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Long-Term Changes in Cottonwoods on a Grazed and an Ungrazed Plains Bottomland in Northeastern Colorado

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Long-term Changes in Cottonwoods on a Grazed and an Ungrazed Plains Bottomland in Northeastern Colorado[1]

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Numbers of cottonwood trees declined between 1961 and 1978 on a grazed and an ungrazed bottomland in northeast Colorado. Cottonwoods were larger in diameter in 1978, but basal area stocking was unchanged. Trees were taller in 1978 on the ungrazed area, and amounts of canopy deadwood were greater on both areas. Water management, grazing by livestock and deer, plant competition on the ungrazed area, and beaver-felling of young trees all contributed to a lack of regeneration that appears responsible for the general decline in overstory vegetation.

Cottonwood bottomlands are unique habitats in the shortgrass plains of eastern Colorado. They provide almost the only native tree cover and are inhabited by many species of wildlife. Bottomlands also provide livestock pastures that are protected from the severe winter weather so common on the Plains.

Albertson and Weaver (1954) found that the number of native woody species decreased westward from the Mississippi River. Pioneer tree types, such as cottonwood (*Populus* spp.), willow (*Salix* spp.), elm (*Ulmus* spp.), and boxelder (*Acer negundo*), extend furthest west, but only along water courses. Along the South Platte River, in northeastern Colorado, cottonwoods (P. *deltoides* var. *occidentialis*) and willows (S. *amygdaloides*) are virtually the only trees remaining from the large number of species found further east.

Aboreal vegetation was apparently sparse in the last century compared to today along the South Platte River (Conklin 1978, Fremont 1956, Fuller and Hafen 1957, Ware 1911, Williams 1976).

Large-scale ranching began in the late 1860's. During most of the year, cattle were scattered on upland ranges, but in winter they would move to native hay meadows along the river. Irrigated farming began in the early 1860's using water diverted from the river, but large-scale operations did not begin until later in the 19th century. Land-use patterns are similar today.

By the late 1950's, cottonwoods of various sizes were relatively abundant over most of the South Platte bottomlands. In mid-summer, some seedlings were present on moist sandbars and along the edges of recently inundated channels. Older trees up to 1 foot d.b.h. occurred in fairly dense groves, usually along dormant

[1] *The research reported from 1961 was conducted while the author was with the Colorado Cooperative Wildlife Research Unit, Colorado State University, and the Colorado Game and Fish Department. The work in 1978 was conducted at the Rocky Mountain Forest and Range Experiment Station.*

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channels, while the largest individuals, up to 30 inches d.b.h., were widely scattered and usually considerably distant from the river channels. Willows were fewer in number, but similarly distributed.

The Study

Cottonwood on two tracts of bottomland along the river between the towns of Crook and Iliff, Colorado, were studied from 1959 to 1961 to determine effects of grazing on wildlife habitat (Crouch 1961). In this area, the bottomland plant community averaged about one-half mile in width, and the main river channels meandered within the belt. One of the 2-linear-mile tracts was owned by the Colorado Game and Fish Department (now Colorado Division of Wildlife) and had been protected from grazing for about 7 years. The second tract, privately-owned, was located about 10 miles upstream. It was subjected to several grazing regimes, with cattle present all year on some portions, and seasonally on others. Data were collected again in 1978 from the same study transects. The results derive therefore, from bottomland protected from grazing for 8 and 25 years, and from a similar area grazed continuously during that time.

Methods

Cottonwoods were inventoried along 10 baselines, spaced one-fifth mile apart, extending across the bottomlands on each study area. In winter 1960-61, three permanently marked sampling points were randomly spaced along each transect on the ungrazed tract, and similar points were temporarily established on the grazed area. Each point served as the center of a 0.1-acre circular sampling plot on which trees were counted, and the d.b.h. and height of each tree was determined. Estimates were also made of percentages of live wood in the tree crowns as a measure of relative vitality.

In spring 1978, most of the permanent plots on the ungrazed area were located and remeasured. On the grazed tract, sampling plots were again randomly spaced and measured along transects reestablished close to those utilized in 1961.

Data were analyzed by t-tests at $P = 0.05$. Data from 1961 and 1978 were compared for the various attributes evaluated on each study area.

Results

Numbers and characteristics of cottonwoods measured in 1961 were similar on both study areas (table 1). Cottonwoods were widely distributed (63% of plots occupied), and frequencies were the same on the ungrazed and grazed tracts. Relative vitality of cottonwoods was also similar between areas.

By 1978, numbers of cottonwoods had declined by 33% on the ungrazed and 53% on the grazed area (table 1). The trees were larger in diameter in 1978 than in 1961, and partition into 5-inch-diameter classes showed a dramatic shift to larger individuals (fig. 1). Basal area stocking was not significantly different between years on either area. Although fewer trees were counted, those present were larger in diameter than in 1961. Cottonwoods were significantly taller in 1978 than in 1961 on the ungrazed area, but not on the grazed tract. Relative vitality of cottonwoods also declined between the two measurements on both areas.

Table 1.—Characteristics of cottonwoods in 1961 and 1978 on a grazed and an ungrazed bottomland in northeast Colorado

	Grazed		Ungrazed	
	1961	1978	1961	1978
Number/acre	38.3	[1]17.6	47.7	[1]32.0
D.b.h. (*inches*)	8.9	[1]13.4	8.6	[1]12.8
Height (*feet*)	29.9	31.8	27.1	[1]35.4
Basal area/acre, (*square feet*)	25.8	21.1	28.9	33.4
Live crown, (*percent*)	70.1	[1]48.2	72.1	[1]55.8

[1]*Year values within this category and grazing class are significantly different (P = 0.05).*

Discussion

Conditions for tree growth in the bottomlands probably began to improve about 1900, when irrigation projects somewhat stabilized the flow of water in the river, and provided a year-round surface and shallow subsurface flow. Gradual

reduction in livestock grazing and changes in their season of use probably also contributed to the relatively high number of trees observed in 1961. Heavy grazing has long been recognized as a detriment to the reproduction of cottonwoods and other bottomland hardwood trees (Kellogg 1905, Putnam 1951).

Although no data are available, it seems reasonable to assume that numbers of trees reached a high point in the 1950's and declined since then. Moreover, current evidence points to a continued decline in numbers on both study areas, if the same environmental conditions persist that have occurred between 1961 and 1978. Data from the few cottonwoods cored and aged in 1978 indicated that trees greater than or equal to 12 inches d.b.h. were more than 50 years old. More than 50% of the cottonwoods on the ungrazed tract and 60 percent of those counted on the grazed area were in this diameter class (fig. 1). Five trees, ranging from 7 to 10 inches d.b.h., were estimated to be 30 to 40 years old.

Several causes appear plausible to explain the decline in cottonwoods. Completion of their life-cycles has removed many of the older trees, but mortality has been lowest within this class. Insects and disease may also be the important reasons, but no evidence was observed to support them as major causes. Beavers account for removal of many of the smaller trees. Lowering of water tables, believed responsible for cottonwood mortality elsewhere on the Plains, did not occur, according to long-term records from wells adjacent to the study areas (Hurr et al. 1975, Major et al. 1975). Mechanical restructuring of the main channel after floods in the 1960's removed some trees from the ungrazed tract. Browsing by livestock on the grazed area and by increasing numbers of deer on both areas also probably restrained cottonwood reproduction. Competition from the protected understory vegetation may have limited regeneration on the ungrazed tract. Among all possibilities, the most important factor appears to be water management.

Barclay (1924) and Putnam (1951) stated that cottonwood seed requires bare, moist, mineral soil for germination. Such sites were uncommon on the ungrazed tract during the spring and early summer of the earlier study period, and presumably in most years since protection. Herbaceous growth began in early spring, and on the ungrazed tract, grasses and forbs soon covered nearly all areas not already occupied by woody vegetation. By early summer, when cottonwoods were disseminating seed, herbs

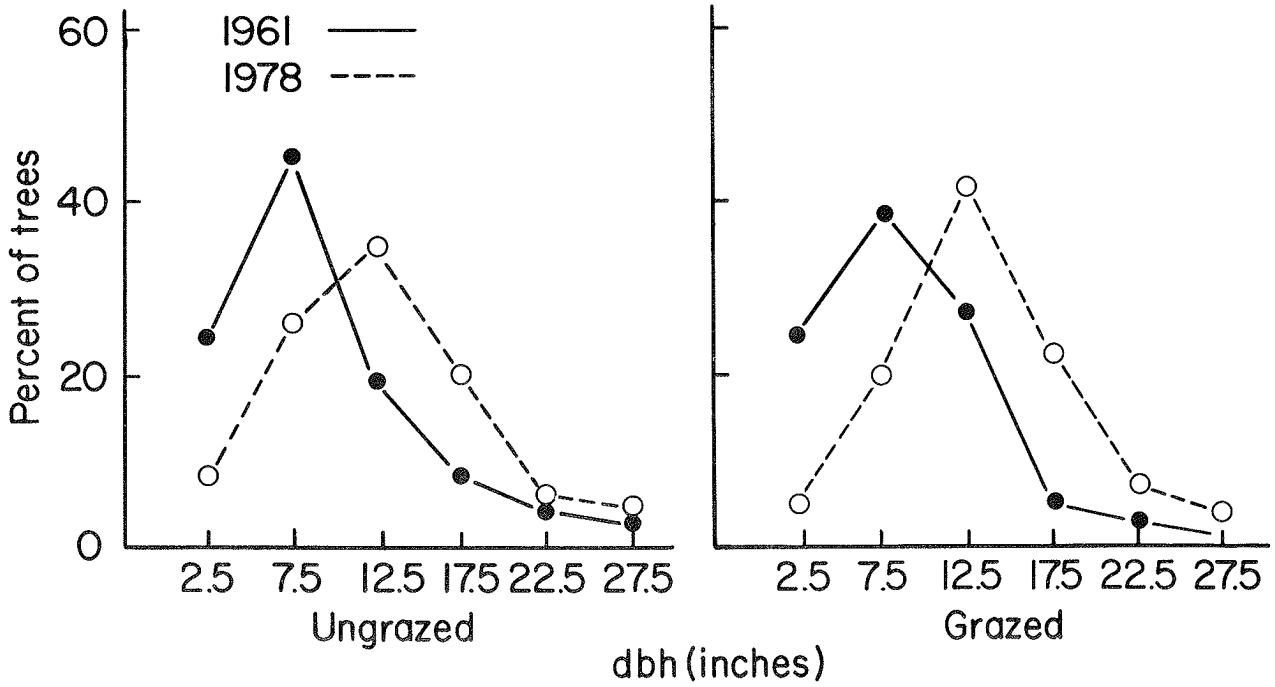

Figure 1.—Diameter class distribution of cottonwood trees in 1961 and 1978 on a grazed and an ungrazed bottomland in northeastern Colorado.

had reached heights of 1 to 3 feet. The only available sites for cottonwood germination on the ungrazed bottomland were in the channels themselves where water levels did not begin to recede until late June. Actually, in 1960 and 1961, there was an abrupt decline in river flow in mid-June when the water level dropped about 2 feet in a few days because of irrigation demand. This decrease bared most of the channel bed, which dried out almost immediately because of its sandy-gravelly texture. It was only on the margins of the permanently flowing main channels, or around small pools cut off from main channels that seedlings were found; by late September these were once again submerged by the increased flow of post-irrigation water.

The grazed area offered a more suitable habitat for the germination and establishment of trees. The main channels were wider, partially because of less plant cover to retard erosion, and minor reductions in volumes of water flow caused extensive areas of potential seedbeds to be exposed. However, the large numbers of cattle present during the spring and early summer consumed virtually all of the seedlings that sprouted.

All of these factors probably contributed to the lack of regeneration that seems largely responsible for the general decline in cottonwoods on both areas. Moreover, it is likely that numbers of trees will continue to decline if (1) upstream controls on riverflow are effective in preventing overbank flooding during seed dissemination, (2) understory vegetation remains totally protected from livestock grazing and fire on the ungrazed area, (3) heavy livestock use continues on the grazed tract, and (4) predation by beavers continues at the current rate.

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