil/Site Stability indicators offered that would measure these parameters were not included for the Agate Desert rangeland assessment. The Agate Desert assessment tool provides indicators that strongly overlap with five of the rangeland health indicators. The ranks can be reviewed as early warning signals of ecological problems, and used to inform efforts to modify management strategies.

The rangeland health assessment developed as a part of this report has been applied to the set of monitoring observations that The Nature Conservancy and others have made on 14 sites for the three focal species and the grassland community. The sites include public lands, preserves of The Nature Conservancy, and other private lands where permission was granted. The detailed accounts of the surveys completed are provided in Appendix 5.

[66] Pellant, M., P. Shaver, D. Pike, J. Herrick 2000. Interpreting Indicators of Rangeland Health, version 3. USDI BLM National Science and Technology Center Information and Communications Group, Denver CO. Technical Reference 1734-6.

A PRELIMINARY ASSESSMENT OF FOCAL SPECIES, SYSTEMS, AND GRAZING

Methods

Assessments of condition (primarily abundance) for the two focal plants species on the Agate Desert date back to the early 1980's. Early survey work was intent on locating where the plants occurred and much less on precise estimates of abundance. Survey estimates are affected by survey effort, the condition and phenology of the target species and other species at the time of the survey that impact the visibility of the target. The Nature Conservancy began more rigorous monitoring of the occurrences in 1984 on what would become the Agate Desert Preserve, starting with a complete census for the meadowfoam. Sampling was used when the plants were more numerous. In some cases where the population was in good condition when last visited, only reference plots were sampled to check the perceived trends. All of this work is referenced in Appendix 5.

In addition to the ongoing monitoring on the preserves, The Nature Conservancy assisted in survey work on public lands and private lands where permission has been granted. Since 1999, surveys have targeted getting more precise accounts of the abundance and location of species. Nevertheless, abundance accounts reported here are carefully assessed approximations that were the best possible under the constraints of the acreage and number of sites to cover, the number of survey targets, the short phenological window for surveying, and a limited budget.

There has been considerably less monitoring to date for the vernal pool fairy shrimp than for the conservation target plants. Extensive surveys for the presence of the vernal pool fairy shrimp in selected pools was completed in 1999 by the Oregon Natural Heritage Program under another contract with the US Fish and Wildlife Service[67]. The results from the surveys on the Whetstone Industrial Park (grazed) and the Oregon Department of Fish and Wildlife Denman Wildlife Area (not grazed) are noted below. The work of David Evans and Associates, completed for the Rogue Valley Council of Governments in 2000, also surveyed for vernal pool fairy shrimp on several larger tracts of private ranch land under grazing use[68]. Over the past few years, The Nature Conservancy conducted or helped conduct shrimp surveys on numerous sites, and completed comprehensive surveys at the three preserves. The number of pools is a somewhat flexible accounting due to the variability in rainfall from year to year. In a year with higher rainfall, additional depressions fill, and other discrete pools observed in a dry year merge with others in a wet year.

In May 2001, The Nature Conservancy evaluated vernal pool and upland vegetation cover in several of the sites mentioned thus far. We walked the complex extensively to evaluate the plant communities occurring there and subjectively selected representative pools for sampling. We positioned a plot in the pool and estimated cover of all species and other surface features. Since 2002, the Conservancy has determined the cover of species and a variety of other cover attributes using a point intercept method that gathers data from a wide spread, evenly distributed grid with

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[67] Oregon Natural Heritage Program 1999. Vernal Pool fairy shrimp survey on public lands on the Agate Desert landform, Jackson County, Oregon. Reported to the USFWS, Portland Oregon.

[68] David Evans and Associates, Inc 2001. Agate Desert Vernal Pool Surveys. Reported to the Rogue Valley Council of Governments, Central Point, Oregon.

a random start. The most current data available were used to assess the condition rank for each monitored occurrence using the assessment tool and condition ranks described in the preceding section and detailed in Appendix 4. Information on abundance, or cover, distributions, and structure gathered from sites are summarized and compared to a classification of conditions for each indicator. Rankings for the condition classes can also be thought of in terms of departure from the Ecological Reference Site Conditions such as those used in the rangeland health assessment tool. These rankings are labeled *Poor*, representing extreme departure, *Fair* for moderate departure, *Good* for slight to moderate departure, and *Very Good* for none to slight departure from the reference conditions. Development of these rankings is described in Appendix 4. The results show the rankings for each of the indicators is listed below. The desired status is a rank of Good, where the conditions exceed a minimum acceptable integrity threshold.

Results

Assessment of Focal Species and System Indicator Status on the Agate Desert

A summary of the ranks and trends for each of the evaluated target species occurrences is shown in Table 2. A detailed site by site description of these measurements is provided in Appendix 5 and 6. Additional terrestrial species composition data is provided in Appendix 7.

Indicator 1: Cook's Desert Parsley:

At all but three of the assessed sites, the abundance of plants does not meet the condition goal for occurrences. The majority are in *Fair* or *Poor* condition. The occurrence on the Agate Desert Preserve, South Denman, and the patch off Avenue E were ranked *Good* and *Very Good*. Two of these sites have been rested from grazing for seventeen years or more, while the other, a leveled site, has been grazed nearly continuously at varied intensities.

During rest from grazing, the abundance of young plants in the patch on the Agate Desert Preserve initially increased, but the pulse of recruits diminished after a few years. A comparable short-lived increase occurred at the Whetstone Savanna Preserve with the cessation of grazing. After three years without grazing or a fire, thatch accumulated and recruitment of young Cook's desert parsley declined, particularly on the mounds, where medusahead is prevalent. The local extirpation of two small patches on mounds on the Denman Wildlife Area occurred since their discovery in the 1980's and early 1990's. Prescribed burns reduced thatch at the Agate Desert Preserve and renewed pulses of seedling establishment. At the Whetstone Savanna Preserve, The Nature Conservancy implemented mowing to prevent further decline. The large ungrazed patch within the occurrence on the South Denman tract has not shown the impacts associated with thatch accumulation. There, the abundance of Cook's desert parsley steadily increased from *Fair* (730 reproductive plants) in the year 2000 to *Good* (2830 reproductive plants) in 2003. This patch, like the one off Avenue E, also occurs in a relatively flat area of mounded prairie that may be less inclined to support medusahead and thatch development.

The Avenue E occurrence was the only grazed occurrence that met or exceeded the viability goals for the Cook's desert parsley. Livestock grazing combined with the leveled conditions likely contributed to low abundance of medusahead, little accumulated thatch, and abundant *Lomatium cookii* plants of all growth stages.

Fair ranks combined with short term stable or increasing trends were determined at four sites under both ongoing grazing and rest from grazing. The occurrence at the W. Antelope Rd. site declined after fill was placed in occupied habitat there in 1987, and the abundance has remained smaller since then. The two occurrences ranked *Poor* are on sites not grazed. These were small patches to begin with, and both have declining or stable long-term trends.

Table 2. Summary of indicator status and trend for 14 sites assessed on the Agate Desert as of 2003.

For methods and details see text and Appendices 4 and 5. Note Rx=prescribed, rest = no grazing, OHV=off highway vehicles, ATV= all terrain vehicle use, W=winter, S=spring, SS= spring and summer, F=Fall. Ranks without color shaded codes are estimated from site visits. "--" insufficient data to determine, "*NA*" = The target species did not occur there.

Site Name	Pool character	Management (& season if grazed)	*Lomatium cookii*		*Limnanthes floccosa* ssp *grandiflora*		*B. lynchi*	thatch	Gopher use	veg. structure	functional groups
			status	trend short	status	trend short					
Agate Desert Preserve	Intact	Rx Fire, rest	*Good*	up	*Very Good*	up	*Good*	*Good*	*Very Good*	*Good*	*Fair*
Whetstone Savanna Preserve	Intact	rest	*Poor*	down	*Good*	up	*Good*	*Fair*	*Very Good*	*Good*	*Fair*
BOR Antelope Creek	Intact	rest	*NA*		*NA*		*Fair*	*Poor*	--	*Good*	*Fair*
Jackson Co. Hoover Ponds	weakly expressed	rest, OHV	*Fair*	stable	*NA*		*Poor*	*Poor*	*Poor*	*Good*	*Poor*
ODFW Denman (south)	partial fill, plantings	rest, rank grass, wood	*Good*	up	*Good*		*Poor*	*Poor*	*Fair*	*Good*	*Fair*
ODFW Denman (north)	partial fill, plantings	rest, rank grass, wood	*NA*		*Good*		*Poor*	*Fair*	*Fair*	*Good*	*Fair*
ODOT Highway 140	weakly expressed	rest, ATV	*Poor*	down	*Poor*	up	*NA*	*Poor*	--	*Good*	*Poor*
Rogue River Plains Preserve	Intact	grazing W/S	*NA*		*Good*	up	*Good*	*Very Good*	*Poor*	*Fair*	*Fair*
Rice tract North Pasture	Intact	grazing W/S	*Fair*	up	*Fair*	up	--	*Very Good*	*Good*	*Fair*	*Fair*
Whetstone Ind. Park (W. Antelope Rd.)	partial fill	grazing W/S	*Fair*	up	*Fair*	up	*Fair*	*Very Good*	*Poor*	*Fair*	*Poor*
Whetstone Ind. Park (Newland Rd.)	intact	grazing W	*Poor*	up	*Fair*	up	*Fair*	*Very Good*	--	*Fair*	*Fair*
Rogue Aggregates (Kirtland Rd.)	intact	grazing W	*Fair*	up	--		*NA*	--	--	--	*Fair*
Rogue Aggregates (Modoc Rd.)	intact	grazing W	*NA*		*Good*	stable	*NA*	--	--	--	*Fair*
Rural Residential Avenue E.	intact	grazing WSSF	*Very Good*		*Poor*		--	*Very Good*	--	*Fair*	*Fair*

Indicator 2: Large-flowered woolly meadowfoam:

The condition of the meadowfoam met or exceeded the goal at the majority of sites assessed. The trend in abundance is generally up for occurrences regardless of their grazing or no-grazing status. All but one of five rested sites met the goal, while only two of six grazed settings met the goal. Poor condition occurrences were observed under both grazing and rest.

The Agate Desert Preserve population of the meadowfoam demonstrated a dramatic increase in abundance and extent after livestock grazing was ceased in 1987. The population has generally increased with annual fluctuation in response to annual variation in precipitation and inundation.

Several small occurrences and the more widespread occurrence of the meadowfoam at the Rogue River Plains Preserve recently exhibited increasing trends under winter grazing. The occurrence of the species on grazed City of Medford land off Newland Road has exhibited more volatile shifts in abundance in response to annual variation in precipitation, compared to several ungrazed occurrences. A reduction by two orders of magnitude occurred between 2000 and 2001 in the Newland Road pasture, while the Agate Desert Preserve without grazing declined by only 50%. The vacillations at the City's Newland Road site send the occurrences between *Good* and *Poor* status, depending on change in winter precipitation from year to year.

Indicator 3: Vernal Pool Fairy Shrimp:

The vernal pool fairy shrimp occupancy rate varied widely across the suite of complexes assessed. The highest occupancy rates, near 50% of pools on the site, occurred on the Agate Desert Preserve where the rest from grazing has been practiced for seventeen years, and periodic burning was initiated after nine years. Sites with *Good* ranks for occupancy of the vernal pool fairy shrimp were found on both grazed and ungrazed sites, where the mounded topography and hydrology were well expressed. Sites that did not meet the goal included both grazed and ungrazed site. The Denman sites with Poor-ranked occurrences (with occupancy rates around 10%) were also were influenced by the application of log deck debris, and plantings of dense stands of perennial non-native grass cultivars. There, the pool water develops a brown tint, presumably from unusually high levels off organic acids, and the aquatic plant and animal communities appear depressed[69]. At the Jackson County Hoover Ponds area, thatch accumulation from the annual grasses may be a factor, however the weakly expressed mounded topography and hydrology there may be a more important factor. The Whetstone Savanna Preserve, with its *Good* ranking, was the only ungrazed site with well formed mounded topography, typical hydrology, and few other management influences to confound the results.

[69] Borgias, D., Jay Doino, and S. Nyoka. 1999. Vernal pool fairy shrimp survey on public lands on the agate Desert landform, Jackson County, Oregon. Prepared for the Oregon Natural Heritage Program under a contract with the USFWS, Portland OR.

Indicator 4: Excessive Accumulation of Thatch:

Ungrazed stands sampled in 2001 had a mass of accumulated thatch and litter on mounds that exceeded the annual production of biomass for the year, covering over 50% of the ground. For comparison, under several grazing regimes, thatch ranged from 2-13% cover. In 2002 through 2004 we measured thatch height and recorded the frequency of occurrence in a series of point intercept pin drops across several tracts. The results are provided in Appendix 6. See above and Appendix 5 under the discussion on *Lomatium cookii* for description of the impact of thatch accumulation. Excessive thatch accumulation results in *Poor* and *Fair* ranking for this indicator at sites not grazed. Such sites have thatch cover in excess of 15% cover. In contrast at the grazed sites where data was available, excessive thatch did not occur and the indicator ranking was *Very Good* (thatch less than 5% cover). The exception is the ungrazed Agate Desert Preserve where the Conservancy has conducted prescribed fires in part to prevent thatch from accumulating to critical levels. The mowing at Whetstone Savanna Preserve is used as an alternative to fire in the short term, applied to patches of Cook's desert parsley on mounds where it is feared that recruitment of juvenile plants would otherwise fail under the accumulated thatch of medusahead.

Indicator 5: Gopher Use:

In some grazed stands sampled, the abundance of gopher mounds and the associated gopher use is extremely low, with less than 1% cover and patchy distribution of gopher use. These conditions are associated with grazing at the Rogue Plains Preserve and at the Whetstone Industrial Park, where extensive data was taken. The two ungrazed sites with extensive data were found with abundant gopher use indicated by a cover of fresh gopher mounds in excess of 6% cover on the ground surface. The remaining reported observations on gopher use are based on limited assessment and are less reliable. A *Good* rating for gopher use was estimated based on limited data from the Rice tract with ongoing grazing. A *Poor* rating was ascribed to the Jackson County Hoover Ponds area.

Indicator 6: Vegetation Structure:

We assessed vegetation structure at a wide array of sites in 2001 and fewer sites in 2002 and 2003. The height of vegetation and cover of elevated litter was greater in ungrazed sites than on grazed sites. All of the ungrazed sites had taller vegetation structure that ranked as *Good*, while grazed site, with lower vegetation heights and reduced cover of elevated litter all fell in the *Fair* condition rank.

Indicator 7: Community Composition, Functional Groups:

This analysis used similarity index analysis of the spatially extensive data on species composition from four sites; two grazed and two ungrazed (Table 3). In addition we visited other sites to place releves in representative locations for comparison. Because plant

communities

Table 3. Percent Similarity Index at four sites under varied management across the Agate Desert.
Summary based on relative cover of functional groups determined by point intercept of all plant species. N=Native, I=Introduced, P=Perennial, A=Annual, B=Biennial, G=Graminoid, F=Forb. Reference cover is based on hypothetical Ecological Reference Site condition, and likely optimal restoration potential. Similarity Index (functional group) categorical ranking: *Very Good* **>80%;** *Good* **>60%;** *Fair* **>40%;** *Poor* **<40%**

		Agate Desert Preserve						Whetstone Savanna Preserve						Rogue Plains Preserve						Whetstone Indust. Park		
		No grazing, prescribed fire June '02						No grazing since '96, partial mowing						Grazing--December through April						Grazing--Winter		
		2002			2003			2002			2003			2002			2003			2002		
Functional Group	**Reference cover(Rel.)**	Abs. Cover	Rel. Cover	Allowed	Abs. Cover	Rel. Cover	Allowed	Abs. Cover	Rel. Cover	Allowed	Abs. Cover	Rel. Cover	Allowed	Abs. Cover	Rel. Cover	Allowed	Abs. Cover	Rel. Cover	Allowed	Abs. Cover	Rel. Cover	Allowed
PNG	38.0	6.7	6.6	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ANG	8.0	2.0	2.0	2.0	7.9	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.8	19.8	13.7	8.0	3.0	2.4	2.4
PNF	20.0	17.4	17.1	17.1	11.3	8.5	8.5	20.4	21.9	20.0	20.8	15.4	15.4	12.4	10.2	10.2	4.0	2.7	2.7	4.0	3.2	3.2
ABNF	25.0	12.8	12.5	12.5	55.6	42.0	25.0	25.5	27.3	25.0	43.6	32.3	25.0	36.1	29.7	25.0	44.6	30.8	25.0	21.0	16.8	16.8
PIG	*3.0*	6.0	5.9	3.0	14.6	11.0	3.0	9.5	10.2	3.0	8.7	6.5	3.0	24.7	20.3	3.0	20.8	14.4	3.0	27.0	21.6	3.0
AIG	*3.0*	47.0	46.1	3.0	13.2	10.0	3.0	27.0	28.9	3.0	40.3	29.9	3.0	27.8	22.9	3.0	24.8	17.1	3.0	38.0	30.4	3.0
PIF	*0.5*	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.6	0.5
ABIF	*2.5*	10.1	9.9	2.5	29.8	22.5	2.5	9.5	10.2	2.5	20.8	15.4	2.5	19.6	16.1	2.5	30.7	21.2	2.5	30.0	24.0	2.5
Total	100.0	102.0	100.0	46.7	132.5	100.0	48.0	93.4	100.0	54.0	134.9	100.0	49.4	121.6	100.0	44.5	144.6	100.0	44.2	125.0	100.0	31.4
%Similarity				47% *Fair*			48% *Fair*			54% *Fair*			49% *Fair*			45% *Fair*			44% *Fair*			31% *Poor*

are a complex array of many

communities are a complex array of many species of both native and nonnative origin, the data is "rolled up" into the cover for functional groups of species, such as "native perennial grasses". These cover estimates are then compared to the cover in an Ecological Reference Site Description, and a simple similarity index is calculated that shows the percent similarity between the subject and the reference conditions. Rather than a strict adherence to the estimated presettlement conditions, absent any nonnative species, this indicator allows a small amount of cover from nonnative species in several functional groups in the reference. The desired future condition may or may not be a suitable goal for management but allows for comparison of sites and their management.

For the four sites where we gathered the most extensive data, all but one had a composition of functional groups that ultimately ranked *Fair* for community composition (Table 3). The only site of this set ranked lower was the grazed Whetstone Industrial Park – Antelope Road pasture, scoring a 31% with the cutoff for *Fair* below 40%. It had considerably lower cover of native forbs, replaced by an abundance of nonnative annual forbs. The total diversity of species occurring at the point intercepts when both mound and vernal pool habitats are combined was noticeably low; the nonnative species count was relatively high and provided most of the cover (Table 4). The relative cover of natives was lowest of the three sites, paralleling the results of the similarity index. The nonnative species, least hop clover (*Trifolium dubium*) and mouse-ear chickweed (*Cerastium glomeratum* [*viscosum*]) were especially abundant. The grazed Rogue Plains Preserve ranked *Fair*, in part because it had a noticeably higher abundance of the native species and fewer nonnatives species, combined with a higher relative native cover (Table 3, 4). The nonnative species smooth cat's ears (*Hypochaeris glabra*) stands out at the site (Appendix 7-Table 3 and 4). Two other ungrazed sites with only representative releve data also ranked *Poor* based on an ocular estimate. These sites had high cover of the nonnative medusahead grass and excessive thatch that reduced the cover of native forbs.

Table 4. Species diversity and relative cover of native species at four sites with extensive composition data gathered at point intercepts across the site, all habitats combined.

Site	Management	Number native species	Number nonnative species	Native species Relative cover
Agate Desert Preserve	Rest, Rx fire	39	14	57%
Whetstone Savanna Preserve	Rest	41	32	51%
Rogue Plains Preserve	Winter grazing	31	13	54%
Whetstone Industrial Park - Antelope Rd	Winter grazing	15	18	36%

The highest scoring site in terms of the similarity index was the ungrazed Whetstone Savanna Preserve with a 50% similarity to the reference (Table 3). It ranked higher than the others in part because of the notably high diversity of native species that added cover to the native functional groups (Table 4). Whetstone Savanna Preserve and all but one of the other sites lacked native perennial grasses and had few native perennial flowering forbs replaced by an abundance of nonnative annual grasses and forbs that drove the index down. The number of nonnative species was also great on the site; however, their relative cover contribution was not as great as the cover of native species. The Agate Desert Preserve also had similarity indices approaching 50% in the two years that we have data (summarized Table 3). The preserve functional group indicator

benefited from the presence of native perennial bunchgrasses that have been restored to parts of the site, and also from reduced cover of nonnative forbs such as starthistle and others which have been controlled. The diversity of native species is high there, and the number of nonnative species there is noticeably low (Table 4). The relative cover of native species ranged from 0.36 prior to burning in 2002 to 0.57 in 2003 one year post burn. The preburn native species relative cover was among the lowest, while the post-burn relative cover of natives was the highest encountered for the combined mound and vernal pool habitat. At both of these sites native species diversity was higher than at the grazed sites. The native bulb-rooted species were relatively abundant as compared to the two grazed sites.

A separate similarity index for vernal pools alone was not developed for this study (but should be considered in the future). The relative cover of native species in pools and pool edges, combined, was calculated using the point intercept data (Table 5). The ungrazed and periodically burned Agate Desert Preserve vernal pools had the most native species, least nonnative species and highest relative cover of natives in 2003. The relative cover also improved from 0.64 prior to burning in 2002 to 0.70 in 2003. The ungrazed and unburned vernal pools of the Whetstone Savanna Preserve had fewer native species encountered in the point intercepts, and twice as many nonnatives as the Agate Desert Preserve. The winter-grazed Rogue Plains Site had just one less native species, and an intermediate number of nonnatives, combining together to yield a relatively high native species cover. The winter grazed Whetstone Industrial Park – Antelope Road pasture had the lowest native species diversity, moderate nonnative count, and the overall lowest native species relative cover.

Table 5. Species diversity and relative cover of native species in vernal pools at four sites with extensive composition data gathered at point intercepts across the site and all habitats.

Site	Management	Number native species	Number nonnative species	Relative cover native species
Agate Desert Preserve	Rest, Rx fire	22	5	70%
Whetstone Savanna Preserve	Rest	19	11	63%
Rogue Plains Preserve	Winter grazing	18	8	60%
Whetstone Industrial Park - Antelope Rd	Winter grazing	12	8	46%

Grazed vernal pools had much greater microtopographic relief due to the "punching" of cattle hooves, which also appears to alter the topography along the pool margins and increase the turbidity of the water, depending on timing of use. The white brodiea (*Triteleia hyacinthina*), common in ungrazed vernal pools, appear to be uncommon on grazed sites.

Discussion

Assessment of Focal Species and System Indicator Status on the Agate Desert

Indicator 1: Cook's Desert Parsley:

The relative merits of grazing or not grazing *Lomatium cookii* depends on the situation, including the condition of other indicators, and historic conditions. Large occurrences appear to demonstrate greater stability regardless of grazing status, most likely through greater access to more suitable habitat, particularly well-connected vernal pool and vernal pool margin habitat where thatch accumulation is less problematic. Small isolated patches of the species are more threatened by thatch accumulation where medusahead is dominant, especially on ungrazed and unburned mounds. The local extirpations of two small patches on mounds on the Denman Wildlife Area and on several mounds at the Agate Desert Preserve serve as examples. Long-term rest does not necessarily contribute to problematic thatch accumulation in all settings, as demonstrated by the larger ungrazed parsley patch on the east side of the South Denman which increased to *Good* condition since earlier observation.

Several occurrences in *Fair* condition have demonstrated short-term improvement with ongoing grazing. The occurrence at the Whetstone Industrial Park off W. Antelope road is an example. The industrial park occurrence may be recovering from less compatible management in the past. The site, including a small part that would become the Agate Desert Preserve, was formerly grazed between April and June. This grazing practice is distinct from others evaluated in this study. The Nature Conservancy's research on the Howard Ranch points to differential effects of grazing season[70]. The mechanism for this outcome may be related to altered competition, or variation in grazing resilience at different life stages for the plant. In addition, fill placed in formerly occupied habitat at the industrial park reduced the abundance historically and disconnected pool habitat in a way that may contribute to the ongoing substandard abundance there. It is important to note that a patch of the plants on another part of the industrial park site on Newland Road, ranked *Poor,* likely represents a range expansion or an increase in abundance for a formerly overlooked small occurrence.

The Avenue E occurrence with its high abundance and *Very Good* ranking for Cook's desert parsley has been grazed continuously. An important contributing factor is the topographic leveling there that created an extensive area which approximate the margin of a vernal pool—the optimal hydrologic conditions for the species. Similarly dense patches occur on a smaller scale at the Agate Desert Preserve in a previously leveled area. The Avenue E occurrence also demonstrates that Cook's desert parsley can successfully set seed to recruit adequate juveniles in some years under grazing to maintain the population. Past variation in the stocking rate (1 AU per 1.7 acres to 3.8 acres) at that site and varied species of grazer may have contributed to the abundance observed there. A similar response to grazing was documented for the related species, *Lomatium bradshawii* in the Willamette Valley[71].

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[70] Jaymee Marty, 2004, Cows Eat Grass: How Cattle Grazing Maintains Native Species Diversity in California Vernal Pool Grasslands. http://www.vernalpools.org/Marty/index_files/frame.htm

[71] Drew, A. 2000. Effects of livestock grazing and small mammal populations on endangered Bradshaw's desert parsley (*Lomatium bradshawii*) at Oak Creek, Willamette Valley, Oregon. Unpublished Masters Thesis, OSU, Corvallis, Oregon.

Continued monitoring of sites with the plant, and further comparison of the trends will help refine the understanding of Cook's desert parsley and its relationship with grazing. It will be valuable to survey historic occurrences where spring-only grazing is practiced. Further monitoring on the Agate Desert Preserve will help understand how the target plant responds to re-establishment of a perennial grass dominated prairie in combination with periodic fire—conditions that approach pre-settlement. It will also be worthwhile to attempt augmenting the distribution of patches on sites currently in poor condition or addressing habitat alteration that prevent natural range movement.

Indicator 2: Large-flowered woolly meadowfoam:

That four of the five ungrazed settings had *Good* ranked occurrences, while only two of six grazed sites met the goal, suggests that the species may fare better in the absence of grazing. However, the abundance and extent of the meadowfoam in both grazed and non-grazed settings depends in part on natural variation from site to site and historic alterations. While thatch accumulation is a concern, where gophers are abundant the bare soil they produce at the margins of the pools and flanks of mounds may function to offset losses due to thatch in the absence of grazing. The increase and expansion of the meadowfoam occurrence at the Agate Desert Preserve that occurred after removing grazing represents both density increase and expansion of area occupied, and possibly recolonization of formerly occupied habitat that the population had contracted from earlier due to past detrimental livestock practices. Based on the grazing history and trend in the abundance of the meadowfoam at the Agate Desert Preserve, a grazing period restricted to the spring months of April to June may be problematic and should be evaluated further where it is practiced.

Grazing through the winter and spring (tapering off through May) has not shown detrimental effects on the meadowfoam abundance over three seasons observed at the Rogue Plains Preserve. Winter-spring grazing at the Rogue Plains Preserve appears to create pool margin habitat in the center of some pools by creating microtopographic relief that supports the species in the bottoms of pool basins that might normally be too deeply inundated with water.

Local extirpation of an occurrence becomes increasingly likely when low abundance recurs in consecutive years, and then combines with other chance disturbance with negative impacts. Of the occurrences assessed, the probability of extirpation seems greatest in the Whetstone Industrial Park, south of W. Antelope Road, where the potential for increase and expansion in years with favorable precipitation is limited by a generally lower level of pool connectivity caused by past road construction. It would be useful to track changes in the distribution and abundance of the plants during a period of rest. Removal of grazing from the site could slowly confine the species to pool margins and constrain the abundance of available habitat.

Indicator 3: Vernal Pool Fairy Shrimp:

There was no clear relationship between grazing versus rest and the distribution and abundance of *Branchinecta lynchi* occupied pools. The general patterns of distribution and abundance of occupied pools suggests that large tracts with well-distributed intact vernal pools, whether grazed

or not, have occurrences of the species. The abundance of shrimp-occupied pools declines with decreases in complex area, decreased number of pools, pool connectivity, and the indicators of rangeland condition, particularly thatch accumulation. The reduced occupancy rate of vernal pool fairy shrimp at the Denman Wildlife Area is a notable example, where log deck debris, dense plantings of wheatgrass cultivars and rest from grazing appears to compromise the benefits of the large area and an abundance of vernal pools.

The USFWS suggested that "overgrazing" can be detrimental to the vernal pool fairy shrimp through high levels of pasture runoff leading to increased siltation of vernal pool habitat, changes in pool water quality, and excessive physical disturbances, such as trampling[72]. Churning and bare soil has been cited as a source of increased sedimentation in the pools and altered topography (Scoles 1993). While these impacts may occur at sites on the Agate Desert visited during this study, the fairy shrimp occupancy rate is not clearly impacted, since some grazed sites even with soil churning (e.g. Rogue Plains Preserve) had relatively high rates of occupancy. The distribution of occupied pools and the abundance of shrimp in pools for this assessment does not point to clear detrimental impacts from the levels of grazing encountered.

Whether the practice of applying biosolids at the Whetstone Industrial Park contributes to the relatively depressed abundance of pools occupied by shrimp (12%) remains uncertain. Reduced pool connectivity resulting from past filling may also contribute. Observations at the site in 1998 found an elevated abundance of filamentous algae as compared to other sites. Abundant algae in pools there appeared to be associated with pools that are down gradient from others such that they may have functioned as nutrient sinks, conceivably receiving additional nutrients in overland flow from other pools.

Indicator 4: Excessive Accumulation of Thatch:

The results clearly demonstrate the effective role that grazing plays in controlling excessive thatch accumulation. Without grazing, conditions range from *Poor* to *Fair* for excessive thatch, unless periodic fire or mowing is used to remove it. Thatch accumulation reduces recruitment of Cook's Desert Parsley, and has also been observed to interfere with normal growth of the meadowfoam in some pool margin sites. Accumulated thatch in shallow pools may also alter the natural structure and subsequently the type of primary productivity and faunal community that develops there. Thatch is also a structural component used by grassland birds for nesting and cover. As currently designed, "insufficient" thatch to provide cover and structure and material for nesting is addressed under vegetation structure, below.

Indicator 5: Gopher Use:

The results suggest that gopher use more reliably occurred at goal levels on ungrazed sites compared to grazed sites. Gopher use in the two extensively assessed un-grazed sites was

[72] USFWS 1994. Endangered and Threatened Wildlife and Plants; 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. 50 CFR Part 17.

abundant and widespread, ranking as *Very Good*, while the two grazed sites with extensive quantitative data (Rogue Plains Preserve and Whetstone Industrial Park) have considerably less gopher use relegated to isolated patches—ranked as *Poor*. The interaction between livestock grazing and gopher use is uncertain, but it is reasonable that livestock grazing may reduce gopher use by collapsing gopher tunnels, requiring excessive energy outputs to maintain tunnels and burrows, or by reducing hiding cover for the rodent when they are foraging on the surface that may make them more vulnerable to predators. Accumulated thatch on some sites such as at the Hoover Ponds may have contributed to the low grade by reducing our ability to detect gopher use. The observation method may need to revised to better reflect the actual gopher activity level. Continued grazing and reduced use of the mounded prairie by gophers may curtail the long-term maintenance of the mound–swale topography.

Indicator 6: Vegetation Structure:

Vegetation heights and the height of elevated litter were greater in ungrazed sites, meeting the goal and providing greater structure for perching and nesting birds and cover for wildlife. The measurements have been taken in May when vegetation height is influenced by the growth of reproductive stalks, and when grassland birds are most likely to be nesting. Certain less common grassland bird species are impacted by the carpet-like cover of non-native annual grass that results in few patches of bare ground for foraging[73]. Grassland songbirds need cover and structure for nesting, which are reduced by ongoing grazing[74]. The results also point out the value of rest from grazing for allowing the development of vegetation structure that is important for plant form and reproductive ability. Greater differences would be recorded if the measures were taken in winter when vegetation growth is slower and may not keep pace with herbivory by livestock.

Indicator 7: Community Composition, Functional Groups:

The current condition of all of the sites considered in this study has been affected by the historic inadvertent introduction of nonnative annual grasses and forbs, combined with altered grazing regime, that resulted in the widespread loss of nearly all perennial native bunchgrasses and many perennial native forbs, especially summer flowering species. While the advent of domestic livestock grazing contributed to the distinct change in condition, ongoing livestock use and nonuse appear to result in relatively minor changes in comparison. These changes are mediated by relative thatch cover, the amount of bare ground available, along with changes in surface topography and compactions that affect plant germination, growth and the selection of species present. The more recent intentional sowing of nonnative intermediate wheatgrass at the Denman sites adds another dimension to the change that has occurred on the remnants of the prairie. The cultivar is highly competitive with the mix of native and non-native species of the annual

[73] Altman, Bob, 2000. Conservation strategy for landbirds in lowlands and valleys of western Oregon and Washington. Report prepared for Oregon-Washington Parnters in Flight.
[74] ODFW, 2000. Landowner guide to creating grassland habitat for the western meadowlark. 16 page booklet, available from Oregon Department of Fish and Wildlife, Portland, OR.

grassland, but the species appears to be less prone to spreading, at least under the current management.

Under grazing the nonnative perennial bulbous bluegrass and annual Mediterranean barley dominate, while in the absence of grazing these are reduced and nonnative medusahead grass dominates. The change has no net effect on the overall similarity index, however, medusahead contributes to more rapid thatch accumulation. The abundance of thatch on such sites greatly reduces the cover of native species both on mounds and in shallow vernal pools and the edges of deeper pools. Several of the sites shown with estimated ranks of *Fair* in the summary would fall out at the low end of the condition class due to the effects of accumulated thatch on species diversity. Similar observations have been made in Central Valley vernal pools. While the effect of thatch accumulation on plant diversity is a concern, the relatively high ranks for community composition at Whetstone Savanna Preserve, not grazed for nearly a decade, demonstrates ungrazed sites do not necessarily have lower condition. Fire management at the ungrazed Agate Desert Preserve periodically removes the thatch, helping to keep the community condition relatively high. Grazing controls thatch, but also tends to reduce the abundance of perennial forbs, particularly bulb rooted species. Reduction of the perennial forbs makes space available for other species, including aggressive colonizing nonnatives which interfere with the success of native annual and biennial species.

The vernal pools generally have a relatively high proportion of native species. The Agate Desert has relatively higher condition in terms of the greater native species diversity, few nonnatives, and a high relative cover of natives. Whetstone Savanna Preserve, rested from grazing, and the Rogue Plains Preserve, with ongoing grazing, both had comparably high native species cover, while the grazed Whetstone Industrial Park- Antelope Road site had comparatively low native relative cover. The results at the Agate Desert Preserve suggest that periodic fire may be a powerful tool for maintaining vernal pool conditions. In comparison to the situation on the uplands, the tradeoffs between grazing and nongrazing for vernal pool conditions are not clear cut. Tracking change over time to determine if the trend in condition diverged between grazed and ungrazed sites would reveal considerably more than assessment of current condition that likely responds to unique variables on each site. The research at the Howard Ranch points to impacts of short term cattle exclosure and does not yet address what happens over the long term, or vegetation dynamics that may occur on a larger scale.

Conclusion

Assessment of Focal Species and System Indicator Status on the Agate Desert

Overall, sites rested from grazing had higher ranks for the meadowfoam, gopher use, and vegetation structure, while grazed sites benefited from the control of excessive thatch accumulation. The impacts of grazing and not grazing for the remaining indicators of rangeland health on the Agate Desert are mixed. The current conditions for the abundance of Cook's desert parsley and the vernal pool fairy shrimp, and the plant community composition, did not fall out as clearly benefited by either management type. Trend analysis over time or controlled experimentation will be necessary to elucidate these relationships further.

The annual grassland system has arrived at a new state dominated by a mixture of native and exotic species (including the two plant species that are a focus for conservation) adapted to varying degrees to the historic and ongoing use. While the system is altered, and the site, soil, and productivity are relatively stable, the long term persistence of the plant focal species remains uncertain. The assessment data and anecdotal observations available from across the Agate Desert suggest that vernal pools and the three focal species targets co-exist at varying levels with the prevailing winter-through-spring livestock grazing and with ungrazed management. The effects of spring-only grazing were not adequately assessed here. The short term improvements in plant species occurrences observed under grazing point to a level of compatibility with livestock grazing practices. Several of the grazed occurrences are at or tending toward a *Good* ranking. Simple removal of grazing at the Agate Desert Preserve demonstrated mixed results for the rare plants. Other ecological factors that constrain occurrences of the focal species on some sites elevate their sensitivity to grazing or the effects of curtailing grazing and their vulnerability to population collapse. Examples include the meadowfoam occurrence at the grazed Whetstone Industrial Park and the Cook's desert parsley occurrence at the ungrazed Whetstone Savanna Preserve. The hypothesis that spring-only grazing may be detrimental to the meadowfoam should be further evaluated.

The timing, duration, and intensity of grazing are driven by the seasonal opportunity to take advantage of the rapid forage production by the prairie over the fall, winter and spring. Operators balance capitalizing on this opportunity with the desire to maintain site stability and productivity. Enhancing the compatibility of grazing practices to improve rangeland health on the Agate Desert will call on operators to gauge their work by more than sustained productivity and soil stability. Ranchers have an opportunity to address concerns for native plant and animal species associated with the mounded prairie. Investments in modifying grazing practices can garner positive effects both for forage quality (prevention and control of invasive noxious weeds or other undesirable species), promotion of native perennial species that offer additional forage value, and for the species that depend on the habitat.

An adaptive management approach should be applied—monitoring the impact of management along with external influences, and adjusting practices as necessary to achieve the variety of goals held for a site. The annual plant dominated system remains susceptible to novel invasive plants, which can adversely modify the structure and processes of the plant communities and forage quality as well. The bunchgrasses and other native summer-flowering perennial plant species that once occurred there appear unable to re-establish on their own under continued grazing, and the compatibility of ongoing livestock operations with active restoration of perennial species is untested.

ENHANCING COMPATIBLE GRAZING PRACTICES FOR THE AGATE DESERT VERNAL POOL – MOUNDED PRAIRIE: A Menu of Options for Grazing Operators

The array of practices cited below are offered not as a prescription, but as a list of practices that have merit in different conditions to help achieve and maintain *Good* ranks for the key indicators of rangeland health on the Agate Desert. The need for monitoring is emphasized, followed by general land-use and land management practices, and followed with specific livestock practices that target various outcomes for specific indicators.

It is likely that manipulation of livestock practices can only go so far in improving the conditions. Working to control or remove non-natives or to reestablish the native functional species and groups that have been extirpated will take extra effort such as altering grazing practices, and possibly the re-introduction of fire in the system.

Monitoring Focal Species and the System

Monitoring is a critical part of any effective management. The Nature Conservancy has developed a streamlined set of monitoring protocols for the focal conservation targets and the other indicators of rangeland health. For plant species, detailed mapping and census data are gathered for *Poor* and *Fair* condition occurrences in March and April, while less rigorous qualitative assessments of abundance and distribution are made for occurrences in *Good* or *Very Good* condition ranks. Vernal pool fairy shrimp occurrence and abundance can be assessed at the peak period of occupancy in early late January to early February. For the mounded prairie system, a "point intercept" [75] method is used for estimating cover of species and other ground conditions such as thatch-cover, pocket gopher abundance, and vegetation height. The community monitoring is conducted in late April or early May. A more rapid qualitative assessment will be helpful and should be developed. Weed mapping is conducted when the target weed species are readily apparent. Operators should be on the lookout for new invasive species. The identity of a new species should be determined with certainty and the potential threat determined. Keeping a map updated each year with the locations of weeds is ideal. Abstracts of weed information are available from multiple sources, including from The Nature Conservancy[76].

With monitoring data, necessary management changes or modifications can be made. Operators should review the status of the indicators annually when management is changed, or as conditions appear to change. Intensive monitoring can be relaxed to a lower frequency on sites where the indicators are stable over several years. Annual results should be considered in the context of annual climatic variation, past condition and trend.

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[75] Elzinga, C. L., D. W. Salzer, and J.W. Willoughby, 1998. (Chapter 8 in) Measuring and Monitoring Plant Populations. BLM Technical Reference 1730-1. USDI-BLM National Applied Resource Sciences Center, Denver, CO. 477 pages.

[76] http://tncweeds.ucdavis.edu/esadocs.html

Other Management

Weed Control

New nonnative invasive species should be identified and controlled as soon as possible to prevent infestations from becoming a larger problem. Extensive information and support is available from the Oregon Department of Agriculture (ODA) and the Oregon State University Extension Service. Consideration of weeds should expand from the list of "noxious" species maintained by the ODA. Appendix 2 lists all species currently documented for the Agate Desert and whether the species is native or not, its typical habitat, growth habit, and flowering period. Additional information on controlling weeds that are not considered "noxious" can be found at The Nature Conservancy's Wildland Weeds site on the internet[77].

Irrigation

Irrigation contributes to the conversion of vernal pool plant communities to other communities. New irrigation systems should not be installed and existing adjoining systems should be assessed for leakage or overflow that impacts mounded prairie vernal pool areas considered important to the conservation of the system. Irrigation systems that impact target vernal pools should be evaluated for correction, or alteration. Such work restores vernal pool wetland function and may qualify for mitigation credits, which could be used to offset wetland losses elsewhere on site, or potentially sold to developers with mitigation requirements.

Fire

The careful use of prescribed is highly effective at reducing medusahead and thatch, for controlling other species, and for preparing a stand for planting of native perennial species. Curtailing grazing earlier in a season prior to burning will help retain sufficient fuel to promote better coverage by a fire. Where thatch has accumulated to excessive amounts, grazing a stand to reduce the standing biomass, and reduce the vegetation height prior to burning may be desirable. The required burn frequency appears to be reduced on sites restored to bunchgrasses.

Burn plans should consider the ecological impacts as well as smoke impacts on the community in the Rogue Valley. The Nature Conservancy has historically conducted burns with the assistance of the Jackson County Fire Department. Use of prescribed burning during the month of June, prior to seed set for medusahead, has proven highly effective in reducing the abundance of the species for several years. Production in the several following years tends to shift to soft brome, which does not accumulate thatch as readily. Increases in *Erodium* should be expected following application of fire. Control of the medusahead calls for a June burn. Thatch reduction can be achieved by burning later in the year.

[77] http://tncweeds.ucdavis.edu/esadocs.html

Altering Grazing Practices (intensity, duration, season, variability)

The recommendations below are presented as options available to operators.

Supplemental Feeding Concerns

Careful consideration should be given to the quality of hay used to feed livestock while pastured on the Agate Desert. Hay may be contaminated with seed from noxious weeds, which could be a source of new weed species on site, especially where the soil becomes churned by hoof action. Some operators currently feed cattle by spreading hay on the ground, and typically minimize bare soil and churning by moving the location of feeding on a regular basis. The disturbed soil is prone to the establishment of new weed species and should be closely monitored each growing season. This concern should be considered along with an effort to confine the feeding area to minimize the extent of area that may become prone to colonization by new invasive species.

Achieving a *Good* rank for *Lomatium cookii* and *Limnanthes floccosa* ssp *grandiflora*

1. Vary grazing intensity, duration, and season. Some variation is introduced by annual variation in precipitation and subsequent forage production, and in this way modifying grazing intensity. Changing the size of the herd may be necessary to augment the natural variation due to climate control on production.
2. Introduce spring rest (beginning in March). A spring season rest several times in a decade should increase flower survival in target plant species and seed production, promoting abundant seedling recruitment the following year. Use of a temporary exclosure around known occurrences may be advantageous, as an option to resting an entire pasture.
3. Introduce a season long rest. In pastures typically grazed, a season long rest one to three times in a decade, or over a period of one up to three years in a decade should increase growth and survivorship of the perennial *Lomatium cookii* plants that resprout each fall and winter. Extended rest without follow-up grazing or burning should be avoided.
4. Introduce grazing in fall in pastures typically not grazed. Fall grazing takes advantage of the green-up production following early rains, especially of early germinating nonnative species. This practice may prove valuable for reducing the productivity and competitive advantage of medusahead and crane's bill (*Erodium* spp). Fall grazing may be practiced beneficially through December while the two focal plant species are dormant or still low to the ground. Most of the native species initiate growth after the non-natives.
5. Either Burning, or some form of grazing (fall or season long), or mowing should be initiated by the 3rd or 4th year after cattle exclusion to reduce accumulated thatch.
6. Grazing conducted during the early winter may be used as a tool to help distribute seed of the focal conservation species. To be effective, grazing should occur after the soil is wet, to allow for translocation of seed mixed with soil, but prior to germination of focal species.
7. In some pastures with highly isolated occurrences of the target species, it may be advantageous to manually disperse seed of the species collected on site. The target species were presumably once widespread around the vernal pool habitats, and reduced through a combination of factors that have left populations small and isolated. Assisting the species in

colonizing nearby available habitat could greatly speed progress toward *Good* condition for the target. Patch specific seed should be used.

Achieving and maintaining a *Good* rank for *Branchinecta lynchi*

Impacts or benefits of grazing to the vernal pool fairy shrimp were not deciphered in this assessment. The effects of livestock grazing should be more carefully monitored in small complexes with few occupied pools, or where stocking rates are outside the range considered here. Livestock grazing conceivably may play a role in moving soil and cysts from one pool to another and, under the correct conditions, could be tried as a tool to promote more widespread colonization on sites not currently grazed.

Achieving and maintaining a *Good* rank for *(low) Thatch Accumulation*

1. Restore the native perennial species to reduce the prevalence of medusahead and its capacity to produce thatch.
2. On sites not restored to native bunchgrasses, grazing or burning must be periodically implemented.
3. Without grazing, burning should be conducted at 3-5 year intervals. See Fire, above.

Improving the rank for Mounded Prairie Composition, Vegetation Structure, and Gopher Use.

1. Changing the dates when livestock are put on or taken off may be a key consideration in changing the species composition and vegetation structure. See discussion under the plant targets above. Increased sensitivity to the summer flowering forbs and grasses is needed to restore and maintain them on sites selected for higher condition status. Periodic introduction of spring season rest may prove helpful for allowing these species to establish or increase.
2. Making changes in livestock type could also be effective. Sheep tend to select and crop vegetation differently than cattle. Changes in species and age class of livestock with different effects on soil and vegetation could be used to introduce variation that may offer relief from grazing related stresses or change the competitive dynamics between species.
3. Restoring the missing functional groups is a vital management action that should be considered and implemented where possible. The establishment of native perennial species of grasses from seed sown following fire has been demonstrated to be variably successful. Seed from local sources has been developed by The Nature Conservancy and can be made available for restoration efforts with a commitment to maintenance. These species add to the diversity of species and functional groups, may serve to improve the viability of the target plants, and improve overall productivity and forage value as well.
4. Periodic Rest may allow increase in abundance of existing perennial plant in the vernal pools.
5. Rest may be essential to allow establishment of perennial upland species reintroduced to a site.
6. Rest appears to be helpful in meeting goals for ongoing gopher use.

A manager of ongoing grazing that desired to attempt optimizing grazing and ecological benefits might consider the following: introduce a spring season rest, followed by an early summer burn, then sowing of native perennial species. To allow establishment, the sowing should be followed by an entire winter–spring season of rest, before initiating ongoing winter-spring grazing again for two years. The rest and restoration practices would be implemented again after that time. In this way, standard practices are maintained in 6 years in a decade, grazing with spring rest in two years of a decade, and two years of complete rest. With favorable weather, and establishment of the perennials, the restoration sowing would become less important, and eventually unnecessary. Weed monitoring and management would need to be completed annually. Intensive indicator monitoring would be implemented during the evaluation of this practice to adapt it to more site specific applications.

Limits to Compatible Grazing, and Compensating Operators

From an economic standpoint, current landowners of most tracts of vernal pool mounded prairie, agree that grazing use is the "highest and best use". Short-term economic return on pastures would be decreased to the extent that ranchers consider and implement rest and other measures on pastures. In addition, not grazing a pasture imposes costs to find and secure alternative pasture or feed sources to maintain a herd. Temporary negotiated leases or conservation easements with permanent or long-term schedules of rest may become a useful means to compensate for these changes, providing added incentives for ranchers to voluntarily modify land use. These agreements would be negotiated individually to account for the range of variation in ecological conditions, interests, and logistical constraints among sites. Several conceptual descriptions of such easements are provided in Table 6, below.

From a broad conservation perspective, it will be ideal to manage for *optimal* prairie conditions on a few reference sites strategically selected for maximum conservation benefit. Such conditions call for restoration toward the reference site conditions with treatments that will likely include prescribed burning, followed by seeding in native bunchgrasses, subsequent maintenance burns every few years, and ongoing weed control. Such optimal prairie sites may still call for grazing periodically, under adaptive ecological prescriptions. For private lands, acquisition of fee title, from willing sellers, will likely prove a more reasonable approach than an easement in these cases (Table 6). On key public lands, revised management plans will be necessary.

This document will be a good starting place to begin accounting for key conditions, and to assess opportunities for improving them. Additional information can be found through the Range and Agricultural Extension Programs of the Oregon State University, the range program of the NRCS and other private range consultants. Further assistance in planning may be available from Rogue Basin Technical Team, the NRCS Resource Conservation Development (RCD) program, and the local Soil and Water Conservation District.

Developing a Coordinated Resource Management Plan with the assistance of the NRCS may be beneficial. Such a plan would identify opportunities that would allow ranchers and other land owners, including the Nature Conservancy, to look at range resources on a broader scale with an

eye toward finding opportunities to work cooperatively to gain both economic and conservation benefits.

Table 6. Conceptual approaches to facilitate conservation, incorporating grazing best management practices (BMP's) for the Agate Desert vernal pools-mounded prairie

Approach	Location	Description
Purchase	Core of the largest high integrity vernal pool complexes (ca. 100 ac). Smaller satellite occurrences of target species	Fair market value paid to willing sellers for fee title. Precludes development and allows for optimal conservation management to restore *Good* or *Very Good* condition for focal species and system targets (existing, restored, or to be established). Emphasis on restoring native summer perennial species as dominants. Allows limited grazing for restoration.
Core Easement	High integrity vernal pool complex adjacent to central most core area. Extensions of key occurrences of target species on cores.	Conservation Easement to purchase critical rights to development and other land use, while allowing grazing under BMP's to restore *Good* condition for focal species targets (existing, or to be established). Rest periods may extend to 2-5 years consecutively during initial restoration effort. Rest typically prescribed in 4 or fewer years per decade. Weed and fire management as funds permit.
Peripheral Easement	Peripheral tracts selected to maintain grassland core area, but not specifically targeted for a rare plant occurrence.	Conservation Easement to prevent development under future up-zoning. Allows incidental development under current zoning consolidated along existing roads. Less-restrictive BMP's to maintain *Fair* to *Good* condition for vernal pools and fairy shrimp, *Fair* condition for target plant species and prairie composition. Rest may be prescribed for up to 3 years per decade (up to 2 years consecutively). Cooperative weed and fire management as funds permit.
Grassland Easement	Buffer, contiguity and matrix habitat	Conservation Easement to prevent development under future up-zoning. Allows incidental land development under current zoning consolidated along existing roads. Precludes conversion of current grassland vegetation cover. Grazing use within range of ongoing practices.
Seedbank Lease	Element occurrences within future development areas	Short-term lease to harvest target species seed (e.g. *Lomatium cookii)* and to secure winter and spring rest from grazing prior to and during harvest. Seed to be used on unoccupied portions of core complex.

A "grass bank" approach may be helpful for enhancing compatible grazing by potential partners. Such a grass bank would be leased out to ranchers in exchange for resting appropriate pastures at optimal times. Coordination and cooperation could also reduce costs for management of weeds,

fire, fencing, monitoring and restoration plantings, for example. In many cases what occurs on one side of a fence impacts conditions on the opposite side.

Funding for incentives can come from a variety of sources. Exchanging access to land, as with a grass bank, could be an important way to fund such cooperation. For example, The Nature Conservancy could allow access to selected pastures in its preserve system at times in exchange for rest on important tracts owned by others. The USFWS has a strong interest in the recovery of proposed and listed species and can make recovery funding available under provisions of the Endangered Species Act. Additional funding for conservation work on private lands is available through the Farm Security and Rural Investment Act of 2002 (Farm Bill) under the administration of the Natural Resources Conservation Service and the Farm Service Agency. The applicability of the Wetland Reserve Program (WRP) to vernal pools systems has been demonstrated in California at several preserves managed with grazing. Fencing to facilitate management to improve wildlife habitat can be funded by the Wildlife Habitat Incentive Program (WHIP) and under the Environmental Quality Incentive Program (EQIP). The Grassland Reserve Program, a new program in the bill, can provide rental payments to maintain the grassland and grazing where the land is likely to come up for conversion to developed uses. The possibility of funding restoration with The North American Wetlands Conservation Act funding for both wetland and upland bird habitat has been discussed with Partners in Flight. The Oregon Watershed Enhancement Board may also be receptive to proposals involving watershed restoration. Private funding, as has been brought to the table by The Nature Conservancy and its donors, will likely remain an important part of the support for conservation measures.

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Appendix 1 -- Plant Species list for the Agate Desert vernal pool – mounded prairies.

Prepared from observations by The Nature Conservancy, including Frank Lang and Russ Huddleston, Kama Almasi, Ed Hoover, and others.

A six page table follows.

Species are listed in alphabetic order. Fore each species we identified the species guild (e.g. forb, grass, etc.). The primary and secondary habitat preferences, whether mound, flank, or vernal pool, are listed. The origin of the species, whether native or introduced is provided when determined. Wetland indicator status both in the Pacific Northwest Region and the California Region are provided from the most current available lists. The growth form and flower season are listed. References to the project of The Nature Conservancy, or work by others that served as the source of the species observation on the Agate Desert are given in the final column.

Additional incidental species will be added to the list as species from surrounding habitats spread into the Agate Desert. Please contact Molly Sullivan of The Nature Conservancy with updates.

Agate Desert Vernal Pool-Mounded Prairie Plant Species

Southwest Oregon Field Office
33 N. Central Ave., Suite 405
Medford, OR 97501

Updated: May 27, 2004

Number of species = 308

Agate Desert habitat preference codes: VP=vernal pool, F= Flank, M=mounded prairie or grassland, OS=oak savanna, IRR=irrigate

Guild: F=forb, G=grass, R=rush, S=shrub, SE=sedge, T=tree

Origin: N=native, I=introduced

Growth: A=annual P=perennial B=bulb Bi=biennial

Flowering period: WI=winter, SP=spring (prior to June 1), SU=summer (after Jur

USFWS **Wetland Indicator** Status (1988, 1993):
OBL(obligate)
FACW (Facultative wetland)
FAC (Facultative)
FACU (Facultative upland)
UPL (upland obligate)
NOL (Not on USFWS wetland indicator list)
NI (insufficient data)
* = limited ecological information

DATABASE

Reference Codes
RM= TNC "Barbour" mounded prairie releves (2001)
RE= TNC "Barbour" vernal pool releves (2001)
WS= TNC Whetstone Savanna Inventory
AD=Frank Lang, Agate Desert checklist
FR = TNC frequency data, Agate Desert or Whetstone Savanna Preserves
RH= R. Huddleston's, "Preliminary Report on the Plant Ecology of the Agate Desert Vernal Pools".
PP= TNC vernal pool photopoint monitoring at WSP or ADP

Code	Species (Sorted alphabetically)	Common Name	Guild	Primary Habitat	Second. Habitat	Origin	R-9 Wetland indicator	CA Wetland Indicator	Growth	Flower	Refer.
ACMI	Achillea millefolium	Yarrow	F	M		N	FACU	FACU	P	SU	FR
ACLE	Achnatherum lemmonii	Lemmon's needlegrass	G	M		N	NOL	NOL	P	SU	RM
ACMO	Achyrachaena mollis	Blow-wives	F	M	F	N	NOL	FACU	A	SP	RE
AGGR	Agoseris grandiflora	Large-flowered agoseris	F	M		N	NOL	NOL	P	SP	RM
AGHE	Agoseris heterophylla	Annual Agoseris	F	M	VP	N	NOL	NOL	A	SP	RH
AGOSE	Agoseris sp.	Agoseris	F	M	VP	N			A	SP	RE
AGHE2	Agrostis hendersonii	Henderson's bent grass	G	VP		N			A		
AICA	Aira caryophyllea	Silver hairgrass	G	M	F	I	NOL	NI	A	SP	RM
ALAM	Allium amplectens	Slim-leaf onion	F	F	VP	N	NOL	NOL	B	SP	RE
ALLIU	Allium sp.	Onion	F	M					B		FR
ALPR	Alopecurus pratensis	Meadow foxtail	G	VP		I	FACW	FACW	P	SP	RE
ALSA	Alopecurus saccatus	Meadow foxtail	G	VP		N	FACW+	OBL	A	SP	RE
AMLY	Amsinckia lycopsoides	Tarweed fiddleneck	F	M		N	NOL	NOL	A		AD
AMME	Amsinckia menziesii var. intermedia	Rancher's fireweed	F	M		N	NOL	NOL	A	SP	RM
ANCO	Anthemis cotula	Mayweed chamomile	F	M		I	FACU	FACU	A		FR
APOC	Aphanes occidentalis	Lady's mantle	F			N	NOL	NOL	A		AD
ARTH	Arabidopsis thaliana	Mouse-ear cress	F	VP		I	NOL	NOL	A	SP	RH
AROL	Aristida oligantha	Praire threeawn	G	M	VP	N	NOL	NOL	A	SU	WS
ASFA	Asclepias fascicularis	Narrow-leaf milkweed	F	M	VP	N	FAC-	FACU	P	SP	WS
ASCLE	Asclepias sp.	Milkweed	F	M	VP						RE
AVFA	Avena fatua	Wild oat	G	M		I	NOL	NOL	A	SP	WS
BLSC	Blepharipappus scaber	Rough eyelash	F	M		N	NOL	NOL	A	SU	AD
BRASS	Brassica sp.		F			I			A		
BRMI	Briza minor	Little quaking-grass	G	M	VP	I	FAC	FACW-	A	SP	RE
BRIZA	Briza sp.	Quaking grass	G	M	VP						RE
BRCOCO	Brodiaea coronaria ssp. coronaria	Elegant brodiaea	F	M	VP	N	NOL	NOL	B	SU	WS
BREL	Brodiaea elegans	Harvest brodiaea	F	M		N	FACU	FACU	B	SU	RM
BRELHO	Brodiaea elegans ssp. hooverii		F	M		N			B	SU	WS
BRODI	Brodiaea sp.	Brodiaea	F	M		N			B		RM
BRDI	Bromus diandrus (rigidus)	Ripgut brome	G	M		I	NOL	NOL	A	SP	RM
BRHO	Bromus hordeaceus (mollis)	Soft brome	G	M	VP	I	NOL	FACU-	A	SP	RE
BRJA	Bromus japonicus	Japanese brome	G	M	F	I	UPL	FACU	A	SU	RM
BROMU	Bromus sp.	Brome	G	M		I					FR
BRST	Bromus sterilis	Poverty brome	G	M		I	NOL	NOL	A	SP	FR
BRTE	Bromus tectorum	Cheat grass	G	M		I	NOL	NOL	A	SP	WS
CALLI	Callitriche sp.	Water-starwort	F	VP		N	OBL	OBL	A	WI	RH

Code	Species (Sorted alphabetically)	Common Name	Guild	Primary Habitat	Second. Habitat	Origin	R-9 Wetland indicator	CA Wetland Indicator	Growth	Flower	Refer.
CATO	Calochortus tolmei	Pussy ears	F	OS		N	NOL	NOL	P	SP	AD
CAQU	Camassia quamash	Common camas	F	VP	M	N	FACW	FACW	B	SP	RE
CABU	Capsella bursa-pastoris	Shepherd's purse	F	M		I	FACU	FAC-	A		FR
CACA	Cardamine californica var. sinuata	Milkmaids	F	M		N	NI	NI	P		FR
CAOL	Cardamine oligosperma	Little western bittercress	F	M		N	FAC	FACW	A	SP	AD
CADE	Carex densa	Dense sedge	SE	IRR		N	OBL	OBL	P	SU	WS
CAREX	Carex sp.	Sedge	SE	VP	M	N			P		WS
CAAT	Castilleja attenuata	Valley tassels	F	VP	M	N			A	SP	RE
CALA	Castilleja lacera (Orthocarpus l.)	Cut-leaved paintbrush	F	M		N	NOL	NOL	P		AD
CATE	Castilleja tenuis (Orthocarpus hispidus)	Hairy paintbrush	F	VP	M	N	FACU-	FAC	A	SP	RH
CECU	Ceanothus cuneatus	Buck brush	S	M		N	NOL	NOL	P	SP	RM
CESO	Centaurea solstitialis	Yellow star thistle	F	M		I	NOL	NOL	A	SU	RM
CEEX	Centaurium exaltatum	Common centaurium	F	M		N	FACW	FACW	A		AD
CEMU	Centaurium muehlenbergii	Monterey centaury	F	M		N	FACW	NOL	A	SU	WS
CEFOVU	Cerastium fontanum ssp. vulgare	Chickweed	F	M		I	NOL	NOL	P	SP	WS
CEGL	Cerastium glomeratum (viscosum)	Mouse-ear chickweed	F	VP	M	I	NOL	NOL	A	SP	RE
CENU	Cerastium nutans	Nodding chickweed	F			N	FACU	NOL	A		AD
CERAS	Cerastium sp.	Mouse-ear chickweed	F	VP	M						RE
CHSESE	Chamaesyce serpyllifolia ssp. serpyllifolia	Thyme-leafed spurge	F	M		N	NOL	NOL	A	SU	FR
CHSU	Chamomilla suaveolens	Pineapple weed	F	M		I	FACU		A		AD
CHIN	Chicorium intybus	Chicory	F	M		I	NOL		P	SU	FR
CHNA	Chrysothamnus nauseosus	Rubber rabbitbrush	S	M		N	NOL	NOL	P		AD
CLGR	Clarkia gracilis	Slender clarkia	F	VP	M	N	NOL	NOL	A	SP	RE
CLPU	Clarkia purpurea	Purple godetia	F	M		N	NOL	NOL	A	SU	RM
CLPUPU	Clarkia purpurea ssp. purpurea		F	M		N			A	SU	FR
CLPUQU	Clarkia purpurea ssp. quadrivulnera	Four spot	F	M		N			A	SU	WS
CLPUVI	Clarkia purpurea ssp. viminea		F	M		N			A	SU	WS
CLRH	Clarkia rhomboidea	Rhombic-petalled clarkia	F	M		N	NOL	NOL	A		AD
CLARK	Clarkia sp.	Clarkia	F	M		N					FR
CLPE	Claytonia perfoliata	Miner's lettuce	F	M		N	FAC	FAC	A	SP	FR
CNBE	Cnicus benedictus	Blessed thistle	F			I	NOL	NOL	A		AD
COGR1	Collinsia grandiflora	Large-flowered blue-eyed mary	F	M		N	NOL	NOL	A	SP	AD
COLI	Collinsia linearis	Linear-leaved blue-eyed mary	F	M		N	NOL	NOL	A		AD
COPA	Collinsia parviflora	Small-flowered blue-eyed mary	F			N	NOL	NOL	A	SP	AD
CORA	Collinsia rattanii	Rattan's blue-eyed mary	F	M		N	NOL	NOL	A		AD
COLLI	Collinsia sp.	Collinsia	F	M	VP					SP	RE
COSP	Collinsia sparsiflora	Few-flowered collinsia	F	F	M	N	NOL	NOL	A	SP	RE
COGR2	Collomia grandiflora	Chinese pagodas	F	M		N	NOL	NOL	A	SU	RM
COAR	Convolvulus arvensis	Bindweed	F	M		I	NOL	NOL	P	SP-SU	AD
CONVO	Convolvulus sp.	Morning-glory	F	M							RM
COTETE	Cordylanthus tenuis ssp. tenuis	Bird's-beak	F	M		N	NOL	NOL	A	SP	WS
CREPI	Crepis sp.	Hawksbeard	F	VP							RE
CRMU	Crocidium multicaule	Spring gold	F	F	M	N	NOL	NOL	A	SP	AD
CUHO	Cuscuta howelliana	Boggs lake dodder	F	VP		N	NOL	NOL		SU	WS
CYEC	Cynosurus echinatus	Hedgehog dogtail	G	M		I	NOL	NOL	A	SP	RM
CYAC	Cyperus acuminatus	Short-pointed flatsedge	SE	IRR		N	OBL	OBL	A	SU	WS
CYER	Cyperus eragrostis		SE	IRR		N	NI	FACW	P	SU	WS
CYPER	Cyperus sp.	Nutsedge	SE	VP							RE
DACA	Danthonia californica	California oatgrass	G	M		N	FACU*	FACW	P	SP	WS
DACA2	Daucus carota	Queen Anne's lace	F	M		I	NOL	NOL	Bi	SU	WS
DAPU	Daucus pusillus	American carrot	F	M		N	NOL	NOL	A	SU	RM
APIACE	Daucus sp. (Apiaceae sp.)	Unknowk Apiacea	F	M							RM

Code	Species (Sorted alphabetically)	Common Name	Guild	Primary Habitat	Second. Habitat	Origin	R-9 Wetland indicator	CA Wetland Indicator	Growth	Flower	Refer.
DEDA	Deschampsia danthonioides	Annual hairgrass	G	VP	F	N	FACW-	FACW	A	SP	RE
DESCU	Descurania sp.	Tansy mustard	F	M							FR
DICA	Dicholostemma capitatum	Blue dicks	F	M		N	NOL		B	SP	RM
DICO	Dicholostemma congesta (Brodiaea c.)	Ookow	F	M		N	NOL		B	SP	RM
DICHO	Dicholostemma sp.		F	M		N					FR
DIFU	Dipsacus fullonum (D. sylvestris)	Teasel	F	IRR		I	FAC	NI	Bi	SU	AD
DOBA	Downingia bacigalupii	Bach's downingia	F	VP		N	NOL	NOL	A		WS
DOYI	Downingia yina	Cascade downingia	F	VP		N	OBL	OBL	A	SP	RE
DRABA	Draba sp.	Draba	F	M							FR
DRVE	Draba verna	Vernal whitlow-grass	F	M	VP	N	NOL	NOL	A	SP	RH
ECCR	Echinochloa crus-galli	barnyard grass	G	VP		I	FACW		A		WS
ELMA	Eleocharis macrostachya (E. palustris)	Creeping spikerush	SE	VP		N	OBL	OBL	P	SU	RE
ELEOC	Eleocharis sp.	Spikerush	SE	VP							FR
ELEL	Elymus elymoides (Sitanion hysterix)	Squirreltail	G	M		N	FACU-	FACU-	P		RM
ELIN	Elytrigia intermedia (Agropyron I.)	Intermediate wheatgrass	G	M	F	I	NOL	NOL	P	SU	RM
EPBR	Epilobium brachycarpum (E. paniculatum)	Annual willow-herb	F	M	VP	N	NOL	UPL	A	SU	RE
EPDE	Epilobium densiflorum (Boisduvalia densiflora)	Dense-flowered fireweed	F	VP	F	N	FACW-	OBL	A		AD
EPPY	Epilobium pygmaeum (Boisduvalia glabella)		F	VP		N	FACW+	OBL	A		WS
EPILO	Epilobium sp.	Fireweed	F	VP	M						RE
EPTO	Epilobium torreyi (Boisduvalia stricta)	Spike primrose	F	VP	M	N	FACW	FACW	A	SU	RE
ERSE	Eremocarpus setigerus	Turkey-mullein	F	M	VP	N	NOL	NOL	A	SU	RE
ERCO	Eriogonum compositum	Northern buckwheat	F	M		N	NOL		P		AD
ERLA	Eriophyllum lanatum	Wooly sunflower	F	M		N	NOL	NOL	P	SP	RM
ERCI	Erodium cicutarium	Storksbill	F	M	VP	I	NOL	NOL	A	SP	RM
ERODI	Erodium sp.	Storksbill	F	M		I					FR
ERPE	Eryngium petiolatum	Coyote thistle	F	VP		N	OBL	NOL	P	SP	RE
FEAR	Festuca arundinacea	Tall fescue	G	M	VP	I	FACU-	FAC-	P	SU	RE
FEID	Festuca idahoensis	Idaho festcue	G	M		N	FACU*	NOL	P	SU	FR
GAAP	Galium aparine	Catchweed	F	M		I	FACU	FACU	A		RM
GAPA	Galium parisiense	Wall bedstraw	F	M		I	NOL	NOL	A		FR
GALIU	Galium sp.	Bedstraw	F	M							RM
GEDI	Geranium dissectum	Cut-leaved geranium	F	M	VP	I	NOL	NOL	A	SP	RE
GEMO	Geranium molle	Dove-foot geranium	F	M		I	NOL	NOL	A/Bi	SP	FR
GEPU	Geranium pusillum	Small-flowered crane's-bill	F	M		I	NOL	NOL	A		AD
GERAN	Geranium sp.	Geranium	F	M		I					RM
GISP	Githopsis specularioides	Common blue cup	F			N	NOL	NOL	A		AD
GLOC	Glyceria occidentalis	Western mannagrass	G	VP		N	OBL	OBL	P	SP	RE
GNPA	Gnaphalium palustre	Lowland cudweed	F	M	VP	N	FAC+	FACW	A		FR
GREB	Gratiola ebracteata	Bractless hedge-hyssop	F	VP		N	OBL	OBL	A	SP	RE
HEFI	Hemizonia fitchii	Fitch's tarweed	F	VP	M	N	NOL	NOL	A	SU	RE
HEPU	Hemizonia pungens	Common spikeweed	F			N	NOL		A		AD
HEPU2	Hesperochiron pumilus	Dwarf hesperochiron	F			N	FAC	FACW	P	SP	AD
HOLA	Holcus lanatus	Common velvet grass	G	M		I	FAC	FAC	P	SP	AD
HOJU	Hordeum jubatum	Foxtail barley	G	M		N	FAC	FAC+	P/A		FR
HOMA	Hordeum marinum	Mediterranean barley	G	VP	M	I	NI (FAC	NI (FAC)	A	SP	RE
HORDE	Hordeum sp.	Barley	G	M		I					FR
HYPE	Hypericum perforatum	St. John's-wort	F	M		I	NOL	NOL	P	SU	RM
HYRA	Hypochaeris radicata	False dandelion	F	M		I	FACU*	NOL	P	SU	WS
HYGL	Hypochaeris glabra	smooth cat's ears	F	M	F	I			A	SP	DB
IDSC	Idahoa scapigera	Flat-pod	F	M	F	N	NOL	NOL	A	SP	FR
ISNU	Isoetes nuttallii	Nuttall's quillwort	F	VP		N	OBL	OBL	B	WI	RE
JUBU	Juncus bufonius	Toad rush	R	VP		N	FACW	FACW+	A	SP	RE

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JUDI	Juncus diffusissimus		R	VP		I	NOL	NOL	P	SP	WS
JUEFEX	Juncus effusus var. exiguus	Soft rush	R	VP		N	FACW	OBL	P	SP	WS
JUEFPA	Juncus effusus var. pacificus	Soft rush	R	VP		N	FACW	OBL	P	SP	WS
JUEN	Juncus ensifolius	Dagger-leaved rush	R	VP		N	FACW	FACW	P		AD
JUHE	Juncus hemiendytus	Herman's dwarf rush	R	VP		N	FACW+	OBL	A	SP	RH
JUOX	Juncus oxymeris	Pointed rush	R	VP		N	FACW+	FACW	P	SU	WS
JUPA	Juncus patens	Spreading rush	R	IRR		N	FACW	FAC	P		AD
JUNCU	Juncus sp.	Rush	R	VP							RE
JUUN	Juncus uncialis	Inch-high rush	R	VP		N	FACW+	OBL	A		AD
JUXI	Juncus xiphiodes		R	VP		N	OBL	OBL	P	SU	WS
KOMA	Koeleria macrantha	Junegrass	G	M		N	NOL	NOL	P		AD
LASA	Lactuca saligna	Willow lettuce	F	M		I	NOL		A	SU	FR
LASE	Lactuca serriola	Prickly lettuce	F	M	VP	I	FACU	FAC	A/BI	SU	RE
LARA	Lagophylla ramosissima	Hareleaf	F	M		N	NOL	NOL	A		RM
LAAM	Lamium amplexicaule	Henbit	F	M		I	NOL	NOL	A		AD
LAMIU	Lamium sp.	Dead nettle	F	M							FR
LACA	Lasthenia californica	Smooth goldfields	F	F	M	N	NOL	FACU*	A	SP	RE
LAGL	Lasthenia glaberrima	Goldfields	F	VP		N	OBL	OBL	A	SP	RE
LENI	Lepidium nitidum	Shining peppergrass	F	M	VP	N	NOL	NOL	A	SP	RH
LIFLFL	Limnanthes floccosa ssp. floccosa	Woolly meadowfoam	F	F	VP	N	OBL	OBL	A	SP	RE
LIFLGR	Limnanthes floccosa ssp. grandiflora	Agate Desert meadowfoam	F	F	VP	N	NOL	NOL	A	SP	RE
LIBI	Linanthus bicolor	Bicolored linanthus	F	M	VP	N	NOL	NOL	A	SP	RE
LIGL	Lithophragma glabrum	Prairie star	F	M		N	NOL	NOL	P	SP	
LIPA	Lithophragma parviflorum	Small-flowered prairie star	F	M		N	NOL	NOL	P	SP	WS
LOMU	Lolium multiflorum	Italian ryegrass	G	M	VP	I	NOL	NOL	A	SP	RM
LOPE	Lolium perenne	Perrenial ryegrass	G	M	VP	I	FACU	FAC*	P	SU	WS
LOLIU	Lolium sp.	Ryegrass	G	M		I					FR
LOCO	Lomatium cookii	Cook's lomatium	F	VP	M	N	NOL	NOL	P	SP	WS
LOMA	Lomatium macrocarpum		F	M		N	NOL		P	SP	PI
LONU	Lomatium nudicaule	Pestle lomatium	F	M		N	NOL	NOL	P	SP	RM
LOUT	Lomatium utriculatum	Foothils lomatium	F	M		N	NOL	NOL	P	SP	RM
LOCO2	Lotus corniculatus	Birdfoot trefoil	F	M		I	FAC	FAC	P	SP	FR
LOPU	Lotus purshianus	Spanish clover	F	M		N	NOL	NOL	A	SU	WS
LOTUS	Lotus sp.	Lotus	F	M							RM
LOUL	Lotus uliginosus	Bird's-foot trefoil	F			I	NOL	NOL	P		AD
LOWR	Lotus wrangelianus		F	M		N	NOL	NOL	A	SP	WS
LUBI	Lupinus bicolor	Minature lupine	F	M	F	N	NOL	NOL	A	SP	RE
LUMI	Lupinus microcarpus var.microcarpus	Chick lupine	F	M	F	N	NOL	NOL	A	SP	AD
LUPIN	Lupinus sp.	Lupine	F	M							FR
LYTHR	Lythrum sp.	Loosestrife	F	VP							RE
LYHY	Lythum hyssopifolium	Hyssop loosestrife	F	VP		I	OBL	FACW	P	SP	WS
MAELDE	Madia elegans ssp. densifolia	Common tarweed	F	M		N	NOL	NOL	A	SU	WS
MAEX	Madia exigua	Threadstem tarweed	F	M		N	NOL	NOL	A	SU	RM
MAGR	Madia gracilis	Slender tarweed	F	M		N	NOL	NOL	A	SU	WS
MAMA	Madia madioides	Woodland tarweed	F	M		N	NOL	NOL	P		AD
MADIA	Madia sp.	Tarweed	F	M		N				SU	RE
MARSI	Marsilea sp.	Marsilea	Fern	VP		N					WS
MELU	Medicago lupulina	Black medick	F			I	FAC	FAC	A		AD
MEPO	Medicago polymorpha	California burclover	F	M		I	NOL	NOL	A		FR
MICA	Micropus californicus	Slender cottonweed	F	M	VP	N	NOL	NOL	A	SP	RE
MIAC	Microseris acuminata	Sierra foothills microseris	F	F		N	NOL	NOL	A		AD
MIDO	Microseris douglasii	Douglas microseris	F	VP		N	NOL	NOL	A	SP	RH

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MILA	Microseris laciniata	Cut-leaved scorzonella	**F**	F		N	NOL	NOL	P		AD
MIGU	Mimulus guttatus	Seep-spring monkeyflower	**F**	VP		N	OBL	FACW+	A/P	SP	PI
MICA2	Minuartia californica	California sandwort	**F**	VP	M	N	NI	NI	A	SP	WS
MINUA	Minuartia sp.	Sandwort	**F**	VP						SP	RE
MOER	Moenchia erecta	Moenchia	**F**	M		I	NOL	NOL	A		RM
MOFO	Montia fontana	Water chickweed	**F**	VP		N	OBL	OBL	A	SP	WS
MOLI	Montia linearis	Narrow-leaved Montia	**F**	VP		N	NOL	NOL	A	SP	RE
MYDI	Myosotis discolor	Yellow-and-blue forget-me-not	**F**	M		I	FACW	NI*	A	SP	FR
MYMI	Myosurus minimus	Least mouse-tail	**F**	VP		N	OBL	OBL	A	SP	RE
MYSE	Myosurus sessilis	Mouse-tail	**F**	VP		N	NOL	NOL	A	SP	WS
NAHE	Navarretia heterandra	Tehama navarretia	**F**	VP		N	NI	OBL	A		AD
NAIN	Navarretia intertexta ssp.propinqua	Great Basin navarretia	**F**	VP		N	FACW	FAC*	A		AD
NALE	Navarretia leucocephala	White-flowered navarretia	**F**	VP		N	OBL	OBL	A	SP	RE
NAPU	Navarretia pubescens	Downy navarretia	**F**	M		N	NOL	NOL	A	SU	WS
NAVAR	Navarretia sp.	Navarretia	**F**	VP	M	N			A		RE
NATA	Navarretia tagetina	Marigold navarretia	**F**	VP	M	N	NOL	NOL	A	SU	RE
NEPE	Nemophila pedunculata	Meadow nemophila	**F**	M	F	N	FAC	FAC+	A	SP	RE
ORUN	Orobanche uniflora	Naked broom-rape	**F**	M		N				SP	WS
ORBR	Orthocarpus bracteosus	Rosy owl-clover	**F**	M	VP	N	NOL	NOL	A	SP	RE
ORTHO	Orthocarpus sp.	Orthocarpus	**F**	M		N					RM
PAVI	Parentucellia viscosa	Yellow parentucellia	**F**	M		I	FAC-	NI*	A	SU	WS
PADI	Paspalum distichum	Knotgrass	**G**	M		I	FACW	FAC	P	SU	FR
PELA	Penstemon laetus	Gay penstemon	**F**	M		N	NOL	NOL	P	SU	WS
PENST	Penstemon sp.	Penstemon	**F**	M		N			P		FR
PEGA	Perideridia gairdneri	Gardner's yampah	**F**			N	FAC*	FACW	P	SU	AD
PHPR	Phleum pratense	Timothy	**G**	M		I	FAC-	FACU	P	SP	FR
PHGR	Phlox gracilis (Microsteris g.)	Pink annual phlox	**F**	M	F	N	FACU	FACU*	A	SP	RE
PHLOX	Phlox sp.	phlox	**F**	M							FR
PIAM	Pilularia americana	Pillwort	**Fern**	VP		N	OBL	OBL			AD
PLAU	Plagiobothrys austinae	Austin's allocarya	**F**	VP	F	N	NI	OBL*	A	SP	RE
PLBR	Plagiobothrys bracteatus	Bracted plagiobothrys	**F**	VP		N	FACW+	OBL	A	SP	WS
PLCO	Plagiobothrys cognatus	Allied allocarya	**F**	VP		N	NOL	NOL	A	SP	WS
PLFU	Plagiobothrys fulvus		**F**	M	F	N	NOL	NOL	A	SP	WS
PLGR	Plagiobothrys greenei	Greene's allocarya	**F**	VP	F	N	FACW	FACW	A	SP	RE
PLNO	Plagiobothrys nothofulvus	Rusty plagiobothrys	**F**	M		N	FAC	FAC	A	SP	RM
PLAGIO	Plagiobothrys sp.	Popcorn-flower	**F**	VP	M	N			A	SP	RE
PLST	Plagiobothrys stipitatus	Stalked allocarya	**F**	VP		N	FACW	OBL	A	SP	RE
PLTE	Plagiobothrys tenellus	Slender popcorn-flower	**F**	M		N	FAC	FAC*	A		AD
PLLA	Plantago lanceolata	English plantain	**F**	M		I	FAC	FAC-	P	SP	RM
PLANTA	Plantago sp.	Plantain	**F**	M							FR
PLCO	Plectritis congesta	Rosy plectritis	**F**	M		N	FACU	FACU	A	SP	FR
PLMA	Plectritis macrocera	Longhorn plectritis	**F**	M		N	FACU+	FACU*	A		AD
POBU	Poa bulbosa	Bulbous bluegrass	**G**	M	VP	I	NOL	NOL	P	SP	RE
POCO	Poa compressa	Canada bluegrass	**G**	M		I	FACU+	FAC	P	SU	FR
POPR	Poa pratensis	Kentucky bluegrass	**G**	M	VP	I	FAC	FACU	P	SP	RE
POSE	Poa secunda	One-sided blugrass	**G**	VP	M	N	NOL	NOL	P	SP-SU	WS
POZI	Pogogyne zizyphoroides	Bristly pogogyne	**F**	VP		N	NI	OBL	A	SP	RE
POAR	Polygonum arenastrum (P. aviculare)	Common knotweed	**F**	M		I	NOL	NOL	A	SU	FR
POPOCO	Polygonum polygaloides ssp. confertiflorum	Close-flowered knotweed	**F**	VP		N	FACW-	OBL	A	SP-SU	WS
POLYG	Polygonum sp.	Knotweed	**F**	M							RM
PSSP	Pseudoroegneria spicata	Blue-bunch wheatgrass	**G**	M		N	NOL		P		
PRVU	Prunella vulgaris	Self-heal	**F**			I	FACU+	FAC*	P		AD

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PSBR	Psilocarphus brevissimus	Dwarf woolly-heads	F	VP		N	FACW+	OBL	A	SP-SU	RE
PSOR	Psilocarphus oregonus	Oregon woolly-heads	F	VP		N	OBL	OBL	A	SP-SU	WS
QUGA	Quercus garryana	Oregon white oak	T	M	OS	N	NOL	NOL	P		FR
RAAR	Ranunculus arvensis	Field buttercup	F	VP?		I	NOL	NI*	A/Bi	SP	AD
RAAU	Ranunculus austro-oreganus	Southern Oregon buttercup	F	M	OS	N	NOL		P	SP	WS
RAOC	Ranunculus occidentalis	Western buttercup	F	VP	M	N	FAC	FACW	P	SP	RE
RARE	Ranunculus repens	Creeping buttercup	F	M		I	FACW	FACW	P	SU	WS
RANUN	Ranunculus sp.	Buttercup	F	M							FR
RILE	Rigiopappus leptocladus	Bristle-head	F	F	M	N	NOL	NOL	A		AD
ROEG	Rosa eglanteria	Sweet-brier	S	M		I	FACW*	NOL	P	SU	WS
RONU	Rosa nutkana var. nutkana	Nootka rose	S			N	FAC	NI	P		AD
RUDI	Rubus discolor	Himalayan blackberry	S	M		I	FACU	FACW*	P	SU	WS
RUCR	Rumex crispus	Curly dock	F	VP	M	I	FAC+	FACW-	P	SP	RE
SAAP	Sagina apetala	Dwarf pearlwort	F			N	NI	FAC			AD
SACR	Sanicula crassicaulis	Pacific snakeroot	F	M		N	NOL		P		
SAIN	Saxifraga integrifolia	Northwestern saxifrage	F	M		N	NI	NI*	P	SP	RM
SCLI	Scirpus lineatus (Peck)		SE	IRR		N	NOL	NOL	P		WS
SECE	Secale cereale	Rye	G	M		I	NOL	NOL	A	SU	RM
SEIN	Senecio integerrimus	Western groundsel	F	OS		N	FACU	FAC	P		AD
SHAR	Sherardia arvensis	Blue field-madder	F	M		I	NOL	NOL	A		FR
SIER	Sisymbrium erysimoides		F	M		I	NOL	NOL		SU	WS
SiOF	Sisymbrium officinale	Hedge mustard	F	M		I	NOL	NOL	A	SP	FR
SIBE	Sisyrinchium bellum	Blue-eyed-grass	F	M		N	FACW-	FAC	P		AD
TACA	Taeniatherum caput-medusae	Medusahead wild rye	G	M	F	I	NOL	NOL	A	SP	RM
TAOF	Taraxacum officinale	Dandelion	F	M		I	FACU	FACU	P	SP	FR
THRO	Thermopsis rhombifolia	Round-leaved thermopsis	F	M		N	FACU	NOL	P		FR
THCU	Thysanocarpus curvipes	Fringepod	F	M		N	NOL	NOL	A	SP	RM
THRA	Thysanocarpus radians	Large fringepod	F	M		N	NOL	NOL	A		AD
TOAR	Torilis arvensis	Hedge parsley	F	M	VP	I	NOL	NOL	A		RE
TRPR	Tragopogon pratensis	Meadow salsify	F	M		I	NOL		A	SU	RM
TRLA	Trichostema lanceolatum	Vinegar weed	F	M	VP	N	NOL	NOL	A	SU	RE
TRAR	Trifolium arvense	Rabbitfoot clover	F	M	VP	I	NOL	NOL	A	SP	RM
TRDE	Trifolium depauperatum	Poverty clover	F	VP	M	N	NI	FAC-	A	SP	RE
TRDU	Trifolium dubium	Least hop clover	F	M	VP	I	NOL	FACU*	A	SP	RE
TRGR	Trifolium gracilentum	Slender clover	F			N	NOL	NOL	A	SP	AD
TRMA	Trifolium macraei	Macrae's clover	F	M		N	NOL	NOL	A		AD
TRPR2	Trifolium pratense	Red clover	F	M		I	FACU	FACU+	P	SU	WS
TRRE	Trifolium repens	White clover	F	M		I	FAC*	FACU+	P	SU	WS
TRIFO	Trifolium sp.	Clover	F	M							RM
TRSU	Trifolium subterraneum	Subterranean clover	F	M		I	NOL	NOL	A	SP	WS
TRVA	Trifolium variegatum	White-tipped clover	F	M		N	FAC+	FACW-	A/P	SP	WS
TRWI	Trifolium willdenovii	Spring-bank clover	F	M	VP	N	NOL	NOL	A	SP	RE
TRHY	Triteleia hyacinthina	White brodiaea	F	VP	M	N	FACU	FACW*	B	SP	RE
TRITE	Triteleia sp.	Triteleia	F	VP	M	N			B		RE
VACA	Valerianella carinata	Keeled corn-salad	F	M		I	NOL	NOL			AD
VALO	Valerianella locusta	European corn-salad	F	VP	M	I	NOL	NOL	A	SP	RE
VEBL	Verbascum blattaria	Moth mullein	F	M	VP	I	NOL	FACW	Bi	SU	WS
VERBA	Verbascum sp.	mullein	F	M	VP	I			Bi		RE
VEAR	Veronica arvensis	Common speedwell	F	M	VP	I	FACU*	NI	A	SP	RM
VEPE	Veronica peregrina	Purslane speedwell	F	VP		N	OBL	OBL	A	SP	RE
VEPE2	Veronica persica	Persian speedwell	F			I	NOL	NOL	A		AD
VERON	Veronica sp.	Speedwell	F	M							FR

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VIAM	Vicia americana	American vetch	**F**	M	VP	N	FAC*	NI	P	SP	PP
VISAAN	Vicia sativa (var. angustifolia?)	Common vetch	**F**	M		I	UPL	FACU	A	SP	FR
VICIA	Vicia sp.	Vetch	**F**	M	VP						RE
VIVI	Vicia villosa	Hairy vetch	**F**	M		I	NOL	NOL	A		AD
VIDO	Viola douglasii	Douglas violet	**F**	M		N	NOL	NOL	P	SP	WS
VUBR	Vulpia bromoides	Six-weeks fescue	**G**	M		I	NI	FACW	A	SP	AD
VUMI	Vulpia microstachys var.microstachys	Nuttall's fescue	**G**	M?		N	NOL	NOL	A	SP	AD
VUMY	Vulpia myuros	Rat-tail fescue	**G**	M	VP	I	FAC	FACU*	A	SP	RE
VUMYMY	Vulpia myuros ssp. myuros		**G**	M	VP	I			A	SP	WS
VULPI	Vulpia spp.	Annual fescue	**G**	M		I			A		RM
WYAN	Wyethia angustifolia	Narrow-leaf mule's ears	**F**	M		N	FACU	FACU-	P	SU	AD
ZYVEVE	Zygadenus venenosus var. venenosus	Death camas	**F**	M		N	FACU*	FAC	P	SP	WS

Appendix 2-- Grazing Practices considered and reported on the Agate Desert

The table below summarizes the land managers, grazing practices, and presence of target species on tracts considered during the assessment of the rangeland health for the Agate Desert, and the development of best management practices for grazing.

Site	Owner/ Operator	Grazing practices	Cook's desert parsley	Agate Desert meadow-foam
Agate Desert Preserve	TNC	Rx fire, prairie restoration, *Spring* Grazing discontinued 1987	X	X
Whetstone Savanna Preserve	TNC	Winter/Spring grazing discontinued 1996.	X	X
Whetstone Industrial Park	City of Medford / Terry & Judy Jackson	Spring Grazing until 1995 Winter/Spring grazing since 1996 Bio-solids application periodically	X	X
Rice Tract	Marilyn Rice / Jerry Mefford	Winter/Spring grazing Summer grazing incidental to adjoining irrigated pasture.	X	X
Denman Wildlife Area	ODFW	Reclamation grass plantings, soil amendment w/ log deck waste	X	X
Rogue Plains Preserve (Formerly "Tipton")	TNC/Wilson Dalton Strauss, Randy White	Winter/Spring grazing, varied herd size		X
Jackson County Hoover Ponds	JACO	Cattle Exclosure, some ORV use. Historic use unknown	X	
Medford Ready Mix—City, Kirtland	Jackson	Grazing	X	
Rural residential 5-10 ac lots, E. White City		Varied livestock, partially year long grazing	X	X
Other Grazing lands and livestock operations not included.				
Roseburg Resources Tract– Kirtland Rd.	RR Inc, Vern Gephart	Spring grazing	X	X
Reese Creek	Anderson	Grazing, large pasture		
Reese Creek	Nevin	Grazing large pasture, supplemental irrigation		
140- Agate Lake	Morley Pingle	Grazing large pasture,		
Newland Road	Mrs. Bertha Owens, Ron Anderson	Grazing large lots		X
Modoc/Antioch	RRR, Jacob Wood	Intensive grazing, with supplemental feeding		X
Duffy	Patrick Duffy	Rest (uncertain history)		X
Hwy 140	Robert Youngs	?		
E. 140	Donald Grissom	?	X	

Examples of Ongoing Livestock Practices

Abbreviations
LIFLGR = Limnanthes floccosa ssp grandiflora,
LOCO = Lomatium cookii,
AUM =Animal Unit Month.

1. The Nature Conservancy Rogue Plains Preserve and a portion of Mrs. Wilson's tract Dalton Straus, operator.

TNC/Wilson pasture, 167 acres of vernal pool complex w/ LIFLGR
-- 60 cows and their calves (2.8 acres/AUM for 6 months) in 2002, 2002 and 2003. Similar in 2000/2001, but taken off after 5 months.

Straus has operated there most recently since 1997. In 1997 he ran 100 AUM, then reduced the number to 60 for last few years. Over the period between 1990 to 1996, Randy White was the operator, running a smaller herd of 45 AUM.

Straus also operated on site from the early 1980's until 1990. In some years as many as 100 AU, and at least one year as many as 120 AUM have been over-wintered there.

The cattle are generally put in the pasture December 1. Take off date is timed for loss of palatability and forage value, which typically occurs prior to June 1, depending on rainfall. Logistics and conditions on alternative pasture also play a role in determining the take off date.

The herd is fed supplemental hay through the winter, starting in mid December and continuing through March. The cattle are fed about 30 lbs of hay per AUM. The amount of feed is held steady, independent of the forage growth on site. Feed is spread on the ground on a 25-acre portion of Wilson tract, where ground is better drained. The growing forage is thought to be secondary to the hay during the period when hay is available.

The pasture is rested for a short period each spring when the cattle are moved off for 2-3 weeks around April 1 to graze an adjoining pasture. The timing and duration is designed to maintain desired conditions on the alternate irrigated pasture. The previous operator, Randy White reported similar operations.

Cattle get water from vernal pools when wet, and supplemental water from springs at the base of the Agate Desert terrace, or from a slough alongside the Rogue River.

**2. City of Medford Industrial Park and a portion of Rogue Aggregates-
Terry and Judy Jackson, operators. Earlier operators include the Pingle family, and the Bighams.**

Operation Prior to 1955 - 1995[1]

440-acre pasture, south of the railroad, including the W. Antelope Rd, and Newland Rd. pastures, and Conservancy, Alstom, and City tracts. —200 cow/calf pairs (2.2 acres/AUM/ 2 months from mid to late April through mid-June. Spring only grazing was the typical grazing pattern for some period prior to 1955 as operated by the Bigham Family, and from 1955 until the mid 1990's, operated by the Pingle family. After approximately 1995, the permit was granted to the Terry and Judy Jackson, who run cattle there through the winter and spring.

The current grazing permit on the City of Medford industrial park stipulates that the property will only be used for cattle grazing (no sheep or horses), and that the number of cattle or time of operation will not damage the property for grazing use (no feedlot operation). Occurrences of conservation targets have been monitored in three of the pastures.

Current Grazing Operation as of 2002, run by Terry and Judy Jackson

W. Antelope Rd", 192 acres with 100 acre vernal pool complex w/LOCO & LIFLGR
—80 cows (2.4 acres/AUM/ 0.5 month in for short duration in late November, early December). Once entire herd has arrived, they are moved off to the adjacent Newland Rd. pasture for early winter (through December and part or all of January) (see below). The herd is returned to W. Antelope Rd pasture after Jan 1, depending on grass condition, but before Feb 1st, so that most of the cows will have calves there, for better access. The Jackson's begin to reduce the herd in mid April. A smaller herd is left as late as July in some years.

"Newland" pasture, 147 acres with 97 acres of vernal pool complex w/LIFLGR
—80 cows (1.84 acres/AUM/1-2 months, December and January). Residual dry forage and early winter growth are used on site for one to two months before the herd is moved back to the W. Antelope Road pasture. Depending on feed, some cattle are moved back the cows have calved.

"Kirtland" pasture, with 82 acres with 30 acres of vernal pool complex w/LOCO
--23 cows and 23 yearlings until about March when the calves are taken out. (3.6 acres/AUM/4.5 months)

The cattle are generally put out in the pastures after Thanksgiving. Total numbers vary with moisture trends and growth of forage. Take off dates are timed to grass growth slowing down, and the desire to leave enough growth on the pasture to ensure sufficient grass seed, and sufficient dried forage for cattle the following fall. Cattle eat the dried dead grass along with fresh grass in the early winter.

The operators feed supplemental hay depending on moisture, temperature and grass growth. In an average year, with the right balance of herd size and forage growth, supplemental feed is not necessary. The Jackson's determine feed needs based on grass growth, feeding when the grass

[1] Personal communication with Allen Pingle, August 16, 2002

gets too short. Feeding can start in early winter. In 2002 the herd was fed supplemental hay for six weeks in January and February.

A 4th pasture on the City land is also used by the Jackson's but was not further assessed in this study. "Riverfront" pasture with 59 acres -- 14 cows (4 acres/AUM for just over 4 months) in 2002, 22 cows in 2000/2001 (2.7 acres/AUM for 4 months) in 2001. They get water from a stream there. The small herd is kept on the pasture until mid April.

2. Jim and Marilyn Rice tract,
Jerry Mefford, Operator

The same family has been operating similarly for 60 years, but used to have access to pasture to the west. Herd was probably 75 cows at times in past.

"Rice North" pasture, 21 acres of vernal pool complex, LOCO and LIFLGR

The vernal pool complex is part of a larger tract that includes 52 acres leveled irrigated pasture. Irrigation overflow occurs in some of the inter-mounds. This pasture is also used in conjunction with a 75-acre pasture to the south, covered in oak savanna. Water available out of the pools, and that water is extended with irrigation as well, otherwise well water to the south. Pasture under the oaks not thought to be utilized as much until later in spring.

Typically 50 cows are over-wintered on the property but they are fed on the pasture to the south for the winter. Mefford turns out the cattle on the North pasture as early as possible once growth is up, typically March 15. The herd is rotated between halves of the pasture every 2.5 weeks more or less. The herd uses the forage on the mounded prairie until it starts to go to seed at which time the livestock begin to forage on the irrigated pasture adjoining. The herd may lounge on the mounded prairie during the summer.

Grazing by a smaller herd (25 cows) resumes on the mounded prairie with fall green up. Incidental supplemental hay is fed to mix with the fresh grass to avoid health problems. Usually off by 15 to 20 November, depending on year.

3. Avenue E Rural Residential (varied intensity, year round grazing). Site was leveled in the 1950's for residential development. LOCO abundant, LIFLGR present.

Active grazing mixed between ownership, from 5 to 15 acres. Stocking rates range from 3.75 acres/AUM to 1.7 acres /AUM and the species have been mixed. Sub-pastures have not all had the same treatment. The adjoining pastures have varied levels of horse grazing or are covered in heavy thatch. A well-established occurrence of Cook's desert parsley, and a few incidental plants of the large flowered meadowfoam are found on the grazed site, and apparently scarce on the pastures covered in thatch.

APPENDIX 3-- Agate Desert Vernal Pool--Mounded Prairie Ecological Reference Site Description

Introduction

Upland grasslands on the Rogue River Plains are commonly dominated by non-native species that replaced the native perennial bunchgrasses following European American settlement. The nature of the original upland grassland remains conjectural Franklin and Dyrness (1988), Reigel, et al (1992), Smith (1985). Prairies on the floodplains were converted to cultivated agriculture during early settlement, reducing the extent of grassland. Colonization by non-native annual grasses and herbs, facilitated in part by historic cultivation and abandonment of fields, and historic grazing on the valley terraces and surrounding hills by herds of domestic swine and other livestock, dramatically altered the remaining prairies prior to the earliest ecological descriptions there.

The current prairie on the Rogue River Plains represents a new relatively stable system, comprised predominantly of Eurasian non-native species along with residual native species. The annual-dominated system was developed through a combination of extirpation of species and functional groups of species, and by invasion of novel species facilitated by litter and thatch accumulation, fire suppression, and altered grazing. Perennial species, with growth and reproduction occurring after the winter and spring flush, were presumably the most strongly impacted by this constellation of factors. Annual species, and especially non-native annual species better adapted to livestock grazing, had selective advantages (early maturity, seed designed for easy spread, and drought avoidance via their annual habit) and spread with livestock use and disturbance associated with agricultural and other development. The processes of fire, biomass accumulation, and nutrient cycling, along with competitive interactions were changed, and the system ultimately passed a threshold over which it appears incapable of returning without active management. While some research has pointed to failed attempts to restore the native grasses (Borman, Krueger, and Johnson 1991), other recent evidence demonstrates partial success in restoring the prairies of the Rogue Plains (Huddleston 2001).

In contrast, the flora of the vernal pools appears to be largely intact, presumably matching the presumed presettlement conditions with only minor changes. A much smaller percentage of non-native species have colonized the habitat of the vernal pools compared to the uplands. The most important changes were on the margins of pools, where upland species, once perennial bunchgrasses, intermixed with the vernal pool species.

Managing the condition and use of prairie benefits from considering a historic ecological reference describing its composition and structure. Such descriptions typically rely on locating relict stands of presettlement vegetation and developing quantified descriptions, or by integrating perspective gained from multiple related sites and other information (NRCS 1997). As there are no known exemplary ecological reference sites on the Agate Desert for the upland prairie, the reference site description outlined below was based on a combination of historic accounts, study of less degraded fragments, careful consideration of closely related grasslands nearby, and on the published ecological interpretations available.

While historic condition is valuable as an ecological reference, it is not necessarily a suitable goal for management. For this reason, a “desired future condition” description has been offered at the end of the text. It accepts that some nonnative species will likely remain a component of the prairie community in the future. It will not be practical to achieve this desired future condition on any but the most important sites for conservation. A minimally viable state, that retains the potential for long term viability, and leaves open the potential for improvement, should be maintained more widely.

Developing the Ecological Reference Site Description

Ecological Interpretation

NRCS Potential Native Vegetation-- The potential natural vegetation for the Agate soils was outlined in the Soil Survey of Jackson County (Johnson [NRCS] 1994). For the dry uplands of the mounds, bluebunch wheatgrass (*Pseudoroegneria spicata)* is listed as the principal component, associating with Idaho fescue (*Festuca idahoensis),* Nevada (pine) bluegrass (*Poa nevadensis)*, and lemmon's needlegrass (*Acnatherum lemmonii)*. Of the grass species listed by the NRCS, the most commonly found currently is the needlegrass, occurring in a few small patches where it is a dominant species.

The Soil and Vegetation Interpretation of the Southwestern Cascades--Thompson and Drewein (1983) described potential native vegetation on five different range types in the "Rogue Dry Upland Zone". The study used extensive observations on intact relict sites as well as others in various conditions. Listed in table below are the potential native dominant grasses, along with species considered "increasers" or resilient to disturbance, particularly livestock grazing. These are divided by Range Types, which are described in the table.

Table 1. Potential natural vegetation by range type (Thompson et al 1983).

Range Type	Habitat	Potential Natural Vegetation Dominants	Resilient species.
Oak- Pine-Oatgrass	Gentle or flat slopes, clay	*Danthonia californica* (wet) *Festuca idahoensis* *Koeleria macrantha* *Poa nevadensis* (dry site) *Elymus elymoides* (dry site)	*Elymus glaucus,* *Acnatherum lemmonii* *Brodiaea sp., Ranunculus sp., Navarretia sp.*
Oak- Pine-Fescue	Rolling hills, shallow, well drained, rocky soils	*Festuca Idahoensis* *Koeleria macrantha* *Poa nevadensis* *Pseudoroegneria spicata* (dry).	*Elymus elymoides* *Elymus glaucus* *Eriophyllum lanatum,* *Lomatium sp., Lupinus sp., Achillea millifolium, Madia sp.*
Dry Meadows	Flat areas moderately deep soils, high shrink-swell clays	*Danthonia californica* *Poa nevadensis,* Variable forbs	
Shrubby Scabland	Shallow, rocky soils; Ceanothus cuneatus dom., few oaks	*Festuca Idahoensis* *Pseudoroegneria spicata* *Acnatherum lemmonii,* *Elymus elymoides*	*Acnatherum lemmonii,* *Elymus elymoides* *Phacelia sp. Achillea millifolium,* *Lomatium sp., Madia sp., Navarretia sp., Plagiobothrys sp.*
Steep Foothill	Slopes > 40%, shallow, rocky soils	*Pseudoroegneria spicata* (dry, low) *Festuca Idahoensis* (higher) *Koeleria macrantha* *Poa nevadensis* *Elymus elymoides* (xeric)	*Acnatherum lemmonii, Elymus elymoides* *Lomatium sp., Brodiaea sp.* *Potentilla sp., Navarretia sp.* *Madia sp., Clarkia sp.*

Note: The taxonomy of species has been updated to that in Hickman 1993.

Historic Accounts

Cadastral Surveys-- The earliest Cadastral Survey (1855) at the time of settlement offers maps of the extent of grassland, but little on the composition and structure of the grassland, referring to "*grass, etc*.".

Anecdotal Accounts-- A variety of anecdotal accounts of vegetation near the Agate Desert from the time of settlement have been reviewed. In each, uncertainty about the location and ecological potential of the

described site diminishes the value. For example, in 1846, Lindsay Applegate travelling through the Rogue River Valley from the north toward Emigrant Creek, observed: *"...a splendid view of the Rogue River Valley, it seemed like a giant meadow interspersed with groves of oak which appeared like vast orchards. All day long we traveled over rich black soil, covered with rank grass, clover and peavine"* (Rucker 1930). The comment appears to be a reference to the black and gray soils on the low terraces and floodplains of Bear Creek, and not applicable to the vegetation that occupied the brown[1] soil of the Agate Desert. Joseph Lane recorded similar observations in the 1850's: *"...the wild grasses grew in profusion, covering everywhere the land...rich soil as yet unimpaired in fertility...sent up the stalks to the height of a man or of a horse"* (Walling 1884). The "rank" and tall grass may have been Great Basin wild rye (*Elymus cinereus*) or possibly robust blue wild rye (*Elymus glaucus*) growing in the prime agricultural soils on the low terraces of the floodplains, but the reference was not likely applicable to the Agate-winlo soil. From other historic accounts, these grassland systems were apparently exposed to frequent fires (Davies 1980, Leiberg 1900, Rucker 1930, Walling 1884, Wilkes 1849).

Native species in the current upland grassland on mounds

The resilient species of native bunchgrasses found in the Agate Desert upland prairie are Lemmon's needlegrass *(Acnatherum lemmonii* [formerly *Stipa lemmonii*]) and squirreltail (*Elymus elymoides* [formerly *Sitanion hystrix*]). These are common on the edge of the landform, at the airport, and sites near chaparral. Bluebunch wheatgrass and Roemer's fescue (aka Idaho fescue east of the Cascade Range), blue wildrye (*Elymus glaucus),* and Junegrass (*Koeleria macrantha*) are found on Provig soils on the escarpment of the Agate Desert terrace and in the understory of oak savanna. Pine bluegrass (*Poa scabrella* [*Poa secunda*]) is common in rocky swales, while the California oatgrass (*Danthonia californica*) occurs at the margins between mounds and pools at the Whetstone Savanna Preserve. Spring flowering annual grasses in the genus *Vulpia* are a common but minor constituent important, and prairie three-awn (*Aristada oligantha*) is common in the summer.

Many of the native forbs currently found in the annual grassland were likely important parts of the original upland prairie. While spring flowering annual species still occur in abundance in most settings, perennial species that flower in summer, or that have above ground perennial stems are largely absent. The bulk of species present are winter annuals that are part of the winter and spring flush of growth. There are three functional/structural groups of spring-flowering perennial species. These functional groups include one for the bulbous species, including *Brodiaea,* and *Tritellia,* which are frequently found, and *Camus* and *Zygadenus,* which are infrequently found. Taprooted plants in the carrot family comprise another spring perennial group. This second group includes the sensitive species *Lomatium cookii,* among several other species in the genus. The third a group consists of fibrous rooted species such as Viola (*V. douglasii*), larkspur (*Delphinium menziesii*), and buttercups (*Ranunculus occidentalis* and *R. austro-oreganus*).

Infrequent and missing native species of upland grassland on mounds

Summer flowering, perennial forbs are almost completely absent or rare in most vernal pool mounded prairie complexes on the Agate Desert. The most common perennial summer flowering forb is mule's ears (*Wyethia angustifolia*). The remaining list of perennials are rarely found: yarrow (*Achillea millifolium*), Oregon sunshine [or Oregon sunflower] (*Eriophyllum lanatum),* and phacelia (*Phacelia sp. [heterophylla*]). Species only found on the edges of the Agate Desert Mounded Prairies, often associated

[1] Soil colors, defined on "Munsell Color Chart" used by the USDA NRCS, of the flood plain soils range from black to grey (e.g. Central Point Sandy loam, Coker clays) while the Agate-winlo soil is dark brown.

with chaparral or savanna habitat include balsamroot (*Balsamorhiza deltoidea*), penstemon *(Penstemon laetus)*, paintbrush (*Castilleja applegatei*), lupine (*Lupinus albicaulis*), and cinquefoil (*Potentilla* sp [*glandulosa* most likely]).

The Oregon Natural Heritage Program did not ascribe species to the "Rogue Valley Mounded Prairie" type, but they do list a Rogue-Umpqua bluebunch wheatgrass – Idaho fescue Upland Grassland and a California oatgrass (*Danthonia californica)* valley grassland in their inventory of types. These types are well represented at the Round Top Butte Preserve several miles northeast of Eagle Point and less well represented at the Table Rocks and elsewhere. Smith (1985), studying in the Rogue and Umpqua basin grasslands, found incidental native grasses including *Danthonia californica, Poa scabarella, Elymus glaucus, and Poa. Sandbergii*.

A draft description of the presettlement grassland composition and structure is developed below from the preceding information. It is offered as a starting point for discussions, and should be used with careful consideration.

Vernal Pool Presettlement Composition

While a few species are shared between pools and mounds, the species assemblages of vernal pools are quite distinct from that found on the mounds. The flora of the vernal pools is still dominated by native species. Native forbs typically dominate deeper vernal pools, and a native annual grass dominates some ephemeral pools. In deeper pools, about 90% of the species are native. The USFWS has classified the wetland indicator status for most of the species, with thirty-three of the vernal pool species classified as "obligate" wetland plants in either the Northwest or California region. Some of the species have hydrophytic leaves only apparent when the pools are filled, and then later develop a set of terrestrial leaves as the pool soils dry down. The unique habitat of the vernal pools offers a set of environmental factors to which few species, worldwide, are adapted.

The duration of ponding, soil depth over the hardpan, and soil texture influence plant growth and ultimately the plant associations found within and among pools. Because of annual climatic variation, the suitability of each pool or location within a pool for a given species or plant assemblage can also vary somewhat annually. Classification of the variation in the vernal pool vegetation depends on the scale considered, both the size of the vegetation unit described, from a vernal pool system, a single whole pool, to subunits within a pool, and the size of the plot used. Reflecting variation within pools, and using a very small plot Huddleston and Borgias (1999) described seventeen types. Currently, some of the types appear to represent intergradation between types, and more coarse aggregation has been described herein. Seven broader types are defined below, using an approach coordinated with an ongoing California statewide effort led by researchers from the University of California at Davis. These are used as the basis, with some interpretation, to form a presettlement ecological reference site description

Historic accounts of the Agate Desert vernal pool composition have not been found. Prior to settlement, surrounded by mounds with native bunchgrasses, the pool margins once likely had a Danthonia californica - Poa secunda (California oatgrass - Pine bluegrass) type with *Camassia quamash* an important constituent. All three species are found in and around vernal pools. The occurrence of these species may have been more prevalent in the presettlement setting.

The vernal pool vegetation is considered relatively intact, particularly in the deeper pools or those with longer duration ponding. Changes in the composition of the vernal pools since settlement include the establishment of several non-native species, and the possible reduction and elimination of natives. Two non-native species are of special concern in the vernal pools: *Lolium perenne*, a spreading grass, and a tall

forb, *Rumex crispus*, These can form dense stands that appear to crowd out the native forbs. The interaction between another non-native forb, *Ranunculus arvensis*, and native vernal pool species is not known. *Eleocharis macrostachya*, a spikerush, is a fourth species of concern that spreads by rhizomes that allow it to crowd out the other plant communities if not controlled by disturbance such as grazing or burning. About a quarter of the species found within and on the margins are introduced. Currently the dryer margins of pools are dominated by *Hordeum marinum* (Mediterranean barley), a non-native grass that replaces the annual hairgrass. Under grazing, this band appears to be broadened part way up the flank of surrounding mounds. Hoof prints and soil churning from over-wintering elk would have been a variable occurrence. The forb rich vernal pools may have been important forage in the spring.

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General Ecological Reference Site Description

Rogue Plains Bluebunch Wheatgrass – Idaho Fescue Upland Grassland.

The historic plant community type for the mounds of the Agate Desert is the *Pseudoroegneria spicata - Festuca roemeri* type. Bluebunch wheatgrass and Roemer's fescue (formerly lumped with Idaho fescue [*F. idahoensis*]) were dominant species in this community. As such, the community appeared similar to the prairies of the Columbia Plateau, Blue Mountains and the loamy soils of the Oregon High Desert, with the notable replacement of *F. roemeri* for *F. idahoensis*, and the absence of several other grass species. Lemmon's needlegrass *(Acnatherum lemmonii* [formerly *Stipa lemmonii*]) and squirreltail (*Elymus elymoides* [formerly *Sitanion hystrix*]) which were likely to have been important constituents of the community in any successional state[2]. The secondary grasses included pine bluegrass (*Poa scabrella* [*Poa secunda*]), and Junegrass (*Koeleria macrantha*). The California oatgrass (*Danthonia californica*), would be prevalent at the margins of pools and extend into the community on the mounds. Spring flowering annual grasses were a minor but common constituent of the community with various species of *Vulpia* important. Prairie three-awn (*Aristada oligantha*) was a common summer flowering species of annual grass.

A wide variety of annual forbs occurred in the interstices between the bunchgrasses taking advantage of the ubiquitous soil disturbance by gophers and incidental, patchy and variable disturbance caused by deer, elk, and pronghorn. The bulk of these annual species, which germinate in the fall or spring, quickly flower and set seed with the approach of summer (species in the genera *Lupinus*, *Plagiobothrys*, *Collinsia*, *Nemophylla*, etc.). Perennial species in the community consisted of representatives from several functional groups. Spring flowering species were comprised of three functional groups. These include the bulbous species (*Brodiaea*, *Tritellia, Camus*, *Zygadenus*), taprooted plants in the carrot family (*Lomatium* spp,.), and the third a group of fiberous rooted species such as Viola (*V. douglasii*), larkspur (*Delphinium menziesii*), and buttercups (*Ranunculus occidentalis* and *R. austro-oreganus*). Summer flowering perennial forbs, comprised of two groups, were an important base of the vegetation cover. Taprooted species include: mule's ears (*Wyethia angustifolia*), yampa (*Perideridea*) and balsamroot (*Balsamorhiza deltoidea*). Fiberous rooted perennials included penstemon *(Penstemon laetus)*, paintbrush (*Castilleja applegatei*), lupine (*Lupinus albicaulis*), cinquefoil (*Potentilla* sp [*glandulosa* most likely]), yarrow (*Achillea millifolium*), Oregon sunshine [or Oregon sunflower] (*Eriophyllum lanatum),* and phacelia (*Phacelia sp. [heterophylla,* most commonly][3]). A final group of subshrubs, represented by semi-woody species of buckwheat (*Eriogonum spp*.), may also have occurred. The potential role of a cyrptobiotic crust (a low mat of lichens and bryophytes) is not known.

The variety and abundance of species on any particular mound or in a complex of patterned ground depended on numerous factors, including the proximity to other plant communities, use by ungulate grazers and burrowing mammals, and the incidence of fire. Forb species, especially annual species were abundant in the years following fire events or other disturbance. Within longer fire free intervals, subshrubs may have established or increased.

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[2] The Nature Conservancy established *Acnatherum lemmonii* from seed following a spring burn at the Agate Desert Preserve in 1996 (11 lbs./ac, cleaned and de-awned seed). Three years later, following a second burn, bunchgrasses occurred at an average density of 12 plants/m^2 and as many at 26 plants/m^2 (Huddleston 2001). The cover of native grass exceeded that for annual grasses after 5 years

[3] The Nature Conservancy established *Achillea millifolium*, *Wyethia angustifolia* and *Eriophyllum lanatum* from seed on the Agate Desert Preserve. Other species grown successfully for seed include *Potentilla glandulosa*, and *Penstemon laetus.*

Assessing condition relative to a reference. Following are two tables showing historic and desired future condition. Table A provides an estimate of the dominance ratings for species and other surface cover components in the Historic condition. Table B provides the proposed desired future condition in terms of cover of plant species functional groups. One indicator of prairie viability and health is the similarity index of a site relative to the desired future condition reference. This reference reflects the uncertainty and natural variation of the actual composition by functional group expected for an array of sites.

Table A. Ecological Reference Site Description (Historic Condition)

Rogue Plains Bluebunch Wheatgrass – Idaho Fescue Upland Grassland

Estimated Composition on 120-hectare patch of prairie. Cover Classes: 1 *Dominant* (roughly >40%), 2 *Subdominant* (or co-dominant) (11-40%), 3 *Important* (3-10%), 4 *Minor* (<3%) 5 *infrequent/patchy*, 6 *rare (not all rare spp are listed)*

	GRASS PERENNIAL NATIVE	**1**		**FORB NATIVE SPRING PERENNIAL**	**3**
ACLE	ACNATHERUM (Stipa) LEMONII	2	LOCO	LOMATIUM COOKII	5
ELEL	ELYMUS ELYMOIDES (Sitanion)	3	LOUT	LOMATIUM UTRICULATUM	3
FEID	FESTUCA ROEMERI (idahoensis)	3	LONU	LOMATIUM NUDICAULE	5
POSE	POA SECUNDA (SCABRELLA)	3	ORUN	OROBANCHE UNIFLORA	6
PSSP	PSEUDOROEGNERIA SPICATA	2	RASP	RANUNCULUS SPP (occid, austro-oreganus)	6
DACA	DANTHONIA CALIFORNICA	4	SAIN	SAXIFRAGA INTEGRIFOLIA	5
KOMA	KOELERIA MACRANTHA	4	VIDO	VIOLA DOUGLASII	5
	GRASS ANNUAL NATIVE	**4**		**FORB NATIVE BULB**	**4**
VUSP	VULPIA SPP. (spring)	4	BRCO	BRODIAEA CORONARIA	4
AROL	ARISTIDA OLIGANTHA (summer)	4	BREL	BRODIAEA ELEGANS	4
	CAREX PERENNIAL NATIVE	4	CAQU	CAMASSI QUAMASH	6
CAZZ	CAREX SPP.	6	DICO	DICHELOSTEMMA CONGESTA	4
	FORB NATIVE SUMMER PERENNIAL	**4**	TRHY	TRITELEIA HYACINTHINA	4
ACMI	ACHILLEA MILLEFOLIUM	5	ZYVE	ZYGADENUS VENENOSUS	5
AGHE	AGOSERIS (heterophylla, grandiflora)	5		**FORB NATIVE WINTER ANNUAL**	**3**
ASFA	ASCLEPIUS FASCICULARIS	5	AMSP	AMSINKIA SPP (retrorsa, intermedia)	5
BADE	BALSAMORHIZA DELTOIDEA	4	ACMO	ACHYRACHAENA MOLLIS	4
CAZZ	CASTILLEJA (applegatei?)	5	COSP	COLLINSIA SPARSIFLORA	4
ERLA	ERIOPHYLLUM LANATUM	4	DRZZ	DRABA spp.	4
LUAL	LUPINUS ALBICAULIS	5	EPTO	EPILOBIUM TORREYI	4
MIAC	MICROSERIS ACUMINATA	5	IDSC	IDAHOA SCAPIGERA	4
PELA	PENSTEMON LAETUS	5	LARA	LAGOPHYLLA RAMOSISSIMA	5
PHAN	PHACELIA ANGUSTIFOLIA	5	LIBI	LINANTHUS BICOLOR	4
POGL	POTENTILLA GLANDULOSA	5	LISP	LITHOPHRAGMA SPP	4
WYAN	WYETHIA ANGUSTIFOLIA	5	LUBI	LUPINUS BICOLOR	3
	FORB NATIVE SUMMER ANNUAL	**3**	LUMI	LUPINUS MICRANTHUS	3
CLPU	CLARKIA PURPUREA	3	LYHY	LYTHRUM HYSSOPIFOLIUM	4
HEFI	HEMIZONIA FITCHII	4	MICA	MICROPUS CALIFORNICUS	4
MASP	MADIA (elegans, exigua, glomerata)	5	MIGR	MICROSTERIS GRACILIS	4
EPBR	EPILOBIUM BRACHYCARPUM	3	NEPU	NEMOPHYLLA PEDUNCULATA	4
ERSE	EREMOCARPUS SETIGERUS	4	ORZZ	ORTHOCARPUS spp.	4
TRLA	TRICHOSTEMMA LANCEOLATUM	4	PLSP	PLAGIOBOTHRYS (fulvus, nothofulvus).	3
CIPA	CIRCIUM PASTORALIS	6	PLCO	PLECTRITUS CONGESTA	4
			TRSP	TRIFOLIUM (variegatum, wildenovii)	4
	Ground Cover	**na**	VEZZ	VERONICA SPP.	4
MOSS	**MOSS**	5	THCU	THYSANOCARPUS CURVIPES	4
	Live Vascular Plant	1		**FORB NATIVE ANNUAL**	**4**
	Standing dead	2	NAHE	NAVARETTIA HETERANDRA	4
	Thatch cover	4	NATA	NAVARETTIA TAGETINA	4
	Thatch Height	2 cm	NAPU	NAVARRETIA PUBESCENS	4
	Litter (in contact with soil)	3	CHSE	CHAMAESYCE SERPYLLIFOLIA	5
	Rock/Gravel (>10cm)	5	COTE	CORDYLANTHUS TENUIS	5
	Bare Ground	5	DEZZ	DESCURANIA spp.	5
	Gopher Mounds (raised)	3	PHZZ	PHLOX spp.	5
	Hoof prints in soil	6	GAAP	GALIUM APARINE (divaricatum)	4

Table B. Ecological Reference Site Description (Desired Future Condition)

Rogue Plains Mounded Prairie Grassland

Target cover for Agate Desert plant species functional groups for combined upland and vernal pool parts of the mounded prairie (can be estimated or quantified by various means. Reference cover is based on hypothetical Ecological Reference Site condition, and likely optimal restoration potential.

Functional Group	Reference cover (Rel.%)
Perennial Native Gramminoids	38.0
Annual Native Grasses	8.0
Perennial Native Forbs	20.0
Annual and Biennial Native Forbs	25.0
Perennial Introduced gramminoids	*3.0*
Annual Introduced gramminoids	*3.0*
Perennial Introduced Forbs	*0.5*
Annual and Biennial Introduced Forbs	*2.5*
Total	100.0

Ecological Reference Site Description

Agate Desert Vernal Pools

While a total of six vernal pool plant association are proposed based on releve data taken between 2001 and 2003, individual pool basins generally contain two to three and sometimes four different plant associations. The most common association is Navarretia leucocephala (whitehead navarretia) type. Pools with longer standing water support a Eryngium petiolatum - Navarretia leucocephala (Coyote Thistle– whitehead navarretia) type. With slightly shorter inundation, a Lasthenia glaberrima (Smooth Lasthenia) community may form, often covering pool bottoms or forming a ring around Navarretia types. The Downingia yina (Cascade calico flower) type is spatially dynamic from year to year, generally occurring peripheral to Navarretia and Lasthenia types, in a setting that suggests a shorter duration of inundation. All four of the types above have important coverage from the dominant species cited in the name of the community. *Plagiobothrys stipitatus* and *Isoetes nutallii* are widespread in pools and important in all three communities. An array of secondary species also occur, the most notable: *Myosurus minimus, Alopecurus saccatus, Psilocarphus brevissimus, Juncus uncialis, Gratiola ebracteata, and Callitriche sp.*

The margins of most pools and the bottoms of shallow ephemeral pools support the Deschampsia danthonioides (Annual Hairgrass) type. The association is sensitive to variation in inundation from year to year and tends to move up and down within the pool. The driest margin of the pools supports a band of Deschampsia - Lasthenia californica (Annual Hairgrass - California goldfields) type. The type is currently dominated by the non-native *Hordeum marinum,* yet supports a wide array of species. In some years, and especially after disturbance such as fire or grazing, the gold fields lend an eye-catching yellow ring around the white and purple flowers in the pool basin. The width of the marginal band depends on the slope of the pool basin/mound, and on disturbance, including incidence of fire, gophers, ungulate grazers, and annual variation in inundation. The same vegetation type can also occur in swales where water flows overland between pools. Species often in this type include *Montia linearis, Alopecurus saccatus, Trifolium depauperatum, Collinsia sparsiflora, Epilobium densiflorum (Boisduvalia densiflora), Lupinus microcarpus var. microcarpus, and Achyrachaena mollis.* The endangered species, *Limnanthes floccosa* ssp *grandiflora* and *Lomatium cookii*, occur in these margins but also in the Deschampsia danthonioides type. Finally, an uncommon and poorly documented proposed type is the Camassia quamash (blue camas) association that has been found in cobbly swales and in the adjoining pools.

Vegetation cover in the vernal pool communities tend to have up to 5-20% exposed soil, part of that from gopher activity which occurs after the water recedes. Pocket gophers commonly cache the bulbs of the abundant *Tritelaea hyacinthina*. In summer several other native plant species become more prevalent. These include annual species that germinate after the water recedes and a perennial: *Trichostema lanceolatum, Croton (Eremocarpus) setigerus, Hemizonia fitchii,* and *Asclepias fascicularis.*

Table C, following, shows the vernal pool composition by plant community.

Table C. Vernal Pool plant associations and species composition on the Agate Desert, Jackson County, Oregon.

Classification and summary of frequency and cover for species based on data from 49 releves in 22 pools at six sites in 2003.
Releve plots were 2 x 2 m except 1 x 2 m where associations occurred in narrow linear patches.
Species with distributions of occurrence that are primary contributors to the classification are listed in bold, and where thier varied contribution distinguishes the associations is outlined in bold.
Species that occurred with less than 1% cover in any type are excluded from the table.

	Plant association															
	frequency of occurrence and average cover (percent)															
	NALE n=9		**ERPE NALE** n=10		**LAGL-ERPE** n=5		**DOYI** n=8		**DEDA** n=5		**DEDA LACA** n=4		**CAQU** n=5	
Pool Interior																
Navarretia leucocephala s. leucocephala	100	**32.9**	90	**12.4**	.		25	**2.0**	20	**12.0**	25	**2.0**	.	
Eryngium petiolatum	.		100	**19.3**	100	**27.6**	75	**6.8**	20	**10.0**	.		.	
Lasthenia glaberrima	11	**2.0**	20	**4.5**	100	**14.2**	63	**11.4**	.		.		.	
Downingia yina	89	**6.3**	100	**6.6**	100	**5.2**	100	**33.4**	100	**8.3**	100	**3.5**	.	
Isoetes nuttallii	89	**8.4**	100	**19.2**	80	**14.5**	75	**21.7**	100	**6.0**	75	**3.0**	.	
Plagiobothrys stipitatus v. micranthus	100	**20.4**	100	**12.6**	100	**7.2**	100	**4.4**	40	**14.0**	100	**3.0**	.	
Alopecurus saccatus	100	**3.7**	90	**2.1**	60	**2.3**	50	**2.0**	20	**3.0**	50	**1.0**	.	
Gratiola ebracteata	89	**3.8**	80	**3.1**	80	**4.3**	75	**3.8**	60	**1.0**	.		.	
Juncus hemiendytus	44	**3.5**	60	**6.3**	20	**2.0**	63	**3.6**	100	**3.0**	50	**3.0**	.	
Callitriche species	33	**2.0**	20	**2.0**	40	**2.0**	25	**2.5**	80	**2.3**	50	**3.0**	.	
Psilocarphus brevissimus v. brevissimus	22	**1.0**	70	**7.6**	20	**4.0**	50	**3.8**	20	**1.0**	50	**3.0**	.	
Myosurus minumus	22	**3.0**	20	**2.5**	20	**1.0**	13	**1.0**	40	**1.5**	.		.	
Eleocharis palustris	.		10	**1.0**	40	**4.5**	.		.		.		.	
Eleocharis species	.		.		.		25	**3.0**	.		.		.	
Pogogyne ziziphoroides	.		.		.		.		20	**1.0**	.		.	
Lower Margins														
Deschampsia danthonioides	22	**4.0**	20	**2.5**	.		75	**3.0**	100	**29.0**	100	**19.8**	.	
Juncus bufonius	.		.		.		13	**3.0**	.		75	**11.3**	.	
Trifolium depauperatum	.		.		.		.		.		75	**3.3**	.	
Lasthenia californica	.		.		.		.		20	**1.0**	75	**2.0**	.	
Hemizonia fitchii	11	**1.0**	.		.		.		.		50	**4.0**	.	
Plagiobothrys greenei	.		.		.		.		.		50	**2.0**	.	
Limnanthes floccosa s. grandiflora	.		.		.		.		.		25	**3.0**	.	
Plagiobothrys austiniae	.		.		.		.		.		25	**2.0**	.	
Polygonum species	.		.		.		13	**1.0**	.		.		.	
Upper Margins														
Hordeum marinum s. gussonianum	11	**3.0**	10	**10.0**	.		13	**1.0**	.		100	**10.8**	80	**3.8**
Triteleia hyacinthina	33	**17.3**	40	**6.3**	.		75	**4.2**	100	**9.0**	75	**6.7**	100	**12.0**
Camassia quamash	.		.		.		.		.		.		100	**23.6**
Rumex crispus	.		.		.		.		.		.		20	**3.0**
Limnanthes floccosa s. floccosa	.		.		.		.		.		.		20	**1.0**
Upland Opportunists														
Trichostema lanceolatum	11	**3.0**	.		.		13	**4.0**	40	**1.0**	.		.	
Veronica peregrina s. xalapensis	22	**1.0**	.		.		25	**1.0**	80	**3.0**	50	**1.0**	20	**1.0**
Achyrachaena mollis	.		10	**1.0**	.		.		.		25	**1.0**	40	**1.0**
Clarkia purpurea	.		.		.		.		.		50	**2.5**	.	
Lupinus bicolor	.		.		.		.		.		50	**2.0**	.	
Poa bulbosa	.		.		.		.		.		25	**3.0**	.	
Castilleja attenuata	.		.		.		.		.		25	**2.0**	.	
Bromus hordeaceus	.		.		.		.		.		25	**1.0**	20	**4.0**
Lolium perenne s. multiflorum	.		.		.		.		.		.		100	**27.2**
Bromus species	.		.		.		.		.		.		40	**4.5**
Taeniatherum caput-medusae	.		.		.		.		.		.		40	**1.0**
Elymus elymoides s. elymoides	.		.		.		.		.		.		40	**1.0**
Madia species	.		.		.		.		.		.		20	**1.0**
Vulpia myuros	.		.		.		.		.		.		20	**1.0**

NALE *= Navarretia leucocephala ssp. leucocephala type,* ***ERPE -NALE*** *= Navarretia leucocephala s. leucocephala - Eryngium petiolatum type,* ***LAGL ERPE*** *= Lasthenia glaberrima - Eryngium petiolatum type,* ***DOYI =*** *Downingia yina type,* ***DEDA*** *= Deschampsia danthonioides type,* ***DEDA-LACA*** *= Deschampsia danthonioides- Lasthenia californica type,* ***CAQU*** *= Camassia quamash type*

Appendix 4-- Assessing Rangeland Health (ecological integrity, and effects of grazing practices) in Vernal Pool—Mounded Prairie Systems on the Agate Desert, Jackson County, Oregon

The indicators described here are used in assessing rangeland health on Agate Desert Mounded Prairies. There are many indicators that could be chosen for this task— for example, forage production, or fire hazard, among others. The assessment described here is meant to assess ecological conditions and effects of management, particularly of livestock grazing, on ecological integrity. Areas of interest are assessed relative to an Ecological Reference Area Site Description—a description of a landscape unit in which ecological processes are functioning within a normal range of variability and the plant community has adequate resistance to and resilience from most disturbances (Pellant 2001, Pyke 2002). The Ecological Reference Area Description, along with the process used to develop the reference, is provided in Appendix 3. This description captures the critical conditions and features of a vernal pool mounded prairie with optimal ecological integrity.

Key ecological factors of the prairie system and the focal species of that system are used along with the critical stresses (*altered factors that threaten ecological integrity)* there to define seven indicators of ecological integrity or rangeland condition. The indicators, their importance, and measurable attributes are described below.

Methods developed for measuring each indicator are also provided. Condition classes defining ecological thresholds are used to rank the status of the indicators. The Ecological Reference Site Description for the vernal pool mounded prairie captures a state of optimal ecological integrity that would be ranked *Very Good*. For the focal conservation targets, the desired status is a rank of *Good*, where the conditions exceed a minimum acceptable integrity threshold. Below this level the status is *Fair*, a state where the target is vulnerable to significant disruptions from additional disturbances that exert degrading pressure. Below this, passing over an imminent loss threshold is the status of *Poor*. The *Poor* rank is applied if the target is so severely altered from its minimum integrity threshold that allowing it to remain in this condition or trajectory for another 10-25 years will make restoration of the target or prevention of its extirpation practically impossible. These ranks are described for each indicator. **The condition classes constitute hypotheses, serving to inform and possibly improve management while remaining open to refinement.**

The *size and distribution* of a species population is a recurring indicator in this system. Large well-distributed populations have greater ecological integrity for numerous reasons. Larger populations typically have greater genetic variation and access to varied habitat, allowing them to subsist under natural environmental variations. Large populations are less vulnerable to being pushed outside their acceptable range of variation by chance events or human caused disturbances, and therefore are perceived with greater confidence to be “secure”, requiring less human intervention to be maintained. Such populations more closely approximate their “natural state” or function within their “natural range of variation.” As populations shrink, they become increasingly susceptible to further collapse in abundance or range.

Indicator 1 *Number and Distribution of Reproductive Plants for Cooks Desert Parsley*

For Cook’s desert parsley the indicator is the size of occurrence as measured by the *number and distribution of reproductive plants*.

Indicator 2 ***Number and Distribution of Plants for Large Flowered Wooly Meadowfoam.***

For meadowfoam the indicator is the size of occurrence as measured by the *number and distribution of plants*.

Indicator 3 ***Vernal Pool Fairy Shrimp Distribution and Number of Pools Occupied***.

For the listed vernal pool fairy shrimp, the coarse scale population size, distribution, and stability is determined by the *distribution and number of pools occupied*.

Indicator 4 ***Accumulation of Excessive Thatch***

The *accumulation of excessive thatch* (an interwoven mat of litter suspended above the surface) is assessed by determining its aerial cover and height.

Indicator 5 ***Soil Disturbance by Gophers***

The key ecological factor of *soil disturbance by gophers* is measure by determining the cover and distribution of fresh gopher mounds.

Indicator 6 ***Vegetation Structure***

The height of vegetation, and cover and height of elevated, vertically oriented litter and thatch are evaluated as a measure of nest and perch structure for grassland birds. The criteria for ranking vegetation structure were derived in part from Altman (2000a and b), work on habitat functionality and compatible management for grassland birds.

Indicator 7 S*tatus of functional groups of plants, including invasive plants.*

This indicator assesses the composition of the grassland species based on the cover of functional groups of species, including invasive nonnative plants, targeting overall diversity of species, and the similarity to an ecological reference site description.

Agate Desert Condition Indicators Compared to Rangeland Health Indicators

The indicators developed by the US Department of Interior and Department of Agriculture in their recent document "Interpreting Indicators of Rangeland Health—Version 3" (Pellant et al., 2000) and described in Pyke et al (2002) were reviewed during the development of this rangeland assessment for the Agate Desert. The USDA/USDI rangeland health assessment compares conditions relative to an Ecological Reference Area for a given soil type. The assessment includes 17 indicators focussed on soil and site stability and on hydrology. The assessment is especially sensitive to detecting the signs of erosion and the susceptibility to erosion. These are significant contributors to loss of site productivity particularly in arid grasslands of the intermountain west. The list includes ten indicators to assess soil stability: *Rills, Water Flow Patterns, Bare Ground, Gullies, Wind Scour, Litter Movement, Soil Surface Resistance to Erosion, Soil Surface Loss or Degradation, Compaction Layer*, and *Plant Community Composition and Distribution Relative to Infiltration and Runoff*.

The USDI/USDA assessment includes several indications of susceptibility to erosion that may be useful on the Agate Desert. *Soil Surface Resistance to Erosion* is a measure that is influenced by soil organic matter that binds soil aggregates, or by biological crusts that grow on the surface. There is currently little sign of biotic crusts on the Agate Desert grassland, and no historic anecdotes found. In the case of *Soil Surface Loss or Degradation*, evaluating organic matter content and structure near the surface, it is likely that soil churning by pocket gophers typically reduces extensive organic matter. The possibility that a *Compaction Layer* could occur under grazing or other uses has not been evaluated in the field, however, frost heaving and shrink swell phenomena likely alleviate such compaction to some extent.

On the Agate Desert prairies, soil erosion due to rain impact and sheet flow, or due to wind, appears to be insignificant. The mounded topography occurs on a relatively small scale, with low slopes, such that for most of the Soil/Site Stability Indicators, the conditions depart little from the natural range of variation. While not a significant contributor to erosion, bare ground on the Agate Desert is an important substrate where competition is reduced and it is optimal substrate for some species for germination and growth. That erosion and loss of site stability are minor concerns on the Agate Desert reflects the innate physical attributes of the soil which provide the site with greater ecological resilience to ongoing grazing practices. Soil churning from hoof action particularly on the margins of pools during the wet season has been cited as a source of increased sedimentation in the pools and modified topography (Scoles 1993). Such modification, its scope and severity, should be evaluated further, but has not been addressed here.

The last of the site stability indicators offered by Pellant focus more on the integrity of the biotic community, the most crucial concerns for the maintenance of the system: *Functional/Structural Groups, Plant Mortality/Decadence, Litter Amount, Annual Production, Invasive Plants, and Reproductive Capability of Perennial Plants*. Counterparts to these, or at least components of these indicators are included in the assessment outlined for the Agate Desert.

Assessment Methods

Quantitative measurements are valuable to accurately describe conditions for the assessment. The assessment is informed by a summary of data collected through four separate data collection processes. One for vernal pool fairy shrimp, one each for the rare plants, and one for the vegetative community composition and structure. See notes under each indicator for more information on methods.

Information on abundance, or cover, distributions, and structure gathered from sites are summarized and compared to a classification of conditions for each indicator. Rankings for the condition classes can also be thought of in terms of departure from the Ecological Reference Site Conditions as in the rangeland health assessment tool. *Poor*, represents extreme departure, *Fair* for moderate departure, *Good* for slight to moderate departure, and *Very Good* for no departure to slight departure from the reference conditions. The rankings for each of the indicators is listed below. The assessment pinpoints opportunities to adjust management as necessary to raise the condition. Typically management would focus on the indicator with the lowest rank. A species list with the functional groups is provided in Appendix 1 to the body of this document.

Condition Class descriptions for Agate Desert vernal pool mounded prairie Indicators of Health

Indicator 1 ***Number and distribution of reproductive plants for Cooks desert parsley***
(method: census & map plants for populations < 2,000/100 ac, coarse scale mapping and sampled abundance estimate for populations >2,000.)

Poor: Cook's desert parsley abundance < 500 reproductive plants in 100 acres of vernal pool mounded prairie complex. Patches occupy < 2% of the complex.

Fair: Cook's desert parsley abundance > 500 reproductive plants in 100 acres of vernal pool mounded prairie complex, and patches occupy > 2% of the complex.

Good: Cook's desert parsley abundance > 2,000 reproductive plants in 100 acres of vernal pool mounded prairie complex, and patches occupy > 10% of the complex.

Very good: Cook's desert parsley abundance > 5,000 reproductive plants in 100 acres of vernal pool mounded prairie complex, and patches occupy > 10% of the complex.

Indicator 2 ***Number and distribution of plants for large-flowered woolly meadowfoam.***
(method: census & map plants for populations with < 3,000 plants/100 ac, coarse scale mapping and abundance estimate for populations >3,000.)

Poor: Number and distribution of plants < 200 plants in 100 acres of vernal pool mounded prairie complex in average year, occurrence with patches in < 20% of 10-acre grids in such a complex (poorly distributed).

Fair: Number and distribution of plants < 3,000 plants in 100 acres of vernal pool mounded prairie complex in an average year, occurrence with patches in > 20% of the 10-acre grids in such a complex.

Good: Number and distribution of plants > 3,000 plants in 100 acres of vernal pool mounded prairie complex in an average year, and the occurrence with patches in > 50% of the 10-acre grids in such a complex.

Very Good: Number and distribution of plants > 50,000 plants in 100 acres of vernal pool mounded prairie complex in an average year, occurrence with patches in > 90% of the 10-acre grids in such a complex (well distributed).

Indicator 3 ***Vernal Pool Fairy Shrimp distribution and number of pools occupied***.
(method: Evenly distributed, random selcction of pools surveyed in late January or early February for occupancy and abundance by class in occupied pools ["moderate abundance"-- ≥ 3 adults of both sexes)

Poor: Vernal pool fairy shrimp occupy < 20% of pools typically hydrated in an average precipitation winter. Pool occupancy occurs in < 20% of 10-acre grids in a 100-ac complex. Fairy shrimp not moderately abundant in sweep of any pools.

Fair: Vernal pool fairy shrimp occupy > 20% of pools typically hydrated in an average precipitation winter. Occupied pools in > 20% of 10-acre grids in a 100-ac complex. Fairy shrimp of both sexes found with at least moderate abundance in at least 2 pools.

Good: Vernal pool fairy shrimp occupy >40% of pools typically hydrated in an average precipitation winter. Occupied pools occur in > 40% of 10-acre grids in a 100-ac complex. Fairy shrimp of both sexes found with at least moderate abundance in > 25% of occupied pools.

Very good: Vernal pool fairy shrimp occupy >50% of pools typically hydrated in an average precipitation winter. Occupied pools in > 60% of 10-acre grids in a 100-ac complex. Fairy shrimp of both sexes found with at least moderate abundance in > 50% of occupied pools

Indicator 4 ***Accumulation of excessive thatch***

(Point intercept method for cover (includes measurements from both mounds and vernal pools), and highest thatch within 20 cm radius of pin drop, calculating average height.)

Poor**:** Thatch a dominant feature, predominantly of medusahead grass—occurring with > 40% cover (exceeding native plant cover), and with average height > 4 cm.

Fair: Thatch a subdominant feature—occurring with < 40% cover (and less than native plant cover) with average maximum height typically less < 4 cm.

Good: Thatch a minor feature of mixed sources—occurring with < 15% cover (< 30% of live vegetation cover), typically less < 3 cm average maximum height.

Very good: Thatch insignificant to minor, predominantly part of native bunchgrasses rather than from medusahead—occurring with < 5% cover (< 10% of the live vegetation cover)., with average maximum height less < 2 cm,

Indicator 5 ***Soil disturbance by pocket gophers***

(method: point intercept method, recording occurrence, and calculating cover. Ocular assessment of distribution)

Poor: Fresh pocket gopher mounds uncommon, with most mounds and intermounds not apparently used by gophers, cover of gopher mounds < 1% of the ground surface

Fair: Fresh pocket gopher mounds not evenly distributed, observed on and around few mounds or intermounds, and with < 2% cover of the ground surface.

Good: Fresh pocket gopher mounds common, generally observed on and around many mounds and intermounds, often with > 3% cover of the ground surface.

Very good: Fresh pocket gopher mounds common, typically observed on and around most mounds and intermounds occupying > 6% cover of the ground surface.

Indicator 6 ***Vegetation Structure***
(method: point intercept method, recording highest vegetation within 20 cm radius of pin drop, and cover of elevated litter (dead plant matter, vertically oriented, >2 cm above soil surface), and thatch cover.

Poor: Close clipped vegetation dominates setting, with average height < 15 cm and minimal variation. Cover of elevated litter < 5%. Thatch < 1% or absent. Primary infloresences of most spring and summer-flowering perennial plants clipped off, and nest and perch structure for grassland birds essentially absent in most years. Areas of low vegetation or bare ground occur in vernal pools and widely across mounds.

Fair: Average vegetation height > 15 cm with increased variability. Cover of elevated litter < 10%; thatch < 3%, absent, or in excess of 30%. Primary infloresences of most spring and summer flowering perennial plants clipped off and nest and perch structure for grassland birds occurs infrequently across the site in most years. Areas of low vegetation or bare ground occur in vernal pools and may occur widely across mounds.

Good: Average vegetation height >25 cm (grazed or not); cover of elevated litter > 10% in most years, unless recently burned; thatch <40%. Bunchgrasses contributing regularly to variability (texture), with many infloresences of most spring and summer-flowering perennial plants present, and nest and perch structure for grassland birds occurs frequently across the site in most years. Areas of low vegetation or bare ground occur primarily in vernal pools.

Very good: Average vegetation height >25 cm (grazed or not); elevated litter cover > 15%; thatch < 30%. Bunchgrasses contributing high variability in height (texture), and most infloresences of spring and summer-flowering perennial plants present contributing to nest and perch structure for grassland birds which occurs frequently across the site in most years. areas of close cropped vegetation or bare ground occur primarily in vernal pools.

Indicator 7 S*tatus of Functional Groups of Plants, Including Invasives*.
(method: point intercept method used for calculating cover in mid-May. Uses similarity index relative to Ecological Reference Site conditions (ERS) for functional groups modified to allow some nonnative species presence expected in a restored community)

***Poor*:** ERS Similarity for functional groups < 40%. Stands dominated by non-native annual grasses (medeusahead, bromes, Mediterranean barley), or non-native perennial grasses (bulbous bluegrass, intermediate wheatgrass, orchard-grass, Kentucky bluegrass, field fescue), and with moderate diversity and cover of native winter annuals and biennials. Native perennial grasses absent or rare, and perennial forbs minor. Non-native forbs are widespread and with significant cover.

Fair: ERS Similarity for functional groups > 40%. Stands dominated by non-native annual grasses with high diversity and greater representation of native annual and biennial forbs, and perennial forbs. Native perennial grasses absent, rare or patchy. Non-native summer flowering forbs are scattered widely with dense patches in places.

Good: ERS Similarity for functional groups > 60%. Stands with native perennial bunchgrasses an important component, and with diverse and abundant native annual, biennial, and perennial forb species present in a 100-acre complex. Non-native summer flowering forbs are infrequent and contribute low cover.

***Very good*:** ERS Similarity for functional groups > 80%. Native bunchgrasses dominant, native summer-flowering forbs scattered including 50% of those in the reference description in a 100-acre complex, summer non-natives are rare.

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Appendix 5-- Assessment of Focal Species Indicator Status on the Agate Desert

Lomatium cookii

Agate Desert Preserve (management: initial 10-year rest, followed by periodic Rx fire and rest for 8 years)

Indicator status: ***Good,*** Trend: short-term varied, long-term stable, last surveyed in 2004

Under agreement with the City of Medford, The Nature Conservancy excluded livestock from a small exclosure in 1985, part of which was later incorporated in the Agate Desert Preserve. Results of monitoring in 1986 suggested higher recruitment of plants in the exclosure[1]. Incidental plants grazed early in the season continued to grow, while plants grazed later did not[2].

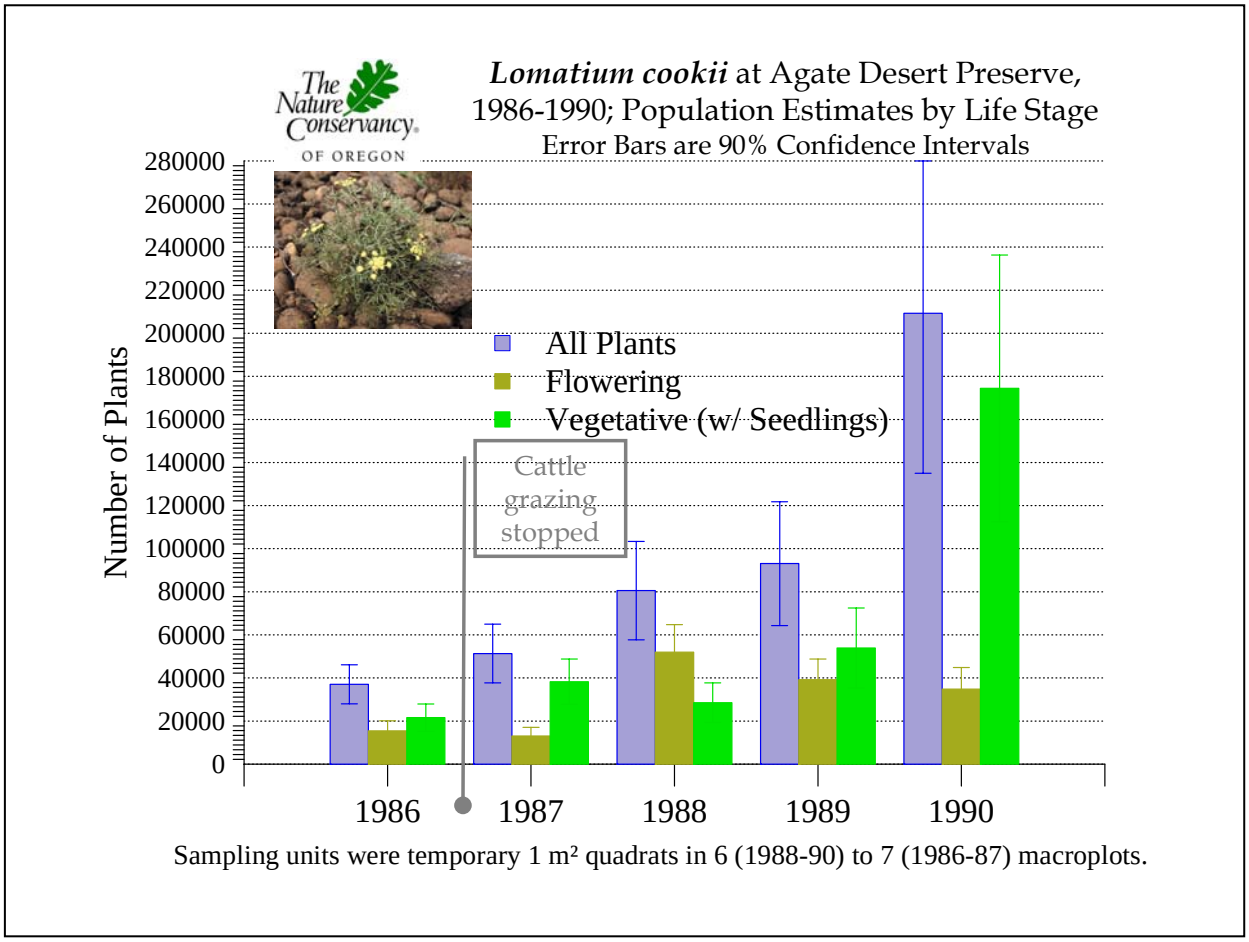

Figure 1. *Lomatium cookii* abundance at the Agate Desert Preserve in macroplots over the largest patches of the occurrence from 1986 to 1990.

Abundance monitoring reveals the trends in the *Lomatium cookii* population (Figure 1 and 2). Cattle were excluded from 49 acres at the Agate Desert Preserve in 1987 with the construction of West Antelope Road and fencing on City owned land on the south side. The population overall climbed for several years after cattle exclusion, buoyed primarily by an increase in seedling and

[1] The Nature Conservancy 1986. Lomatium cookii Monitoring Plan, monitoring results and discussion, Unpublished document on file at The Nature Conservancy, Portland Oregon.
[2] Brock, Richard, 1987. The ecology of Lomatium cookii: an endangered species of the Rogue Valley. Unpublished senior project report, available from the Biology Department at Southern Oregon University.

juvenile plants. A flush of flowering was also detected early on. This flush may have resulted in part from increased detection of plants in the absence of grazing.

With overall abundance markedly increased over five years, quantitative monitoring was discontinued, replaced with qualitative assessments for several years (Figure 2). In 1994 a meaningful decrease became clear and quantitative monitoring was re-initiated. The initial increase in flowering and juvenile plants had diminished, the population dropping to abundance levels found while under grazing.

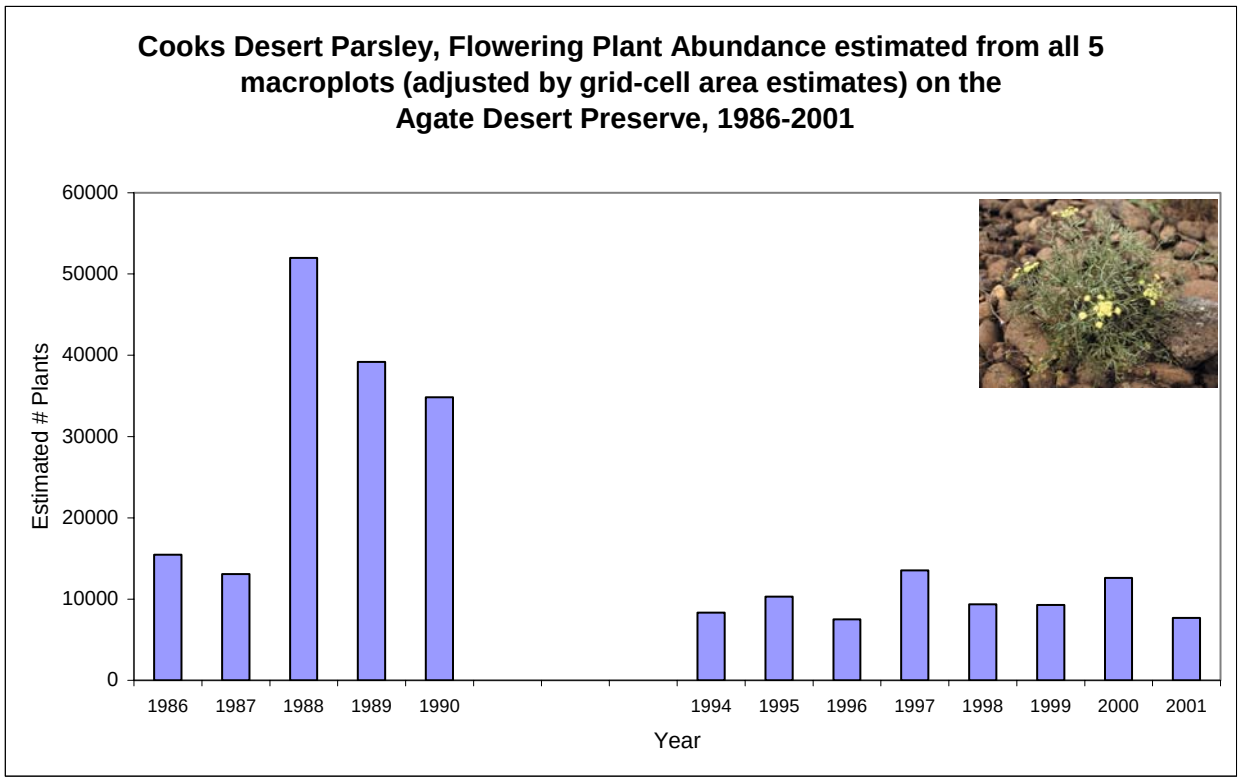

Figure 2. Lomatium cookii flowering plant estimated abundance across the entire preserve from 1986-2001.

The decrease is attributed to thatch accumulation, particularly on the mounds where medusahead grass is prevalent. Seeds may remain lodged in the thatch, elevated above the soil, and reducing soil contact. Growing seedlings are also shaded under the thatch. The Conservancy conducted careful seeding trial with *Lomatium cookii* under three levels of thatch at the Agate Desert Preserve. Seedlings emergence in thatch was half that where thatch was removed. In the absence of thatch, 50% of seedlings survived and resprouted the following year, while only 13% survived under accumulated thatch. The accumulation of thatch also shades adult plants as they grow. Finally, thatch accumulation appears to lead to increased use of the area by voles, and resulting increased herbivory.

We measured height, weighed, and estimated cover of thatch and annual production in prairie stands under varying management in 2001. In some ungrazed stands sampled, the mass of accumulated thatch and litter exceeded the annual production of biomass for the year, covering over 50% of the ground. For comparison, the cover of thatch under several grazing regimes sampled ranged from 2-13%.

The Conservancy implemented prescribed burns in 1996, 1998, and 2002 to reduce thatch and increase recruitment. The burns were highly effective at removing the thatch, and resulted in renewed pulses of seedling emergence and the recruitment of juvenile plants, apparent in our monitoring data (Figure 3). As of 2003, the accelerated recruitment, and the initial transition of juveniles to flowering adults had not yet begun to offset attrition of adults.

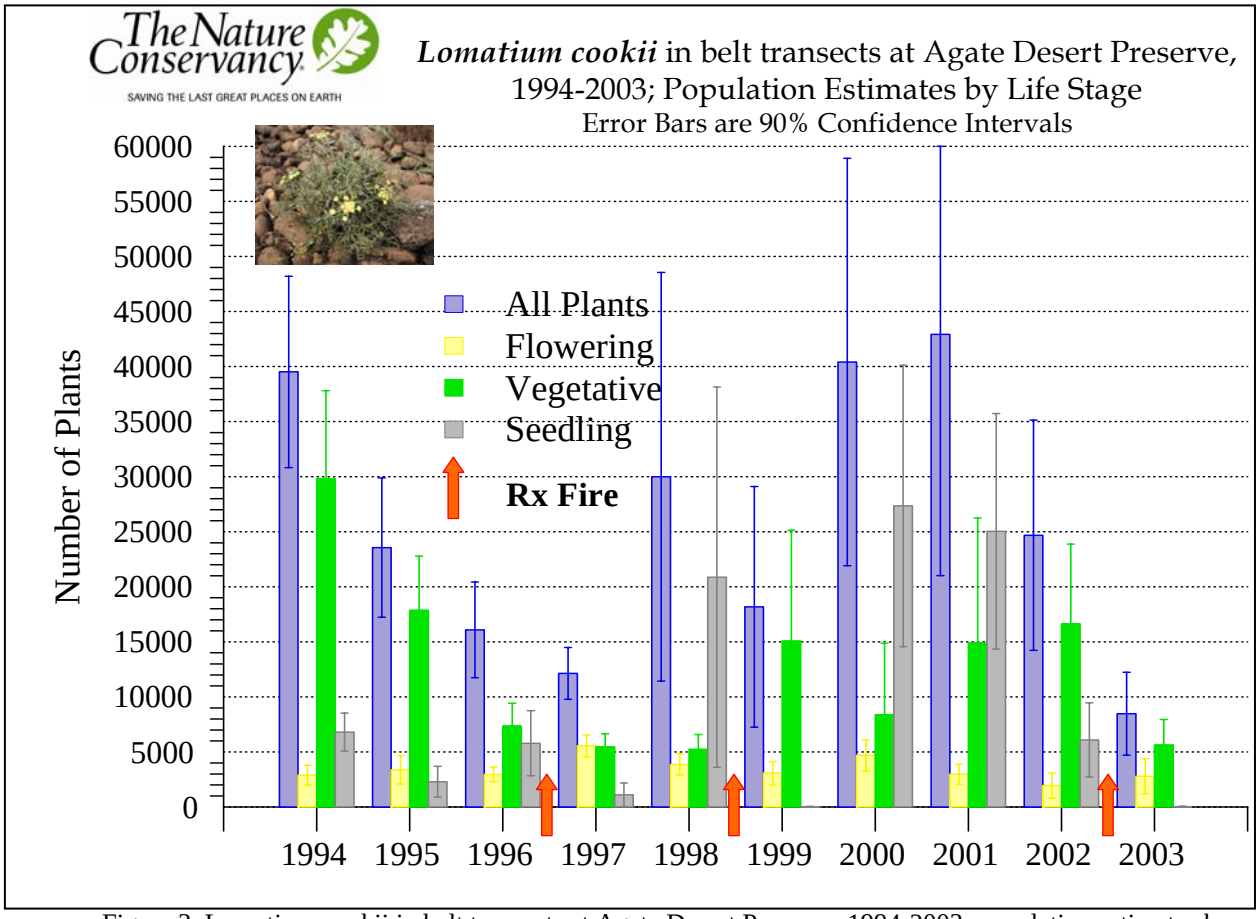

Figure 3. Lomatium cookii in belt transects at Agate Desert Preserve, 1994-2003; population estimates by life stage. Error bars are 90% confidence intervals

Loss of formerly occupied habitat on mounds, where thatch impacts were the greatest, and slow re-colonization of the mound habitat may be a factor in the slow response in the adult plant abundance. The area of occupied upland (mound) habitat declined by an estimated 40-80%. Livestock grazing may have maintained patches of the plant on mound tops by reducing competition and distributing seed from the nearby pool flanks.

Whetstone Savanna Preserve: (management—rest 8 years, targeted mowing)

Indicator status: ***Poor,*** Trend: Initial increase, short term decreasing, last surveyed in 2004.

The occurrence of Cook's desert parsley on this site was found in a 1992 survey for the Oregon Department of Transportation. An estimated 300 plants of all growth stages were found. Cattle last grazed seasonally until 1996. A complete census on the preserve was completed each year

between 1996 and 2004. As at the Agate Desert Preserve, the number of reproductive plants increased for several years with cattle grazing excluded (Figure 4). The number of reproductive plants declined after the third year of rest. Total numbers are currently at the level originally documented for the occurrence. With seedlings in decline the Conservancy started mowing patches of grassland in late June or early July to help curtail thatch accumulation and increase seedling abundance.

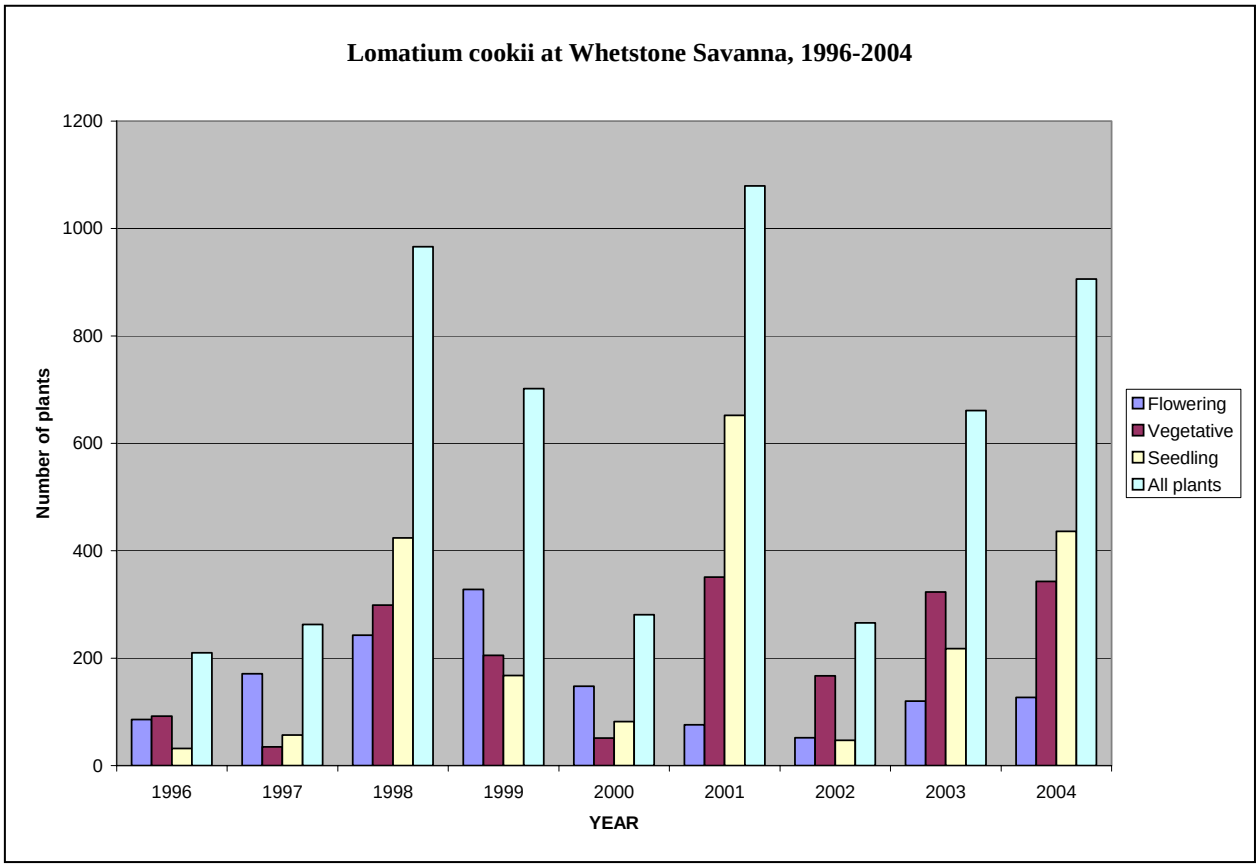

Figure 4. *Lomatium cookii* abundance by growth stage at Whetstone Savanna Preserve.

Rice Tract: (management—ongoing winter/spring grazing)

Indicator Status: ***Fair,*** Trend: short-term increasing, last surveyed in 2002.

The occurrence of Cook's desert parsley on this tract was first assessed in 2000 by David Evan's and Associates, for the Rogue Valley Council of Governments. The inventory-level search reported 100+ plants observed. The patch is located on the west site of the fence dividing the pasture. The Nature Conservancy staff and Marilyn Rice conducted a complete census of reproductive plants in 2001 and 2002. A total of 680 flowering plants were located in 2001, however some plants may have been missed, as the search was conducted while a significant proportion of plants were in seed and therefore less visible. In 2002, 904 flowering plants were observed. In both years, the plants were apparently grazed (short) and with a reduced number of infloresences.

Whetstone Industrial Park—W. Antelope Rd. tract (ongoing late winter/spring grazing)

Indicator Status: ***Fair,*** Trend: increasing, last surveyed in 2003.

This 192-acre pasture has roughly 100 acres of vernal pool complex with a small and patchy population of the Cook's desert parsley. In 1986, The Nature Conservancy recorded two important patches, with 1800 reproductive plants estimated for the macroplots[3]. One was centered near the intersection with Table Rock Rd., the other along the old wagon road across the tract, which was partially filled with overburden during construction. Both were impacted by the construction of West Antelope Road before spring sampling 1988 with overburden soil from the new roadway spread in the vernal pool depressions.

The 2000 census found 305+ reproductive plants. In 2001 we found 556 plants. In 2002 among 6 patches we found a total of 739 plants. One of these patches with 165 plants represents the remaining numbers in the macroplot partially filled in 1988. In 2002 most of the plants were apparently grazed (short) and with a reduced number of infloresences. The extent of cropping was less apparent in 2001. In 2003 we found a total of 979 reproductive plants.

Jackson County, Hoover Ponds (no grazing, some off-highway-vehicle use)

Indicator Status: ***Fair,*** Trend: short- term Stable, last surveyed in 2002

This large tract has nearly 80 acres of weakly expressed vernal pool complex has several small patches of Cook's desert parsley. The result of survey level assessment in 2000 was an estimated 1000 reproductive plants. A complete census in 2002 located 5 patches with 650 reproductive plants. The population receives extensive OHV tracking which alters the topography and hydrology, but also reduces the thatch accumulation.

ODFW, South Denman tract (no grazing, habitat limited)

Indicator Status: ***Good,*** Trend: increasing. Last surveyed in 2003

The occurrence near the ponds on the eastern side of the tract occupies an area of annual grassland with weakly expressed mounded topography. The occupied area is confined by habitat planted to "Largo" tall wheatgrass, spread log-deck debris, and a pond. We completed a census each year from 2000 through 2003. The number of reproductive plants increased each successive year starting from 730 plants in 2000, then 882 in 2001, and 1,903 in 2002, and 2,825 flowering plants in 2003. The 2003 survey represents the best-timed for detecting plants by coinciding with the early period of flowering while competing grasses and other species are relatively low in stature. A smaller occurrence recorded in 1992 on the western side of the tract has been absent during attempts in several years to relocate it.

[3] 22 plants occurred in 25 –1.0 sq meter samples, in an area of 2090 sq. meters

ODOT, Highway 140 right of way (no grazing, varied OHV use)

Indicator Status: ***Poor,*** Trend: Long term and short term decreasing. Last surveyed in 2003

This tract has weakly expressed vernal pool complex with a portion of a "marginal occurrence" with <200 plants discovered in 1987. The plants are distributed among several small patches. A census in 2000 found only 26 reproductive plants. In 2002 and 2003, only 19 and 20 plants, respectively, were found. The population receives bicycle and motorized OHV tracking which may crush individuals, alter the topography and hydrology, but also serves to reduce the thatch accumulation, and possibly reduces competitive species.

Rogue Aggregates/Whetstone Ind. Park—Kirtland Road tract (grazing late fall/winter/spring)

Indicator Status: ***Fair,*** Trend: short-term increasing. Last surveyed in 2000

This historic occurrence was first observed in 1992. The number of plants can not be determined from the data recorded at that time. In 2000 we observed 277 *Lomatium cookii* and in 2002 we found 1,403 reproductive plants

Avenue E, Rural Residential Leveled Pasture (varied, year round grazing most years of last 15)

Indicator Status: ***Very Good,*** Trend: Long term increasing. Last observed in 2001

The Oregon Natural Heritage Program first recorded this occurrence in 1987, and later recorded a reduction after visiting in 1992. ORNHP records indicate that the area had been leveled in 1954. The result of leveling is apparent, mounded topography is absent with the soil hydrology and the vegetation taking on the appearance of a continuous pool margin. In 2001 plants in all growth stages were highly abundant. The flowering plants in the population were estimated for the 15-acre patch was 580,000 plants.

Limnanthes floccosa ssp grandiflora

Agate Desert Preserve (management: Rx burning, rest [7-12 yrs.])

Indicator Status: ***Very Good,*** Trend: long term increasing. Last observed in 2004

The large-flowered woolly meadowfoam occurrence now found on the Agate Desert Preserve has been monitored since 1984. Initially, surveys accomplished an entire census of plants including portions of the population spread across an area that would later be divided by West Antelope Road. By 1990, the numbers were so great that sub-sampling became more efficient means than a complete census to estimate the number. The figure below provides the number of large-flowered meadowfoam counted, or estimated from counts in a sampling of permanent plots, for the preserve. The amount of effective rainfall (for the meadowfoam, the period from January to March) was compared to the average for that period, and a departure from normal is shown in bars above or below the mean line. The period during which the population was under livestock grazing is shown below the x-axis with dates. The timing of three burns, the first a wildfire, the later two conducted under controlled conditions is also shown.

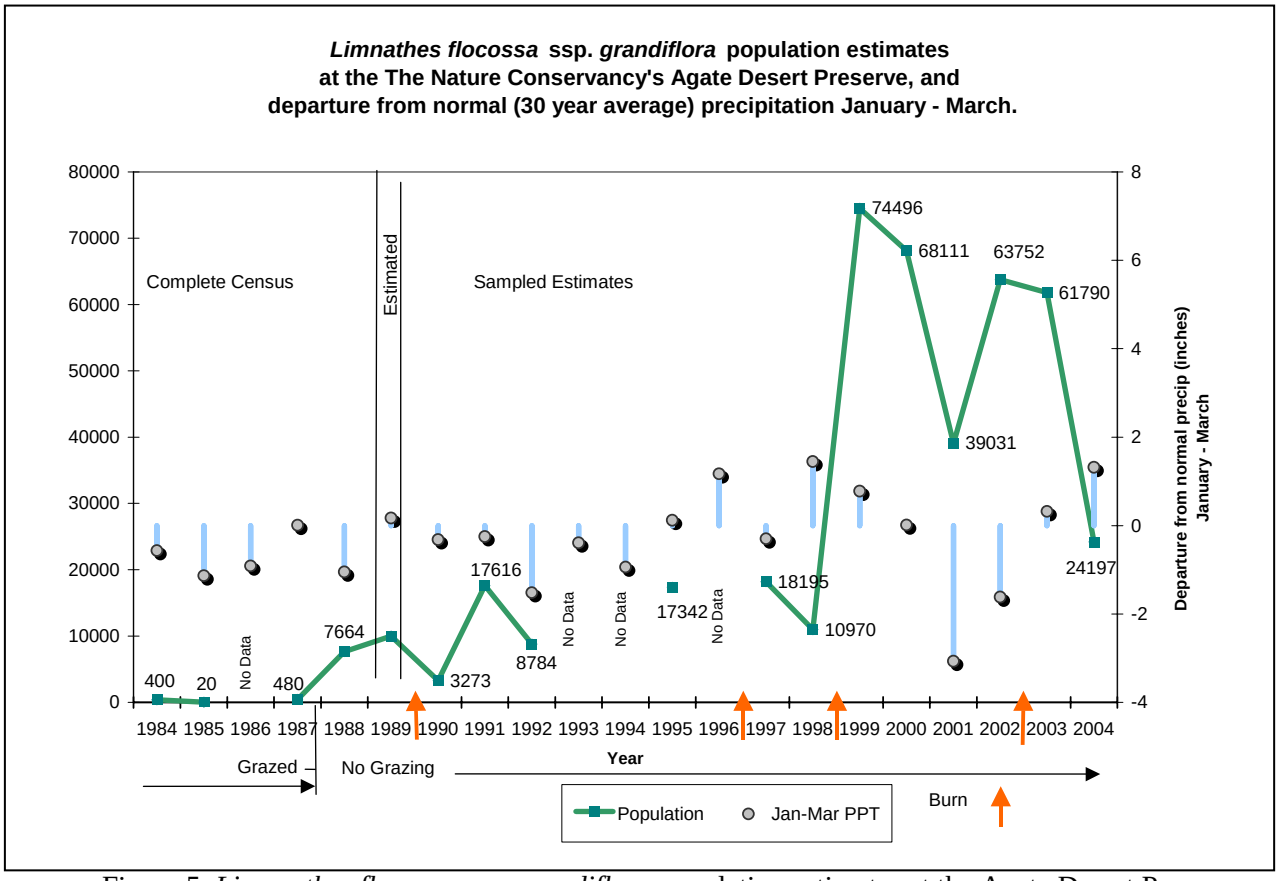

Figure 5. *Limnanthes floccosa* ssp. *grandiflora* population estimates at the Agate Desert Preserve and departure from normal cumulative precipitation over the months of January through March 1984 through 2004.

The counts taken for the species were very low between 1984 and 1987 while under cattle grazing. The fact that winters were dry over this period appears to have contributed to the low counts. After grazing was discontinued, the population began an increasing trend. With the population estimates in the thousands, quantitative estimates were abandoned after 1992, in favor

of qualitative checks on the abundance. An important part of this increase is due to expansion of the population to pools not previously occupied by the species. The number of permanent plots occupied by the species increased by nearly 50% in between 1990 and 1991, with colonization especially pronounced in the network of interconnected pools. The population was quantified again in 1995 to recalibrate during a "peak" year, and since 1997 the data has been collected annually. Note several short-term declines associated with relatively large fluctuation in precipitation. Consecutive years of similar precipitation, either relatively dry or wet, yield increases.

Whetstone Savanna Preserve: (management—rest 7 years)

Indicator Status: ***Good,*** Trend: increasing, variable. Last surveyed in 2003

A complete census in 1995 accounted for 2140 plants in the north 40 acres block while cattle were on-site. 128 of these plants were located in five reference pools randomly selected for future sampling. Since 1996, the counts for these pools have varied widely, predominantly in response to winter precipitation.

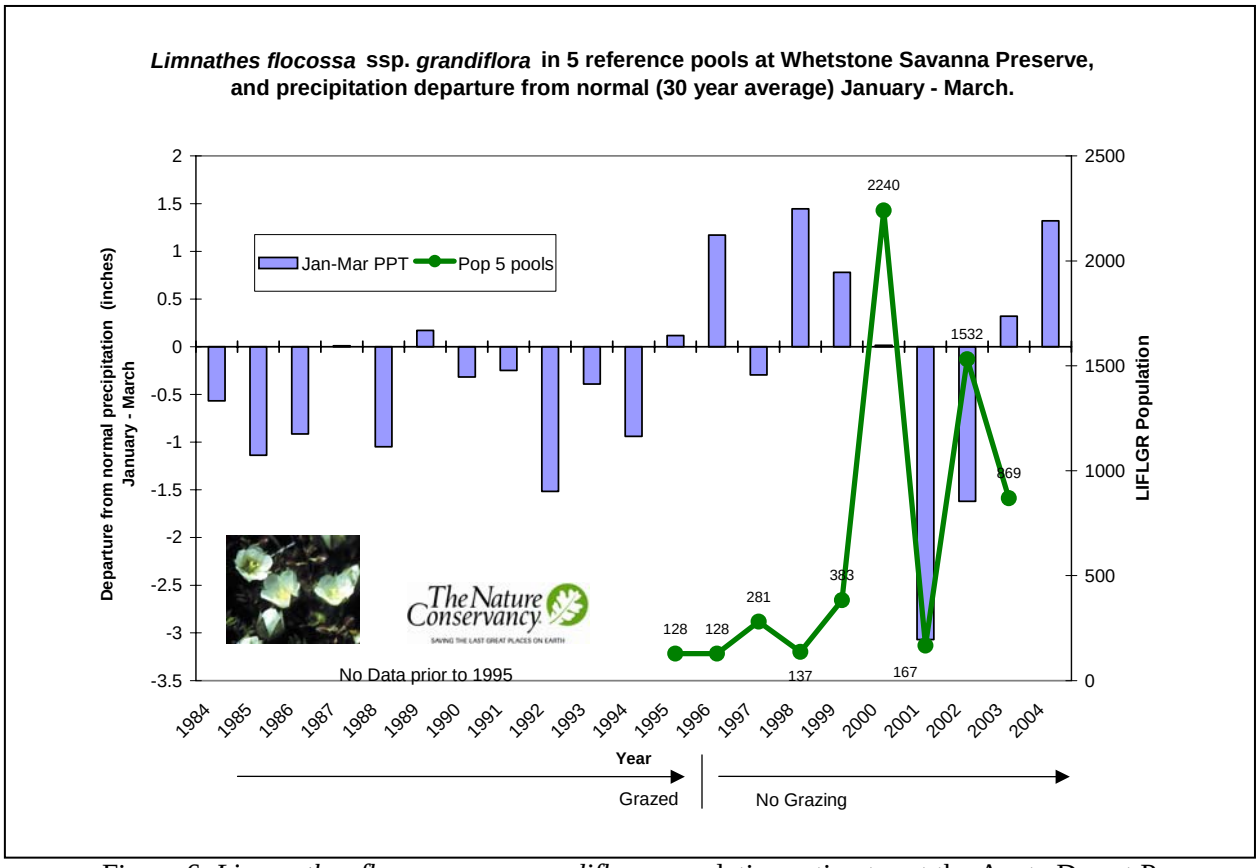

Figure 6. *Limnanthes flocossa* ssp. *grandiflora* population estimates at the Agate Desert Preserve from 1995 through 2003 and departure from normal cumulative precipitation over the months of January through March 1984 through 2004.

The population increased 5-fold in 2000 with average precipitation, and then dropped back within the previously observed range with extremely low winter precipitation in 2001. Increased winter rains prior to spring of 2002 yielded another order of magnitude increase, and total number of plants on site perhaps 20,000.

Rogue River Plains Preserve-- (winter/spring grazing)

Indicator Status: ***Good,*** Trend: short term increasing. Last surveyed in 2004.

The vernal pool complex monitored is a 120-acre portion of a 167-acre complex. The pool complex is extensive and well interconnected. In some areas the vernal pools could be described as vernally wet flats. The population was inventoried in 2000 by David Evans, with follow-up estimates by the Conservancy. We estimated that there were between 2000 and 3000 plants in the year 2000. A complete survey with a census in 2001 found an estimated 3,500 to 3900 plants. The boundaries of three large and abundant patches were established as demonstration plots and the number of plants was estimated at fewer than 1,500 plants. In 2002 we completed a detailed survey only around the three demonstration plots, where 12,000 plants were counted. The population was widespread and abundant across most available habitat where it had been mapped in the past. In 2003 12,790 plants were counted, and in 2004 3013 plants were found in the same established areas.

At the Rogue River Plains Preserve the vernal pool bottoms are churned extensively by cattle. Where this churning is associated with the large-flowered woolly meadowfoam, the species appears to be more widely spread across the pool bottoms, but at a lower density than observed at some sites. The plants were large and robust. The meadowfoam is also occurring with vegetation that the rare plant does not otherwise typically occur with. It may be that the hydrology of these pools would normally support the annual hairgrass type, where the meadowfoam typically can be found, but instead the surface is covered with a Navarretia community typically found in basins with deeper, longer duration pools. Grazing disturbance may be altering the composition of the community.

Rice Tract: (management—ongoing grazing)

Indicator Status: ***Fair,*** Trend: short-term increasing. Last surveyed in 2002.

The Oregon Natural Heritage Program found this occurrence of the large-flowered woolly meadowfoam in 1992 in a survey for ODOT. The patch is located on the eastern part of the pasture, which is fenced from the western side. The Nature Conservancy staff and Marilyn Rice conducted a complete census of plants in 2001 and 2002 with 172, and 1120 plants, respectively. The meadowfoam occurred on the pool margins, and some were scattered higher on mound flanks.

Whetstone Industrial Park—W. Antelope Road tract (late winter/spring grazing)

Indicator Status: ***Fair,*** Trend: short-term increasing. Last surveyed in 2003

This is a 192-acre pasture has roughly 100 acres of vernal pool complex with a small and patchy population of the meadowfoam. Between the years of 1984 and 1987, the meadowfoam population consisted of a portion of the total census numbers reported in the figure above for the Agate Desert Preserve. Qualitative assessments were not repeated until 1993 during prison siting review, when a handful could be found. A complete census and mapping has been completed since 2000. The number of mapped patches and plants: year 2000 (4 patches, 185 plants), year 2001 (3 patches, 44 plants), year 2002 (6 patches, 783 plants), year 2003 (11 patches, 478

plants). In contrast to the population on the Agate Desert Preserve, across the street, this population appears to be suppressed. The placement of fill in pools during construction of the road in 1988, in addition to voiding habitat, may have critically disconnected and isolated pools remaining, limiting dispersal and re-colonization in the more favorable years. Wetland mitigation work in the form of excavation and removal of the fill during the fall of 2003 on a portion will likely help this population. A complete census was not conducted in 2004, however within and around the areas where the fill had been removed a few plants were observed.

Whetstone Industrial Park—Newland Road tract (late fall/winter grazing)

Indicator Status: ***Fair,*** Trend: declining. Last surveyed in 2003.

This is a 150-acre pasture with roughly 97 acres of vernal pool complex and an extensive population of the meadowfoam. The meadowfoam population was discovered in surveys for the 500 kV power line in 1991. A 2000 survey completed as part of the Rogue Valley Council of Government vernal pool function and value assessment found an estimated number of plant much greater than 10,000. The following year, a complete census and mapping found only 112 plants, and many patches mapped the previous year had no apparent plants. By 2002 the occurrence recovered to an estimated 3,000 plants. The 2003 survey found only 1800. The source of the high variability of the population on this site is unknown..

ODOT Highway 140 (rest, and ATV use)

Indicator Status: ***Poor,*** Trend: increasing. Last surveyed in 2003.

Plants were first recorded in 2000 in vicinity of *Lomatium cooki* occurrence. An estimated 100+ plants of the meadowfoam were recorded. In 2002 the number counted in a complete census was 456 A new small patch was also found in 2002. A total of 180 plants were surveyed in 2003. In several instances patches of the plants were found on the edge of ATV tracks from recent years. The largest patches occurred where the vernal pools were well formed.

ODFW, South Denman tract (no grazing, habitat limited)

Indicator Status: ***Good,*** Trend: Stable. Last surveyed in 2002.

Large dense patches of the meadowfoam occur in the middle of this tract, west of the excavated ponds. The total population was estimated at >15,000 in 2000, and partial search of the historic area of the occurrence confirmed much greater than 3,000 plants were present in 2002. The occurrence is confined by severely altered habitat planted to “Largo” tall wheatgrass, and spread log-deck debris, which occupy many pool margins. In addition, *Vicia* and *Poa bulbosa* were overtopping the meadowfoam in some ephemeral pools.

ODFW, North Denman tract (no grazing, habitat limited)

Indicator Status: ***Good,*** Trend: Stable. Last observed in 2002.

Dense patches of the meadowfoam occur in this large tract. Nearly 17,000 plants were estimated in 7 separate map units in 2000. These units were checked again in 2002 and both reductions and increases were found in a partial survey. Over 14,000 plants were estimated to occur in 2002. The occurrence is confined in some places by altered habitat planted to "Largo" tall wheatgrass on spread log-deck debris. Pool margin habitat is reduced as a result.

Rogue Aggregates, Modoc Road (winter grazed in 2002)

Indicator Status: ***Good,*** Trend: Stable. Last surveyed in 2002

Meadowfoam was found here by the Native Plant Society surveys conducted in 1983. The plants are especially abundant on the NW corner of the tract where the vernal pools are well formed. In 2000 the number of plants was estimated at 3,000. A partial survey in 2002 found the plant well distributed and over 3600 were counted in the historically occupied area. Thatch accumulation was minimal on this site that had been grazed during the winter.

Avenue E, Rural Residential Leveled Pasture (varied, year round grazing most years of last 15)

Indicator Status: ***Poor,*** Trend: none

Several plants of the large flowered wooly meadowfoam were found, but insufficient to map or to be classified as an occurrence. The Oregon Natural Heritage Program did not record this species for the site in either 1987 or 1992.

Branchinecta lynchi

Agate Desert Preserve (Rx fire, varied rest)

Branchinecta lynchi Indicator Status: ***Very Good,*** Last surveyed in 2004

This site has just over 53 acres of vernal pool complex and roughly 100 pools. Over the seven-year history of sampling between 1998 and 2004, a total of 47 pool depressions have been found to contain BRLY. Students from Southern Oregon University (SOU) sampled four pools in the winter of 1997/1998 and BRLY occurrences were documented in two of them (Helm and Field 1998). TNC survey effort that winter detected the animals in an additional six pools. Doino sampled 40 pools on the preserve in the winter of 1998/99, detecting occurrences in 20 additional pools. In 1999-2000 Doino detected occurrences in four additional pools. The Nature Conservancy survey effort in 2000/01 mapped all pool depressions, of which half had standing water during the survey, and added two new pools found to be occupied by BRLY. The Conservancy's survey of 64 pools in 2002 detected occurrences in two additional pools, and documented shrimp in five depressions that had not pooled the previous year. Combined, these efforts account for BRLY occurring in 47% of known pools. Of the pools found occupied in 2003, eleven had not been previously documented. Of these eleven newly detected occupied pools, four had no record of a previous survey[4]. A January 2004 survey of 25 randomly selected pools detected shrimp in 13, or 52%. This represents a complex occupancy rate of 1.1 acres of complex per occupied pool.

Whetstone Savanna Preserve (8 years rest)

Branchinecta lynchi Indicator Status: ***Good,*** last surveyed in 2003

A single-season comprehensive pool survey for BRLY has not been completed for the preserve with 156 identified pools. A total of 67 pools on the preserve have been found occupied by BRLY in one or more years since 1998. Some of these pools and an additional set are also occupied by a second species, the Oregon fairy shrimp, *Eubranchipus oregonus.* Helm and Field (1998) documented two BRLY occupied pools in 1997/1998, and TNC fieldwork accounted for nine more that winter. Doino sampled 70 pools on the preserve in the winter of 1998/99, detecting occurrences in 29 additional pools. Doino's work in 99/00 detected an occurrence in one additional pool. The Nature Conservancy mapped all pools in 2000/01, but only three had standing water during the survey, and no additional occupied pools were detected. The Conservancy's survey of 112 pools in 2002 detected BRLY occurrences in 14 additional pools, half of which had been surveyed previously. The 2003 survey visited 70 pools that had been surveyed in fewer than three years, including two that had not previously been surveyed, and yielded 17 pools new to the list of those with documented occurrences of BRLY. All of the 17 newly detected occupied pools had been surveyed in 2002 with no animals detected, and each was found dry in the winter season of 2001, but had no other previous survey recorded. The combined survey effort over six years detected BRLY in 43% of all pools. The presence of these occupied pools across the 80 acres of complex on the preserve represents a complex occupancy

[4] Pools with no record of previous may actually have been surveyed in earlier efforts when results where recorded only for pools in which BRLY were found.

rate of 1.2 acres per occupied pool. Nine mapped pools remain there that have been surveyed only once in addition to being noted as dry in 2001.

Rogue River Plains Preserve, (ongoing grazing)

Branchinecta lynchi Indicator Status: ***Good (to Fair),*** last surveyed in 2003

The pools complex occupies roughly 120 acres and contains 139 identified pools. The Nature Conservancy conducted comprehensive surveys for BRLY in all pool depressions with standing water in both 2002 and 2003. Not all pools were filled during the survey in either year. The February 2002 survey detected BRLY in 54 of 133 identified pools or 41%. The February 2003 comprehensive survey of all 123 depressions holding water detected BRLY in 31 (25%). Of the pools found occupied in 2003, two had not been previously documented. Combined with TNC surveys in 2002, swimming BRLY have been detected in 56 pools, or 42% of all pools. The occupied pools are spread across the 120 acres of complex represents a complex occupancy rate of 2.1 acres of complex per occupied pool.

Whetstone Industrial Park—W. Antelope Rd. tract (late fall/winter grazing, biosolids)

Branchinecta lynchi Indicator Status: ***Fair***, last surveyed in 2003

The 100-acre vernal pool complex located on the central portion of the City of Medford tract has an estimated 200 pools. The Oregon Natural Heritage Program conducted a comprehensive survey in 1999, when vernal pool fairy shrimp were found in 20 pools, including four on the west side near the historic dump. Returning in March 2003 to the known occupied pools first detected in 1999 (Borgias et al 1999), we found only 5 of the 20 occupied and another 3 were dry. The Nature Conservancy also dipped into 47 randomly selected pools with at least 8 cm standing water, and 4 pools occupied by BRLY were newly detected. To date a total of 24 pools have been found occupied on the complex, representing an occupancy rate of 12% of the pools, and results in a complex occupancy rate of 4.17 acres of complex per occupied pool.

Whetstone Industrial Park—Newland Road tract (late fall/winter grazing)

Branchinecta lynchi Indicator Status: ***Good*** Last surveyed in 2003

This 150-acre pasture has roughly 70 acres of vernal pool complex with a well distributed array of pools estimated at roughly 116 in number. The 2003 survey of 27 randomly selected pools (with at least 8 cm standing water) detected three BRLY occupied pools. To date a total of 25 pools have been found occupied on the tract. These 25 occupied pools among the estimated total of 116 pools on the site represent an occupancy rate of 22%. The occupied pools spread across the 80 acres of complex represent a complex occupancy rate of 3.2 acres of complex per occupied pool. Some pools were also found to support the Oregon fairy shrimp.

ODFW, South Denman-- (no grazing, Log deck debris, plantings of wheatgrass)

Branchinecta lynchi Indicator Status: ***Poor,*** last surveyed 2004

The 100-ac complex with an estimated 104 pools occupying portions of the 280-acre tract was first sampled in 1998, with limited sample and no occupied pools detected. An intensive survey was completed over six days in January 1999 by the ORNHP, when three pools were found occupied by BRLY. The resulting occupancy rate was roughly 3% of pools. In 2003 and 2004, The Nature Conservancy and the Oregon Department of Fish and Wildlife completed surveys in an 80-ac portion of the complex dipping into 31 randomly selected pools with greater than 8 cm ponded water. Shrimp were detected in 1 of 31 pools in 2003, and 3 of 31 pools 2004. The occupied pools result in a pool occupancy rate of 10%. Altogether, eight pools have been found occupied since 1998 among the estimated 104 pools on site for an occupancy rate of 8%. The known occupied pools represent a complex occupancy rate of 12.5 acres of complex per occupied pool. Pools with the Oregon fairy shrimp were also found. Water quality appeared to be altered by log deck debris spread in and around the pools and the area planted to intermediate wheatgrass cultivar. The occupied pools were found in areas lacking the wood waste and not planted to the wheatgrass.

ODFW, North Denman-- (no grazing, Log deck debris, plantings of wheatgrass)

Branchinecta lynchi Indicator Status: ***Poor*** Last surveyed in 2003

The large tracts referred to as the Military Slough and Creek Units of the Wildlife Management Area contain approximately 200 and 130 acresof vernal pool complex, respectively. The habitat was surveyed extensively by the Oregon Natural Heritage Program in 1999, with two occupied pools found on the Military Slough unit and three occupied pools on the Creek unit. These occurred in areas surrounded by typical annual grassland, rather than the plantings of wheatgrass cultivar. In 2003 on the Military Slough unit a random selection unit of 26 pools deeper than 8 cm across 70 acres (among roughly 70 pools) detected shrimp in 2 pools (8%). A random selection of 14 pools on 60 acres of the Creek (among roughly 100 pools) detected no occupied pools. The combined 6 total known occupied pools across the estimated 170 pools on 130 acres result in a pool occupancy rate of 4%, and a complex occupancy rate of 22 acres per occupied pool.

Appendix 6 -- Status of Terrestrial Ecosystem Indicators on the Agate Desert

Descriptions of the data used in the assessment ranks are provided below. The summarized data on cover and other measurements for each site is provided in a series of tables in Appendix 7

Excessive Accumulation of Thatch

Agate Desert Preserve (management: initial 10-year rest, followed by periodic Rx fire and rest for 8 years)

Thatch Indicator status: ***Fair to Very Good, (Good)*** Trend: varied, long-term stable, last surveyed in 2004

In the absence of grazing since 1987, thatch levels have varied depending on the interval between fires. The Conservancy implemented periodic prescribed burns to reduce thatch over a portion of the preserve in 1996, and over the entire preserve in 1998, and 2002.

In 2001 an average thatch height of 11 cm and a cover 48% of the ground surface was measured in a representative releve of upland prairie on the preserve in a portion not burned or grazed for eleven years. In June of 2002, in an area burned four years earlier, the average thatch height was 5.5 cm across the preserve and the cover of thatch was 42%. These thatch levels coincided with low abundance of seedlings for Lomatium cookii, and were the justification for a prescribed fire that year. In 2003, one year after a burn, thatch was absent. By the late spring of 2004, the frequency of thatch occurrence was at 25% with an average height of 5.7 cm where it occurred. Burning is an effective short-term means for abating the excessive thatch accumulation and exposing the soil for increased abundance of the seedlings of *Lomatium cooki*.

Whetstone Savanna Preserve: (management—rest 8 years, targeted mowing)

Thatch Indicator status: ***Fair,*** Trend: stable, last surveyed in 2003.

In the absence of grazing since 1996, thatch levels initially increased rapidly, but then apparently stabilized. In June of 2002, average thatch height in the annual grassland portions encountered at 66 intercept points was 3.8 cm across the preserve, and the cover of thatch was 45%. In 2003 the average height and cover were statistically unchanged with an average height of 3.4 cm and a cover of 39%. Thatch cover and height estimates for the preserve would be lower if conditions in an around the *Ceanothus* shrubs and oak woodland that occur over part of the site were included in the estimate. The Nature Conservancy has been mowing patches of prairie where the *Lomatium cooki* occurs to reduce thatch accumulation. There is also incidental foot traffic by birders, and staff and volunteers that monitor the site and control weeds that serves to reduce thatch accumulation there.

Rogue River Plains Preserve, (ongoing winter-spring grazing)

Thatch Indicator status: ***Good to Very Good,*** last surveyed in 2003, observed in 2004

In June of 2002, average thatch height was 1.4 cm where it occurred and a provided a cover of 14% across the preserve. In 2003 the average height of thatch where it occurred was unchanged and the cover dropped to 3%.

Antelope Creek (Bureau of Reclamation) (ongoing rest)

Thatch Indicator status: ***Poor***, last surveyed in 2001.

In 2001 an average thatch height of 11 cm and a cover 34% of the ground surface was measured in a representative releve of upland prairie on the tract in a portion not burned or grazed in recent years.

Rice Tract: (management—ongoing winter/spring grazing)

Thatch Indicator status: ***Very Good,*** Trend: stable, last surveyed in 2001.

In 2001 an average thatch height of <1 cm and a cover 3% of the ground surface was measured in a representative releve of upland prairie on the tract. These measurements are presumed to represent the conditions of the ongoing winter and spring grazing on the tract

Whetstone Industrial Park—W. Antelope Rd. tract (ongoing late winter/spring grazing)

Thatch Indicator status: ***Good to Very Good,*** Trend: Stable, last surveyed in 2002.

In 2001 an average thatch height of 4 cm and a cover 9% of the ground surface was measured in a representative releve of upland prairie on the tract. In June of 2002, average thatch height was 1.4 cm where it occurred across the tract, and the cover of thatch was 14%. This thatch level is presumably representative of the conditions under the ongoing winter and spring grazing management.

Jackson County, Hoover Ponds (no grazing, some off-highway-vehicle use)

Thatch Indicator status: ***Poor,*** Trend: short- term Stable, last surveyed in 2001

In 2001 an average thatch height of 10 cm and a cover 37% of the ground surface was measured in a representative releve of upland prairie on the tract. This thatch level is estimated to be representative of the conditions under the rest from grazing management and incidental off-highway vehicle use.

ODFW, South Denman tract and North Denman tract (no grazing)

Thatch Indicator status: ***Poor to Fair,*** Last surveyed in 2001

In 2001 an average thatch height of 10 cm and a cover of 40% of the ground surface was measured in a representative releve of upland prairie in an area on the southern Denman tract

with annual grassland. Conditions were varied across the large site. In similar areas on the north Denman tract, an average thatch height of 8 cm and a cover 22% of the ground surface was measured in a representative releve. In areas planted to intermediate wheatgrass, an average thatch height of 18 cm and a cover 18% of the ground surface was measured in a representative releve.

ODOT, Highway 140 right of way (no grazing, incidental OHV use)

Thatch Indicator status: (estimated ***Poor***) Last observed in 2003

The weakly expressed vernal pool complex has received little management attention in recent years. Incidental bicycle and motorized OHV tracking serves to reduce the thatch accumulation in some areas at times, but otherwise thatch is a dominant feature on the site both on uplands and encroaching on vernal pools.

Avenue E, Rural Residential Leveled Pasture (varied, year round grazing most years of last 15)

Thatch Indicator status: ***Good to Very Good,*** Last observed in 2001

Thatch levels were very low and *Lomatium cookii* seedling abundance was high on this grazed tract. The current grazing at the time of the observation was just two calves, but stocking levels were higher in previous years.

Gopher Use

Agate Desert Preserve (management: initial 10-year rest, followed by periodic Rx fire and rest for 8 years)

Gopher Use Indicator status: ***Very Good,*** Trend: varied, long-term decline, last surveyed in 2004

In 2001 fresh gopher mounds in five representative releves had an average cover of 5.4% (range 0-16%). In the June 2002 point intercept method that used 150 points across the entire preserve, the cover of fresh gopher mounds was 10%. In 2003, one year after a burn, gopher use as indicated by the cover of fresh mounds was 8%, but statistically unchanged. In 2004, the cover of gopher mounds declined to 4.6%.

Whetstone Savanna Preserve: (management—rest 8 years, targeted mowing)

Gopher Use Indicator status: ***Very Good to Good,*** Trend: varied, last surveyed in 2003

In 2001 fresh gopher mounds in one representative releve had a cover of 8%. In June of 2002 gopher use as indicated by the cover of fresh mounds was 12%. In 2003, the cover of fresh gopher mounds declined to 1%, but gopher use was detectable widely distributed on and around most mounds and intermounds. The data reveal that mounds were only intercepted in and around the vernal pools. Closer inspection in 2004 revealed that abundant gopher use occurs on the site, and that the point intercept field protocol has not allowed detection of fresh gopher mounds when they occur under thatch.

Rogue River Plains Preserve, (ongoing winter-spring grazing)

Gopher Use Indicator status: ***Poor,*** last surveyed in 2004

In 2001 fresh gopher mounds in two representative releves had a cover of 5% (0 and 10%). In the June 2002 point intercept data that used 100 points across the entire preserve, gopher use was low as indicated by the 1% cover of fresh mounds. In 2003 and in 2004, fresh gopher mounds were not detected in the samples, and evidence of gopher use was patchy in distribution.

Rice Tract: (management—ongoing winter/spring grazing)

Gopher Use Indicator status: ***Good,*** last surveyed in 2001.

In 2001 fresh gopher mounds in a single representative releve had a cover of 5%.

Whetstone Industrial Park—W. Antelope Rd. tract (ongoing late winter/spring grazing)

Gopher Use Indicator status: ***Poor***, last surveyed in 2002

In 2001 fresh gopher mounds in two representative releves had a cover of 0%. In the June 2002 point intercept method that used 100 points across the entire tract, gopher use as indicated by the cover of fresh mounds was 1%.

Jackson County, Hoover Ponds (no grazing, some off-highway-vehicle use)

Gopher Use Indicator status: ***Poor,*** Trend: short- term Stable, last surveyed in 2001

In 2001 fresh gopher mounds in one representative releve had a cover of 1%.

ODFW, South and North Denman tracts (no grazing)

Gopher Use Indicator status: ***Poor to Fair,*** Last surveyed in 2001

In 2001 the three representative releves each had fresh gopher mounds evidence with cover of a 1% and 3%. Conditions were varied across the large site.

Indicator 6: Vegetation Structure

Agate Desert Preserve (management: initial 10-year rest, followed by periodic Rx fire and rest for 8 years)

Vegetation Structure Indicator status: ***Fair to Good,*** Trend: varied, long-term stable, last surveyed in 2004

The height of live vegetation and the cover of elevated litter and thatch used by grassland birds for nesting, perching, and hiding structure has varied depending on the interval since fire. Structure is temporarily reduced until fall rains reinitiate growth of the grassland plants. The Conservancy began to restore native perennial bunchgrasses and summer-flowering native forbs that contribute additional nesting, perching and hiding structure.

In 2001 an average vegetation height determined on five representative releves was 25 cm. In June of 2002, live vegetation within 10 cm the 150 intercept points had an average maximum height of 25.5 cm. Elevated litter provided 11% cover, and thatch covered 42% of the ground. In 2003, one year after a prescribed fire, the average maximum vegetation height was statistically unchanged at 25.2 cm, but elevated litter was reduced to 4% cover and thatch was absent.

Whetstone Savanna Preserve: (management—rest 8 years, targeted mowing)

Vegetation Structure Indicator status: ***Good,*** Trend: stable, last surveyed in 2004.

In the absence of grazing since 1996, the height of live vegetation and the cover of elevated litter and thatch used by grassland birds for nesting, perching, and hiding structure has increased and

then stabilized. In 2001 an average vegetation height determined on a representative annual grassland releve was 18 cm. In June of 2002, live vegetation within 10 cm of the 66 intercept points had an average maximum height of 25.5 cm. Elevated litter provided 23% cover, and thatch covered 45% of the ground. In 2003 the average maximum vegetation height was 36.2 cm, elevated litter was 22% cover and thatch 39% of the ground at 69 intercept points.

Rogue River Plains Preserve, (ongoing winter-spring grazing)

Vegetation Structure Indicator status: ***Fair,*** last surveyed in 2003

In 2001 an average vegetation height determined on two representative grassland releve was 14 cm. In June of 2002, live vegetation within 10 cm of the 100 intercept points had an average maximum height of 24.4 cm. Elevated litter provided 7% cover, and thatch covered 14% of the ground. In 2003 the average maximum vegetation height was 16.1 cm, elevated litter had 1% cover and thatch 3% of the ground.

Antelope Creek (Bureau of Reclamation) (ongoing rest)

Vegetation Structure Indicator status: ***Good***, last surveyed in 2001.

In 2001 an average vegetation height of 28 cm and thatch cover of 34% was measured in a representative releve of upland prairie on the tract.

Rice Tract: (management—ongoing winter/spring grazing)

Vegetation Structure Indicator status: ***Fair,*** Trend: stable, last surveyed in 2001.

In 2001 an average vegetation height of 17 cm and thatch cover of 3% was measured in a representative releve of upland prairie on the tract. These conditions are estimated to be representative of the current and ongoing conditions under the typical winter - spring grazing regime on the site.

Whetstone Industrial Park—W. Antelope Rd. tract (ongoing late winter/spring grazing)

Vegetation Structure Indicator status: ***Fair,*** Trend: Stable, last surveyed in 2002.

The height of live vegetation and the cover of elevated litter and thatch used by grassland birds for nesting, perching, and hiding structure has varied with the annual productivity changes along with variation in the duration and intensity of grazing. In 2001 an average vegetation height determined on two representative grassland releves was 20 cm. In June of 2002, live vegetation within 10 cm of the 100 intercept points had an average maximum height of 17.8 cm. Elevated litter provided 5% cover, and thatch covered 14% of the ground.

Jackson County, Hoover Ponds (no grazing, some off-highway-vehicle use)

Vegetation Structure Indicator status: ***Good,*** Trend: stable, last surveyed in 2001.

In 2001 an average vegetation height of 30 cm and thatch cover of 37% was measured in a representative releve of upland prairie on the tract. These conditions are estimated to be representative of the ongoing rest with incidental off-highway vehicle use.

ODFW, South Denman tract and North Denman tract (no grazing)

Vegetation Structure Indicator status: ***Good to Very Good,*** Trend: stable, last surveyed in 2001.

In 2001 an average vegetation height of 24.5 cm and thatch cover of 40% was measured in two representative releves of annual grassland prairie on the tract. Conditions were varied across the large site. In a releve representative of areas planted to intermediate wheatgrass, vegetation height was 55 cm, and the thatch covered 18% of the ground surface. This structure is notably different than many other sites across the Agate Desert, and although we did not measure elevated litter in 2001, it is abundant on the site where the wheatgrass is present.

ODOT, Highway 140 right of way (no grazing, incidental OHV use)

Vegetation Structure Indicator status: (estimated ***Good***) Last observed in 2003

The absence of fire, grazing, and mowing on this site has helped retain structure.

Avenue E, Rural Residential Leveled Pasture (varied, year round grazing most years of last 15)

Vegetation Structure Indicator status: ***(****estimated* ***Fair),*** Last observed in 2001.

Indicator 7: Status of Functional Groups of Plants, Including Invasives.

The results of a point-intercept method that determines cover by species and other physical attributes is the primary source of data for this indicator. The summary table for each site and year follow in Appendix 6 – Table 1. The species covers were assembled by functional guilds and then these were compared to cover given in the Ecological Reference Site Description (Appendix 3-Table B), modified to allow for some nonnative species presence expected in a restored community and ranked using criteria provided in Appendix 4.

Agate Desert Preserve (management: initial 10-year rest, followed by periodic Rx fire and rest for 8 years)

Functional Groups Indicator status: ***Fair,*** Trend: improving, last surveyed in 2004

The mix of native and non-native species on the site contribute to a similarity index of 47% to 48% of ERSD. While perennial native grasses are entirely absent on most sites, the Conservancy began to restore them on the preserve in 1991, first by transplanting and later by seeding them in after prescribed fires. Currently, the functional group provides roughly 7% cover across the preserve, and the while there are some patches where the grasses dominate (38% cover in 2001), establishment is sparse elsewhere. The lack of cover for the group in 2003 data is an artifact of having been burned the previous year. Many of the bunchgrasses recovered by 2004 and more were observed established. The table demonstrates the shifts from annual introduced grass dominance prior to burning in 2002, to native annual and biennial forbs in the post fire conditions in 2003. The Conservancy has also been diligent in removing invasive species such as wild oats, starthistle and curly dock that would otherwise reduce the similarity index from the ERSD.

Whetstone Savanna Preserve: (management—rest 8 years, targeted mowing)

Functional Groups Indicator status: ***Fair,*** Trend: stable, last surveyed in 2004.

With measured similarity index scores of 54% and 49%, this site has the best overall composition. This result is due in part to the presence of oak savanna and buckbrush chaparral habitats overlaid across the vernal pool landscape which increase the species diversity, particularly in the native forb groups that contributes to the slightly higher similarity index for this site. Native perennial bunchgrasses are sparsely distributed and introduced non-native annual grasses dominate. The Conservancy has been diligent in removing invasive species such as wild oats, starthistle and curly dock that would otherwise reduce the similarity index from the ERSD.

Rogue River Plains Preserve, (ongoing winter-spring grazing)

Functional Groups Indicator status: ***Fair,*** last surveyed in 2003

With measured similarity index scores of 45% and 44% in the two years reported, this site falls in the Fair range for overall species composition. The proximity of oak savanna and buckbrush chaparral habitats on the periphery may increase the species diversity, for this site. Native perennial bunchgrasses are absent and while introduced non-native grasses dominate, grazing

serves to reduce annual grasses in favor of the non-native perennial grass *Poa bulbosa* and a mix of forbs. The perennial native forbs, especially the bulb producing *Tritellia* and *Brodiaea*, are scarce on the site. The Conservancy has begun controlling the invasive species starthistle and curly dock that would otherwise further reduce the similarity index from the ERSD.

Whetstone Industrial Park—W. Antelope Rd. tract (ongoing late winter/spring grazing)

Functional Groups Indicator status: ***Poor,*** Trend: Stable, last surveyed in 2002.

This site was only visited for the point-intercept cover monitoring in 2002. The similarity index of 31% is the lowest of the sites for which the data are available. The site falls short for overall species composition. Native perennial bunchgrasses are absent. Non-native grasses dominate. Under the ongoing grazing management the annual grass Mediterranean barley (*Hordeum murinum*) is favored on the flanks of mounds and pool edges, while the non-native perennial bulbous blue-grass *Poa bulbosa* dominates the mounds. The perennial native forbs, especially the bulb producing *Tritellia hyacinithia* and *Brodiaea* spp are scarce on the site. The non-native annual forb species *Trifolium dubium* and others are common at the expense of the native annual forbs.

The similarity index score has not been generated for the remaining sites, however, based on the 2001 releve data and comparison to the point intercept data on similar sites a ranking can be estimated. The sites were visited relatively late in a dry year, and so little can be said about spring flowering species.

Antelope Creek (Bureau of Reclamation) (ongoing rest)

Functional Groups Indicator status: (*estimated* ***Poor to Fair***) last surveyed in 2001.

The abundance of medusahead and thatch, and the presence of the summer flowering non-native forbs suggest a relatively low similarity.

Rice Tract: (management—ongoing winter/spring grazing)

Functional Groups Indicator status: ***(****estimated* ***Fair),*** Trend: stable, last surveyed in 2001.

The presence of a variety of native forbs, including some perennials, with the addition of the two target plant species is a clear indication of *Fair* condition.

Jackson County, Hoover Ponds (no grazing, some off-highway-vehicle use)

Functional Groups Indicator status: (*estimated* low ***Fair***) last surveyed in 2001.

The abundance of medusahead and thatch, and the presence of the summer flowering non-native forbs suggest a relatively low similarity index, however a range of native forbs were also encountered in the releve.

ODFW, South Denman tract and North Denman tract (no grazing)

Functional Groups Indicator status: (*estimated* low ***Fair***) last surveyed in 2001.

Conditions vary widely on these tracts. Where annual grassland occurs, the abundance of medusahead and thatch, and the presence of the summer flowering non-native forbs suggest a relatively low similarity index, and the two releves lacked a diversity of native forbs.

In a releve representative of areas planted to intermediate wheatgrass, the cover of the non-native perennial (60%) and its thatch and litter (18% and 20%) preclude many species of occurring there

ODOT, Highway 140 right of way (no grazing, incidental OHV use)

Functional Groups Indicator status: (*estimated* low ***Fair***) last surveyed in 2003.

The abundance of medusahead and thatch, and the presence of the non-native forbs (such as annual cow vetch (*Vicia villosa*) suggest a relatively low similarity index, however a range of native forbs were encountered particularly around vernal pools, including the two ESA species.

Avenue E, Rural Residential Leveled Pasture (varied, year round grazing most years of last 15)

Functional Groups Indicator status: ***(estimated Fair),*** Last observed in 2001.

Appendix 7 -- Summarized data on cover for species and physical attributes for sites assessed using the point intercept method.

Following is a series of tables summarizing the composition of the mounded prairies at the Agate Desert Preserve, Whetstone Savanna Preserve, Rogue Plains Preserve, and the Whetstone Industrial Park. Data was taken in both 2002 and 2003 for all sites except the industrial park, for which only 2002 data is available.

The tables are split to show cover across the site including uplands and wetlands together, then the mound data alone, and finally the vernal pools and surrounding pool margins.

Cover data are listed by species and summarized for each functional groups. The native species groups are listed first, followed by the nonnative groups. Measures of cover for other surface attributes follow, and finally height measurements are provided

List of Tables

Appendix 7, Table 7. Summary of point intercept cover and associated data for **Whetstone Industrial Park**, 2002, by and over major habitat types (mound vs. flank & vernal pool).

	Total Site (n = 100)			Mounds (n = 64)			Flank & Pool (n = 36)		
		90% CI			90% CI			90% CI	
Category/Species	% Cover	Lower	Upper	% Cover	Lower	Upper	% Cover	Lower	Upper
Total Native Cover	26	18.9	34.2	16	8.7	25.1	44	30.2	59.4
Total Non-native Cover	72	63.7	79.3	83	73.2	90.1	53	38.0	67.2
Total Cover for Unknown Origin	3	0.8	7.6	5	1.3	11.7	0	0.0	8.0
Native Annual Grasses									
Deschampsia danthonioides	3	0.8	7.6	2	0.1	7.2	6	1.0	16.5
Native Annual Rushes									
Juncus bufonius	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Native Perennial Forbs	4	1.4	8.9	3	0.6	9.5	6	1.0	16.5
Brodiaea sp.	2	0.4	6.2	3	0.6	9.5	0	0.0	8.0
Eryngium petiolatum	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Lomatium nudicaule	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Native Annual/Biennial Forbs	21	14.5	28.8	9	4.2	17.7	42	27.7	56.7
Cardamine oligosperma	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Epilobium densiflorum	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Hemizonia fitchii	2	0.4	6.2	2	0.1	7.2	3	0.1	12.5
Lasthenia glaberrima	3	0.8	7.6	0	0.0	4.6	8	2.3	20.2
Myosurus minimus	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Plagiobothrys sp.	5	2.0	10.2	0	0.0	4.6	14	5.6	27.0
Plagiobothrys nothofulvus	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Plagiobothrys stipitatus	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Plagiobothrys tenellus	5	2.0	10.2	6	2.2	13.7	3	0.1	12.5
Triteleia hyacinthina (Biennial)	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Non-native Perennial Grasses									
Poa bulbosa	27	19.8	35.3	33	23.2	43.7	17	7.5	30.3
Non-native Annual Grasses	38	29.9	46.7	41	30.3	51.7	33	20.5	48.3
Bromus hordeaceus	13	7.9	19.9	16	8.7	25.1	8	2.3	20.2
Hordeum marinum	11	6.3	17.6	6	2.2	13.7	19	9.5	33.4
Lolium multiflorum	2	0.4	6.2	3	0.6	9.5	0	0.0	8.0
Taeniatherum caput-medusae	7	3.3	12.7	9	4.2	17.7	3	0.1	12.5
Vulpia spp.	4	1.4	8.9	3	0.6	9.5	6	1.0	16.5
Vulpia myuros	3	0.8	7.6	3	0.6	9.5	3	0.1	12.5
Non-native Perennial Forbs	2	0.4	6.2	3	0.6	9.5	0	0.0	8.0
Convolvulus arvensis	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Taraxacum officinale	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Non-native Annual Forbs	30	22.5	38.4	41	30.3	51.7	11	3.9	23.6
Brassica sp.	1	0.1	4.7	0	0.0	4.6	3	0.1	12.5
Cerastium glomeratum	11	6.3	17.6	13	6.4	21.4	8	2.3	20.2
Erodium cicutarium	8	4.0	14.0	13	6.4	21.4	0	0.0	8.0
Lactuca saligna	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Lactuca serriola	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Trifolium dubium	13	7.9	19.9	20	12.5	30.3	0	0.0	8.0
Other Forbs	3	0.8	7.6	5	1.3	11.7	0	0.0	8.0
Polygonum sp.	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Trifolium sp.	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Veronica sp.	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Surface condition									
Algae	2	0.4	6.2	0	0.0	4.6	6	1.0	16.5
Bryophyte	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Litter	50	41.4	58.6	58	46.8	68.3	36	22.9	51.2
Plant	24	17.1	32.1	25	16.4	35.5	22	11.6	36.5
Rock > 7 cm	3	0.8	7.6	3	0.6	9.5	3	0.1	12.5
Bare Soil	20	13.7	27.7	13	6.4	21.4	33	20.5	48.3
Abiotic									
Gopher Mound	1	0.1	4.7	2	0.1	7.2	0	0.0	8.0
Cattle hoof print	9	4.8	15.2	0	0.0	4.6	25	13.7	39.6
Elevated Litter	5	2.0	10.2	6	2.2	13.7	3	0.1	12.5
Thatch	14	8.7	21.0	13	6.4	21.4	17	7.5	30.3
Height (cm)									
Thatch	1.4	1.00	1.74	1.2	0.81	1.62	1.6	0.84	2.36
No. points	38			23			15		
Vegetation	17.8	16.93	18.71	19.0	17.95	19.98	15.8	14.20	17.36
No. points	100			64			36		

Appendix 8. Photo images of vernal pool mounded prairie in a variety of conditions.

Figure 1. Agate Desert Preserve. Rest from grazing over 17 years, periodic prescribed fire, and restoration of native perennial bunchgrasses on the mounds. Early April photo captures spring annual forbs, particularly the California gold fields in the foreground, and foothill desert parsley and popcorn flower in the background.

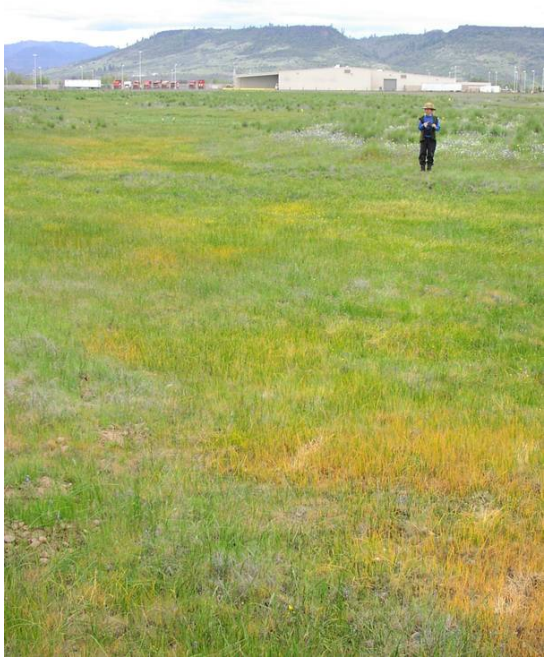

Figure 2. Agate Desert Presereve. Rest from grazing and periodic burning appear to support a lush growth of native bulb- rooted *Triteliaea hyacinthina* in pools, typically missing or suppressed on regularly grazed sites.

Appendix 8. Photo images of vernal pool mounded prairie in a variety of conditions.

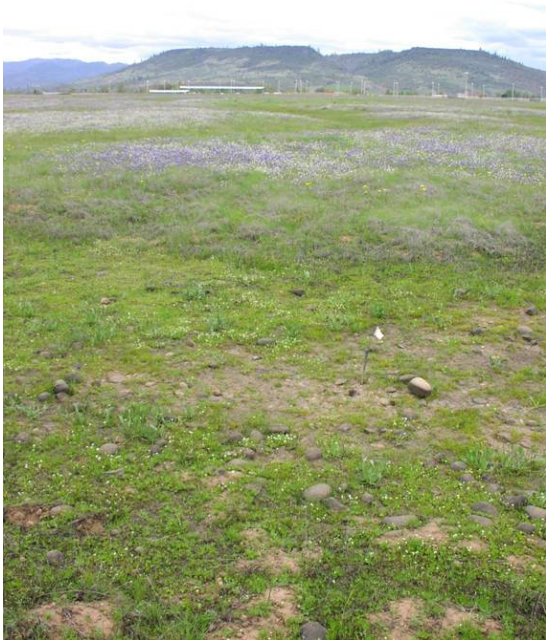

Figure 3. Agate Desert Preserve. Bare ground abundance in vernal pools depends in part on the activity of gophers. Note abundance of coyote thistle, popcorn flower in the pool depression and also the annual forbs on the mounds that had been burned in the previous year.

Figure 4. This tract off West Antelope Road is ungrazed, and has had soil spread in the vernal pool depressions. Thatch is prevalent, and the tall stems of the nonnative curly dock are visible in the filled pool.

Appendix 8. Photo images of vernal pool mounded prairie in a variety of conditions.

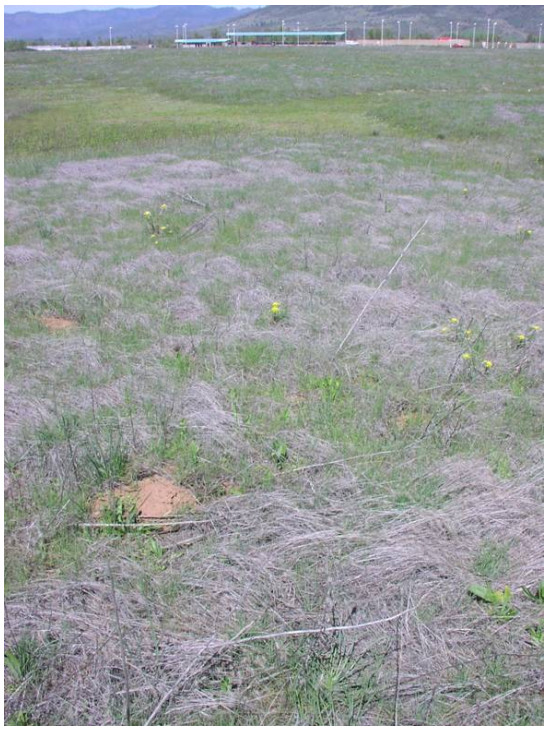

Figure 5. City of Medford Industrial Park off Table Rock Road, ungrazed 20 acre tract. Note thatch layer composed of accumulated medusahead grass stems on the mounds, and lack of thatch in the vernal pool depression. This photo was taken moments after the photos shown for the Agate Desert Preserve. Annual forbs are uncommon, but the foothill desert parsley persists.

Figure 6. Denman Wildlife Area. The plantings of wheatgrass cultivars provides abundant cover for wildlife, but at the expense of native species of grasses and forbs. Thatch development is also a factor on this ungrazed site. Vernal pools still support the Agate Desert Meadowfoam in abundance, but the vernal pool fairy shrimp is seldom found in pools surrounded by such plantings.

Appendix 8. Photo images of vernal pool mounded prairie in a variety of conditions.

Figure 7. Whetstone Industrial Park, Antelope Road tract, grazed winter and spring. Note lack of thatch and texture of soil surface due to cattle hoof punching, and apparent reduction in annual flowering forbs, but abundance of foothill desert parsley.

Figure 8. Whetstone Industrial Park with ongoing winter and spring grazing. Forbs are abundant in this slightly later spring photo.

Appendix 8. Photo images of vernal pool mounded prairie in a variety of conditions.

Figure 9. A spring grazed site off Newland Road. Note abundance of purple Downingia in vernal pool, goldfields on the edge of pool. Nesting structure for wildlife is notably limited

Figure 10. Rogue Plains Preserve, taken in early in spring during ongoing grazing.

Appendix 8. Photo images of vernal pool mounded prairie in a variety of conditions.

Figure 11. Whetstone Savanna Preserve. Cattle grazing was excluded seven year prior to the date of the photo. The variety of habitats on the site add to the species diversity encountered. Note coyote thistle in the pool bottom and the surrounding chaparral of wedgeleaf ceanothus. Absence of grazing at this site results thatch accumulation at the pool margins, reducing the available habitat there.