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Drivers of Vegetation Change on Texas Rangelands

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Rangeland vegetation in Texas is diverse and changing. The main causes of this change are natural factors, human activities, and large-scale (macro) vegetation changes. Ranchers who understand these factors can design better integrated management programs for their rangelands.

Natural factors that typically affect vegetation at a macro-scale include:

- soil type
- soil microbes
- insect infestations
- drought and rain cycles
- wind and rain erosion
- fire
- increasing carbon dioxide (CO_2) concentrations in the atmosphere

Human activities that drive vegetation change can have a negative or a positive impact. Negative activities include:

- land fragmentation
- overgrazing livestock
- vehicle traffic
- oil and gas drilling
- accidental distribution of unwanted seeds

Positive activities include:

- restoration and reseeding efforts
- brush management
- grazing management
- protection of critical land

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Vegetation changes at the macro level will eventually alter the plant populations in smaller (micro) areas such as individual ranches, or even smaller parcels of land. These secondary changes can occur when weeds, grasses, or woody plants affect the existing vegetation in a particular area (Fig. 1). The rate of change in vegetation can be slow or fast, depending on the cause.

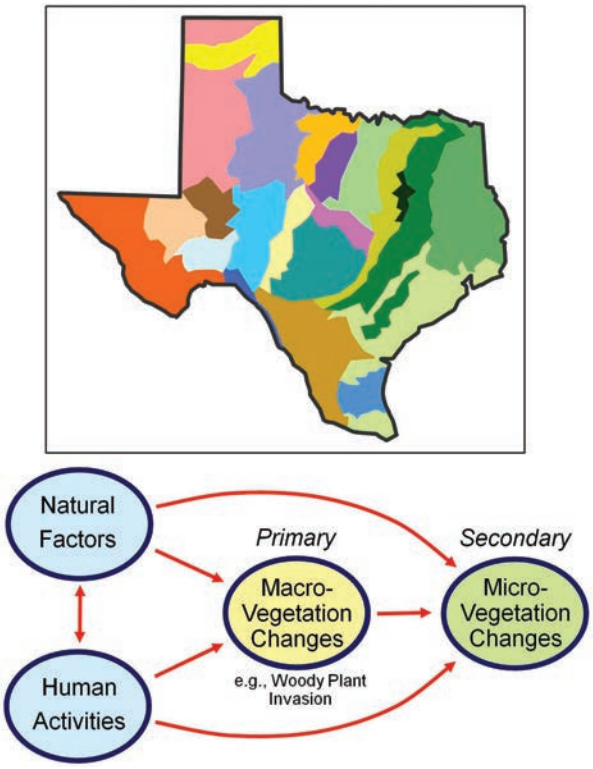

Figure 1. Major vegetation regions in Texas (top) and flow chart illustrating causes and effects of change on vegetation (bottom).

Woody plants (or "brush") are becoming more prevalent all across Texas (Fig. 2). This increasing woody cover both benefits and harms rangeland ecosystems and rural economies. Advancing brush cover reduces grass production for the livestock industry and often increases bare ground and soil erosion, but it can increase wildlife hunting opportunities.

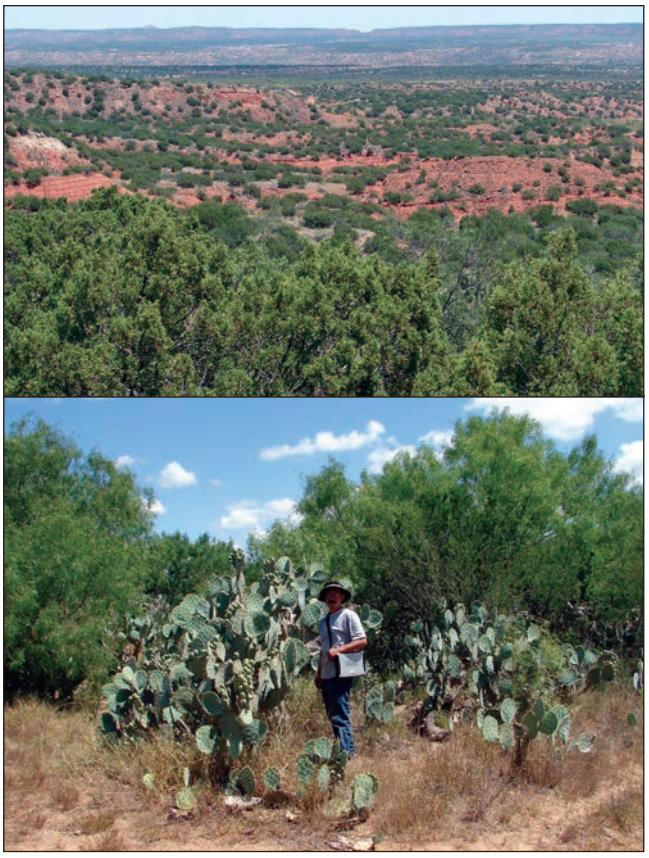

Figure 2. Redberry juniper invasion in northwest Texas (top). Honey mesquite and pricklypear cactus invasion in South Texas (bottom).

What caused this macro-scale change in Texas vegetation?

Key drivers of woody encroachment are fewer natural fires, more cattle grazing, and climate effects. Before the southern Great Plains were settled by Europeans, it is estimated that in most areas, fires occurred every 1 to 6 years (Fig. 3). Since then, less frequent fires are thought to contribute greatly to the increase of woody plants.

Fire can control the spread of woody plants by killing their seedlings; however, these plants are vulnerable to fire for only short periods. Research shows that

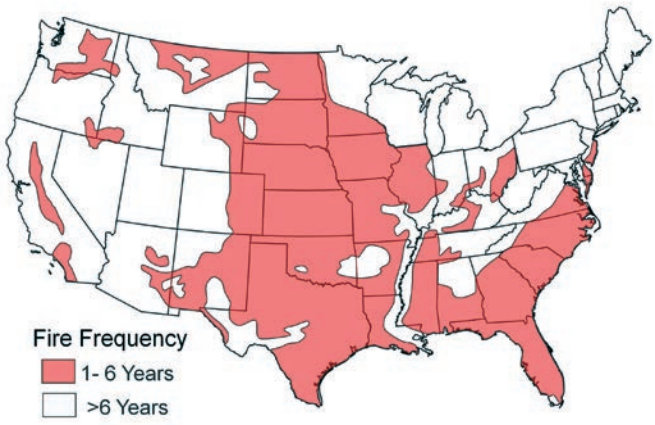

Figure 3. Presettlement fire frequency in the United States. (adapted from Frost, 1998)

mesquite seedlings less than 1.5 years old are very vulnerable to fire, but survival of older seedlings increases considerably, especially in low-temperature fires (Fig. 4). Therefore, even a 3 year interval between fires is too long to kill many mesquite seedlings, suggesting that factors other than fire have driven brush expansion.

	% Mortality at Fire Temperature	
Seedling Age (Yrs)	220 F (104 C)	435 F (224 C)
0.5	43	91
1.5	60	100
2.5	20	40
3.5	8	8

Figure 4. Mesquite seedling death based on age and fire temperature (Wright et al., 1976).

Cattle grazing has caused the spread woody plants for several reasons. First, in mid-summer when ripe beans fall to the ground, cows eat the beans and then deposit them via manure across the landscape. A cow's digestive system roughens the seed coat and primes the seeds for germination. These seeds are often deposited in open areas away from competing adult mesquite trees. One study found that 42 percent of cattle dung piles with emerging seedlings established at least one mesquite plant (Fig. 5). Wildlife can also contribute to woody plant invasion but the degree to which they have an effect is thought to be much less than cattle. Deer, for example, have been observed consuming mesquite beans and occasionally a mesquite seedling will be seen emerging from a deer pellet (Fig. 5).

A second way that cattle promote woody invasion is less direct than distributing seed. Overgrazing can deplete the amount of standing grass and thus reduce the effectiveness of any fire that might keep woody plants in check.

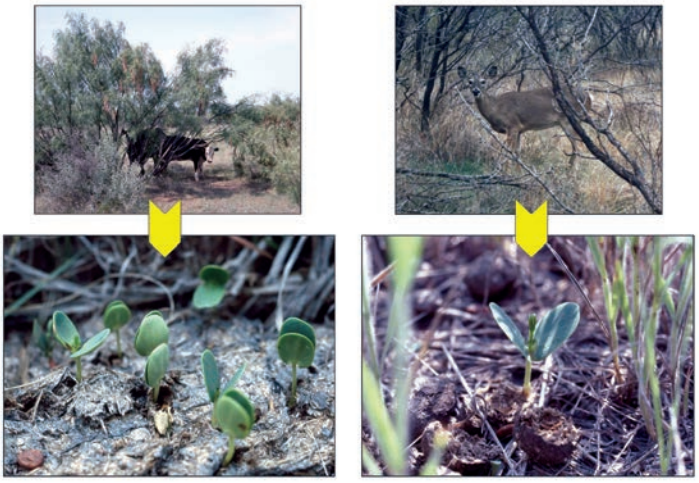

Figure 5. Mesquite seedlings emerging from cattle dung and deer pellets. See Kramp et al. 1998.

Overgrazing may also directly reduce the ability of grasses to compete with woody plants. Healthy stands of grass can limit but not stop woody plant invasion. The example in Figure 6 shows a healthy stand of grass that was planted as part of the Federal Conservation Reserve Program (CRP) in which an area farmed for many years was seeded to grassland and not grazed to conserve topsoil. Even under this condition, mesquite seedlings established. Because the area had been farmed for many years, there was probably not much mesquite seed already in the soil—seed was probably brought in by wildlife (deer, feral hogs, rodents) from the adjacent mesquite thicket shown in the background. Regardless of their source, emerging mesquite seedlings can establish within stands of grass.

Though the presence of mesquite and other brush species was documented by the earliest European settlers, most of the southern Great Plains at that time is thought to have been grassland or very open savanna (grassland with scattered woody plants). Brush encroached slowly as deer and other wildlife spread seed around established clusters. These clusters gradually expanded, but the expansion was localized (Fig. 7, left).

In the late 1800s, cattle herds increased rapidly and during drives from south to north they would rest

Figure 6. Mesquite seedlings emerging in a healthy grass stand near Haskell, Texas (top), and juniper gradually invading from an initial plant into successive generations of plants (bottom).

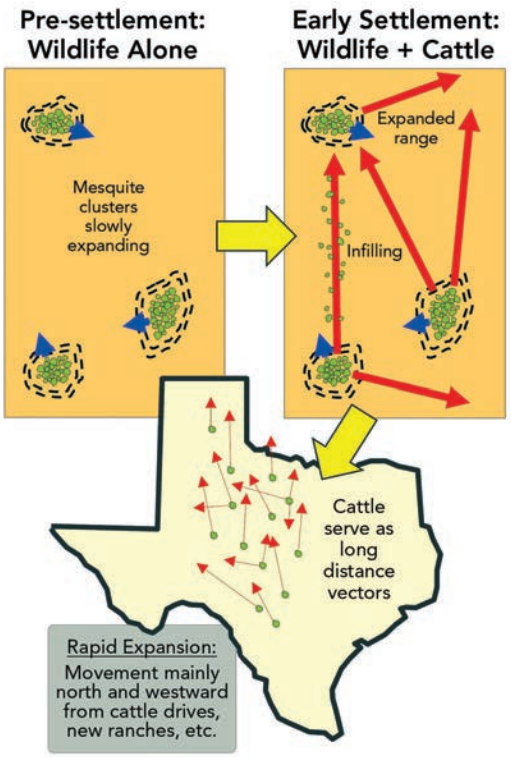

Figure 7. Wildlife expanded clusters of mesquite slowly in Texas (upper left). Cattle expanded the mesquite range greatly and filled in the areas between mesquite clusters (upper right). Mesquite populations expanded to the northwest (bottom).

and eat mesquite beans from under mesquite patches then move to another location miles away the next day. These herds moved an average of 15 miles a day, spreading seed between established mesquite patches and expanding the overall range of the species (Fig. 7, right). In addition to cattle drives, settling and establishment of new ranches in the northwestern portions of Texas led to the continual presence of cattle in new regions. The overall effect statewide was an increase in mesquite distribution and density in a northwesterly direction (Fig. 7, bottom).

The way juniper spreads is not as obvious but multiple generations of juniper plants can often be seen in the same stand (Fig. 6). Cattle don't eat juniper seeds, yet redberry juniper coverage in northwest Texas increased by 61 percent between 1948 and 1982 (Fig. 8). Juniper expansion continues today. Birds do spread juniper seeds, but juniper did not begin expanding dramatically until after European settlement. It appears, therefore, that fire limited juniper expansion more than it did mesquite. Unlike mesquite, juniper can be killed by fires even when plants are up to 8 years old.

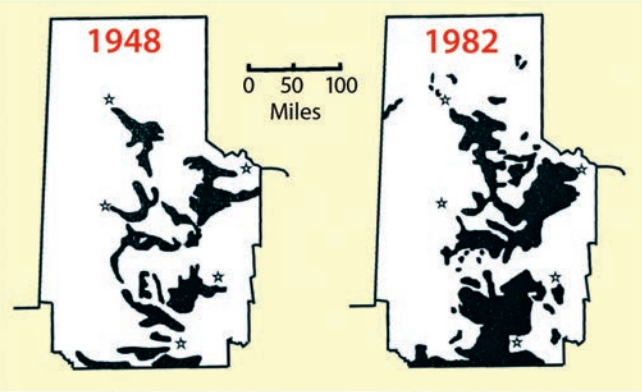

Figure 8. Redberry juniper distribution in northwest Texas from 1948 to 1982 (Ansley et al., 1995). Amarillo, Lubbock, Vernon, Abilene and San Angelo are indicated.

Climate also affects the spread of woody plants. There is evidence that the amount of CO_2 in the atmosphere has increased significantly worldwide since the mid-1800s. Some estimates put the concentration at about 280 ppm in 1750 and studies show an increase from around 320 to 390 ppm since 1958. This increase favors growth of plants like mesquite, juniper, and cool-season grasses because they have a different photosynthetic pathway than do most of the tall grasses such big bluestem or mid-grasses such as sideoats grama. The result is that higher CO_2 concentrations give woody plants a competitive growth advantage over many of the primary plains grasses.

Other factors such as drought also can increase the spread of woody plants, especially when coupled with fewer fires and cattle grazing. In the southern Great Plains, droughts are frequent and the added pressure of continual grazing leaves little grass. Any new grass that is produced by short periods of rain is eaten quickly, leaving weak stands that compete poorly with woody plants.

Figure 9. Mesquite tree showing lateral roots and branching taproot.

Unlike grasses, woody plants have deep root systems that can reach soil moisture five or more feet underground. Some species like mesquite have extensive networks of lateral roots, as well as a deep taproot. Mesquite uses its lateral roots to compete directly with grasses for shallow soil moisture immediately following rains, but can survive on deep moisture during droughts when grasses go dormant or die (Fig. 9).

How does woody encroachment change other vegetation?

Research in South Texas shows that as brush encroaches, the production and diversity of grasses declines from tall- to mid- to short and finally annual grasses (Fig. 10). The landscape eventually transitions from grassland to shrubland and it will not return to grassland unless there is a major disturbance such as a fire. In a brush-dominated landscape, grass succession operates only within the bounds of what is possible

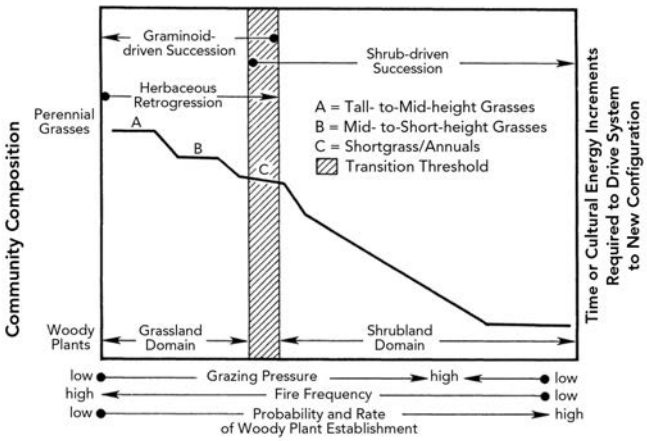

Figure 10. Vegetation responses to increasing woody expansion in South Texas (Archer et al., 1990).

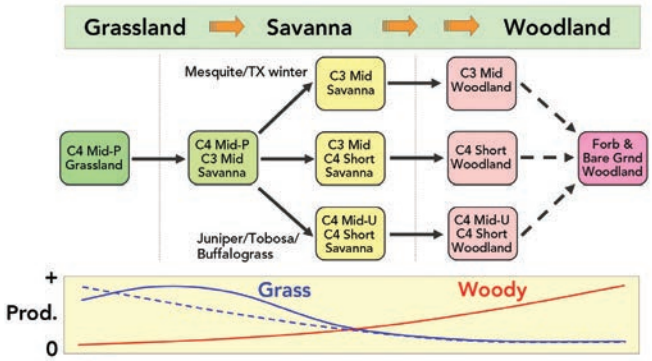

Figure 11. As woody plants encroach into grassland, grass production drops in North Texas. (Ansley, unpublished observations).

C3 Mid = cool-season mid-grasses (mainly Texas wintergrass)

C4 Short = warm-season short grasses (buffalograss, etc.)

C4 Mid-P = palatable warm-season mid-grasses (sideoats grama, etc.)

C4 Mid-U = unpalatable warm-season mid-grasses (tobosagrass)

under shrub dominance; grasses may shift from short-grasses to annuals, but will not revert to tall-grasses.

Figure 11 shows how grasses in North Texas respond to woody encroachment. Those plant communities are a mixture of warm-season grasses and perennial cool-season grasses, such as Texas wintergrass. As woody encroachment increases, grasslands become savannas and the ground cover shifts from mostly mid-grass to a mixture of mid-grasses and Texas wintergrass.

As the landscape shifts from savanna to woodland, three types of grassland are possible (Fig. 11). Two of these are typical responses to mesquite encroachment—a savanna dominated by a cool-season mid-grass such as Texas wintergrass, and a mixture of Texas wintergrass and short-grasses such as buffalograss.

A third type of grassland develops in the western part of North Texas, mostly in response to increasing redberry juniper. These grasslands are dominated by buffalograss and a drought tolerant mid-grass, tobosagrass, which is unpalatable to livestock.

These three types of grassland seem able to persist until woody cover is nearly 100 percent. However, under heavy grazing, these grass communities will

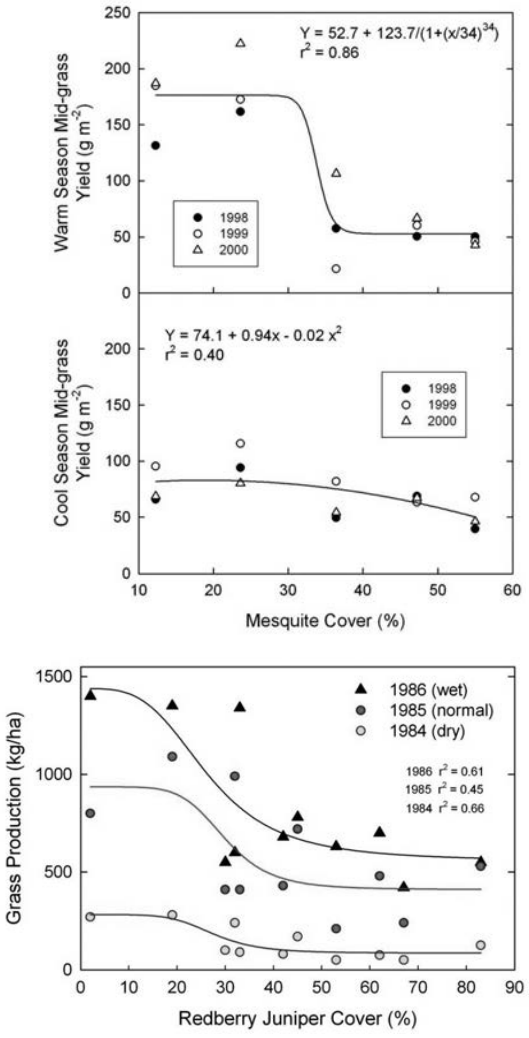

Figure 12. Reduced grass production caused by increases in mesquite (Ansley et al., 2004–top); and redberry juniper (McPherson and Wright, 1990–bottom).

eventually give way to forbs (e.g. ragweed, broomweed) and bare-ground.

Many studies have shown that grass production declines with increasing brush cover, as depicted by the blue dashed line in Figure 11. Other studies found grass production is steady or slightly enhanced when brush is sparse and declines as brush cover increases (solid blue line).

Studies show that warm-season mid-grasses such as sideoats grama maintain production at up to about 20 percent mesquite canopy cover but decline sharply under higher covers (Fig. 12, top). The cool-season mid-grass, Texas wintergrass, production is slightly enhanced under light mesquite cover and mostly unaffected by increasing mesquite cover. In another study, total grass production responded similarly to increasing redberry juniper cover in contrasting precipitation years in West Texas (Fig.12, bottom).

Summary

Many natural and human factors affect vegetation changes on Texas rangelands, both locally (micro) and regionally (macro). Local herbaceous changes are often secondary responses to macro-scale influences, such as woody plant invasion. People will continue to have positive and negative impacts on vegetation in rangeland ecosystems. Often these impacts can be significant and irreversible. Therefore, baseline information that considers the effects of multiple factors on rangeland vegetation is essential for designing economically and ecologically effective rangeland management programs.

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