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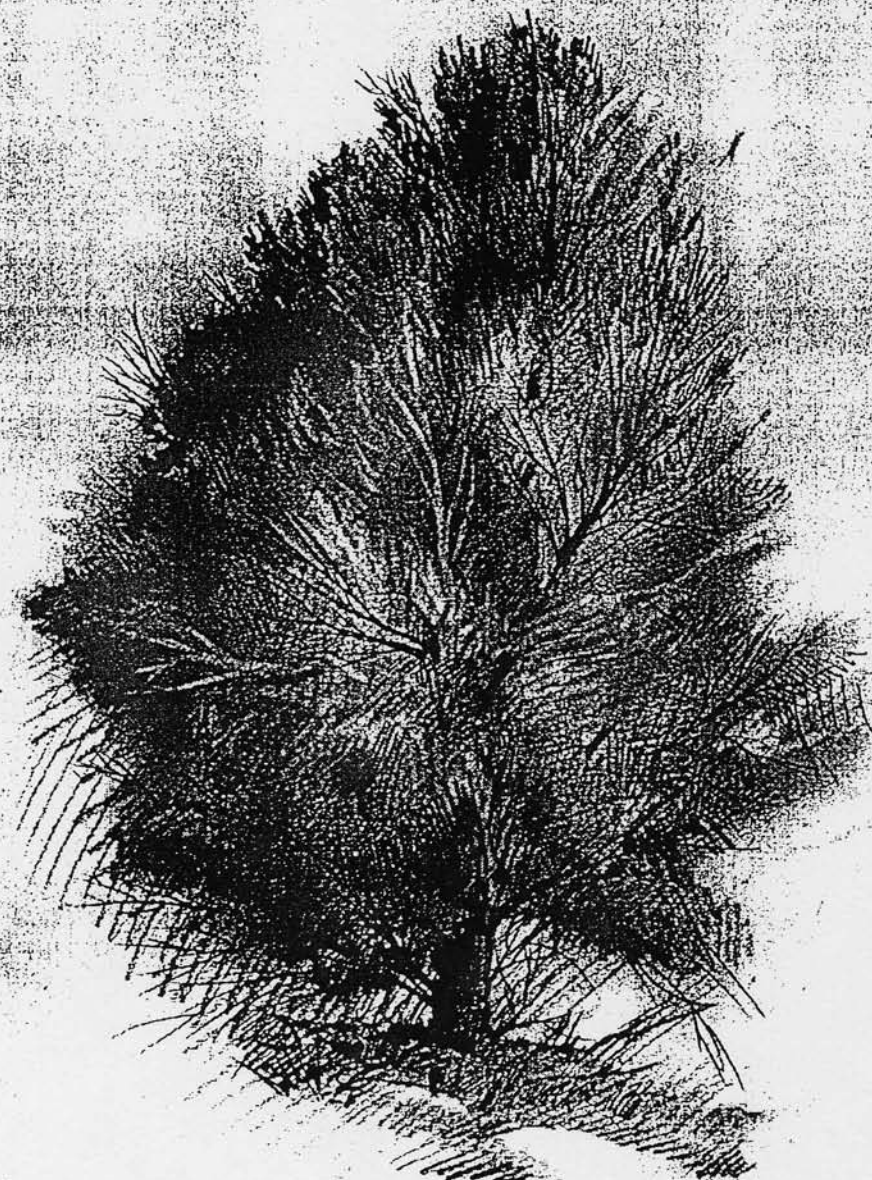


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**Sustaining and Restoring a Diverse Ecosystem**

# Implications of Weedy Species in Management and Restoration of Pinyon and Juniper Woodlands

Tony Svejcar

**Abstract**—A survey of the literature was done to determine if the presence of a weedy species is a short-term annoyance or a long-term threat on pinyon-juniper lands. The conclusion is that situations differ with no "cookbook" solutions for managers. Six-step guidelines will help managers find answers for site-specific questions.

Rangeland weeds have attracted an increasing level of attention during recent years. There is concern over potential weed problems that may result from woodland (juniper or pinyon/juniper) conversion projects. In spite of the interest in both rangeland weeds and woodland conversion projects, I found surprisingly little research that specifically addresses weed problems in woodlands. Much of the work was more focused on control of woody species rather than the weeds that might follow restoration efforts. Young and others (1985) pointed out that juniper control methods would influence subsequent weed control/revegetation options in the understory. If standing dead trees were left in place (for example, using herbicides or fire) there are physical limitations to the use of weed control and seeding equipment. For example, in a formerly dense woodland the dead canopy might make it impossible to use ground-seeding equipment.

Cheatgrass (*Bromus tectorum* L.) has probably received more attention than any other weedy species that occurs in woodlands. So I will try to summarize the literature results for this species. In this paper I will: 1) present some of the reasons why woodland conversion projects pose the risk of weed invasion, 2) discuss the role of cheatgrass in woodland conversion, and 3) suggest several planning steps where weeds are considered in a larger ecological context.

## Why Should Weeds be a Concern?

Woodland tree species, junipers in particular, are very effective at using soil resources. Using field data in conjunction with a simulation model, Angell and Miller (1994)

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estimated that western juniper would use about 44 percent of the total precipitation in a year that received 32.0 cm (12.6 inches). They assumed the site was stocked at 75 trees per ha (30 per acre) and that the leaf area index was 1.6. The effect of the juniper stand was to reduce precipitation available to other species to about 18 cm (7 inches). Seventy-five trees per hectare is not a particularly dense juniper stand. These authors point out that juniper may also intensify drought effects during dry years, and create site-water deficits early in the growing season. These conclusions were confirmed by Bates and others (1998), who found that soil moisture and nitrogen availability were much higher in cut woodlands, compared to those uncut. In a pinyon (*Pinus monophylla* Torr. & Trem) woodland, Everett and Thran (1992) found that about half of the total site N was contained in above-ground tree biomass and half in soil. Thus, the pinyon sequestered a major portion of site N, which would no longer be available to other species.

The fact that woodland trees use a good deal of the resources on a site actually provides a degree of protection against weed invasions. Unfortunately, the tree dominance also tends to reduce the diversity and productivity of understory species (Bates and others 1998). The potential risk to woodland conversion projects is that an opportunistic weedy species will take advantage of the additional resources more quickly than desirable species (either existing or seeded species). The challenge is to determine whether the presence of a weedy species is a short-term annoyance or a long-term threat.

## Cheatgrass and Others

As mentioned earlier, there is more research information available on cheatgrass than on any other weedy species associated with North American woodlands. Much of this research has dealt with vegetation dynamics after a woodland fire. Barney and Frischknecht (1974) identified a weedy annual stage that peaked within 3 to 4 years after a fire, followed by several stages with differing mixes of perennial grasses, forbs, and shrubs. The change in cheatgrass cover values was dramatic ranging from 12.6 percent in 3-year-old burns to less than 1.0 percent in burns older than 22 years. A similar pattern was identified by Erdman (1970) in southwestern Colorado. The pattern may be similar with chaining. Working in central Utah, Davis and Harper (1990) measured a high density of both cheatgrass and burr buttercup (*Ranunculus testiculatus*) immediately after chaining on a pinyon juniper site. However, by the third year after chaining, the density of both species had declined by 85 percent or more compared to the initial year values. In this



study, the density of seeded perennials increased over the 3-year period. Evans and Young (1985) measured a dramatic increase in standing crops of cheatgrass (from near zero to 1400 kg/ha) after controlling juniper with picloram pellets. Cheatgrass frequency declined in the treated areas over a 7-year period, but there was a continual increase in frequency of medusahead (*Taeniatherum asperum*).

There is a body of research that shows weedy annuals, cheatgrass in particular, can increase immediately after woodland trees are killed, whether it be by fire, chaining, or herbicides. Much of the research indicates that this response will be transient, or that it may not even occur. For example, Barney and Frischknecht (1974) point out that the annual stage may be by-passed in areas that have good cover of perennial herbaceous species prior to burning. In central Oregon, Quincey (1984) stratified fire response of juniper woodlands into dry and moist sites. Dry sites contained cheatgrass prior to burning, and the increase persisted for 20 years in some cases. On the moist sites, perennial grasses dominated the unburned vegetation with little cheatgrass present. The moist sites did not have a fire-induced increase in cheatgrass. These results suggest that responses to woodland conversion projects will be site-specific and depend heavily on the initial floristics of each plant community (Everett and Ward 1984, Koniak 1985).

Although cheatgrass is the weed species mentioned most frequently in the literature, it certainly is not the only weed of concern in woodlands. There is presently an on-going invasion of diffuse and spotted knapweeds (*Centaurea diffusa* and *C. maculosa*, respectively) in upland sites and Russian knapweed (*C. repens*) in the moister sites (Lee Eddleman, personal communication). There are many other alien species that have the potential to invade woodlands.

## Principles and Planning

There are many variables that interact to influence the threat weeds pose on any given piece of rangeland. Every situation will be different and few "cookbook" answers will be available. However, there are general principles that will prove useful and every manager can develop site-specific information that will aid their future decisions; this approach is really adaptive-management.

I would suggest everyone become familiar with the old ecological concepts of relay floristics and initial floristics. An orderly succession of plant communities is the basis of relay floristics. Each seral plant community relays the site to the next (see Barbour and others 1980, or other plant ecology texts for a more detailed discussion). The successional sequence is considered well defined and repeatable. In contrast, the implications of initial floristics is that succession of plant communities is not so easily defined and may not be repeatable (Barbour and others 1980). A number of factors may influence the course of succession. There is a degree of chance in which species are present on a site, which migrate quickly to the site after a disturbance, the type of year immediately following disturbance, etc.

There may be elements of both initial and relay floristics that apply to any given situation. For example, there may be an annual phase that gives way to perennials over time (relay), but the annual phase may not occur if cheatgrass isn't a major component of pre-burn vegetation (initial

floristics). In a study of post-burn succession in pinyon-juniper stands, Everett and Ward (1984) suggest that elements of both relay and initial floristics were evident. There may be multiple successional pathways (Everett and Ward 1984) and successional patterns may vary among different sites (Koniak 1985). This led Koniak to conclude that it will be necessary to characterize a site (elevation, soil type, post-burn climate) and the disturbance (severity and timing) if community response is to be predicted.

With appropriate planning and monitoring, land managers will be in a position to make informed decisions about woodland manipulation projects. Weeds should be considered within this larger framework. I would suggest the following six steps for a starting point:

1. *Develop clearly defined objectives.* What are the land management goals for the site? What is the problem and what will be gained from a particular woodland treatment? Be as specific as possible.
  2. *Describe the site.* Parameters, such as land area, tree density, tree age, species composition, slope, aspect, soil depth, elevation, prior management, should be used in the decision-making process. The nature and initial floristics of a site may give clues as to the risk of weed dominance.
  3. *List the available management options.* These will vary from one area to another, and by land ownership. These options should be evaluated for cost and effect on plant succession (next item).
  4. *Consider how proposed treatments might influence the primary causes of succession.*
    - a. *Site availability for colonization.* What sites (actually microsites) might favor occupation by invader species? How will changes in density of woodland trees influence site availability? Different management tools have varying impacts, for example, prescribed fire will have a different effect on site availability than will cutting. Maybe a goal could be to reduce tree density to make sites available for other species, rather than total conversion of a woodland.
    - b. *Species availability.* What species are on site or within easy dispersal distance? Are there species that tend to appear on a particular site after treatment (even if they are not obvious prior to treatment)? Do any of the species listed pose a major weed risk? Are species present that might close the site to weed invasion?
    - c. *Species performance.* Are there site characteristics such as slope, soil texture, soil depth, aspect, that might favor a weedy species of concern? In many areas, drier south-facing slopes appear more susceptible to invasion by weedy species than do north-facing slopes.
- A more detailed discussion of successional weed management can be found in Sheley and others (1996).
5. *Prescribe site management after woodland management.* Will seeding be necessary? Keep in mind that residual native species often respond favorably to woodland manipulation, even on sites that appear depleted. Is the site to be grazed, and if so, what type of management will be necessary to allow recovery of understory species?

6. *Develop a follow-up monitoring plan.* How will adaptive management be accomplished if we don't keep track of our successes and failures? It is worthwhile setting goals for monitoring what you hope to accomplish. What is an appropriate monitoring system and time frame? How will the information be summarized and interpreted? Were weeds a problem?

Although it is not specific to weeds, Aldon and others (1994) have developed an ecosystem management checklist for pinyon-juniper communities.

## Closing Thoughts

Many of the decisions made on rangeland must be site-specific, yet often site-specific information is not available. This is unfortunate because there are often treatments that have been applied in any given area, but no system was in place to evaluate the results and pass them along to future land managers. There is a need for ways of assembling fairly complex information into a simple format. One option is to use some form of the state-and-transition model initially proposed by Westoby and others (1989). This model is really a means of organizing information for use in management. Svejcar and Sheley (1995) suggested that state-and-transition models, and the primary causes of succession (site availability, species availability, and species performance), can be molded into a framework that would better integrate research and management. State-and-transition models could be developed using ecological principles, research results, and local knowledge. The site-specific monitoring data could then be used to evaluate and refine the state-and-transition models. Gaps in information would serve to prioritize research needs.

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