

Ecological Implications of Using Goats for Control of Juniper in Texas

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Abstract—The Edwards Plateau region of central Texas supports a rich diversity of plants and animals. The diversity and abundance of trees and shrubs is especially noteworthy, but two species of juniper (*Juniperus ashei*, *Juniperus pinchotii*) now dominate much of the landscape. Goats are currently being recommended to control juniper infestations. The concept of using biological methods for the control of nuisance plant species has gained much attention in recent years. Some claim that biological control is more environmentally friendly and cost effective than herbicides or heavy equipment. Because juniper is one of the poorest browse plants in the region, other more desirable shrubs are browsed in preference to juniper. While goats can be managed to cause damage or even death to juniper, this level of browsing is very detrimental to a host of more palatable shrubs and trees. These more palatable species become stunted and unproductive and often die prematurely when subjected to this kind of browsing. Reproduction is impaired and eventually they are lost from the local plant community. These harmful side effects of biological juniper control are not often considered by practitioners. These side effects are easily observed, but have not been scientifically studied nor quantified.

Background and History

The Edwards Plateau region of Texas is a 24 million acre area that lies in the central and southwestern portion of the State. The region is characterized by rolling to steep topography, shallow, rocky, limestone soils, and receives 14 to 32 inches of rainfall on a west to east gradient. The region is biologically very diverse being the transition between forests to the east and deserts to the west and between grasslands to the north and thorn shrublands to the south. There are about 2,500 species of vascular plants native to the region (Hatch and others 1990).

The historic climax plant communities varied greatly, depending on soils, topography, rainfall, and the extent of natural fire. Historic landscapes included mid grass prairies on the flatter divides, oak savannas across the rolling uplands, juniper-oak woodlands in the canyonlands and steep terrain, and riparian forests. Most natural resource professionals agree that periodic and recurring wildfire was responsible for maintaining the open character of the prairie divides and the rolling oak savannas (Smeins 1980). This fact was recognized in the early 1900s (Bray 1904; Foster 1917).

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The presence and extent of juniper in pre-settlement times has been hotly debated and argued by ranchers, natural resource managers, ecologists, and environmentalists. Despite the ongoing debate, the historical record is abundant and clear that juniper was common and dominated some sites, and was uncommon or absent on other sites (Curtis 2000; Smeins 1980; Weniger 1984).

The region is almost entirely privately owned ranches and has been grazed by domestic livestock for over 100 years. Various combinations of cattle, sheep, goats, exotic ungulates, and native white-tailed deer are present across the region and are the basis of the ranching and hunting economy.

Because of poor grazing management and the resulting reduction in fires, the vegetation and general appearance of the region has changed dramatically over the past century (Smeins and others 1997). Herbaceous cover has been degraded by heavy and continuous grazing. Tall and mid grasses and desirable forbs have been eliminated or greatly reduced in most pastures. A sparse ground cover of low successional species and excessive bare ground has caused poor infiltration, accelerated runoff, and erosion. The lack of adequate fine fuel has greatly reduced the opportunity for natural or prescribed fire.

Juniper Encroachment

As grasslands were thinned by heavy and continuous grazing, fires were not able to burn with the intensity or at the scale and frequency required to suppress and control increases in woody plants. Several species of woody plants including two species of juniper have taken advantage of this opportunity. Red-berry juniper (*Juniperus pinchotii*) and Ashe juniper (*Juniperus ashei*) have increased in extent in response to the overgrazing and subsequent lack of fire. Rangeland managers often refer to this as an “invasion” as if juniper had some insidious power to overwhelm healthy grasslands. Others consider the increase of juniper merely a natural ecological response to a man-made disturbance.

The spread and increase of juniper into what formerly were grasslands and savannas has caused problems for the rancher. The cover of grass that had already been altered by grazing practices was being weakened further by increases in juniper. The shading of grasses by the juniper canopy, the competition for moisture, and the interception of rainfall all contribute to the progressive loss of grass cover and forage (Thurrow and Carlson 1994; Ueckert 1997). The inability of the rancher to see and manage livestock is also impaired by increases in juniper. Several million acres of once productive grazing land now supports dense canopies of juniper and sparse densities of grass.

Juniper Control

Since increases in juniper were first observed, ranchers as well as agricultural and conservation agencies have been busy discovering and promoting methods to control juniper (Wolff 1948). Many different methods have been used and millions of dollars spent to kill juniper. Mechanical methods including grubbing, dozing, chaining, and rootplowing with large equipment have been popular (Scifres 1980). Hand cutting of ashe juniper, a nonsprouting species has long been used and is effective. Chemical methods have been tried but with limited and small scale success. The use of prescribed fire is gaining in popularity, yet most landowners are either unwilling or unable to use this method, and less than one-tenth of 1 percent of the acreage in the region is burned each year (Nelle, unpublished data).

Regardless of the method of control or the effectiveness of control, one thing is certain: juniper begins to reappear and increase soon after it has been removed. Many areas within the Edwards Plateau have had all juniper removed several different times in the past 50 years only to see it return to undesirable densities. In the ecological tussle for control of the landscape, juniper is winning and healthy grasslands are loosing.

Goats

Goats have been numerous in the region for over 100 years. The Edwards Plateau has led the country in goat production ever since records have been kept. Goat numbers reached their peak in the mid 1960s with about 4 million head. Since that time, goat numbers have declined (Findley 1990). Goat numbers on individual ranches are commonly as high as one goat per 3 to 5 acres.

Diet and food habit studies have confirmed that goats eat large amounts of browse even when other kinds of forage are available (Bryant and others 1979). The rich diversity and the abundance of desirable woody plants in the Edwards Plateau have provided a natural resource base for a thriving goat industry. When managed on a renewable basis the raising of goats can be very compatible with the sustainability of the browse resource (NRCS 1994)

Are Goats Nature's Herbicide?

Some agricultural professionals have been making the claim in the popular media that goats are "nature's herbicide" and an "environmentally friendly" way to control juniper. The word, "herbicide" literally means "plant killer." It is true that goats or any other kind of livestock can be managed intentionally or unintentionally in a way that causes harm to plants. Grazing or browsing an excessive amount of leaf material will necessarily reduce the photosynthetic ability of a plant to sustain itself. If this excessive level of leaf removal continues, plants will be reduced in vigor and can eventually be killed. When this process is unintentional and unplanned, it is called overgrazing or overbrowsing. When it is planned, it is often called biological control.

There is an important distinction between the normal consumption of juniper by goats and the biological control of

juniper. Goats and deer will naturally consume some juniper as a part of their diet, especially in winter when the availability of other green browse is limited. This degree of normal browsing is not heavy enough to exert physiological damage to established plants although some seedling mortality is likely to occur.

Side Effects

When any land management practice is considered, it is wise to evaluate the potential negative side effects prior to full-scale endorsement (Hughs 2000). If a practice successfully meets the intended objective and if associated side effects are minimal or tolerable, the practice might be safely prescribed. If the practice meets its objective, but there are serious unintentional side effects, the practice would at least be considered questionable. The consequences of the side effects would be weighed against the benefits before the practice is recommended. In the case of biological control of juniper with goats, the ecological side effects are substantial.

Juniper is one of the least preferred browse plants of the region. The secondary chemical compounds in the leaves make juniper relatively unpalatable to browsing animals (Launchbaugh and others 1997). This built-in defense mechanism against browsing is one reason why juniper has proliferated in the face of large numbers of browsing goats and deer. Even though juniper is nonpreferred and relatively unpalatable, goats can be managed for an unnaturally high consumption of juniper, even to the point of causing injury and death of juniper.

Goats, like most other herbivores are selective feeders. They will selectively consume the best, most palatable plants in preference to less palatable plants. As the more preferred plants become heavily browsed, goats will move to progressively less and less preferred plants. A host of more palatable woody plants will be very heavily browsed when goats are forced to eat unnaturally high amounts of juniper (table 1). When such heavy use continues over a sustained period, the woody plant diversity of the area suffers loss. Although most ranchers agree that there are many desirable kinds of shrubs and trees, their dislike of a few brush species such as juniper often overshadows their desire to manage the beneficial species.

An experienced observer can easily discern this loss or reduction of desirable woody species across the region. Decades of heavy goat grazing have caused distinct browse lines on preferred and moderately preferred species. All growth within reach of animals is consumed. Shorter plants exhibit severe hedging, a reduction in leaf size, dead twigs and branches, and an overall reduction in vigor. Flowering and seed production is curtailed. Successful reproduction, if it occurs at all, is limited to protected sites where goats and deer cannot browse. This reduction of plant diversity is one of the major side effects of this practice.

Ecological Implications

The reduction of plant diversity is a fairly clear side effect of heavy goat browsing. The long term ecological implications of this loss are less clear but should be considered. There has been little or no research in this area. In the

Table 1—A partial listing of desirable woody plants that are browsed in preference to juniper and that may be lost under heavy browsing.

Common name	Scientific name
Texas kidneywood	<i>Eysenhardtia texana</i>
Littleleaf leadtree	<i>Leucaena retusa</i>
Texas sophora	<i>Sophora affinis</i>
Carolina buckthorn	<i>Rhamnus caroliniana</i>
Mountain mahogany	<i>Cercocarpus montanus</i>
Texas mulberry	<i>Morus microphylla</i>
White honeysuckle	<i>Lonicera albiflora</i>
Black cherry	<i>Prunus serotina</i>
Hawthorne	<i>Crataegus crusgallii</i>
Rusty blackhaw	<i>Viburnum rufidulum</i>
Inland ceanothus	<i>Ceanothus herbacea</i>
Texas oak	<i>Quercus texana</i>
Netleaf hackberry	<i>Celtis reticulata</i>
Cedar elm	<i>Ulmus crassifolia</i>
American elm	<i>Ulmus americana</i>
Black willow	<i>Salix nigra</i>
Bumelia	<i>Bumelia lanuginosa</i>
Clematis	<i>Clematis drummondii</i>
Roemer acacia	<i>Acacia roemeriana</i>
Wild plum	<i>Prunus angustifolia</i>
Redbud	<i>Cercis canadensis</i>
Grapevine	<i>Vitis</i> sp.
Virginia creeper	<i>Parthenocissus quinquefolia</i>
Greenbriar	<i>Smilax bona-nox</i>
Carolina snailseed	<i>Cocculus carolinus</i>
Western soapberry	<i>Sapindus drummondii</i>
Elbowbush	<i>Forestiera pubescens</i>
Ephedra	<i>Ephedra antisyphylitica</i>
Live oak	<i>Quercus virginiana</i>
White shin oak	<i>Quercus durandii</i>
Vasey shin oak	<i>Quercus pungens</i>
Blackjack oak	<i>Quercus marylandica</i>
Skunkbush sumac	<i>Rhus trilobata</i>
Evergreen sumac	<i>Rhus virens</i>
Littleleaf sumac	<i>Rhus microphylla</i>
Flameleaf sumac	<i>Rhus copallina</i>
Feather dalea	<i>Dalea formosa</i>
Roughleaf dogwood	<i>Cornus drummondii</i>
Buttonbush	<i>Cephalanthus occidentalis</i>

absence of unbiased scientific studies, general knowledge, common sense, and experience must be used to consider what the implications may be. A reduction in native plant diversity has the probability of impacting native wildlife diversity. Changes in specific cover requirements and the diversity of food items may affect a whole array of bird species. Simplified plant communities are usually less stable and resilient than more diverse communities. Energy and mineral cycling through an ecosystem is impaired when plant diversity suffers. Soil microbes, soil tilth, and soil stability may be affected when plant communities change. Riparian health and stability are most certainly impacted with a loss of key woody species. Consequently, water quality and fish habitat are affected. Indirectly, gradual damage to the natural resource base (soil, water, plants, animals) will lead to insufficient economic returns from ranching and land-owners may be forced to subdivide and sell off native ranges for the profits of commercial and residential development.

A Holistic Perspective

Natural resource managers would be wise to take a long term, wide-angle look at land management practices before they are recommended (White 2000). Instead of looking at a single facet of a problem (such as an increase in juniper) and a simple solution, managers need to take a more ecologically holistic view (Nelle 1997). Considering the causes of a problem, distinguishing between symptoms and root causes, and discovering the possible side effects of various treatments are essential elements of wise land management. In the case of juniper and its control with goats, the following considerations are important in gaining a holistic perspective:

1. Juniper–oak woodlands are the native climax vegetation type on certain sites in the region. Juniper control on these sites is ecologically questionable.
2. Juniper has encroached and increased on other sites where it was not a part of the climax vegetation.
3. Under conditions of overgrazing, the increase of juniper is the natural ecological response and provides a degree of protection to the site.
4. Juniper encroachment is due directly to a reduction in fires and indirectly to overgrazing, which prevents the buildup of adequate fine fuel.
5. The increase of juniper to undesirable densities causes significant problems for ranching.
6. The control of juniper where it has encroached should only be considered after a long term commitment has been made to proper grazing management.
7. The periodic use of fire to control small encroaching juniper is strongly encouraged.
8. Goats can be managed to exert some control of juniper, but at the expense of many other desirable woody species.
9. Maintaining the native plant diversity of a site is important to wildlife habitat, soil health, watershed function, ecological stability, and economic viability.

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