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Broom Snakeweed Increase and Dominance in Big Sagebrush Communities

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ABSTRACT

Broom snakeweed (Gutierrezia sarothrae (Pursh) Britt. & Rusby) is a native sub-shrub that is widely distributed on rangelands of western North America. It often increases to near monocultures following disturbance from overgrazing, fire or drought. Propagation is usually pulse driven in wet years, allowing large expanses of even-aged stands to establish and dominate plant communities. It can maintain dominance following fire, or can co-dominate with cheatgrass (Bromus tectorum L.) on degraded sagebrush rangelands. State-and-transition models show that competitive grasses in the respective plant communities can prevent snakeweed dominance.

In Monaco, T.A. et al. comps. 2011. Proceedings – Threats to Shrubland Ecosystem Integrity; 2010 May 18-20; Logan, UT. Natural Resources and Environmental Issues, Volume XVII. S.J. and Jessie E. Quinney Natural Resources Research Library, Logan Utah, USA.

INTRODUCTION

Broom snakeweed (*Gutierrezia sarothrae* (Pursh) Britt. & Rusby) is widely distributed across western North America, from Canada south through the plains to west Texas and northern Mexico, and west through the Intermountain region and into California (figure 1). It ranges in elevation between 50 and 2900 m (160 and 9500 ft) and commonly inhabits dry, well-drained, sandy, gravelly or clayey loam soils (Lane 1985). The closely related threadleaf snakeweed (*G. microcephala* (DC) L. Benson) is similar in growth form and appearance, but differs in that it has only 1 to 2 florets per flowering head, compared to 3 to 5 in broom snakeweed. It occurs mostly in the southwest deserts (figure 1).

Broom snakeweed is a native plant that can increase in density when other more desirable plants are reduced or removed by disturbance, such as overgrazing, fire or drought. It can dominate many of the plant communities on western rangelands including: salt-desert-shrub, sagebrush, and pinyon/juniper plant communities of the Intermountain region; short- and mixed-grass prairies of the plains; and mesquite, creosotebush and desert grassland communities of the southwestern deserts (US Forest Service 1937). In addition to its invasive nature, it contains toxins that can cause abortions in livestock (Dollahite and Anthony 1957). Platt (1959) and DiTomaso (2000) ranked it among the most undesirable plants on western rangelands.

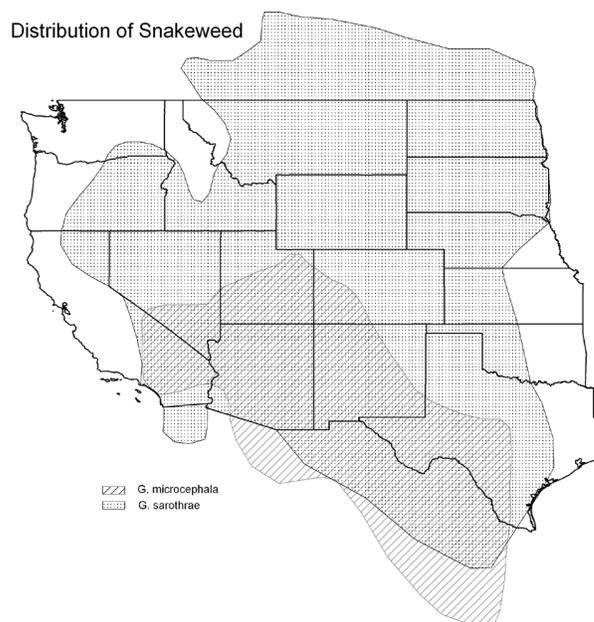


Figure 1. Distribution of broom and threadleaf snakeweed.

ECOLOGY

Broom snakeweed is a suffrutescent sub-shrub, having many unbranched woody stems growing upwards from a basal crown, giving it a broom-shaped appearance. These stems die back each winter and new growth is initiated from the crown in early spring. Once established, snakeweed typically survives 4 to 7 years (Dittberner 1971). It is a prolific seed producer with 2036 to 3928 seeds/plant (Wood et al. 1997). Seeds held in dried flower heads are gradually dispersed over winter. They have no specialized structures such as wings to aid in long

range dispersal, thus they usually drop close to the parent plant. Seeds remain viable into spring, but rapidly disintegrate after May if they remain exposed on the soil surface (Wood et al. 1997).

Germination is light-stimulated (Mayeux 1983), therefore seeds must remain partially exposed on the soil surface (Mayeux and Leotta 1981). Furthermore, the soil surface must remain near saturation for at least 4 days for the seeds to imbibe and successfully germinate (Wood et al. 1997). Buried seeds remain viable for several years and germinate when moved to the soil surface by disturbance (Mayeux 1989).

Pulse Establishment

The fluctuating resource availability theory of invasibility (Davis et al. 2000) suggests that plant communities are more susceptible to weed invasion whenever there are unused resources. This occurs when there is either an increase in resource supply or a decrease in resource use. Snakeweed populations often establish in years with above average precipitation following disturbance that reduces competition from other vegetation (McDaniel et al. 2000).

Ralps and Banks (2009) reported a new crop of snakeweed plants ($30/m^2$) established in a wet spring (precipitation 65 percent above average) in a crested wheatgrass seeding (*Agropyron cristatum* (L.) Gaertner). Intense grazing reduced the grass standing crop (which reduced use of soil moisture by crested wheatgrass) and trampling disturbed the soil surface, thus providing ideal soil and environmental conditions for snakeweed establishment.

In a companion defoliation study (Ralps 2009), density of snakeweed seedlings was higher in clipped plots in both the crested wheatgrass seeding and in a native bluebunch wheatgrass (*Pseudoroegneria spicata* Pursh) stand. Clipping reduced competition for soil moisture from grass and mature snakeweed plants, allowing new snakeweed seedlings to establish. This study showed that in wet years, snakeweed can establish even in healthy stands of native bluebunch wheatgrass or seeded crested wheatgrass, when defoliation of the grasses reduces competition for soil moisture.

Population Cycles

Pulse establishment allows massive even-aged stands of snakeweed to establish. There is little intraspecific competition among snakeweed seedlings (Thacker et al. 2009a), thus large expanses of even-aged stands establish in wet years. As these stands mature, they become susceptible to die-off, mainly from insect damage or drought stress. Although snakeweed is highly competitive for soil moisture, it is not particularly drought tolerant (Pieper and McDaniel 1989; Wan et al. 1993b). Ralps and Sanders (2002) reported that snakeweed populations in a salt desert shrub community on the Colorado Plateau died out in 1990, reestablished in 1994, declined in 1996, completely died out in 2000, and have not established during the current region-wide drought (figure 2).

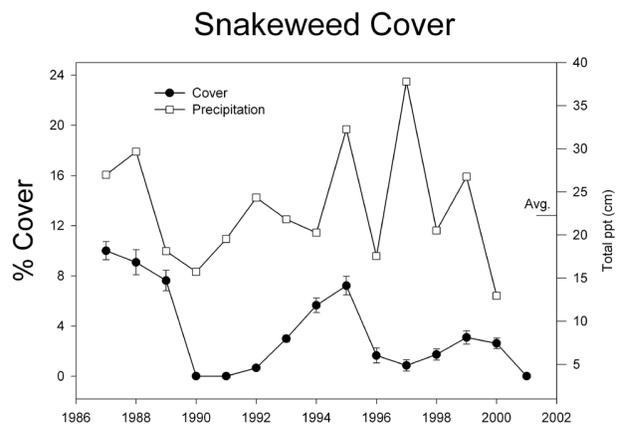


Figure 2. Population cycle of broom snakeweed and annual precipitation.

Competition

Once established, snakeweed is very competitive with other vegetation. McDaniel et al. (1993) reported a negative exponential relationship between snakeweed overstory and grass understory that implies snakeweed's presence, even in minor amounts, suppresses grass growth. Partial removal of snakeweed allowed remaining plants to increase in size and continue to dominate the plant community (Ueckert 1979). Total removal allowed grass production to increase >400 percent on blue grama grasslands (McDaniel et al. 1982, McDaniel and Duncan 1987). Control strategies should strive for total snakeweed control.

Snakeweed's root structure and depth provide a competitive advantage over associated grasses for soil moisture (Torell et al. 2011). In the southwest, its deeper roots enable it to extract soil water at greater depths (30-60 cm), compared to the shallow rooted sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray) (Wan et al. 1993c). In its northern range, snakeweed is acclimated to a saturated soil profile from snowmelt and spring rains to sustain rapid growth (Wan et al. 1995). When soil water stress increases seasonally or during drought, leaf stomata do not close completely (Wan et al. 1993a, DePuit and Caldwell 1975), allowing snakeweed to continue transpiring. This depletes soil moisture to the detriment of associated grasses. If drought persists, leaf growth declines and leaves are eventually shed to cope with water stress, but stems continue photosynthesis to enable it to complete flowering and seed production (DePuit and Caldwell 1975). However, as drought stress increases, tissues dehydrate and mortality occurs rapidly (< 10 days) when soil water potential drops below -7.5 MPa and leaf water content declines to 50 percent (Wan et al. 1993b).

State-and-Transition Model

Healthy sagebrush/bunchgrass communities can suppress snakeweed. Thacker et al. (2008) described a fence line contrast between a Wyoming big sagebrush/bluebunch wheatgrass community and a degraded sagebrush/Sandberg bluegrass (*Poa secunda* J. Presl) community in northern Utah. A 2001 wildfire removed the sagebrush in both communities. Snakeweed established on the degraded side of the fence and increased to 30 percent cover and dominated the site by 2005. Bunchgrasses on the other side of the fence prevented establishment of snakeweed.

Thacker et al. (2008) proposed a new broom snakeweed phase to the Upland Gravelly Loam (Wyoming big sagebrush) ecological site state-and-transition model (figure 3) (NRCS 2007). Two "triggers" were identified that lead to snakeweed invasion. Heavy spring grazing over decades eliminated most of the bunchgrass in the plant community, putting the community "at risk" and eventually transitioning from the Current Potential

State (2.2) over a threshold (T2b) to a dense Wyoming Sagebrush State (4). The lack of competition from bunchgrasses allowed snakeweed to establish in the understory. Fire then removed the sagebrush and snakeweed was the first plant to germinate, establish, and rapidly increase and dominate the Snakeweed /Sandberg bluegrass phase (4.2). Subsequent fires will remove snakeweed and the site will likely transition over another threshold (T4b) to a cheatgrass (*Bromus tectorum* L.) community in the Invasive Plant State (5). Thacker et al. (2008) suggests that if robust perennial bunchgrasses can be maintained in the community, they will provide "resilience" to resist snakeweed invasion or expansion, recover from fire or drought, and produce more forage for wildlife and livestock.

CONTROL

Snakeweed can be controlled by herbicides and prescribed burning. McDaniel and Ross (2002) recommended prescribed burning during the early stages of a snakeweed infestation if there is sufficient grass to carry a fire. Herbicide control is recommended on dense snakeweed stands, particularly where fine fuels are not sufficient to carry a fire. Picloram at 0.28 kg ae/ha (0.25 lb/ac) or metsulfuron at 0.03 kg ai/ha (0.43 oz/ac) applied in the fall provided consistent control in New Mexico (McDaniel and Duncan 1987, McDaniel 1989). Sosebee et al. (1982) suggested fall applications were more effective than spring in the southwest because carbohydrate translocation was going down to the crown and roots, thus carrying the herbicide down to the perennating structures. Whitson and Freeburn (1989) recommended picloram at 0.56 kg ae/ha (0.5 lb/ac) and metsulfuron at 0.04 kg ai/ha (0.6 oz/ac) applied in the spring on shortgrass rangelands in Wyoming. In big sagebrush sites in Utah, the new herbicide aminopyralid at 0.12 kg ae/ac (0.11 lb/ac) was effective when applied during the flower stage in fall, as was metsulfuron 0.042 kg ai /ha (1.67 oz/ac) and picloram + 2,4-D at 1.42 kg ae/ha (1.25 lb/ac) (Keyes et al. 2011). Picloram by itself at 0.56 kg ae/ha (0.5 lb/ac) was most effective and eliminated snakeweed when applied in either spring or fall. Residual control was obtained with tebuthiuron (80 percent wettable powder) at 1.1 to 1.7 kg ai/ha (1 to 1.5 lb/ac) on mixed grass prairies in west Texas (Sosebee et al. 1979).

Upland Gravelly Loam (Wyoming big sagebrush)		
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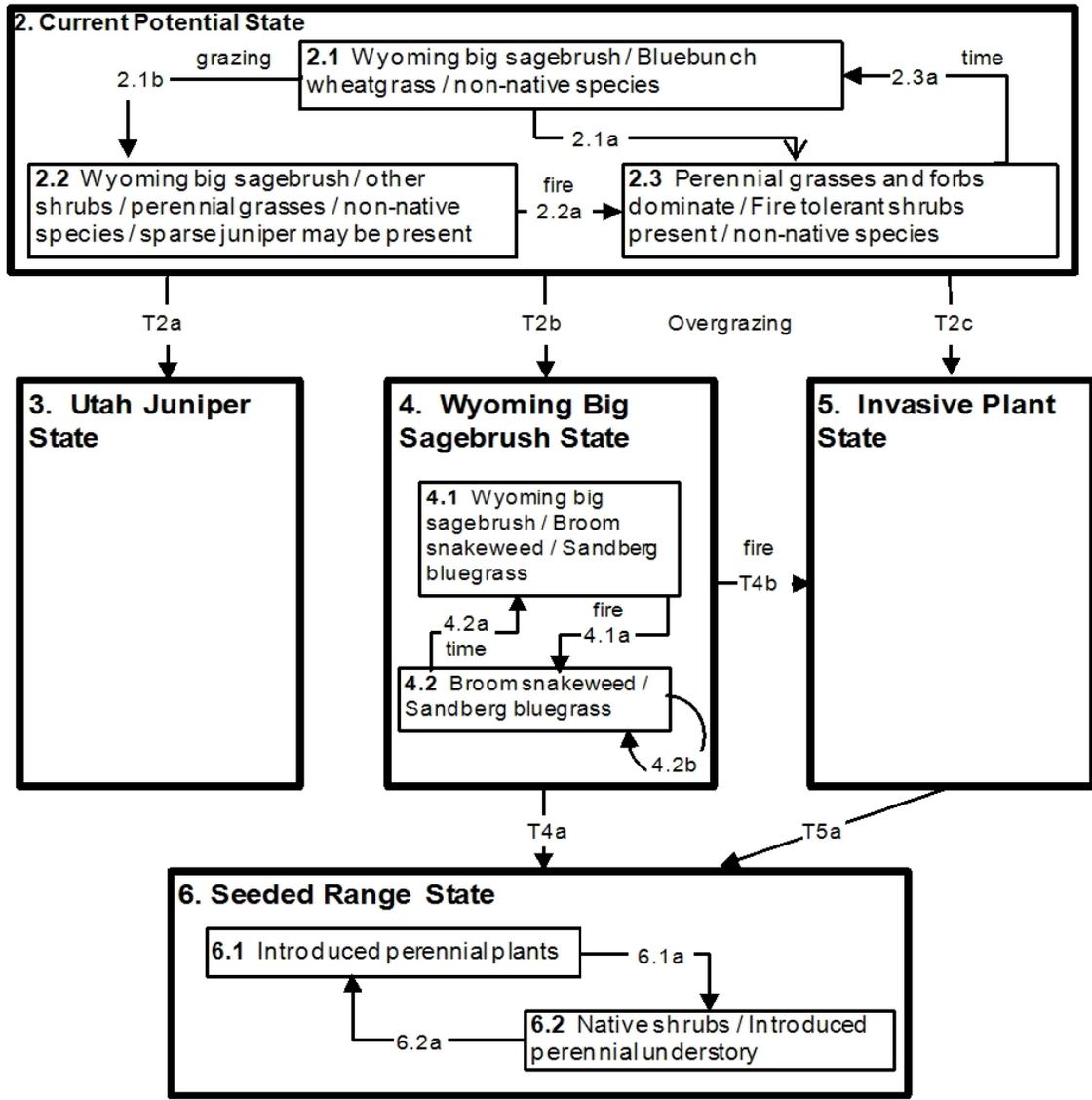


Figure 3. Upland Gravelly Loam (Wyoming big sagebrush) Ecological Site state-and- transition model. Available: <ftp://ftpfc.sc.egov.usda.gov/UT/Range/D28AY307UT.pdf> [Nov 17, 2007].

After snakeweed control, a weed-resistant plant community should be established to prevent reinvasion of snakeweed, cheatgrass and other invasive weeds. Thacker et al. (2009a) reported competition from cool season grasses prevented establishment of snakeweed seedlings in both potted-plant and field studies. Snakeweed seedlings appear to be sensitive to competition from all established vegetation, including cheatgrass. Hycrest crested wheatgrass (*Agropyron cristatum* (L.) Gaertner x *A. desertorum* (Fisch. Ex Link) Schultes) was the most reliable grass to establish on semi-arid rangelands, thus was most effective in suppressing snakeweed establishment and growth (Thacker et al. 2009b). There appears to be a window of opportunity for grasses to suppress snakeweed in its seedling stage, if the grasses can be rapidly established. However, once established, snakeweed is very competitive and will likely remain and dominate the plant community.

SUMMARY

Broom snakeweed is an invasive native sub-shrub that is widely distributed across rangelands of western North America. In addition to its invasive nature, it contains toxins that can cause death and abortions in livestock. It establishes in years of above average precipitation following disturbance by fire, drought or overgrazing. This allows widespread even-aged stands to develop that can dominate plant communities. Although its populations cycle with climatic patterns, it can be a major factor impeding succession of plant communities. Snakeweed can be controlled with prescribed burning and herbicides, however a weed-resistant plant community should be established and/or maintained to prevent its reinvasion.

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