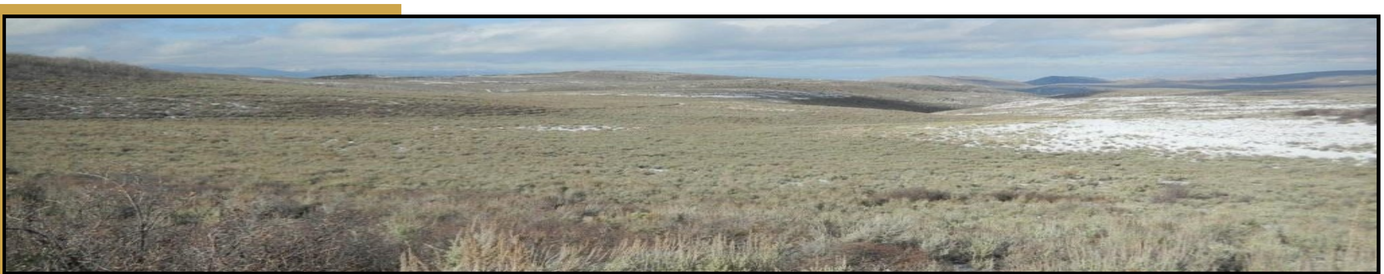


Utah Shrubland Management

Happy New Year!

This Winter 2014-2015 Newsletter discusses accomplishments over the past year for the Shrubland Management project. We highlight the Ecological Sites and targeted shrubs at the ranch owned by Mr. Rial Berry in Cedar Fort, Utah.

CONTENTS

Project Updates

This summer, we were once again busy collecting project data at all eight study sites. This included the small-scale plot-based measurements within fenced demonstration areas, and transect-based measurements at the ranch-wide scale. Data were taken for shrub density, shrub cover, herbaceous and ground surface cover, and herbaceous biomass. Lab technicians are now entering data and processing biomass samples.

The 2014 field crew, raring to go!

In the small-scale demonstration areas, seed was applied at the end of October, 2014 using a Truax drill seeder. In each area, 1/3 of the test plots receive a **"Standard"** seed mix (traditional plant varieties), another 1/3 of plots received an **"Improved"** seed mix (recently developed market varieties), and the final 1/3 of plots receive no seed. Density and cover of these plant materials will be measured in all plots. The study will evaluate the performance of plant materials in multiple ecological sites, allowing us to understand the interactive effects of chemical control, mechanical control, and seeding on target shrub abundance and seeded plant material performance.

Species	***Improved*** Mix	***Standard*** Mix	Rate (lbs/acre)
Basin wildrye	'Continental'	'Trailhead'	1.75
Bluebunch wheatgrass	'P33' (experimental)	'Anatone'	1.75
Crested wheatgrass	'Hycrest II'	'Hycrest'	1.75
Indian ricegrass	'Whiteriver' (germplasm)	'Rimrock'	1.75
Russian wildrye	'Bozoisky II'	'Swift'	1.75
Siberian wheatgrass	'Vavilov II'	'P-27'	1.75
Snake River wheatgrass	'Discovery'	'Secar'	1.75
Thickspike wheatgrass	'Bannock II' (experimental)	'Critana'	1.75
Sanfoin	'Eskie'	'Eskie'	0.75
Small burnet	'Delar'	'Delar'	0.75

We are also excited to have underway a meta-analysis related to shrub management. Meta-analysis is a process of summarizing data available from all peer-reviewed, published literature to make statistically sound generalizations. We conducted a search of studies set in North American sagebrush ecosystems that involved shrub reduction treatments. This resulted in over 360 peer-reviewed, scientific articles from which we extracted over 1,300 data records. Our goal is to summarize region-wide patterns in the effect of shrub reduction treatments (chemical, mechanical, burning, and grazing), on shrub, grass, and forb abundance. Data from the meta-analysis will be included in the Utah Shrubland Management Handbook, which is targeted for release in late 2015.

Interview with Rial Berry, ranch owner in Cedar Fort, Utah

Rebecca Mann, Utah State University

I met with Rial Berry in June of 2014, and he was happy to share stories of his experiences on his ranch in Cedar Fort, UT. In 1933, he and his brothers inherited 640 acres in the foothills of Flat Top mountain, east of Utah Lake, plus 15 acres in the valley; they later bought an additional 100 acres of irrigated land. In those earlier days, the family ran about 60 head of cattle on a total of 1,500 acres that included private property and nearby state-owned land. I was curious why they had chosen cattle as stock, and Mr. Berry said that although their rangeland would have also been excellent for sheep, those animals require much more hands-on attention and would have been too much of a demand on the family's time. All brothers held jobs while ranching, Rial himself working at Lewis Aerospace Engineering. Currently, Rial has stepped away from running his own herd and leases his property to a neighbor who grazes 28 cow-calf pair.

The biggest challenges Mr. Berry has faced on his ranch include sorting out water rights with the neighboring town of Cedar Fort, illegal trespassing by area travelers, and the persistent encroachment of woody species onto the rangeland. Having been close to this land for nearly his entire life, Mr. Berry has witnessed rapid expansion of juniper and fluctuations in other dominant woody species over time. To manage juniper and sagebrush on his property, 300 acres of his property were chained over thirty years ago. Twenty years ago, snakeweed invaded the ranch and the herbicide tebuthiuron was applied aerially for control. Unfortunately, snakeweed is a very persistent species and still poses a challenge to the ranching operation today. Four years ago, a fire crossed the northern end of the property; this turned out to have the unforeseen positive consequence of reducing juniper cover where the burn occurred.

Last summer, Mr. Berry worked with USDA-NRCS and the Utah Grazing Improvement Program to apply Cimarron Max® at a low rate of 1 oz/acre, and again attempt to reduce snakeweed dominance. Recently, cheatgrass has also established on the ranch, which could potentially replace any eliminated snakeweed. To encourage establishment of a perennial grass community and combat these two undesirable species, Mr. Berry used a tractor-mounted drill to apply seed throughout the ranch; his mix included intermediate wheatgrass, crested wheatgrass, forage kochia, burnet, and alfalfa. The plan is now to let this seeding establish by resting the area from grazing for two years. This property supports an array of desirable species and seems to have high potential for improvement; we have already seen natural recovery of perennial grasses from remnant plants and seed banks in just the last two years within fenced experimental areas associated with the Shrub Management Project.

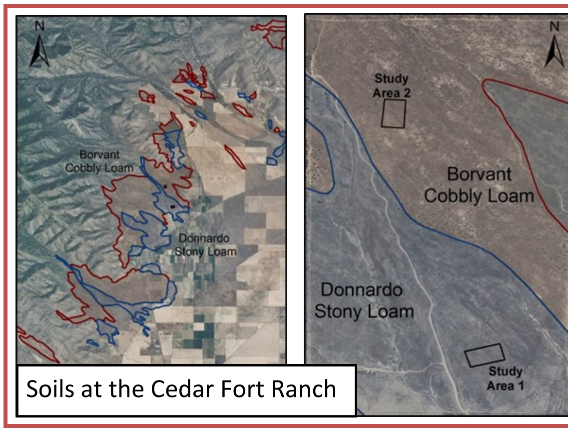
Ecological Sites at the Cedar Fort ranch study site

Rebecca Mann, Utah State University

The Ecological Sites at Cedar Fort are set apart by their rockiness, and this site faces a set of challenges familiar to many Utah landowners: invasion by snakeweed, cheatgrass, and Utah juniper. This article discusses the soil and site dynamics at the Cedar Fort ranch. The following article considers management options for these persistent species.

Soils and Topography

At Mr. Berry's ranch near Cedar Fort, Utah, two soils predominate on the landscape. They are Borvant Gravelly Loam at the northern part of the property, and Donnardo Stony Loam in the southern part. As the names imply, one way to differentiate these soils is by the types of rocks in the profile. In the Borvant soil series, gravels and cobbles take up an average of 35-60% of the soil volume; these rocks range from 2mm up to 25cm in diameter[1]. In contrast, the Donnardo series contains a larger range of fragments, including some that are up to 60cm in diameter ,which are classified as stones. In the Donnardo series, total rock volume is slightly higher at 35-70%, and rocks typically occur in horizontal layers[2].



Soils at the Cedar Fort Ranch

Delving deeper below the surface reveals another key difference between the two soil series. Our team was able to dig a 14" deep pit in the Borvant soil before reaching a layer that was cemented and too hard to get through with a spade – this was a "petrocalcic" horizon, characteristic of the Borvant series[1]. This is a zone of calcium accumulation due to long-term leaching of calcium -rich water. At the southern site in Donnardo soil, we could only dig about 12". This was not due to a cemented layer but because we ran into a layer of large stones that prevented further excavation. Had we been able to move the rocks, we would have found that this soil is effectively deeper than the Borvant, continuing to at least 60", although it will be extremely rocky at depth[2].

Borvant soil pit

Both soils occur along the foothills of Flat Top Mountain, Borvant occurring higher in elevation and typically having steeper slopes than Donnardo. The sloped landscape and petrocalcic horizon of the Borvant soils encourage water runoff and loss. Drainages carry this moisture downhill and across the lower alluvial fans, where the Donnardo soils lay. Drainages are localized zones of sediment loss and soil mixing and the landscape's rockiness can easily be observed in these ephemeral washes that meander across Mr. Berry's ranch.

Donnardo soil pit

Vegetation and Ecological Site Dynamics

Although the vegetation on the Borvant and Donnardo soil types is similar, there are some definite differences. The overall area is characterized by cold, snowy winters and warm, dry summers with an average annual precipitation of 13-18"; most summer precipitation comes as small, intermittent showers that do not wet the soil deeply[1,2]. At both sites, we observed frequent snakeweed and occasional gray rabbitbrush, with an understory of cheat-grass and bulbous bluegrass. But on Borvant soils specifically, Utah juniper was encroaching from the lower foothills, while on Donnardo soils, big sagebrush was the dominant woody species and juniper was uncommon. Furthermore, the Borvant soils appear to have slightly greater forb and perennial grass diversity, including bluebunch wheatgrass, western wheatgrass, and Indian ricegrass.

Vegetation on Borvant soils

Ecological Sites at the Cedar Fort ranch study site (continued)

What is causing these outwardly similar landscapes to support different dominant woody species? The most important difference between the sites is their available soil water, as influenced by soil properties and site topography. Borvant soils occur on steeper slopes, experiencing greater water runoff than Donnardo soils. Borvant soils also have a nearly impermeable petrocalcic horizon; these attributes create an overall arid environment.

Figure B - Pedogenic Carbonate Development Stages - Coarse Fragment Matrix

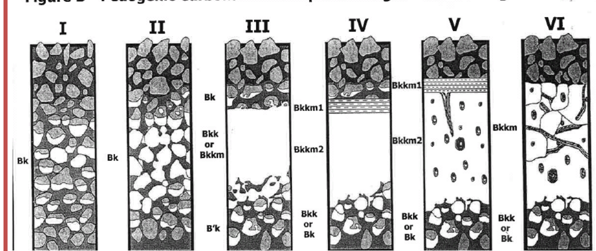


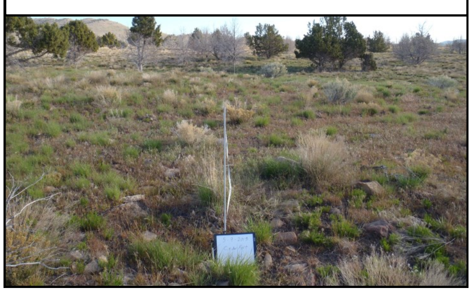
Diagram shows accumulation of calcium (white) on rock fragments over time, with eventual formation of a petrocalcic horizon. Calcium is transported down through the soils profile while dissolved in water.[4]

Juniper species are not well adapted to fire and are historically found on sites that burn infrequently, such as dry sites with very shallow, rocky soils. Juniper will however encroach into deeper, loamier soils, and in fact its range has vastly increased from the late 1800s into such environments[3]. Range expansion is partly due to climatic shifts towards warmer growing conditions, but expansion is primarily due to long-term decrease in fire burn intervals, either directly through modern fire-fighting efforts, or indirectly through grazing-induced reduction of fine fuels[3]. We see this encroachment happening on Mr. Berry's Cedar Fort ranch, and encroachment has been concentrated on the arid Borvant soils, probably because competition from grasses and forbs is least.

Junipers in the foothills of Flat Top mtn.

The Borvant soil at Cedar Fort falls into an Upland Shallow Hardpan Ecological Site. Ecological Site names are further qualified by the species that was dominant on the site prior to European settlement. Although it is tempting to call this a "Pinyon-Juniper" Ecological Site, it is in fact more likely a "Mountain Big Sagebrush" Ecological Site that has undergone a transition to a juniper-dominated State[5,6]. The distinction is very important because it relays information on the site's potential. A historically juniper-dominated landscape is unlikely to respond positively to juniper reduction or management for high perennial grass cover because it lacks soil nutrients and moisture to support such a community. Conversely, it is much more practical to attempt to remove junipers from a historically sagebrush-dominated site, and work to transition the site to a grass-shrub community, because the soil and climatic environment will be favorable[6]. Fortunately for the landowner, this appears to be the case at Cedar Fort, where there is evidence that the junipers are a recent, rather than historic presence on the landscape. Evidence of recent invasion includes absence of very old wood, current tree recruitment, and mollic (nutrient-rich) soil colors.[6,4] The Reference ("climax") State for this Upland Shallow Hardpan (Mountain Big Sagebrush) Ecological Site will be dominated by mountain big sagebrush with a perennial grass understory; the official Description for this Ecological Site is currently being developed by the USDA-NRCS[5].

Upland Shallow Hardpan Ecological Site on Borvant soils



The Donnardo soils further downslope at the Cedar Fort ranch are associated with the Upland Stony Loam (Mountain Big Sagebrush) Ecological Site[7,25]. At this site we can also see a transition occurring; as ecological condition deteriorates due to grazing pressure, bluebunch wheatgrass, Indian ricegrass, bitterbrush, and desirable forbs will tend to decrease, while big sagebrush, low rabbitbrush, and snakeweed increase. Cheatgrass and annual forbs are likely to invade this Ecological Site, also observed at the ranch. The Reference State for this ecological site is dominated by Mountain big sagebrush with approximately 50% perennial grasses, 10% forbs, and 40% shrubs.[7]

Upland Stony Loam Ecological Site on Donnardo soils

Management at the Cedar Fort ranch

Rebecca Mann, Utah State University

For land managers with long-term goals in mind, the adaptive management approach provides a robust and efficient means of moving forward. Adaptive management is a process with five primary steps that will be illustrated in a simplified fashion here for the Cedar Fort ranch.

1. **Planning:** setting goals and objectives
2. Implementing management **Actions**
3. **Monitoring** outcome of management
4. **Evaluating** results of management
5. **Adjusting** objectives and actions to better meet goals

Planning

Setting appropriate goals and objectives is critical for management, and knowledge of soils and Ecological Site potential is extremely helpful in setting achievable targets.

- Goals for the Cedar Fort ranch include re-establishing a robust perennial grass community for grazing and reducing cover of undesirable species: snakeweed, juniper, and cheatgrass. The owner is also interested in retaining winter browse for wildlife.
- Challenges: Barriers to perennial grass establishment are high abundances of snakeweed and annual species such as cheatgrass. Standing dead trees and soil rockiness creates occasional limitations for machinery access, and potential for drought is an important consideration for seeding success.
- Objectives: Specific benchmarks are created from goals. Examples for Cedar Fort might include:
  - Reduce cover of snakeweed to <5% biomass .
  - Reduce cover of juniper each to <10% cover for at least 30 years.
  - On Upland Shallow Hardpan Ecological Site, obtain 150lbs/ac forbs, 400lbs/ac perennial grass.
  - On Upland Stony Loam Ecological Site, obtain 85lbs/ac forbs, 425 lbs/ac perennial grass.

Action

All possible management practices and resources available should be assessed before selecting the most economic and effective treatment for meeting objectives. Action that has taken place on the Cedar Fort ranch in the past three years includes:

- Application of Cimarron Max® (a combination of 2,4-D, metsulfuron, and dicamba) to reduce cover of snakeweed (2013).
- Drill seeding to encourage regeneration of grasses and forbs; obtain seed through USDA-NRCS and Utah DWR (2014).
- Rest from grazing (will occur 2015-16).

Monitoring

- The Shrub Management project installed 40 transects across the Cedar Fort treatment site to monitor shrubs, grasses, forbs, and bare ground (density, cover, production). Data will be collected for a total of 3 years following treatment.
- Additional monitoring that could be conducted by the land owner include monitoring of stubble height throughout the season to judge grazing offtake, photographic records, yearly species lists, and surveys of the extent of undesirable/invasive species.

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Management at the Cedar Fort ranch (continued)

Evaluation

- The first year after Cimarron Max ® was applied, it appears to have reduced snakeweed significantly. Data are still being entered and evaluated for exact results but this treatment seems to have been initially successful.
- Unfortunately, areas experiencing a decline in snakeweed are showing a strong rebound in cheatgrass cover; this annual grass takes advantage of the soil resources no longer used by snakeweed.
- Success of drill-seeded crop will be evaluated over the coming years.
- Fenced areas that have been protected from grazing are showing a remarkable increase in cover of native grasses.
- Time will tell how the two Ecological Sites present on the Cedar Fort ranch differ in their reaction to recent management actions.

Adjustments

Mr. Berry and other managers will take what they've learned from this project to adjust future goals and objectives, and to plan additional actions going forward. Some initial consideration and insights have been:

- The potential for re-invasion by snakeweed must be addressed. If snakeweed was reduced significantly by the recent treatment, remaining patches could possibly be spot-treated with herbicides such as 2,4-D or glyphosate.
- To suppress snakeweed seedlings that may arise from the seedbank, a strong perennial grass community must be established. The seed applied this year will be monitored and evaluated and could potentially be supplemented if needed.
- Rest from grazing appears to be very beneficial to the rejuvenation of perennial grasses. Evaluation and careful management of the grazing system at the Cedar Fort ranch may enhance site-wide recovery of healthy and resilient vegetation.

For more information on the adaptive management process

Contact your local extension agent or visit these on-line resources:

Dept. of Interior Discussion of Adaptive Management

http://www.doi.gov/ppa/upload/Chapter1.pdf

The Collaborative Adaptive Management Project in California

http://leslie-roche.weebly.com/collaborative-adaptive-management-project.html

A USDA collaborative adaptive grazing project in north-eastern Colorado

http://www.ars.usda.gov/Main/Docs.htm?docid=24218

Snakeweed natural history and management

Rebecca Mann, Utah State University and Justin Williams, USDA-ARS, Logan, UT

Photo ©Al Schneider, www.swcoloradowildflowers.com

The primary shrub targeted for reduction at the Cedar Fort site is a common range plant called broom snakeweed (*Gutierrezia sarothrae*). It is a native subshrub, usually less than two feet tall, that is sometimes considered invasive in plant communities ranging from salt desert shrubs to pinyon-juniper associations[8,10]. It has increased in cover and density at the Cedar Fort site due to a combination of disturbances including wildfire, grazing, and climate. It is most noticeable in the fall when its yellow flowers carpet the rangelands it infests, and at other times of year, the plants can be distinguished by their straw-colored flowering stalks that resemble broom fibers.

At the Cedar Fort ranch, snakeweed management started with an herbicide treatment. This was followed by seeding competitive grasses and forbs. The treated area will be allowed to rest from livestock grazing for at least two years.

Close-up of snakeweed flower heads. Photo by Stan Shebs.

Broom snakeweed is most easily confused with its cousin, green rabbitbrush (*Chrysothamnus viscidiflorus*). To distinguish these species, take a close look at the stems and flower heads. Snakeweed has brown twigs, whereas green rabbitbrush has light colored, nearly white stems. Also, the flower heads of snakeweed have ray flowers with flat yellow petals; rabbitbrush flowers lack these petals, having only tubular disk flowers[9]. Finally, although both species have bright green leaves that are somewhat resinous in summer, green rabbitbrush leaves will generally be more spiraled than snakeweed leaves.

Why is snakeweed undesirable?

- Snakeweed is an aggressive competitor with beneficial forage grasses and forbs.
- Its foliage contains toxic saponins and can accumulate selenium. These chemicals may cause illness, death, and abortions, especially when consumed in combination with a low protein, low nutrient diet. [10]
- High concentrations of crude resin make snakeweed unpalatable to horses and cattle, although it is a fair quality winter browse for domestic sheep when other green forage is scarce. [10]
- Once established, snakeweed may dominate the plant community and can be difficult to remove or reduce without intense management.

What is snakeweed's role in plant communities?

Invasion by Snakeweed

Snakeweed is tricky to manage because of its performance on the landscape: it can be quick to establish and is very competitive once it does. Snakeweed takes advantage of disturbances that release soil water and nutrients previously used by other plants. Disturbances displacing desirable vegetation include fire, consistent heavy spring grazing, and drought.[8] Although snakeweed itself is not tolerant of drought or fire, it produces prolific seed (up to 4000 seeds per plant in a single year [11]), and seedlings quickly establish in wet years where competition has been removed.[12] Most notably, snakeweed is cyclic, responding in growth to fluctuations in climate, especially precipitation. In an extreme example, researchers documented establishment of snakeweed in a mature crested wheatgrass stand, when spring precipitation was high and after the area had been heavily spring grazed.[13]

Snakeweed natural history and management (continued)

Snakeweed's role in plant communities (continued)

Competition from Snakeweed

Snakeweed has a negative and exponential effect on the growth of grass, whereby even at fairly low densities it can suppress neighboring forage species.[14] Furthermore, when neighboring plants are reduced (such as through grazing), snakeweed will increase. In a study that clipped vegetation surrounding snakeweed, its density increased from an average of 16 to 57 plants/m^2 in a crested wheatgrass stand, and from 1.5 to 7.9 plants/m^2 in a bluebunch wheatgrass stand. This was most likely a quick response to released soil moisture.[15] Snakeweed has an advantage over other species due to its extensive root structure, root depth, and inefficient leaf transpiration that causes soil moisture in its vicinity to decline, ultimately stressing less drought-tolerant neighboring grasses.[16]

Snakeweed and Site Dynamics


Snakeweed invading a sagebrush site

Although high densities of snakeweed are related to climatically favorable years, there are other noted triggers causing its increase. Consistent, heavy grazing can cause snakeweed to invade deeper, more fertile soils than it typically inhabits.[8] Dr. Eric Thacker (Range Extension Specialist at Utah State University) and his colleagues proposed an update to the vegetation dynamics associated with the Upland Gravelly Loam Ecological Site, which is a similar environment to that at the Cedar Fort Ranch. They suggested that heavy spring grazing over decades can eliminate bunchgrasses from a climax plant community and cause a transition over an ecological threshold to a sagebrush-dominated "State". A lack of competition from bunchgrasses in the understory allows snakeweed to invade the site in wet years. If the Sagebrush State burns, sagebrush will be removed and the site will become dominated by snakeweed. Additional repeated burning may cause the site to transition over another ecological threshold, to a cheatgrass-dominated State.[8,17] After such drastic change, it is very difficult to reverse this Ecological Site back to a bunchgrass-dominated community, even with intensive management. However, to consider the reverse scenario, working to maintain an existing healthy bunchgrass population is an effective tool against invasion and dominance by snakeweed.

How can snakeweed be controlled?

- ***Conventional grazing management is key to maintaining a competitive plant community for suppression of this invasive native plant.[24]***

  For example, short-duration and rotational grazing systems were noted to show lower levels of snakeweed over time[18], and fence line studies have shown that heavily grazed sites are more likely to experience invasion after disturbance than those which are more moderately grazed.[17]

- ***Prescribed fire followed by re-seeding can be used to control broom snakeweed.***

  It is best to target early infestations[8]. If conditions are safe, burning when mature plants are sparse but when there is enough grass to carry a fire, significant damage can be done to adult snakeweed plants.[19]

- ***A long-term strategy involves application of broadleaf herbicide followed by rest from grazing and re-seeding with competitive, weed resistant varieties of grasses and forbs to provide long-term control.***

  Effective chemicals include picloram and metsulfuron.[20-22] For low-level populations, spot spraying with 2,4-D and roundup using a wetter-sticker type surfactant should kill adult plants.[6] Fall applications may be more effective because carbohydrate translocation is down into roots in that season.[23] Snakeweed may also be more responsive to chemical treatment on deeper soils (even if rocky), because these sites will be more capable of re-establishing other species that can out-compete snakeweed.[6]

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