

Prescribed Burning in Grassland Management for Prairie Chickens in Illinois¹

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FIRE has long been absent as a recurring natural phenomenon affecting prairie chickens (*Tympanuchus cupido*) in Illinois. The Eastern tallgrass prairie has been transformed into a seemingly endless vista of corn (*Zea mays*), soybeans (*Glycine max*), and other crops characteristic of modern intensive agriculture. Numbers of prairie chickens have declined from the millions of birds coinciding with pioneer farming efforts on the Illinois prairie about 100 years ago to about 500 birds in the spring of 1972.

Fortunately for the prairie chicken, redtop (*Agrostis alba*), believed to be an introduced grass by Fernald (1950), Hitchcock (1950), and Jones (1963), provided a "substitute prairie" in southeastern Illinois as early as 1867, according to Buzzard (1931:466). By the turn of the century, redtop seed was an important money crop in southeastern Illinois, and this area of the state maintained the title of "redtop capital of the world" until about 1947 (Yeatter 1963:749). However, during the 1950's redtop was largely replaced by soybeans (Yeatter 1963:750), and had it not been for the Federal

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Conservation Reserve (CR) Program initiated in 1958, "a majority of the few remaining flocks of prairie chickens in Illinois in 1966 would have been extinct by then" (Sanderson and Edwards 1966:328). Most of the CR contracts expired by the mid-1960's, and currently acreages set aside under the Federal Feed Grain Program provide about the only possibility for undisturbed cover on private farmland for nesting prairie chickens. Set-aside acres generally provide either no cover or a poor quality of nest cover, and the future of the program remains uncertain.

The Prairie Chicken Foundation of Illinois (PCFI) was formed in 1959, and in 1962 this agency bought, near Bogota in Jasper County, the first tract (77 acres) to be managed as a nest sanctuary. In 1965, a second fund-raising group was formed, the Prairie Grouse Committee, Illinois Chapter, The Nature Conservancy (PGC). The Illinois Department of Conservation, acting through the Illinois Nature Preserves Commission, is currently increasing its role in the effort to save the prairie chicken by purchasing sanctuary lands from the PGC and thereby acting as perpetual landowner. Through the efforts of these groups, the sanctuary system as of May 1972 has been expanded to a total of 1,420 acres, 960 near Bogota, Jasper County, and 460 near Farina, Marion County. From the beginning, it was obvious that in this area of intensive cash-grain farming and high-priced land, only limited acreages could be acquired for management of prairie chickens. Because the efforts to save the prairie chicken were funded by contributions from private individuals, it was essential that the cost of management be kept within reason.

In 1962, we did not know much about the nest ecology of prairie chickens and thus knew little about how to manage the sanctuaries we were beginning to acquire. In the fall of 1962, a cooperative research project on prairie chickens was initiated by the Illinois Natural History Survey and the Illinois Department of Conservation. Principle emphasis of this project has been on the status and distribution of remnant flocks and the nest ecology of prairie chickens on the primary management area near Bogota. In terms of management, the objectives of the nest study were to determine preferred types of nest cover, how these preferred types could best be established, and what types of management were necessary to maintain vegetation in an acceptable state over a period of years.

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Intensive nest studies conducted annually on the Bogota Study Area, 1963 through 1971, have resulted in detailed information on a sample of 242 prairie chicken nests. These data are supplemented by an additional sample of 51 nests, based on reliable reports by local residents. Although a wide variety of cover types are represented in this sample, the great majority of the nests have been found in redtop. The high incidence of nests in redtop is in part due to the fact that properly managed redtop is a preferred nest cover and in part because redtop is the grass most frequently seeded on newly acquired sanctuaries.

Relatively early in the study it became apparent that the age of a stand of redtop was an important factor affecting nest placement by prairie chickens. Data for the years 1963–68 indicate that if the management of redtop is limited to harvesting for seed or clipping for weed control, or if redtop acreage is left unmanaged, the fields are most attractive to nesting prairie chicken hens the second spring after seeding and decline in attractiveness as they get older (Table 1). Although comparable sample sizes were not available for other species and combinations of grasses, the same phenomenon was readily apparent. The significance of this observation is that some combination of annual treatment, periodic rejuvenation, or reseeding of grasslands is necessary in the management of nest sanctuaries for prairie chickens. Prescribed burning, the harvest of grass seed, delayed haying, and light grazing are being tested as possible techniques for managing stands of redtop and other grasses for nest cover for prairie chickens.

The purpose of this paper is to evaluate the role of prescribed burning, to date, as a management tool on nest sanctuaries for prairie chickens in Southeastern Illinois.

METHODS

STUDY AREA

The Bogota Management Area covers approximately 16 mi². The topography is flat to gently rolling in Jasper County. The soils are predominately fine-textured, light-colored silt loams that are slowly permeable. Drainage is usually provided by surface ditches. There are, on the average, 180–190 frost-free days that normally occur

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TABLE 1. USE OF VARIOUS AGE-CLASSES OF REDTOP BY NESTING PRAIRIE CHICKENS, BOGOTA STUDY AREA, 1963-68.

| Year Growth | Acres Searched | Nests Found | Acres per Nest |
|-------------|----------------|-------------|----------------|
| 1 | 125 | 4 | 31.3 |
| 2 | 147 | 19 | 7.7 |
| 3 | 164 | 10 | 16.4 |
| 4 | 36 | 2 | 18.0 |
| 5 and Older | 468 | 19 | 24.6 |

from 17 April to 20 October. The average annual precipitation is about 40 inches (Page 1949).

A total of 53 occupied rural farmsteads, one small town (Bogota), and 37 miles of public roads on the area indicate a rather dense human settlement. Cash-grain farming is the most common occupation; approximately three-fourths of the area is cultivated annually. Soybeans, corn, and wheat (*Triticum aestivum*) are the predominant crops; the availability of winter food has not presented a problem to prairie chickens in Illinois during the period of our research. Other uses of the private farmland include pasture, tame hay, set-aside acres under the Federal agricultural programs, and woods. Providing suitable safe nest cover in such a landscape is the major problem in management of prairie chickens in Illinois.

Most of the 960 acres currently comprising sanctuaries for prairie chickens on the Bogota Area (Fig. 1) were planted annually to soybeans and corn prior to acquisition. These tracts were initially seeded to redbtop and timothy (*Phleum pratense*), plus various admixtures of legumes, to expedite the establishment of nest-brood cover.

NEST SEARCHING

Prairie chicken nests have been located by making systematic searches on foot, primarily after the peak of hatch (about 1 June), on the nest sanctuaries. The nest-searching crew usually consists of two to four men walking side by side, each covering a 5-foot swath, and using a stick to part the cover in an attempt to view each possible nest site. In addition, nests located by local farmers were visited

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whenever possible. The ecology of each nest is described and recorded in detail for subsequent analysis and evaluation.

TECHNIQUES OF BURNING

Prescribed burning has been conducted on sanctuaries on the Bogota Area in either March or August on a total of 166 plots totaling 662

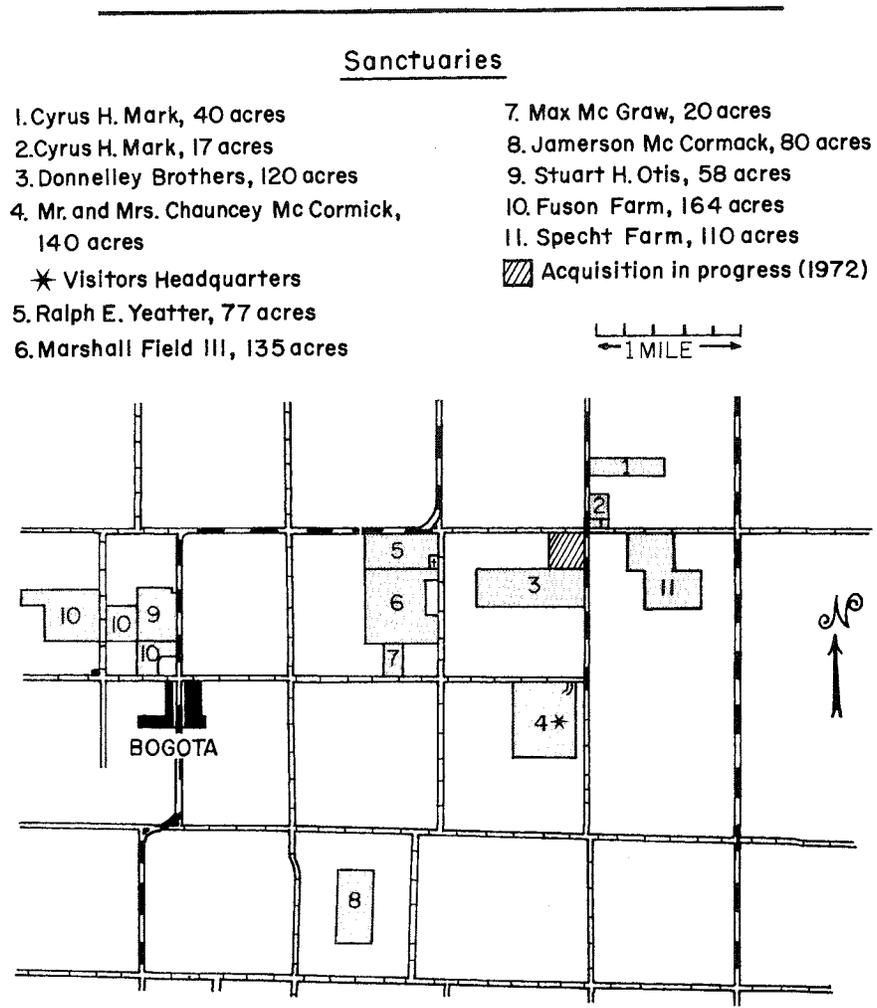


FIG. 1. Distribution of prairie chicken sanctuaries near Bogota in Jasper County, Illinois, May 1972.

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acres, over the 4 years, 1968–71. The burning has been done on sods 2 years of age and older that were composed primarily of redbud and timothy and in fields in which prairie restoration was being attempted. Typically, each burn was made in a plot consisting of one-fourth to one-half of a particular cover type on a given field. In subsequent years, additional burns were made until the rotation covered an entire field. Where possible, an effort was made to create a checkerboard of burned and unburned plots on each sanctuary. Where necessary, firebreaks about 12 feet wide were made by disking, plowing, or mowing around plots scheduled for burning. Backfires were set, then forefires were started when control of the fire was reasonably assured. Two to four individuals were present during each burn. The aim for each burn was to remove about 80 percent of the residual cover and duff from the soil surface and to leave a mosaic of relatively unburned and closely burned patches. Wet soil with the vegetative debris saturated 1–2 inches above the soil surface was considered ideal for a *cool* burn. All burning was done in accordance with a permit granted by the Illinois Environmental Protection Agency.

FINDINGS

NESTING IN POSTBURN VEGETATION

Since the initiation of prescribed burning in 1968, a total of 69 prairie chicken nests were found on the burned plots. However, no nests have been found in 30 plots, totaling 125 acres, during the first nest season after a March burn (Table 2).^{*} Some good densities of nests have resulted during the second (one nest per 6.3 acres) and fourth (one nest per 5.8 acres) nest seasons after burning in March. Curiously, during the third nest seasons after March burns, only 2 nests were found in 22 plots totaling 74 acres, a density of only one nest per 37.0 acres.

Only two nests have been found in 133 acres (30 plots) during the first nest season after an August burn (Table 3). However, the excellent density of one nest per 4.2 acres was achieved with 42 plots,

^{*}One week prior to the 1972 conference, my nest-searching crew found an active nest in a field that had been burned in March 1972, the first occurrence in this category.

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TABLE 2. COMPARISON OF NESTING BY PRAIRIE CHICKENS IN PLOTS BURNED IN MARCH, ACCORDING TO THE INTERVAL SINCE BURNING, BOGOTA STUDY AREA, 1968-71.

| Nesting Season After March Burn | Acres Searched | Nests Found | Acres per Nest | Plots Searched | | |
|---------------------------------------|-------------------|----------------|-------------------|----------------|---------------------------|---------|
| | | | | Total | With one or more nests | |
| | | | | | No. | Percent |
| 1 | 125 | 0 | — | 30 | 0 | 0 |
| 2 | 146 | 23 | 6.3 | 36 | 14 | 38.9 |
| 3 | 74 | 2 | 37.0 | 22 | 2 | 9.1 |
| 4 | 23 | 4 | 5.8 | 6 | 3 | 50.0 |
| Mean of 2-4 | 243 | 29 | 8.4 | 64 | 19 | 29.7 |

totaling 161 acres, during the second and third nest seasons after prescribed burning in August. Fifty-seven percent of the plots had one or more nests each during the second and third nest seasons after a burn in August. By contrast, only 29.7 percent of the March burns (Table 2) had at least one nest each during the second, third, and fourth nest seasons after burning.

Burned sods in the second, third, and fourth nest seasons after burning in March or August contained higher densities of nests during each of the past 3 years (1969-71) at Bogota than similar but unburned sods that were in the second or later nest seasons after seeding (Table 4). The overall mean nest density of one nest per 6.0 acres for the burned plots 2 or more years after burning (Table 4) was significantly greater ($P < 0.05$) than the overall mean nest density of one nest per 9.3 acres for comparable unburned sods.

The individual fields that contained the highest densities of nests in 1970 and 1971 at Bogota are shown in Tables 5 and 6. The list of

TABLE 3. COMPARISON OF NESTING BY PRAIRIE CHICKENS IN PLOTS BURNED IN AUGUST, ACCORDING TO THE INTERVAL SINCE BURNING, BOGOTA STUDY AREA, 1968-71.

| Nesting Season After August Burn | Acres Searched | Nests Found | Acres per Nest | Plots Searched | | |
|--|-------------------|----------------|-------------------|----------------|---------------------------|---------|
| | | | | Total | With one or more nests | |
| | | | | | No. | Percent |
| 1 | 133 | 2 | 66.5 | 30 | 2 | 6.7 |
| 2 | 118 | 27 | 4.4 | 30 | 18 | 60.0 |
| 3 | 43 | 11 | 3.9 | 12 | 6 | 50.0 |
| Mean of 2-3 | 161 | 38 | 4.2 | 42 | 24 | 57.1 |

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fields was limited to those of at least 1 acre that contained more than one prairie chicken nest and had a density exceeding one nest per 5 acres. For example, on the Otis Sanctuary in 1970 (Table 5), three nests were found in 3.5 acres (one nest per 1.2 acres) of a fourth-year stand of timothy that was burned in March 1969 and then combined for seed in August 1969. This cover type was one of 10 different cover types available. It comprised only 6.7 percent of the 52 acres searched on the Otis Sanctuary but contained 37.5 percent of the eight nests found on that sanctuary in 1970.

Likewise, on the Mark 40, Yeatter, and Field sanctuaries in 1970, 12 to 17 different cover types, involving various age-classes, species, burn and unburn categories, and uses prior to nesting, were available to nesting hens, but redtop and timothy stands in the second nest season after burning in August (four fields) and March (one field) resulted in high densities ranging from one nest per 1.3 acres to one nest per 2.5 acres (Table 5). Some high densities of nests were also attained in unburned cover types on the McGraw and Donnelley sanctuaries in 1970; however, two of the three fields involved were second- and third-year sods that had been shown to be preferred covers (Table 1). The 21-acre field of redtop with seven nests on the Donnelley Sanctuary was an exception to the pattern emerging here. However, while nest success in each of the other eight fields (Table 5) ranged from 50 to 100 percent hatched nests, only two

TABLE 4. A COMPARISON OF THE NEST DENSITIES IN UNBURNED SODS, IN THE SECOND NEST SEASON AND LATER SEASONS AFTER SEEDING WITH NEST DENSITIES IN THE 2-4 NEST SEASONS AFTER BURNING IN MARCH OR AUGUST ON SODS THAT WERE TREATED BY PRESCRIBED BURNING, BOGOTA STUDY AREA, 1969-71.

| Year | Unburned Sods in the Second or Later Nest Seasons After Seeding | | | Burned Sods in the 2-4 Nest Seasons After Burning | | |
|---------|---|-------------|----------------|---|-------------|----------------|
| | Acres Searched | Nests Found | Acres per Nest | Acres Searched | Nests Found | Acres per Nest |
| 1969 | 221 | 24 | 9.2 | 21 | 3 | 7.0 |
| 1970 | 278 | 36 | 7.7 | 155 | 26 | 6.0 |
| 1971 | 293 | 25 | 11.7 | 228 | 38 | 6.0* |
| 1969-71 | 792 | 85 | 9.3* | 404 | 67 | 5.9* |

* Differences were significant at $P < 0.05$ for 2 df ($t = 3.1$, $t_{.05, 2 \text{ df}} = 2.92$), paired comparisons.

TABLE 5. LIST OF FIELDS OF AT LEAST 1 ACRE THAT CONTAINED MORE THAN ONE PRAIRIE CHICKEN NEST AND HAD A DENSITY EXCEEDING 5 ACRES PER NEST, ON NEST SANCTUARIES, BOGOTA STUDY AREA, 1970.

| Sanctuary | Number | | | Best Cover Types in 1970 | | | | | | | | |
|-----------|----------------|-----------------------|-------------|--------------------------|--------------------|------------------|---------------------------|----------------------------|-------------|----------------|---------------------------------|------------------------------|
| | Searched Acres | Cover Types Available | Nests Found | Acres | Age of Sod (Years) | Dominant Species | Burn Category | Last Mgt. Prior to Nesting | Nests Found | Acres per Nest | Percent of Total Cover Searched | Percent of Total Nests Found |
| Otis | 52 | 10 | 8 | 3.5 | 4 | Timothy | Mar. burn II ¹ | Seed harv. | 3 | 1.2 | 6.7 | 37.5 |
| Mark 40 | 25 | 12 | 3 | 3.8 | 4 | Timothy | Aug. burn II | Undist. | 3 | 1.3 | 15.2 | 100.0 |
| Yeatter | 65 | 12 | 10 | 3.9 | Old | Redtop | Aug. burn II | Undist. | 3 | 1.3 | 6.0 | 30.0 |
| | | | | 4.9 | 8 | Timothy | Aug. burn II | Seed harv. | 3 | 1.6 | 7.5 | 30.0 |
| Field | 117 | 17 | 14 | 5.0 | 5 | Redtop | Aug. burn II | Undist. | 2 | 2.5 | 4.3 | 14.3 |
| | | | | 5.0 | 5 | Redtop | Mar. burn II | Undist. | 2 | 2.5 | 4.3 | 14.3 |
| McGraw | 20 | 3 | 5 | 12.0 | 3 | Redtop | Unburned | Patch mowed | 4 | 3.0 | 60.0 | 80.0 |
| Donnelley | 107 | 12 | 17 | 21.0 | 6 | Redtop | Unburned | Undist. | 7 | 3.0 | 19.6 | 41.2 |
| | | | | 9.5 | 2 | Redtop | Unburned | Seed harv. | 2 | 4.8 | 8.9 | 11.8 |

¹ Roman numerals refer to the nest season after burning. Thus, Mar. burn II indicates a field in the second nest season after a burn made in March.

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(28.6 percent) of the seven nests hatched in the 21-acre field of sixth-year redtop.

In 1971, eight fields of at least 1 acre each on four sanctuaries contained more than one nest each and had densities greater than one nest per 5 acres (Table 6). Each field represented a small percentage of the total cover searched, but each contained a disproportionately high percentage of the total nests found on each sanctuary. Again, 12 to 28 different cover types were available to nesting hens on each sanctuary, but six of the eight fields were in stands dominated by redtop or timothy that were in the second, third, and fourth nest seasons after prescribed burns in March or August. One of the two unburned fields, the 10-acre redtop seed meadow on the Field Sanctuary, was still a relatively young sod, in the fourth growing season, and the field was located about 100 yards from a booming ground that contained 45–46 (55) cocks (minimum-maximum number of cocks regularly present and highest count, respectively) in 1971. The 3.7-acre unburned timothy seed meadow on the Otis Sanctuary contained three nests, for a density of one nest per 1.2 acres, but this field was also ideally located with respect to a booming ground. Only one of the three nests successfully hatched. Rates of success in the other seven fields (Table 6) ranged from 50 percent to 75 percent, except for the 3.3-acre redtop seed meadow that was in the fourth nest season after a March burn where both of the two nests were unsuccessful. These samples, plus the 21-acre field of 6-year unburned redtop on the Donnelley Sanctuary (Table 5), suggest that the rate of success of prairie chicken nests tends to decline as grasslands age, particularly in the absence of burning and by the fourth nest season after a burn. Probably the most important conclusion to be reached from the data in Table 5 and 6 is that regardless of the age of a stand of grass, prescribed burning is an effective rejuvenator so far as its successful use by nesting hens is concerned.

BOOMING GROUNDS ON RECENT BURNS

Our observations of the social behavior of the prairie chicken leave little doubt that the booming ground is a focal point of activity throughout most, if not all, of the year. It appears highly desirable for management to provide suitable sites for booming, properly

TABLE 6. LIST OF FIELDS OF AT LEAST 1 ACRE THAT CONTAINED MORE THAN ONE PRAIRIE CHICKEN NEST AND HAD A DENSITY EXCEEDING 5 ACRES PER NEST, ON NEST SANCTUARIES, BOGOTA STUDY AREA, 1971.

| Sanctuary | Number | | | Best Cover Types in 1971 | | | | | | | | |
|------------------|----------------|-----------------------|-------------|--------------------------|--------------------|------------------|---------------------------|-----------------------------|-------------|----------------|---------------------------------|------------------------------|
| | Acres Searched | Cover Types Available | Nests Found | Field Size (acres) | Age of Sod (years) | Dominant Species | Burn Category | Last Mgmt. Prior to Nesting | Nests Found | Acres per Nest | Percent of Total Cover Searched | Percent of Total Nests Found |
| Field | 108 | 17 | 16 | 2.5 | 8 | Timothy | Aug. burn II ¹ | Undist. | 3 | 0.8 | 2.3 | 18.8 |
| | | | | 10.0 | 4 | Redtop | Mar. burn II | Seed harv. | 7 | 1.4 | 9.3 | 43.8 |
| | | | | 10.0 | 4 | Redtop | Unburned | Seed harv. | 3 | 3.3 | 9.3 | 18.8 |
| Yeatter | 65 | 12 | 13 | 4.9 | 9 | Timothy | Aug. burn III | Seed harv. | 4 | 1.2 | 7.5 | 30.8 |
| | | | | 3.9 | Old | Redtop | Aug. burn III | Undist. | 3 | 1.3 | 6.0 | 23.1 |
| Otis | 52 | 12 | 8 | 3.7 | 5 | Timothy | Unburned | Seed harv. | 3 | 1.2 | 7.1 | 37.5 |
| C. McCormick 119 | 119 | 28 | 13 | 3.3 | 6 | Redtop | Mar. burn IV | Seed harv. | 2 | 1.7 | 2.8 | 15.4 |
| | | | | 5.1 | 6 | Redtop | Aug. burn II | Seed harv. | 2 | 2.6 | 4.3 | 15.4 |

¹ Roman numerals refer to the nest season after burning. Thus, Aug. burn II indicates a field in the second nest season after a burn made in August.

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located with respect to high quality nest cover developed on the sanctuaries. By late September and early October, cocks are becoming conspicuous on the booming grounds even though peak activity does not occur until early April. Ideally, suitable booming grounds should be developed in late summer or early fall.

Some success has been attained with the use of fire to establish booming grounds in desired locations on the sanctuaries at Bogota. A 140-acre farm (the Mr. and Mrs. Chauncey McCormick Sanctuary, Fig. 1) was acquired by the PGC in March 1966, at which time the cover on the farm was primarily soybean stubble and small grains. The farm received practically no use by prairie chickens until February 1968, by which time the tract contained 15 types of grass and grass-forb mixtures. By 30 March 1968, a booming ground was established on a 10-acre burn made on 28 February in the center of the McCormick Sanctuary (Westemeier and Edwards 1969). The burn was made in 5 acres each of a timothy-prairie grass stand and a redtop seed meadow. Peak numbers of 6 cocks and 10 hens, possibly one-third of the hen population in the Bogota flock in 1968, were seen on the new green vegetation that appeared after the burn. During the previous fall, a 4.5-acre field adjacent to the 10-acre burn was mowed to ground level as a potential booming ground, and, although the prairie chicken cocks began booming on the mowed field, a shift to the burned field was clearly evident after the burned sod turned green. In a subsequent search of 94 acres of surrounding grassland, seven prairie chicken nests were found in a radial pattern encircling the booming ground. Similarly, in each spring from 1969 through 1972, several different sites were available in likely locations for booming grounds on the McCormick Sanctuary. The available sites included closely mowed fields, short new grass-legume seedings, plowed fields, wheat seedings, and recent burns made in February, March, and August. Each spring, booming grounds were located on fresh burns made in February and March.

Similar instances of selection for recent burns for booming grounds have occurred on other sanctuaries at Bogota. On the Marshall Field III Sanctuary, acquired by the PGC in 1968, a booming ground that had been defunct since 1964 was reestablished as a booming ground by about 12 cocks in the spring of 1970. The booming site was a

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stand of mixed redtop and timothy that had been flattened by snow during the previous winter. A 5-acre portion of the 20-acre field on which the booming ground was located was burned in August to further promote its use for display activities. By 22 October 1970, up to 70 prairie chicken cocks were counted on the greened-up burn. During the spring of 1971, the booming ground on the Field Sanctuary regularly held 45-46 cocks, the largest booming ground on the study area. The adjacent cover types contained high densities of nests (Table 6). The booming ground on the Field Sanctuary was closely mowed during the late summer of 1971. Although 3 or 4 cocks boomed on the mowed sod during the spring of 1972, the major booming site shifted about 165 yards to the southwest to a 10-acre field of soybean stubble and regularly contained 61 to 65 cocks.

DISCUSSION

MANAGEMENT RECOMMENDATIONS

The response of prairie chickens to management at Bogota has been gratifying. Population increases have been closely associated with the availability of suitable nest cover. The low in the population occurred in the spring of 1968, with 37 cocks observed on booming grounds at Bogota. In subsequent springs, the peak counts of cocks were 51 in 1969, 108 in 1970, 159 in 1971, and 196 in 1972. This response gives us confidence that the concepts of managing grassy nesting cover that have evolved from our continuing studies of prairie chicken ecology are on the right track.

On the basis of the encouraging results attained to date with prescribed burning, the use of this tool should continue as an integral part of prairie chicken management in Illinois, and probably elsewhere as well. Tentatively, it appears that one or possibly two prescribed burns may be used to maintain the attractiveness of a redtop or timothy meadow for at least 6-9 years after seeding.

It will probably be desirable to make a first burn in August, after the third nest season after seeding, or in March prior to the fourth nest season after seeding. A second prescribed burn may be desirable if, by the end of the third nest season after the first burn, the sod is still not heavily invaded with such forbs as yarrow (*Achillea mille-*

folium), goldenrod (*Solidago* sp.), evening primrose (*Oenothera biennis*), cinquefoil (*Potentilla simplex*), sweet clover (*Melilotis alba* or *M. Officinalis*), daisy fleabane (*Erigeron annuus*), aster (*Aster ericoides*), sedges (*Carex* spp.), rushes (*Juncus tenuis*), and foxtail (*Setaria* sp.), or woody species such as maple (*Acer saccharinum*), multiflora rose (*Rosa multiflora*), and even dewberry (*Rubus flagellaris*).

Our experience has been that the harvest of grass seed from the sanctuaries is desirable for several reasons and that some of the highest yields of redtop and timothy were harvested the summer after a prescribed burn in either March or the previous August. If redtop is to be harvested, seed meadows should be relatively free of *weeds* and should be capable of producing at least 50 lbs of seed per acre in order to interest local sharecroppers.

It can be speculated that redtop sods that are diversified with the weedy forbs mentioned above are preferred by nesting hens over weed-free stands of more economic value. This speculation is not necessarily so. Some of our best prairie chicken production areas (Tables 5 and 6) were also some of the best grass seed meadows. The best production of prairie chickens on the best grass seed meadows was particularly true in the case of redtop meadows that were diversified with an admixture of timothy and domestic legumes. A weedy sod may also be a top producer of prairie chickens during the second nest season after a burn, but the costs of controlling weeds and woody plants are magnified if clipping by combining for grass seed is not feasible. Also, real estate taxes are paid on sanctuary land as an aspect of local public relations, and weedy sods do not *pay their way* from the tax standpoint. Thus, such sods should be plowed, fertilized, seeded to soybeans for 1 year, using a herbicide if necessary, and then reseeded to a redtop-timothy-legume mixture, using a small grain, preferably oats, as a nurse crop. At Bogota, this entire renovation has been accomplished by a sharing agreement with a local farmer at little cost to us.

There are advantages and disadvantages to prescribed burning in either March or August. The data in Tables 2 and 3 reveal that nesting hens were more attracted to the vegetation that develops after an August burn than to the vegetative growth after a burn made in

March. However, because prairie restoration is also a prime objective in the development of a sanctuary system in Illinois, some burning in March is desirable because March burns appear better for encouraging the development of native prairie vegetation and stimulating legumes. Burning in August appears better for such domestic grasses as redtop and timothy, which have matured and are essentially dormant in August. The rule of thumb here seems to be to burn the *cool season* introduced grasses in late summer (*warm season*) and to burn the *warm season* native grasses in late winter (*cool season*).

A desirable feature of burning in August in southern Illinois is that nearly 2 months of the growing season are still left, during which a sod can green up before frost. This new leafy material and the mosaic of unburned patches so characteristic of an August burn may account for the limited nesting recorded in the spring after an August burn. March burns usually result in more complete removal of vegetative debris, and there is little time for vegetative growth and duff accumulation prior to the initiation of the earliest (early April) prairie chicken nests in southern Illinois.

The implications of prescribed burning for prairie chicken management that are revealed in this paper apply principally to domestic grasses and legumes in southeastern Illinois. Currently, the establishment of native grasses on prairie chicken sanctuaries in Illinois is limited to only about 50 acres and consists primarily of switch grass (*Panicum virgatum*), big bluestem (*Andropogon gerardi*), and Indian grass (*Sorghastrum nutans*), with these few species of grass mostly limited to admixtures in 1-to 20-acre fields that are dominated by redtop and timothy. Nevertheless, it seems likely that the patterns of use by nesting hens after burning of domestic grasses and legumes would be similar in native prairie vegetation. The findings imply that *the all or none approach* to burning should not be used, especially in states where this grouse is an endangered species. Except when managing for booming grounds, annual burning of individual fields is definitely not warranted.

I recommend that no more than one-half of the nest cover within 1 mile of a traditional booming ground be burned in a given year, including both March and August burns. Because a booming ground

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is a focal point of prairie chicken activity, a 1-mile radius from a booming ground encompasses a vitally important segment of the reproductive habitat for the birds using a particular booming ground (Westemeier 1971, 1972). Burning all the nest cover within 1 mile of a booming ground would seem to place the status of such a ground in jeopardy for at least 1 year.

The acreage and distribution of tracts to be burned in a given year should depend primarily on the total acreage available for prescribed burning and the age and condition of the cover. Tracts as large as 40 acres might conceivably be burned in a checkerboard fashion in management areas consisting of a square mile or more of grassland. Fire lanes, which can be seeded to small grains and domestic legumes, provide desirable dust sites, travel lanes, and, in general, the necessary *edge* for nesting hens and for broods and adult birds as well.

Because the locations of booming grounds tend to be relatively permanent (Westemeier 1971, unpublished data for Illinois), annual burning may be a useful means of maintaining or creating attractive sites for booming. As Hamerstrom et al. (1957:48) point out, a site suitable for booming should be more than "a little hole in the weeds." Sites of about 10 acres have proved most desirable for the maintenance or creation of booming grounds on sanctuaries in Illinois. It is true that through repeated display activities prairie chickens can and will tramp out a site suitable for booming, but such a management scheme is risky. A traditional booming ground may be abandoned due to invasion of the site by tall weeds or the development of grassy cover too rank for display activities. Burning in late September or early October can provide suitable sites for both autumn and spring displays. Also, the provision of suitable booming sites in early autumn may be more important than is generally realized. At any rate, burning in either early fall or late winter seems to greatly enhance the use of either traditional or potential sites for booming grounds.

BASIC PROBLEMS WITHOUT BURNING

The attractiveness of redbud to nesting hens appears to be enhanced if it has been harvested by combining for seed, although occasional good densities of nests have been found in undisturbed stands, usually

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thin stands containing a heavy admixture of dewberries and weedy forbs such as yarrow or goldenrod. Combining reduces the redtop plant from a height of about 28 inches to a 10-to 14-inch open stubble that withstands the weather and stays erect for the next nest season. The redtop stubble permits easy visibility for a standing prairie chicken and ample concealment for nesting. The wheel tracks of a self-propelled combine provide travel lanes, and the clipped stems, seed heads, and leaves provide the necessary duff for nesting material.

Combining creates a desirable patchwork of holes in an otherwise too-thick stand of redtop by leaving, in addition to the wheel tracts, wads of chaff and stems scattered throughout the stubble. These wads of duff partially smother the sod, and the resultant openings, usually 1-2 ft² in size, are commonly found within 1 yard of nest sites. Hence, the accumulation of residual cover is desirable for a 1-to 2-year period after an initial seeding of redtop. However, the data (Table 1) for redtop for the period 1963-68 indicate that redtop is most attractive to nesting prairie chicken hens during the second growing season after seeding.

The decline in use of redtop by nesting prairie chickens after the second or third growing season is attributed to the excessive buildup of matted dead vegetation that promotes cold wet soil conditions during the period of nest initiation; impedes movements; reduces food availability for prairie chickens, especially young chicks; delays the phenology of new plant growth; and otherwise alters the ecology of grass stands as they grow older.

The finding that new seedings of redtop are preferred runs counter to Yeatter's (1943: 389) data for 1935-36 on an area only 10 miles northeast of Bogota. The obvious reasons for this difference are due to (1) a change in cultural practices and (2) higher levels of soil fertility. Thirty years ago redtop was cut with a binder, shocked by hand, and then removed from the field and threshed for seed, with the resulting straw stacked and used for hay. Some farmers even grazed their meadows after seed harvest. Our current use of combines for harvesting seed results in the top half of the redtop plant being returned to the field. Presently, there is little demand for redtop hay, and its removal from the field may be undesirable because of

the openings in the stubble that the clippings from the combine provide for prairie chickens. Likewise, the present rates of fertilization of soils in southeastern Illinois result in stem densities that were probably nonexistent in the 1930's. According to Buzzard (1931: 472), a yield of 70–75 lbs per acre was an average seed yield for a good meadow in the 1920's. Currently, an experienced operator, with a self-propelled combine, can obtain a yield in excess of 200 pounds per acre from a good stand of redtop.

Without prescribed burning, the yield of seed shows a pattern of decline. It thus becomes difficult to interest local farmers in harvesting seed from old sods, where the return is not sufficient to cover expenses of combining, hauling, and marketing.

In 1964, on the 77-acre Yeatter Sanctuary (Fig. 1), Ellis (1965: 7) found a density of eight nests in a 19.1-acre field (one nest per 2.4 acres) of redtop seeded in the fall of 1962. This field, which was classed as a second-year seed meadow in 1964, also contained an admixture of red clover (*Trifolium pratense*). Seven more nests were also found on the Yeatter Sanctuary in 1964, primarily in the younger sods. These examples of high use of the limited acreage of sanctuary grassland in the early 1960's were followed by sharp declines in nest densities as the sods aged and the remnant flock of prairie chickens at Bogota evidenced a decline similar to that of the unmanaged statewide census areas. The Bogota flock leveled off at about 42 cocks in the springs of 1965–67 and reached its lowest level of 37 cocks in the spring of 1968. Of significance was the fact that in 1967, one of only two nests on the Yeatter Sanctuary was established in a narrow strip about 2 feet wide that had been burned, using a flame thrower, the previous spring, so that an electric fence could be maintained to exclude roaming dogs. In the burned strip the cover was vigorous and green and devoid of the dense mat of old dead vegetation.

Timothy has on several occasions proven to be an even more attractive cover to nesting hens than redtop. The 14-to 18-inch stubble resulting from a seed harvest has worked exceptionally well at Bogota. Unlike redtop, however, the main problem with timothy is the low commercial value of the seed. Like redtop, the yield of

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timothy seed declines as stands age, particularly in the absence of burning. Regardless of the yield, the profit from harvesting timothy seed is seldom adequate to cover harvesting costs. For this reason it is difficult to get timothy stands managed annually by local farmers. Left undisturbed, timothy has generally proven to be poor for nesting, especially where old sods are involved. Hence, a small amount of timothy is usually added to new redtop seedings to help diversify the stands, but it is not seeded in pure stands.

The frequent occurrence of legumes such as red clover and Korean lespedeza (*Lespedeza stipulacea*) at nest sites indicates that legumes are undoubtedly desirable in sanctuary grasslands. Legumes help maintain the grass through nitrification of the soil and quite likely increase the number and kinds of insects, and insects are essential to growing chicks. In the absence of burning, legumes tend to disappear by about the third year after seeding.

Although prairie chickens have readily accepted such exotic vegetation as redtop, timothy, and domestic legumes, it is axiomatic that the establishment and maintenance of native vegetation should be emphasized in prairie chicken management. Several seeding techniques are showing promise for the establishment of native grasses on sanctuaries; however, their rate of development appears to be slow in the absence of burning. By contrast, native species such as big bluestem, Indian grass, and switch grass have shown dramatic response to prescribed burning about 3 or 4 years after initial seedings on several sanctuaries. Because of the height and rankness characteristic of big bluestem, Indian grass, and switch grass, a haying or grazing form of management appears essential for these grasses after establishment. Left undisturbed, these grasses, especially big bluestem, develop a rank impenetrable layer of cane-like stems and residual cover. We have not found prairie chicken nests in any rank vegetative cover, and it is highly unlikely that young broods make use of it. By contrast, an encouraging amount of nesting and brood use has been noted in the more open stands of switch grass on the Yeatter Sanctuary during the past 5 years. On this sanctuary, the rankness has been controlled by annual mowing for seed (redtop and timothy), by mowing for weed control, and by burning.

SUMMARY AND CONCLUSIONS

1. The abundance and distribution of prairie chickens in Illinois is clearly limited by the availability of suitable grassy vegetation for nesting. Providing attractive, safe nest cover is the primary problem in perpetuating remnant flocks of native prairie chickens in Illinois.

2. All grasslands are not equally attractive to nesting prairie chicken hens. Of particular significance is the fact that unmanaged grasslands are attractive for relatively few years after seeding.

3. Redtop, long the *substitute prairie* for prairie chickens in south-central Illinois, provides the dominant type of nest cover on our sanctuaries. Redtop has proved most attractive to nesting hens during the second nest season after seeding, or, in the case of sods 4 or more years of age, the second nest season after prescribed burning, especially after a burn in August. Redtop is best for nest cover when the stands are diversified with timothy, legumes, dewberries, and weedy forbs such as yarrow and goldenrod. Combining redtop for seed provides a weather-resistant, open stubble with desirable edge created by the combine and the vegetative debris resulting from the seed harvest.

4. Timothy is also an attractive nest cover for prairie chickens, but unlike redtop, the commercial value of the seed is too low at present to interest sharecroppers; harvesting of timothy for hay also presents problems. Thus, small quantities of timothy and legumes are added to new redtop seedings to diversify the resultant cover for nesting hens, but timothy and legumes are not seeded in pure stands.

5. Prescribed burning in August is proving beneficial for rejuvenating overage redtop and timothy sods, as nest densities up to one nest per 0.8 acre were found in some plots during the second nest season after a burn. Seed production is also increased by burning. Prescribed burning in March is best suited to the development of native prairie grasses on the sanctuaries. The nest density of one nest per 6.0 acres for burned plots in the second, third, and fourth nest seasons after burning in March and August was significantly greater than the density of one nest per 9.3 acres for similar but unburned fields that were in the second nest season, or later, after seeding. The rule of thumb seems to be to burn cool-season grasses

(redtop and timothy) in late summer (warm season) and warm-season grasses (prairie grasses) in late winter (cool season).

6. Because of the high densities of nests and high levels of nest success in plots 2-4 years after burning, it can be concluded that prescribed burning has played a significant role in the dramatic population increase that this endangered species has shown in the past 4 years at Bogota. The greater prairie chicken has proven to be an adaptable species in Illinois because of its ready acceptance of introduced flora such as redtop, timothy, and domestic legumes. This boomer of the prairie will continue to respond just as far as habitat management will permit, especially with properly applied prescribed burning.

7. Establishment of native vegetation, principally such grasses as big bluestem, little bluestem (*Andropogon scoparius*), Indian grass, switch grass, and side-oats grama (*Bouteloua curtipendula*), is an objective in the development of a sanctuary system. Once established, however, some of these grasses present a problem because of excessive height, density, and rankness. Haying and grazing, as well as prescribed burning, appear essential to maintain these grasses in an attractive condition for nesting prairie chicken hens.

8. Combining of grass seed and use of sharecropping in the establishment of new grass seedings are basic tools that offer significant economic as well as ecologic advantages to prairie chicken management.

9. While aspects of grassland management for prairie chickens suggested here are highly artificial in terms of the evolution of the fauna and flora of the prairies of Illinois, they undoubtedly reflect the role of periodic disturbance in the prairie environment and the role of fire as a principle cause of disturbance and rejuvenation of prairies.

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