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BLUESTEM AND TUSSOCK FIRE AND PASTORALISM IN THE FLINT HILLS OF KANSAS AND THE TUSSOCK GRASSLANDS OF NEW ZEALAND

JAMES F. HOY AND THOMAS D. ISERN

The ghost of Lady Barker haunts public discourse on the question of burning tussock grassland in New Zealand. The image of this gentle English woman, author of the Canterbury classic *Station Life in New Zealand*, transformed into a pastoral pyromaniac professing “the exceeding joy of ‘burning,’” is compelling. She contests with friends over who can set the most magnificent blaze, exults at solitary cabbage trees exploding into flame, and regrets that she was not there to see the first blaze rage across the plains. Of this ritual, she says, she and her friends “never were allowed to have half enough of it” before the spring burning season passed.¹

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The spectacle of pasture burning in the Flint Hills of Kansas is no less prepossessing than its parallel in New Zealand. Modern observers often speak of the beauty of nighttime prairie fires in the Flint Hills: the orange glow in the sky, swirling billows of scarlet smoke, ribbons of golden flame moving sinuously across hill-sides. But early reports from the tallgrass prairie, such as Baptist missionary Isaac McCoy’s in 1830, more often expressed awe at the “sublime” flames that leapt twenty feet into the air and left apparent devastation in their wake. Horses would stampede, grown men fall to their knees in prayer, and women go mad when confronted with the fearsome sight of a nighttime fire, recalled an unknown traveler to Kansas in the 1850s:

Seen from a distance it looked as if the flames came out of the earth. The reflection on the sky, particularly when the sky was overcast, added to the terror. . . . When a man has seen a prairie fire at night, infuriated by a wind, with half of the sky for a background, and the whole earth, apparently, for its field of action, everything he sees after that looks a bit tame.²



FIG. 1. *Flint Hills, Chase County, Kansas.* Courtesy of Kansas State Historical Society.

THE TWO ENVIRONMENTS

In visual spectacle, pastoral practice, scientific development, and public discourse, there are powerful parallels between burning tussock grassland on the South Island of New Zealand and burning tallgrass prairie in the Flint Hills of Kansas. The two situations are by no means identical: there are variations in detail and in concept, owing to differing natural conditions, pastoral systems, and human cultural influences. The parallels are, nevertheless, so striking as to suggest telling patterns in human adaptation to, transformation of, and thought about subhumid grasslands devoted to grazing.

The Flint Hills, including their southern extension into Oklahoma, where they are designated the Osage Hills (or, more simply, The Osage), represent the remnant of a native tallgrass prairie that once reached from Canada down to Texas, from Kansas back to Indiana and Kentucky. The Kansas portion of the Hills begins near Nebraska in Marshall County and extends south in a band roughly fifty miles wide bisecting the eastern half of the state. The Bluestem Grazing Region, which includes the Flint Hills proper as well as native pastureland to the east of the Hills, encompasses all or part of seventeen counties.

The veins and nodules of flint (or chert) that give the Hills their name were first recorded in



FIG. 2. Montane tussock grassland on the South Island of New Zealand. A musterer overlooks the flats of the Tasman River, Glentanner Station, 1953. Photograph courtesy of National Archives, Head Office, Wellington, New Zealand, Ministry of Agriculture and Fisheries Series 6330 "DA" Black and White Prints 43026.

1806 by explorer Zebulon Pike: "Passed very ruff flint hills today. My feet blistered and very sore." The dominant rock in the Flint Hills, however, is limestone, deposited by an inland sea from the Permian period some 300 million years ago. Because the Flint Hills were formed by erosion, not upheaval, peaks do not tower above the surrounding countryside, although their relief, in silhouette, can be striking and the slopes of some hillsides steep. Outcroppings of limestone give the Hills a bench-like or terraced appearance, with hilltop ridges sometimes extending for miles, the grass-covered sides sloping down and away to tree-lined banks of clear-water streams in the valleys. The Flint Hills assumed their present appear-

ance some ten to twelve thousand years ago, at the end of the last ice age.³

The dominant native grasses in the Flint Hills are big bluestem (named for its seedstem, which sometimes exceeds nine feet in height; it is also called turkey-foot from the shape of the terminal end of the seedstem), little bluestem (whose seedstem is around two feet tall), Indian grass (named for its feathery seed-head), and switch grass. Other grasses, particularly side-oats grama and buffalo grass (on the thinner or disturbed ground), are also common in the Flint Hills. Bluestem is an especially powerful feed grass in spring and early summer when its leaves contain not only high levels of protein (which puts flesh on a steer)

but also calcium (from the soluble limestone, which increases a steer's bone growth, thereby promoting an even greater rate of gain). In late summer, however, bluestem begins to transfer energy from its leaves to its roots (sometimes extending nearly a dozen feet into the ground); thus, it has little nutritive value in fall and winter.

Because its bluestem grass provides an extremely economical rate of gain and requires no fertilizer or reseeding, the Flint Hills region has long been prized for custom grazing of transient cattle. Yearlings raised elsewhere are brought in for the grazing season, running from mid-April to mid-October, then shipped on to feed lots or occasionally directly to the packers. Resident herds and yearlings brought to the Flint Hills for the fall and winter must have tame grasses on which to graze and be fed hay and protein supplements.

Partly because of the terrain's rockiness and partly because large portions of the Flint Hills were sold in blocks rather than homesteaded, much of the native grass was preserved from the plow. By the early 1880s, when many of the bottom lands along Flint Hills streams had been turned into fields, the open range of the uplands was being grazed both by locally owned cattle and herds brought in from outside the region. At the end of the decade, fencing of upland pastures was well under way, as was the practice of custom grazing whereby a local entrepreneur, sometimes known as a "pastureman," would lease land from an absentee owner, then sublease it to a cattle owner, or else arrange with either or both to look after the cattle.⁴ Whether pastureman or rancher, however, the livelihoods of both types of pastoralists ultimately depended upon grass, the health of which was maintained by proper management, including, more often than not, the practice of intentional burning.

The tussock grasslands on the South Island of New Zealand comprise the rain-shadowed area east of the towering, glacier-capped New Zealand Alps. Along the east coast, the alluvial Canterbury Plains are dissected by braided rivers. The climate ranges down to semiarid-

ity, with annual rainfall just over twenty inches. West of the plains are the downlands, or hill country, and west of them the mountains. The plains and downlands were short tussock country, burned over by early pastoralists. Subsequently, having been taken in freehold, they were planted to exotic grasses, and cut into paddocks bounded by fences and gorse hedges. The high country was, and remains, tall tussock country, now developed by overseeding and fertilization. Pastoralism here commenced with burning, and the practice persists to a limited degree. The more remote sections are given over to Merino flocks, some strictly for wool production. Rainfall in the high country may approach forty inches, but slope, altitude, and thin soils—graywacké and schist-based—contribute to marginality. Pastoral runholders occupy the Crown lands of the high country under lease with considerable security of tenure.⁵

Dominant species of the short-tussock lands were fescue tussock (*Festuca novae zealandiae*) and silver tussock (*Poa caespitosa*), grasses of tussock habit some eighteen inches tall. Dominant species of the tall-tussock lands include snow grass (*Danthonia raoulii* var. *flavescens*) and red tussock (*Danthonia raoulii* var. *rubra*), three feet or more in height. The tussock habit of these species is important to defining conditions for the use of fire in the region and for differentiation from the situation in the Flint Hills. The tussocks, spaced inches or feet apart, provide shelter in a micro-environment for lesser inter-tussock species, native and exotic. A community of slow-growing, long-lived tussocks is in some respects more comparable to a forest than a prairie. Tawny tussock foliage is relatively unpalatable to livestock.⁶

BURNING IN THE TUSSOCK

Primary recorders—Lady Barker among them—consistently connected pastoral occupation of the tussock, from the 1850s to 1870s, to conflagration. J. B. A. Acland and C. G. Tripp, cadets (apprentice pastoralists) in search of open lands to take up, burned every-

where they explored. Acland explained that "the only way in which a sheep-walk, or 'run' is cultivated, and the pasturage improved, is by putting a lucifer-match under a tuft of grass and setting the whole country ablaze." Tripp recollects he was able to read fine newsprint at night by the light of tussock blazes a mile away. Laurence Kennaway described the desperate efforts of runholders to save their flocks from fires out of control in the Mackenzie basin. Samuel Butler pointed out the remarkable transformation of the environment that attended first burning.⁷

Secondary chroniclers, on uncertain evidence, extrapolated from singular instances to posit a pattern of annual burning, capricious as to cause or season, extending through the first generation of the twentieth century. Historical geographers Andrew Hill Clark, Kenneth B. Cumberland, and D. H. Relph wrote of the "severe effect of repeated burnings," of a "century of burning," and of fires that were "indiscriminately-lit." Ecologist A. P. Barker referred to fires "for many years . . . lit at any time or season."⁸

Fortunately, daily diaries kept by managers of pastoral runs provide more authoritative detail about routine burning practice. Historical geographers P. G. Holland and R. P. Hargreaves, studying diaries from The Point Station on the Rakaia River for the years 1866–71, found that burning figured in a definite annual regimen, occurring on an average of six days between late August and early October. Only parts of the run were burned in any one year. Clearly, runholders were exercising some discretion, picking their time for burning according to weather conditions and choosing areas where they perceived a need.⁹

Station diaries in the manuscripts department of the Turnbull Library, Wellington, further illuminate practice in the late nineteenth century. (See Table 1.) Notably, Benmore Station, in the four years for which diaries are available, did no burning at all. Clayton Station, during the seven years of available diary accounts, generally pursued burning in a pattern similar to that found at The Point, but

in 1888 did no burning. The practice at Rakaia Station, for which an excellent run of diaries exists, is particularly intriguing. During certain periods of years it burned in a pattern similar to that of The Point and Benmore but at other times—notably in the late 1880s and early 1890s—did no burning at all. Both here and at Benmore, one reason for this lack is evident from the diaries: station personnel were concentrating on development of small cultivated paddocks of gorse, turnips, English grasses, and small grains. All burning at stations under study took place in the late winter or spring, or from late August to October. Diary entries commonly recorded exactly which tracts were being burned on a particular day, thereby indicating such information was considered important for future reference. To be sure, some diary entries could cause confusion to readers. A reference to "burning tussocks" does not mean burning tussock grasslands but piles of tussocks grubbed out of improved paddocks; "burning grass" generally means burning off paddocks of English grasses. There also was quite a bit of gorse burning. All this is learned by reading entries in context. Overall, the most definitive evidence, detailed station diaries, quietly dispels the myth of habitual and indiscriminate burning on pastoral runs.¹⁰

After the turn of the century, however, beliefs about burning figured prominently in rising public and scientific concern about depletion of tussock lands. For instance, the report of the parliamentary commission appointed to inquire into the condition of "southern pastoral lands," issued in 1920, devoted a substantial section to their "deterioration and depletion." As "causes of deterioration and ultimate depletion" it listed "burning of the tussocks, especially at the wrong season of the year"; overstocking with sheep; the proliferation of rabbits ("the most potent cause of all"); and insecurity of land tenure.¹¹

The commission issued what seemed a powerful explication and recommendation in regard to burning. Whereas the original reason for burning, most agreed, had been to open up to sheep a country overgrown with tall tus-

TABLE 1
REFERENCES TO TUSSOCK BURNING IN STATION DIARIES

Benmore Station, 1865, 1867, 1870, 1871

- 1865: no burning
- 1867: no burning
- 1870: no burning
- 1871: no burning

Clayton Station, 1877, 1879, 1881-84, 1888

- 1877: 18 Sept., 28 Sept.
- 1879: 20 Sept.
- 1881: 1 Sept., 2 Sept., 15 Sept., 17 Sept., 20 Sept., 21 Sept., 24 Sept., 30 Sept.
- 1882: 25 Aug., 31 Aug., 2 Sept., 4 Sept., 22 Sept., 23 Sept., 7 Oct.
- 1883: 25 Aug., 28 Aug., 29 Aug., 20 Sept., 21 Sept., 3 Oct., 8 Oct., 9 Oct., 17 Oct.
- 1884: 9 Oct., 10 Oct., 11 Oct.
- 1888: no burning

Rakaia Terrace Station, 1867, 1869-70, 1874-78, 1887-91, 1894-96, 1909

- 1867: 16 Sept., 17 Sept., 24 Sept.
- 1869: no burning
- 1870: no burning
- 1874: 7 Oct., 19 Oct., 20 Oct., 22 Oct., 23 Oct.
- 1875: 4 Sept., 4 Sept.
- 1876: 12 Sept., 28 Sept., 4 Oct.
- 1877: 3 Sept., 6 Sept., 7 Sept., 20 Sept., 21 Sept., 22 Sept., 29 Sept., 3 Oct.
- 1878: 16 Aug., 3 Sept., 14 Sept., 20 Sept., 24 Sept., 3 Oct.
- 1887: 31 Aug., 2 Sept.
- 1888: no burning
- 1889: no burning
- 1890: no burning
- 1891: no burning
- 1894: no burning
- 1895: 16 Aug., 22 Aug., 23 Aug., 28 Aug., 30 Aug., 5 Sept., 6 Sept.
- 1896: 14 Sept., 19 Sept.
- 1909: no burning

Source: Station diaries, Manuscripts Department, Alexander Turnbull Library, Wellington, New Zealand.

socks and spiny brush, runholders continued the practice for a variety of reasons: to bring on growth of tender, green, palatable tussock foliage; to clear away dead foliage; and to prevent rampant spread of accidental fires. Critics said that continual burning weakened and killed tussocks, which were necessary for protection of inter-tussock vegetation and pre-

vention of erosion. The commission insisted that "burning tussock is desirable," but condemned "*indiscriminate burning*." It recommended amending the Land Act to regulate burning on the basis of conditions in individual districts and on individual runs and called for research to explore the effects of burning on tussock lands. In the meantime, it

cautioned pastoralists to burn only when growth was "choked out"; to burn only in early spring on damp ground; and to be particularly reluctant to burn snowgrass, tussocks in weakened condition, sunny faces, shingley slopes subject to erosion, or any place where baring the ground might encourage the proliferation of undesirable plants or rabbits.¹²

Although the commission's rhetoric was stern, its recommendations were ambivalent. It seemed particularly concerned about indiscriminate or untimely burning but offered no specifics as to where this had actually occurred. A reasonable inference from the document is that the commissioners and their pastoralist-informants, faced with evidence of depleted lands but committed to the practice of burning, fashioned themselves a straw man, or perhaps a grass man—the irresponsible pastoralist, not named, who ignited the tussock by whim. They cut this grass man to pieces, then slyly recommended imposing the more restrained pastoral practice they knew already prevailed.

Leonard Cockayne was a member of this commission. As the intellectual father of grasslands ecology in New Zealand, he was acquainted with the writings of botanist J. Buchanan, who as early as 1869 had sounded a warning that the semiarid grasslands of Central Otago could not suffer habitual burning. As the biological father of A. H. Cockayne, he was familiar with his son's study, "The Effect of Burning on Tussock Country," published in 1910. The younger Cockayne had asserted, without citing evidence, that each spring in the tussock country, "as much as possible is burnt over. . . . Large portions of this country may again be burnt later in the year, and much firing is done in midsummer and autumn, more or less unintentionally." He had allowed that burning was essential under certain conditions, strictly for control of bracken, matagouri, manuka, or other scrub, but was not to be used to stimulate tender growth for grazing. Burnt-over lands should be spelled, not grazed; immediate grazing sapped the tussock. Said A. H. Cockayne, "It

is safe to predict that if the present system of burning is adhered to, all those pastures existing in localities of low-rainfall will in time be rendered completely barren." Leonard Cockayne also knew that another Department of Agriculture scientist, W. J. McCulloch, in 1917 had cited burning as the first cause of grassland depletion. Offering no more sources than had A. H. Cockayne, McCulloch wrote, "Often no thought was given as to where it [fire] might spread or finally burn out, with the result that vast tracts of fine tussock and native-grass country were subjected to annual destruction for the short-sighted gain of a few weeks' feed."¹³

At the time of his participation in commission proceedings, the elder Cockayne was himself engaged in a long-term inquiry published as "An Economic Investigation of the Montane Tussock-Grassland of New Zealand."¹⁴ This multi-site experimental study was concerned mainly with regrassing depleted lands, but insomuch as it discussed burning, it agreed with A. H. Cockayne's positions. Surely Leonard Cockayne was an important presence on the commission, forcing it to address the issue of burning; at the same time, the Cockaynes' questionable assertions that indiscriminate burning was rampant gave the commission the opportunity to condemn this abuse, without addressing more basic questions the practice raised.¹⁵

By the following decade a new concern—soil erosion—entered public discussion of burning. Government bulletins exploring the causes of erosion in the 1930s and 1940s incorporated assumptions that burning had been indiscriminate and had caused depletion of vegetation, which in turn led to erosion. A landmark survey of the tussock grasslands by V. D. Zotov, noted for its characterization of much of this area as "induced steppe" due to land use, also tied burning and vegetational depletion to erosion.¹⁶

The passage of the Soil Conservation and Rivers Control Act in 1941, setting up a Soil Conservation and Rivers Control Council to coordinate local catchment boards, was



FIG. 3. Snowgrass burned in September 1954 shows poor recovery by January 1955 because of continuous grazing following fire. Burke's Pass, South Island, New Zealand. Photograph courtesy of National Archives, Head Office, Wellington, New Zealand, Ministry of Agriculture and Fisheries Series 6329 "MNS" Black and White Prints 30/15/102.

instrumental in bringing burning to public attention. The key individuals in this development were conservationist L. W. McCaskill and geographer Kenneth Cumberland. McCaskill, a disciple of America's Hugh Hammond Bennett, was the major advocate of the act on the South Island. His rhetoric directed against abuse of the land was often less than temperate. Official bulletins of the Soil Conservation and Rivers Control Council echoed this tone and placed particular onus on burning. Cumberland had arrived in New Zealand from England in 1938 and immediately commenced study of soil erosion. In 1944 the Soil Conservation and Rivers Control Council published his book, *Soil Erosion in New Zealand*.¹⁷

That same year Cumberland began work as a consultant to the North Canterbury Catchment Board and conducted a major survey of burning practices among about fifty pastoralists in that area. He found that nearly all of them employed fire but did so at long intervals—five to twenty years—and with thoughtful calculation. The responsible behavior of runholders, Cumberland judged, was much

improved over an earlier generation when, he remained convinced, universal annual burning prevailed. The catchment board, nevertheless, still considered it necessary to caution practitioners that "burning should be practiced as little as possible."¹⁸

The strident rhetoric of the catchment boards won little support among pastoralists in having them granted direct control over pastoral operations. A royal commission reporting on the state of sheep farming in 1949 was forthright about this, labeling the catchment boards' missives on erosion "misleading propaganda," insisting that erosion was not a problem of land deterioration, and calling for the boards' abolition. While granting that burning was "dangerous if practiced without discretion and good judgment," the commission considered it "necessary to farming operations" and that it be regulated on a permit basis on Crown lands by the Commissioner of Crown Lands and on freehold lands by the county councils. The Land Act of 1948 had placed such regulatory authority in the hands of the Commissioner of Crown Lands, but despite the royal commission's wrath, he proceeded to delegate authority for burning permits to local catchment boards.¹⁹

Burning generally declined under the catchment boards, although the permit policy was not excessively stringent. Pastoralists objected that the permit system was a nuisance and a hindrance to flexibility in management. In 1958 a group of twenty-five landholders in Otago formed the Mt. Benger and Moa Flat Conservation District, commissioned a study of land conditions, then negotiated an agreement with the local catchment board to let them govern their own burning. They burned little—an average of 7 percent of their tussock lands annually—and were mainly interested in burning preparatory to land development through overseeding and aerial topdressing.²⁰

Land development, fueled by government subsidy, dominated pastoral affairs from the 1950s into the 1980s. Although in the downlands this meant plowing tussock and

seeding to exotic grasses, in the high tussock country it involved calculated burning to open the tussock (which was retained, however, for its soil-holding and micro-climatic effects), aerial sowing of inter-tussock grasses and legumes, and aerial fertilization with superphosphates. Catchment boards were sympathetic to those seeking permits to burn, providing they intended to restore cover on the ground through development.²¹

During this period a diverse corps of scientists was re-assessing the place of burning in the tussock environment. Through both holistic observations and meticulous physiology, they learned that the tussock complex as a whole, and snow tussocks individually, were resilient and adapted to fire. Tussocks recovered well from spring burning, which stimulated growth and flowering. One of these scientists, K. F. O'Connor, also undertook historical research and quantitative analysis, examining burning in the context of such concepts as nutrient cycling, systems ecology, and sustainability. The arguments for and against burning were becoming more and more complex. Soil scientists even repudiated earlier thought about erosion, concluding that in the high country environment, erosion—and in particular the silting of streams—had little to do with burning or any other suspected causes of land deterioration. On these soils in this environment, they said, erosion was a natural phenomenon. By 1988, the Otago Catchment Board concluded in a position paper that the management of land *after* fire, not fire itself, was the most important factor affecting vegetation.²²

Governmental reorganization in recent years has shifted jurisdiction over burning, removing it from the catchment boards. With its organization for administration of Crown lands in 1989, Landcorp has taken over issuing permits for Crown lands, doing so in consultation with the Department of Conservation. On private lands, the newly-organized regional councils have assumed this function.²³

Practical pastoralists continue to use burning in judicious fashion. In 1989 the Otago

Regional Council received survey responses from fifty sheep farmers who burned, nearly all agreeing that the practice is important to their operations. They burned, they said, to eliminate matagouri, remove rank tussock growth, and open access for stock—old and familiar reasons. Where runs have passed through generations of a family, a good deal of lore about the setting and spread of fires on particular slopes is passed along. In the more arid or unstable environments, pastoralists have all but ceased burning. There are serious environmental problems in the high country today, but they do not derive from burning. It is difficult to find any evidence of irresponsible burning on the land.²⁴

Burning would seem, then, to be a settled question, but in 1990 the Department of Scientific and Industrial Research, citing the “widely-held view” that misuse of fire had led to degradation of vegetation and soils, produced a detailed review of literature on the subject. The Department’s report, which covered fire’s effects on vegetation and soils and its role in grasslands management, concluded there was a need for new research and additional models. It is difficult to imagine what purpose such inquiry would serve. Moreover, in the preface to a major public document of 1991, *Sustainable Land Use for the Dry Tussock Grasslands in the South Island*, the contents of which do not otherwise address the issue of burning, the Parliamentary Commissioner for the Environment could not resist a gratuitous swipe at “unsustainable practices such as burning tussock.”²⁵ Although it is difficult to imagine what purpose renewed research would serve, both documents reveal the tenacity with which the ghost of Lady Barker continues to haunt public discourse.

At several points, largely due to the Fulbright exchange program, the history of burning in the New Zealand tussock has intersected with American range management. In 1952 Kling L. Anderson, Professor of Pasture Management from Kansas State College and a Fulbright scholar in residence at Massey Agricultural College on the North Island

spent considerable time in the tussock country of the South Island. The reciprocal effect of this experience is not certain, but Anderson went on to pursue significant research that critically questioned the practice of pasture burning in the Flint Hills of Kansas. Kevin F. O'Connor, who subsequently held the chair in range management at New Zealand's Lincoln University, studied soil science under a Fulbright at Cornell University in 1953. Most important, R. Merton Love's Fulbright visit to New Zealand from the University of California-Davis in 1956 proved catalytic in stimulating high-country land development.²⁶

By and large, however, burning in the tussock grasslands and in the tallgrass prairies has proceeded without reciprocal influence. The 1991 review by New Zealand's Department of Scientific and Industrial Research cites none of the extensive literature on burning in the Flint Hills of Kansas. Similarly, a major anthology, *Fire in North American Tallgrass Prairies*, cites no New Zealand literature at all.²⁷

BURNING IN THE BLUESTEM

Intentional pasture burning was extensive in the Flint Hills, as in all eastern Kansas, during the last half of the nineteenth century, but those doing the burning were much less inclined to talk about it than were those opposed to the practice. Popular opinion, in fact, was vehement in its denunciation of prairie fires and those who set them, particularly because the influx of settlers had increased the danger of fire and its potential for destruction of life and property. In territorial and early statehood days, when, except for an occasional wooded stream and a few scattered plowed fields, the entire region was covered with tallgrass no longer grazed short by bison and elk, prairie fires would burn unhindered for days, wiping out everything—houses, livestock, crops, outbuildings—in their path. A report from a Chase County newspaper in 1882 records the destruction of eighty rods of fence

resulting from an intentionally set fire in early April. The unapprehended perpetrator, according to the editor, should have been lynched for his criminal recklessness. Loss of life in such fires was not uncommon. In 1879 in northern Sedgwick County, a few miles west of the Flint Hills, for instance, two men, noticing the rapid approach of a large blaze, started to run from the barn to the house but were cut off by the smoke and burned to death.²⁸

Although town dwellers in the Flint Hills were generally safe from the worst ravages of prairie fires, they were not immune from the unpleasant aftereffects. In the late nineteenth century, for example, the newspapers from both Council Grove and Manhattan report the suffocating smoke and blizzard of soot that enveloped the towns following conflagrations in the surrounding grasslands.²⁹

Another negative consequence of burning, according to those nineteenth-century Kansas immigrants who missed the shaded groves of their old homes in Ohio or Kentucky, was its impeding the growth of timber. Lone Elm School, near the village of Climax in Greenwood County, is said to have gotten its name from the single tree ("the only tree this side of Eureka") that grew from a rocky hillside ledge where it was protected from fire. A report from the 1 April 1870 edition of the *Walnut Valley Times*, published in El Dorado, noted that whenever burning is suppressed, "dense thickets of trees spring up and soon develop into forests." Four years earlier Kansas's state geologist had decried the "reprehensible practice" of what he termed "late burns" (i.e., those set after March first) because it supposedly weakened the grass and destroyed young trees.³⁰

The position of the anti-burners was perhaps best summed up by the 1875 fulminations of the editor of the *Walnut Valley Times* when he blamed prairie fires for causing drought, searing winds, ruined crops, invasions of grasshoppers, dwindling water in springs and streams, and the destruction of "thousands of young trees."³¹

With the majority of farmers and townspeople so vehemently opposed, it is small wonder that those doing the burning maintained a discreet, although not total, silence. The few surviving nineteenth-century accounts favorable to the practice, however, tend to come early, one from territorial days, another within two years after statehood. The latter, a diary (one of the few available from the Flint Hills, unlike the many that have survived from the New Zealand Tussock) and the only one to have mentioned intentional burning, was kept in 1863 by Elisha Mardin, who ranned in Chase County. On five separate occasions in April he notes (seemingly as a matter of course and not as an unusual occurrence) the intentional burning of pastures. In 1856, only two years after Kansas had been officially opened, an eastern Kansas settler from Connecticut whose mind seems to have been open to the lessons of his new environment had already learned that the previous year's tallgrass had to be burned in order to obtain the best growth and use of the new stand.³²

The question of where early Flint Hills pioneers acquired the practice of intentional burning has no definitive answer. Terry Jordan has noted that British settlers of the southeastern states, perhaps influenced by indigenous Indians, practiced burning. The cultures of both groups were also prominent in the Flint Hills. Many early settlers came from Great Britain to establish large corporate ranches and to take homesteads, which may help explain why towns in the region frequently bear English geographical names: Reading, Westmoreland, Cambridge, Matfield Green, Chelsea. But folk tradition in the Flint Hills credits the Kaw Indians with introducing white settlers to the practice when a mounted brave purportedly dragged a burning ball of prairie grass with a rawhide lariat until literally miles of prairie had been set ablaze.³³

Indians burned for the same reason farmers and ranchers did, to get rid of old grass and make tender, attractive, new growth more accessible to grazers. As transient grazing devel-

oped into an established industry in the later nineteenth century, the practice of burning became widespread as well. While ranchers with resident cow herds were less inclined to burn, those pasturing Texas steers regularly burned at the behest of cattle owners who believed their cattle gained more weight on burned ground. Many pasture contracts, in fact, specified that pastures be burned. Prominent Flint Hills cattleman E. T. Anderson observed in 1961, for example, that his grandfather, who ranched near Burdick in the later nineteenth century, had been required by cattle owners to burn. Oral tradition suggests that up until the mid-twentieth century large portions of the central Flint Hills went up in smoke annually. A few matches tossed down from the back of a horse on a windy day or a kerosene-soaked hay bale or tire lighted and pulled behind a pickup, with no attempt at backfiring or establishing fire guards, would literally set the entire countryside ablaze.³⁴

While twentieth-century pasture operators continued to burn quietly, as had their nineteenth-century fathers and grandfathers, the forum for opposition to burning switched from the popular press to scholarly journals. There were no Kansas equivalents to New Zealand's parliamentary commissions or catchment boards. Rather, specialists in range management at Kansas State Agricultural College began, as early as the teens, to test for the detrimental effects that received wisdom imputed to intentional burning. Although the results of this early experimentation were used for half a century by agricultural extension agents to discourage burning, the actual outcomes seem ambiguous at best. In fact, a chronological survey of experiments in pasture burning shows clearly the changing scientific attitudes toward the practice, attitudes that would eventually coincide with folk custom concerning burning's efficacy and utility.³⁵

While the original reason for burning New Zealand's tussock seems to have been to make the range accessible to sheep, the initial impetus for bluestem burning in the Flint Hills was apparently range enhancement: aged Texas

steers would graze more readily and gain more weight on burned pasture. (Both regions continue with spring burns to clear old foliage and increase the palatability of new growth.) Advocates of burning in the tallgrass also believed it produced a healthier pasture, with fewer weeds, trees, and woody plants, and thicker, stronger grass. Overgrazing, they felt, caused more harm than burning, and a rancher could not overgraze a pasture marked for burning without depleting dead grass sufficient to carry the fire. Graze half the grass, leave half for burning was the rule of thumb. Burning could also help even out grazing patterns in a large pasture (large numbers of Flint Hills pastures are thousands of acres in size, and many were even more extensive earlier in the century). Because cattle graze into the wind and prevailing summer winds in Kansas are southerly, the south end of a pasture would often be overgrazed at the end of the season, while the north end would remain relatively untouched. By burning the south third of a pasture first, then the middle third a week or so later, and the north third a couple of weeks after that, ranchers could draw cattle to new growth, allowing grass on the southern end to "get ahead" of the cattle.³⁶

The earliest research on pasture burning was conducted by Kansas State faculty member R. L. Hensel, who seems to have been somewhat surprised when his four-year experiment, begun in 1918, failed to corroborate the expected injurious effects. Instead, he concluded that burning could control weeds and help to raise soil temperature, thus encouraging early growth. Little Bluestem, he believed, was encouraged by burning, although Big Bluestem seemed to be somewhat discouraged. Some of Hensel's results, particularly the effect of pasture burning on soil temperature, were confirmed in a six-year study begun by A. E. Aldous in 1927. Aldous concluded that spring burning was preferable to fall (which was not widely practiced in any case), and that exotic grasses, such as Kentucky bluegrass, tended to invade unburned pastures more readily than those that had been burned.³⁷

No accounts of significant pasture burning experiments were published during the 1940s, but in 1954 Carlton Herbel, in his Kansas State master's thesis, "The Effects of Date of Burning on Native Flint Hills Range Land," concluded that although burning was detrimental to major climax vegetation, any burning that did occur should be done in late spring. Later in the decade Kling Anderson (probably influenced by his 1952 sojourn in New Zealand) published the first in a long series of articles about pasture burning. He generally opposed the practice, although his work always reflected the ambiguity of results alluded to above. Moreover, as the 1960s progressed, his position softened, although he never seems to have become an outright advocate of burning in the way that, say, Clenton Owensby was. Anderson's first publication (with R. J. Hanks) on the subject strongly urged an end to burning in order to conserve water and increase forage yields; it equivocated, however, by arguing that if one must burn, one should do it in late spring, not in March. Anderson repeated these conclusions and recommendations in 1963 and again in 1965. By 1967 he was leaning more toward acceptance of burning as part of an overall regimen of range management, allowing that fire was one of the components in maintaining productivity in bluestem pastures and that late spring burning will cause no reduction of forage but would significantly reduce weeds.³⁸

The 1970s showed a dramatic increase in the number of published studies dealing with pasture burning, all reflecting the positive aspects of the practice. Among those investigating the use of regular burning to control infestations of trees, particularly red cedar, Thomas B. Bragg and Lloyd C. Hulbert clearly state the consensus: burning is much more effective and much less expensive than mechanical removal or chemical treatment. Other research, tending to become more technical, established that burning could improve the quality of plant carbohydrates in bluestem, did no damage to the soil, and, contradicting earlier opinion, even lowered the rate of loss of

soil moisture. Experiments during this decade also validated the old-time cattleman's belief that burned pastures encouraged cattle to gain more weight more rapidly.³⁹

Research in the 1980s and 1990s has continued along much the same lines, with equally encouraging results. Soil erosion, for instance, in possible contrast to the situation in New Zealand, seems a negligible factor in Flint Hills pasture burning, according to initial reports. In fact, having affirmed the efficacy of the Flint Hills folk practice of pasture burning, the scientific community has now begun to advocate burning in grasslands other than tallgrass, although not on such a regular basis. Many Flint Hills pastures have been burned, without apparent harm, nearly annually for almost a century.⁴⁰

CONCLUSION

Although there is no apparent direct relationship between intentional burning in the Bluestem and in the Tussock, there are some compelling parallels, which seem to result from the occupation of pastoralism, and some important distinctions, largely resulting from ecological differences. In other words, in both hemispheres economic success as a grazier seems to have dictated the use of fire to create or maintain optimum range conditions, while geography and climate have dictated the temporal spacing of burns. Some Flint Hills ranchers burn nearly every year, some only every few years (scientists recommend three years out of five), while some have never burned. New Zealanders, after apparently annual burns in earlier times, now use fire more sparingly, burning only once every five to twenty years, depending on conditions and the nature of the range to be burned. Governmental restrictions and conflicts have caused problems for New Zealand pastoralists, whereas in Kansas the chief hindrances to fire have been public opinion and the agricultural extension service. Local ordinances at the county level, such as the fire bans occasionally enforced by Butler County, are sometimes imposed. Rangeland

scientists in both countries began to reassess burning and determine its actual effects, rather than those credited by conventional scientific wisdom, at approximately the same time, the 1950s. An important difference in agricultural practice between the two ranching cultures is determined by geography: fire is sometimes used in New Zealand to prepare the uplands for aerial seeding or fertilization, whereas the native tallgrasses of the Flint Hills require neither reseeding nor supplemental fertilizers.

Rainfall in the Tussock and the Bluestem is sufficient to support forestation, yet both have become and remain grasslands. Fire may not have created the grass, but grass certainly favored fire, whether set by lightning or by Maoris or Paleo-Indians. Or by South Island sheep raisers or Flint Hills pasturemen. The ultimate survival of both areas as viable pastoral regions will depend not only on fire, however, but (as wisely observed by the Otago Catchment Board) on the proper management of the land after the flames have burned out. Lady Barker would undoubtedly be pleased.

NOTES

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1. Lady Mary Anne Barker, *Station Life in New Zealand* (1870; rpt., introduction by Fiona Kidman, Auckland: Penguin Books, 1987), pp. 194-99.

2. Contemporary views are from De McGlashon, "Flint Hills Heat," *Kansas Magazine* 1 (1983): 7, and Ray Call, *Emporia Gazette*, 3 April 1986. Historical views are from Joseph W. Snell, "Prairie Fires," *Kanhistique*, May 1985, p. 2; *Kansas City Star*, c. 1900, clipping from Kansas State Historical Society.

3. Donald Jackson, ed., *The Journals of Zebulon Pike*, entry for 12 September 1806 (Norman: University of Oklahoma Press, 1966), p. 317. This summary of the Flint Hills and its grazing economy draws upon the following studies: Thomas D. Isern, "Farmers, Ranchers, and Stockmen of the Flint Hills," *Western Historical Quarterly* 16 (1985): 253-64; Walter M. Kollmorgen and Davis S. Simonett, "Grazing Operations in the Flint Hills-Bluestem

Pastures of Chase County, Kansas," *Annals of the Association of American Geographers* 55 (1965): 260-90; and James C. Malin, "An Introduction to the History of the Bluestem-Pasture Region of Kansas," *Kansas Historical Quarterly* 11 (1942): 3-28.

4. Thus two distinctive figures of agricultural folklife in the Flint Hills are the farmer-stockman (a rancher who raises both cattle and crops) and the pastureman (who looks after cattle). In practice, a single individual can, and often does, fill both roles.

5. For standard descriptions of this area, see these works of Kenneth Cumberland: "The Agricultural Regions of New Zealand," *Geographical Review* 112 (July-September 1948): 44-45, 55-60; and *New Zealand: A Regional View*, 2d ed. (1963; rpt. Christchurch: Whitcombe and Tombs, 1968), pp. 26, 166-82, 211-32. Also see, in addition to the numerous works of botanists, ecologists, and geographers cited below, Howard J. Critchfield, "Pastoral High-Country South Island, New Zealand: The Second Century," *Yearbook of the Association of Pacific Coast Geographers* (Corvallis: Oregon State University Press, 1969), pp. 51-68.

6. In addition to other scientific works cited below, see F. W. Hilgendorf, "The Grasslands of the South Island of New Zealand: An Ecological Survey," *New Zealand Department of Scientific and Industrial Research Bulletin* 47 (1935); "Tussock Grassland," *Canterbury Agricultural College Agricultural Bulletin* 180 (1944); and H. H. Allan, "An Introduction to the Grasses of New Zealand," *New Zealand Department of Scientific and Industrial Research Bulletin* 49 (1936): 142-44. The standard account of pastoralists' occupation of the Tussock is the introduction to L. G. D. Acland, *The Early Canterbury Runs*, 4th ed. (Christchurch: Whitcoulls Ltd., 1975), pp. 21-30.

7. J. B. A. Acland, "Sheep Farming in New Zealand" [primary account from 1858], *Tussock Grassland and Mountain Lands Institute Review* No. 39 (December 1980): 65; R. M. Burden, *High Country: The Evolution of a New Zealand Sheep Station* (Auckland: Whitcombe and Tombs Ltd., 1938), pp. 54-55; Laurence J. Kennaway, *Crusts: A Settler's Fare Due South* (1874; rpt., Christchurch: Capper Press, 1970), pp. 140-43; Samuel Butler, *A First Year in Canterbury Settlement* (1863; rpt., Auckland: Blackwood & Janet Paul, 1964), pp. 51-52.

8. Andrew Hill Clark, *The Invasion of New Zealand by People, Plants and Animals: The South Island* (1949; rpt., Westport: Greenwood Press, 1970); Kenneth B. Cumberland, *New Zealand* (note 5 above), p. 177; D. H. Relph, "A Century of Human Influence on High Country Vegetation," *New Zealand Geographer* 14 (October 1958): 133; A. P. Barker, "An Ecological Study of Tussock Grass-

land: Hunters Hills, South Canterbury," *New Zealand Department of Scientific and Industrial Research Bulletin* 107 (1953): 6.

9. P. G. Holland and R. P. Hargreaves, "The Trivial Round, the Common Task: Work and Leisure on a Canterbury Hill Country Run in the 1860s and 1870s," *New Zealand Geographer* 47 (April 1991): 22.

10. Station diaries used are named in the table. The authors express appreciation and thanks to Lotte Isern for conscientiously scanning and re-cording from these valuable but tedious sources.

11. *New Zealand Parliamentary Papers*, 1st Sess., 20th Parl., C-15 (1920), pp. 14-15.

12. Ibid., pp. 20-21.

13. John Buchanan, "Sketch of the Botany of Otago," *Transactions and Proceedings of the New Zealand Institute* 1 (1868): 22-28; A. H. Cockayne, "The Effect of Burning on Tussock Country," *New Zealand Journal of Agriculture* 1 (15 June 1910): 7-15 (quoted pp. 7-8, 14); W. J. McCulloch, "The Depleted Lands of the South Island Central Regions," *New Zealand Journal of Agriculture* 14 (20 April 1917): 293-302 (quoted p. 294).

14. L. Cockayne, "An Economic Investigation of the Montane Tussock-Grassland of New Zealand," *New Zealand Journal of Agriculture* 18 (20 January 1919): 1-9; 18 (20 June 1919): 321-33; 19 (20 September 1919): 129-38; 19 (20 December 1919): 343-46; 20 (20 February 1920): 82-94; 20 (20 April 1920): 209-17; 20 (21 June 1920): 337-45; 21 (20 October 1920): 176-88; 21 (20 December 1920): 324-34; 22 (21 March 1921): 148-57; 23 (20 September 1921): 137-47; 24 (20 June 1922): 321-34; 25 (20 July 1922): 1-22; 25 (20 September 1922): 129-44.

15. This is an appropriate point at which to acknowledge K. F. O'Connor, "The Influence of Science on the Use of Tussock Grasslands," *Tussock Grasslands and Mountain Lands Review* (1985, no. 43), pp. 15-78, for its survey of the work of the Cockaynes and other scientists, as well as for its conceptualization of scientists and pastoralists as story-tellers.

16. V. D. Zotov, "Maintenance of Vegetative Cover in New Zealand, with Special Reference to Land Erosion (Report of Committee of Inquiry)," *New Zealand Department of Scientific and Industrial Research Bulletin* 77 (1939): 27-28, 36; H. S. Gibbs et al., "Soil Erosion in the High Country of the South Island," *New Zealand Department of Scientific and Industrial Research Bulletin* 92 (1945): 43-46; Zotov, "Survey of the Tussock-Grasslands of the South Island, New Zealand," *New Zealand Journal of Science and Technology* 20 (December 1938): 212-44.

17. L. W. McCaskill, "Conservation and the Tussock Grasslands," *Soil & Water* 2 (September

1965): 36-37; McCaskill, *Hold This Land: A History of Soil Conservation in New Zealand* (Wellington: A. H. & A. W. Reed, 1973); Soil Conservation and Rivers Control Council, "The Menace of Soil Erosion in New Zealand," *Bulletin* 1 (1944), "Tackling High Country 'Problem Land' at Molesworth," *Bulletin* 2 (1944), and "First Steps in Soil Conservation," *Bulletin* 4 (n.d.); Kenneth Cumberland, *Soil Erosion in New Zealand* ([Wellington]: Soil Conservation and Rivers Control Council, 1944).

18. Cumberland, "Burning Tussock Grassland: A Geographic Survey," *New Zealand Geographer* 1 (1945): 149-64; North Canterbury Catchment Board, *Burning Practice on Tussock Grassland*, Canterbury Chamber of Commerce, Agricultural Bulletin No. 189 (April 1945). It is remarkable that Cumberland, who condemned burning as pastoral practice, in subsequent publications was to credit the supplanting of forest by tussock grassland to the use of fire by moa-hunting Maori centuries earlier (a thesis Zotov had intimated). It seems not to have occurred to Cumberland that if the moa-hunters had induced tussock formation by fire, its husbandry might require periodic burning. See Cumberland, "Moas and Men: New Zealand about A.D. 1250," *Geographical Review* 52 (April 1962): 151-73; "Man in Nature in New Zealand," *New Zealand Geographer* 17 (October 1961): 137-48.

19. Royal Commission to Inquire into and Report upon the Sheep-Farming Industry in New Zealand, New Zealand Parliamentary Papers, 3d Sess., 28th Parliament (1949), H-46A, pp. 61-77.

20. Department of Lands and Survey, Land Settlement Board, *High Country Policy* (1980), p. 37; K. F. O'Connor, "An Introduction to the Waitaki," *New Zealand Man and Biosphere Report* 1 (1976): 2; G. A. Bain, "The Mt. Benger and Moa Flat Conservation District," *Tussock Grasslands and Mountain Lands Review* 20 (December 1970): 69-75; personal interview with Marcelle and Pat Garden, Avenel Station, 29 November 1991; agreement with Otago Catchment Board for "Combined Conservation Districts District Committee," ca. 1965, copy courtesy Pat Garden.

21. H. K. Edie, "Development of Tussock Grassland in Waihemo County," *New Zealand Journal of Agriculture* 87 (November 1953): 458-63; A. R. Dingwall, "High Country Tussock Grassland Improvement in Canterbury," *ibid.* 91 (December 1955): 554-55; W. R. Lobb and R. L. Bennetts, "Improvement of Tussock Grassland in Canterbury," *ibid.* 96 (June 1958): 537-49; H. A. Arthur, "Tussock Grassland Improvement on 'Shenley,'" *ibid.* 98 (February 1959): 122-31; R. D. Dick, "Tussock Grassland Improvement—Waimakariri," *Soil & Water* 1 (March 1965): 21-23; John Hunt, "Education and the High Country Problem," *ibid.*: 26-

27; K. F. O'Connor, "The Role of Burning and Top-Dressing in Snow-Tussock Management," *Tussock Grasslands and Mountain Lands Review* 3 (September 1962): 17-36.

22. Barbara H. Hercus, "Method of Studying Botanical Changes that Follow Burning on Tussock Grassland," *New Zealand Journal of Agriculture* 104 (March 1962): 190-94; O'Connor, "Role of Burning" (note 21 above), pp. 17-26; A. F. Mark, "The Narrow-Leaved Snow Tussock," *Tussock Grassland and Mountain Lands Institute Review* 10 (March 1966): 28-40; Jennifer Rowley, "Effects of Burning and Clipping on Temperature, Growth, and Flowering of Narrow-Leaved Snow Tussock," *New Zealand Journal of Botany* 8 (September 1970): 264-82; personal interview with Alan F. Mark, University of Otago, 13 November 1991; K. F. O'Connor, "The Implications of Past Exploitation and Current Developments to the Conservation of South Island Tussock Grasslands," *New Zealand Journal of Ecology* 5 (1982): 97-107; P. J. McKendry and K. F. O'Connor, "The Ecology of Tussock Grasslands for Production and Protection," unpublished report for Department of Conservation, June 1990; K. F. O'Connor and Peter S. Harris, "Biophysical and Cultural Factors Affecting the Sustainability of High Country Pastoral Land Uses," unpublished paper, n.d., courtesy of O'Connor; K. F. O'Connor, "Nutrient Cycling and Systems Ecology, Pastoral Science and Practice, and Mountain and Steepland Land Use," review of refresher leave, Lincoln University, December 1990, copy courtesy of O'Connor; Ian E. Whitehouse, "Erosion in the Eastern South Island High Country—A Changing Perspective," *Tussock Grasslands and Mountain Lands Institute Review* 42 (December 1984): 3-23; K. B. Duggan, "Effects of Fire on Soil and Vegetation, with Particular Reference to the Tussock Grasslands of the East Coast of the South Island: A Review," unpublished paper, courtesy Fraser McCrae, Otago Regional Council, Dunedin.

23. Personal interview with Fraser McRae, Chief Resources Officer, Otago Regional Council, Dunedin, 12 November 1991.

24. J. F. McRae, "A Farmer View of Burning," *Otago Catchment Board Report* 89/60 (1989), copy courtesy of McRae; personal interviews and reconnaissances with Geoffrey Thomson and Reta and Tommy Thomson, Earnslaw Station, 7 November 1991, Lorraine and Arthur Borrell, The Branches, 8 November 1991, Marcelle and Pat Garden (note 20 above), and Alistair France, 17 November 1991.

25. L. R. Basher, C. D. Meurk, and K. R. Tate, "The Effects of Burning on Soil Properties and Vegetation: A Review of the Scientific Evidence Relating to the Sustainability of Ecosystems and

- Land Use in the Eastern South Island Hill and High Country," DSIR Land Resources Technical Record 18 (October 1990); Parliamentary Commissioner for the Environment, *Sustainable Land Use for the Dry Tussock Grasslands in the South Island* (March 1991), p. ii.
26. Fulbright Grantee Files, New Zealand-United States Educational Foundation, Wellington.
27. Scott L. Collins and Linda L. Wallace, eds., *Fire in North American Tallgrass Prairies* (Norman: University of Oklahoma Press, 1990).
28. *Chase County Leader*, 6 April 1882; Snell, "Prairie Fires" (note 2 above), p. 4.
29. Snell, "Prairie Fires" (note 2 above), p. 4.
30. From Helen Bradford's typescript history of Climax, deposited in the Greenwood County Historical Museum; G.C. Swallow, *Preliminary Report of the Geological Survey of Kansas* (Lawrence: John Speer, Printer to the State, 1866), pp. 118-19.
31. Quoted in Snell "Prairie Fires" (note 2 above), p. 4. It is, of course, fire's very ability to check woody growth that makes it popular with both ecologists and Flint Hills agriculturalists today.
32. James F. Hoy, "A Window on Flint Hills Folklife, Part II: The Diary of Elisha Mardin," *Kansas History* 14 (Winter 1991-1992, no. 4): 252-53; Snell "Prairie Fires" (note 2 above), pp. 2-3.
33. Terry Jordan, *Trails to Texas: Southern Roots of Western Cattle Ranching*, (Lincoln: University of Nebraska Press, 1981), pp. 10, 37; Jerry Moxley, 11 December 1972, Flint Hills Oral History Collection, William Allen White Library, Emporia State University.
34. George Montgomery, "The Bluestem Is Going to Cow-and-Calf," *National Livestock Producer*, April 1961, p. 32. Surviving copies of early twentieth-century pasture contracts from the Whitney Ranch, originally established by the Western Land and Cattle Company in 1882, specify burning. Malin, "An Introduction" (note 3 above), also notes this requirement. Personal interview with Dudley "Slim" Pinkston, 2 April 1987.
35. James F. Hoy, "Controlled Pasture Burning in the Folklife of the Kansas Flint Hills," *Great Plains Quarterly* 9 (Fall 1989): 232. Range management specialists, however, prefer late April to early May burning, while many ranchers still begin burning in mid-March.
36. Personal interview with Wayne Rogler, April 1987; personal interview with Sam Methvin, June 1987.
37. R. L. Hensel, "Effect of Burning on Vegetation in Kansas Pastures," *Journal of Agricultural Research* 23 (1923): 631-43; A. E. Aldous, "Effect of Burning on Kansas Bluestem Pastures," *Kansas State Agricultural College (KSAC) Agricultural Experiment Station Technical Bulletin* 38 (November 1934).
38. Kling Anderson's articles on burning include the following: "Pasture Burning and Moisture Conservation," *Journal of Soil and Water Conservation* 12 (1957): 228-29; "Burning Bluestem Ranges," *Crops and Soils* 13 (1961): 13-14; with Wilfred E. McMurphy, "Burning Bluestem Range—Forage Yields," *Transactions of the Kansas Academy of Science* 66 (1963): 49-51; "Burning Flint Hills Bluestem Ranges," *Proceedings of the Third Annual Tall Timbers Fire Ecology Conference*, Tall Timbers Research Station, Tallahassee, Florida (1964), pp. 88-103; "Time of Burning as It Affects Soil Moisture in an Upland Bluestem Prairie in the Flint Hills," *Journal of Range Management* 18 (1965): 311-16; "Grazing Management and Fire in the Flint Hills," *Transactions of the Kansas Academy of Science* 70 (1967): 171-76; with Clenton E. Owensby, "Yield Responses to Time of Burning in Kansas Flint Hills," *Journal of Range Management* 20 (1967): 12-16; and with Ed F. Smith and Clenton E. Owensby, "Burning Bluestem Range," *Journal of Range Management* 23 (1970): 81-92.
39. Thomas B. Bragg and Lloyd C. Hulbert, "Woody Plant Invasion of Unburned Kansas Bluestem Prairie," *Journal of Range Management* 29 (1976): 19-24; Leland J. Allen et al., "Range Burning and Fertilizing Related to Nutritive Value of Bluestem Grass," *Journal of Range Management* 29 (1976): 306-08; Clenton E. Owensby and John Bruce Wyrill, III, "Effects of Range Burning on Kansas Flint Hills Soil," *Journal of Range Management* 26 (1973): 185-88; Clenton E. Owensby and Ed F. Smith, "Burning True Prairie," *Third Midwest Prairie Conference Proceedings*, Division of Biology, Kansas State University, 1973, pp. 1-4; John S. Woolfolk et al., "Effects of Nitrogen Fertilization and Late-Spring Burning of Bluestem Range on Diet and Performance of Steers," *Journal of Range Management* 28 (1975): 190-93.
40. "Burned Prairie Makes Soils Vulnerable," *Grass and Grain*, 1 August 1989, p. 21. Despite the misleading headline, initial findings at the Konza Prairie Research Natural Area suggest that "prairie soil is not very vulnerable to erosion following burning." Sevie Kenyon, "Prescribed Burning Goes West," *Kansas Farmer*, 15 March 1991, p. 54; Pinkston Interview (note 34 above).