A GUIDE TO
PRAIRIE CHICKEN MANAGEMENT

Rachmaninoff
"Piano Concerto # 2"

Brahms
"Symphony # 4"

TECHNICAL WILDLIFE BULLETIN NUMBER 15

Game Management Division
WISCONSIN CONSERVATION DEPARTMENT
Madison, Wisconsin
1957

A GUIDE TO PRAIRIE CHICKEN MANAGEMENT

By

F. N. Hamerstrom, Jr., Oswald E. Mattson and Frances Hamerstrom

Pittman–Robertson Project 79–R

(Cover drawing by Charles W. Schwartz)

TECHNICAL WILDLIFE BULLETIN NUMBER 15

Game Management Division
WISCONSIN CONSERVATION DEPARTMENT
Madison, Wisconsin

1957

FOREWORD

The management of a wildlife species through proper control of the animals themselves or the improvement of their habitat is the goal of wildlife research. This bulletin contains the culmination of many years of research on prairie chicken and prairie chicken habitat—a management plan based on a careful study of the birds' most vital requirements, designed to perpetuate these native grouse in one of their few remaining strongholds in the country.

To pave the way for management, research must go through a series of steps. There has been a great deal of research on prairie chickens in Wisconsin from about 1930 to the present, by many persons. This has not been merely a duplication of efforts, but a gradual fitting together of the pieces of the management puzzle from observation on booming grounds, nest and brood studies, hunting season collections, winter trapping and habitat studies. It has also involved extensive surveys of prairie chicken habitat throughout the prairie chicken range in the United States and Canada.

When enough information has been gathered and the picture begins to emerge on what the birds need and when they need it, management must begin. This does not mean that research will stop; it must continue to work out the puzzle. And further, research must continually search for ways to cope with habitat changes brought about either naturally or by man's use of the land.

In comparison to what has been done in the way of quail management and pheasant management, very little has been accomplished for prairie chickens. Years ago, when chickens were abundant, no management was needed. Later, when they became scarce, there was for many years a feeling of pessimism—"nothing can be done about it"—which delayed any serious attempt. Something *can* be done, and has been done on a small scale here and there, but real efforts at chicken management are quite new. Haphazard management may satisfy people but not the birds! To be successful, prairie chicken management depends upon careful evaluation of habitat conditions and the provision of exactly what is needed.

The management plan proposed here details the needs of prairie chickens and suggests the means for providing their necessary requirements. This guide is aimed at Wisconsin, but in principle applies to all states having prairie chicken populations remaining.

L. P. VOIGT
Conservation Director

ACKNOWLEDGMENTS

This plan is the outgrowth of several studies: (1) the pioneering work of Aldo Leopold (1931a, 1931b, 1933), Alfred O. Gross (1930), and Franklin J. W. Schmidt (1936, unpubl.); (2) our own earlier researches in Wisconsin and, to a lesser degree, in other states, (Hamerstrom 1939, 1940, Hamerstrom and Hamerstrom 1949, 1955); and (3) Pittman–Robertson grouse research under successive leaders, as follows:

Wallace B. Grange ----------Project FA–5R Sept. 1940–June 1942
Bernard J. Bradle ----------W–13–R July 1947–Sept. 1947
Ralph B. Hovind ----------W–13–R Sept. 1947–Jan. 1948
James B. Hale ----------W–13–R Feb. 1948–Sept. 1948
William S. Feeney ----------W–13–R Oct. 1948–April 1949
James B. Hale ----------W–13–R May 1949–Oct. 1949
F. N. Hamerstrom, Jr. ----------W–13–R Nov. 1949–June 1955
F. N. Hamerstrom, Jr. --W–79–R (Phases C, G, H) July 1955–Present

Most of the Project's findings to date have been presented as quarterly progress reports for the years listed above, rather than in final published form. Grange, however, has published the work done under his direction (1948) as well as independent studies of his own (1949).

It is a pleasure to acknowledge the contribution which these studies have made in laying the foundations upon which the present plan is built. Our own part in it has been sponsored by several agencies: two years, 1935–1937, by the U. S. Resettlement Administration and successors; two and a half years, 1939–1941 by the University of Wisconsin, under the direction of Professor Aldo Leopold; during the autumn of 1941 and the springs of 1941, 1942, 1943, 1947, and 1948 by the Museum of Zoology, University of Michigan; and from the autumn of 1949 to the present by the Wisconsin Conservation Department. In our field work, we have been given a great deal of extremely valuable help and information by the residents of the Bancroft, Plainfield, Hancock, and Necedah neighborhoods; by other members of the Wisconsin Conservation Department, particularly by members of the game, law enforcement, and forestry divisions; by faculty members and students of the University of Wisconsin and of Wisconsin State College, Stevens Point; and by ornithologists and interested sportsmen. Our information on broods on the Buena Vista Marsh—a particularly important part of the work—has come to a very large extent from the cooperation of farmers in the area and of the Mangelsdorf, Peppard,

Rudy–Patrick, and Sumner seed companies, and Thomas Sawyer, an independent seed grower. Colleagues in other states and in Canada have been most generous in sending information, much of it unpublished, on prairie chickens in their parts of the range of the species. These contributions are individually identified in Appendix A.

The photographs are by the authors unless otherwise indicated.

We wish particularly to thank Cyril Kabat, Research Coordinator, for his very real support and encouragement since 1949, and for his direct help in synthesizing the materials of many kinds, and from many sources, which together make up this report. We are indebted also to Ruth L. Hine, editor of this series, who has helped us far beyond the editorial requirement.

(Submitted for Publication in 1956)

Edited by Ruth L. Hine

CONTENTS

George Socha

INTRODUCTION

The Conservation Commission's "The Wisconsin Prairie Grouse Management Policy", adopted May 14, 1953, calls for an action program in the interest of prairie chickens and sharptails—"Consistent with . . . statutory obligations, in establishment of a policy for the management of Wisconsin prairie grouse, it is considered basic that every reasonable effort be made to maintain a huntable population through management and restoration of habitat for these birds in the state and to assure their presence for future generations." We offer herewith a management plan for the prairie chicken or pinnated grouse *(Tympanuchus cupido pinnatus)*.

The plan does not guarantee the return of "the good old days" of enormous abundance of prairie chickens. It does not guarantee even that prairie chicken hunting as it is known today can be maintained into the future. But of one thing we are confident: *the prairie chicken can be saved for the enjoyment of future generations of Wisconsin's citizens.*

The plan which follows is not yet complete in all details, but the most important steps are clear. Further research is needed on some aspects, and can best be done while management is under way.

In this report, we will first discuss the distribution of the prairie chicken in Wisconsin (Part I), aspects of habitat management (Part II), and finally aspects of population management (Part III), namely hunting regulations, introduction of exotic species, and predator control.

Part I—PAST AND PRESENT DISTRIBUTION OF THE PRAIRIE CHICKEN IN WISCONSIN

A thumbnail sketch of the history of prairie chickens in Wisconsin is given below. The small maps are diagrammatic, rather than precise.

About 1800

1. Original range

Limited to prairies and oak openings of southern half of state. (Adapted from Schorger [1944], Finley [1951], and Curtis [1950]).

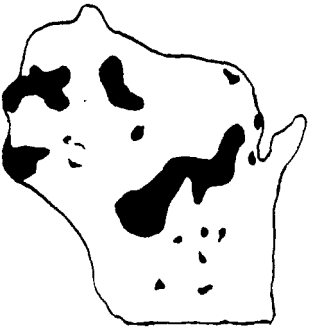
1875–1920

2. Original range disappearing; new range in North

Original range being converted to farmland; chickens being driven out by cow and plow. New range created in the north (in every county but not every township) by lumbering followed by fire.

3. New range shrinking

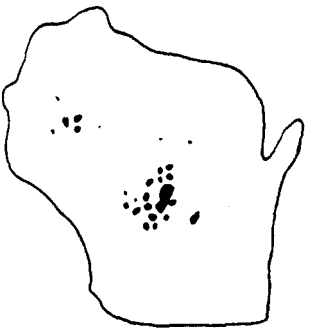
Original range reduced to few isolated spots; new range growing back to timber and brush or converted to clean farmland. (After Leopold and Schmidt's map of 1930 [Gross, 1930]).



1920–1940

4. Loss of range continues

The return of the forest in the north, and intensive land use on both the original range and the acquired range in the north continue to destroy prairie chicken habitat. For more detailed map, see Figure 1.



1950

5. The future

The future of the prairie chicken in Wisconsin will be determined by the amount of management which is begun *within the next 5 years.*

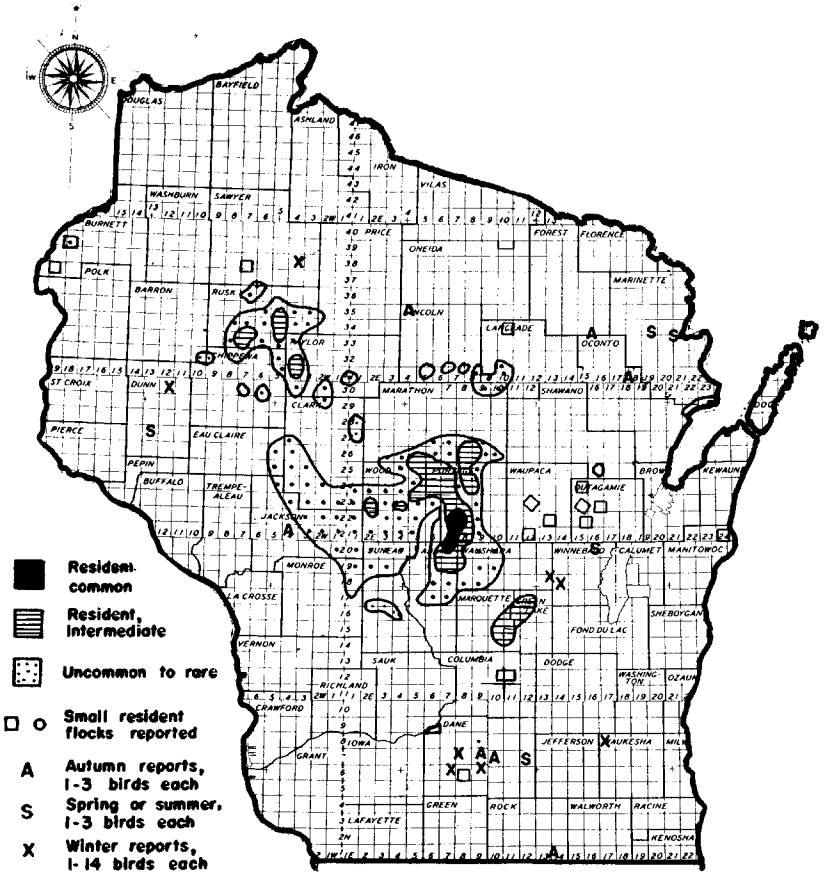


Figure 1. Distribution of the prairie chicken in Wisconsin, 1948–1953.

Part II—HABITAT MANAGEMENT

Prairie chickens must have large areas of open country—wide horizons. They must have grassland. They must have food. These are the basic requirements throughout the range of the species, and cannot be compromised. Fortunately, only *part* of any area need be under special management in order to meet these requirements. This, we believe, is the key to prairie chicken management.

The discussion which follows is based primarily on studies in Wisconsin; first as these studies throw light on habitat requirements and management needs in general, then as related to a specific area, the Buena Vista Marsh. From the literature, from correspondence, and from our travels in other states and in Canada, we believe that the broad outline of habitat requirements in Wisconsin applies in the main to most of the continental range of the species, although there are differences in detail from one region to another. We hope that the management plan here proposed may also, with local modifications, prove to be helpful elsewhere.

Prairie Chicken Habitat Requirements

Space

Large sweeps of open country are essential to the breeding range, although chickens do use woods in autumn and especially in winter in Wisconsin. For best production, we estimate that an area should be not more than 20–25 per cent wooded, with the wooded tracts in scattered blocks (see also Grange, 1948). The point of "too much woods" cannot be defined exactly, for the pattern of distribution of woods and openings is probably even more important than total acreage. Chickens do not like to be hemmed in: thus, a relatively small percentage of timber, in the form of tall fencerows or windbreaks around every field and meadow, would destroy the breeding potential of an area which was otherwise suitable; this despite the fact that chickens do sometimes loaf in widely spaced fencerows and feed in winter in enclosed fields.

Because of the requirement for free space, extensive planting of windbreaks in prairie chicken areas must be discouraged. On nesting grounds there should be a tree-free sweep of at least a half mile in

one direction (length) and preferably in both length and width. This restriction does not refer to landscape plantings around farm homes; it would apply rarely if at all to trout stream improvement and ditch bank plantings. Forest plantations in the same locality are, of course, incompatible with prairie chicken management.

Cultivated fields, wet marshes, close-grazed pastures—even airports, in Michigan—contribute to the quality of openness, even though they may be wholly unsuitable for nesting. So also does brush to some extent, although the dividing line between tall brush and low timber would be difficult to define.

Grassland

Grassland is of vital importance to prairie chickens, the keystone in prairie chicken ecology. This relationship holds true throughout the range of the species as shown, in Appendix A, by a continent-wide survey. The results of the survey can best be presented as a self-contained unit, rather than scattered through the text, and so are given as an appendix. To anticipate a little, the survey shows that prairie chickens are most abundant where there is the greatest amount of grassland, particularly permanent grassland; and, conversely, that where grassland has dwindled or disappeared, so too have prairie chickens.

Such qualities as height and density of grass, and the land-use practices in which it is involved, seem clearly to be more important to prairie chickens than species composition. The bird does *not* require true prairie. The original prairie was undoubtedly a better habitat, in most respects, than the "substitute prairie" in which it now lives in Wisconsin and in most states east of the Dakotas. Nevertheless the prairie chicken can and does get along reasonably well in the new and very different kind of grassland in which it now finds its home. That it has been able to make such a change is evidence of a high degree of adaptability.

Nest-brood cover: Grassland, preferably with some slight admixture of broad-leaved herbaceous plants and sedges *(Carex* spp.) is virtually indispensable as nesting and rearing cover. In comparison with the ring-necked pheasant *(Phasianus colchicus),* very few nests are found in alfalfa or clover hay. Bluegrass *(Poa pratensis)* is the key species on the Buena Vista Marsh in Wisconsin because of certain practices which go along with the harvest of bluegrass seed, as explained in a later section. A redtop *(Agrostis alba)* seed-growing area in southern Illinois has been important to prairie chickens in that state for the same reason (Yeatter, 1943). Still other grasses and

Booming grounds have wide horizons and short cover. Hugh Wilmar

sedges are important elsewhere in Wisconsin and in other states, where land use permits.

There is a great deal still to be learned about the details of *quality* of nesting and rearing cover. In general, however, medium-dense stands of some of the mid-grasses are best, for example: bluegrass, redtop, timothy *(Phleum pratense)*, and quack grass *(Agropyron repens)*. A good stand of reed canary grass *(Phalaris arundinacea)* is apt to be too dense. Big bluestem *(Andropogon Gerardi)* generally makes too sparse a stand on Wisconsin's sandy soils, where we are most familiar with it. Well-drained sites are best. Marshes and sedge meadows are ordinarily too wet except around their edges.

Booming ground cover: Booming grounds are generally on sod, but we have known a few to persist for 5–10 years on plowed ground. Since we have worked mainly on drained marshlands, most of the booming grounds that we know are on low ground, generally level or slightly rolling. A few are on sandy uplands, and a very few are in wet, undrained marshes. We have found no clear preference for knolls, even where they were available.

Despite these variations, booming grounds do have two common characteristics: They are placed in open, exposed places with wide horizons. They have short cover, as on grazed or mowed meadows and

George Socha

"The possibility to see and be seen, to hear and be heard is plainly important to chickens in the selection of booming grounds." Prairie chickens abandoned this booming ground when it was invaded by tall weeds. . .

. . . and this one when it became hemmed in by pine windbreaks.

George Socha

where grass has been flattened under snow, or no cover at all, as on plowed ground. One booming ground, after many years of use, was abandoned when it became hemmed in by pine windbreaks. Several have changed position, or have been abandoned, when they became overgrown with coarse weeds whose dead tops were still standing in spring. The possibility to see and be seen, to hear and be heard, is plainly important to prairie chickens in the selection of booming grounds.

Roosting cover: Grass is used for both day and night roosts from spring until early winter. Grass of the right density for nesting and rearing young is often not stout enough to stand up after the hard frosts of autumn, and is particularly apt to go down under the first snows of winter. Quack and timothy stand up better than bluegrass. Reed canary and some of the coarse sedges—much too thick for nest-brood cover—now offer excellent roosting cover.

Thus in contrast to the short cover used for booming and the medium density needed for nesting and rearing, a third and denser type is needed for autumn and early winter roosting.

Other cover types

Brush and woods are also used for cover under some circumstances.

Winter roosting cover: In central and northern Wisconsin, with two to three feet of snow on the ground in most winters, most grasses and sedges are buried by mid-winter. When snow is deep, prairie chickens commonly use the snow itself as roosting cover. Day roosts are generally open pockets, sometimes scratched out of wind-hardened drifts. Night roosts are often made by digging down a few inches beneath the surface, then tunnelling horizontally for several feet (see also Lumsden, 1949). During winter also, brush patches and the edges of woods are often used for roosting, particularly at night.

Loafing and shading cover: A variety of types are used for loafing at all seasons—grassland, the edges of grain or clover fields, clumps of cherry *(Prunus* spp.) and other fruit-bearing shrubs, aspen *(Populus tremuloides)* and willow *(Salix* spp.) in summer; all these plus oak woods *(Quercus* spp.) and aspen thickets, the edges of cornfields, and sometimes the tops of haystacks in autumn and winter. Such cover is generally used after feeding in the morning. "Loafing" is not a precisely defined activity, for while the birds may spend hours doing little except preening and dusting, they may also feed on greens, fruits, and—in late autumn and winter—acorns, buds, and catkins during this

Winter day roosts are sometimes scratched out of wind-hardened drifts.

Under-snow night roost

part of the day. In summer such cover may be used at least to some extent for shade; in autumn and winter the same sites may be used for sunning.

Escape cover: Grassland is used for escape cover during the warm months, although brushy thickets are used to some extent even by young broods. In autumn and winter brush and woods are used more and more for this purpose. When hard pressed by hunters, chickens will go into large stands of dense aspen, where they are very hard to follow.

Food

Prairie chickens eat a great many kinds of food. The food list includes insects and greens in summer and autumn; fleshy fruits, weed seeds, and small grains as soon as they ripen and for as long as they remain available; and with corn, buds, and catkins added in autumn and winter. Our experience differs from Schmidt's (1936) in two respects. He reported that: "In Wisconsin Prairie Chickens live almost entirely on buds when the temperature is above zero, but eat, and probably need, corn when it is below zero." In our studies, in areas which are moderately to lightly farmed, we have found no season in which the birds "live almost entirely on buds" although we have found them budding to some extent in autumn, winter, and spring. We have found them regularly eating corn in autumn, long before the tempera-

ture drops to zero, and into March and April, through and after the spring thaw. Schmidt also found a preference for shocked corn over standing corn, at least in the case of hens. We find both sexes feeding in standing corn as well as on shocks, and can see no consistent preference for either.

Corn or other concentrates, such as small grains or weed seeds, are needed in central and northern Wisconsin in most winters (Hamerstrom, Hopkins, and Rinzel, 1941). Summer foods are generally provided by the farmland environment in which the prairie chicken lives, but deliberate winter feeding is necessary. It is possible, but not yet demonstrated, that intensive management for maximum production might need to give more attention to summer food. Less is known about food habits in summer than at other times of year. This is particularly true of the food habits of the growing young: therein may lie one of the most important clues to qualitative differences from one meadow to another.

For details of prairie chicken food habits, see the following: for Wisconsin—Gross (1930), Schmidt (1936), Hamerstrom, Hopkins, and Rinzel (1941), and Grange (1948); for Wisconsin and other states—Judd (1905); for other states—McAtee and Beal (1924), Yeatter (1943), Schwartz (1945), Mohler (1952), Baker (1953), and Edminster (1954).

General Management Considerations

Management Areas

Priorities. The future of the prairie chicken in Wisconsin depends on land management. We now know where these lands are, and which ones offer the greatest possibilities.

The present range (as of 1948–1953) is shown in Figure 1, except for a few scattered flocks.

As limited funds prohibit managing *all* existing flocks, carefully selected priorities are essential. The highest priorities should be given those areas in which the prairie chicken can most certainly be preserved.

The primary objective is to insure the survival of the one best area in the state, namely the neighboring and interconnected Buena Vista and Leola Marshes in Portage and Adams counties. This area now has by far the largest population of prairie chickens in Wisconsin, and it offers the greatest possibilities for permanent management. There is

no other area in which prairie chickens are equally certain to survive, even with management.

Secondarily, prairie chicken management should extend as much further as funds and public interest will allow. The areas with intermediate populations (Fig. 1) offer the best chances in this respect.

Thirdly, it would be a serious mistake to jeopardize the primary objective by treating a larger number of areas less adequately. While such a procedure might make a more impressive showing for a time, it would be at the very real risk of losing all our prairie chickens in the end. One area—the best one—should be permanently managed; management of other areas would also be highly desirable, but only in addition to the primary objective, not in place of it.

Size of Area. The prairie chicken is a wide-ranging bird. Management should consider nothing less than half a township, except as a last resort, and more if hunting is anticipated. The smallest possible area is difficult to define with absolute certainty, and is in any case a poor objective. A single, small isolated flock is in a highly vulnerable position, especially at the low of the 10-year cycle. Four sections (2560 acres) is about the smallest piece of land which could be considered for a management area.

Management Needs

Although a prairie chicken area must be measured in thousands of acres, only a small part of it needs to be under specific management. By the same token, the greater part of the area does not need to be managed for prairie chickens at all. Since chickens are now moderately abundant only in or on the edges of farming country, the "space factor", for example, is provided automatically by current farm practices. This factor costs the Conservation Department nothing. By restricting management to a relatively small part of the total area, attention can thereby be focussed directly upon the major limiting factors. These are lack of (1) nesting and rearing cover, the critically important one; and of (2) winter food.

Grassland Reserves for Nesting and Rearing Young

The first and most important step in prairie chicken management is to establish permanent units of grassland for nesting and rearing young. These might be called grassland reserves.

"Prairie chicken management is primarily grassland management: no grass, no chickens." (Photos by Dean Tvedt)

Why needed? Prairie chickens have disappeared from most of Wisconsin for one all-important reason: present land use is generally incompatible with their needs. Where the basically indispensable grassland has not been converted to plowland, or grazed too heavily, or put in short-term rotation, or reverted to forest—where prairie chickens still persist—it is purely by chance. *No single area in the state is secure against further loss* unless management is undertaken. *The fact that the prairie chicken is already gone from most of the state is plain warning that chance alone is not to be relied on, if the species is to be held in Wisconsin.*

The most important basic need is to guarantee nesting and rearing cover. Two things are of paramount importance: (1) Nesting meadows must be kept in sod year after year. Permanent sod would be best of all. The minimum period is about five years, because few chickens are produced during the first two or three years after the establishment of new sod; therefore it is plain that the usual farm rotation is too short for prairie chickens and special arrangements must be made. (2) The grass must not be removed by mowing or grazing until about the first week in August at the earliest and September would be still better; even then it would be highly undesirable to have all available grassland mowed or grazed to a short stubble, for this would leave no cover for the growing young. Mowing at the usual time (late June and early July) removes rearing cover just as it becomes needed, and may kill adults and young directly. Grazing of usual intensity is overgrazing from the standpoint of best prairie chicken management. Hayland and pasture, even grass in rotation, do contribute a little nesting and rearing cover, but only where there is relatively undisturbed long-term grassland nearby. Why this is so is as yet unknown. *It is unrealistic to assume that a good distribution of permanent undisturbed meadows will persist without deliberately setting aside the lands on which they lie.*

How much grass? Prairie chicken management is primarily grassland management: no grass, no chickens. Chickens occur, except sporadically and temporarily, only in open non-forested country which is at least about a third grassland. They are abundant only where the proportion of grass is even higher, from a half to three quarters. Since there are also qualitative differences in grassland, these figures are only approximations, but they are a good rule of thumb guide. Experience in other states tends to bear out these estimates, with rather few exceptions (See Appendix A).

Not all of the grassland needs to be nesting and rearing cover. Pastures offer good booming ground cover, if there is nesting cover nearby. Mowed hay meadows, even in rotation, offer loafing and roosting cover and food during part of the year. Heavy marsh grass, often too thick for nesting, makes excellent roosting cover. All of these, and cultivated land as well, contribute to the quality of openness (space factor) which is essential. In all of the areas which we know well enough to judge, the above requirements are met to a reasonable degree by present land-use practices and little or no management is necessary for them. Booming grounds are one possible exception. It would be well to keep the major booming grounds on all managed areas in hay or pasture land, or at least in a rotation which includes grass. Since the landowners would still have essentially full use of the lands on which booming grounds lie, this should not be a major difficulty.

It is nesting and rearing cover for which grassland reserves are particularly needed. The number of reserves necessary will vary with the general suitability of the area to be managed, and will have to be worked out specifically for each area. On the Buena Vista Marsh, for example, about one 40 per section (6–7 per cent) is needed to maintain the present population. At the other extreme, if one were to try to establish a wholly new prairie chicken area in southern Wisconsin, where general land use is much less favorable, as much as four to eight 40's per section (25–50 per cent) would probably be required.

Food patches

Where? Winter feeding would be beneficial wherever grain stubbles are buried under snow and shocked or unpicked corn is unavailable or poorly distributed—in other words, wherever prairie chickens occur in Wisconsin. Since farmers now leave much less corn in the fields over winter than they used to, and will probably leave even less in the future, this is a highly uncertain and unreliable source of winter food. Planned winter feeding will be even more necessary in the future than it has been in the past.

How many? Banding studies have shown that food patches need not be closer than about four miles apart (Hamerstrom and Hamerstrom, 1949; Quart. Prog. Rpts.); four or five should be enough for one geographic township (36 sections). Prairie chickens tend to concentrate in familiar spots winter after winter. Food patches should be planned with such preferences in mind, rather than placed mechanically at fixed intervals.

Standing unpicked corn makes the best food patch. Prairie chickens have been here.

General specifications: A food patch should be large enough to last the winter. The flock whose food supply fails in mid-winter is forced to move, perhaps into unfamiliar country, at the very time when food and cover are at a minimum (Hamerstrom and Hamerstrom, 1949, Hine and Bersing, 1951). Standing unpicked yellow dent corn makes the best food patch. It is an excellent winter food, high in vitamin A; it stands above the snow and needs no servicing. The short-stalked, short-season hybrids are best, both because of their ability to mature in poor growing seasons and because the ears are within easy reach. One acre of standing corn of the quality grown on the Buena Vista Marsh will feed about 30 prairie chickens through the winter; larger flocks have required more, up to four and five acres. Shocked corn is also good, but the shocks have to be opened and new ears exposed from time to time through the winter. As an emergency measure, unpicked bundles of corn can be hauled where needed and re-shocked, to bolster an inadequate food supply or to put food where otherwise there would be none. We did this successfully in the winter of 1950–51, when there was very little corn on the Buena Vista Marsh because of a summer freeze.

Prairie chickens prefer their food patches out in the open, rather than at the edge of woods. Birds feeding in the open are less easily approached by predators and poachers. Squirrels are less apt to compete for corn that is away from trees. It is best to place food patches a hundred yards or more from well travelled roads.

Hoppers and spike feeders are unsatisfactory except for small isolated flocks or other special circumstances. They must be replenished often throughout the winter, and are apt to be neglected at times of deep snow and bad weather—when food is most needed. Prairie chickens are reluctant to bunch closely while feeding, which means that large flocks will rarely take food from hoppers. Spike feeders are better in that respect, but would have to be tended almost daily. Hopkins calculated the grain consumption of hopper-fed penned wild prairie chickens in the winter of 1938–39 at about 1½ ounces per bird per day, or 10½ ounces per week (Hamerstrom, Hopkins, and Rinzel, 1941). Hawkins (1937) found that free-ranging prairie chickens, eating ear corn at a spike feeder at Faville Grove in the winter of 1935–36, ate 1.5 pounds per bird per week. Hine and Bersing (1951) put the figure at about two pounds of corn per bird per week.

Buckwheat, oats, wheat, and soybeans are readily eaten. Buckwheat is a preferred food. But to be available when they are most needed, all such crops must be harvested, and serviced during deep snow. This can be done through hopper feeding; by exposing and opening bundles left on the ground; by stacking the unthreshed bundles on raised platforms and opening the bundles through the winter; and the like. There are several ways by which such grains can be fed, but all of them require continuous attention. Anyone who has snowshoed out in bad weather to fill hoppers or spike feeders, to turn bundles or open shocks, appreciates the practicality of standing corn which grows ears at just the right height for prairie chickens to reach above the snow.

In most areas where prairie chickens now occur in Wisconsin, there is no need for buckwheat food patches for autumn feeding for at that season there is more waste grain available than the birds can eat. Buckwheat or oats might occasionally be useful for deliberately manipulating the autumn distribution of birds, as to draw them into closed areas or to a neighboring corn patch to be left for winter feed. In some situations small patches of buckwheat or oats, planted near booming grounds, might perhaps be useful as a source of food in spring, after the winter packs have dispersed and the snow has gone.

Chemical control of weeds in food patches may be important in the future, both to reduce the need for cultivation and to encourage food-bearing weeds (Hamilton and Buchholtz, 1953).

Management of the First Priority Area

The management plan described here has been developed for the Buena Vista Marsh. It is an example of the application of the general principles of habitat management, which have been outlined, to the major prairie chicken area in Wisconsin. It can be adapted and extended to the Leola Marsh, part of the top priority area. However, the information in this discussion pertains primarily to the Buena Vista Marsh.

Summary: The excellence of the Buena Vista Marsh derives from two things in combination—(1) Much of the area has been in grassland for many years; (2) The harvest of bluegrass seed means that much of this grassland is subject to less disturbance than is generally true elsewhere, and so is suitable for nesting and rearing young. Despite the importance of the bluegrass seed industry, *nearly 5,000 acres of good and medium quality nesting and rearing cover has been reduced to poor quality or destroyed outright in two years.* Prairie chicken management is needed; namely, maintenance of: (1) nesting and rearing areas established by means of a scatter-pattern of grassland reserves; (2) booming grounds; (3) winter food; and (4) winter cover.

In broader terms, we look upon prairie chicken management on the Buena Vista Marsh as a truly cooperative undertaking between the local farming community on the one hand, and the state as a whole—including the Conservation Department and individual contributors—on the other. Neither half of the partnership can do the whole job alone; each has its vitally important share. Left alone, the Marsh would quickly revert to brush and timber. Farming keeps it open and guarantees the "space factor", one of the indispensable needs of the prairie chicken. The weeds and insects as well as the crops that go along with farming provide a great deal of the warm-weather food of the prairie chicken, to an extent which no food-patch system could feasibly duplicate. Pastures and hayfields, and cultivated lands to some extent, provide the short cover in which the cocks have their booming grounds for the mating display in spring. The relatively large blocks of land owned by the seed companies provide the heart of the nesting and rearing areas, and the scattered smaller parcels of grassland owned

by many individuals supply the rest of it. The seed company lands alone, however, are not enough to maintain the present numbers of prairie chickens, and the scattered individual parcels are increasingly subject to change or to outright destruction, particularly by overgrazing and plowing.

This is the crux of the matter, for a *permanent, stable* scatter-pattern of grassland reserves for nesting and rearing young throughout the Marsh is essential. It is asking too much to expect the local community to provide this, too. Conservationists from the state as a whole can carry to completion the task of building a strong and lasting environment in which the prairie chicken can maintain itself into the far distant future, by guaranteeing for their part a continuing, stable pattern of well-distributed nesting and rearing areas, and by providing winter food patches where they are needed.

It is a mutual undertaking, in which each participant can well feel genuinely proud of his own part while respecting the contribution of the other partner, for both are essential to the common goal.

Characteristics of the Buena Vista Marsh

Since 1949 we have been carrying on year-round field research on the Portage County study area, a block of about 74,000 acres in the southwestern part of the county. The study area includes, and is somewhat larger than, the northern two-thirds of the range occupied by the best population of chickens in Wisconsin today (Fig. 1). We have learned that only part of the study area is important as breeding habitat, although the birds may be found in any part of it (and sometimes outside it) in winter. The prairie chicken management area has been set up to include primarily breeding habitat, and the management area is therefore somewhat smaller than the original study area. Figure 8 shows the management area superposed on the study area. The management area encloses all but one of the booming grounds which were found on the study area in 1950.

Virtually all of the important breeding habitat within the management area is on the Buena Vista Marsh, from which the area takes its name. The boundaries of the Marsh are not easy to define with precision, for the transitions from peat and muck to organically stained poorly drained sand to the surrounding upland sand are gradual rather than clear cut. In a somewhat formalized manner we have attempted to show the boundaries of the Marsh in Figure 10. The boundaries of the management area and of the Marsh do not exactly coincide,

but the agreement is close enough so that for the sake of convenience we use the terms "Buena Vista Marsh" and "prairie chicken management area" interchangeably.

General Description. The prairie chicken management area is about 46,000 acres in size. The original "marsh" was actually a tamarack swamp, with open marsh at its center, at the time of the Government Land Office survey (Finley, 1951). It was cleared and drained about 40 years ago and the area now consists largely of drained peat and Newton sand, with scattered islands of higher Plainfield sand. Land use and cover types are shown in a formalized manner in Figure 2, summarized in Figure 3 and Table 1, and are described in more detail in Appendix B. About 28 per cent of the area is under cultivation, about 46 per cent in long-term sod, and about 25 per cent in brush, timber, wet marsh, farmyards, etc. In general, most of the cultivated lands lie around the edges of the area and merge with the surrounding region of general farming, although some cultivated fields are centrally placed. Conversely, the largest non-rotational grasslands are central, following the northeast-southwest axis of the Marsh. The largest tracts of aspen and willow also follow the central axis.

The area is by no means undisturbed wild land. Including tame hay and recently seeded pastures, about 28 per cent was under cultivation, with no less than 7,740 acres of plowland and fallow in 1953. The

Table 1

Cover Types and their Contribution to Nest-Brood Cover, 1953

	Acres					
Nesting and Rearing Cover	Plowland and Fallow	Tame Hay	Recently Seeded Pasture	Grass-Forbs	Woods, Brush, Wet Marsh*, Farmyards, Etc.	Totals
Good	-----	9	---	3,207	------	3,216
Medium	70	103	20	7,304	------	7,497
Poor	170	3,559	54	4,456	------	8,239
None	7,500	949	553	6,276	11,429	26,707
Totals	7,740	4,620	627	21,243	11,429	45,659**

*738 acres of wet marsh—wet in spring in most years.
**Plus 320 acres not mapped.

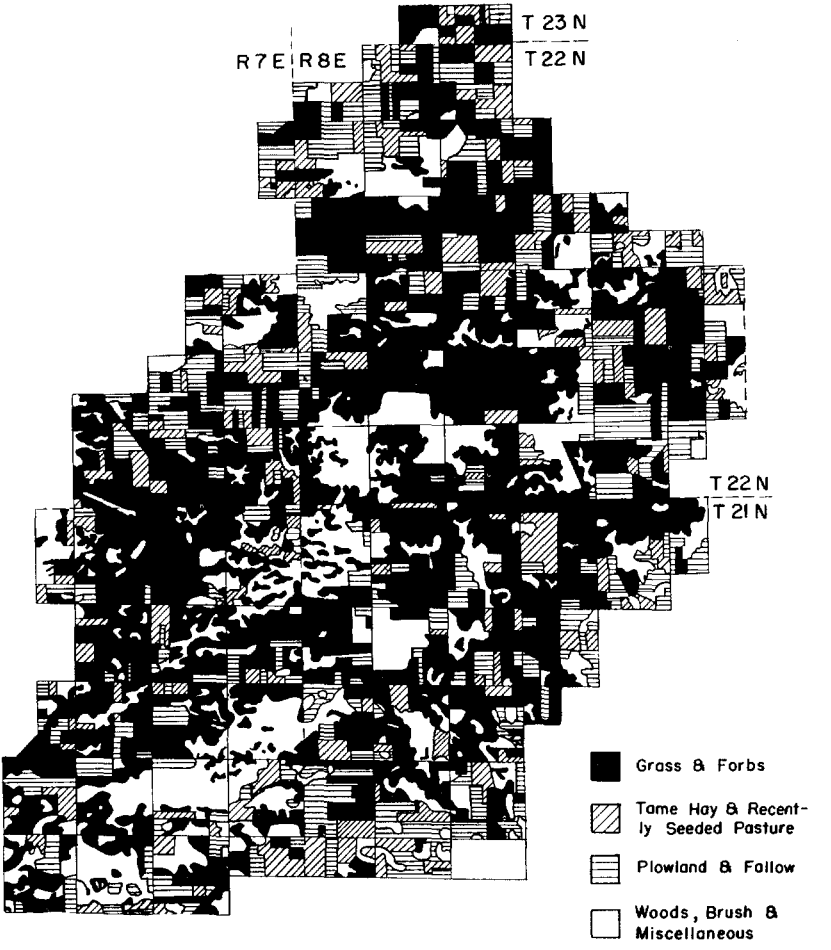


Figure 2. Land use and cover-type patterns on the Buena Vista Marsh Management Area, 1953.

fact that prairie chickens have done so well here for so many years is good evidence that prairie chickens and people can live quite closely together. The presence of suitable habitat is more important by far than the mere absence of mankind.

The most distinctive feature of the area is its high proportion of non-marshy grassland. This amounted to a total of about 26,500 acres, 58 per cent of the whole area, in 1953. Both cultivated and "wild" grassland are included in this figure; see Appendix B for detailed analysis.

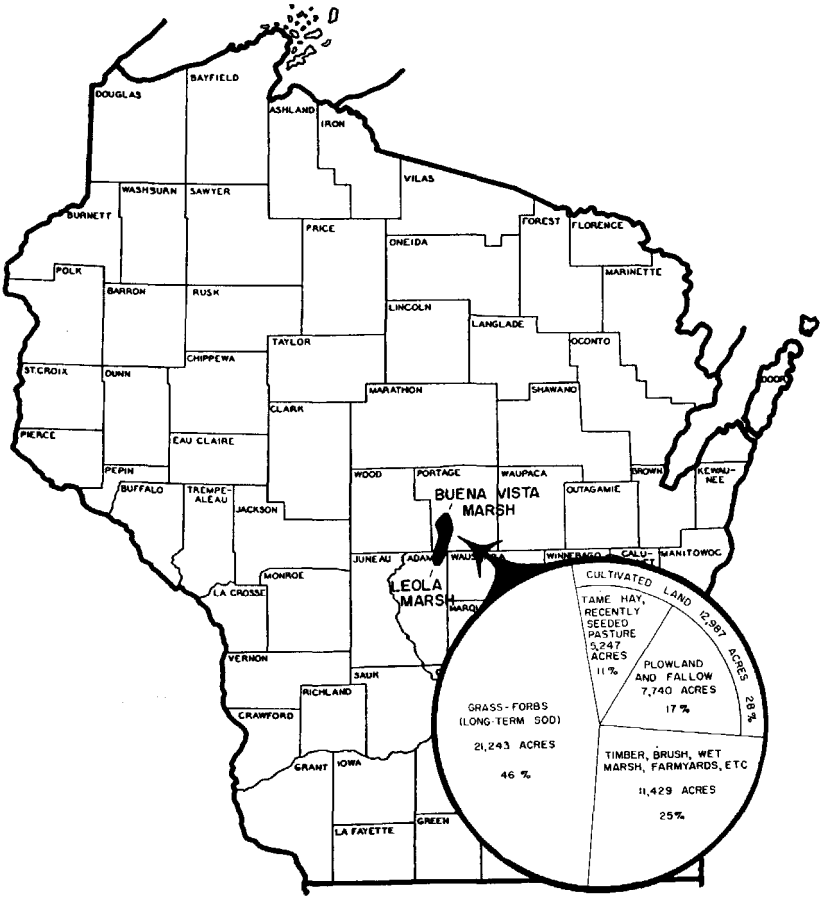


Figure 3. Major cover types on the Buena Vista Marsh Management Area, 1953.

Present Nest-Brood Cover. An exceptionally large proportion of the total grassland—77 per cent of it in 1953 and 46 per cent of the whole area—has been relatively permanent, long-term sod. In addition, a variable but large amount of the long-term grassland is harvested for bluegrass seed, a special kind of land management which gives prairie chickens a much better chance to nest and rear their young than is possible under other kinds of farming. *These two factors are the key to the present production and future management* of prairie chickens in the area.

It is important to understand *why* these two conditions exist. The answer can be summed up in one word: frost. "It is well known that

frosts frequently occur on marsh land where there is no frost on higher land . . . It may be stated as a general guide, that the occurrence of killing frosts is as liable on marsh lands at any given point as it is on upland soil having good air drainage about 150 miles farther north . . ." (Whitson, Geib, Dunnewald, and Hanson, 1918: 59). The average growing season at the Coddington weather station (within the Buena Vista Marsh) is 104 days, 44 days less than at the Stevens Point station, only 12 miles away (Ebling, 1953). This is not just a matter of later spring frosts and earlier autumn frosts on the Marsh, which could be circumvented by the use of crops with shorter than average growing seasons. Killing frosts occur with considerable frequency *during* the normal growing season, as in both July and August of 1950, for example. Summer frosts are reflected in the following figures (Ebling, 1953): shortest frost-free season at Coddington, 47 days, and at Stevens Point, 103 days; longest frost-free period at Coddington, 119 days, at Stevens Point, 186 days.

Landowners on the Marsh have learned that it is wise to hold a larger than usual amount of land in grass to diversify their investment and to carry them through the years of crop failure. The grassland acreage is apt to expand after a few crop failures in quick succession, and to shrink after a period of good crop years. But by the nature of the climatic-economic situation, grassland is not apt to disappear entirely although it is apt to be used more intensively for pasture and for hay. For this reason we are convinced that successful prairie chicken management can be projected into the future. That management is needed will be shown in a later section.

The general importance of grass to prairie chicken ecology is clear enough. Qualitative differences are much more difficult to evaluate, but the attempt must nevertheless be made.

Of all grassland types taken together (26,500 acres in 1953) only a fraction—3,216 acres—was good nesting and rearing cover in 1953. More of it—7,497 acres—was of medium quality, and still more—8,239 acres—was poor in quality. The poor type alone would not support prairie chickens, although some are produced in it. About 8,648 acres of grassland was totally unproductive, mainly because of land-use practices.

Virtually all of the good and medium quality nesting and rearing cover was in long-term grassland, the grass-forb* type, of which there was a total of about 21,243 acres in 1953 (Table 1).

* The term *forb* is used to denote herbs other than grasses and sedges.

Only about 1,672 acres of the grass-forb type, or 8 per cent of it, had been plowland during the five years before 1953. Thus, about 19,471 acres of grassland had not been plowed for five years or more; most of this had been unplowed sod for 5–10 years, and an estimated 15–20 per cent or more of it had not been plowed for more than 10 years. Since it is abundantly clear that prairie chickens do not fit into the usual short rotation, the importance of the relative stability of these grass meadows cannot be overestimated.

Even in this potentially strong habitat, however, prairie chicken production is often held down or prevented entirely by the manner in which the land is used. About 6,276 acres (30 per cent) of the grass-forb type produced no birds, primarily because of heavy grazing pressure and to some extent because of mowing. A substantial part of this heavy grazing pressure, incidentally, antedates the beef cattle boom of the past few years and will not be relieved even if the herds are reduced to their former level. Another 4,456 acres (21 per cent) of the grass-forb type is poor in quality, partly because of land use and partly be-

Stripping bluegrass for seed on the Buena Vista Marsh.

"Stripping removes only the grass heads leaving most of the plant as cover." This meadow has produced a crop of bluegrass seed and a crop of prairie chickens as well.

cause of deficiencies in the cover itself. Thus, only about half (49 per cent) of the grass-forb type, the type which holds the greatest potential, provides medium or good cover for nesting and rearing.

Where the grass-forb type is highly productive of prairie chickens, it is generally because of the special practices which go along with the harvest of bluegrass seed. The seed harvest ordinarily begins about July first and lasts 10–14 days. The harvesting machine is called a "stripper", and consists of (1) the beater, a horizontal spike-studded cylinder, about 6 feet wide and about 2 feet in diameter; (2) the box, mounted behind the beater, and in which the seed collects; and (3) a supporting framework, made up of a drawbar and two wheels, one of which, the bull-wheel, is connected by a chain and gears to the beater. Two or three strippers are pulled by one tractor; as the stripper moves forward, the turning bull-wheel makes the beater spin at high speed; the whirling spikes of the beater send a shower of grass heads, seeds, and weed tops back into the box. Unlike the cutter bar of a mower, the beater spikes travel at about the height of the heads of grass, and

can pass over chicks or a hen sitting tight on a nest without injury. Some birds are, nevertheless, killed by strippers each year. Although we have no precise figures, we are confident that fewer birds are killed, and fewer nests destroyed, by bluegrass strippers than by hay mowers.

Far more important is the fact that stripping removes only the grass head, leaving most of the plant as cover. Some meadows are mowed after stripping, but such mowing generally comes much later than the usual date of hay mowing—rarely before July 15, often not until August 1, and sometimes as late as October or November. Some meadows are grazed after the seed harvest, but again the cover is not removed until the young are partly grown. Some meadows are grazed before stripping, which reduces their production of both seed and prairie chickens. In general, however, the seed industry allows the same piece of land to produce chickens plus a direct economic return. The critically important factor is not that bluegrass is of itself the best possible nesting and rearing cover, but that the cover which it does offer remains available for a much longer part of the vitally important nesting and rearing period.

The distribution of the good and medium nest-brood cover types within the proposed management area is shown in Figure 4, and the characteristics of each type are described in Appendix C.

The lands which the seed companies own make up the core of the breeding range. These lands occur in rather large blocks (Fig. 7). The rest of the good and medium quality areas, both central and peripheral in position, occur as scattered parcels of smaller size. They are all in private ownership. Some are leased to the seed companies for periods of 3–5 years; on some the seed is sold annually; some are not stripped at all. The areas of poor quality are also scattered. They are for the most part rotational grasslands, or pastures which are grazed too hard to provide much nesting and rearing cover. A few are grass-forb meadows which are too weedy to be productive.

It is apparent from Figure 4 that prairie chickens are now produced in a *patch-pattern of breeding units,* scattered through a matrix of lands which produce few or no birds, but which do provide some of the other things which prairie chickens need, such as space, booming ground cover, and food. *The primary objective of management on the area as a whole is to insure the continuity of a good pattern of scattered breeding units,* and where feasible to improve the present pattern. *That pattern, under present land use and without management, is highly insecure,* as will be shown below.

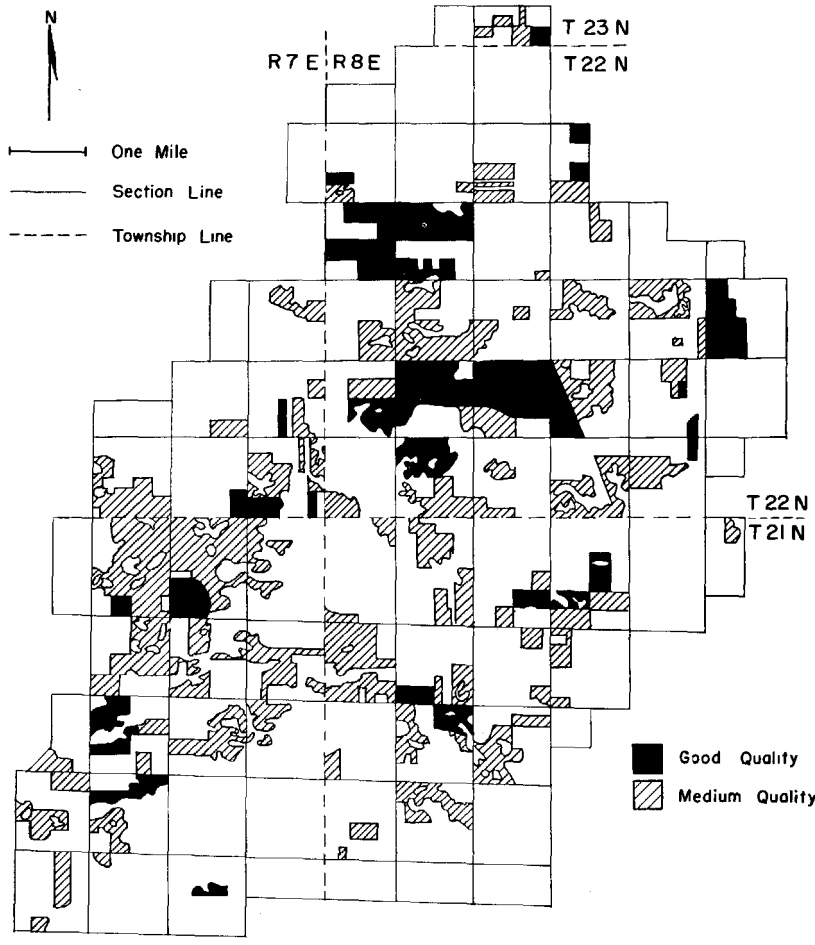


Figure 4. Good and medium quality nest-brood cover on the Buena Vista Marsh Management Area, 1953.

Changes in Nesting and Rearing Cover

A total of 4,716 acres of good and medium quality nesting and rearing cover, all of it long-term sod, was reduced to poor quality or wiped out entirely between 1951 and 1953. During the same period, summer 1951 to autumn 1953, 988 acres which were formerly poor or wholly non-productive improved to the point of being of medium quality or (two cases) good in 1953. *The losses were thus almost five times greater than the gains.*

Hugh Wilmar

Some plowland is of real benefit to prairie chickens; too much can wipe out nest-brood cover. On the Buena Vista Marsh, 1,490 acres of nest-brood cover were plowed under between 1951 and 1953.

The losses are divided as follows: (a) plowed—1,490 acres; (b) increased grazing pressure—2,755 acres; (c) weed and brush invasion —471 acres (Fig. 5). Note that most of the good and medium areas of 1953 were not in as good condition as they had been in 1951, because of a widespread increase in weeds throughout the area. Only these 471 acres had dropped below medium quality because of weed and brush invasion alone, and most of this acreage represents brush invasion. The gains were as follows: (a) tame hay reverting to bluegrass—437 acres; (b) lessened grazing pressure—204 acres; (c) cleared of encroaching willows—193 acres (Fig. 6).

Most of the gains are almost certainly temporary. To cite one example, half of the total gain represents former tame hay fields which were reverting to bluegrass (437 acres). They did not reach medium quality until 1953, and most of them had probably "escaped" from rotation for a very short time. On the other hand, two areas totalling 193 acres had been cleared of willow and appear to be permanent gains.

Further losses are clearly predictable. While looking up the records of land sales within the management area for the period 1950 through part of 1954, we got information on the sale of 10,694.96 acres. To our certain knowledge at least nine additional parcels, totalling 2,007.41 acres also changed hands during the same period and it is likely that there have been other sales of which we are still ignorant. Thus at least 12,702.37 acres have changed ownership during the last four and a half years, or about *28 per cent of the entire area.* No fewer than 1,064.03 acres have been sold *twice* during the same period. While it does not invariably follow that changed ownership means changed land-use practices (some of the land was bought by the seed companies, for example), such changes generally do go together for the new owner commonly brings with him a new plan of farm operation. There are also a good many changes in tenancy each year, which again set in motion a new series of changes in farm practice. We have in fact seen many changes of this sort during our period of study on the area, although we have not made a systematic record of them.

No nesting cover for chickens here. About 30 per cent of the potential nest-brood cover on the Buena Vista Marsh during 1953 was grazed out of existence; nearly half of this (2,755 acres) was due to increased grazing pressure in just two year's time, 1951 to 1953.

Hugh Wilmar

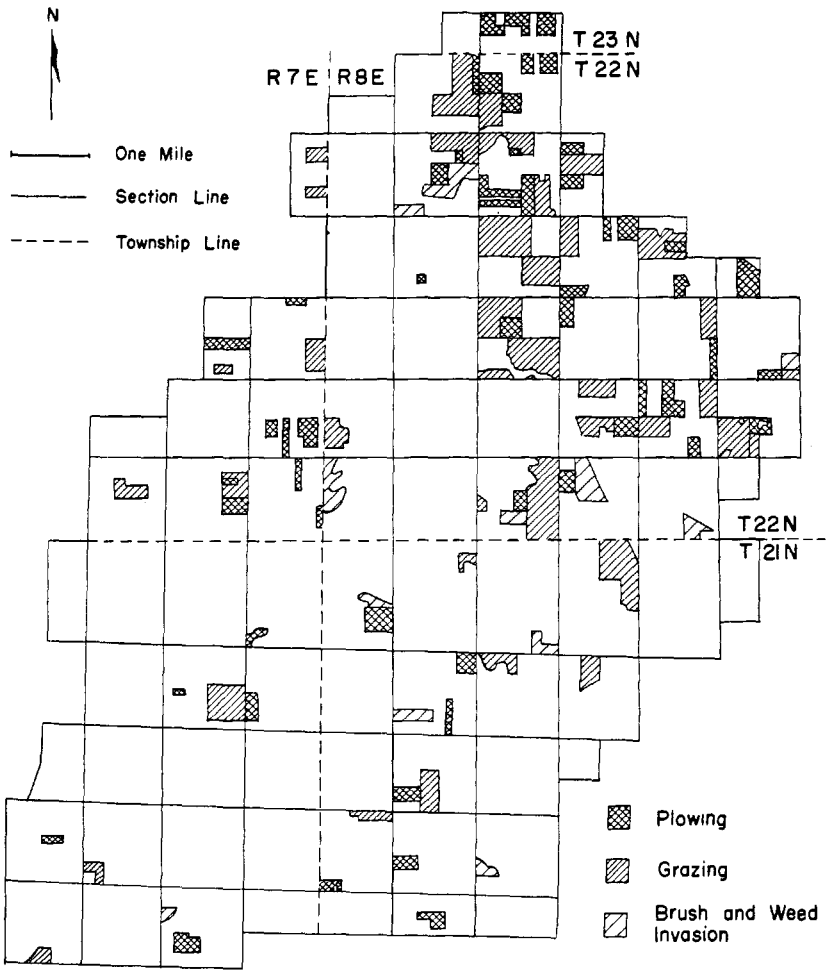


Figure 5. Losses in nest-brood cover on the Buena Vista Marsh Management Area, 1951–1953 (4,716 acres).

Altogether, the losses of nesting and rearing cover from 1951 to 1953 and the record of land sales since 1950 point in only one direction. It is perfectly plain that although prairie chickens depend on stable grassland, the prerequisite stable pattern of land ownership and farm tenancy has by no means become established on the Marsh as yet. In the past this lack of stable ownership was of little importance, for

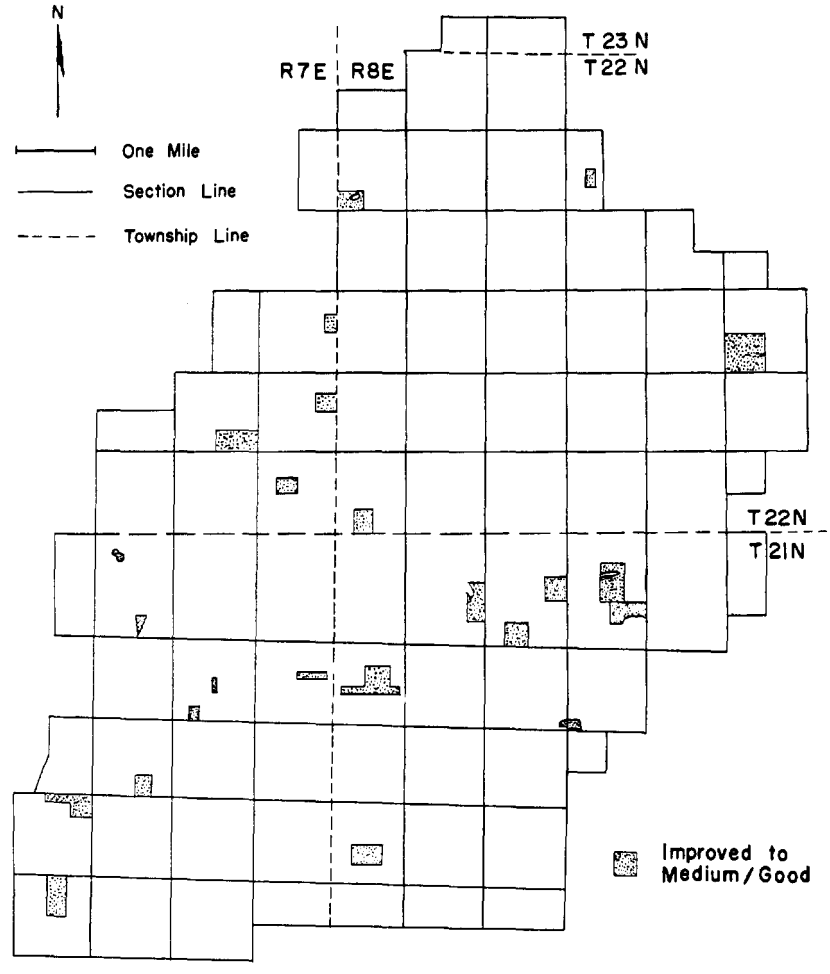


Figure 6. Gains in nest-brood cover on the Buena Vista Marsh Management Area, 1951–1953 (988 acres).

in those rather easy-going times stability (from the prairie chickens' point of view) was provided by the much larger acreage of idle land, left in grass. With today's more intensive land use, idle land can no longer be relied on for there is less of it. Stable grasslands, vitally important to prairie chickens, must be guaranteed in another way—by carefully planned management.

"Odd it is that birds, and rivers, should know what people don't—that bluegrass is the most praiseworthy thing that the white man has brought into this land; the thing that comes nearest to atoning for what he has taken away."

ALDO LEOPOLD
Round River

Management Needs: 1. Nesting and Rearing Grounds

Grassland Reserves

Why needed? The presence of the bluegrass seed industry, as important as it is, does *not* guarantee the continuation of the present population of prairie chickens. The following points bear out that statement, and show the need for setting aside undisturbed nest-brood areas:

The losses outlined above are an inescapable reality. They have occurred in spite of the fact that the seed industry has flourished in the area for the past 25 years. The lost acres in fact include 2,050 which were stripped in 1951.

It is by no means true that all lands used for seed harvest produce prairie chickens as well. In 1953, there were about 2,597 acres which were stripped for seed but which provided poor nesting and rearing cover, or none.

While the foregoing applies mainly to lands which are leased, rather than owned, by the seed companies, even the seed companies' own lands are not certain to continue to be good producers of prairie chickens. One company started to graze its own lands with a herd of cattle established in 1952, as an experiment in better seed production (including control of whitehead disease of bluegrass). In 1953 the herd was enlarged, and neighboring farmers were allowed to graze an additional 580 acres of company land. By 1955 several hundred acres of nest-brood cover had been reduced to poor quality as the result of this grazing. Again, in both 1955 and 1956 another seed company had virtually all of its land mowed immediately after stripping, in early July: these meadows, totalling more than 1,000 acres and including some of the best nest-brood cover on the Marsh, were thus treated even more harshly than haylands by being put, so to speak,

Prairie chickens need areas of permanent nesting and rearing cover, set aside as "grassland reserves". The forked stick in the foreground marks a chicken nest.

in double jeopardy. It may be that these two new developments will be short-lived; grazing pressure on the lands of the one company was in fact cut down in 1956. Nevertheless, these things did happen, and may happen again. Thus, as important as they are, even the seed company lands do not assure stable, dependable nest-brood cover.

Assuming that the lands actually owned by the seed companies do not deteriorate still further, it is probable that a small population would persist on those lands alone, with no management by the State. This is not a safe assumption, as shown above. Even if it were, the population so maintained would be no more than about a third of the present numbers, which falls far short of the objective of permanent security for prairie chickens in the area. To maintain the present population, *both the seed company lands and the peripheral lands must continue to be productive. Since the peripheral lands have been shown to be the more subject to disturbance, it is there that the need to build permanence is greatest.* The proposed scatter-pattern of grassland reserves is designed particularly to meet that need.

If the present unfavorable trend in land use continues to the low of the cycle without provision for holding a pattern of breeding units, the effect on the prairie chicken population may be catastrophic.

How many? To fit existing conditions on the Buena Vista Marsh, we believe that the managed breeding-unit pattern requires an average of about one 40 per section, or about 3,200 acres. This does not literally mean one 40 in every section; flexibility is required. For example, we selected and mapped a scatter-pattern in 1952. By 1954 it was necessary to make a new selection because two large farms (totalling about nineteen 40's) in the original pattern had been ruled out and 16 of the remaining sixty 40's had in the meantime been partly or wholly plowed. The 1954 selection is shown in Figure 7. We want to emphasize, however, that both the original selection and the newer one are merely *illustrative* of the kind of pattern and the approximate amount of land needed, rather than a specific record of the precise land parcels which are essential to the program. No one of these 40's is vitally necessary; for virtually every one of them there is an acceptable replacement nearby, generally in the same section. It is vitally important that (1) about eighty 40's be set aside as permanent nesting and rearing areas, and (2) that these parcels be well distributed throughout the Marsh. As long as a good scatter-pattern is obtained, the exact position of the individual parcels is of secondary importance.

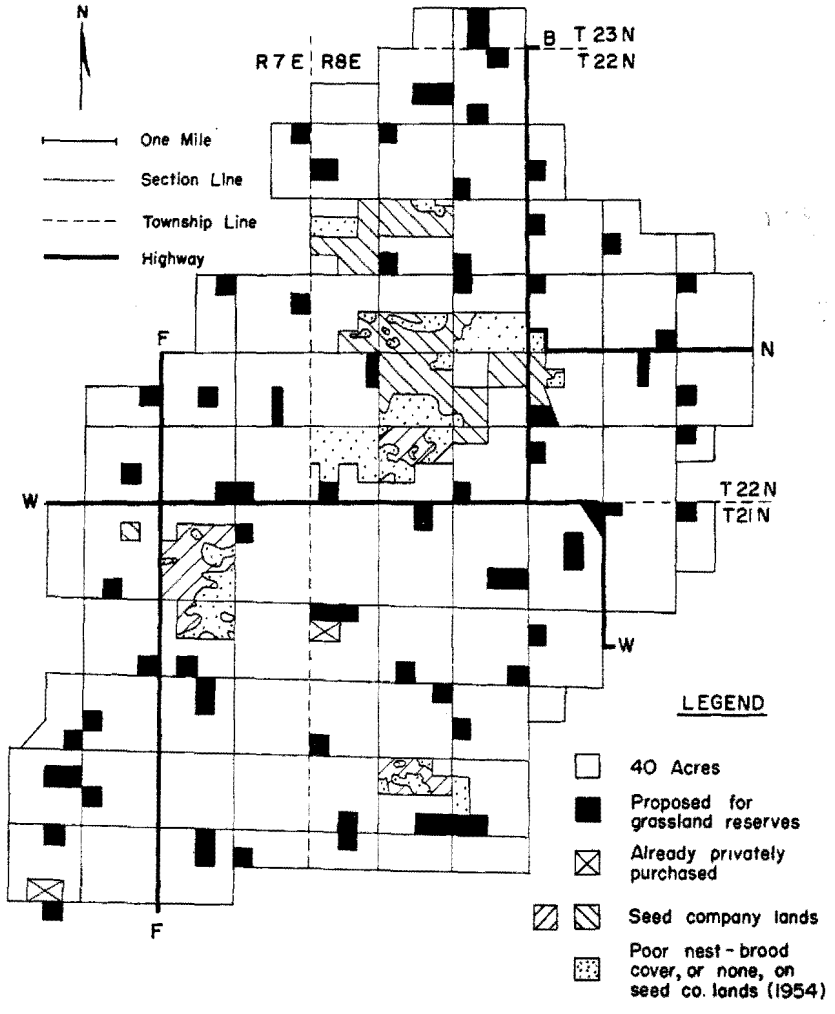


Figure 7. Scatter-pattern of grassland reserves for the Buena Vista Marsh Management Area, needed to insure the continuity of a stable pattern of breeding units throughout the area. This figure illustrates the kind of pattern and the approximate acreage needed. The exact position of the individual parcels is of secondary importance. Although lands owned by seed companies are important to prairie chickens, they affect only the central core of the Marsh and are not certain to continue to be productive. (As proposed in 1954.)

How obtained? Permanent grassland reserves could be secured in two ways: by lease or purchase. Either possibility has both advantages and disadvantages.

Leasing from the farmers now in the area would not interfere with the tax base, since the owners would continue to pay taxes as in the past. Leasing could also be fitted into the Department's annual budget more easily than purchase, since a lease program would probably cost no more than $6,000–$7,000 a year. The disadvantages are these: To be most effective, the grassland reserves should be kept free of disturbance during the nest-brood period (*i.e., until August first each year,* except for seed harvest) permanently. The shortest feasible individual lease period would be *at least ten years,* and this still leaves the problem of renewal or replacement of lost leases at the end of that time. From the individual farmer's point of view, however, it is difficult to foresee land-use needs ten years into the future. For this reason, the leases which have already been entered into have a provision which allows for earlier withdrawal. The high rate of turnover in land ownership, already mentioned, also cuts down the effectiveness of a lease program, for there is no assurance that a new owner would be willing to continue a lease already in effect. Finally, a lease program would be much more expensive than purchase in the long run.

State purchase of the scatter-pattern of grassland reserves has two clear advantages: permanence and stability would be guaranteed, and the total cost would be less. However, loss of local taxes is at present a serious obstacle to purchase by the State. The first step toward removing that difficulty was taken by the 1955 legislature, which passed a new law (Chapter 612, Laws of 1955) authorizing the payment of school taxes on State-owned lands. In 1953 the owners of the specific land parcels which we have recommended as grassland reserves on the Buena Vista Marsh (Fig. 7) paid a total of $1300.12 in taxes to four townships. School taxes amounted to $779.22 of this total, or *59.9 per cent.* The total real estate tax for these four townships was $166,596.80 in 1953.

We recommend purchase rather than lease, in the belief that it will better serve the needs of the prairie chickens. We wish to emphasize that our recommendation for purchase is limited to the purchase of a scatter-pattern of grassland reserves, amounting to about one forty per section: we do not believe that purchase of all, or even most, of the Marsh in the interest of prairie chickens would be desirable. We further recommend that consideration be given to the development of legislation enabling the payment of full taxes on all land parcels

which the State may buy, because the prairie chicken is a natural resource of great interest and value to the citizens of the state as a whole.

Private individuals and groups have already shown an interest which is tremendously encouraging—which strongly suggests, indeed, that a considerable part of the scatter-pattern might be bought by public-spirited conservationists. Two parcels have been bought specifically for prairie chickens thus far: one of 80 acres by the Wisconsin Conservation League, and one of 63 acres by Mr. and Mrs. Gordon E. Kummer of Milwaukee. The Wisconsin Society for Ornithology has raised a fund with which to buy a third. The Wisconsin Conservation League is continuing its long-range program toward buying more land, and we know that still other groups and individuals are seriously considering the same kind of help to prairie chickens. Private purchase is especially helpful in that it keeps land on the tax rolls. At its meeting on December 16, 1955, the Conservation Commission declared that it stands ready to lease and manage suitable lands which are privately purchased for prairie chickens, for few individuals or groups will be in a position to manage their land themselves. Such leases should cost little, in most cases no more than enough to cover taxes. Leases of this sort have a definite part in the management program for without them it is unlikely that many private purchases will be made.

Two points should be considered further: (1) The plan is tailored to fit the area in approximately its present land use, with allowance for what seem to be forseeable changes in the future. It will fit some further expansion of grazing and it allows for some further increase in general farming with grass in rotation. (2) If the area should be as thoroughly changed to plowland as southern Wisconsin now is, the plan would fail in its present objective unless it were modified. There would be three alternatives: (a) Increase the number of reserves. (b) Trade land parcels, to consolidate into fewer, larger, self-supporting units with a smaller total population. (c) Abandon the program. According to all advice from agronomists so far received, such an intensification of agriculture in this area is most improbable. If it should ever happen, however, any land which had been purchased would then have a ready market.

Maintenance of Lands in the Pattern

What needs to be done? The prime necessity is to keep the scattered breeding units in the grass-forb stage of plant succession, which

is a matter of weed and brush control. The lands selected for management are with few exceptions lands on which brush invasion will be slow and relatively easy to check. They are lands with good sod, which greatly hinders aspen invasion, and with good enough drainage to hinder invasion by willows. Brush invasion can be prevented by mowing and burning, two practices which are now in common use on the area for the purpose, and by controlling with chemicals.

Ideally, prairie chicken management for best production would allow no disturbance of the grassland reserves until about the first of September, after which about half of each forty would be mowed each year, alternating the two halves from year to year. This would permit nesting and rearing with no man-caused interference. It would also keep down the accumulation of dead grass, which we believe (see also Grange, 1948) can become too thick for very young chicks. Brush control, and to some extent weed control, would be accomplished at the same time, although mowing would not be necessary as often as this for brush control alone. Controlled grazing would probably accomplish these ends equally well, but we do not yet know how to regulate it to get best results.

A workable compromise, sacrificing some chicken production in order to have a cash crop on the same land, would allow grass seed harvest followed by (a) mowing, preferably half of each forty, as late as practicable thereafter but in no case earlier than August 1; or (b) grazing, so regulated that the grass would not be grazed short until late August or early September. This is essentially the arrangement, occurring by chance and with a more and more doubtful future, under which many of the chickens now alive on the Marsh were produced.

If a minimum of maintenance is decided upon, most parcels will need treatment only once in three to five years for brush control, and in many cases even less often.

Weed invasion, apart from overgrazing or other abuse, is probably governed largely by climate and may be more difficult to control. It is important to remember, however, that *the type of grassland that we want to maintain on most of these parcels is the type that develops naturally* on the drained peat of this area: tame hay meadows and cultivated fields revert naturally to bluegrass, without seeding or other treatment. This simplifies maintenance enormously.

It may be desirable to fertilize from time to time, especially south of Highway W, to improve the stands of grass. In a minimum program, this could be omitted or held to a low acreage. It is most apt to be needed if the parcels are stripped for bluegrass seed. If stripping

Left alone the Marsh would revert to brush and timber. Brush control will be one of the management needs on grassland reserves.

is permitted, there will be income with which to carry out a fertilizing program.

Fencing may ultimately be necessary on most parcels, to keep cattle out rather than to keep them in.

How can it be done? Maintenance should be relatively simple. *With few exceptions, bluegrass seed could be sold next summer and every summer on the parcels which have been proposed for management.* The seed companies do all the harvesting with their own men and equipment, and pay about $2.50 per acre for the seed; the land parcels in the proposed scatter-pattern should command a potential seed revenue of roughly $5,000 to $10,000 a year. In addition, the two seed companies which have been asked have indicated that they would do what mowing or burning might be necessary for brush control, if stripping rights were leased to them. These are not hard and fast commitments, but they do indicate that the job of maintenance on lands which might be leased to the seed companies could be done at no cost to the Department, and with income available to help pay the cost of other operations, such as fencing and fertilizing.

The precise degree to which the program could be self supporting in this manner cannot be determined as yet, for it will be governed

largely by two factors which are still indefinite: (1) The degree to which we will be able to manage first quality grasslands, as opposed to less desirable substitutes; and (2) the intensity of prairie chicken management decided upon.

There are other possible arrangements for low-cost or no-cost maintenance of a substantial proportion of the grassland reserves, including: (a) Mowing by local farmers in exchange for the hay. Since mowing should be done after the time which is best from the standpoint of hay quality, there might be no cash value in addition. (b) Bluegrass hay, even after stripping, is used as bedding on fur farms; it is commonly mowed for this purpose as late as September and October. (c) Grazing leases, with dates and intensities specified by the Department, are another source of revenue or of labor.

The details of maintenance will have to be fitted to the individual parcels; only the broad outlines are pertinent at this time. The foregoing, however, shows that maintenance should be no great problem.

Improvement of Private Lands

Along with the establishment of the breeding-unit pattern, it would be highly desirable to improve the habitat on the intervening lands where this can be fitted into normal farming operations. Possibilities for improvement include the following:

Cooperative bluegrass research: A cooperative program was started in 1954 with the seed companies and other landowners; University agronomists, soils men, and entomologists; the County Agricultural Agent; and the Conservation Department, to attack such interrelated problems as ways to increase seed yield and to control weed invasion and whitehead disease of bluegrass. It would be well to set out some of the experimental plots for such studies on land bought by the Department in at least three parts of the Marsh to achieve continuity of the experiments and adequate distribution throughout the area.

Delayed mowing: Make arrangements with individual landowners to delay mowing until August 1 for a period of years, in return for fertilizer provided by the Department. A number of farmers are interested in this approach.

Land clearing: The Department could clear (including plowing in some cases) lands which are now in brush and which are suitable for development as bluegrass lands, in return for which such lands would be managed for seed for a period of years. There are a number of good possibilities, particularly on seed company lands. Both the Man-

gelsdorf and Sumner Companies, the only ones owning land here, are interested. Some work of this sort has already been done, and more is planned.

Rotational grazing: Rotational grazing on permanent pastures offers some promise, but we do not know how readily such a plan could be worked into farm practice here.

Cooperative grazing study: It would be highly desirable, with the help of the University, County Agricultural Agent, and interested landowners, to make a study of grazing practices on the Marsh. Such a study is needed from the standpoint of the local farm economy, quite apart from its relation to prairie chickens. We believe that in many cases it would be better farm practice, and with a higher economic return to the farmer in the long run, if grazing were less intensive. We doubt that pastures which are well managed, in the strict economic sense, will alone sustain a high prairie chicken population. It would be extremely important to learn just how far apart good pasture management and good prairie chicken management really are, to see whether the difference could be bridged by a moderate subsidy. This would be a major study in itself. In any event, a generally high ratio of grassland to plowland is basic to our management plan, even though much of the grassland does not contribute directly to nesting and rearing cover. Anything which bolsters a grassland economy will be helpful to the prairie chicken program.

A. S. C. Program: For the same reason, any encouragement of grassland which can be had through the Agricultural Stabilization Program will provide an excellent general background for prairie chicken management. Largely through the local efforts of R. J. Neugebauer of this Department and the County Agricultural Agent, M. P. Pinkerton, the County A.S.C. docket in 1954 included new payments for the improvement of bluegrass lands. Where such payments increase the acreage harvested for seed, prairie chickens are likely to benefit directly. The Conservation Department can help in this by clearing or breaking brushlands (not included in the A.S.C. benefits) for landowners who are interested in this practice. *It is not to be supposed, however, that grassland improvement alone can substitute for the pattern of permanent breeding units outlined above.* To double or triple the forage or hay on a 40 *will not add a single brood* if the extra grass is simply converted to extra pounds of beef or extra bales of hay, with no more left for chickens during the critical season than there was before.

What Has Been Done?

Game managers of the Conservation Department have made a start toward management of nest-brood cover. In 1956, a total of 1,059 acres were leased for 10 years on the Buena Vista Marsh, including the two private purchases already described. In 1955 and 1956, 138 key acres were chemically treated for weed and brush control. On the Leola Marsh, 140 acres were leased in 1956 and an additional 400 acres were optioned for purchase by the State; the entire area was cover-mapped; and one of the leased forties was seeded to blugrass and timothy. The cooperative bluegrass experiments have already been described, and the current winter feeding program is the subject of a later section.

2. Booming Grounds

There is little need for specific booming ground maintenance. Present land practices are preventing brush invasion, mainly through mowing and grazing. Booming grounds should be inspected each autumn to see whether or not individual attention is necessary. Occasionally one may be found which needs mowing or spring burning, most probably to remove tall weeds where grazing has been too severe. When such mowing is found desirable, it should be done in the autumn, and the mowing should be extensive enough so that the booming ground is not just a little hole in the weeds. It would be well to mow about 40 acres with the booming ground in the center.

The pattern of distribution of booming grounds on the area is shown in Figure 8.

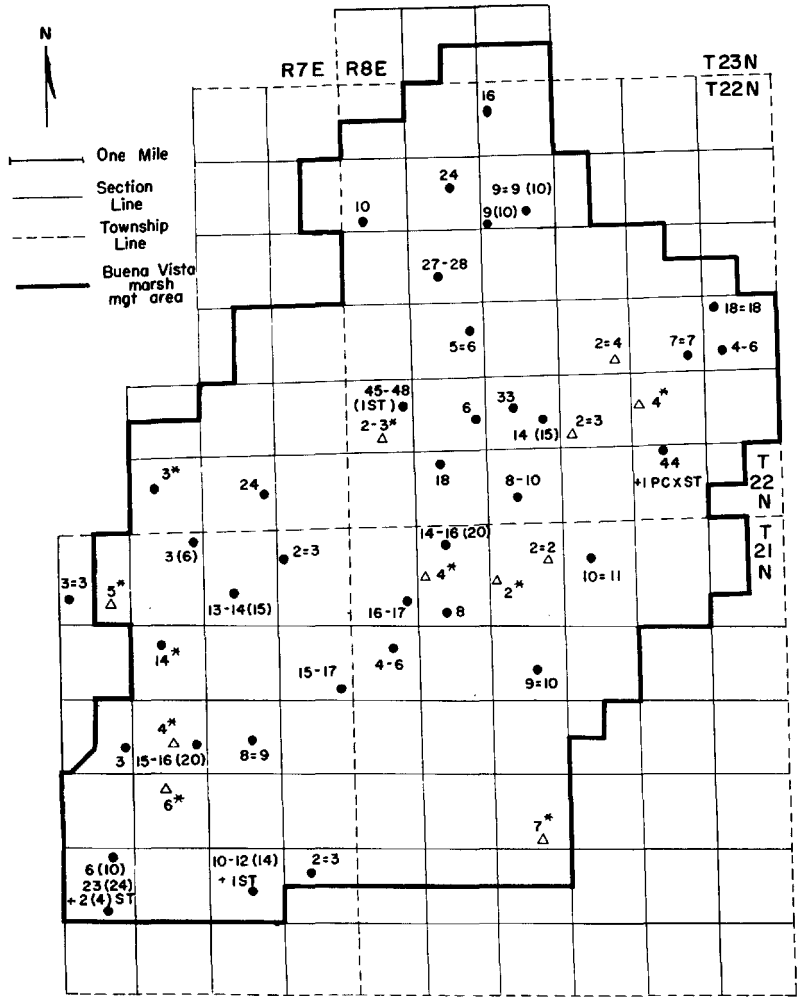
3. Winter Food

Food Patches

Specifications for winter feeding have been outlined under "general management considerations" and are not repeated here. The food patch program on the Buena Vista Marsh is described below.

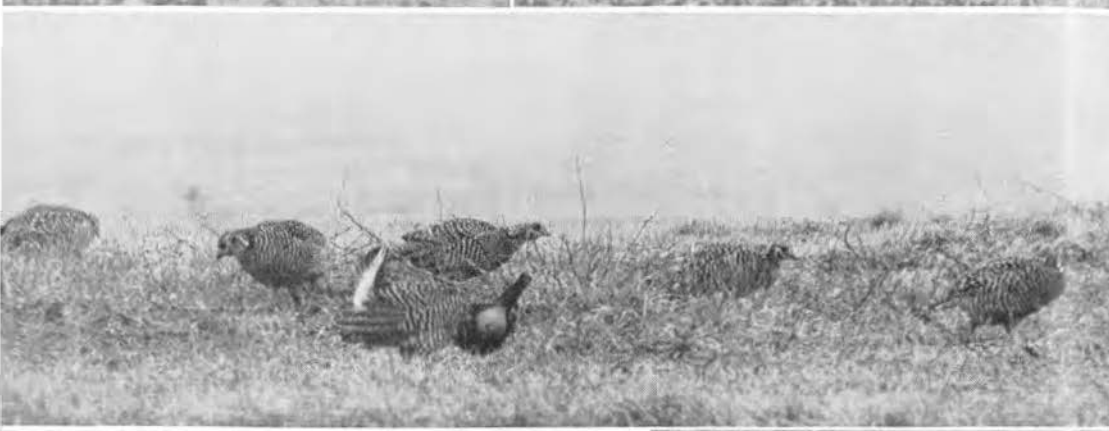
Starting in 1949 winter food patches have been arranged for in two ways: on a voluntary basis, and by contract. Prairie chickens now find their winter food in part in corn patches which have been contracted for in spring, and in part in corn left out over winter, mainly around the edges of the Marsh, in the course of normal farm operations (see Figs. 9 and 10).

Voluntary food patches were tried first. Under this arrangement individual farmers provided land and labor; the Conservation Depart-



- ● Booming ground used regularly
- ▲ Booming ground of uncertain status
- 10 Usual number of cocks ("regulars"), based on three or more counts
- 10-12 Usual number of cocks falls between these limits
- 2=4 Usual number of cocks, based on only two counts
- * Usual number of cocks, based on one count
- (6) Highest count of cocks on any morning throughout the spring
  All numbers refer to prairie chicken cocks, except:
- ST Sharptail cock
- PC x ST Prairie chicken x sharptail hybrid

Figure 8. Booming grounds on the Portage County Study Area, 1950.



ment provided seed, and fencing when requested. A few buckwheat patches were tried in the beginning but were given up because buckwheat is ordinarily buried under snow in this region. Corn has been used almost exclusively. Most of the voluntary food patches were one acre or less in size; a few were two acres. Several farmers did not even ask for seed corn and contributed everything, leaving part of their own crops unharvested for prairie chickens and other wildlife. Most of the food patches have been left unpicked and standing, which is best; a few have been shocked. Despite the fine spirit and hard work of the farmers who really took hold of the program, and the efforts of the special Food Patch Committee of the Southern Portage County Sportsmen's Club in Bancroft, the voluntary food patches did not fill the prairie chickens' need.

An acre of corn is a very generous contribution. Yet many flocks needed more, up to four or five acres and occasionally still more. No individual could be expected to give so much. Because of the pattern of farming, parts of the area had more food patches than were needed, while other parts had no winter food at all. Some individuals who had intended to leave corn, when food patches were being planned in spring, found themselves unable to do so. The food patch pattern was thus too uncertain, and in any case could not take care of important parts of the area.

Starting in 1950, therefore, a few larger food patches (up to five acres in size) were contracted for in spring and added to the system of voluntary food patches. These were to improve distribution and give more food to the largest flocks. Other supplementary purchases were needed from time to time, especially during the winter of 1950–51. That winter the largest prairie chicken population of many years, according to local report, was faced with an unusual food shortage caused by severe frosts in both July and August.

We have come to depend on contract food patches for winter feeding. They are planned for the places where they are most needed, and with assurance that there will be enough corn in the right places when the prairie chickens must have it. The Conservation Department pays $25 an acre and provides the seed corn, which is a short-season, short-stalked hybrid developed by the University of Wisconsin. The farmer provides land, fertilizer, and labor; leaves the corn standing until the end of March; and may harvest whatever is left uneaten. Voluntary food patches as such have dropped out, but the farming community still

Courtship and mating: booming grounds on the Buena Vista Marsh. Photos by George Socha.

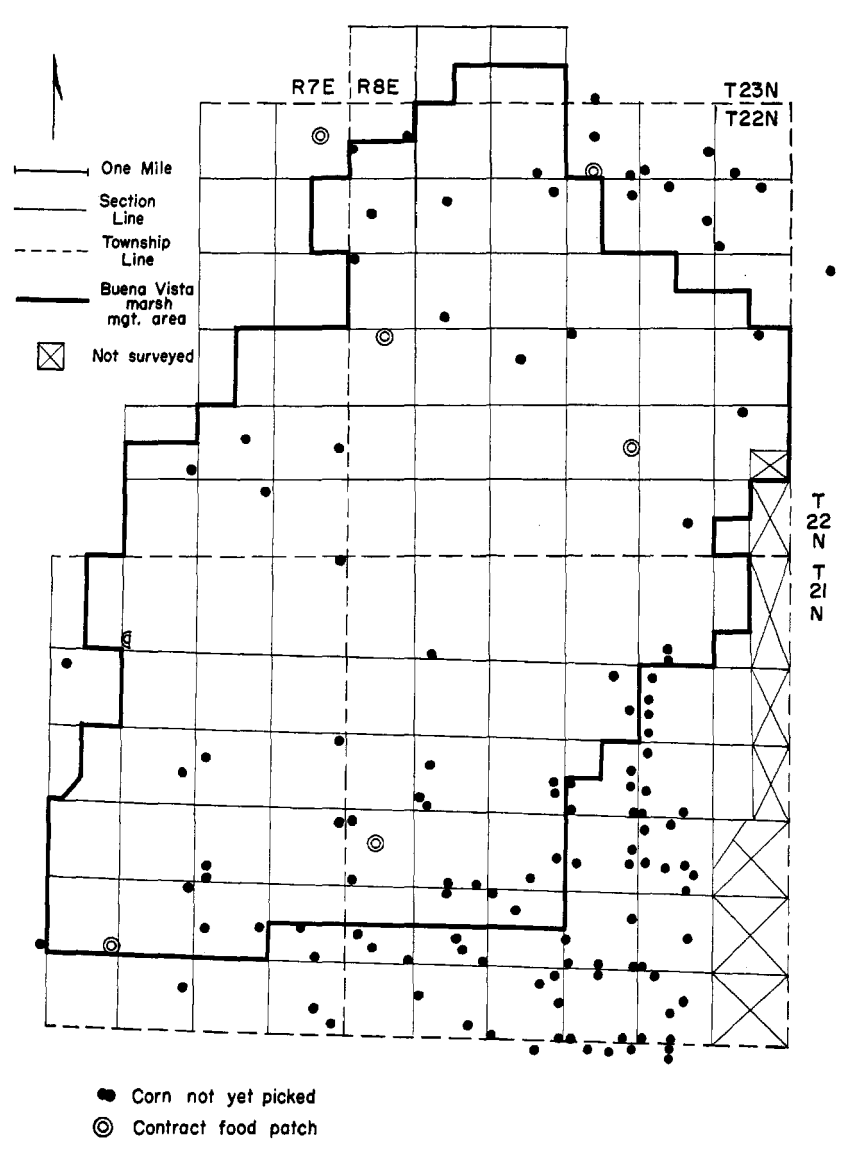


Figure 9. Corn available to prairie chickens on the Portage County Study Area in late autumn and early winter, 1953–54.

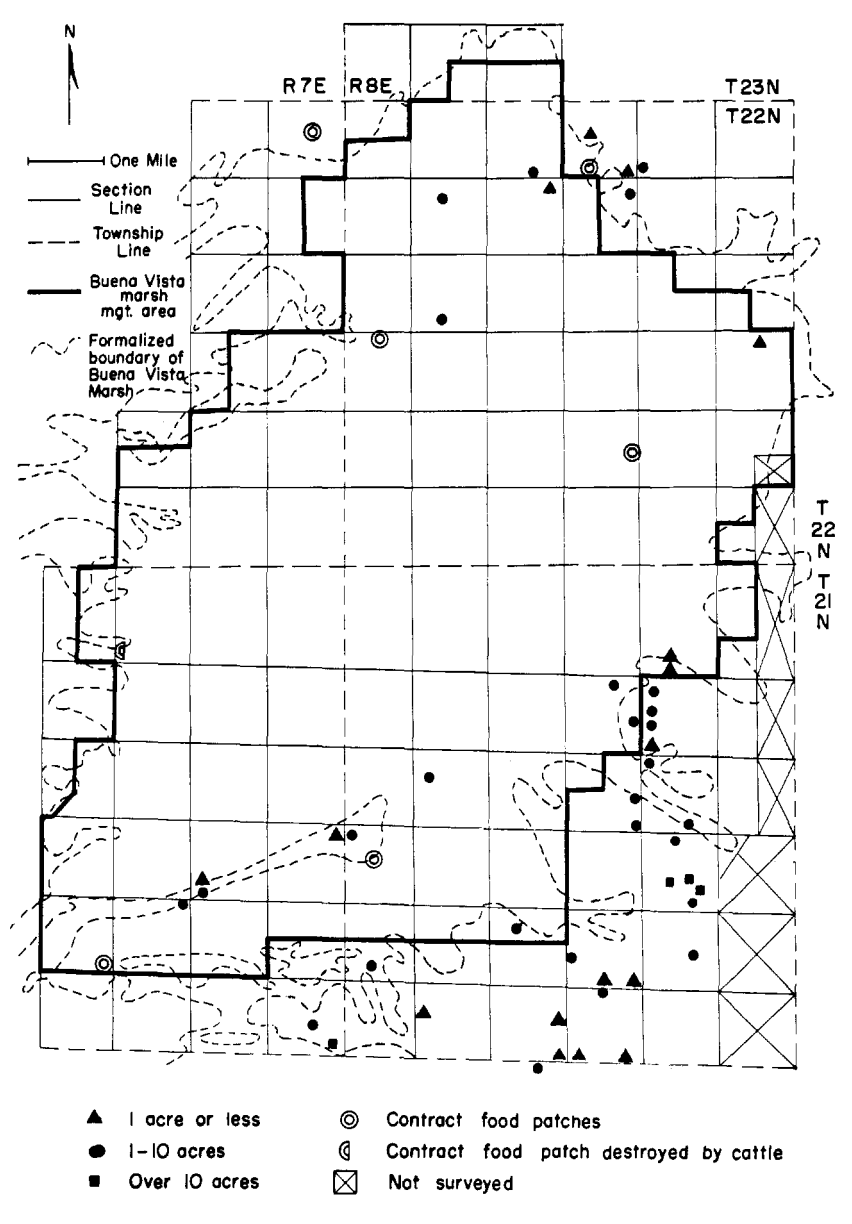


Figure 10. Corn available as food during mid-winter on the Portage County Study Area, 1953–54.

contributes a great deal of winter food in the corn which is not harvested until spring and in the shocks which spend part or all of the winter in the fields. Many farmers take pleasure in having prairie chickens feed in their fields in this way, and some continue to leave a few rows deliberately. Unusually large concentrations of prairie chickens, however, sometimes take more than even the most generous farmer can well afford.

We recommend that the system of contract food patches be continued on both the Buena Vista and Leola Marshes. Slight modifications are necessary from year to year, to adjust to the particular situation. Most such changes are easily made and include the following:

The size of individual food patches should be altered with changes in the population. At the low of the cycle most of them need not be as large as at the high. In 1956 the food patches were two and three acres in size; in 1950 some were five acres.

The locations of the food patches are determined not only by the distribution of the birds, but also by the distribution of corn which is ordinarily available because it is left out by the owners. Food patches have been particularly needed thus far in the northern and western parts of the Buena Vista Marsh. Along the southeastern side there has generally been so much corn available that, except during the high years, no additional corn was needed. This, however, raises two points:

The time will almost surely come when less corn is left in the fields over winter even in the southeastern part of the area, and the food patch system will have to be expanded by the addition of one to three units. This will actually simplify planning.

The food patch plan must continue to allow for buying some corn in winter to give the system flexibility and to take care of emergencies. Except under unusual circumstances, an extra $50–100, above the amount contracted in advance, should be ample. Especially during the high, and when the system of contract food patches was being started, we bought corn in this manner in winter in fields which were being used heavily by large flocks. This, however, encouraged others to ask for damage payments, but the conservation law does not provide for payment of such claims. Since a farmer's 40-acre unpicked cornfield is more attractive to a large flock of chickens than a four-acre food patch, the problem cannot be solved simply by planting more food patches. The problem has not been fully solved as yet.

Three small experimental food patches were planted in 1954. They consist of perennial species of the genera *Silphium* and *Desmodium*, native prairie plants which may have been important prairie chicken

foods in pre-settlement days. Some of the Silphiums are reported to live at least 30 years.

Water: It is highly doubtful that prairie chickens in Wisconsin need free water. In any event, there is an ample water supply (which as far as we know is used very little) in the drainage ditches which grid the area.

4. Winter Cover

It would seem that little or no deliberate management of winter cover is necessary for the present. Woody cover is used for both day and night roosting, and the existing pattern of woods and brush (Fig. 2) makes winter cover of this sort available in all parts of the area. Willow and aspen most often serve, although pine and oak are sometimes used. Pulp cutting in some of the stands of larger aspen would improve them for prairie chickens by encouraging younger growth. Some pulp cutting is in fact being privately done; still more would be desirable.

The fact that prairie chickens roost in grass and sedge as late into the winter as they can suggests a preference for these types over woody cover. The fact that chickens use brush and woods when grass and sedge are buried under snow does not necessarily mean that woody cover is a wholly adequate substitute. As far as we know now, it is; and it would be very difficult to develop grass-sedge cover that would stand up under the normal winter's snow. We recognize that winter cover needs some further investigation, but it can be done while management is under way.

Management of Secondary Areas

This plan can be adapted to fit the secondary areas in other parts of Wisconsin. It can, in fact, be adapted to fit prairie chicken areas in other states, especially the Lake States. The basic problem is the same in all areas—to insure nesting and rearing cover and winter food—but the details of management will vary. There are important differences from one area to another in Wisconsin in soil and cover types, which will govern both the kind and amount of land treatment needed; in kinds and intensity of land use, which will govern the size and numbers of grassland reserves needed; and in land ownership, which will have a great deal to do with the manner of establishing grassland reserves.

For the secondary areas, more information of the following kinds is needed:

George Socha

"Grass of the right density for nesting and rearing young . . .

. . . is particularly apt to go down under the first snows of winter."

Hugh Wilmar

Stouter grasses and sedges are good roosting spots until snow covers them up. Here, bluegrass is down, under ten inches of snow, but sedges, quack, timothy and Muhlenbergia still give roosting cover.

When grass is buried under snow, brush patches and woods' edges are used for roosting, especially at night.

F. J. W. Schmidt

1. *Rough cover maps.* Much can be learned about the management potentialities of individual areas from maps showing grasslands, brush, woods, cultivated lands, and marshes, without going into the details of size and stocking classes of woodlands and the actual crops on farmlands, etc. What is important is the extent and distribution of the grassland, its kind, quality, drainage, and current use. Such maps can be prepared in considerable part from air photos, in advance of the field work to follow.

2. *Booming ground surveys.* On every area which is considered for management, there should be a complete booming ground survey. This involves finding all booming grounds, and getting complete counts of the cocks using them. This information is needed for two purposes: (a) As a population index for comparing one area with another and following trends from year to year on individual areas; (b) The larger booming grounds are in or near (from a quarter to a half mile) the better nesting areas. Since booming grounds are more easily found and appraised than nesting grounds, knowledge of the booming grounds is a highly valuable short-cut toward knowledge of nesting and rearing conditions. Complete booming ground counts should be made every two weeks from late March or early April to mid-May.

3. *Information concerning land use* should be added to the base map through the summer, particularly in the case of grasslands. This will show a) where changes in land use, particularly with respect to dates of mowing and intensity of grazing, can most quickly improve nesting and rearing grounds, and b) where changes in the existing pattern of nesting and rearing grounds are most needed for long range improvement.

4. *Land ownership* should be determined. There are publicly owned tax delinquent lands on some of the secondary areas. Such parcels can be of great importance in a management program, as is the case of the parcels already leased from Taylor County.

5. Something should be learned of the *history* of each area, both as to cover types and land use, and of its *probable use in the future.* Where the probable development is toward intensive farming, the prospects for prairie chicken management are apt to be poor. Complete abandonment of farming would require much greater management effort in holding back brush and tree invasion to meet the space requirement. The best possibilities will generally lie in areas which are apt to be more or less stabilized at a low level of farming intensity, particularly at the edge of marshland. The highly specialized nature of cranberry growing offers good possibilities.

6. With grassland farming on the increase, *new chances* for prairie chicken management should be watched for. It is not likely that grassland farming alone will support large populations of chickens, for reasons already discussed; it should, however, provide the generally favorable background which would permit chickens to increase as the result of management of scattered parcels of permanent nesting and rearing cover. The possibility of developing new grass-seed-producing areas, outside of the good pheasant range in the state, is worth exploring. Examples of suitable grasses include bluegrass, redtop, timothy and brome.

"Ecological Patterning" as a Tool in Wildlife Management

Wildlife management generally means the management of *habitat* as much as the management of the animals themselves. Habitat management means land management, to produce the specific kinds and amounts of cover and food without which wildlife cannot live. It happens sometimes that existing land management quite inadvertently produces both commercial crops—whether measured in bushels, pounds, or board feet—and excellent crops of wildlife too. For example, in the days of Wisconsin's early development, bumper crops of game were produced as purely accidental by-products. This was true of prairie chickens and quail during the first steps in the breaking of the prairies. It was true of prairie chickens and sharptails in the north when the forests were cut and fire ran through the slashings. It was true of deer and ruffed grouse when young forest began to creep back into the cut-over. No one planned it that way. For most upland game, the changes brought about by early settlement were in fact, if not by intent, habitat management on a scale which Wisconsin will never see again. Even the introduced pheasant simply fitted into an environment which was ready for it by chance.

We are still clipping coupons from that early wildlife bonanza. Most of our present wildlife habitats are simply what is left from that rich earlier period, rather than what we have produced by intention. The ruffed grouse is our most abundant upland game bird. It has about reached, or has perhaps already passed, its time of greatest numbers. There will be fewer of them as the northern forests continue to grow older. We are well past the peak in deer numbers. Our middle-aged forests cannot even maintain the tremendous herd that the young forests produced. The prairie chicken, with the sharptail close behind, was among the first to benefit by pioneer settlement, among the first to

lose ground as settlement advanced, and the closest now to extirpation. For the prairie chicken it is obvious that habitat management is vitally, desperately, necessary *now* to save the species. It is less obvious but none the less true that other species are travelling down the same road. The very forces which once produced an incalculable wealth of game have now gone too far, and are destroying the habitats they once created.

It is hardly an exaggeration to say that in southern Wisconsin every marsh which is drained in the future means fewer pheasants, ducks, and rails; every fencerow and roadside which is de-brushed, fewer quail and songbirds; every woodlot which is heavily grazed, fewer cottontails and ultimately, as the trees disappear through lack of replacements, fewer squirrels and woodland birds. Thus, not only for the prairie chicken but for every important game species and many other wild creatures, habitat management is now or soon will be needed. For most game species it is needed now. For many, a start has already been made.

How this situation has come about is no secret. It is the result of increasingly intensive use of agricultural (and marginal) lands, increasing age and more intensive use of the northern forests, and increasing hunting pressure—in short, of greater human demands on the land. Just as these demands make habitat management all the more essential, so also do they make it all the more necessary to pay for the lands on which commercial production is cut down in the interest of wildlife production. Ironically enough, as the need for wildlife management increases, there are fewer and fewer acres which can be diverted to the purpose, and the cost of each acre becomes greater and greater.

These expensive acres must be managed with great skill, to produce the best possible stand of wildlife in return for the investment in land, effort, and money. In part, this is a matter of putting ecological knowledge to work in developing the land which is available. Much study and practice has already gone into this phase, and a considerable body of knowledge (although not yet enough) is already at hand. It is just as important—and will become increasingly so in the future—to make a good choice when the acres to be managed are selected in the first place. This phase has not been developed as far as the other. In the past, game managers have largely been forced to do the best they could on lands which were available because they were odd corners, unproductive bits and pieces in otherwise "good" land, and on larger areas in "wild" land. In short, on lands which were available

because they had no high immediate value for commercial production, and which were selected because of availability rather than choice. Such lands have had and will continue to have an important place in wildlife management. But it should be plain enough that if wildlife is to be produced only on those acres which nobody wants for any other purpose, there will soon be whole regions with no game of any kind, and no other wildlife except mice and insects—a poor country for humans to live in, as well.

We do not believe that the people of Wisconsin will allow themselves to become so impoverished. It follows, then, that some of the better lands will have to be reserved for wildlife. It is likely that such acres will be managed in such a way that commercial production is modified, rather than cut out entirely. But whether it is done that way or by reserving them completely for wildlife, one thing is certain: such acres will have to be chosen with great skill.

Ecologically speaking, most species will be most benefited by a scatter-pattern of relatively small land parcels, rather than by an equal acreage in one solid block. Completely unmodified farm practices provide *some* of the things needed by farm game. It is necessary only to bolster the weak spots, allowing the unchanged surrounding farmland to provide a considerable part of the total habitat with no cost to management. Thus the effective area will be much larger than the actually managed (and paid for) area.

We have already shown, for example, that in the farming community on the Buena Vista Marsh two things in particular need to be made more secure for prairie chickens: nest-brood cover and winter food. It is obvious enough that the total acreage of food patches should not be combined into one large field in the center. It is the nature of the birds to form flocks which are scattered through the area in winter, and it is easy to see that food supplies should be correspondingly scattered. It is not so easy to see, but just as true, that nest-brood cover also should be scattered. Here again it is the nature of the bird which governs. It is their nature to disband the flocks and to be even more scattered—much more scattered—during the nesting and rearing season than in winter.

Other things also dictate a scatter pattern for prairie chickens on the Buena Vista Marsh, for example:

Quality—There is no part of the Marsh in which one could find a solid block of 3,200 acres of uniformly good nest-brood cover. Why waste money on unwanted acres?

Crowding—There is an upper limit to crowding, even though the

reasons for it are not clearly understood. Eighty forties in a scatter pattern will produce more prairie chickens than 80 forties in one block. Some of the underlying reasons are undoubtedly involved in some of the headings below.

Interspersion—Different kinds of cover are needed for different uses: short cover for booming, medium cover for nesting and rearing young, dense cover (including aspen and willow) for winter roosting and escape from predators and hunters. Different kinds of food are needed at different seasons: insects, fruits, clover and other greens, weed seeds and small grains for the growing young and adults in summer and fall; corn in winter. *All* of these types are necessary. A scatter pattern makes them all available for the price of *only* the nest-brood cover and food patches. In a solid block, a large proportion would have to be used to produce this essential variety, with a corresponding loss of nest-brood cover. Since nest-brood cover is the critical bottleneck, every acre diverted from it cuts down the effectiveness of the program.

Edge effect—A solid block of 3,200 acres would have about nine miles of edge. A scatter-pattern of 80 individual forties would have *80 miles of edge.*

Distribution—The old adage about not putting all one's eggs in one basket applies here also. A single block would be more vulnerable to such accidents as fire, disease infestation, flooding as a result of heavy rains or the failure of one drainage ditch, etc. There is reason to believe that booming grounds of moderate size (16–20 cocks) are more efficient as mating grounds than the really big ones (Hamerstrom and Hamerstrom, 1955). It follows that a scattering of moderately large booming grounds throughout the whole Marsh would be better than a concentration of large ones within a limited area.

Opportunism—Birds distributed throughout the area in a scatter pattern are always in position and ready to take advantage of favorable developments in neighboring habitat, such as lessened grazing pressure in the next pasture, a hay meadow left idle, etc. In the aggregate this could be very important. Birds in one large block would have many fewer chances of finding such new habitats.

The same sort of thing applies to forest and forest-edge species. In the case of the sharptail, for example, there is now vastly more winter range than is needed, in the bogs and swamps, and in the aspen and birch, and to some extent the hardwood, forests of the north. Summer habitat—brushlands and openings—is in critically short supply and is the major limiting factor. Even in the best wildland sharptail

areas there is an extensive matrix of forest, much of it excess winter range and much of it totally unusable. Within this matrix lies an interrelated pattern of good breeding habitat, without which the sharptail cannot survive. The matrix generally amounts to about two thirds of even the best sharptail areas, the productive openings and brushlands only one third. The amount of money available for sharptail management is limited. It will buy or lease only a limited number of acres. Patterned land acquisition will give about *two to five times* the amount of productive habitat as the same number of acres in one solid block. The practical implications are obvious.

In short, by modifying the size, shape, number, or distribution of the land parcels, the scatter-pattern plan which we have developed for prairie chickens on the Buena Vista Marsh could be the key to the management of many other species in other places. This might be called "ecological patterning", in contrast to solid blocking.

Ecological patterning is not yet a popular concept, although we have been urging it for several years. Administratively it is simpler to handle solidly blocked lands. The problem is largely one of scale, for on a geographically larger scale ecological patterning is already being practiced. When a marsh is flooded for waterfowl, the entire basin must, of course, be purchased and this is solid blocking. But no one proposes, in waterfowl management, to buy all the intervening land from the breeding marshes of the north to the southern wintering grounds. The individual nesting, resting and wintering marshes throughout a flyway are directly comparable, on a vastly greater scale, to the individual parcels in a scatter-pattern within a township. Deer yard acquisition is another example. No one suggests that, because deer yards in Vilas County need to be managed, the whole county should be leased in the interest of blocking.

Certainly it will be more complex to administer a scattering of small land parcels than fewer, larger areas. But in the face of increasing pressures on the land, every phase of wildlife management is becoming more complex. Without question there are a number of complications that will have to be worked out before ecological patterning is fully workable on a local scale. But of this we are convinced: Solid blocking, with straight outside boundaries measured in miles rather than in 40's, is fast becoming an administrative luxury, incompatible with the efficient management of upland game habitat. The sooner ecological patterning is whipped into fully usable form, the sooner will wildlife management be ready to cope with the problems of the future. Those problems, indeed, are already upon us.

Part III—POPULATION MANAGEMENT

In the management of any species, habitat is a prime consideration, for without a place to live, the species cannot exist. However, the existence of a species is also influenced by the safeguards surrounding the population itself. In the case of a game bird of generally low density and high trophy value such as the prairie chicken, the regulation of hunting becomes particularly important. In addition, the importance of competing species and predators should be judged in any management plan. Some thought needs also to be given to diseases and parasites and to weather emergencies, at least to decide whether or not anything can be done about such hard-to-get-at problems.

Summary: Limiting factors which may exert direct pressure on prairie chicken populations include the following: (1) Hunting, which must be restricted to the harvest of surplus birds, when available. Past regulations have been satisfactory, but new and different ones will be needed to prevent over-hunting of the few areas of prairie chicken habitat which will persist into the future. (2) Competition with exotic species having similar habitat requirements should be held to a minimum on all areas managed for prairie chickens. (3) Control of predators is less important than the provision of strong habitat. (4) The spread of diseases and parasites can be discouraged by dispersing, rather than concentrating, winter food supplies. (5) Strong habitat is the best and only practicable defense against extremes of weather.

Regulation of Hunting

General Biological Aspects

Biologically, we see no reason to discourage hunting during years of abundance *provided* that two conditions are met: First, an actual harvestable surplus must have been produced. Second, hunting—including crippling loss—must not remove more than the surplus. These limitations are not unique to prairie chickens, of course. They apply to all game.

How may a surplus be recognized? In the case of cyclic species, with no stable year-to-year population level, it is hard to set specific numerical standards. It is all the more difficult in the case of animals with a 10-year cycle, such as the prairie chicken, for the habitat of a given population may change markedly during a single cyclic period. Changing habitats will support differing numbers of birds during suc-

cessive highs. Wisconsin's total prairie chicken population has been progressively smaller at each of the highs for many years. The surplus available for hunting has therefore not been the same at each high, but has dwindled correspondingly.

There is now good reason to believe that some species have a huntable surplus even at the low of the cycle. The ruffed grouse was hunted during every year of the last cyclic low in Michigan, and without detectable harm to the population (Ammann, 1949). This does not necessarily mean that prairie chickens, in the densities which now occur in Wisconsin, can safely be hunted during the low. Prairie chickens are far less abundant than ruffed grouse. Their distribution is distinctly spotty, rather than uniform. The few good areas are well known and so are subject to disproportionate hunting pressure. Theoretically, these areas might have huntable surpluses at the low. From the practical standpoint, however, the surplus would be so small and the actual or potential hunting pressure so great, that there would be real danger of killing too many. Prairie chickens have not been hunted during recent lows, and should not be hunted at low population levels in the future under the prevailing type of hunting regulations.

There is no simple formula to show when the season can best be opened on the cyclic rise, the size of the surplus during each of the open years, and when to close the season again. No state, including Wisconsin, has yet managed prairie chickens intensively enough to set up the elaborate and closely controlled experiments on which to base such a formula. Empirical rules have been followed in the past to regulate the hunter kill. Hunting regulations, described later, are based on characteristics of the birds themselves which make hunting relatively easier or harder, and on characteristics of the hunter which lead him to turn toward or away from prairie chicken hunting for his sport. A more precise formula, if it could have been worked out and enforced, would probably have allowed a somewhat larger hunter kill than there actually has been in recent years. We suspect, for example, that the open seasons of the last cyclic high could have been started one or two years earlier than they were, if there had been census figures to show the stage of the cyclic rise. There are no precise figures to show what the allowable kill should be. Our best guess, at present, is 25–30 per cent of the population, perhaps somewhat more during the rise and somewhat less during the decline, with a closed season when the population drops to about 50 per cent of the high.

Certain characteristics of the birds have a particular bearing on hunting regulations. In early autumn the coveys are relatively small

in size, generally on the order of 7–15 birds. They are then well scattered through the breeding cover. At this time the birds lie particularly well to dogs. They commonly flush within easy gun range, whether hunted with dogs or without. Coveys often fly no more than a few hundred yards, and so are easily marked down for a second flush, and perhaps even a third. They are relatively easy to hunt at this season, and large bags are to be expected. Later in the autumn the coveys draw together into larger groups, called "packs", which may number from 50–100 or more birds. The packs are much wilder and harder to hunt —much more difficult to approach, flushing at greater distances, and flying much farther, often a mile or more. Thus they are apt to jump well out of range on the first flush, and to fly so far that they cannot be marked down for a second try. The time of packing is variable, depending on the weather. Warm weather delays packing, frosty mornings bring it on. Packing has usually started by late September. The larger the pack, the more difficult it is to approach. Once the birds are packed they offer very few chance shots, and it is a rare hunter indeed who has the skill and the persistence to hunt them successfully. Few prairie chickens are killed during late seasons, for example, after mid-October. This is trophy hunting, in the best sense of the word.

Broods in late summer and early autumn appear to have rather restricted home ranges, perhaps no more than a quarter section (160 acres). An autumn pack may range over the better part of four sections (Hamerstrom and Hamerstrom, 1949). The size of a closed area, therefore, will have an important part in determining how much protection it gives. The dates of the hunting season must also be considered in this connection. A one-section closed area might completely protect several coveys in early September, but four sections are needed for a single pack in October. Closed areas thus offer many possibilities for manipulation. At one extreme, a scattering of one-section closed areas would give partial refuge to many packs over a large area during a late season, thus reducing the kill a little. At the other extreme, an entire unit of range, amounting to a township or more, could be made a closed area to give complete protection to a whole colony.

Effects of Hunting

Market hunting, 100 years ago, took an annual toll of prairie chickens probably many times greater than the total state-wide population of today. Forty to fifty years ago, when sport hunters shot prairie chickens by the wagonload, the annual kill was almost unbelievable by to-

Aldo Leopold

This is trophy hunting!

day's standards. In those earlier days hunting came in late August and early September, at the time when the birds are especially easy to shoot.

But would there be many more prairie chickens in Wisconsin today if those astronomical numbers had never been shot? We doubt it very much. A bird must be hatched and reared before it can be shot. Production must come before harvest. Prairie chicken production is possible only in a certain kind of habitat. When that habitat is gone, no more prairie chickens can be produced. That habitat is gone from most of the state. The birds that never hatched far outnumber the ones that have been shot.

Prairie chicken hunting, then, is not the cause of the general decline which is now under way. This does not mean that hunting has had no effect on prairie chicken numbers. It is entirely possible that hunting, and especially market hunting, did have serious effects at times and places in the past (Schorger, 1944). It is even possible that some remnant flocks disappeared sooner than they would have had there been no hunting, especially as the result of accidental killing in the course of pheasant hunting. We cannot evaluate the effect which pheasant hunting may have had on remnant flocks: the evidence is no longer clear. It is worth remembering, however, that there was *no* pheasant

hunting to complicate matters during the final disappearance of the heath hen *(Tympanuchus cupido cupido),* the eastern race of the prairie chicken, nor during the great decline of the prairie chicken in Missouri.

In the long view, we are convinced that it is the pressure of plows, cows, and trees—increased human pressure on the land—not gun pressure, which has brought prairie chickens to their present low level.

On a shorter time scale, the normal cyclic decline is often mistaken for the result of overshooting. This is perhaps inevitable, for in recent years the hunting season has not been opened until the high of the cycle or just before it. It is to be expected that a high will be followed by a drop in numbers, but this fact is apt to be overshadowed by the immediate and spectacular realization that after a few years of hunting there suddenly are fewer birds. We have seen it happen twice in Wisconsin, at the last two highs.

During the recent high the Buena Vista and Leola Marshes were open to hunting only in 1951. The Leola Marsh makes up about a quarter of one of our major study areas, the Plainfield area. On the Leola Marsh and the Plainfield area as a whole, booming ground counts started downward in the spring of 1951, *before* the open season. On both the Buena Vista Marsh and the Plainfield area the spring counts of 1952 were only 50 per cent of the high, after the heavy hunting pressure of 1951—but strong decreases apparently occurred simultaneously in the Marquette–Green Lake Counties area in Wisconsin (Damaske, unpubl. field notes) and were also recorded for Indiana (Mumford, 1955b), although there has been no chicken hunting in either of these areas for many years. Spring counts for 1953 were higher than 1952 on both the Buena Vista and Plainfield areas, but not on the Marquette–Green Lake area nor in Indiana. In 1954 spring counts were somewhat higher again on the Plainfield area, lower on the Buena Vista Marsh, and lower in Indiana (Mumford, 1955a). By 1955, still without chicken hunting on any of these areas, the situation was as follows: lower on the Plainfield area (53 per cent below the high), higher on the Buena Vista Marsh (44 per cent below the high), and lower in Indiana (57 per cent below the high). The Marquette–Green Lake Counties area was not censused as intensively in 1954 and 1955 as in 1952 and 1953, but it is plain that the population is at a very low level.

To summarize: Of these four areas, two were hunted during one year of the last high, and both showed population increases during

two of the springs *after* the hunting season (Buena Vista Marsh and Plainfield area). On two areas there was no prairie chicken hunting at all during the last high (Marquette–Green Lake area and Indiana). *All four* areas showed strongly reduced populations in the spring of 1955, about half or less of the numbers at the high. Whatever the cause of these low 1955 populations, it plainly was not prairie chicken hunting.

The same paralleling of shot and unshot areas occurred during the high of the 1940's. There were open seasons on prairie chickens in Wisconsin in 1938 through 1942, after which the season was closed until 1950. In Indiana there has been no prairie chicken hunting since 1936 (Mumford, 1955b). We began our spring censuses of the Plainfield area in 1939. Our spring counts rose to a high in 1940, dropped in 1941, rose again in 1942, (but not quite as high as 1940), and dropped in 1943. Our census was then interrupted until 1947, when we found the lowest count of all—76.5 cocks regularly using the booming grounds on the area, as compared with 257.5 cocks in 1940 (Hamerstrom and Hamerstrom, 1955). Letters from friends living in the area informed us that there was no increase of any consequence during the three springs that we were absent. Subsequently the population rose to a high in the spring of 1950. Here the population rose to a high in the spring of 1940 despite hunting since 1938, rose again from spring 1941 to spring 1942 although hunting was still going on and reached the lowest point of all in 1947 (possibly 1946) even though the last of that series of open seasons was in 1942. And in Indiana, with no prairie chicken hunting, spring counts dropped from 1942 through 1946, then rose to a high in 1951 (Mumford, 1955b).

The Indiana booming ground figures, above, give the longest consecutive record of actual counts over a large area known to us, and there has been no prairie chicken hunting to confuse the account of cyclic behavior. The record begins in 1942, with a count of 438 cocks, then drops steadily to 1946, to 130 cocks. There follows a rise to 1947, a slight dip in 1948, and a further rise to a high of 325 cocks in 1951. The downswing began in 1952, and has continued without interruption to 1955 (the last count available), when there were only 140 cocks (Mumford, 1955a, 1955b). *Complete closure against hunting has not permitted this population to stockpile indefinitely, nor has it prevented two cyclic declines.*

It is characteristic of both prairie chickens and sharptails that, at the time of the cyclic high, birds appear in places where there were apparently none during the low. While this may sometimes be only

the increase of a resident population which was so small as to be unnoticed at the low, it is probably more commonly the result of spread from larger centers of population (Rowan, 1948). The continental range of the prairie chicken expanded for hundreds of miles to the north and west in the 1800's and early 1900's (Leopold 1931a; Baker, 1953; Edminster, 1954), and banding studies in Wisconsin have shown several moves of 20–30 miles and one of about 100 miles (Hamerstrom and Hamerstrom, 1949; and Quart. Prog. Repts.). Since the total area of suitable habitat is now shrinking rather than expanding in Wisconsin, such wanderers have little value as potential colonizers. The loss of some of them through hunting has probably not been serious.

Current hunting regulations: Basically, the same pattern of regulations has been in effect for many years, with modifications of detail to fit changing circumstances. The essential elements of the pattern are as follows:

Most hunters do not distinguish between prairie chickens and sharptails before pulling the trigger. Further, both species were abundant over much of Wisconsin, often in habitats which actually overlapped one another, when the pattern was first established. The two species have therefore been treated essentially as one, with one set of regulations covering both. There has been no hunting during the low years of the cycle. During open seasons, the kill has been regulated by the standard methods of varying the length of the open season and the bag limit, which applies to the aggregate of both species, and by varying the amount of country open to hunting. Newer and even more important methods have been to vary the date of the opening of the season and to reduce the kill by opening the prairie grouse season concurrently with several other species. Table 2 outlines the regulations in force during the last series of open seasons, from 1950 through 1955, and Table 3 lists the counties that were open during the same period.

Since 1943 prairie chickens have been protected by closed seasons, or have been exposed to rather closely limited hunting pressure. There was no open season from 1943 through 1949, during the last cyclic low and most of the rising phase which followed. Those counties with small remnant populations of prairie chickens and no sharptails (or virtually none) have not been opened at all—Columbia, Dane, Green Lake, Manitowoc, Marquette, Outagamie, Waupaca, and Waushara Counties. The one best population, on the Buena Vista and Leola Marshes, was hunted only once, in 1951. Thus, more than half of

Table 2

Sharptail–Prairie Chicken Hunting Regulations, 1950–1955

Year	Dates of Open Season	Number of Days	Daily Bag Limit	Possession Limit	Opening Date Concurrent With:
1950	9/23–10/6	13½	3	6	Ruffed grouse only. Other species opened later.
1951	9/22–10/14	22½	3	6	Ruffed grouse only. Other species opened later.
1952	10/4 –10/26	22½	3	6	Waterfowl state-wide; ruffed grouse in all counties open to sharptails and chickens; pheasant, squirrels, and rabbits in northern zone.
1953	10/3 –10/26	23½	3	6	Same as 1952.
1954	10/2 –10/15	13½	3	6	Waterfowl state-wide; ruffed grouse, squirrels, and rabbits.
1955	10/15–10/30	15½	3	6	Pheasant state-wide; ruffed grouse, squirrels, rabbits, Hungarian partridge and bobwhite *south* of Highway 64. Species opening *earlier*, on Oct. 1 — waterfowl state-wide; ruffed grouse, squirrels, rabbits, and (few counties) Hungarian partridge and bobwhite *north* of Highway 64.

Bag and possession limits mean the total of both sharptails and prairie chickens.

Northern and southern zones have varied somewhat from year to year, and from one species to another within the same year. In general, however, the northern zone includes all sharptail–chicken counties except Adams, Jackson, Juneau and Monroe. A few counties in the northern zone have occasionally been closed to otherwise concurrently opening species, particularly squirrels and rabbits.

Table 3

Counties Open to Sharptail–Prairie Chicken Hunting, 1950–1955

County	1950	1951	1952	1953	1954	1955
Adams	---	1/2	3/8	3/8	---	---
Ashland	---	x	x	x	x	x
Barron	---	---	x	---	---	x
Bayfield	---	x	x	x	x	x
Burnett	x	x	x	---	---	x
Chippewa	1/3	1/3	x	x	---	x
Clark	x	x	x	x	---	x
Douglas	x	x	x	x	---	x
Dunn	---	---	x	---	---	---
Eau Claire	---	---	x	x	---	---
Florence	x	x	x	x	---	x
Forest	x	x	x	x	---	x
Iron	x	x	x	x	x	x
Jackson	1/2	1/2	1/2	1/2	---	x
Juneau	2/3	2/3	1/3	1/3	1/3	x
Langlade	x	x	x	x	---	x
Lincoln	x	x	x	x	x	x
Marathon	x	x	x	x	x	x
Marinette	4/5	2/3	x	2/3	---	x
Monroe	---	---	1/3	1/3	---	x
Oconto	1/4	1/4	x	1/4	---	x
Oneida	x	x	x	x	x	x
Pepin	---	---	x	---	---	---
Pierce	---	---	x	---	---	---
Polk	---	---	x	---	---	x
Portage	4/5	x	4/5	4/5	---	---
Price	x	x	x	x	x	x
Rusk	x	x	x	x	x	x
St. Croix	---	---	x	---	---	---
Sawyer	x	x	x	x	x	x
Shawano	---	---	x	---	---	x
Taylor	x	x	x	x	---	x
Vilas	x	x	x	x	x	x
Washburn	x	x	x	---	x	x
Wood	x	x	x	x	x	x

x = Whole county open, except for relatively small closed areas.
Fractions = Only part of county open, approximate amount indicated by the fraction.

Wisconsin's total prairie chicken population has not been hunted during most of the recent years with open seasons.

In those counties with enough sharptails to warrant an open season, in some of which prairie chickens also occur, there were open seasons on both in 1950 through 1955. The heaviest hunting pressure was in the two years with the highest populations of the current cycle, 1950 and 1951. Only in those two years was the season opened relatively early, on September 22 and 23. Even these were much later openings than the August and early September openings which once were common. All openings after 1951 were in October, with the birds well grown and wary and already starting to pack. Under these conditions most hunters quickly give up sharptail and chicken hunting and turn to easier game; the opening dates were set with that fact in mind. The sharptail-chicken season has opened with ruffed grouse in each of these years.

Hunting pressure on prairie chickens was still further reduced, after 1951, by opening the sharptail-chicken season concurrently with a number of other species—with waterfowl (except 1955), pheasant (except 1954), rabbits and squirrels. In 1955, the concurrent opening was more complex (see Table 2). Since the heaviest kill occurs on the opening week end, one of the most effective steps in holding down the total kill is to lower hunting pressure on those critically important two days. Field checks have shown that there were many fewer hunters in the best sharptail–chicken areas on opening week end during the years with concurrent openings than in 1950 and 1951 when sharptails, prairie chickens, and ruffed grouse were the first to open. Within some of the open counties there have been areas closed to sharptail–chicken hunting, from one to four sections in size, which further limited the kill.

Future hunting regulations: Aldo Leopold often pointed out that the prairie chicken is a highly important part of Wisconsin's heritage, of value to hunter and non-hunter alike. Because of its outstanding qualities as a game bird, we agree that it is important to continue prairie chicken hunting for as long as this can be done *without damage to the prairie chicken population,* and without harm to the equally important pleasure of those who enjoy prairie chickens by watching them without hunting them, or simply by knowing that they are still here. Important as it is, however, hunting is definitely secondary: the birds themselves come first. We further believe that recent sharptail–chicken hunting regulations have accomplished both results with reasonable success. Limited hunting has continued, and we have no evi-

dence to show that sharptail–chicken hunting has really harmed either species in recent years.

We do not believe that the same regulations will accomplish the same results in the future. Why not? Most of Wisconsin's better prairie chicken areas were open to hunting during at least part of the cyclic high just past. They could be hunted again under the same regulations if their habitats were in equally good condition at the next high, and if general hunting pressure were no greater than it has been. These are not safe assumptions, however. It is well known that prairie chicken range is shrinking over the state as a whole. More will go before the next high. It is obvious that a time must come, sooner or later, when a critical point is reached—when the regulations which were good enough in the past no longer fit the situation. That time has come. The high of the 1950's marks the end of an era in the history of Wisconsin's prairie chickens.

The formulation of hunting regulations is the province of administration, management and law enforcement. Our function is to make recommendations to fit the biological situation.

On this basis, we feel that new and different regulations are needed for the future.

According to present evidence, prairie chickens will no longer be able to withstand hunting in all areas where sharptails also occur and can be hunted. There should be enough sharptails in central and northern Wisconsin to justify general open seasons. There will not be enough prairie chickens except on managed areas and in those few places where some unpredictable happening—pure luck—keeps the habitat in good condition a little longer. From the biological standpoint, therefore, it is highly important to have separate regulations for the two species, which would require that the average hunter learn to distinguish between prairie chickens and sharptails.

Even with separate regulations, accidents will happen. The accidental kill of wood ducks, for example, is known to be high despite protective laws. There will be a number of mixed sharptail–chicken areas in which the prairie chicken can be expected to persist for a longer time if neither species is hunted. It would be unreasonable to close sharptail hunting wherever a few chickens persist, for that would mean closing virtually all of the central counties' sharptail range. But in those areas where there are still enough chickens to have a chance of holding on for a few more years, the conservative course would be to keep the season closed on both species. There are actually few such areas. They occur primarily in northwestern Portage and northern

Adams Counties (already closed in 1954 and 1955) and in highly localized areas in parts of Marathon, Wood, Taylor, and Rusk Counties. At least one of these, in western Taylor County, has already been put under sharptail-chicken management and can probably be handled in another way (below). The most effective way to protect most such remnant populations would be through closed areas or refuges, in each case large enough to include the entire range of the individual colony—in other words, from one to several townships each.

Where prairie chicken hunting can be allowed, it will need much stricter regulation than has been necessary in the past in order to be sure that the kill is not excessive. This means limiting prairie chicken hunting to those specific areas in which there are large enough populations to warrant an open season, as opposed to large blocks of counties. Such areas will very soon be limited to those which are actively managed for prairie chickens. It is most probable, in fact, that there will be huntable populations *only* on managed areas by the time of the next cyclic high. As a corollary, some means will have to be found of preventing an over-concentration of gun pressure in the few areas which can be opened to hunting. This might be done by closing individual areas after a predetermined number of birds has been shot (admittedly difficult). It might be done by allowing hunting only under permit, with the kill roughly limited by the number of permits issued, and with cooperating landowners given first priority in getting permits in recognition of their help in the management program. Managed hunting is still very new in Wisconsin, at present possible only on federally-owned lands. It is an established part of big game management in a number of other states. Its potential value in prairie chicken management has been pointed out by Grange (1948 and administrative reports). It is time now to evaluate the possibilities and make positive plans.

A schedule of proposed hunting regulations for both prairie chickens and sharptails is given in Table 4.*

Public Opinion

Hunting seasons are not set purely on the basis of the safely allowable harvest. The Buena Vista Marsh could have been hunted in 1950 had not public opinion prevented it. It could have been lightly hunted again in 1953 and 1955, and perhaps in 1952 and 1954, had there been a way of holding the kill within prescribed limits.

Note: New regulations are now in effect. In 1956 for the first time, sharptails were hunted but the chicken season was closed. Large areas were closed to sharptail hunting to give added protection to chickens.

Table 4
Proposed Hunting Regulations for Prairie Grouse

Species	Conditions	Recommendations	Factors to be Considered	Problems
PRAIRIE CHICKEN:				
Opening date	Population below average (spring census down 50%)	1. Closed season *and* 2. Closed areas: Best chicken areas within sharptail range closed to sharptail hunting.	Little chicken range left; best areas are well known and subject to disproportionate hunting pressure. Protection needed in all areas during cyclic low.	Chickens and sharptails are sometimes hard to distinguish, and occur in overlapping range. Even with separate regulations, closed areas would be needed to prevent accidental killing of chickens.
	Population average or above (spring census more than 50% of cyclic high)	1. Special season on specific areas only, with limited kill. *And* 2. Closed areas as above, closed to both sharptails and chickens. 3. Open generally on Saturday nearest Oct. 1; in no case earlier than last week of September.	Limit hunting to those areas (primarily, and probably wholly, managed areas) which can stand it. Protect other flocks against accidental kill, to prolong their survival as long as possible. With managed hunting, joint opening with other species not essential but could reduce administrative load by reducing pressure on special chicken areas.	
Season length	Special season	Indefinite: kill limited by closure when a predetermined number has been killed. *or*	Biologically best: kill most closely in balance with production.	Needs legislation.
		2 or 3 weeks: kill limited by number of hunting permits issued. *or*	A rougher approximation of above.	Needs legislation.

		2 weeks: kill limited by setting the season late (*mid-October*) and jointly with pheasant and, if possible, waterfowl.	Birds will be packed, wild, and difficult to approach. Past experience has clearly shown that joint openings with waterfowl and/or pheasant greatly reduces pressure on chickens and sharptails. *Less precise control; thus fewer open seasons possible under this method than under either of the two methods above.*	Danger that these usually excellent safeguards might prove inadequate because of exceptionally great hunting pressure in the few areas that could be opened. Joint opening with either pheasant or waterfowl would be absolutely essential, but perhaps impossible.
SHARP-TAILED GROUSE:				
Opening date	Population low or average	Mid-October *and* joint opening with pheasant if possible.	Birds will be packed, wild, and difficult to approach. Past experience has clearly shown that joint openings with waterfowl and/or pheasant greatly reduces pressure on chickens and sharptails. There was virtually no pressure on sharptails when late season and joint opening (with pheasant) were combined in 1955.	See Prairie Chicken. 1955 experience strongly suggests that season can be held open through cyclic low, but situation must be watched closely. Sharptails are being restricted to less and less range of generally poorer quality; hunting in general is increasing. Closed season for 1 or 2 years at cyclic low may be necessary.
	Population above average	With ruffed grouse	Can stand heavier hunting in the last 2 or 3 years of cyclic rise; can then open, with ruffed grouse, before waterfowl, but not to include more than last week of September.	See Prairie Chicken. Zone lines for ruffed grouse may not fit sharptail range.
Season length	Population low or average (except emergency)	Two weeks		
	Population above average	Three weeks		

In 1952 and 1953 the entire Buena Vista Marsh was protected against prairie chicken (and sharptail) hunting by making it a closed area. The rest of Portage County was open. There were some who felt that if the Marsh, part of the best area in the state, should have been closed during those two years, it must then have been wrong to open the season on the much smaller prairie chicken populations in the rest of the county. As a result, all of Portage County was closed in 1954 and 1955. Reasonable enough, on the surface. However, this line of thought ignores one decisively important factor: the fame of the Buena Vista Marsh. It is known state-wide to be the best spot and attracts far greater hunting pressure than the rest of the county. Car counts and field checks bear out this difference. If the difference did not exist, there would have been no need to treat the Marsh differently from the rest of the county. Similar problems may well arise elsewhere, as other areas are put under management, and should be anticipated in future hunting season plans.

Exotic Species

It is generally recognized that a unit of land can support a limited number of animals. If two species with similar requirements are present on the same area, the total number of individuals remains the same and neither species can be as abundant as either one alone. The actual number which can be supported varies from place to place, depending on differences in carrying capacity of one area as compared with another. Nowhere can a new species with similar habits be established except at the expense of the one already present.

Since there is now so little prairie chicken range left in Wisconsin, none of it—and especially no area which is considered for prairie chicken management—should be jeopardized by stocking with exotics. Gross (1930) and Grange (1948) made the same recommendation. The Conservation Department is authorized to exercise such control over stocking by section 29.535 of the conservation laws.

Predator Control

It is by now virtually axiomatic that a strong environment is the most practicable defense against predators. Good habitat produces enough animals and gives them enough protection so that normal losses to predators seldom really damage the population. Poor habitat produces few animals, whose future is at best highly insecure. Predator control is no substitute for habitat management.

We do not say that predators eat no prairie chickens. They do (Hamerstrom and Mattson, 1939; Grange, 1948). But Leopold's analysis (1931b) is just as sound today as it was 25 years ago: "One after another, the analysts of the life equation of game birds are finding that food, cover, disease, or some other environmental factor needs attention first, and predators afterward. A dollar spent on these other factors will go farthest at the outset."

We believe that habitat management is the indispensable first priority need in the management of Wisconsin's prairie chickens. Whether or not there may be a secondary need for predator control can best be determined *after* the effect of habitat management has made itself felt.

Diseases and Parasites

Prairie chickens are host to a considerable number of diseases and parasites (Boughton, 1937; Gross, 1930; Leigh, 1940; Morgan and Hamerstrom, 1941; Schwartz, 1945). The fact remains, however, that little can be done about it: ". . . as yet no well defined practises can be recommended for the suppression of disease in natural environment. It is suspected, however, that during periods of deep snow or in prolonged, severe winters, parasitic and other diseases may be spread through close contact of game birds unless their feeding stations are shifted occasionally to new ground" (Schillinger and Morley, 1942). This statement points up again the need for a system of well distributed winter feeding places, and gives one more reason for the superiority of food patches over hoppers and other feeding devices which concentrate birds in small spaces. Since prairie chickens are subject to several of the diseases and parasites of domestic chickens and turkeys, food patches should not be placed on ground over which domestic poultry habitually run.

Weather

The only real defense against extremes of weather is good habitat. Recognition of this fact brings us back once again to our main thesis: The prairie chicken can be saved only by guaranteeing to it a place to live. *Above all else, this means habitat management.*

SUMMARY AND CONCLUSIONS

Originally a bird of the prairies of southern Wisconsin, the prairie chicken adapted itself to the grasslands which were created when northern Wisconsin's forests were logged-off in the late 1800's and early 1900's. Intensive agriculture and the return of the forest have destroyed most of the original range and the acquired range in the north as well. There is now very little prairie chicken habitat left in the state. There is only one area—the Buena Vista and Leola Marshes together—in which a sizeable population can certainly be saved, and perhaps a half dozen other areas in which small populations might be preserved.

State-wide, the major limiting factors are lack of (1) nesting and rearing cover, the critically important one; and (2) winter food. Prairie chickens are dependent on relatively undisturbed, long-term grassland for nesting and rearing their young—grass which is not mowed off or grazed down until late July or early August. This is the most difficult requirement to meet, for land control is necessary. The less critical requirement, winter food, can easily be met through a food-patch program, already under way in some areas.

A management plan is here described, designed for an area of 46,000 acres on the Buena Vista Marsh (drained about 40 years ago). About 28 per cent of the area is under cultivation, about 25 per cent is in brush, timber, wet marsh, farmyards, and other miscellaneous types, and about 46 per cent in long-term sod. When tame hay and improved pasture are included, the total area of non-marshy grassland comes to about 58 per cent.

The excellence of this area for prairie chickens derives from two things in combination: (1) the fact that so much of the area has been grassland for many years; (2) the harvest of bluegrass seed in the area means that much of the grassland is subject to less disturbance during the nesting and rearing season than is true elsewhere. Despite this generally favorable situation, however, a total of 4,716 acres of good and medium quality nest-brood cover, all of it long-term sod, was reduced to poor quality or wiped out entirely between 1951 and 1953. Only 988 acres improved from poor to medium or good quality during the same period. The losses during this two-year period were thus almost five times greater than the gains, and further losses are clearly predictable.

Prairie chicken management is urgently needed to save this population at its present level, and should consist of: As the primary objective, (1) establishment of a scatter-pattern of grassland reserves,—i.e., permanent nesting and rearing areas—amounting to about one 40 per section and totalling about 3,200 acres, (2) maintenance of these areas in good condition and (3) continuation of the present food-patch system; secondarily of (4) improvement of other lands throughout the Marsh, as far as practicable, and (5) maintenance of booming ground cover and of winter cover. It is not to be supposed that grassland improvement on existing farms can alone substitute for the pattern of grassland reserves. To double or triple the forage or hay on a 40 will not save a single brood if the extra grass is simply converted to extra pounds of beef or extra bales of hay, with no more left for chickens during the critical season than there was before.

Prairie chicken management on the Buena Vista Marsh thus becomes a cooperative undertaking, including both the local community and the state as a whole. The presence of a strong farming community is essential to the program. It will, for example, prevent brush invasion and provide summer and autumn food in the form of the insects, greens, weed seeds, and waste grain that go along with cultivation, as well as some grain for winter. Lands owned by the bluegrass seed companies may continue to be the heart of the nesting and rearing areas. These lands, however, being in large blocks and centrally placed, cannot make the *whole* area productive. To maintain the present population it is also necessary to maintain a scatter-pattern of small nest-brood areas *throughout* the Marsh. Such a scatter-pattern does in fact now exist, but it is being destroyed by more intensive land use. It is asking too much to expect the local community to sacrifice normal farm practice to keep these essential parcels in grass for prairie chickens. Conservationists from the state as a whole can, as their share, guarantee a continuing, stable, and well distributed pattern of nest-brood areas throughout the Marsh, and can provide winter food patches where they are needed. Neither the local community nor the state can be expected to do the whole job alone; both together can save the prairie chicken for the future.

Management is also needed on the Leola Marsh, as part of the primary objective of preserving the one best area and the one best population in Wisconsin. As a secondary objective, prairie chicken management could be extended into as many other areas as funds and public interest will allow.

The scatter-pattern plan—"ecological patterning" as opposed to ad-

ministrative blocking—has important implications for the management of other species.

Habitat management, summarized above, is presented against a background of general ecological requirements. There is also a discussion of certain safeguards which have been grouped under the term "population management", and which can be summarized as follows: (1) Hunting must be restricted to the harvest of surplus birds, when available. Past regulations have been satisfactory, but new and different ones will be needed to prevent overhunting of the few areas of prairie chicken habitat which will persist into the future. (2) Competition with exotic species having similar habitat requirements should be held to a minimum on all areas managed for prairie chickens. (3) Control of predators is less important than the provision of strong habitat. (4) The spread of diseases and parasites can be discouraged by dispersing, rather than concentrating, winter food supplies. (5) Strong habitat is the best and only practicable defense against extremes of weather.

In conclusion, the prairie chicken *can* be saved in Wisconsin—*but only if action is taken now.*

APPENDIX A

The Importance of Grassland in Prairie Chicken Ecology

Through a search of the literature and correspondence with men in all the states and provinces which now have prairie chickens, we have brought together and summarized material to show (1) an inclusive survey of the proportion of grassland in the environment of the prairie chicken throughout its range, and (2) relative population densities on the best areas in each state and province, where such information is to be had. Wisconsin material has been drawn from earlier reports and the text of this publication.

The following men have helped in the preparation of this material, often to the extent of contributing unpublished data: G. A. Ammann (Michigan); A. B. Erickson, R. E. Farmes, and W. H. Petraborg (Minnesota); W. B. Barnes (Indiana); R. E. Yeatter (Illinois); M. E. Stempel (Iowa); D. M. Christisen and C. W. Schwartz (Missouri); W. L. Miller (North Dakota); R. G. Janson (South Dakota); G. Schildman and L. L. Mohler (Nebraska); M. F. Baker, J. L. Coats, and M. D. Schwilling (Kansas); K. F. Jacobs (Oklahoma); R. L. Patterson (Wyoming); H. M. Swope (Colorado); H. G. Lumsden (Ontario); G. W. Malaher and J. A. McLeod (Manitoba); Stuart Housten,

R. W. Nero, and F. G. Bard (Saskatchewan); and William Rowan (Alberta). Without the help of these gentlemen, the survey would have far less value.

The survey dealt only with the greater prairie chicken. Results are summarized in Table 5.

In comparing habitat composition and population densities from one place to another, both shape and size of sample area have to be taken into account. It is fortunate that most of the sample areas in Table 5 are fairly regular in outline, for areas with highly irregular shapes would be difficult to compare. For example, by running boundaries in such a way as to cut out unproductive habitat, the best half-township of amoeboid shape on the Buena Vista management area shows a 1950 count of 25.7–27.0 booming ground cocks per section, in contrast to 14.2–14.8 on the best 3 x 6 mile block. It is even possible to draw boundaries in such a way as to include all but two of the area's total complement of booming grounds within the acreage equivalent to a single township, for a density of 14.8–15.6 cocks per section. Compare this figure with the density of 7.5–7.9 cocks per section for the whole area, which totals about 46,000 acres or about two townships. In these examples, density figures have been about doubled in each case by manipulating sample area boundaries.

Size of area can be equally important. Again using Buena Vista counts in 1950, the figures show a density of 28.0–29.5 booming ground cocks per section on the "best" 2 x 2 mile block, 14.2–14.8 on the best 3 x 6 mile block, and 7.5–7.9 on the area as a whole. Indiana's counts show the same lowering of density as sample size increases: 26.8 on the best 2 x 2 mile block in 1950, as compared with 12.1 on a 16 section area of which the 2 x 2 mile block is a part.

Complications due to size and shape of sample area arise in several ways. Most important, prairie chicken habitat is now so "spotty" throughout most of the range that there are very few areas of uniformly good quality. As far as we know, large areas of good habitat are now to be found only in parts of Kansas and perhaps also in parts of the sandhills of Nebraska. Elsewhere most prairie chicken areas contain large proportions of overgrazed pasture, plowland, woods, or other unproductive types. Where the habitat is far from uniform, the birds and their booming grounds will be unevenly distributed. For this reason, and because the prairie chicken is such a highly mobile bird, sample areas which are very small or very irregular in shape are apt to be local "hot spots" rather than representative samples.

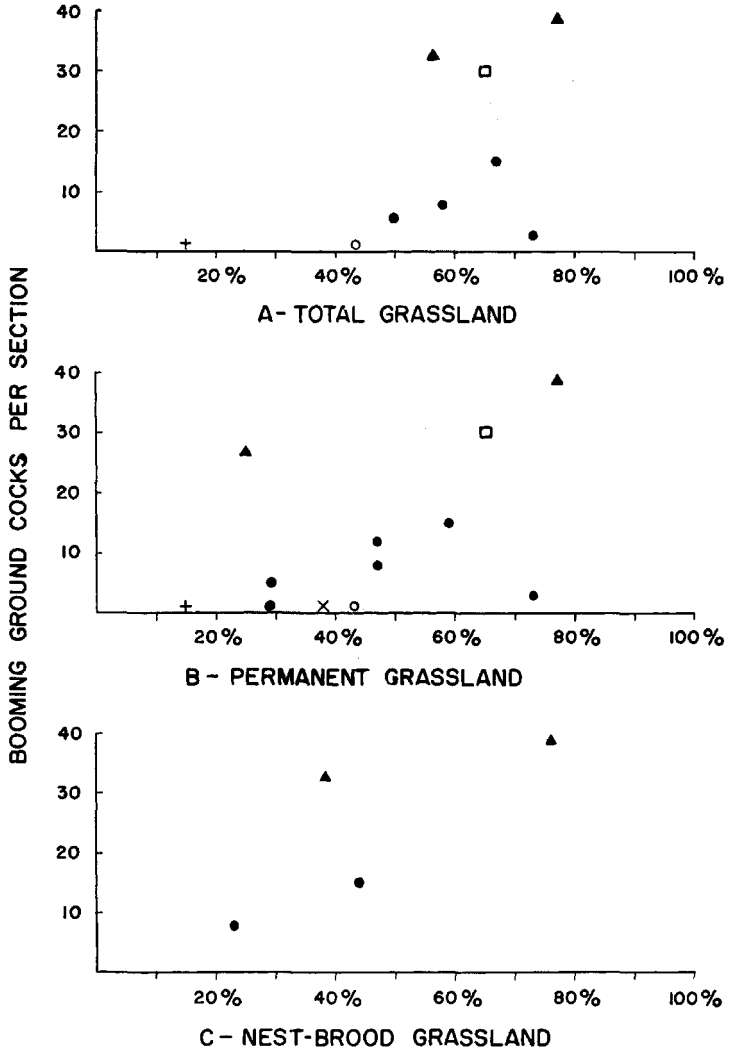
Thus, habitat specifications and population densities should be com-

pared only on the basis of sample areas which are similar in size and fairly regular in shape, and large sample areas are preferable to small ones. How large is large enough? In Oklahoma 20 years ago, Davison (1940) concluded that on his 16-section study area, 2 x 2 miles was the minimum sample that gave representative census data for the closely related lesser prairie chicken *(T. pallidicinctus)*. However, he added that "the results from areas 3 x 3 or 4 x 4 miles square are more dependable" (Davison, 1940). Baker (letter) believes that the figures in Table 5 from his 2 x 2 mile block "would be quite typical" of the best range of the greater prairie chicken in Kansas. But for most parts of the present day range, we believe that sample areas larger than 2 x 2 miles would be more reliable, especially for comparing one area with another. No doubt the best sample size differs from place to place, depending on the degree of uniformity of the habitat. Our work in Wisconsin leads us to suggest a half township (3 x 6 miles) as a minimum, and we prefer even larger areas.

Population densities can properly be compared only at similar stages of the 10-year cycle except, of course, where there is no evidence for cyclic fluctuation. For that reason the densities given in Table 5 are dated. Only the figures for the most recent high, or the time of highest population in the late 1940's or early 1950's, should be used to compare present day densities from one area to another.

The search for clear-cut relationships in the material summarized in Table 5 is complicated not only by differences in size and shape of sample areas, but also by the fact that there is considerable variation in the amount of information available for different areas. And factors other than grassland, such as winter food in the north, also influence populations but are not considered here. Nevertheless, some general conclusions do seem to be in order.

Table 5 abundantly documents the vital role of grassland in prairie chicken ecology. We have tried to quantitate this relationship in Figure 11, which plots prairie chicken densities, as indicated by the number of booming ground cocks per section, against the amount of grassland in the environment, based on the material in Table 5. Figure 11–A shows density in relation to total grassland—i.e., all upland grass except corn and small grains; whether planted or wild, permanent or rotational; and whether land-use is favorable to chickens or not. Unlike some agronomists, however, we do not include leguminous hay and pasture. Total grassland appears to be a rough index to habitat quality, in that the densest populations are shown to be in those areas which are 55–60 per cent or more grassland.



▲ 2 x 2 mile sample area

● Larger sample area

x Least amount of permanent grassland supporting prairie chickens in Missouri (Schwartz, 1945; no census data)

o Average amount of permanent grassland on 6 townships of marginal range in Kansas (Baker, 1953; no census data)

□ Average amount of permanent grassland on 2 townships of optimum range in Kansas (Baker, 1953; no census data); density has been interpolated.

\+ "Low populations lingering on" with 10–15% permanent grassland in South Dakota (Janson, letter).

Figure 11. Grassland in relation to prairie chicken density.

Figure 11–B shows increasing densities with increasing amounts of *permanent* grassland; thus permanent grassland seems a better clue to habitat quality. At the low end of the density scale, Janson (letter) writes that in South Dakota "we find low prairie chicken populations lingering on with as little as 10–15% of the area in relatively undisturbed grasses of the mid-grass type." This is the lowest proportion of grassland supporting chickens that we know of. At the other extreme, the highest modern population on record is in the area with the highest proportion of permanent grassland—38.8 cocks per section on the 2 x 2 mile Welda area, in Kansas, with 77 per cent of permanent grassland. Also in Kansas, Baker (1953) found that two townships of optimum range averaged 62.9 and 66.4 per cent in grass, virtually all of it permanent; in the absence of census data, we have interpolated the figure 30 cocks per section, which is somewhat below his best 2 x 2 mile sample, as an approximation. In the main, then, we find minimum populations when permanent grassland is from 10–15 per cent to about 40 per cent of the total environment, while above about 40 per cent populations are increasingly larger as the proportion of permanent grassland increases. This differs from Schwartz' (1945) findings in Missouri: "the proportions of permanent grassland varied from 39% to 84% but above the minimum figure no relationship was found between the amount of permanent grass and density of prairie chickens." A few of the data points in Figure 11–B also disagree with the general trend. The unusually high population toward the low grassland end of the scale (25 per cent permanent grassland with 26.8 cocks per section) comes from a 2 x 2 mile sample area in Indiana at a time when chickens were more abundant than they are now, and may reflect distortion due to sample size. The figure of 5.5 cocks per section on Michigan's Missaukee County area, with about 30 per cent permanent grassland, is probably influenced by the fact that uninhabitable woody types have been excluded from the base acreage, thus raising the percentage figure for grassland. The exception at the high end of the scale—73 per cent permanent grassland with only two to three cocks per section, in South Dakota—suggests that carrying capacity is rather low in the grasslands of the westernmost parts of the range.

A perfect correlation between grassland alone is not to be expected. Land use can cut down or destroy completely the potential value, for prairie chickens, of a given meadow. "Total grassland" includes grass in rotation; even permanent grassland may be grazed or mowed so thoroughly that no chickens are produced. There are very few measurements to show the relationship between grassland which is actually

suitable as nest-brood cover and population density. Of the four such measurements available (Figure 11–C), two are from 2 x 2 mile areas in Illinois and Kansas, and two are from the Buena Vista Marsh in Wisconsin. Here again the relationship is a direct one. Although the data are few, they lend support to our conclusion that a shortage of nest-brood cover is critically important in Wisconsin and generally through much of the present range of the species.

The prairie chicken occurs over a wide geographic range—from Ontario west to Alberta, and from these northern points as far south as Oklahoma. It is a remarkably adaptable bird, as shown by its spread north, south, and west from its original range when human settlement made new habitat available, and by the wide variety of conditions—geographic, climatic, vegetational and agricultural—under which it lives today. Grassland is the common denominator, but it is obvious that the *species* of grass cannot be the decisive factor for grasslands differ widely from one part of the range to another. Such things as height, density, growth form, spacing, and perhaps the time of rapid growth, must be of greater importance than species composition. Land use is an influence of enormous importance. Associated populations of insects as food for the growing chicks, must play a large—and little known—part in determining habitat quality. It would seem that few states have even tackled the problem of understanding qualitative factors as yet. Certainly no one has yet produced a complete set of objective standards by which qualitative standards can be measured, or even recognized. An understanding of qualitative factors is of extreme importance to the management of grasslands for prairie chickens. The field is still virtually unexplored.

Finally, it is well known that there has been an enormous reduction in prairie chicken numbers during the last 50–100 years. *These losses are still going on.* Many reasons have been, and still are being, given—overshooting, foxes and other predators, disease, to name only the commonest. Specific examples of continuing losses in recent years are shown in Table 5, documented with dates, places, and census data: see particularly Illinois, Indiana, Iowa, Minnesota, Missouri, and, in non-specific terms, North Dakota. *Without exception,* these records of dwindling populations are directly related to loss of habitat, specifically to loss of grassland. On a shorter time scale, a similar loss of habitat has been measured and described on Wisconsin's Buena Vista Marsh. Wherever one looks, the answer is the same: to save the prairie chicken, grasslands must be preserved and managed for them. There are no substitutes.

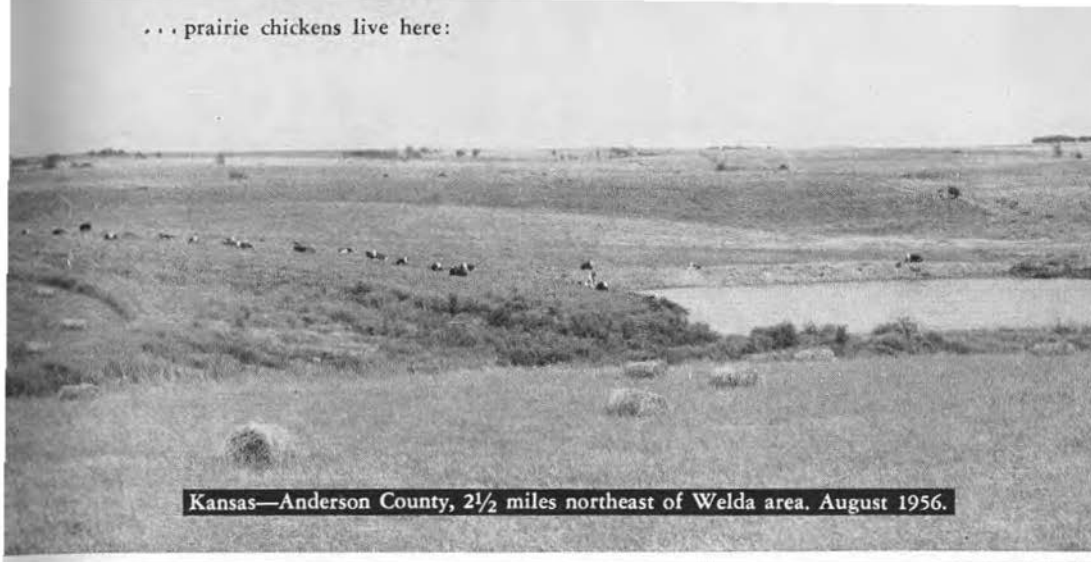
Good grass and wide horizons . . .

Missouri—Pettis–Benton Counties area. August 1956.

North Dakota. (Photo by N. D. Game and Fish Dept.)

Nebraska—Keith County, near Keystone area. September 1956.

. . . prairie chickens live here:



Kansas—Anderson County, 2½ miles northeast of Welda area. August 1956.

Oklahoma—Osage County, Adams Ranch. August 1956.

Colorado—Yuma County, Conrad Ranch. September 1956.

Table 5

Grassland in Relation to Prairie Chicken Abundance, with a Historical Review

(Note: **"Total grassland" includes all upland grasses except corn and small grains, whether planted or wild, and whether suitable for chickens or not. It does not include leguminous hay or pasture, or wet marsh.)**

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
WISCONSIN	1800's and early 1900's	GENERAL—Schorger's (1944) study of early records indicates that the pre-settlement breeding range was confined roughly to the grasslands of the southern half of the state; that early-day abundance can be traced back at least to 1831 but, on the original range, the population began seriously to decline in the early 1850's, and "The sole tenable cause for the decline is the construction of railways that permitted the rapid transportation of game to Chicago, and thence to the eastern markets". Concerning the loss of original range and spread northward he adds: "While agriculture may have increased the population for a brief period, the damage resulting from the destruction of its natural habitat by the same agency can scarcely be repaired. The prairies of the uplands are extinct, and there are few in the lowlands that have not undergone profound change. The result has been to force the species northward into localities that to the best of our knowledge were not occupied in primitive times. The prairie chicken reached Lake Superior due to the felling of the forests and the opening of farms." (*Ibid.*)			
	1928–1930	SAME—Both Gross (1930) and Leopold (1931a) show the breeding range as extending to the northern boundary of Wisconsin. Range extension into northern Michigan and northern Wisconsin "represents a northward shift of over 300 miles . . . it is obvious that the bulk of its present distribution and numbers in this region occurs on acquired range" (Leopold 1931a). "An apparent requisite for favorable environment for the prairie chicken is extensive marsh and grass lands . . . " (Gross 1930).			

	1940's	SAME—"Productive chicken range seldom has more than 25% of the area in woodland; the most productive range shows even less wooded acreage. Exact tolerance limits are undetermined . . . An ideal Wisconsin prairie chicken range of several thousand acres should have at least one third of the area in upland grass, another third in lowland grass or marsh and the balance devoted to weedy crops, with much unharvested corn, plus a few park-like groves of oaks and a few stands of dense aspen for refuge cover . . . The grassland component need not be pure grass-sedge; it can be interspersed with considerable thicket and shrub growth" (Grange 1948).			
	1950	BUENA VISTA MARSH—Part of best area. Cover types *in 1953*: *Total grassland* 58%; plowland 17%; woods, brush, wet marsh, etc. 25%. Total *permanent grassland* 46.5%; total good and medium quality *nest-brood cover* (virtually all of it permanent grassland) 23.3%. Most recent high in 1950 and 1951; counts are expressed in terms of cocks regularly present on booming grounds, with highest cock count in parentheses, in the spring of 1950:			
		Whole area (1953 cover types above)	46,000 acres	539–568 (590)	7.5–7.9 (8.2)
		Best 3x6 mile subsample. Cover types in 1951: *Total grassland* 67.3%; plowland 8.4%; woods, brush, wet marsh, etc. 24.2%. Total *permanent grassland* 58.7%; good and medium quality *nest-brood cover* 44% (approximately).	3x6 secs.	256–267 (274)	14.2–14.8 (15.2)
		Best density on 2x2 mile subsample (too small to be truly representative)	2x2 secs.	112–118	28.0–29.5
MICHIGAN	1800's to early 1900's	GENERAL—". . . found in great abundance by the first settlers of Michigan, inhabiting the marshes and patches of prairie land and among the more open hills upon which the scattered, wide spreading oak trees grew" (Watkins 1901, quoted in Ammann 1950). ". . . probably absent from all but the southernmost part of Michigan when the state was heavily forested, but with the clearing of the land in the nineteenth century, it evidently spread northward" (Wood 1951). Scarce, or already gone, in parts of southern Michigan by 1894 (Cook 1894) and 1912 (Barrows 1912), but did not reach the straits of Mackinac until about 1930 (Ammann 1950). "About the beginning of the 20th century prairie chickens found their way into Michigan's Upper Peninsula, presumably from Wisconsin", and reached its eastern tip by about 1931 (*Ibid.*).			

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
MICHIGAN (cont.)	1950's	SAME—"Now limited to a few small colonies in the eastern part of the Upper Peninsula and probably not more than 100 colonies scattered among 17 counties in the northeastern part of the Lower Peninsula. Population decline due primarily to loss of habitat, brought about by intensive land use in agricultural areas and forest succession on abandoned clearings and old burns" (Ammann, letter).			
	1953	MISSAUKEE COUNTY AREA—Best area; highly irregular in shape; cover mapped in 1955. This area, like others in Michigan, is actually a series of openings interrupted by large tracts of timbered swamp, upland woods, and heavy brush. These woody types, presumed to be uninhabitable by prairie chickens, have been excluded from the cover type analysis which follows, a factor to be considered in comparing the number of birds here with other areas. *Total grassland* about 50%; plowed croplands, stubble, wheat, and leguminous hay, about 50%. *Permanent grassland*: 17% minimum to 35% maximum, depending on availability of lowland grass and brush as determined by water level; about 30% in 1953, the time of the most recent high (Ammann, letter).	17½ secs.	97	5.5
MINNESOTA	1800's to 1950	GENERAL—The prairie chicken "entered the state from the east and south some time previous to the middle of the nineteenth century and spread rapidly west and north with the settlement of the country". At first it "kept largely to the open country that was its natural habitat and where were the large grain fields. Later, either because of continued persecution in the open or because attracted by clearings and crop plantings in forested areas, it entered the timber . . . " (Roberts 1932). "During the first few years of its invasion, the prairie chicken increased enormously . . . But, gradually, as agricultural practises were intensified, their numbers began to dwindle, and in spite of bag limits, shorter seasons, and finally closed seasons, they disappeared from the southern half of the state, except for small remnants here and there . . . Destruction or alteration of their environment is the one thing that all studies show to be the *chief* cause of the disappearance . . . " (Schrader and Erickson 1944). Remaining populations are mainly in central and northwestern Minnesota.			

	1950's	SAME—Recent findings have modified the earlier belief (Schrader and Erickson 1944) that native prairie grasses are essential; other grasses are now known to be used (Erickson, letter).			
	1950's	MAHNOMEN COUNTY—" . . . somewhat of an aspen-parkland type. Here patches of grassland, some of which is native sod, are fairly numerous but not extensive—perhaps 2 to 3 ten to twenty acre patches per section in the best part. There are innumerable cattail marshes in the county . . . I believe the area offers the minimum essentials for prairie chickens." A few flocks; no census (Farmes, letter).			
	1951	GOOSE LAKE AREA, Pennington County—Drained lake bed, 6 by 1½–2 miles, and its borders. Most of the lake bed was in wild hay until 1952 (Farmes 1954). Highest recent count in 1951 (Farmes, letter)	12,000 acres	Based on partial census	6.7
	1952–1955	SAME—"During the extremely dry summer of 1952, much of the grassland in this area was plowed" (Petraborg and Farmes 1953). In 1954 "not a single pinnate was heard booming while in 1951 ten dancing grounds were located"; no other area in northwest Minnesota shows so severe a decline since 1951 (Farmes, Petraborg, and Zorichak 1954). A small population (five booming grounds) found in 1955 (Farmes, letter).			
INDIANA	1800's	GENERAL—"The early distribution of the prairie chicken was determined by the extent of grasslands . . . Although it was found in greater abundance in the large prairies of northwestern Indiana, it apparently also was present on small, isolated, savannah-like areas in southwestern Indiana. In addition, reports from counties where no grassland was present, indicate that it may have extended its range into the clearings created by early settlers." Its numbers "must have seemed inexhaustible" (Mumford 1955b).			
	1912–1941	SAME—"Madden's work in 1941 revealed that about 1,000 prairie chickens remained . . . a drastic reduction from the estimated 100,000 reported in 1912" (*Ibid.*).			
	1941–1953	SAME—"Since the start of the study, [booming] ground after ground has become inactive. In general, it would seem that the flocks showing the slightest decrease in numbers during the period above have been those subjected to the least amount of disturbance by farming." Bluegrass "is rarely found today . . . and where 21 booming grounds were on bluegrass in 1943, only one was situated on this type of cover in 1953. The trend toward breaking up more and more of the bluegrass sod is clearly indicated" (*Ibid.*).			

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
INDIANA (cont.)	1942–1955	NEWTON COUNTY AREA—About 75% of Indiana's chickens are now in parts of 2 1/3 townships in Newton County; even this is not a single block of continuous range; loss of habitat is continuing (see below) (Mumford 1955a, 1955b).			
	1950	McCLELLAN TOWNSHIP AREA (part of Newton County area)—The largest block of best habitat. *Permanent grassland* at least 48% (native sod 32%; native sod with light brush invasion, nest-brood cover, 7%; reed canary, mostly closely grazed. 9%), cultivated land including an unknown amount of grass in rotation, about 52%. It is possible that the proportion of permanent grassland was somewhat higher than shown here (Barnes, letter). Most recent high in 1950 (Mumford 1955a, 1955b).	16 secs.	194	12.1
	1950	WILLIAM RAFF AREA (part of McClellan twp area)—Best count on 2x2 mile area. *Permanent grassland* 25%; cultivated land including some grass in rotation (amount unknown), 75%. Most recent high in 1950 (Barnes, letter).	2x2 miles	99	26.8
	1950–1955	SAME—Since 1950, all permanent grassland has been plowed, leaving only grass in rotation. Booming ground count has dropped 93% from the high of 1950 (99 cocks) to 1955 (7 cocks), while the statewide decrease has been 57%. The remaining 12 sections of the McClellan twp area has retained a core of long-term sod (permanent grassland 26.3%; permanent grass with brush invasion, 9.6%; former permanent sod converted to reed canary in 1950 and 1951, 18.8%) (Barnes, letter), and here the decrease from the high of 1950 to 1955 has been only 13% (Mumford 1955a, 1955b).			
	1951	The most recent high for the state as a whole was in 1951. Acreage of present range not specified, but chickens now occur in parts of only three counties, in contrast to 44 and possibly 46 counties in the past (Mumford 1955b).		325	

ILLINOIS	1800's	GENERAL—"Prairie chickens were originally distributed over the grasslands of Illinois. During the early stages of agricultural development, they extended their range to the cleared woodland soils and increased in numbers, probably reaching their highest populations in the 1860's. Thereafter they declined sharply, chiefly as a result of the rapid expansion of agriculture . . ." (Yeatter 1943).			
	1930's	SAME—"The densest populations of prairie chickens occur in localities of relatively high redtop acreages, and, as a rule, the greater the amount of redtop harvested for seed, rather than hay, the better the range . . . new seedings apparently are used less often than old stands" for nesting. Best populations occur in the gray soil prairie region of southeastern Illinois, where *total grassland* amounts to 50% or more, and with 20% to more than 30% *nest-brood grassland.* Minimum grassland requirements: "Although, in some instances, prairie chickens have persisted for long periods in dark soil prairie districts, where up to 85 per cent of all farm land is plowed annually, their rate of reproduction in most districts of this type has been too low to prevent their ultimate disappearance" (Yeatter 1943 and letters).			
	1939	HUNT CITY AREA—In best range; "nowhere in Illinois . . . was there continuous range where populations would be as high, although I think they would have applied in 1939 to a few areas as large as 15,000 acres". *Total grassland* 55.6% (redtop 15.5%, redtop and mixed herbaceous 11.3%, redtop and timothy 7.7%, timothy 3.1%, pasture 12.0%, grassy fallow 4.0%, waste grassland 2.0%); corn, soybeans, oats, wheat, and non-grassy fallow, 39.9%; farmyards and non-grassy wasteland, 4.5%. *Nest-brood grassland* about 38% (redtop seed and hay plus timothy and mixed hay, 26%; grassy fallow and pasture 10%; waste grassland 2%) (Yeatter, letter). Area censused 1936–1955, highest count 1939 (Yeatter 1943 and letters).	2x2 miles	131	32.8
	1953	SAME—Redtop acreage has been reduced by about 75%, mainly in the 1940's; booming ground census 1948–1955 has varied from 33 to 47 cocks, highest in 1953 (Shelford and Yeatter 1955, Yeatter letters).	Same	47	11.8

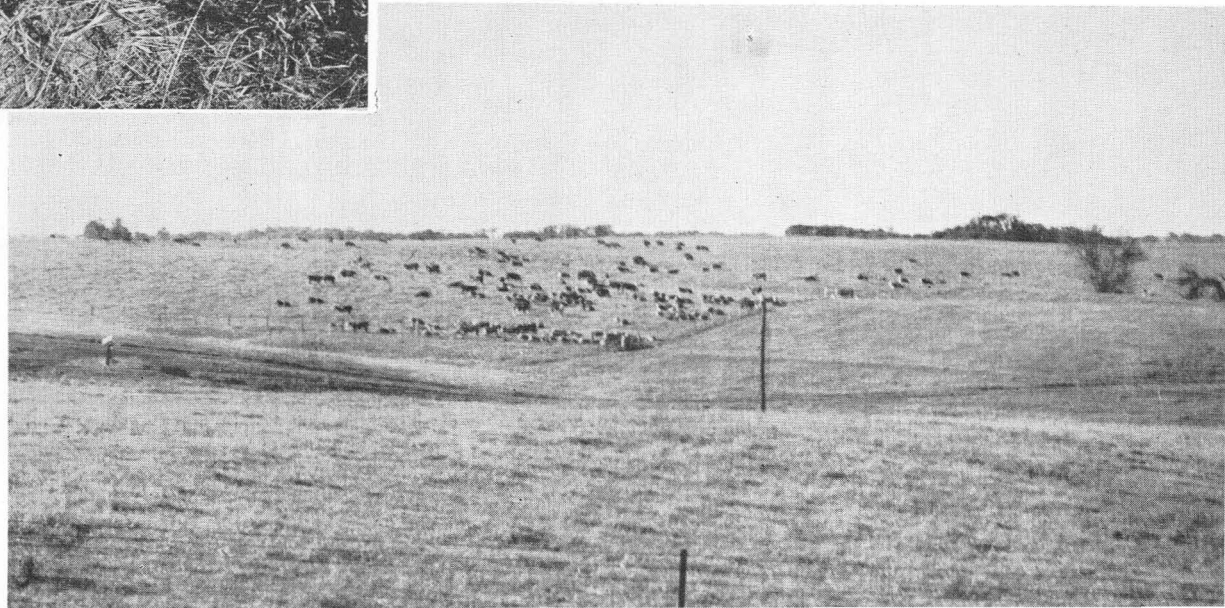
State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
IOWA	1800's and early 1900's	GENERAL—"From past records we learn that the bird increased during the early stages of agriculture, probably because the cultivated crops of scattered fields in the vast prairie served as food patches during the winters. Because much of the prairie was yet untouched, the nesting requirements of the bird were provided by the tall blue-stem grasses. As the remaining prairie lands were taken over for cultivation in Iowa, the prairie chicken moved northwestward into lands where the prairie was still partially intact for nesting" (Scott and Hendrickson 1936). "Closed seasons alone have failed to halt their progressive decline. What they need is management, in the sense of deliberate and skillful provision of food, cover, and protection . . . The decline of prairie chickens since the prohibition of shooting in 1916 may be ascribed entirely to the plowing, cutting, or burning of the remaining large blocks of grass" (Leopold 1932).			
	1950's	SAME—There are few records of occurrence since 1950, as follows: Appanoose County (see below); one found dead near Ft. Madison in 1953; flock of "about a dozen" near Emmetsburg in 1953; unverified reports from Davis, Fayette, and Howard Counties (Stempel, letter).			
	1946–1955	APPANOOSE COUNTY AREA—Best area; 3,942 acres. "Through the 1940's there was a general decrease in grassland. This decrease amounted to about 80%. Following 1946, farmers reported that the number of chickens decreased from over 100 in 1946 to 30 in 1950. Total population (not booming ground cocks) estimated by M. E. Stempel and Sam Rodgers, Jr., at 30 birds in 1950, 50 in 1952, 20 in 1953, and 10 in 1954"; no birds were found in 1955 (Stempel, letter).			
	1953	SAME—*Total grassland*: "Soil Conservation Service records show that there was in 1953, open pasture in the amount of 910 acres, cropland 2,474 acres, also some meadow. The so-called meadow seems to be rough, wet, or otherwise unusable land . . . Most pastures are plowed every 3 to 5 years to get rid of brush. They are seeded to grain, and eventually are seeded again to grass." *Permanent grassland*: "in very rough areas that have considerable brush" (*Ibid.*).			
	1952	SAME—The highest count of booming ground cocks in the 1950's was in 1952 (*Ibid.*).	3,942 acres	33	5.4

MISSOURI	1800's	GENERAL—"During the first half of the 19th century, prairie chickens were to be found throughout most of the state" (Bennitt and Nagel 1937). ". . . common in every prairie county and some dwelt even on the open ridges of the Ozarks . . . Most of the decrease and deterioration of the prairie chicken range occurred during the second half of the 19th century" (Bennitt 1939). "Here is another excellent example of a species reduced in number primarily by changing land use. Large numbers, of course, were shot for food, sport, and sale, even though this has been illegal since 1905; but the principal factor seems to have been the removal of permanent stands of tall grass" (Bennitt and Campbell 1950).			
	Early 1930's	SAME—*Permanent grassland*: "The entire range shows a much higher percentage of permanent wild grassland in the counties where prairie chickens *now* occur than in the counties in the same regions where they do not occur. This is most noticeable in the western counties, where the birds are most numerous." Stability of grassland is emphasized (Bennitt and Nagel 1937).			
	1930's	SAME—Distribution "virtually restricted to medium and low-grade prairie soil types" with lower production of corn, more than twice the acreage of tame hay, and nearly *four times as much wild hay* [i.e., *permanent grassland*], as the prairie soil types supporting no chickens (Bennitt 1939).			
	Early 1940's	SAME—*Permanent grassland*: ". . . the proportions of permanent grassland varied from 39% to 84% but above the minimum figure no relationship was found between the amount of permanent grass and density of prairie chickens . . . While permanent grass seems to be the major attraction for a stable population, tracts of temporary grassland and adjacent cultivated land also are utilized by prairie chickens" (Schwartz 1945).			
	1940's	SAME—"Prairie chickens must have permanent grass, and the larger the area the better; grass in a rotation will not do" (Bennitt and Campbell 1950).			
	1941–1949	SORRELL REFUGE—"slightly over five square miles" in size; "in one of the areas of densest population in the state"; no habitat analysis. Censused each year except 1945–1946, highest count in 1941 (Schwartz 1945; Christisen letter). After 1941 "marked changes in habitat occurred—specifically, more cultivation and intensive grazing" and population dropped to about 10% of former numbers; cock count varied 14–22 in 1944–1949 (Christisen, letter).	5½ secs.	187	34.0
	1953	RANGE IN SOUTHERN AND WESTERN MISSOURI—*Permanent grassland*: Farms on which nests were reported averaged 51.1% native prairie grasses; those on which none were found averaged 10.3%. "Apparently areas having less than 35 to 40 per cent grass cover fail to support chickens" (Christisen 1953).			

Unplowed big bluestem prairie. The grass is nearly six feet tall. Before white settlment, much of the original chicken range probably looked about like this. St. Clair County area, Missouri, August 1956.

St. Clair County, Missouri, prairie immediately after mowing. Despite the overstory of tall grass, there are clear travel lanes at chick level in the spaces between the grass bunches. August 1956.

More cultivation and intensive grazing have reduced the chicken population on the Sorrell area (Sullivan County, Missouri) to about 10 per cent of the number found in the early 1940's. Photographed in August 1956.



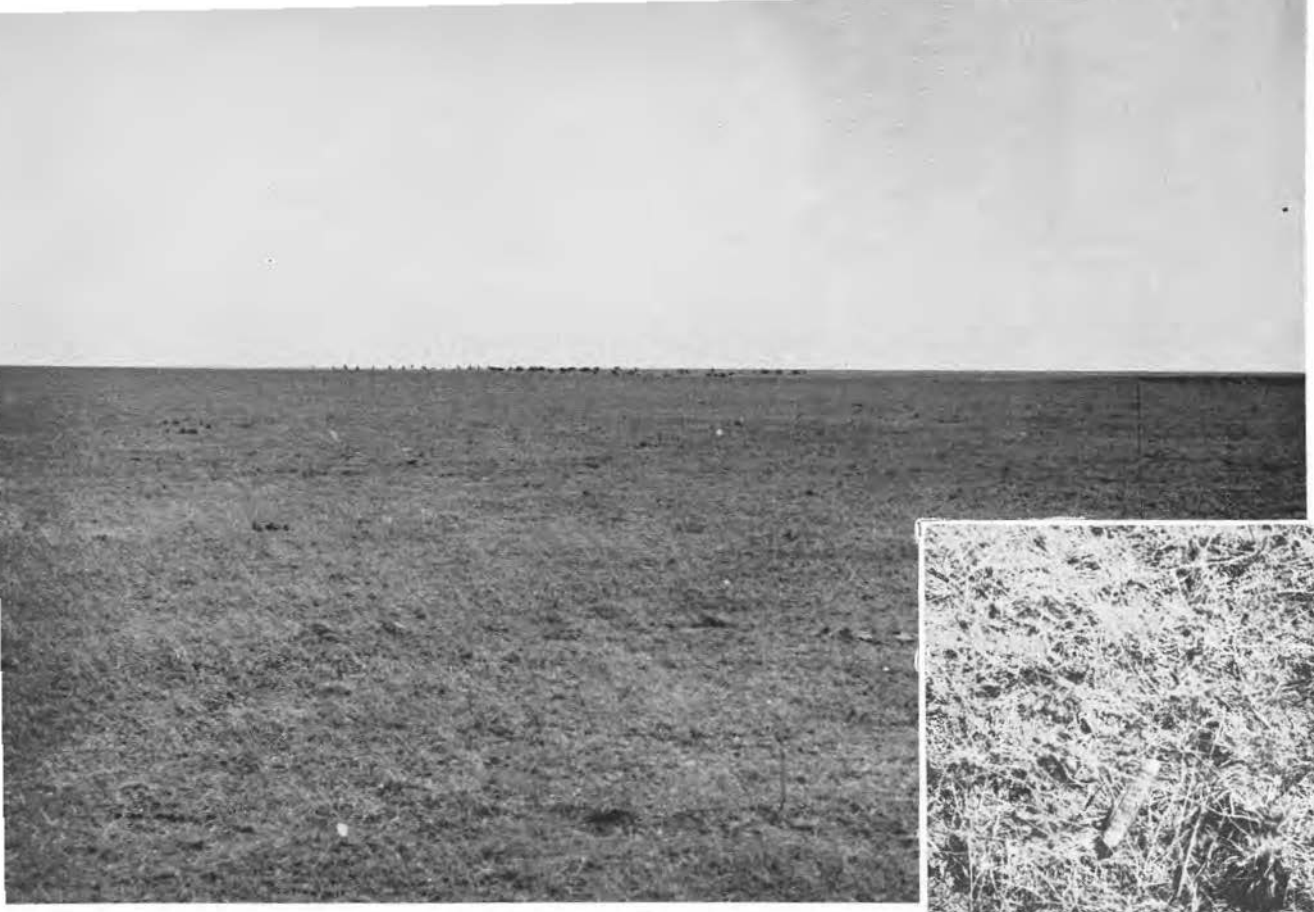
State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
MISSOURI (cont.)	1953	ST. CLAIR COUNTY AREA—"One of our best range samples"; no habitat analysis. Censused 1952–1955, highest count in 1953. As an example of the best present-day densities, these data are comparable with those for the Sorrell Refuge and illustrate the decline since the late 1930's and early 1940's (Christisen, letter).	16.5 secs.	126	7.6
	1945–1954	STATEWIDE BOOMING GROUND CENSUS—Based on 10–12% sample of total occupied range, which apparently continues to shrink in size; counts of cocks only. Since 1945 the count has ranged from a maximum of 6,940 in 1945 to a minimum of 3,170 in 1954; no census in 1955. "I believe the decline is due to loss of habitat and unfavorable weather conditions . . . Our low chicken population density and geographic location lead me to believe that cycles are not operative on chickens here" (Christisen, letter).			
	1950	SAME—The highest count thus far in the 1950's was in 1950 (*Ibid.*).	2,500 *sq. mi.*	5,660	2.3
N. DAKOTA	Late 1800's and early 1900's	GENERAL—The following figures are rough approximations, but the story has wide application: "The plow which made it possible for the pinnate to expand into North Dakota was, ultimately, the factor that caused his decline. When the proportion of grain to grassland was about 20 to 80, the Pinnate moved in and began to increase in numbers. As the proportion of grain to grass moved up to 50–50 . . . the population of pinnates increased to tremendous figures. But then the ratio tipped over the other way, and there was more land in crop than in native grassland. Then the pinnate could find plenty of food, but no nesting cover . . . or escape cover. He was literally plowed out of house and home" (Anon. 1953).			
	1949	SIDNEY STUDY AREA—Habitat analysis not yet complete; censused 1949–1954; highest count 1949, thereafter ranged from 23–39 cocks (Klett 1955).	36 sq. miles	51	1.4

S. DAKOTA	1800's and early 1900's	GENERAL—Chickens first "moved in from the Mississippi valley in the late 1800's, after cultivation had transformed the unbroken grassland into an interspersion of grassland, corn, and grain fields. Under this favorable environment, prairie chickens thrived . . . However, as more and more land was cultivated, and grazing and mowing of the remaining grass became more intensive, the cover necessary for nesting and roosting nearly disappeared. As a result the prairie chicken has nearly died out in areas where it was numerous 20 or 30 years ago . . . Hunting was probably a small factor in the downfall of these birds as compared to farming operations" (Janson 1947).		
	1950's	SAME—"It has been my observation that quality of grassland is fully as important as quantity . . . We have large areas, of which grassland comprises the major portion, which support very few grouse of either species [chickens or sharptails] because of lack of cover due to overgrazing frequently aggravated by drouth." (Janson, letter). *Permanent grassland*: "According to this study [Janson 1953], at least 50% of the area should be in good cover (mostly lightly and moderately grazed grasses of the mid-grass type) to support relatively high populations. About 30% appears to be the minimum for supporting huntable populations. However, we find low prairie chicken populations lingering on with as little as 10–15% of the area in relatively undisturbed grasses of the mid-grass type." Grass in rotation is "so rare as to be negligible" (Janson, letter).		
	1954	GREGORY–CHARLES MIX COUNTIES AREA—Best prairie chicken area. "Most of the area of these two counties is intensively farmed and grazed. However, narrow strips of rough breaks along the Missouri River and some of the tributaries are relatively undisturbed and support most of the prairie chickens remaining in these counties." (Janson, letter). *Total permanent grassland* 73% (lightly grazed 10%, moderately grazed 21%, heavily grazed 2%, mowed 40%); other uncultivated land 18% (trees 14%, alfalfa 3%, weeds 1%); cultivated 9% (small grain 3%, corn 1%, other 5%). Population density based on booming ground transect two miles by seven miles long; best populations in recent years in 1949, 1952, and 1954, each "about equally high" (*Ibid.*).	14 sq. miles	2–3
NEBRASKA	1800's and early 1900's	GENERAL—Pre-settlement grasslands "were the home of the Greater Prairie Chicken" (Viehmeyer 1941), which was "formerly the most abundant game bird in Nebraska . . . abundant over much of Nebraska in the latter part of the last century and the first two decades of the twentieth century. Since then reduction of suitable habitat through plowing of the prairie, drouth, and grazing, has taken place. With reduction of habitat the chicken population rapidly decreased" (Mohler 1952).		

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
NEBRASKA (cont.)	1930's	SAME—"Suitable Nesting Grounds. Here is the major factor that is now limiting the Greater Prairie Chicken and the Sharp-tailed Grouse populations in Nebraska, in my opinion" (Viehmeyer 1941). "I feel that . . . destruction of nesting sites by overgrazing is by far the most serious menace that the Prairie Chicken faces at the present time, and that it is the primary reason that the number of birds has fallen to its present low" (Viehmeyer 1938). [This was written toward the end of the drouth of the 1930's]. *Total grassland*: "When more than one-third of a large natural grassland area becomes cultivated, the area loses its ability to support prairie chickens" (Mohler 1942); however "this statement needs some explaining" (Mohler, letter), thus—"It wasn't that chickens would not tolerate more than one-third of the area in cultivation, but rather that man simply would not stop at that point" where more land could be plowed without danger of its blowing away; in fact, "chickens should do very well in areas having considerably more than one-third in cultivation". Except for the High Plains (unsuitable for chickens), the light soils of the Sandhills have the largest grasslands in Nebraska, because of the need for grass cover to keep the soil from blowing. It is only in areas "where hardlands and sand-lands are interspersed that there will be considerable cultivation but also with as much as two-thirds of the land likely to be left in grass". The main prairie chicken range (parts of about 21 counties) in the early 1930's was "from 12 to 35% under cultivation"; there were wintering birds but fewer breeders where the proportion of cultivated land was higher, and breeding birds but few in winter where the proportion under cultivation was less (*Ibid.*).			
	1940's	SAME—"Prairie chickens today are found chiefly in the counties along the southern and eastern edges of the sandhills area where not over 40 per cent of the land, and usually much less, is under cultivation . . . the species undoubtedly nested in at least 30 counties" in the period 1941–1943. "The breeding and nesting habits of this species require extensive grassland and the disappearance of the native prairie through cultivation was responsible for the eviction of the prairie chicken from eastern Nebraska many years ago" (Mohler 1944).			

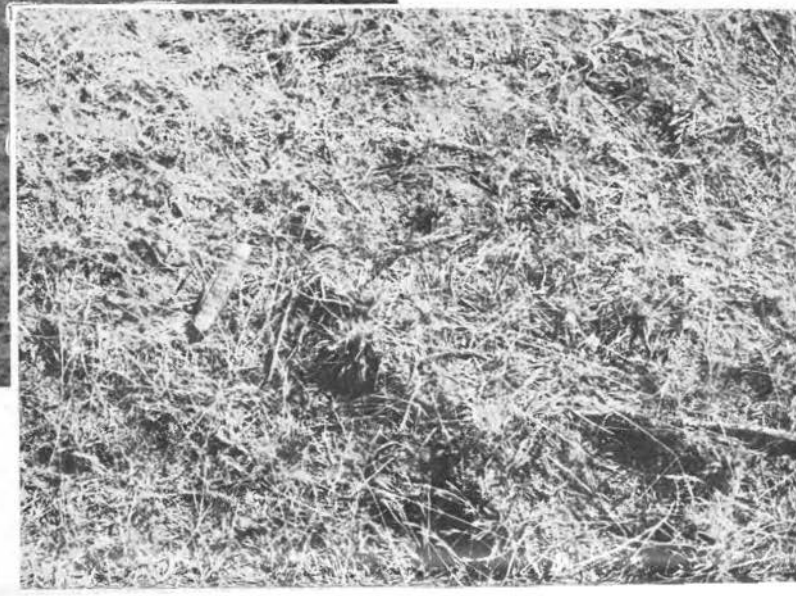
	1950	SAME—Chickens "apparently breed in 31 counties", and "the outstanding fact about their present distribution is that they are always associated with grasslands". The prairie chicken "did not disappear from the areas where extensive tall grass prairie still exists" (Mohler 1950).			
	1942–1955	KEYSTONE AREA, Keith County—Good but not best range: "I believe the density in better Nebraska range would be at least twice as great". No habitat analysis; count based on sampling rather than total census. Highest count in 1952 (Mohler, letter).	52,000 acres	152	1.9
KANSAS	1800's and early 1900's	GENERAL—Under primitive conditions, the greater prairie chicken in Kansas was "at the periphery of its range"; it "did not occur farther west than the middle of Kansas, and . . . did not occur in impressively large numbers". It later became more abundant, for "Most significantly, Koch (1836:163) mentions that the numbers of prairie chickens (presumably greater prairie chickens) increased within three years after settlement of the prairie lands . . . " Chickens spread into western Kansas as settlement advanced, but "It is thought that the changes in food and cover, especially the reduction of the tall grasses, that accompanied the dry years of the 1930–1940 decade, almost eliminated the greater prairie chicken from northwestern Kansas. The disappearance of the greater prairie chicken from much of eastern Kansas is attributable to the reduction of native grasslands by plowing and by the natural succession of woodlands after prairie fires were excluded" (Baker 1953).			
	Early 1950's	SAME—The prairie chicken "has remained on a more or less stable range in parts of the eastern one-third of the State", in areas where "grasslands always have been at least as extensive as at present." Kansas in 1953 "is one of the four states having the largest number of the greater prairie chicken. The Dakotas and Nebraska are the other states" (*Ibid.*).			
	1950	SAME—*Permanent grassland*: "It is evident that approximately one-third of the land must be in permanent grass to provide the minimum requirements for the greater prairie chicken in Kansas, and that approximately two-thirds in permanent grass provides the optimum condition" (Baker 1953).			
	1950	MARGINAL RANGE—average of 6 whole townships: *Total grassland** 43.2% (*Ibid.*).			
	1950	OPTIMUM RANGE—one-township samples: Anderson County, Welda Twp: *Total grassland** 62.9%; Woodson County, Center Twp: *Total grassland** 66.4% (*Ibid.*).			

*Virtually all grassland is *permanent grassland*.

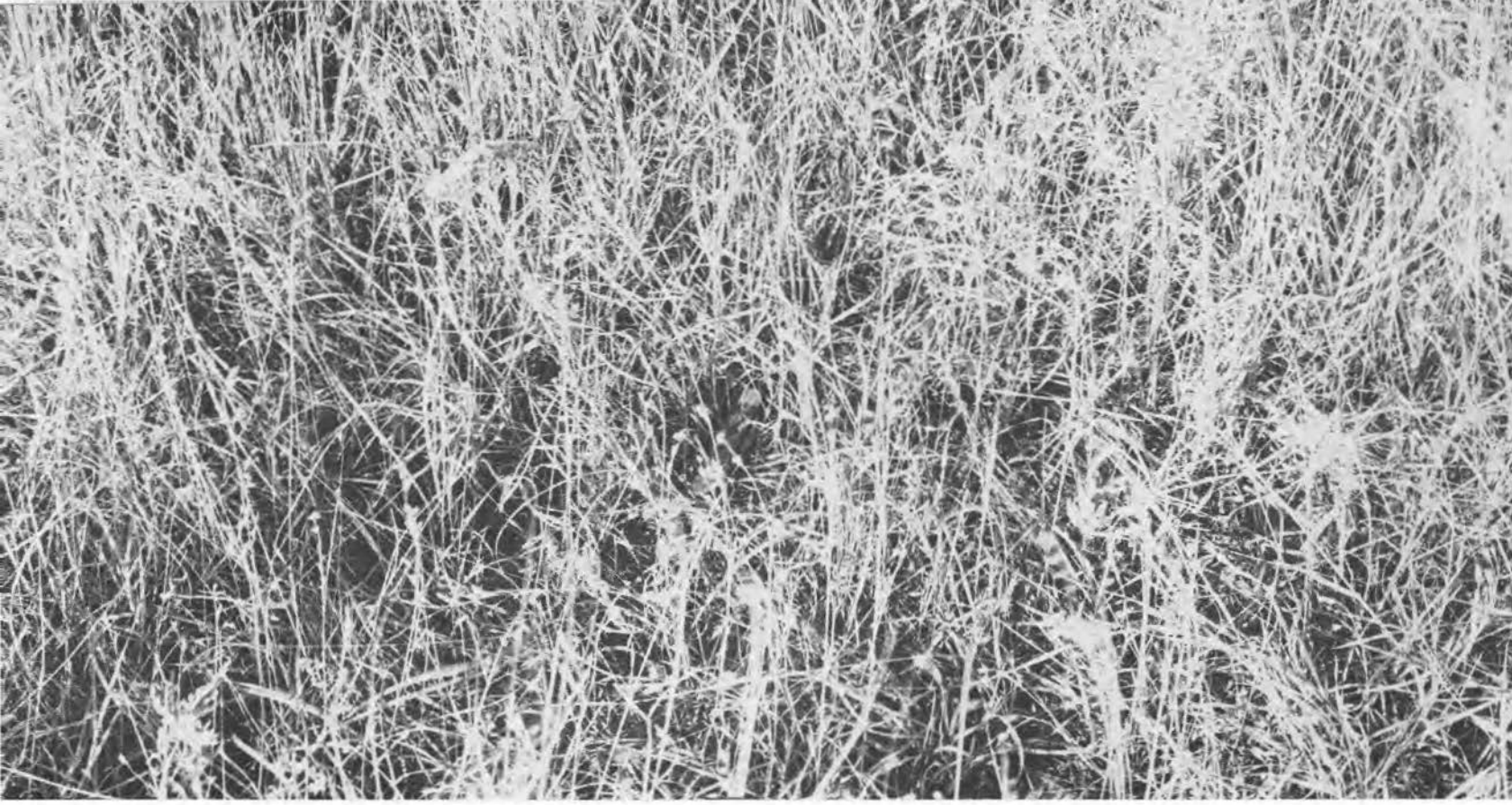


← Although eastern Kansas, near Welda, has one of the best chicken areas in the world, drought and overgrazing have severely damaged the habitat farther west in the Bluestem Hills. Butler County, Kansas, August 1956.

Chickens can no longer live here. Ground cover in the area shown above, August 1956. →



State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
KANSAS (cont.)	1950	WELDA AREA (part of Welda Twp., above)—In best range: *Total grassland** 77%, cultivated land 22%, farmyards 1%; total area about 2215 acres (*Ibid.*). *Nest-brood grassland* 76%; ". . . the exception would be closely grazed and trampled areas near buildings, salt boxes and ponds, certainly not exceeding 1% of the total grassland . . . Prairie hay is cut in August and September after the broods are large enough to move readily. So, virtually all grassland is available as brood cover. Not over 15% of all grass was cut for hay in any year." Most recent high in 1949 and 1950; census data for Welda Area plus land to south to make 2x2 mile block. No census data from larger areas, but "I am convinced that this figure would be quite typical of the best range in Kansas" (Baker, letter).	2x2 miles	155	38.8
OKLAHOMA	1800's and early 1900's	GENERAL—"The greater prairie chicken was formerly an abundant resident of the Tallgrass Prairie Game Type of Oklahoma. It appeared to occupy timbered sections only as a marginal condition to the true prairie, and only came to these areas in the fall to feed on the oak mast . . . Greater prairie chicken populations increased with early settlement . . . but when the country became more thickly settled and agriculture took the place of the natural tall grasses of the prairies and savannah types, the populations began to decrease. This population decrease continued until about 1925 and seemed to remain at a low level for several years, but in the last ten years [i.e., prior to 1944] a slow but definite increase in numbers is noticeable" (Duck and Fletcher 1944).			
	1940	SAME—Most chickens found on lands "more suitable for grazing than for farming". Best populations in Craig and Mayes Counties where, since 1909 and 1934, respectively, there has been a decrease in corn acreage and increase in sorghums; little loss (Craig Co.) or actual increase (Mayes Co.) in both tame and wild hay. "All these trends point toward a general improvement in environment which undoubtedly accounts for the steady recovery of chicken numbers" in the 1930's (*Ibid.*).			



In the drought-stricken Bluestem Hills of northern Oklahoma, chickens persist in good numbers where grazing pressure has been reduced enough. Grass about 14 inches tall nearly hides the knife in the center of the picture. This is good range management as well as good chicken management. Adams Ranch, Osage County, Oklahoma, August 1956.

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
OKLAHOMA (cont.)	1950's	SAME—Osage County, in northeastern Oklahoma, now has a "relatively good population". There are "promising areas" in Jefferson and Murray Counties, in south central Oklahoma, where there have been no chickens for more than 20 years, but where "grassland management has raised the habitat index to such an extent that I now believe it will be worthwhile to attempt restoration" (Jacobs, letter). There are no current census data; the most recent figures are for 1940, below.			
	1940	CRAIG COUNTY AREA—(Duck and Fletcher 1944)	16 secs.	106	6.6
	1940	MAYES COUNTY AREA—(*Ibid.*).	13 secs.	54	4.2
COLORADO	1800's and early 1900's	GENERAL—In extending its range westward, the prairie chicken first reached Colorado in 1897 (Cooke 1898, Sclater 1912). By 1909 it was "locally abundant in northeastern part of the state" and nested in 1907 and 1908 near Barr (Hersey and Rockwell 1909); this was then "the most western record in the United States" (Cooke 1909).			
	1952–1953	SAME—Former range in Colorado has been restricted by plowing; land use, "especially livestock grazing practices", apparently governs populations on remaining range (Swope 1953). "Colorado has approximately one million acres of prairie chicken habitat now occupied by the birds, though population levels are very low over much of this range." *Total grassland* "roughly 80%". *Permanent grassland*: "nearly all of the grassland can be considered permanent". *Nest-brood grassland*: about 27% ("approximately one-third of the grassland was considered to be suitable nesting and rearing cover"), but there has been considerable drought damage since 1953 (Swope, letter).			
	1952–1953	YUMA COUNTY AREA—"It was apparent on the study area that properly grazed range supported much larger grouse populations than did overgrazed range. The grouse appeared to increase or decrease with certain of the grass			

Farthest west. Day roost beside low sagebrush. At the western limit of chicken range in the United States, the current drought is causing tall grass to give way to short grass prairie. The cover shown here is probably about the minimum of tolerable density: there is better grass close by, without which such cover as this would probably support no chickens. Yuma County, Colorado, September 1956.

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
COLORADO (cont.)		species. These climax grasses in the county include big bluestem (*Andropogon furcatus*), little bluestem (*Andropogon scoparius*), switchgrass (*Panicum virgatum*), sideoats grama (*Bouteloua curtipendula*), Indiangrass (*Sorghastrum* sp), and needle and thread (*Stipa comata*). Prairie sandreed grass (*Calamovilfa longifolia*), and Indian rice grass (*Oryzopsis hymenoides*) may also be indicators of proper range use and/or prairie chicken abundance." (Swope 1953).			
WYOMING	1950's	GENERAL—"A bird of the prairie sloughs and short-grass prairie" (Anon., 1955); possibly still present in small numbers in southeastern Wyoming (*Ibid.*; Aldrich and Duvall 1955); but "To the best of our knowledge there have been no authentic records . . . in Wyoming in recent years" (Patterson, letter).			
ONTARIO	1930's to 1950's	MANITOULIN ISLAND—"The Manitoulin pinnate population as far as we know is the only one at present in existence in the province. We had a population between 1828 and 1897 in southern Ontario". The Manitoulin population is unique in its genetic make-up: "I believe the 1932–3 winter invasion of northern sharptails was responsible for the hybridization. They disappeared within one or two years of their arrival after having introduced a strong infusion of their [sharptail] genes into the pool of the newly arrived pinnates . . . Prairie grouse range on Manitoulin Island exists only as a result of current land use practises. The two most important are raising beef cattle and cutting pulpwood. The stock ranges freely from the pastures into the forest effectively destroying much of the regeneration near the edge"; larger trees are cut for pulp in winter. Most pastures are very heavily grazed. "For pinnated grouse this range must be very marginal". Total population for the island, chickens and hybrids of both sexes, was estimated at "probably not more than 200" during the spring of the most recent high year, which was 1951 (Lumsden, letter).			

State	Period	Habitat analysis	Census Area	Booming Ground Cocks	Cocks per Section
ONTARIO (cont.)	1951	GORE BAY–BARRIE ISLAND AREA (part of Manitoulin Island)—Best density; area of 31,700 acres. *Total permanent grassland* (pasture) 29%; farmland (which may contain an unknown amount of grass in rotation) 16%; woodland and scrub 55%. Highest recent count of booming ground cocks was in 1951: 28 cocks, or 0.6 cocks per section for whole area, 1.9 cocks per section of permanent pasture (*Ibid.*).	31,700 acres	28	0.6
MANITOBA	1881–1955	GENERAL—No record of prairie chicken occurrence until 1881 (Seton 1886); "spread with cultivation . . . abundant in all the settled parts" by 1909 (Seton 1909); "reached a moderate peak sometime in the 1920's. The decline which followed has now reduced it to the position of 'occasional' or 'rare' . . . It is typically a grassland inhabiting species but its habitat in Manitoba has been largely eliminated by cultivation . . . The writer has only two personal records extending over the past five years", both "in non-arable land" (McLeod, letter). " . . . has just about died out" (Malaher, letter).			
	Circa 1938–1939	MARCHAND—". . . some six miles south of Marchand, Manitoba, there was a single flock of over 300 prairie chicken. These used to fly out from boggy, part timbered, part cattail slough country to second growth alfalfa fields daily. This habitat has remained virtually unchanged but no birds have been seen for a long time now" (Malaher, letter).			
	1952	BIG GRASS MARSH—Flock of about 30 on east side of Marsh; in "a strip of about five sections of land supporting very tall grass but almost free of herbaceous vegetation" (McLeod, letter).			
	1955	MELBOURNE—A single cock seen "in an area running into many square miles. Here were bluffs of white spruce, aspen and willow to the extent of about 30%. The remainder was of short grass. The entire area was of rolling, dune-type terrain" (*Ibid.*).			

SASKATCHEWAN	Late 1800's through 1955	GENERAL—"The Pinnated Grouse was not an original inhabitant of Saskatchewan, as was its near relative the Sharp-tailed Grouse. The Pinnated Grouse followed the advance of farming westward and at one time was fairly common in open grassy areas in Saskatchewan. However, partly because of more intensive cultivation and partly because of factors unknown, the numbers of the Pinnated Grouse have decreased markedly in the last twenty or twenty-five years" (Houston, 1956). "To my knowledge the Pinnated Grouse in Saskatchewan is completely gone from most areas, but a few small pockets likely do exist" (Houston, letter). "We do receive a few reports from time to time, but I'm quite satisfied they are about gone from Saskatchewan" (Bard, letter).
ALBERTA	Late 1800's through 1955	GENERAL—There is little to add to Rowan's (1926) account of 1926: "How long the species has been represented in this Province it is difficult to estimate, but some of the old-timers remember it as far back as the late nineties." The bird is "really numerically scarce. It is here, moreover, subject to exactly the same cycles as the Sharp-tail, and in years of scarcity it is excessively rare." Its breeding range is "patchy" and limited to "the immediate vicinity of the larger lakes" (about a half-dozen) in central Alberta; however (Rowan, letter), prairie chickens "toured the country along with sharptails" in the autumn. "During the 1925 peak pinnateds were more abundant than I have ever seen them since", but they were "not plentiful" even then (*Ibid.*).

APPENDIX B

Land Use and Cover Types, Buena Vista Marsh Management Area

The base map used in this survey was made for us by the Engineering Division, through the courtesy of John Ockerman. The 1951 cover-type mapping was started by G. G. Holt, Jr., and E. P. Jensen of the Forestry Division, who typed the timber and brushlands from air photos supplemented by field inspections; Mattson finished the field inspection and typed the grassland and farmland areas. The original survey covered the entire Portage County study area (74,000 acres). In the autumn of 1953 that part of the area which has been proposed for prairie chicken management (46,000 acres) was re-surveyed, largely by Mattson with some help from the Hamerstroms; this time, details of land use were added to the cover types. Since we need only a workable approximation of the acreages involved rather than absolute accuracy, the base map was fitted together from individual air photos without additional ground control, and type boundaries which could not be determined from the photos were paced or estimated rather than chained. This procedure greatly reduced costs, and gave results which are accurate enough for our needs. One half-section in the development area (T21N R8E sec. 28, north half) was not typed in the 1953 survey.

The several types are described below and acreages of each are shown in figures 12–15. The numerals shown at the left, below, serve as the legend for Figures 12–15. Acreage figures are for 1953.

1. PLOWLAND AND FALLOW ---------- 7,385 A.

Mainly corn and small grains; some potatoes, cabbage, etc. Bare and weedy fallow land, of which there is little, is included here. Not nesting cover.

2. FALLOW LAND BEGINNING TO FORM SOD ---- 355 A.

Land which has lain fallow for a year or two, but not yet with enough grass to make nesting cover, in most cases, although a few fields have become well enough sodded to make a little poor cover. There are few examples, most of which will almost certainly be plowed again soon.

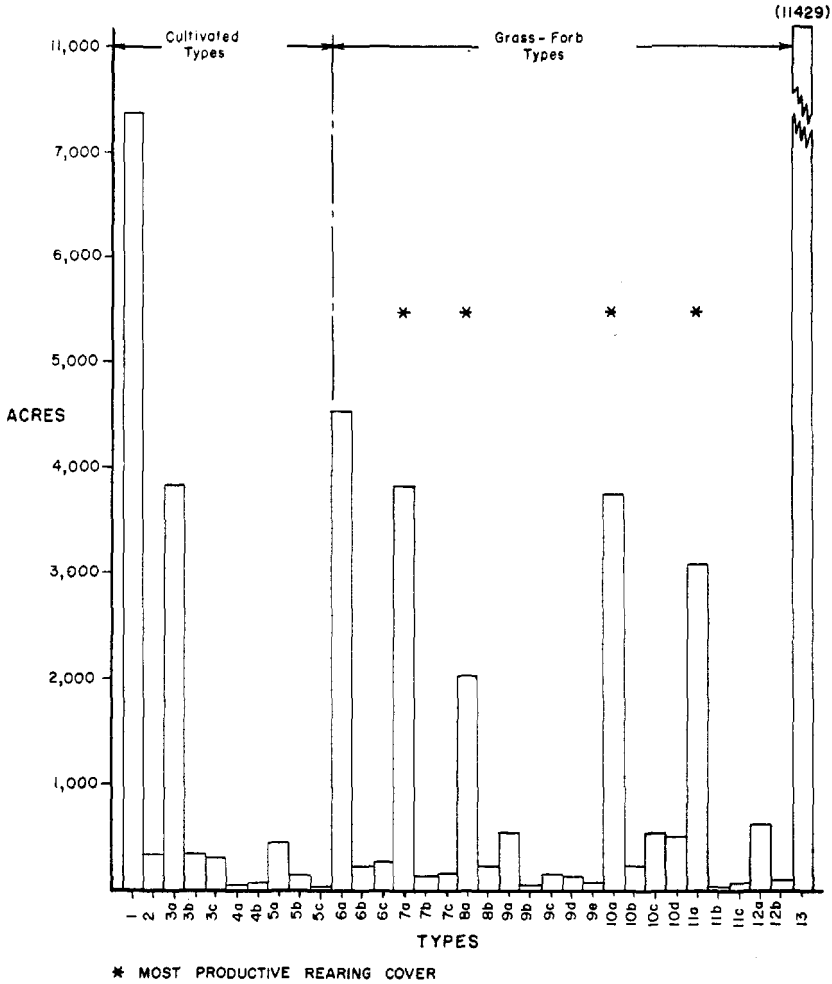


Figure 12. Total acreage of cover types on the Buena Vista Marsh, 1953. (Cover types—1, 2, 3a, etc.—are described in text, Appendix B).

TAME HAY:

Mostly timothy-clover or timothy *(Phleum pratense)* alone; occasionally reed canary *(Phalaris arundinacea)* or clover *(Trifolium* spp.) or alfalfa *(Medicago sativa)* without grass. Provides some nesting cover, practically all of it of poor quality. Nests, hens and young are apt to be destroyed by mowing except in late mowed fields, of which there are few. Has the additional disadvantage of being only a few

years removed from the last plowing. This and the next type (recently seeded pasture) are difficult to separate with certainty, as some hayfields are grazed after mowing and some pastures are also mowed.

3a. Mowed at the usual time	**3,819 A.**
3b. Mowed at the usual time and grazed heavily or moderately	**375 A.**
3c. Mowed at the usual time and grazed lightly	**309 A.**
4a. Mowed late	**37 A.**
4b. Mowed late and grazed	**80 A.**

RECENTLY SEEDED PASTURE:

Various mixtures of grass-clover or of grasses alone. Practically no nesting and rearing cover, except when (rarely) lightly grazed.

5a. Heavily grazed	**488 A.**
5b. Heavily grazed and mowed	**119 A.**
5c. Lightly grazed	**20 A.**

GRASS-FORBS:

A total of 21,243 acres in 1953, including 1,672 acres which were recently cultivated but which were reverting to the grass-forb type. The grass is mainly bluegrass *(Poa pratensis;* some *P. compressa)* with varying admixtures of quack *(Agropyron repens),* timothy, redtop *(Agrostis alba),* big and little bluestem *(Andropogon Gerardi, A. scoparius),* muhlenbergia *(Muhlenbergia* sp.), etc.; occasionally mainly quack or little bluestem. The forbs are most commonly toadflax *(Linaria vulgaris)* and goldenrod *(Solidago* spp.) both of which increased markedly in 1952 and 1953, to the detriment of seed production and hay and pasture values as well as of nest-brood cover.

Grass-forb areas include the best nest-brood cover, except where land use practices interfere. (Note: Tame hay and seeded pastures here tend strongly to revert to bluegrass, so that it is often difficult to make a distinction. In 1953, with unusually heavy grazing and little growth after mowing because of drought, it was particularly difficult. In a few cases, borderline grass marsh and areas of scattered willow, suitable for nesting, have been typed as grass-forb; only a few hundred acres are involved). The type may be subdivided as follows:

Grazed hard: Grass-forbs, grazed hard and generally early; essentially no nesting cover—

6a. Grazed hard ---------- 4,536 A.
6b. Grazed hard and mowed ---------- 216 A.
6c. Grazed hard, recently under cultivation ---------- 290 A.

Grazed moderately: Grass-forbs, grazed moderately from the viewpoint of farm management but too heavily from the standpoint of best prairie chicken production; sometimes grazed late, after being stripped for bluegrass seed. Includes some nesting and rearing areas of medium quality, but would be better with less grazing pressure. Weed invasion severe—

7a. Grazed moderately ---------- 3,817 A.
7b. Grazed moderately and mowed ---------- 116 A.
7c. Grazed moderately, recently under cultivation ---------- 124 A.

Lightly grazed: Includes much good and medium quality nest-brood cover, but many areas were too weedy for best production in 1953—

8a. Grazed lightly ---------- 2,018 A.
8b. Grazed lightly, recently under cultivation ---------- 226 A.

Mowed at the usual time: Mowed generally during the last week of June or early July. Potentially good nest-brood cover, but destructive of nests, adults, and young—

9a. Mowed at the usual time ---------- 554 A.
9b. Mowed at the usual time and grazed ---------- 40 A.
9c. Mowed at the usual time, recently under cultivation ---------- 141 A.
9d. Mowed at the usual time, recently under cultivation, heavy or moderate grazing ---------- 138 A.
9e. Mowed at the usual time, recently under cultivation, light grazing ---------- 80 A.

Mowed late: Such areas are often stripped for bluegrass seed before mowing. Late mowing is far less destructive than early mowing, but as it commonly is done as late as September (sometimes in November) there is very little cover again until growth is well along in the following spring, sometimes too late for nesting—

10a. Mowed late ---------- 3,767 A.
10b. Mowed late and grazed moderately ---------- 219 A.
10c. Mowed late and grazed lightly ---------- 552 A.
10d. Mowed late, recently under cultivation ---------- 508 A.

Less than 20% mowed: Such patch mowing is generally done late, and such areas have usually been stripped for bluegrass seed. Generally good or medium quality nest-brood cover, although often not the best; in many cases not mowed more thoroughly because the grass was thin or weedy. Such areas are often burned in early spring, thus reducing nesting cover—

11a. 0–20% mowed	3,095 A.
11b. 0–20% mowed and grazed lightly	20 A.
11c. 0–20% mowed, recently under cultivation	69 A.

Not mowed, stripped, or grazed: Theoretically, the absence of disturbance should make these the best nesting and rearing areas; actually, however, the lack of disturbance often resulted from the fact that the areas were too weedy to be worth stripping or mowing, and the same excessive weediness greatly reduced their value for prairie chicken production. Exceptions to this occurred in sections 3 and 5, T21N R8E—

12a. Not mowed, grazed, or stripped for seed	621 A.
12b. Not mowed, grazed, or stripped for seed, recently under cultivation	96 A.
13. WOODS, BRUSH, WET MARSH, FARMYARDS and other miscellaneous types which do not contribute to nest-brood cover	11,429 A.

Mainly woods and brush. The *woods* are primarily islands, tongues, and large blocks of aspen *(Populus tremuloides;* some *P. grandidentata),* primarily on the drained peat. On some of the sand islands within the Marsh, and more particularly around the edges, there are stands of oak *(Quercus* spp.) and pine (mainly *Pinus Banksiana,* some *P. resinosa* and *P. Strobus).* There are a few patches of swamp hardwoods. *Brush* consists mainly of willow *(Salix* spp.), sometimes scattered, sometimes in dense thickets, and sometimes associated with aspen, on the drained peat. On the sand islands and around the edges of the Marsh, there are patches of cherry *(Prunus virginiana, P. serotina),* hazel *(Corylus americana),* sweet fern *(Comptonia peregrina)* and associated shrubs. *Wet marsh* totalled about 738 acres in 1953, but varies from year to year. Marsh patches are mostly less than 40 acres in size. Although they are normally wet for too long a period in spring and early summer to permit nesting, they are generally dry by late summer.

Note: 320 acres in the southeast corner of the proposed management area were not mapped in 1953.

APPENDIX C

Nest-Brood Cover, 1953

The good nesting and rearing areas (3,216 acres) were almost without exception in the grass-forb type, described above (Appendix B). One small timothy field, consistently mowed late, is included; so also is one 80 which was in tame hay as recently as 1951. The good areas have consistently been in sod for more than five years. Practically all of them were stripped for bluegrass seed.

The medium quality areas (7,497 acres) were also mostly grass-forb meadows. Many of them have been in sod for a long time, but there were a few which had been more recently in cultivation and were in 1953 reverting to bluegrass. Many of the medium quality areas were also stripped. They ranked lower than the good areas for several reasons, the most important of which were: (1) pastured too heavily for best prairie chicken production; (2) too weedy; (3) grass too thin.

It is important to note that in almost all cases, the good and medium areas of 1953 had deteriorated considerably from their condition in 1951, mainly because of weed invasion.

The poor nesting and rearing areas (8,239 acres) were of two main types: (1) tame hay; (2) grazed too hard. A few early mowed grass-forb areas and other miscellaneous types are included. Although some prairie chickens are hatched in the poor type, this type alone would not support them.

There were about 6,276 acres, in the aggregate, of grass-forbs which because of extremely heavy grazing pressure did not rank even as poor nesting and rearing cover.

There are highly important research studies still needed in connection with nesting and rearing cover. Management must deal with *quality* of habitat as well as its quantity and distribution. While it is known that fertilizer (particularly nitrogen) will increase the density of bluegrass stands on the Marsh, there are no objective standards to show where the endpoint of grassland improvement for prairie chickens should be.

The prairie chicken management area is divided into two almost equal parts by Highway W. The northern part totals 22,416 acres, and the southern part 23,243 acres plus 320 acres not mapped in 1953. Over the area as a whole the four most productive types, from the standpoint of prairie chickens, are grass-forb meadows of long standing which are (1) grazed lightly, (2) grazed moderately, (3) mowed late, and (4) patch mowed, with the patches totalling less than 20 per cent of the meadow. Figure 13 shows that these four types were in 1953 about equally represented in the two parts of the area, with 6,383 acres north of Highway W and 6,314 acres south of it. Ordinarily there are more prairie chickens in the northern part of the area than in the southern, and we believe this to be due to differences in quality of habitat. A comparison of Figures 14 and 15 shows more rearing cover of good quality in the northern part of the area, which would seem to bear out this belief. On the other hand, preliminary analysis of our booming ground counts in 1953 and 1954 indicates that there was very little difference in the number of cocks in the two parts of the area during those two years, while the northern part showed higher counts in 1950, 1951, 1952, and 1955. We cannot yet explain this apparent discrepancy in 1953 and 1954, but it may mean that the northern part of the area has been damaged even more than we realize by the land changes of the last few years, and that our subjective criteria for judging habitat quality are not fine enough.

Most of our work with habitat analysis thus far has been subjective and extensive. For management to be most effective, objective and intensive research is the obvious next step.

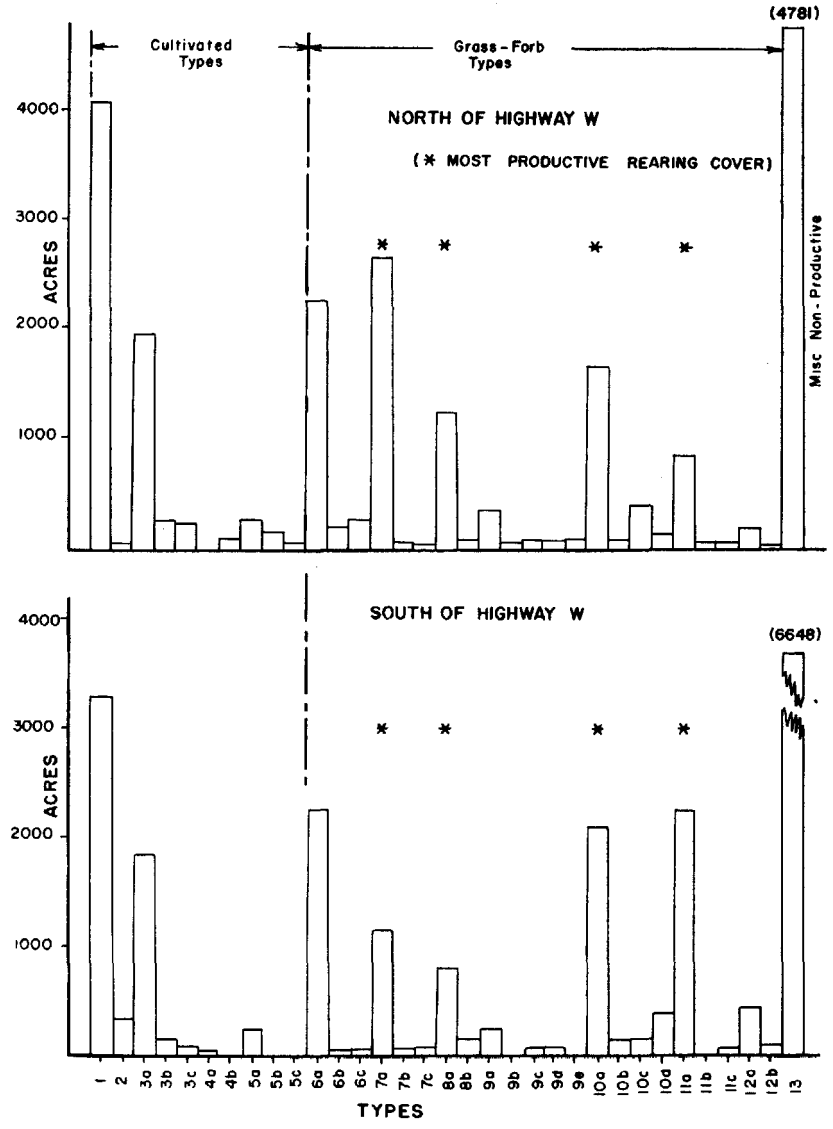


Figure 13. Acreage of cover types north and south of Highway W, 1953. (Cover types—1, 2, 3a, etc.—are described in text, Appendix B).

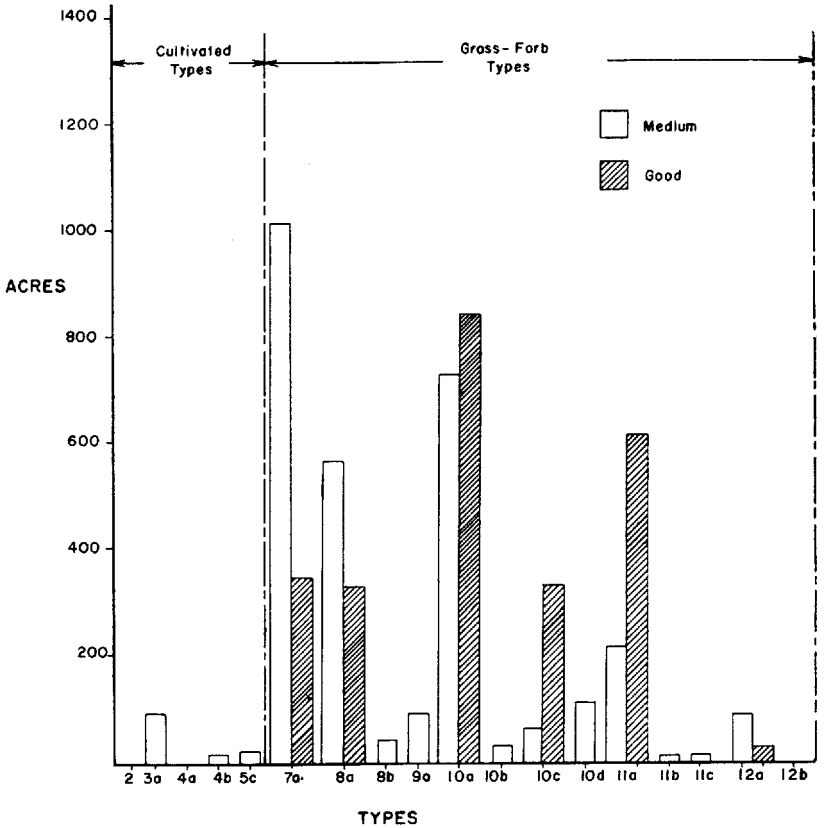


Figure 14. Acreage of nest-brood cover north of Highway W, 1953. (Cover types—1, 2, 3a, etc.—are described in text, Appendix B).

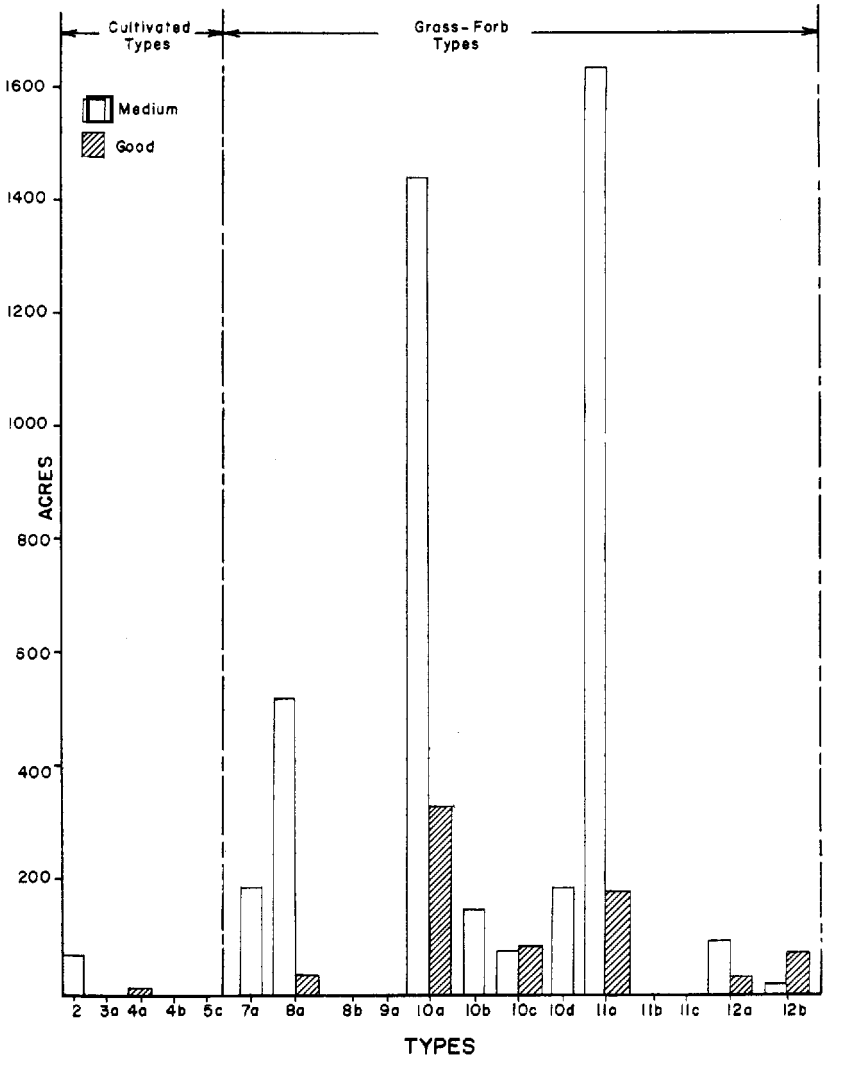


Figure 15. Acreage of nest-brood cover south of Highway W, 1953. (Cover types—1, 2, 3a, etc.—are described in text, Appendix B).

REFERENCES

Aldrich, J. W. and A. J. Duvall

1955 Distribution of American gallinaceous game birds. U.S. Fish and Wildl. Serv. Circ. 34.

Ammann, G. A.

1949 Grouse prospects. Michigan Conservation, 18(5):14–19.

1950 History of prairie grouse in Michigan. Mich. Dept. Cons., Game Div. Rpt. 1119 (processed).

1956 Correspondence.

Anonymous

1953 National Wildlife Week—March 15–21. North Dakota Outdoors, 15(9):8, 23.

1955 Prairie grouse in Wyoming, Wyo. Wild Life, 19(2):18–23.

Baker, M. F.

1953 Prairie chickens of Kansas. Univ. Kans. Mus. Nat. Hist. and State Biol. Surv., Misc. Publ. 5.

1956 Correspondence.

Bard, F. G.

1955 Correspondence.

Barnes, W. B.

1956 Correspondence.

Barrows, W. B.

1912 Michigan bird life. Mich. Agric. Coll., Spec. Bull., xiv + 822 pp.

Bennitt, Rudolf

1939 Some agricultural characteristics of the Missouri prairie chicken range. Trans. 4th No. Amer. Wildl. Conf., pp. 491–500.

---------- and R. S. Campbell

1950 Wildlife. Repr. from "Missouri, its resources, people, and institutions", Univ. Mo. Associates, pp. 113–150.

---------- and W. O. Nagel

1937 A survey of the resident game and furbearers of Missouri. Univ. Mo. Studies, 12(2):1–215.

Boughton, R. V.

1937 Endoparasitic infestations in grouse, their pathogenicity and correlation with meteoro-topographical conditions. Minn. Agric. Exper. Sta., Tech. Bull. 121.

Christisen, D. M.

1953 The 1953 prairie chicken census and reproductive success. MS report, State of Missouri, P–R Project 13–R–7 (1953), Dec. 15, 1953.

1956 Correspondence.

Cook, A. J.
1894 Birds of Michigan. Mich. Agric. Coll. Bull. 94 (*In.* 32nd Ann. Rpt. Mich. State Board of Agric., pp. 192–356.)

Cooke, W. W.
1898 Further notes on the birds of Colorado. An appendix to Bull. No. 37, on the birds of Colo. Colo. Ag. Exper. Sta., Bull. 44.
1909 The birds of Colorado—third supplement. Auk 26:400–422.

Curtis, J. T.
1950 Plant ecology work book. Burgess, Minneapolis, 39 pp.

Damaske, N. E.
Unpublished field notes.

Davison, V. E.
1940 An 8-year census of lesser prairie chickens. Jour. Wildl. Mgt., 4:55–62.

Duck, L. G. and J. B. Fletcher
[1944] A survey of the game and furbearing animals of Oklahoma. Okla. Game and Fish Comm., State Bull. 3.

Ebling, W. H.
1953 Portage County agriculture. Wis. Dept. Agric., Crop Reporting Service Bull.

Edminster, F. C.
1954 American game birds of field and forest, their habits, ecology, and management. Chas. Scribner's Sons, N.Y., xx + 490 pp.

Erickson, A. B.
1956 Correspondence.

Farmes, R. E.
1954 Suggestions for saving the prairie chicken in Minnesota. Minnesota Naturalist, 4:44–45.
1956 Correspondence.

----------, W. H. Petraborg, and J. L. Zorichak
1954 Prairie grouse dancing ground survey, 1954. State of Minnesota, P–R Game Research Project 11–R, Quart. Prog. Rpt., 14(2):40–42 (processed).

Finley, R. W.
1951 The original vegetation cover of Wisconsin. Unpubl. Ph.D. thesis, Univ. Wis., 280 pp.

Grange, W. B.
[1948] Wisconsin grouse problems. Wis. Cons. Dept., Madison, 318 pp.
1949 The way to game abundance, with an explanation of game cycles. Chas. Scribner's Sons, N.Y., xviii + 365 pp.
Unpublished administrative reports.

Gross, A. O.
1930 Progress report of the Wisconsin prairie chicken investigation. Wis. Cons. Comm., Madison, 112 pp.

Hamerstrom, F. N., Jr.
1939 A study of Wisconsin prairie chicken and sharp-tailed grouse. Wilson Bull., 51:105–120.
1940 A study of Wisconsin prairie grouse (Breeding habits, winter foods, endoparasites, and movements). Unpubl. Ph.D. thesis, Univ. Wis., 140 + viii pp.

---------- and Frances Hamerstrom
1949 Daily and seasonal movements of Wisconsin prairie chickens. Auk, 66:313–337.
1955 Population density and behavior in Wisconsin prairie chickens *(Tympanuchus cupido pinnatus)*. Acta XI Congr. Int. Ornith. 1954, pp. 459–466.

----------, Frank Hopkins, and A. J. Rinzel
1941 An experimental study of browse as a winter diet for prairie chicken. Wilson Bull., 53:185–195.

Hamerstrom, Frances, and Oswald Mattson
1939 Food of central Wisconsin horned owls. Amer. Midl. Nat., 22:700–702.

Hamilton, K. C. and K. P. Buchholtz
1953 Use of herbicides for establishing food patches. Jour. Wildl. Mgt., 17:509–516.

Hawkins, A. S.
1937 Winter feeding at Faville Grove, 1935–1937. Jour. Wildl. Mgt., 1:62–69.

Hersey, L. J. and R. B. Rockwell
1909 An annotated list of the birds of the Barr Lake district, Adams County, Colorado. Condor, 11:109–122.

Hine, R. L. and O. S. Bersing
[1951] Winter feeding for wildlife. Wis. Cons. Dept., Madison, 22 pp. (processed).

Houston, Stuart
1956 The pinnated grouse. Bluejay, 14:13.
1956 Correspondence.

Jacobs, K. F.
1956 Correspondence.

Janson, Reuel
1947 Pittman Robertson game research. South Dakota Conservation Digest, 14(4):10–11, 15.
1953 Prairie grouse habitat study, 1950–1952. State of South Dakota, P–R Project W–17 R–7, Job Completion Rpt., Sept. 8, 1953 (processed).
1956 Correspondence.

Judd, S. D.
1905 The grouse and wild turkeys of the United States, and their economic value. U.S. Dept. Agric., Biol. Surv. Bull. 24.

Klett, A. T.
1955 Pinnated grouse dancing ground survey. State of North Dakota, P–R Project W–35–R–2, Job Completion Rpt., Mar. 1955 (processed).

Koch, T.
1836 Beobachtungen über das Cupido-huhn, *Tetrao cupido*. Archiv für Naturgeschichte, 2:159–163 (Not seen; cited in Baker, 1953).

Leigh, W. H.
1940 Preliminary studies on parasites of upland game birds and fur-bearing mammals in Illinois. Ill. Nat. Hist. Surv. Bull., 21(5):185–194.

Leopold, Aldo
1931a Report on a game survey of the north central states. Sporting Arms and Ammunition Mfgrs. Inst., Madison, Wis., 299 pp.
1931b Game methods, the American way. American Game, 20(2): 20, 29–31.
1932 Management of upland game birds in Iowa. Iowa Fish and Game Comm., Des Moines, 35 pp.
1933 Game management. Chas. Scribner's Sons, N.Y., xxi + 481 pp.

Lumsden, H. G.
1949 Pinnated grouse on Manitoulin Island. Canad. Field–Nat., 63:208–209.
1956 Correspondence.

Malaher, G. W.
1956 Correspondence.

McAtee, W. L. and F. E. L. Beal
1924 Some common game, aquatic, and rapacious birds in relation to man. U.S. Dept. Agric., Farmers' Bull. 497.

McLeod, J. A.
1956 Correspondence.

Mohler, L. L.
1942 How farm and settlement affects Nebraska's prairie chickens. Outdoor Nebraska, 20(4):8–9, 23.
1944 Distribution of upland game birds in Nebraska. Neb. Bird. Rev., 12:1–6.
1950 Sharp-tail grouse population climbs. Outdoor Nebraska, 28(3):18–21.
1952 Fall and winter habits of prairie chickens in southwest Nebraska. Jour. Wildl. Mgt., 16:9–23.
1956 Correspondence.

Morgan, B. B. and F. N. Hamerstrom, Jr.
1941 Notes on the endoparasites of Wisconsin pinnated and sharp-tailed grouse. Jour. Wildl. Mgt., 5:194–198.

Mumford, R. E.
1955a 1955 status of the prairie chicken. State of Indiana, P–R Project W–2–R–15, Ind. P–R Wildl. Res. Rpt., 16(1): 34–37 (processed).
1955b Prairie chicken. *In* Indiana Pittman–Robertson Wildlife Restoration 1939–1955, John M. Allen ed., Ind. P–R Bull. 3, pp. 18–35.

Patterson, R. L.
1956 Correspondence.

Petraborg, W. H. and R. E. Farmes
1953 Prairie grouse dancing ground survey. State of Minnesota, P–R Game Research Project 11–R, Quart. Prog. Rpt., 13 (2):64 (processed).

Quarterly Progress Reports of Wisconsin's P–R Grouse Management Research Project, under various authorships and various project numbers, have appeared in Wis. Wildlife Research, Vol. 1 (1941) to the present.

Roberts, T. S.
1932 The birds of Minnesota. Univ. Minn. Press, Minn., 2 vols.

Rowan, William
1926 Comments on two hybrid grouse and on the occurrence of Tympanuchus americanus americanus in the Province of Alberta. Auk, 43:333–336.
1948 The ten-year cycle. Univ. Alta., Dept. of Ext., 15 pp. (rev.).
1956 Correspondence.

Schillinger, J. E. and L. C. Morley
1942 Diseases of upland game birds. U.S. Fish and Wildl. Serv., Cons. Bull. 21.

Schmidt, F. J. W.
1936 Winter food of the sharp-tailed grouse and pinnated grouse in Wisconsin. Wilson Bull., 48:186–203.
Unpublished manuscripts and reports.

Schorger, A. W.
1944 The prairie chicken and sharp-tailed grouse in early Wisconsin. Trans. Wis. Acad. Sci., Arts and Letters, 35:1–59.

Schrader, T. A. and A. B. Erickson
1944 Upland game birds of Minnesota. Minn. Dept. Cons., Cons. Bull. 8.

Schwartz, C. W.
1945 The ecology of the prairie chicken in Missouri. Univ. Mo. Studies, 20(1):1–99.

Sclater, W. L.
1912 A history of the birds of Colorado. Witherby, London, xxiv + 576 pp.
Scott, T. G. and G. O. Hendrickson
1936 Upland game birds in Iowa. Iowa State Col. Ext. Circ. 228.
Seton, E. T.
1886 The birds of western Manitoba. Auk, 3:145–156, 320–329.
1909 Fauna of Manitoba. *In* British Association Handbook, Winnipeg, pp. 183–227.
Shelford, V. E. and R. E. Yeatter
1955 Some suggested relations of prairie chicken abundance to physical factors, especially rainfall and solar radiation. Jour. Wildl. Mgt., 19:233–242.
Stempel, M. E.
1956 Correspondence.
Swope, H. M.
1953 Surveys to determine the population status of the prairie chicken. State of Colorado, P–R Project W–37–R–6, Job Completion Rpt., Apr. 1953 (processed).
1956 Correspondence.
Viehmeyer, Glenn
1938 Is the prairie chicken passing? Neb. Bird Rev., 6:25–28.
1941 The present status of the greater prairie chicken and sharp-tailed grouse in the sandhill region of Nebraska. Neb. Bird. Rev., 9:1–7.
Watkins, L. W.
1901 Michigan birds that nest in open meadow. Mich. Pioneer and Hist. Soc., Hist. Collections 29:665–677. (Not seen; quoted in Ammann, 1950).
Whitson, A. R., W. J. Geib, T. J. Dunnewald, and L. P. Hanson
1918 Soil survey of Portage County, Wisconsin. Wis. Geol. and Nat. Hist. Surv. Bull. 52–C.
Wood, N. A.
1951 The birds of Michigan. Univ. Mich. Mus. Zool., Misc. Publ. 75, 559 pp.
Yeatter, R. E.
1943 The prairie chicken in Illinois. Ill. Nat. Hist. Surv. Bull. 22(4):375–416.
1956 Correspondence.

(All Pittman–Robertson reports have been quoted by permission)

George Socha