Distribution and Control of Several Woody Plants in Texas and Oklahoma

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DURING the period that civilized man has held dominion over the Southwest, dwarf forests of invading shrubs and small trees have insidiously taken possession of millions of acres of the remaining uncultivated grassland. Acreage of mesquite alone in Texas and Oklahoma is greater than the area of the state of Wyoming.

Many have been deceived into believing that trees and brush moved in like a plague or passover and killed out the grass (*13*), but that viewpoint is slowly dying out as the real cause of grass destruction and brush invasion is being understood.

The primeval grasslands that were free of brush stayed free of brush because the dominating grasses had the strength to hold the land against invaders. When livestock crowded the ranges and ate down the best grasses first, the lower class plants which succeeded them were not strong enough to hold off the aggressive brush and trees.

The original native grasses grow with trees and brush when correct grazing is practiced. On heavily grazed brush ranges, the only traces of original grasses are usually found within the thorny basal branches of brush, which guard the grasses against grazing animals. One Texas ranchman says that a sure clue to range improvement is when grazing lightens up so the good grasses can "come out of the bushes into the open". Cedar and other evergreen plants with dense horizontal spreading branches shade the ground so completely that they afford little or no sanctuary to grasses.

While the good grasses may flourish in brush land, they can never reach excellent condition until the trees or shrubs are killed out.

Successful removal and control of dense stands of undesirable woody vegetation gives farmers and stockmen a major opportunity to conserve water and to increase forage production. In areas where there are dense stands of useless woody vegetation more water is lost by transpiration through the leaves each year than runs off down the draws, streams and rivers (*1*).

For the most part woody plants on the range are water hogs. Some, like mesquite, require two to four times more water to grow a pound of dry leaves than do grasses.

Woody Plant Invasions

Woody plants have spread and increased in density since domestic livestock first began intensive grazing of the original grasses and forbs. There are numerous written accounts by scientists about this. Ferdinand Roemer (*10*), father of Texas geology, describes the vegetation found on Mission Hill well enough that present day comparisons can be made easily. Mission Hill lies two or three miles west of New Braunfels, Texas, along Highway 46. Writing in 1846, Roemer says:

"As soon as we reached the summit of the hill, the cedar forest ended. An

open, grassy plain, broken only here and there by brushwood and scattered live-oak trees, spread out before us. It extended to Mission Hill about two miles distant and we had to follow a narrow Indian trail to reach it."

"Mission Hill, . . . is a small round hill, covered with shrubs. From its summit one has a panoramic view of the surrounding hilly country, which is almost barren. Only here and there a sparse growth of trees is seen. . . . The fauna was also not well represented on these heights. Lindheimer's dogs chased a few rabbits of the small American species (*Lepus nanus* Schreber) and at another time we saw a black wolf slinking through the high grass."

The Mission Hill panorama described by Roemer has been modified. Today, a ragged forest dominates the scene. Two short grasses, buffalograss and curly-mesquite, and numerous weeds have replaced the "high grass" that Roemer referred to. Ashe juniper, also called blue-berried cedar, migrated from its original canyon habitat and is interspersed on the uplands with live oak, mesquite, hackberry, cactus, and a variety of invading underbrush. This range is probably less than half as productive as it was when Roemer saw it over one hundred years ago.

Competitive Grasses Help Control Brush Invasion

The most efficient natural enemy of brush is vigorous grass of the kind that dominated when the prairies and plains were first settled. This natural defense has been broken down on too many ranges by intensive grazing that has killed or reduced the number and decreased the vigor of the good grasses. Fortunately, a few areas remain where sound grazing management has prevailed. Brush has been unable to invade ranges dominated by competitive grasses. The rare areas of excellent grass demonstrate the value of original plants in controlling brush invasion. On many ranges, however, there no longer are enough choice grasses left to colonize the ranges naturally. Before such ranges can be improved to the maximum, the best grasses will have to be brought back artificially by planting.

On many ranges the only remaining good grasses are found within the protective low-growing branches of trees and bushes. Once these protective nurseries are removed the remaining seed stock of good grasses is killed when heavy grazing is continued. Artificial seeding is generally far more expensive than natural reseeding would be through correct management.

Correct use of forage must be practiced or the remaining nursery stock of grasses formerly protected by bushes and trees, will be killed and seed stock will be forever lost.

A good stand of vigorous climax grasses is nature's best defense against invading shrubs and trees. This shows up plainly on two adjoining ranges on the Kerr County Soil Conservation District near Center Point, Texas. One of these is in fair condition, the other in good condition. That in fair condition had 456 cedar trees per acre; the other 196. The cedars had invaded the latter area back when it too had been in fair range condition (*8*).

Control and final riddance of brush resolves itself into a major task because of the threat to the livestock industry. Millions of dollars of income is lost each year because of brush. Millions already have been spent trying to kill and control it. More millions must yet be spent to find effective killing and main-

tenance methods. Large sums must be devoted to seeding and managing grasslands correctly to prevent reinvasion of unwanted woody vegetation.

Landowners have waged aggressive killing campaigns against brush for several decades. In spite of their efforts, woody vegetation is still spreading faster than curative programs are controlling it. There are a variety of reasons why current control methods have failed to rid the ranges of brush. *Too often overuse of the forage paralleled brush killing work.* That gives native vegetation no opportunity to revive and check reinvasion of brush. In some cases where light grazing accompanied the brush killing operation, the range plants provided no competition against brush seedlings because they were sometimes lower in the plant succession scale than the brush. Most of the undesirable woody plants are difficult to kill because of abundant sprouting root buds which machinery and chemicals often miss. Brush which can sprout from roots makes vigorous revival unless the live buds are uprooted or killed by fire or chemicals such as kerosene, arsenic, ammate, and hormones. New plants continually are growing from buried seeds which sometimes remain viable for many years. The U. S. Forest Service reports that 40-year-old mesquite seeds germinated at Tucson, Arizona (*9*). Seeds of many woody plants continually are being brought in from adjoining seed sources by birds and mammals.

Extent of Woody Plants

Following is a table listing a few of the more important woody plants and the acreage they occupy in Region 4 (*3*) of the Soil Conservation Service.

Approximate acreage of several woody plants in Texas and Oklahoma

NAME OF PLANT	TOTAL ACREAGE	
	Texas	Oklahoma
Mesquite	55,000,000	3,000,000
All cedar	18,000,000	Not determined
Live oak	20,000,000	Not important
Shinnery oak	8,800,000	1,000,000
Guajillo	6,800,000	None present
Huisache	6,380,000	None present
Creosote bush	16,300,000	None present
Tarbush	12,100,000	None present
Wild rose	40,000	None present
Sand sagebrush	6,400,000	600,000

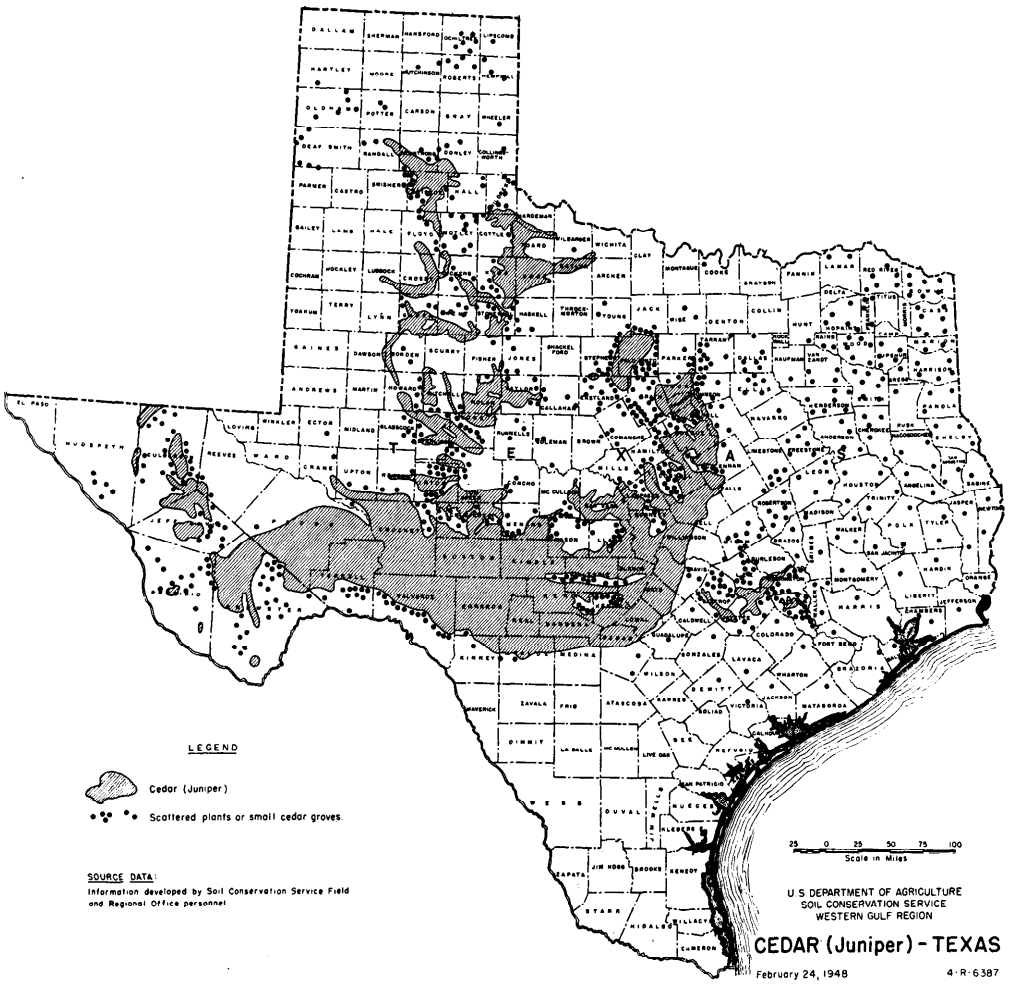
Blackjack oak and post oak which are not included in the table occupy a greater area then mesquite in Arkansas, Louisiana, Oklahoma, and Texas. It is doubtful if these two trees have extended their range perceptibly in the past hundred years, but there is distinct evidence that they have increased in density because of faulty grazing and unsound forestry practices.

Some of the woody plants are not completely troublesome or worthless unless they occur in dense stands. Small amounts of live oak (*14*) and guajillo provide some desirable forage. Mesquite, post oak, and blackjack oak, shinnery and many other trees and shrubs that invade are eaten by animals during certain seasons and also during drought or other periods of feed shortage. However, when conditions prevail that allow for a general displacement of choice grasses by brush, livestock forage is decreased and usually the erosion hazard is increased.

Ranchmen welcome widely scattered mottes for shade and wood, but most woody invaders cannot be tolerated in any sizable amount. That's because trees like mesquite, huisache and redberry juniper can be compared to tumors

in that they increase and finally become exceedingly bothersome. The final goal for control of many such plants must be extinction of the species. Otherwise, seed sources remain a constant threat.

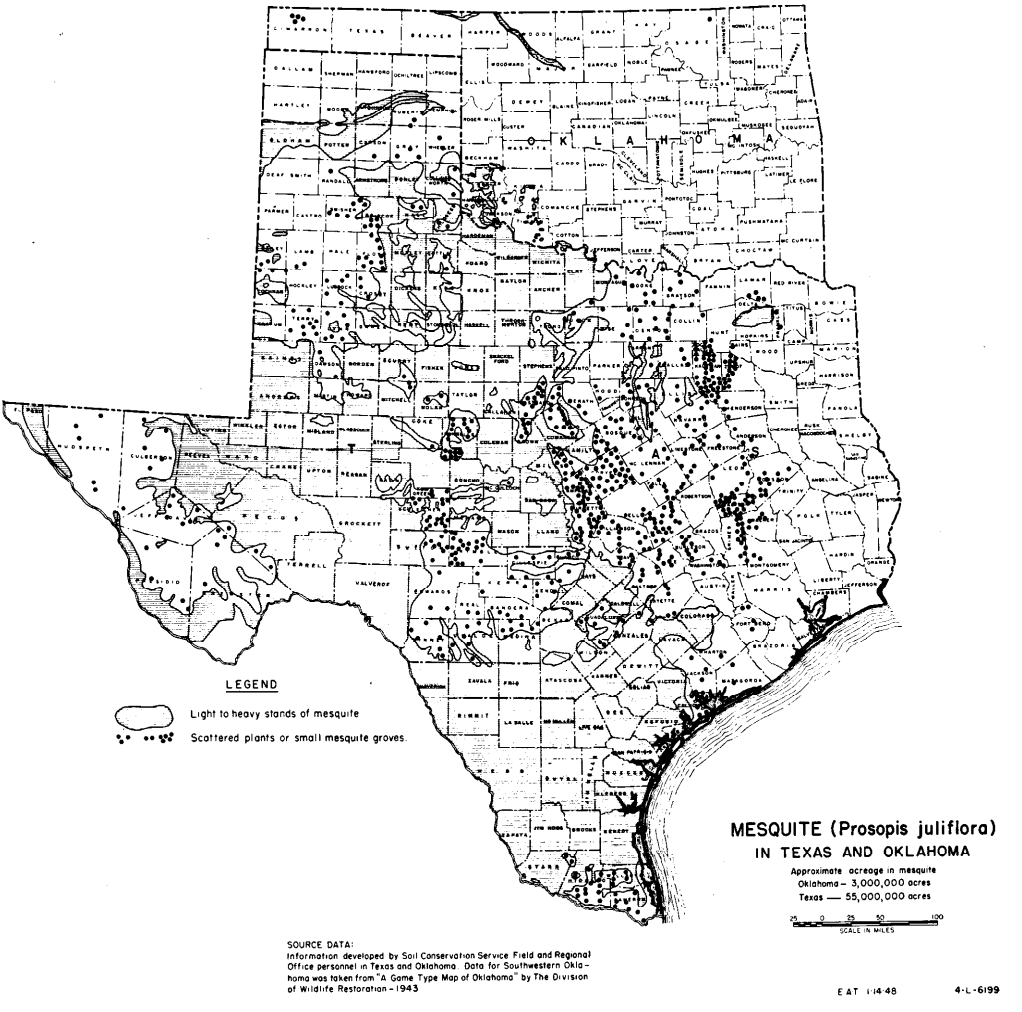
Ashe juniper and eastern redcedar grown in favorable sites often have considerable commercial value since they yield posts, veneer and cedar oil. They don't sprout from roots and they can be killed by fire, dozing, chopping, and probably with 2,4-D applied on the lower trunk. The scrubby redberry juniper has no obvious commercial value. It is especially pestiferous and costly to kill because of its active sprouting bud zone with its dozens of dormant sprouts ready to thrust forth whenever the surface parts are cut back.



Despite certain virtues ascribed to mesquite, ranchmen generally have no active sentiment for it. The value of mesquite beans as drought emergency feed is not great because the beans produce poorest in droughts. They provide improper fare if grazed alone.

Mesquite has never forestalled the effects of drought nor made it possible to carry livestock through extended dry periods. Forced sales of livestock because of drought has been severest in areas where mesquite is abundant.

Some claim that mesquites help put sizable amounts of nitrogen in the soil, but this appears to be untrue. Chemical analyses made by the Soil Conservation Service of soils from 11 major mesquite areas in Texas showed no nitrogen advantages from soils under mesquite trees over adjacent soils from pure grassland. Neither did mesquite roots of grown trees or seedlings display nitrogen nodules.



History of Brush Control

Men have contrived to rid the ranges of encroaching woody plants since pioneer times. Before then the Indians used fire to clear land for corn, and they sometimes set fire to the ranges grazed by their enemies' game. Millions of acres of brush and trees have been hand-grubbed, bulldozed, plowed, sawed,

cabled, kerosened, and sprayed from the air. Some stands have been worked over four or five times in the past fifty years.

C. J. Whitfield, of Soil Conservation Service Research Division at Amarillo, Texas, has results from seven years of research work on mesquite control which was started on the Jay Taylor ranch near Vega, Texas, in 1941. These are given in the following table.

	COST PER ACRE		MAN-HOURS PER ACRE		ERADICATION
	Medium	Dense	Medium	Dense	
					%
Hand-grubbing	$19.49	$31.96	55.7	91.3	85
Kerosene basin	13.23	18.17	27.1	36.8	92
Kerosene-pour	4.02	14.67	2.8	10.5	76
Rootcutter	3.40	5.86	0.8	1.6	63

Whitfield states, "If care is used, a consistent kill of 80 to 90 per cent can be obtained with the kerosene-pour method. The procedure followed in the research work was to measure a quart of kerosene in an opened-top container, pour the oil on the ground at the base of the tree and let it soak into the soil so that the bark of the underground trunk was saturated. The quantity of oil was always carefully measured and the amount applied varied according to the size of the tree. Digging several feet into the ground a day after treatment showed whether enough kerosene was being used to penetrate deep enough to soak the underground buds that are found at the junction of trunk and roots a few inches below the soil surface. To be effective, whatever treatment is used must kill the buds; otherwise they will sprout and make the infestation worse than it was to start with."

Harley Daniel, H. M. Elwell and Maurice B. Cox, of the Soil Conservation Service, report from the Red Plains Conservation Experiment Station at Guthrie, Oklahoma, that: "The average yield of grass on fully cleared land was five times that grown on land 90 per cent shaded by blackjack and post oak." They removed original stands of blackjack and post oak with saws, bulldozers and tree dozers. Small trees were killed with ammate and larger ones with sodium arsenite. Sumac and oak sprouts were kept down with mowers and brush beaters.

Dave Savage, of the Southern Great Plains Experiment Station at Woodward, Oklahoma, reports satisfactory results in control of sand sagebrush, skunkbush sumac, sand plum, and many range weeds with 2,4-D sprayed from an airplane. Savage states that, "Sand sagebrush and many range weeds can be controlled much easier and more effectively with 2,4-D than with a mower. Applying the chemical at the per-acre rate of one pound of acid equivalent, 4 gallons of water, and one of diesel oil with an airplane at adjacent flight intervals of 30 feet in 1947, completely eradicated 80 per cent of the sagebrush plants and greatly reduced the vigor of the remainder." (*12*).

Per-acre beef yields on the Woodward Experiment Station were nearly twice greater for ranges sprayed from the air than similar untreated ones. Landowners in the sand sagebrush belt of Western Oklahoma and the Texas Panhandle have sprayed brush and range weeds on more than 100,000 acres of rangeland during the past two years. Commercial air services have provided planes and chemicals for about $2 to $4 an acre (*12*).

The Soil Conservation Service has assisted local soil conservation districts in developing brush and weed control programs as part of a coordinated soil conservation program.

Recommendations have been based on research results from the Amarillo Soil Conservation Experiment Station, the

Red Plains Soil Conservation Experiment Station, and others. Best mechanical, chemical and management methods recommended by these stations and by experienced landowners have been tried. Also, soil conservation district cooperators have carried on numerous field trials with 2,4-D, ammate, kerosene and diesel oil.

various undesirable kinds of woody plants and weeds by spraying chemicals from airplanes. The 2,4-D, plus a new spreading and penetrating agent, is the brush and weed poison being used. While it is too soon to predict the final results, the effects are being closely watched. Several thousand acres have been sprayed (Fig. 1).

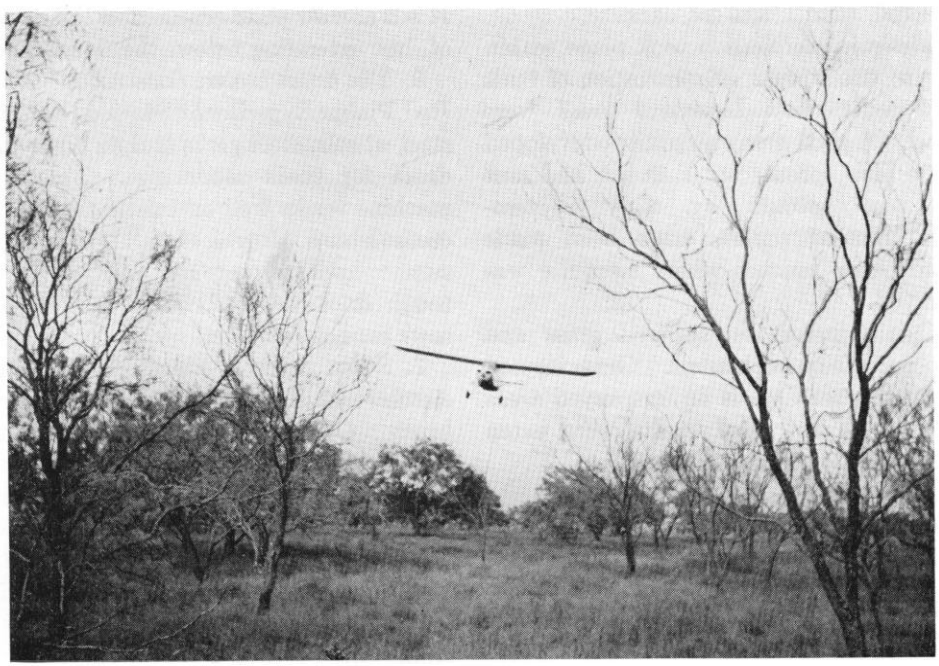


FIG. 1. AIRPLANE USED IN SPRAYING MESQUITE ON THE FLAT TOP RANCH AT WALNUT SPRINGS, TEXAS, IN THE BOSQUE SOIL CONSERVATION DISTRICT

Stull Brothers of Sebree, Ky., did the spraying. The photograph is by E. B. Stull of that organization.

Kerosene has continued to give the most thorough and cheapest kill on mesquite and huisache. Water solutions of various 2,4-D compounds killed a multitude of weeds like plantain, annual horsemint, broomweed, bitterweed, lambsquarter, ragweeds—including the perennial western ragweed, Canada fleabane, and pigweeds.

Several soil conservation districts are cooperating with Stull Bros., Inc., of Sebree, Kentucky, in attempts to kill

Current results from airplane spraying are summarized as follows: Hog plum was killed near Fort Worth, Texas, and one species of Yucca was killed near Granbury, Texas. The palatable shrub, black dalea, escaped with no substanital damage noted after two months.

Prairie sumac appears to be mortally affected by the spray. Examination of buds and rootstocks showed at least 50 out of 52 defoliated specimens dead.

Surface parts and many root buds of

skunkbush sumac were dead, but some roots were still alive on September 6. Condition of sprayed live oak was similar to that of skunkbush sumac, except more of the stems and root buds were still alive. Shinnery oak was turning brown and buds and roots were killed on a few plants. Action on this plant apparently is slow. Grass was specked but generally uninjured, except that the threeawn sprayed June 1 was set back.

Mesquite defoliation took place within one to two weeks. Examination of buds and roots showed several trees were dead. A good many mesquites developed some limb sprouts but rare few had sent up root sprouts by early September. Similar reports have been made from other ranches where mesquite was sprayed.

Cattle prefer the sprayed grass and concentrate on such areas. Grass formed numerous seed heads on unsprayed areas but leaves and seed stalks were eaten completely on sprayed grass.

Woody Vegetation Control Methods

The three best known methods of controlling woody vegetation on grazing lands are: Mechanical, chemical, and biological.

A. Mechanical equipment methods

1. *The tree dozer* is composed of a tractor to which is attached a gigantic push-bar or bumper with a cutting edge that pushes the tree over, exposing the roots. These then are freed from the ground by a v-shaped concave blade that also has a cutting edge (*4*).

2. *The root cutter* has a three or four foot blade set in front of a tractor and operated on a hydraulic lift. The blade gouges deeply enough to sever roots below the bud zone and to lift the tree out of the ground.

3. *The pull-type root cutter* is hitched behind a tractor. Its blade, raised with a hydraulic lift, cuts 12 to 18 inches below the surface.

4. *The brush cutter* has a v-shaped blade attached firmly to side frames. Cutting edges are scalloped much like an old-fashioned hay knife.

5. *The stinger blade* digs out small trees that cannot be forced out by a tree dozer. It is a narrow plate centered in the middle of, but extending below, the dozer blade.

6. *The brush beater*, constructed at the Red Plains Experiment Station, has high steel wheels, steel gears and an eight-inch drum for chain mountings. This type machine works well on brittle shrubs like creosotebush, threeleaf, and skunkbush sumac and on sprouts and weeds on rough or stony land where mowers and saws cannot be taken.

7. *Saws, mowers, and clippers.* Large circular saws have been used to cut dense brush. Old brush is removed and sprouts are cut in succeeding years at a time when root reserves are low. Trials are being made to see if continued mowing will exhaust root reserves and finally kill the plants. Sprouts are cut either with circular saws, mowers, brush beaters, or stalk cutters (Fig. 2).

8. *Cabling* has been used quite a bit on stiff heavy brush and low-branching and shallow-rooted trees. Double cables are attached to two tractors which run parallel and drag the cable between them, pulling over trees and brush. Large cedar, live oak, post oak, blackjack oak, and mesquite are easiest to cable.

Methods which disturb the sod least and remove the root buds allow the quickest range recovery. The tree dozer is good from this standpoint. Where seeding is essential to re-establish a grass stand, the root cutter probably provides an advantage. The brush cutter and saws provide only temporary benefit un-

less mowing of sprouts becomes part of the follow-up operation.

B. Chemical methods

1. *Poured kerosene treatment* proved to be a satisfactory and economical method of killing mesquite on the Amarillo Soil Conservation Experiment Station. Estimates are that of all of the Oklahoma and Texas mesquite land worked on, more than 80 per cent has been treated with kerosene.

The kerosene treatment calls for saturating the soil at the base of the tree with kerosene applied with a power spray or by gravitation. Hand pouring with a long-handled dipper commonly is used. From one pint to one quart of kerosene is usually enough for each tree, but the amount varies with size of the tree, number of branches originating from the crown, and type of soil. Trees on clay soils require more kerosene than those on sandy loam. The bud zone must become saturated if the tree is to be killed. Mesquite can be killed any time of year, but spring, summer, and fall treatments are most common. The soil must be dry. Huisache responds to kerosene very much as mesquite does.

Contractors have taken over a great deal of kerosene treatment. Costs run $10 to $16 per acre at present.

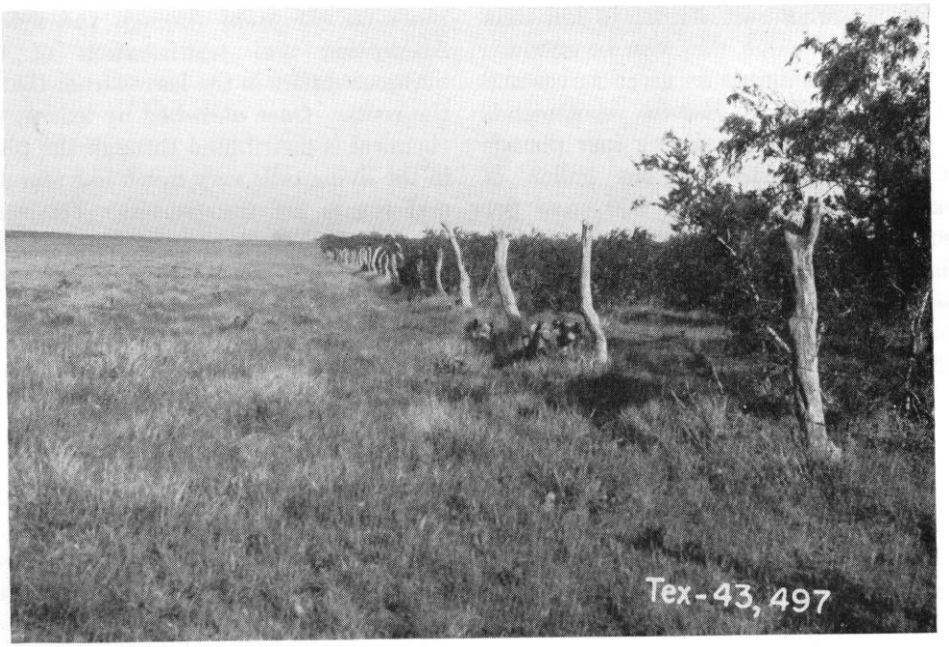


FIG. 2. On the left shrubs have been cleared with brush saw and sprouts are kept down by yearly mowing. Correct grazing has accompanied brush cutting and a vigorous stand of Texas wintergrass, buffalograss, and curlymesquite has taken over. Photo taken near Beeville, Texas.

2. *Sodium arsenite.* This chemical provides one of the surest and most economical means of killing root sprouting trees and shrubs. It seldom is used because it is extremely toxic to humans and animals. Trees or shrubs should be sawed off smoothly near the ground and the flat stump painted with liquid sodium arsenite.

3. *Ammate.* Ammonium sulfamate (ammate) is not poisonous to livestock

but when applied properly it is fatal to trees and prevents root sprouting. To kill trees, small cups should be chipped out around the trunk. The cups should be spaced about two or three inches apart. One tablespoonful of ammate crystals is enough for each cup. Trees should be left standing for a year. Treatment gives best results in late summer, fall or winter (*11*).

Dense sprouts are harder to kill than big trees, although they can be subdued by spraying ammate on green leaves and twigs. The Forest Service recommends a spray made by dissolving four pounds of ammate crystals in one gallon of water. Where there are 300 trees per acre running from one to eight inches in diameter, the spray cost runs about $4 per acre. Cost for treating dense sprouts from one to three feet high runs $15 to $20. Labor is additional (*11*).

The Forest Service has found that ammate crystals give good results on sweet gum, black gum, elm, ash, cypress, bay, ironwood, willow, blackjack, red oak, post oak, pin oak, water oak, and pine. Heavier treatment must be given to slow reactors like hickory, bitter pecan, beech, persimmon, and white oak (*11*).

Spraying has worked best on young sprouts of oaks, sweet gum, hickory, sumac, willow, bay, and black gum. Extremely heavy dosages of ammate spray will kill Ashe and redberry juniper, but the cost is prohibitive.

4. *2,4-D.* 2,4 dichlorophenoxyacetic acid is the chemical title of 2,4-D which was introduced in 1944. It has become renowned for its selective qualities in killing some broadleafed weedy herbs without damaging certain crops (*6*). Its value for killing woody vegetation has not been learned thoroughly, but the possibilities in that field are beginning to outdo original expectations. It is nontoxic to humans and livestock.

The common formulations of 2,4-D are the amines and esters, which are liquid, and the sodium salt, which is sold in dry crystals. 2,4-D is probably absorbed by the living surface cells of leaves, stems, and roots of plants. This hormone herbicide is translocated throughout the plant. When placed on the roots, the hormone is probably taken into the vascular system and transported from roots up the stem through the xylem. Absorption and translocation of the hormone differs in the leaves from that in the roots. Once absorbed by leaves, the chemical is distributed through the plant in the living cells very much like starches and sugars are transported. The same conditions that favor maximum translocation of starches and sugars also favor greatest translocation of 2,4-D. The hormone appears to check plant growth. Respiration of plants is increased; rapid depletion of available carbohydrates and food reserves must be responsible for the herbicidal qualities of 2,4-D.

The hormone is absorbed and translocated best by leaves that are well expanded and grown in the sun. Where the hormone is applied to upper stems, translocation moves both up and down the plant; but when 2,4-D is applied on a stem or trunk near the ground, translocation is first generally downward with an upward movement later. When Stull Brothers Weed and Brush Killer was sprayed from the ground onto the trunks of young Ashe juniper, killing of roots, stems, and leaves occurred within two weeks or less.

5. *Fire.* Fire has been invoked by many to explain the scarcity of brush in early times. It is alleged that recurring grass fires kept trees and brush under control. It is paradoxical that fire has been unsuccessful as a means of killing and controlling most of them now. Being active rootsprouters, mesquite and red-

berry juniper survive fire better than grass does. Lighted cigarettes and matches carelessly dropped along highways cause more fires than were common in olden times. Where grass has been eaten out, the replacement crop of annual weeds makes as good or better tinder than grass. Some of the most constantly recurring fires are in the Texas brush country where mesquite is the densest. In 1946, thirty areas burned in August were checked for mesquite survival six weeks after fires. Stems of 60 percent of the seedlings survived the fires. Most of those whose stems had burned were already sprouting from roots. Only 10 percent of the old trees were burned so badly that the tops were killed and all of these had begun to root sprout. Only a small percent of the young trees had tops killed and these had begun to sprout from roots. Examination of old burn scars on trees showed that fire had been common in the area. Landowners along the highways said that annual burning was common.

The Spur, Texas, Station reports "Burning the grass during the month of February on two successive years destroyed only 31 percent of the seedlings less than one year old and none of those older than one year. Intensive grazing with lambs failed to kill the young plants" (*5*).

C. Biological methods

The operations of man and animals constitute the major biological influences to be considered in controlling spread of woody vegetation. Through the art of correct grazing use, brush eradication plus reseeding of areas where original grasses are gone will, in time, develop a competitive cover that will hold out invading worthless plants. Under such an improved environment many of the animals which help spread seed of undesirable plants will decrease and most of the seed, which the remaining animals spread, will fail to germinate in the unhospitable seed beds of the grasslands (*2*).

In his review of cedar problems in Oklahoma and Texas (*15*), Simon Wolff, of the Soil Conservation Service, Regional Office, Fort Worth, found that the following wild and domestic animals spread red and blue-berried juniper seed: Robins, mocking birds, and many other birds, jack rabbits, cottontails, foxes, ringtails, coyotes, and sheep.

There are probably over 100 domestic and many wild animals, plus numerous birds, that eat and spread mesquite seed. Domestic animals transferred from mesquite areas should be corralled and fed for three days before they are turned out on mesquite-free range. C. E. Fisher of the Spur, Texas Experiment Station, and Jess L. Fults, of the Amarillo Soil Conservation Experiment Station, report that when they fed mesquite seed to mules, 54 percent passed through in viable state; with calves it was 49 percent and with lambs only 12 percent (*5*).

The following animals generally are regarded as mesquite seed spreaders: cattle, horses, mules, goats, deer, peccary, cottontail rabbits, jack rabbits, and coyotes. Others suspected are foxes, raccoons, skunks, opossums, buffalo and antelope.

Those that apparently digest mesquite seed are: gambel quail, Arizona scaled quail, white-winged dove, mourning dove, white-necked raven, turkey, wood rat, kangaroo rat, mice, Colorado rock squirrel, Rio Grande ground squirrel, Texas antelope squirrel, squirrels and prairie dogs. Prairie dogs, however, keep mesquite growth cut off around their towns. They clip off new shoots as they grow. Apparently the prairie dogs chew off brush and other tall growing vegetation that obstructs their view of approaching

enemies. Prairie dogs are animals indicative of run-down ranges.

Weevils bore into mesquite bean pulp, rendering pods unfit for storage. Over thirty insects attack mesquite, but none appear to be hostile enough or aggressive enough to serve as an eradication hope.

Goating off brush has been regarded as a beneficial practice for many years. However, grazing generally has been so intense that many goats and much grass have died, soil has been exposed to erosion, and the brush not killed. Two soil conservation district cooperators have demonstrated on their grazing lands that goats can be used to control brush advantageously provided sprouts are grazed off quickly and animals moved to other pasturage to avoid damaging grass.

Joseph M. Vander Stucken, Chairman of the Board of Supervisors, Edwards Plateau Soil Conservation District, has improved his grass stand and kept down live oak and shinnery oak sprouts and maintained his goats in thrifty shape on his Sonora, Texas, ranch.

J. D. Coffey, of Richland Springs, Texas, a cooperator on the San Saba-Brady Soil Conservation District has doubled his bluestem grasses on cutover blackjack oak and post oak land in 10 years by goating oak sprouts (*7*).

Both men run a large number of goats on a comparatively small area of sprouts; when sprouts are cleared out the goats are shifted to fresh sprouts and grass. Soil is improved, grass and goats thrive, and oak is thinning out from slow starvation.

Summary

1. The mass invasion of undesirable woody plants onto millions of acres of range lands in Texas and Oklahoma constitutes a major economic and conservation problem.

2. There is need to reestablish a cover of competitive original grasses and forbs through correct forage management and seeding of areas that are short of adequate seed stock. This often may go hand in hand with programs of mechanical and chemical control of woody plants, but the former must progress rapidly to check further aggression of unwanted woody plants after control measures have been used.

3. Many mechanical and chemical methods are beneficial, but none thus far devised completely eliminates reestablishment of woody vegetation. Unless treated stands have had follow-up programs applied, infestations have become reestablished, often denser and more formidable than before.

4. Should a method be found that completely kills all living woody plants on a range, there still will remain a long vigilant job of killing new plants that germinate from seed each year. Mesquite, for instance, may keep on sending up seedlings for 50 years or more after all trees are dead.

5. Therefore, maintenance of cleared stands through good management plus mechanical or chemical methods must go on without let-up indefinitely.

6. A number of mechanical and chemical methods already in use can be used effectively and economically as time goes on. Through experience, these methods will be improved and can be applied more economically.

7. Several of the known methods that are being used to complete the first step in control can be used even better for maintenance.

Dozers, brush cutters, saws, beaters and mowers will have a constant value in many types of maintenance. The heavy brush cutter can be used on cleared land to keep down sprouts. Repetition will not be required yearly and in some instances repeat cutting won't be needed

more than once each three or four years.

Spraying, both from airplane and from the ground, with 2,4-D or one of its more effective successors will probably provide one of the fastest, most effective and economical maintenance methods. Greater mobility, speed and selectiveness, plus uniform distribution of solution, gives spraying from airplanes advantages in original application, as well as in maintenance.

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