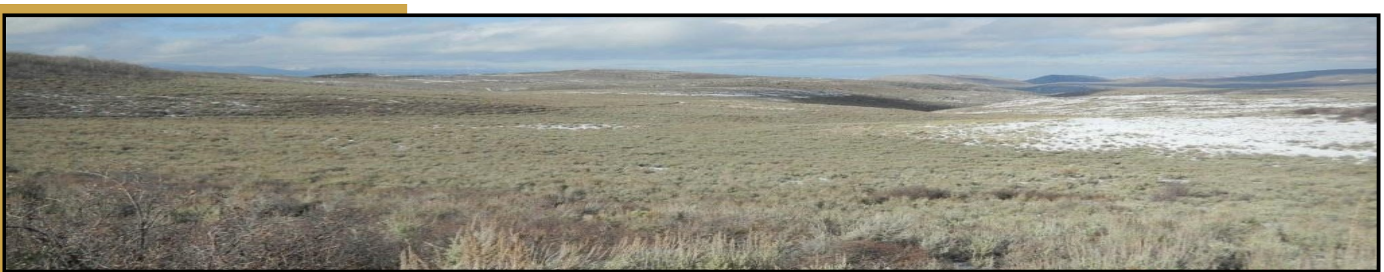

Utah Shrubland Management

The Spring 2015 Newsletter highlights our study site in Park Valley, UT. The ranch where we work is owned and operated by Lance Westmoreland and family; greasewood is the targeted shrub.

CONTENTS

Project Updates and Field Tour Information

The field crew members on the Shrub Management Project are now preparing for their third summer of data collection after management actions were initiated in spring of 2013. It's an exciting year to see the effects of herbicide, mowing, and seeding treatments on a diverse group of shrub, grass, and forb species. With two study sites per ranch, we can begin to compare how response to management varies between closely related ecological sites.

The big news this season is that over the next two months, we're hosting tours of our field sites to share our initial project results. All who are interested in rangelands—management practitioners, property owners, students, neighbors—are invited to come learn about the Utah shrub management project. Ecologists from USDA-ARS and Utah State University will be leading discussions about brush management methods and ecological sites at our four study locations (details below). The tours will also include presentations by state and county conservation agencies (DWR, NRCS, Utah State Extension) on topics such as exotic species control, juniper encroachment, seeding, and wildfire management. Lunches will be provided for tour attendees. This will be a great opportunity to learn about current approaches in range management, come join us!

Photo: Beth Burritt

2015 Summer Field Tour Schedule

Birdseye & Cedar Fort (Central UT) - *See enclosed flyer* **May 20**
Targeted Shrubs: Rubber Rabbitbrush & Snakeweed
Partners: NRCS, DWR, UACD Zone 3
Time: 9am — 4pm

Park Valley (North-Western UT) - *See enclosed flyer* **June 2**
Targeted Shrub: Black Greasewood
Partners: West Box Elder Coord. Res. Mgmt. Group, UGIP, Selman Ranch
Time: 9am—3pm

Bear Lake (North-Eastern UT) **June 25**
Targeted Shrub: Mountain Big Sagebrush
Partners: DWR , UACD Zone 1
Time: 9am—4pm; meeting place to be determined

Please RSVP to Rebecca Mann (rkmann@gmail.com) or Justin Williams (justin.williams@ars.usda.gov, 435-797-3066).

USDA ARS

Utah State University

Ecological Sites at the Park Valley ranch study site

Rebecca Mann, Utah State University

Our Park Valley study sites provide an excellent example that sometimes it can be nearly impossible to neatly divide nature up into succinct and predictable categories. When comparing soils and ecological sites between the project's northern and southern study areas, we found that they exist along an overall gradient of environmental characteristics. There are differences in soils, landscape position, and available water between the sites, but the differences are subtle, and site characterization was tricky. Regardless, these soil and landscape subtleties are related to unique potential plant communities at each area and management, in turn, can be tailored to best fit each location separately.

An additional aspect of the Park Valley region that illustrates how involvement with natural systems can be complex is its long history of human use. In this region, as was common across the Great Basin, there was widespread settlement by various immigrants, dryland farming, and livestock grazing. These past actions still leave an impression, influencing the current state and dynamics of the ecological sites in the area. Management actions taken now do not happen in isolation but rather on top of this imprinted landscape.

<u>Soils</u>

The first challenge in the Park Valley region is that some areas have not been mapped according to unique soil types. Instead, the map unit on which our study sites occur is the Kunzler-Lembos *Association* (Figure 1). Associations contain a mixture of two or more soil types that are different in their morphology and behavior. The soil types can be distinguished at fine scales, but cartographers in Park Valley were unable to delineate the Kunzler series from the Lembos series during their large-scale mapping efforts. So at each study location, we look below the surface to determine which of these two we are dealing with.

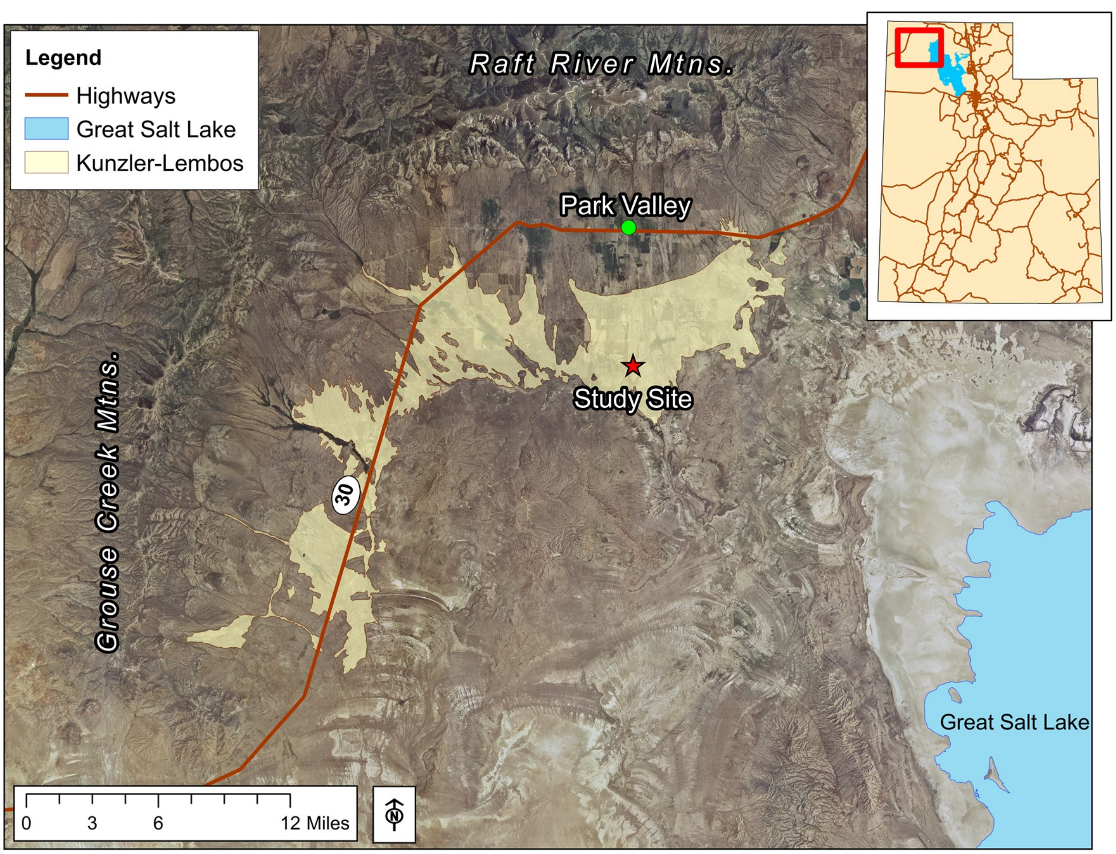

Figure 1. Map of the Park Valley region, bordered on the north and west by the Raft River and Grouse Creek mountain ranges. Alluvium (water-transported soils) drains from the mountains, across the Park Valley plain, and into the Great Salt Lake basin. Shown in pale yellow is the Kunzler-Lembos soil association, in which the study sites are located. Both Kunzler and Lembos soils are fine-textured and moderately saline. They are associated with greasewood and Wyoming big sagebrush plant communities, respectively.

Ecological Sites at the Park Valley ranch study site

Soils, continued

According to the NRCS soil series descriptions, both soils in the Kunzler-Lembos Association are fine-textured at the surface and have a poorly developed A horizon with low organic matter content. The Lembos soil series can be distinguished by a zone of clay accumulation between 4-10", and a duripan (an impenetrable layer cemented by silica and lime) from about 20-40". In contrast, the Kunzler soil does not have a clay layer and instead has a zone of calcium carbonate accumulation from 16-40", with durinodes (weakly cemented soil nodules) below 11".

We dug soil pits to a depth of just over 25" at both study sites, which were approximately 1 mile apart (Figure 2). The soil at the northern site has a clay-loam texture from 3-9.5" with a subangular-blocky structure: evidence of a weak argillic (clay) horizon. The southern site had a loamier texture, and durinodes were observed from approximately 6-26". Loamy textured soil with durinodes suggests that the southern site is characteristic of the Kunzler soil series. The northern site, with its clayey horizon, resembles the Lembos soil series. However, without any apparent signs of a duripan (cemented layer), the northern site may not be a true Lembos soil, but rather a transition zone between the Kunzler and Lembos soils.

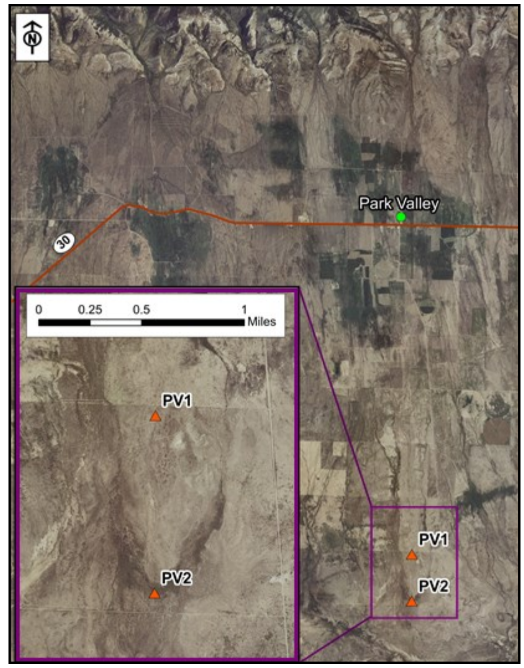

Figure 2. Map of the study sites at the Park Valley location. The southern site is likely on the Kunzler soil series; the northern site in a transition area between Kunzler and Lembos soils.

Ecological Sites

With the soil pits, we observed two points along a soil gradient, that shifts from clayey Lembos, at the northern end of an alluvial plain, to a loamy Kunzler, at the southern end. Salinity and silt content increase at these lower

Table 1. Comparison of ecological sites in the Park Valley area. MAP = mean annual precipitation, AWC = available water holding capacity, EC = electrical conductivity (a measure of percent salts in the soil).

Ecological Sites in the Park Valley Area	*Elev. (feet)*	*Landscape Position*	*Surface Texture*	*Depth*	*MAP*	*AWC*	*EC*	*Soil chemistry; Available water*	*Reference Vegetation*
Semidesert Loam (WY big sagebrush) Site ID: R028AY220UT (Lembos Soil Series)	4400-6500	Alluvial flats, plains, lake terraces	Loam / Silt Loam / Fine Sandy Loam	20"-60"	8"-12"	3.1"-7.4"	0-4	Non- to moderately-calcareous. Moderately to strongly alkaline.	**40% shrubs** (WY big sagebrush, rabbitbrush); **55% grasses** (Indian ricegrass, bluebunch wheatgrass); **5% forbs**
Semidesert Alkali Loam (Black Greasewood) Site ID: R028AY202UT (Kunzler Soil Series)	4250-5800	Lake fans, fan terraces, floodplains	Loam / Silt Loam / Fine sandy loam	>60"	8"-12"	2.9"-6.6"	0-4	High sodium salts and silica cementation limit plant growth	**55% shrubs** (greasewood, WY big sagebrush); **35% grasses** (Indian ricegrass, squirreltail, bluegrass); **10% forbs**
Alkali Flat (Greasewood) Site ID: R028AY004UT (Other Soil Series)	4200-5000	Deltas, floodplains, drainages, basin floors	Silt Loam / Silty Clay Loam / Fine Sandy Loam	>60"	8"	1-6"	4-16	Moderate to strong soil salinity. Water table >3ft deep; water available to plants is reduced by salts.	**70% shrubs** (greasewood, shadscale); **20% grasses** (squirreltail); **10% forbs**

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Ecological Sites at the Park Valley ranch study site

Ecological Sites, continued

elevations, when heading away from the mountains. Farther to the south, towards the Salt Lake basin, we would expect to find even greater salt accumulation on the basin floors. Each of these soil zones are associated with a unique ecological site, where vegetation mirrors soil patterns (Table 1). Salt tolerant plants are found to the south, including greasewood, halogeton, and pickleweed. Sagebrush and seeded grasses such as crested wheatgrass are, by contrast, more common in the northern locations. The two ecological sites we work with are the Semidesert Loam (Wyoming big sagebrush) ecological site to the north, and the Semidesert Alkali Loam (Black Greasewood) ecological site to the south.

Management History

European settlement in Park Valley began in the 1870s and grew during the land boom of the early 1900s. The settlers left their mark when clearing the land for homesteads and agriculture— old wooden plows and other machinery can be seen in the field today. Overstocking of livestock was also common in this area by land owners such as Charles Crocker, a railroad promoter, who had over 45,000 head of cattle. Furthermore, some companies bought land from railroads and sold it back to settlers, making false claims about its productivity and encouraging farming without the use irrigation (known as dry-farming). Dry-farmed lands were cleared, plowed, and planted—a technique popular throughout Utah and the Great Basin. But with less than a foot of water a year, dry-farming had little success in Park Valley; many homesteads were abandoned by the 1920s. What remained were upturned soils ready for invasion by non-native plants that had hitched a ride with the immigrants.[34]

Establishment of non-native species is not the only legacy of early 20th-century land management practices. The plowed soils were susceptible to erosion, compaction, and redistribution of salts and nutrients. Disturbed areas now exist with a different mix of native species compared to those that have never been plowed—increases in greasewood, yellow rabbitbrush, and squirreltail are all associated with old fields.[35]

Today, Park Valley rangelands exist in various states of ecologic integrity. Two sites in the region may have the same soil type and landscape position but respond differently to management due to the effects history has had on species composition, soil condition, and resulting site dynamics.

Photograph of Frank Nye plowing in Cache Junction, Utah east of town. 1914-15. Courtesy Utah State University, Merrill-Cazier Library, Special Collections and Archives, A-Board historical photograph collection, A-0627. Obtained May 8, 2015.

Natural history and management of greasewood, *Sarcobatus vermiculatus* (Goosefoot family: *Chenopodiaceae*)

Rebecca Mann, Utah State University

Greasewood is a persistent, vigorous shrub that thrives in harsh environments, typically on fine-textured, saline or sodic soils. It is native to western North America but because of its ability to re-sprout following disturbance and its toxicity to livestock when consumed in high amounts, it is considered a pest by many land managers who are striving to provide well balanced forage to livestock while maintaining a healthy rangeland.

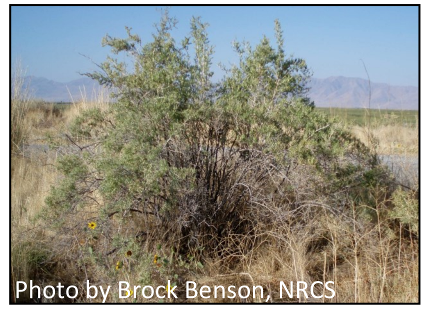


Photo by Brock Benson, NRCS

An adult greasewood shrub, note the highly-branched growth form.

Photos by Brock Benson, NRCS

Greasewood leaves with fruit (top), and spine-tipped branches (bottom).

Identification

Greasewood's leaves are unique and characteristic: they are olive to bright green, oval to round in cross-section, and fleshy or succulent. The leaves resemble tiny worms, inspiring its species name, *vermiculatus,* where *vermi-* is the Latin root word for worm, and *–culus* means small[1]. The bark of greasewood is white on new growth, and black to grey on older stems. The sharp branch-ends are spine-like, which serve as mechanical protection from grazing, and make this shrub a dangerous one to drive over without extremely heavy-duty tires. On his expeditions through Montana, Captain Meriwether Lewis dubbed greasewood the "fleshy leaved thorn"[2]. Individual plants grow erect, often to a height of 3-4 feet, but occasionally reach up to 10 feet[1]. They are semi-evergreen to deciduous, depending on site conditions. As is typical of members in the goosefoot family, this species has very inconspicuous flowers, which are either male or female. Male flowers resemble small yellow or red cones and female flowers are green, occurring at the base of leaves. Flowering occurs May - July, and small (¼" - ½") winged fruit develop between July and September, turning reddish then tan as they mature[3].

Habitat

Greasewood is widespread in western desert lowlands from Mexico to Canada[1,4,5], and can grow on soils from heavy clays to cobbly loams[3]. However, as a drought-tolerant shrub, it is most typically found in cold deserts with fine-textured soils that are saline, sodic, and/or alkaline (high pH), and which experience a seasonally high water table[5,6]. The salts in soils associated with greasewood are predominantly sodium, chloride, calcium, magnesium, and potassium[6,7]. In fact, as the age of a greasewood stand increases, pH and sodium content increase in soil surrounding the shrubs, suggesting that over time, salts are concentrated on the soil surface where greasewood leaf litter accumulates[6]. This high concentration of salts desiccates plants that are not adapted to such conditions[8].

Several ecological sites in Utah characteristically support a greasewood community (e.g. Alkali Flat, Semiwet Saline Meadow, Semidesert Alkali Loam)[9]. Common associated species include four-wing saltbush (*Atriplex canescens*), salt rabbitbrush (*Chrysothamnus nauseosus var. consimilis*), gray molly (*Kochia americana*), alkali sacaton (*Sporobolus airoides*), saltgrass (*Distichlis spicata*), basin wildrye (*Leymus cinereus*), squirreltail (*Elymus elymoides*), and the non-native halogeton (*Halogeton glomeratus*)[1,9]. Wildlife residents include jackrabbits, pronghorn, and mule deer, which forage on greasewood, plus numerous bird and small mammal species which use the community for borrowing and resting sites[1, 10-12].

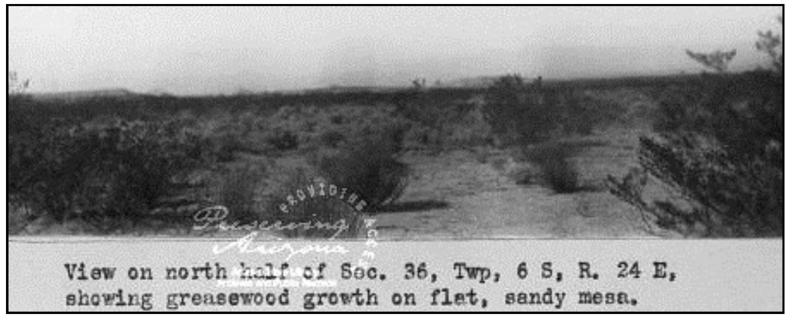
Photo from fws.gov

Deer use greasewood in winter when other browse is limited.

Natural history and management of greasewood, *Sarcobatus vermiculatus*

Habitat , continued

In uplands, where the soil is less saline, greasewood may be a minor component of ecological sites dominated by Wyoming big sagebrush. Certain disturbances, such as mechanical brush treatment or heavy grazing, may cause sagebrush to decrease and greasewood to increase, giving the false appearance that it is a "greasewood" ecological site[5]. The underlying differences are important from a management perspective, however. Soil chemistry and hydrology will influence erosion rates, what species can be used for revegetation, and what species are likely to re-establish naturally after management actions are taken.



Historical photograph of greasewood growing in the desert in Graham County (Ariz.). 1912. Courtesy Arizona State Library, Archives and Public Records. History and Archives Division. Obtained on May 8, 2015 from http://azmemory.azlibrary.gov/

The challenges of greasewood

Toxicity: In general, greasewood is palatable[13] and safe for livestock to consume in moderate amounts, as long there is enough other forage available. However, when consumed in large amounts over a short period of time with little other vegetation, greasewood can be fatal. This scenario can occur in early spring, when hungry animals are turned out into greasewood range where other forage is limited, or in fall and winter when cattle consume leaves that have fallen to the ground. The toxins, sodium and potassium oxalates, are most concentrated in the leaves; exact amounts vary widely by area. Poisoning symptoms appear within 6 hours of a toxic dosage and may include bloating, weakness, altered breathing, and coma. Cattle may die after eating 3 to 3 ½ pounds of greasewood in a short period with no other forage[13].

Potential for re-growth: In addition to its potential toxicity, greasewood can be a challenging species to manage due to its vigorous growth habit. It grows rapidly, has a long lifespan, and good seedling vigor. Greasewood adult plants can have roots 5 to 20 feet deep, with lateral roots up to 12 feet long. Adventitious buds occur all along the root system, and can give rise to new sprouts when the main plant or the root system is damaged. Greasewood may also re-sprout from a damaged crown[3].

Greasewood sites are typically arid, with highly saline and alkaline soils, only habitable by salt-tolerant species.

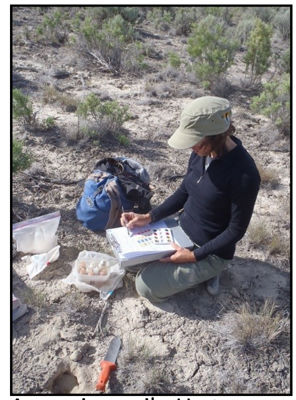
Associated environment: As mentioned, greasewood typically exists in arid environments on soils that are high in salts and often have a high (basic) pH; this limits the suite of species which may be used for re-vegetation projects. Depending on the ecological site, annual invaders may also be a threat in disturbed areas, disrupting ecological processes that maintain potential species diversity and soil health[36, 37]. Furthermore, because greasewood communities are often sparsely vegetated and on fine-grained soils, these sites are very susceptible to water and wind erosion, especially in places where biological soil crusts have been depleted. Erosion from these sites can be detrimental to nearby waterways that subsequently receive higher than usual amounts sediments and salts[1].

Natural history and management of greasewood, *Sarcobatus vermiculatus*

Management Options

Managing a greasewood site requires care. Over grazing of the herbaceous understory vegetation, especially in times of drought, can lead to the increase and eventual dominance of greasewood and weedy annuals. Proper grazing management is critical before and after range improvements to maintain a healthy rangeland[3].

If action is deemed necessary, the first step will be to acknowledge that managing a greasewood site won't be easy![14] The costs (including risks) and benefits of reducing greasewood must be weighed, and a pre-treatment site assessment will be crucial for making sound decisions. During the site assessment, it will be determined whether the property is a "sagebrush" ecological site (on less saline soils) that happens to have a high percentage of greasewood, or if it is a true "greasewood" ecological site on saline or alkaline soils. Web Soil Survey or NRCS consultants can aid with site identification, but this should be verified in the field. Key factors in distinguishing greasewood ecological sites include soil conditions (texture, pH, depth, soil water availability), dominant shrubs (sagebrush, greasewood, shadscale) and their relative ratios, and presence of associated species (salt-tolerant or not). In general, sites with a herbaceous understory and with more sagebrush cover relative to greasewood cover will be easier to treat[3].


Assessing soil pH at a greasewood ecological site

After verifying the ecological site, its potential (species composition and production) can be determined using the ecological site description (ESD). The state-and-transition model in the ESD plus local expert knowledge will help the manager understand processes that drive site dynamics and predict outcomes of various management actions being considered. Addressing ecological processes in the management plan improves chances of seeing lasting, positive change as a result of management actions[36, 37]. Key concerns to address during planning will include: a) what is the current disturbance regime (e.g. due to grazing, drought, fire), drivers of the disturbances, and their effects on species and soil?, b) once greasewood is removed, what is it's anticipated return time?, c) are selected revegetation species appropriate for the site's soils?, and d) given current climate trends, will seeded species respond quickly enough to stabilize soil and limit annual weed invasion? When weighing options, it helps to acknowledge that some greasewood does serve a beneficial role. As a deep-rooted shrub, it helps to stabilize soil, maintain a functionally diverse plant community, provide habitat, and (via competing for soil resources), helps reduce invasion by halogeton, cheatgrass, Russian thistle, and other potential noxious invaders [15]. The following sections describe specific management actions for greasewood-dominated sites.

Mechanical Treatments

Mechanical treatments can produce various results. Crowning, brush beating, and tillage (such as shallow plowing or disking) will often result in increased greasewood cover[3,23], due to its ability to re-sprout following disturbance. However, chaining does have the ability to reduce greasewood vigor and density, at least temporarily[23], and mechanical control may make greasewood more susceptible to herbicide application[3]. NRCS provides recommendations for controlling greasewood by plowing if the site and soil conditions are appropriate: Plow 10" deep on the first pass, then give the shrubs time to regrow (which may take up to a year). Then plow a second pass at a 45° angle to the first[3]. Caution must be taken when using these aggressive practice where soils are highly erodible.

Burning

Burning is not a good management option for decreasing greasewood abundance. Although greasewood may be killed during severe fires[24], in most situations where fires are low to moderate intensity, greasewood will sprout vigorously after a burn[24-28]. Field observations of this activity include: in Nevada, sprouts up to 2 ½ feet were observed within three years of a fire[25]; in Washington, only 1 year after a fire, nearly half of the pre-burn cover of greasewood had recovered[26]; and in Oregon, 90% of plants were found to be vigorously sprouting one year after burning[28]. Furthermore, the ash from burned greasewood can exacerbate the already alkaline soil conditions that exists where it grows[29].

Natural history and management of greasewood, *Sarcobatus vermiculatus*

Herbicides

Herbicide effectiveness for greasewood control is highly dependent on the chemical used, timing of application in relation to shrub phenology, number of applications, and site factors including landscape position and soil water availability. A traditional chemical used for control is 2,4-D. A single low-dose application (1 lb/ac) can provide up to 80% mortality of greasewood if applied when shoots are actively growing (generally early June, ending when male flowers are mature)[16,17]. Adding picloram (0.5 lbs/ac) can extend the window of time in which 2,4-D is effective, increasing otherwise low mortality rates when shoot growth is slow[16]. Because a single application of 2,4-D may damage growing shoots but cause sprouting from the crown after spraying, a second or third season of spraying may be necessary[16,18]. Re-application of 2,4-D has resulted in significant greasewood mortality (86-100%) in some field tests[16].

Metsulfuron ("Ally", "Cimarron", "Escort") and chlorsulfuron ("Glean F.C.", "Telar D.F.") are additional chemicals commonly used to control invasive rangeland plants such as halogeton, and annual mustards[19]. Both can be used to control greasewood; metsulfuron is the more effective of the two. Enloe and colleagues found that higher rates of metsulfuron (1.5-5.9 oz ai/ac) decreased greasewood by over 90% after 12 months, and 80% after 24 months. This was associated with an increase in grass (20% cover pre-treatment vs. 40% cover post-treatment), and an increase in bare ground from approximately 15% to >40%[20]. Chlorsulfuron was somewhat less effective at greasewood control, with just over 80% reduction at higher rates at the 12 month mark (>75% at 24 months). Again, spraying of these chemicals must be done in the spring when plants are actively growing and the new leaves are about 0.5-0.75" long[3].

Other herbicides tested have had mixed results. Dicamba ("Banvel") is effective in combination with 2,4-D, but again may require more than two applications for effective and long term control[3,21]. A combination of triclopyr and benazolin also achieved up to 80% control[22]. Herbicides that have not shown satisfactory control include triclopyr and benazolin alone, picloram alone, 2,4,5-T ("Silvex"), and low- moderate rates of tebuthiuron 20P[22].

Seeding

Seeding is a challenge on greasewood ecological sites where soils are saline or alkaline, but it is often necessary to stabilize soil and reduce runoff, as well as to improve plant diversity and forage availability. Britton and colleagues tested several cultivars specifically on highly sodic soils where greasewood was occurring. They found good potential for establishment during wet years for varieties including 'Alkar' tall wheatgrass, 'Hycrest I' crested wheatgrass, 'Trailhead' basin wildrye, and 'Syn A' Russian wildrye. Trailhead and Alkar tall wheatgrass generally remained green throughout the summer, more than SynA and Hycrest I[30]. Basin wildryes have historically been important in revegetation of greasewood sites[31, 32]. Some bluebunch-quackgrass hybrids also have potential for success on greasewood sites, including 'NewHy' and 'RSH' quackgrass cross; these have high salt tolerance and are adapted to dry areas[30, 33]. For a full list of recommended plant varieties for greasewood sites, see the NRCS Technical Note No. 15, which covers greasewood management (Citation #3 in the following reference list). Although there are many promising cultivars, the practitioner must be prepared for a low success rate due to harsh environment and the need for good moisture the spring after seeding[3]

Seeds can be applied with a drill seeder if the soil isn't too soft and there aren't too many stumps on the ground. Broadcast seeding can also be used, and a short and intense period of animal introduction onto the site may help to tromp the broadcast seed into the soil[31, 32].

For the Shurb Management Project, we drill-seeded several traditional and improved varieties at the Park Valley study site in 2014 to observe what works best on greasewood sites.

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