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DAILY AND SEASONAL MOVEMENTS OF WISCONSIN PRAIRIE CHICKENS¹

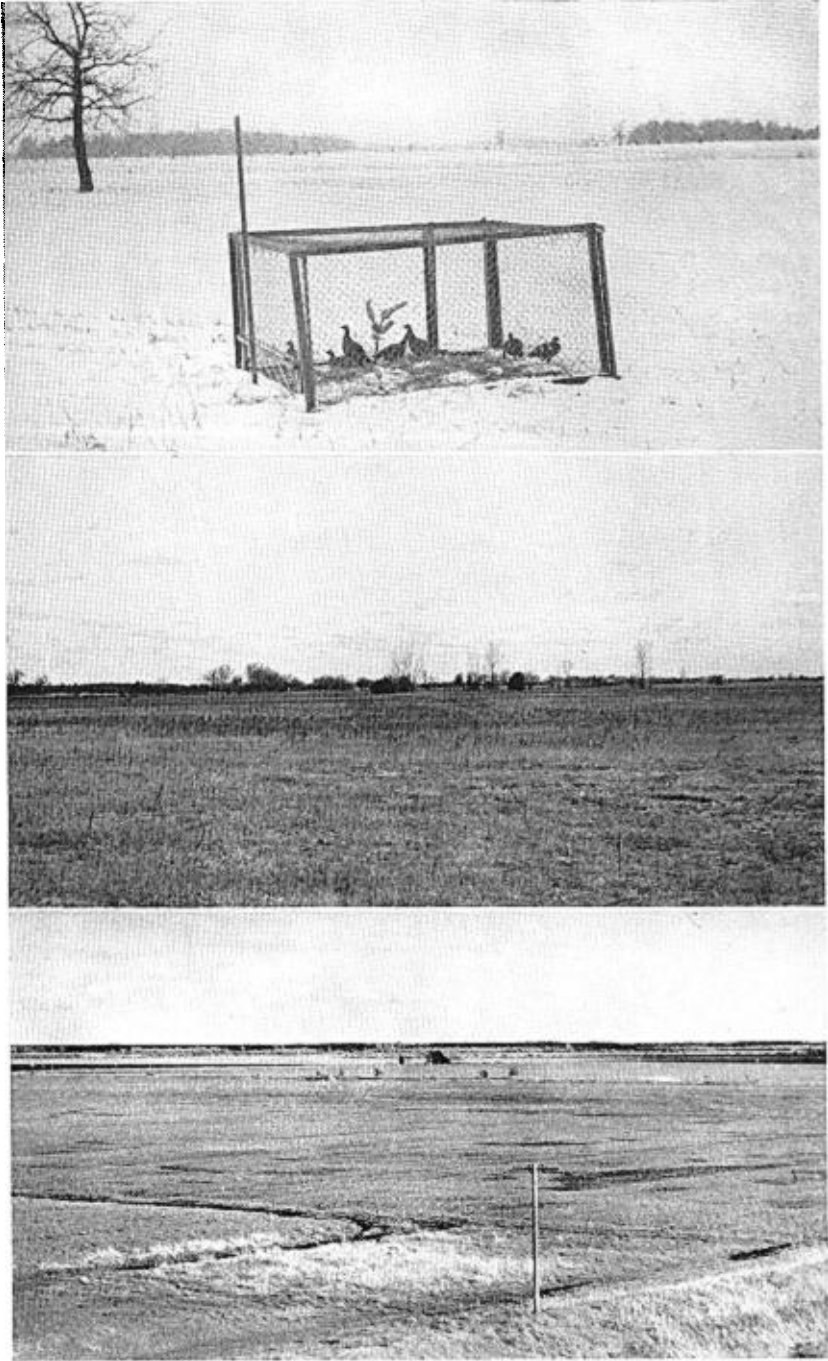
BY F. N. HAMERSTROM JR. AND FRANCES HAMERSTROM

THE prairie chicken, *Tympanuchus cupido pinnatus*, was once abundant in Wisconsin. Now it has all but disappeared. It was originally a bird of the prairies and other openings in the southern half of the state (Schorger, 1944), but settlement quickly destroyed the ancestral range. Although a few flocks still persist in widely scattered spots in the southern counties, most of the present range is in the peatlands of the central and northern counties—a kind of “substitute prairie”—provided by drained marshes and by swamps which have been converted to grass and sedge through lumbering, burning, and dredging.

Prairie chickens are losing even this new range. The fires which helped to open it up sometimes bit too deeply into the peat, resulting in thickly seeded stands of aspen instead of grass. Much of the drained peat is now as intensively farmed as the prairies. Some aspen and some cultivation are good for prairie chickens, but there is now too much of both. The prairie chicken is fast becoming a rare bird in Wisconsin, and in the whole of the Lake States region.

Several studies have sought to learn more about the life history and ecology of the prairie chicken in Wisconsin, in the hope that its situation could be bettered. For lack of space, we cannot here review these studies. Many of them were sponsored by the Wisconsin Prairie Chicken Investigation, begun by the state Conservation Commission in 1928 and continued during some years by that Commission and in others by the Department of Wildlife Management of the University of Wisconsin. This paper covers one phase (movements) of our work for that Investigation. The data come from two

¹ A joint contribution from the Edwin S. George Reserve, University of Michigan, and the Department of Wildlife Management, University of Wisconsin.



PRAIRIE CHICKENS IN WISCONSIN.—(Top) WINTER TRAPPING AT ALBERT'S, 1939-40. (Middle) SANDY SOIL NOT QUITE TOO POOR FOR FARMING, NOT QUITE TOO POOR FOR PRAIRIE CHICKENS. PLAINFIELD TOWNSHIP RANGE. (Lower) PEAT LAND KEPT OPEN BY SOME FARMING IS NOW THE BEST HABITAT FOR PRAIRIE CHICKENS IN CENTRAL WISCONSIN. THE GRANARY RANGE.

sources, direct observation and banding. They deal almost exclusively with local, as contrasted with migratory, movements. We followed groups of birds to watch their daily and day-to-day movements and used band recoveries in tracing exchanges between groups and in getting a sample of movements over longer periods of time, for example, from one season to another and from one year to another. We did most of our field work in two areas in central Wisconsin:

(1) The Plainfield area, in eastern Adams and western Waushara counties (50,000 acres—from January, 1939, through January, 1941, and continued by the Mattsons into March, 1941; the springs of 1941, 1942, 1943, 1947, and 1948). This was our main study area and the one on which we worked most intensively.

(2) The Necedah area, in northern Juneau, southern Wood, southeastern Jackson, and eastern Monroe counties (100,000 acres—from August, 1935, through July, 1937; autumn, 1937; and on occasional short visits in later years).

Both areas lie in the bed of Glacial Lake Wisconsin, the Necedah area almost at its center and the Plainfield area at its eastern edge. In both, peat beds alternate with tongues and islands of sand; in both, former marshes and swamps have been drained and swept with fire. The peat beds now support *Carex-Calamagrostis* marshes in their wetter parts and bluegrass, *Poa pratensis*, meadows in the drier, with large blocks of aspen, *Populus tremuloides*, and willow, *Salix* spp., on some of the old burns. It is primarily the remaining marshes and meadows that make the prairie chicken habitat. On the Plainfield area more of the marshes and meadows have been kept open by mowing and grazing, and much more of the area, both sand and peat, is in cultivation. Thirty years ago the Necedah area was part of the best prairie chicken country in the Midwest. When we were working there the birds were fast losing ground because of widespread brush invasion, the aftermath of a great fire in 1930. Today they are virtually gone. The Plainfield area is now the best remaining prairie chicken habitat in Wisconsin, but even it has deteriorated since 1941.

The sources of the banding data, which cover a 10-year period, are given in Table 1. These data have not been published before.

Acknowledgments: We are glad to acknowledge the supervision and advice throughout of the late Professor Aldo Leopold, whose students we were during the middle part of this study, and the help and information given us by friends in the neighborhood of Plainfield and Hancock, Wisconsin, especially by John Worden, Shirley Barnes, Frank Ingalls, Boyd W. Kelley, and Lloyd Conover, and by Clyde B. Terrell, Oshkosh, Wisconsin.

We were helped in field work on the Necedah area by Millard Truax, Oswald Mattson, James Blake, Burns T. Carter, and J. Roy Goodlad, and on the Plainfield

area by Mr. and Mrs. Oswald Mattson during the winter and spring of 1941. Mr. and Mrs. Robert A. McCabe and Mr. and Mrs. Mattson gave us a great deal of help in getting band recoveries on booming-grounds. Several others contributed to this phase of the study, especially Max L. Partch, Joseph J. Hickey, Bruce L. Stollberg, and George C. Becker.

We are grateful to Professor Leopold and Mr. McCabe for critical reading of the manuscript.

Unpublished banding data from the following sources, in addition to our own, were given to us for analysis (Table I): The late Franklin J. W. Schmidt who was assisted by several trappers whose names we do not know.

Soil Conservation Service: The Necedah area was first a project of the United States Resettlement Administration, later part of the Soil Conservation Service. Banding in 1936-37 was under our direction, assisted by Mattson and Truax. During the last two winters it was directed by William H. Schunke, assisted by Carter, Mattson, and Truax.

United States Forest Service: Deane W. Mather banded prairie chickens for us on the Nicolet National Forest, near Rhinelander, northern Wisconsin.

LOCAL MOVEMENTS

Summer.—We have not succeeded in studying prairie chickens intensively in summer. We suspect that summer is the season of least movement. Booming-ground males in some cases remained close to their booming grounds well into the summer and came to them practically daily long after they had stopped booming. These birds probably roosted and fed close by and had a very short daily cruising radius, perhaps a mile or less. Other booming grounds, however, were deserted in June; we do not know whether the males stayed in the neighborhood or went elsewhere. We have no idea what becomes of unmated hens (if any) and "territorial" males—that is, single cocks which boom daily at the same places apart from booming grounds (Hamerstrom, 1939) in this season.

Dog trainers on the Plainfield area told us that day after day they found broods in certain spots in the meadows along the ditches. Lehmann (1939, 1941) found that broods of the Attwater's prairie chicken, *T. c. attwateri*, remained within about half a mile of the nest during the first three weeks or so, with a daily cruising radius of less than 300 yards, after which they moved to good, shading cover near water. Davison (MS, 1935) found that broods of the lesser prairie chicken, *T. pallidicinctus*, "may move a mile in two or three weeks but are apt to remain on an area of about 160 acres most of the summer." It seems likely that in Wisconsin, too, broods of prairie chickens do not move far during the rearing period.

Autumn.—Autumn is a time of considerable movement. It is the time of such southward migration as still occurs. There is also a good deal of movement on a local scale. Thus, on both areas in late

summer, we found prairie chickens well distributed in numerous small flocks of one to a dozen or so birds; by late autumn these scattered groups and individuals had drawn together into a few much larger flocks or packs. On the Plainfield area there were nine such packs, numbering from 30 or 50 to about 150 birds each. Autumn packing has been reported in other states, for example, in Illinois (Yeatter, 1943), Michigan (Ammann, 1946), North Dakota (Miller, 1947), and South Dakota (Janson, 1947). Packing is the sum of many local movements; it involves a major reorganization of local populations.

The first part of this reorganization seems to come about rather slowly. There is undoubtedly some joining of broods even in late summer. By September we have seen coveys as large as 30 birds although most were from seven to 15. Throughout the autumn, coveys often came together while feeding, but they did not stay together to form packs until the weather turned colder. When cold weather came, the packs formed quickly, generally within a few days. Schorger (1944) has noted the influence of cold on packing. We first saw it on the Plainfield area on October 6, 1939, and October 30, 1940; when we returned to the area on October 17, 1941, the packs had already formed. In both 1939 and 1940, the packs broke up again, temporarily, during a period of warmer weather later in the autumn. In 1941 we were on the area only for three weeks of raw, windy, and rainy weather, during which the packs did not hold together as consistently as during the two preceding autumns.

Figure 1 shows the positions and approximate sizes of the nine major autumn ranges on the Plainfield area. John Worden, for many years the game warden in the district, and the local residents told us that these ranges hold autumn packs each year. More often than not, the same fields are used as autumn feeding places year after year. Figure 1 indicates that three miles is the farthest, and one to two miles the most common distance, that a bird on any part of the area would have to travel in order to reach the center of the nearest autumn range. Autumn movements may be, however, considerably more complex and extensive. Cooke (1888: 105), for example, has recorded a northward movement of young prairie chickens in the fall similar to that of young herons; Leopold (1931: 175) reported late summer and early autumn flights of prairie chickens in Missouri and Illinois; and Lehmann (1941: 24) spoke of a "general fall scattering" of Attwater's prairie chickens before their late autumn movement to the areas on which they spend the winter. The "fall shuffle" of bob-white quail (Leopold, 1931: 49) and the "crazy flight" of ruffed grouse (Schorger, 1945; Edminster, 1947: 43, 308) are well-known examples of an autumn

redistribution of populations in game birds. There appears to be ingress into the Plainfield area and some of it seems to occur in the autumn.

Band returns throw some light on the question of a "fall shuffle." Autumn recoveries from all sources are given in Table 2. These are, for the most part, autumn recoveries of winter-banded birds. We

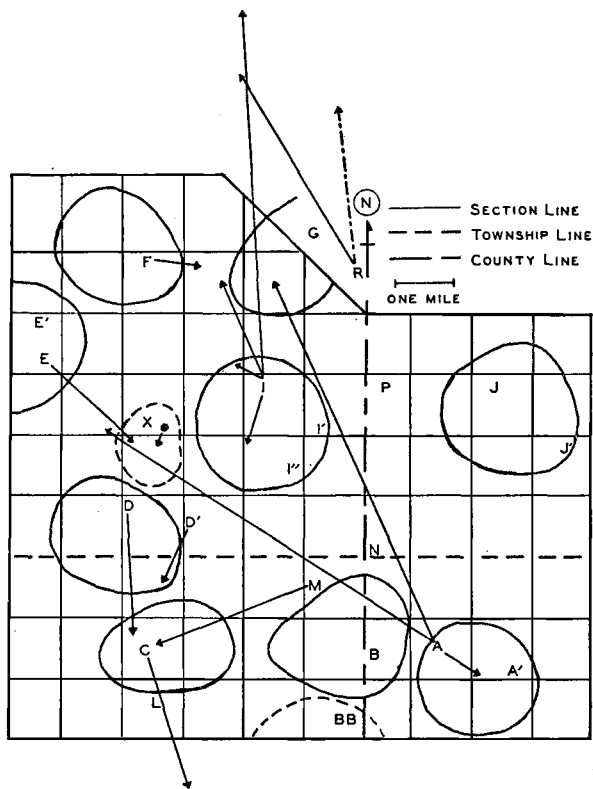


FIGURE 1.—AUTUMN RANGES, AUTUMN BAND RETURNS, AND MAJOR WINTER FEEDING PLACES ON THE PLAINFIELD AREA.

Major feeding places used during one or several winters are shown by letters A through R; letters with prime symbol (A') are more important alternate or secondary feeding places. The nine main autumn ranges (bounded by solid lines) carry same names as winter feeding places within them. Two autumn ranges of uncertain status are bounded by dashed lines; X is an identifying symbol for one of them and is not a winter feeding place; dot in range X indicates booming ground trapping station. Solid arrows show movements of birds shot during first autumn after banding; dash-dot-dash arrow represents a bird shot during fourth autumn after banding.

cannot be sure, therefore, that the movements shown by these returns actually took place in autumn rather than at some other time of year. It seems significant, however, that the autumn returns are at the

greatest distances. They show movements up to 29 miles, while the longest known winter movement was five miles and the longest move from winter feeding place to booming ground was eight miles.

TABLE 1

SOURCES, DATES, AND QUANTITIES OF BANDING DATA ON PRAIRIE CHICKENS

Source	Dates		Number banded	Number recovered
	from	through		
Schmidt	1931-32	1934-35	221	18
Soil Conservation Service	1936-37	1938-39	60	22
U. S. Forest Service	1939-40	1940-41	21	10
Hamerstrom	1938-39	1940-41	295	108
<i>Totals</i>			597*	158

Number Recovered: Some individuals were retrapped and later shot or recognized by sight records of colored bands; such are here counted only once.

* Number banded: 45 birds not released but used experimentally in other studies.

Sex of released birds, based on external characters: 279 ♂♂, 249 ♀♀, 24?

We follow essentially the banding terminology of Lincoln and Baldwin (1929: 100-101), which differs from that of Lincoln (1947: 102), as follows: *Recovery*—a general term, specifying neither time, place, nor manner of getting later information on banded bird. *Repeats*—short-time recoveries of live birds at banding place only. *Returns*—bands from all dead birds, from live birds away from banding place, and from live birds at banding place in a later season of same year.

If the autumn band returns do reflect wider than usual movement at that season, they also show that only a few of the birds moved so far. Two-thirds of all the returns were within three miles. The Plainfield data, plotted on Figure 1, show in some detail this combination of wide movement and rather close localization. For example, although most of the autumn ranges were also winter ranges, 10 of these 16 returns were not in the ranges in which they had been winter-banded. One was banded at the Granary (I, Fig. 1) in February, 1940, spent the spring at a booming ground three-fourths of a mile southwest, and was shot in September of the same year six miles north of the banding place. On the other hand, one spring-trapped male was shot during the following autumn within half a mile of the booming ground on which it had been banded, and five winter-trapped birds were shot within (or essentially so) the ranges in which they were banded. One of these was trapped in a winter pack (at D') in March, 1941, spent the spring at a booming ground just over a mile to the southwest, and was shot in October, 1941, only a quarter of a mile from the booming ground. As a matter of fact, all of the movements of three miles and more in Figure 1 are from stations with a peculiar winter history, described in a later section.

Once the autumn packs have formed, they tend to remain within quite definite areas, apart from the temporary warm-weather separa-

tions which have already been mentioned. There were two partial exceptions to this general rule on the Plainfield area, two places at which we occasionally found flocks of variable size even after the main packs had formed (BB and X, Fig. 1). These seemed to be intermediate gathering places, to which some members of the neighboring packs returned at irregular times, especially in 1939. By late autumn, however, the birds had stopped going to these places.

We know the Granary pack best, having concentrated on it during each of our three autumns on the Plainfield area, but we hunted each of the packs, following the birds all day long, day after day, during one or another of the open seasons from 1939 through 1941. Each year the Granary pack generally fed in the northern part of its range, roosted for the night near a booming ground in the northwest part, and spent much of the day in the central part of the range, either in open meadows and marshes or in one of three strips of fairly open aspen or in one of two oak woods. Upon being flushed in the morning at the feeding field the pack flew to one of the aspen or oak woods in clear weather, or to one of the marshes or meadows on cloudy or stormy days. If undisturbed, the birds spent the rest of the day without much further movement and returned to the same feeding place in late afternoon, shortly before going to roost. During the hunting season, however, hunters often kept the pack moving all day. When repeatedly flushed, the pack flew from one block of cover to another, criss-crossing the range in flights of half a mile to a mile and a half. Sometimes, when extremely hard pressed, the birds went into dense, creek-bottom cover at the southern extent of the range. Most significantly, when they had been driven to the edges of the range, they almost invariably turned back into it instead of going beyond—and this in the face of persistent hunting pressure. A few times part of the pack flew an unknown distance (at least a mile) beyond the usual limits of the Granary range. This did not happen often, however. As long as the pack held together, or split into groups of 30 birds or more, hunters (including ourselves) could seldom get close enough for a shot. Flushing the pack again and again tended to break it up and scatter it, which made for better shooting. Like the pack itself, individual birds dodged from one part of the range to another but seldom crossed its borders.

In 1939 there were about 80 birds in the Granary pack. It usually split first into one group of 50 and one of about 30, or into one group of 50 and two of about 15 each. The flock of 50 was always the hardest to approach and to keep under observation. Occasionally we followed it to the extreme southwest part of the range and jus

beyond (into X, Fig. 1). This elusive group may at times have gone even farther. More than once we lost it for the rest of the day, but we always found it back at the feeding field the next morning. In 1940 there were about 50 birds in the Granary pack. In 1941 there were at first about 125 birds in the pack, but it later dwindled to about 60. We do not know the reason for this decrease, but it was definitely

TABLE 2

AUTUMN RETURNS: HUNTER KILLS AND BIRDS FOUND DEAD (22 ♂♂, 8 ♀♀)

Place and time of recovery	Miles from banding place												Total
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	8-9	9-10	21	29	?	
First autumn after banding	9	5	3	1	1	2	2	1	1		1	1	27
Second										1			1
Third											1		1
Fourth			1										1
<i>Total</i>	9	5	4	1	1	2	2	1	1	1	2	1	30
Females only	2			1			1		1	1	1	1	

not a matter of hunting mortality. During all three autumns, daily movements were essentially the same, except that throughout the last two years the pack stayed even more closely within the Granary range proper than in 1939 (Fig. 1). With minor exceptions the very same parts of the same woods, meadows, and marshes were used each year, often in the same sequence.

Although we were less familiar with the other autumn packs on the Plainfield area, we saw in them the same basic elements of behavior. Each pack turned back at the boundary of its range; within each range there were a few spots to which the birds came most often; in general, the daily cruising radius was from a mile to a mile and a half.

We have seen no regular daily movements to the booming grounds in autumn, although Schwartz (1945: 57), in Missouri, found a definite and prolonged booming season in the fall during which "the entire adult male population appears to visit the booming grounds." On both the Plainfield and Necedah areas, autumn booming was a rare curiosity rather than a regular occurrence. Schwartz (*loc. cit.*) also found that prairie chickens in Missouri formed autumn packs by sex. The preponderance of cocks (22 ♂♂, 8 ♀♀) among the autumn band returns in Wisconsin might seem to be evidence of the same behavior, if one assumes that cock packs would for some reason take more hunting pressure than hen packs. However, we examined 74 hunter-

killed birds, of which only one was banded, on the Plainfield area from 1939 through 1941; 32 were cocks, 38 were hens, three were probably hens, and one was of unknown sex. We have no reason to believe that any of the nine autumn packs on the Plainfield area were wholly or even largely of one sex, although some of the smaller groups which occasionally split off from the main packs might have been.

Table 2 suggests that hens may travel farther than cocks, but this appears doubtful since there are only eight hens represented.

Winter.—For a time in early winter, prairie chickens were unusually hard to find on the Plainfield area. They practically abandoned the grain stubbles and corn fields that they had used so consistently as autumn feeding places; neither did they feed regularly in any certain weed fields. There was no knowing where they might feed next. We were not on the area in December during the first two winters, but probably this change in feeding habits occurred at about the time of the first snows. Later, the birds began to go more regularly to grains again; this occurred more and more consistently as winter settled in. Finally, by midwinter, a daily feeding routine had become established. Regularly, morning and afternoon, the packs came to feed in the grainfields; often the same fields were used day after day. The midwinter feeding routine was established about the middle of January in 1938–39 and 1940–41, but not until early in February in 1939–40. One pack was about two weeks ahead of the others in 1939–40.

Figure 1 shows the positions of the main feeding fields that were used in mid- and late-winter on the Plainfield area. Often these were the same fields that had been used in autumn; occasionally a new one within the boundaries of the autumn range, or just outside it (D') was used in winter. Many of the autumn roosting and loafing places also carried over, so that the change to winter conditions was possible in most cases with little or no movement beyond the normal, daily, cruising radius. Four of the autumn ranges carried birds into the winter each year: the Albert (A, Fig. 1), Stark-Booth (D), Reid (E), and Plainfield Township (J) ranges. Three more did so for each year that we have record: the Townsend and Williams ranges (B and F, two years each) and the Conover range (G, one year and probably also a second).

Winter packs are aggregations of varying degrees of tightness. They become progressively tighter and less mobile as winter clamps down. In midwinter they were most definite while at the main feeding place. The largest (100 to 200 birds), in particular, sometimes broke up into smaller units as the birds flew away. In any but the most severe weather, and perhaps rarely even then, parts of the packs

split off and fed at secondary places for a day or two. These separations were most pronounced during mild weather. The longer the mild spell, the more the packs tended to disperse and the greater the distances travelled. At least, that is our interpretation of the fact that occasionally small flocks were found feeding at unexpected places in any but the most severe weather, and that we found them most often and over a wider area during unusually moderate periods. Such movements may be simply the result of a generally increased cruising radius, or they may be specifically oriented moves of parts of a pack back toward their breeding places. Altogether, winter packs were rather unstable. As a result we were unable to census them accurately. (We estimated the winter population on the Plainfield area as one prairie chicken to 65 to 90 acres in 1939-40, and think there were fewer in both 1938-39 and 1940-41.) We can, however, outline some aspects of general pack behavior.

The midwinter feeding places were generally fields of shocked corn, although buckwheat and soybeans were eaten when available. Weed seeds were also gleaned from these fields. Other wild foods, such as buds, catkins, and acorns, were gathered in the fencerows and woods bordering the grain-fields or near roosting and loafing places. We saw no extensive movements in search of wild foods. Loafing and roosting places were fewer than in autumn, and some of them were revisited with striking regularity. On very cold, windy or stormy days, well-fed prairie chickens sometimes did not leave their roosts at all. When they did feed, they were apt to do it quickly and then to plunge under the snow to roost, at whatever time of day they finished feeding. In cold, but still and sunny, weather they often loafed in the sun at the edge of the feeding ground during most of the day. Night roosts on the Plainfield area were commonly only a quarter to half a mile from the feeding fields, and they were seldom more than a mile and a quarter from them. Apart from the wider movements during mild spells, midwinter is a time of low mobility, with a daily cruising radius of about half a mile to a mile.

Local food shortages have sometimes modified this general pattern of winter behavior. On at least two occasions an autumn range did not carry birds into the winter. The Granary pack, for example, did not start the winter of 1939-40 in its autumn range because of an early winter shortage of food, and probably the same thing also happened in 1938-39 and 1940-41. The corn shocks at the Haskins Place (C, Fig. 1) were hauled away in November, 1940, and the Haskins pack did not winter in its autumn range. Later that winter, three birds which had been banded at the Haskins Place the year before

were retrapped at other stations. Two had moved just short of a mile (to L) and one had moved two and a quarter miles (to D').

Prairie chickens which did start the winter in their autumn ranges were sometimes forced out by failure of the food supply later in the season. During the winter of 1939-40 the Haskins and Wise packs (C and L) had to find new feeding grounds, one before mid-February and the other about the first of March. One bird from the Haskins

TABLE 3

NUMBER OF BIRDS RECAPTURED AT WINTER FEEDING PLACES (48♂♂, 28♀♀, 3?)

Where recaptured	In place only				In place and elsewhere		Elsewhere only		Total
	winters				winters		winters		
	1st.*	2nd.	3rd.	1st. and 3rd.	1st.	2nd.	1st.	2nd.	
In place	59	2	1	1					63
Moved:									
0-1 mile					4	1	2	1	8
1-2 miles					2		1		3
2-3 miles							1	1	2
3-4 miles							1	1	2
4-5 miles					1				1
<i>Totals</i>			63		7	1	5	3	79
Females only			25			1		2	

* First winter: the winter during which the bird was banded.

pack was retrapped on March 15 at a distance of about four miles (N). The Albert pack (A) disappeared during the winter of 1940-41. The Townsend pack (B) also moved that winter but may have simply shifted a mile and a quarter to a different part of its range.

Movements among feeding places, as shown by banding, are summarized in Table 3. The band recoveries, although too few to be significant in themselves, supplement our field observations very well. Of the 79 recoveries, 71 were at the banding place and eight of these 71 birds were recaptured elsewhere as well. The remaining eight individuals were recaptured only at different feeding places. The longest movement was 4.3 miles; only three birds had moved more than three miles. Four birds (Necedah, Nicolet) returned to the banding place after having been retrapped elsewhere; in three instances the two stations were three quarters of a mile apart, in one, a mile and a half. These four returns probably illustrate the use of secondary feeding places. Among the Plainfield data there were only four winter returns at different stations; all four were associated with known movements in response to failure of the food supply. Finally, we know

that certain feeding places are used winter after winter. Band returns show that some of the individuals at these places are the same from winter to winter.

There are two additional complicating factors. First, some birds go to the booming grounds as early as February; this is considered in the next section. Secondly, during at least the first two winters the Plainfield area had more wintering birds than we could account for on the basis of autumn estimates and spring booming ground counts. Part of the increase occurred during pack formation in autumn, but part occurred in winter. Some of the new birds seemed quite definitely to attach themselves to resident packs, especially to the Williams pack (F, Fig. 1) in autumn and to the Albert and Townsend packs (A and B, including BB) in winter. However, new winter packs also appeared at Wise's, Silsbe's, and Stradinger's (L, M, and R), which were not autumn ranges. John Worden has fed prairie chickens at Stradinger's and Silsbe's for many winters. The winter pack at Albert's is generally the largest on the area. The few band returns from these three places suggest that only local movements are involved, but migration is a possibility. It is discussed later.

RETURN TO THE BOOMING GROUNDS

Prairie chickens often display in winter, long before the main booming season. We have seen it as early as February 10 (in 1940) and were told that it occurs on warm days throughout the winter. Often it takes place on the winter feeding field or on a booming ground within the usual, daily cruising radius. Sometimes, however, prairie chickens or their tracks were found on booming grounds which were a mile or two from the range of the nearest winter pack. Visits to the booming grounds are highly irregular in occurrence in midwinter, and far fewer birds go then than during the main booming season.

By late March the booming season is in full swing, and each booming ground has essentially its full complement of cocks. We have traced the movements of 56 winter-banded males to their booming grounds on the Plainfield area. In most cases we recognized color banded birds as individuals by reading with binoculars the large numerals on the colored bands. A few could be identified only to the color of a given trapping station. A few others were retrapped or collected. With the help of several of our friends, essentially every cock on every active booming ground on the area was checked in 1941, 1942, 1943, and 1948; in 1940 we were able to check more than half of the cocks, and in 1947 about three-quarters of them. In 1941 we also checked every cock on four of the peripheral booming grounds just outside the

area and some of the cocks on two more. Figure 2 maps the movements to the booming grounds, and Table 4 lists these band recoveries according to distance travelled and time of recovery.

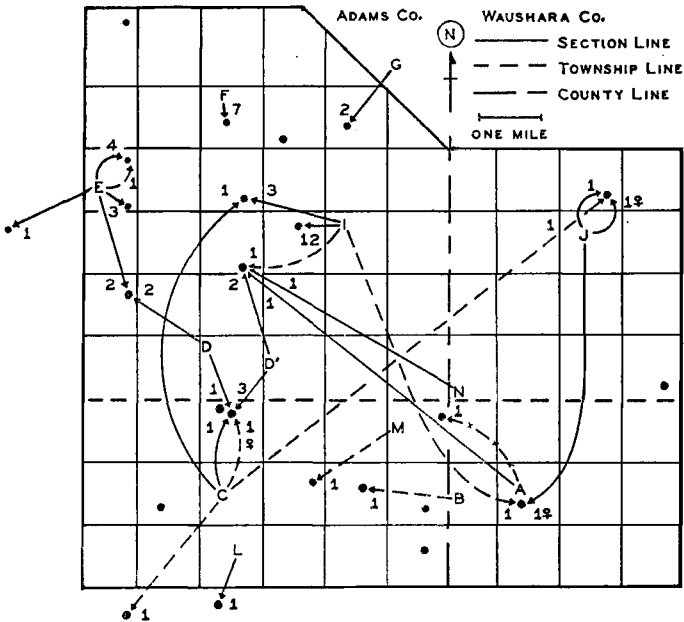


FIGURE 2.—MOVEMENTS FROM WINTER FEEDING PLACES TO BOOMING GROUNDS ON PLAINFIELD AREA.

Winter feeding places lettered as in Figure 1; booming grounds shown as dots. Solid arrows show movements of birds seen on booming grounds during first spring after banding; dashed arrows, during second spring; the dash-x-dash arrow, during third spring. Numerals show number birds from each trapping station (winter feeding place) seen on each booming ground; some were seen again in later springs, but only the first winter-to-booming-ground movements are figured. Movements at A and J are not drawn to scale; they were shorter than shown here.

The great majority of these recoveries on booming grounds show movements of not more than two miles. Of the six males which moved farther, three were from the displaced Haskins pack (C) and three were presumably members of the displaced Granary pack (I). The three long moves by members of the Haskins pack suggest that when birds are forced out of their familiar range, some may not find their way back. As supporting evidence, one male which was released eight miles from the banding place was found dead the next spring, 27 miles from the release point and 35 miles from the trapping station.

The Granary pack deserves further comment. There was a pack of about 80 birds of both sexes in the Granary range in the autumn of

1939. The pack disappeared in early winter. About 30 birds reappeared at the autumn feeding place during the last week in February. At that time also, we saw prairie chickens on the two closest booming grounds for the first time that winter. We banded 27 male prairie

TABLE 4

MOVEMENT FROM WINTER FEEDING PLACES TO BOOMING GROUNDS (56♂♂, 3♀♀)

Time and number of birds	Distance from banding place in miles							Total	
	0-1	1-2	2-3	3-4	4-5	5-6	6-7		7-8
1st. spring after banding	29*	17*		1	2	1			50
2nd.	1	4	1			1		1	8
3rd.		1							1
<i>Totals</i>	30*	22*	1	1	2	2		1	59
Females only	1	1			1				

* Including birds (12 in 0-1 mile group and 3 in 1-2 mile group) from the Granary pack. Some of these birds were seen again on booming grounds in later years. With one possible exception, only the first booming ground recovery of each bird is counted here.

chickens and one male hybrid (prairie chicken by sharp-tailed grouse) at the feeding place. Fifteen of the banded prairie chickens and the hybrid were seen on these two nearest booming grounds during the spring. We do not know where they spent the early part of the winter, before their return to the Granary, but we believe that it was about five miles farther southeast (perhaps after moving to I' to P to N, Fig. 1). These 15 cocks, therefore, may have spent part of the winter at distances of six and seven miles from their booming grounds, although their final shift, as shown in Figure 2 and Table 4, was only one and two miles. On another booming ground near the two mentioned above, we first saw the tracks of displaying prairie chickens on February 22. During the spring, sight records were obtained there of two cocks which had been winter-banded (at A and N) four and six miles to the southeast. It seems probable that a group of birds had moved back to the vicinity of this booming ground also, although we do not know where they were feeding.

The behavior of the birds which reappeared at the Granary is interesting from still another point of view. There can be little doubt that these birds came there in order to be near their booming grounds. Of the 28 prairie chickens banded after their return, 27 were males; this constituted most of the flock. A differential movement of this sort might well account for some of the winter sex packs which have been described by Leopold (1933: 120) and others. The Granary birds were, in fact, the only clear example of packing by sexes that was found in three winters' trapping on the Plainfield area.

We have only three definite returns from hens on the booming grounds; these are shown in Figure 2. One was about a quarter of a mile from the winter banding place, one was a mile and a quarter, and the third about four and a half miles. A hen banded by Schmidt in early March, 1932, was found dead in July, a mile away. We know nothing at all of the dispersal of "territorial" males. Both hens and territorial males do disperse in some manner, because the winter packs break up with the coming of spring.

Spring.—During spring the activity of booming-ground cocks centers on the booming grounds. The males go there every morning and nearly every afternoon. They may be found there at any hour of the day in cloudy weather. On the Plainfield area, cocks often spent the night on their booming ground or at its edge and fed close by, sometimes within a few hundred yards. Loafing places, water, shade, and dust baths were also, in many cases, within a quarter to a half mile. We most often found sign or the birds themselves within a mile or less. The males of a given booming ground generally came to it and left it as a group, or as a main group with a few stragglers. They seemed to stay pretty much together, even during the time that they were away from the booming ground. More information is needed on this part of their daily activity.

Territorial males, on the basis of less extensive evidence, also appeared to stay rather close to their booming places throughout the day. We have seen hens, coming to or flying away from booming grounds, make flights of a third of a mile to a mile and sometimes farther. Most nests have been found within a mile or a mile and a quarter of booming grounds; some have been as close, or closer, to territorial booming places (Hamerstrom, 1939).

It has long been known that prairie chickens may use the same booming grounds spring after spring for many years. It has not been known, however, whether the same cocks return to their former booming grounds in later years, or whether there is exchange among booming grounds in any one season. In the course of our studies on booming grounds on the Plainfield area we have individually identified 50 banded cocks, plus two just off the area. Of these, 21 were seen during more than one spring. Our booming ground observations will be reported in a later paper, but the data on booming ground continuity are summarized in Table 5. Fifteen cocks returned to their original booming grounds in later years and were not found on any other. Three were in place the second spring but were on different booming grounds the year after. Three went to new booming grounds after the first spring. It is likely that two of these last three were

actually on the same booming ground for two springs before moving, for we saw two color-banded males (identified only as to trapping station) on booming grounds where, another year, we read the numbers on bands of the same two colors. Among those cocks which did make a change, the longest move was 2.7 miles.

Rarely, cocks moved from one booming ground to another within the same season. In May, 1940, one booming ground, the First South, lost several of its males at about the time when a neighboring one gained a few, including a banded prairie chicken by sharp-tail hybrid from the First South. In April, 1940, a green-banded male spent one morning on a booming ground which we were watching fairly regularly; he was not seen there again. Although not sure of this bird's band number, we believe that he belonged on a booming ground 1.2 miles away.

Clearly then, also at this time of year prairie chickens show a strong tendency to stay within a rather small area and to be in the same place or close by in later years. Further, in the case of males at least, the spring range is close to or part of the winter range.

MIGRATION

"That at least a part of the pinnated grouse populations of former days performed more or less regular annual migrations admits of no doubt" (Leopold, 1931: 173). These migrations have been described by many authors; for details see Cooke (1888: 104-105), Widmann (1907: 81), Gross (1930), Leopold (1931: 173-175), Schmidt (1936), and Schorger (1944). Briefly, the evidence is of three kinds: (1) In the 1800's migrating flocks were often seen, moving southward in autumn (usually in November and December), northward in spring (March and April). The southward movement was apparently the more conspicuous, involving larger flocks and perhaps a shorter time-span, while the return was more often a straggling of smaller bands. (2) In the southern parts of the geographic range of the greater prairie chicken there were marked increases in the resident populations at the time of the fall migration, and prairie chickens regularly wintered in some southerly areas which had no breeders. (3) There were corresponding decreases in some of the prairie chicken populations in the north, and some northern breeding areas had no wintering birds.

Cooke (*loc. cit.*) wrote that the prairie chicken was a resident bird "in the larger part of its range," that "migration varies in bulk with the severity of the winter," and that "it is the females that migrate." These migrations covered a distance of several hundred miles, from northern Iowa and southern Minnesota to southern Iowa and northern

Missouri, perhaps even into Kentucky. Later, according to Spurrell (1917) and Swanson (MS, 1940: 190), the corn of the settlers increased the winter food in the north and reduced the extent of migrations of prairie chickens. There was still some migration in the Lake States at the time of our study, but there was almost none in Wisconsin.

We know of only one instance in which migrations of prairie chickens have been traced by banding. One of Schmidt's birds, a hen, was banded in February, 1935, in Trempealeau County, Wisconsin, at one of the wintering places of packs of supposedly migratory origin. During the second summer after banding, this bird was found dead near Ladysmith, Wisconsin, about 100 miles north and east. This is likely an instance of migration, rather than emigration, because Trempealeau County is an area to which prairie chickens used to come in considerable numbers (up to about 1935) to spend the winter, rather than an area which produced great numbers during the breeding season. Further, the winter packs came *regularly*, not sporadically.

Schmidt (1936: 197) deduced from winter sex counts that "northern Wisconsin hens winter in the southern half of the state." North of his dividing line he counted 121 cocks and 16 hens at five stations, and south of it, 49 cocks and 272 hens at three stations. His southern stations were from six to about 15 miles south of the line. At his winter-trapping stations, where most of the sex counts were made, he caught:

North of the line—78 ♂♂, 26 ♀♀, 7?

South of the line—25 ♂♂, 84 ♀♀

The Forest Service banding stations were far to the north of Schmidt's dividing line. The Plainfield area is bounded on the north by the dividing line and extends nine and a half miles south. The Necedah area lies athwart the line, but our banding stations in 1936-37 (the only year for which we have complete data) were all from six to 12 miles south. Lumping all these catches, for comparison with Schmidt's, gives:

North of the line—9 ♂♂, 8 ♀♀, 4?

South of the line—165 ♂♂, 131 ♀♀

Our trapping may not give a true winter sex ratio. At the Granary, for example, we caught 27 males and one female (practically the whole pack), but we feel certain that sex segregation there was the result of a purely local movement, as already explained. If this one pack be disregarded, the winter trapping sex ratio for the whole area becomes almost equal—126 to 118. The second greatest predominance of

males was 36 to 11. These birds were trapped at Reid's (E and E', Fig. 1), another feeding place close to a booming ground and one at which we made our largest catches in late winter. On the other hand, more hens than cocks were caught at Albert's (9: 16), Silsbe's (9: 18), and Stradinger's (4: 13), all of which packs had unexplained increments of birds in winter; these are all, unfortunately, small samplings of large packs as the figures are totals of three winters.

Recoveries on booming grounds offer another approach to the problem of differential migration by the sexes, but they likewise fail to give a clear answer. Of 107 winter-banded hens that we released in place, only four (possibly five) were seen on booming grounds in spring. This might mean that our winter hens were largely migrants. However, of 134 comparable males, only 56 were found on the booming grounds. Does this mean that males also migrate? We do not know how much of this winter to spring discrepancy in numbers for either sex may reflect movement, and how much may have been caused by mortality; nor, if movement was involved, how much of it may have been local and how much may have been migratory. Without more data we can only agree with Schorger's statement (1944: 8): "There are insufficient data to permit acceptance of differential sex migration as a general law."

SUMMARY OF BAND RECOVERIES

Some banded birds were recovered several times and thus appear more than once in Tables 2 through 5. Table 6 summarizes all recoveries of birds released in place.

Three-quarters of these 158 birds were recovered within the first year after banding, only two of them as late as the fourth year. On a scale of 100, the rate of regression is:

<i>Banded</i>	<i>Recovered</i>			
	2nd. yr.	3rd. yr.	4th. yr.	5th. yr.
100	16	9	1	0

This regression rate is fairly close to that found by Leopold *et al.* (1943) and Buss (1946) in their more detailed studies of population turnover in ring-necked pheasants in Wisconsin. The data on the pheasant and prairie chicken cannot be compared directly because of differences in intensity of trapping, size of samples, hunting pressure, and methods of recovery. However, even a rough comparison strongly suggests that the prairie chicken's rate of population turnover is of the same order of magnitude as the pheasant's. It is probably in the neighborhood of five years.

Of the 157 prairie chickens for which the data on movements are complete, about a third were recovered only at the banding place, and 81 per cent had not moved more than two miles. Only 13 per cent had moved more than three miles, and only eight per cent more than five miles. For those birds that were retaken at more than one place, we have used only the *longest* moves in these calculations.

TABLE 5
CONTINUITY OF USE OF BOOMING GROUNDS

	Banded males recovered					
	On same booming ground			On same booming ground	On new booming ground only†	
	2nd. year	2nd. and 3rd. years	3rd. year	2nd. year. new one 3rd. year	2nd. and 3rd. years*	3rd. year
In place	11	2	2			
Moved:						
0-1 mile					2	1
1-2 miles				2		
2-3 miles				1		
<i>Totals</i>		15		3	3	

† Two of these may have been at original booming ground for a second spring before moving.

* Each bird was on its new booming ground during both second and third springs.

The birds that were retaken at more than one place seem especially interesting. Seventeen repeated in place and were recovered at one other place as well, three were retaken in place and at two other places; seven were recovered at two places, and one at three, but did not repeat in place. We have 103 records on these 28 birds, ranging from six birds which were retrapped 19 times in place and at one other station during one winter, to one bird which was retrapped at a new place the second winter, seen on one booming ground during the third year and on another during the fourth. Of these 28 birds one was shot 21 miles, and another six and a quarter miles, from the winter banding station; one moved four and a quarter miles to a new winter feeding place. None of the rest were retaken more than three miles from the other places at which they were recovered at other times. Twenty of these birds were each recovered during more than one season of the year, for example—in winter and spring; in winter, spring, and autumn; and in winter and autumn. Some of them gave returns over a period of several years. These birds strongly accent the general trend of the data in Table 6; the great majority of band recoveries have been in place (at banding site) or at distances of one to three miles, even when the same birds have been followed through several seasons of the year and for several years.

Banded birds were more likely to be retrapped or seen at short rather than long distances. This is true for two reasons: First, the farther the movement from the banding place the greater the "dilution" among unbanded birds or birds banded at other stations. This would have been no problem had every bird in every pack been captured, but we practically never caught a whole pack. The distortion caused by the "dilution" factor is augmented by the fact that we caught a *disproportionately* small part of the largest packs. Thus, when a banded bird from another station joined a large pack we had only a slim chance of picking it up. Secondly, we could neither trap nor look for bands on booming grounds over a large enough area. We tried to minimize these flaws by making the Plainfield area a big one (50,000 acres) and covering it as thoroughly as we could. Figure 1 shows the distribution of trapping stations on the area. Some birds were caught at each, except for A', I'', and P. We got much better coverage in our sight records on booming grounds, as explained earlier, but there were a number of movements to the booming grounds which could not be traced for lack of winter-banded birds.

Band returns from hunter kills and birds found dead should give a more nearly random sampling, but they are not wholly free of bias. Such records, including earlier recoveries of four birds which were finally shot or found dead, are shown by the figures in parentheses in Table 6. These data also show a majority in the 0 to 3-mile groups, but there are proportionately more returns from greater distances (one-third of 40 recoveries of 35 birds) than in Table 6 as a whole. There are too few recoveries of dead birds, however, to show quantitatively what part of the population remains within a small area and what part moves about more widely.

There is reason to suspect that the longer moves in Table 6 were caused by deficiencies in food and cover. The Plainfield area lies within the best prairie chicken habitat in Wisconsin. The Necedah-Babcock region, even at the time of the Schmidt and Soil Conservation Service bandings, was already deteriorating as prairie chicken country. The Plainfield returns make up two-thirds of the data in Table 6, yet only 11 of the 21 birds which moved more than three miles were Plainfield birds. Further, the longest movement among the Plainfield birds was 7.5 miles, as compared with 29 and 100 miles among the others. Finally, of the most distant Plainfield recoveries, five were definitely, and four more probably, from winter packs which were displaced by failure of their food supply. In short, the longest moves of all were in the less suitable parts of the state, and most of the longest moves in the best habitat were the result of local food short-

ages. Schmidt's hen, found dead in summer 100 miles northeast of the winter banding place, probably is an example of a migratory movement, but migration of prairie chickens may be the result of inadequate winter food and cover.

SUMMARY AND CONCLUSIONS

Our field observations have shown that some of the same booming grounds have been used in spring year after year, that packs formed in the same autumn ranges each year and tended to stay in these ranges through the winter, and that each pack fed for the most part in a limited number of fields, sometimes in only one or two, during both autumn and winter. Banding showed that some of the same individuals continued to be present in these groups in a given spring or winter and in succeeding springs and winters, that some individuals were found in winter, spring, and autumn within an area two to three miles in diameter, and that 87 per cent of all bands recovered showed no greater movement. Banding also showed that some of the birds were not so closely localized, that there was some exchange among winter packs and among booming grounds, and that some individuals moved much farther than the rest, up to 29 and 100 miles. However, the 100-mile movement was presumably an instance of migration, and most of the remaining longer moves were associated with parts of the state from which prairie chickens have since all but disappeared or were associated with known exhaustion of winter food on specific ranges on the Plainfield area. In a few instances, loss of the winter food supply forced whole packs to leave their usual ranges. At least one group of cocks made a late-winter movement to quarters close to the booming grounds, after an early-winter disappearance of all the birds in that neighborhood. We feel sure that this was a movement to a *familiar* booming ground, not an indiscriminate one to *any* booming ground. There may be a "fall shuffle" of some sort.

There have been unexplained increases in both autumn and winter packs. Winter packs have regularly appeared in a few places which were not autumn ranges. Some of these extra birds may have been members of locally displaced packs and some may have moved in from the immediate neighborhood of the Plainfield area. There may, however, have been some kind of major movement about which we know nothing, especially in the case of the Albert pack which was the largest (100 to 200 birds) on the area. We know nothing of the reasons for the basic behavior patterns which we have seen. Why, for example, should the same acre or two in a 500 acre meadow be used as a booming ground through generations of prairie chickens? Why

should a winter pack continue to feed in one cornfield among many? By the end of winter the other fields must have had more untouched ears on the outside of the shocks and hence a more easily available food supply, than the one which had been worked over daily. Why should the same field be used the next winter, and the next? John Worden has fed prairie chickens at Stradinger's for many years. In some winters the whole crop has been taken in before the birds appeared; a few corn shocks, if put out at once, have held the pack for the rest of the winter, even though whole fields of corn were available within a mile. In short, prairie chickens can and will make wide local movements, even migrations, if necessary. Why, then, do most of them move about so little?

We suspect that the answer lies in habit, or tradition, or, by whatever name it be called, in some sort of sense of familiarity with a place. It is carried through from one year to another, probably by the old birds. An animal in familiar surroundings should be more secure than one in strange territory, especially in the day-to-day happenings which determine the survival of individuals. It is, after all, the sum of the survival of individuals which determines population densities. A movement outside the radius of familiarity, whether to find a winter food supply in the first place or to find a new one during winter, is a movement into strange surroundings. Autumn shifts are doubtless less serious than winter moves, as there is still time during the period of abundant food and cover to learn the details of a new range. It is well that shifts due to population pressure are apt to come in the fall. Winter moves are surely more hazardous; at best they mean the adoption of new headquarters in unfamiliar territory at the time when environmental conditions are at the yearly neap. At worst, a roving band may not find a new food supply. Here again tradition might play a vital part, if a few "old timers" in a flock can lead the rest to a place that offered a safe haven in the past. On the other hand, when a winter pack of prairie chickens has been forced to seek a new feeding place at a distance, the return of the cocks to the booming grounds in late winter may again expose them to a food shortage.

In other words, the usual condition for prairie chickens may be to spend their lives in a small area. Even in the late 1800's, Cooke (*loc. cit.*) considered them resident birds in the greater part of their range. During the time of their great abundance, population pressure doubtless caused some of them to move about, perhaps quite extensively. We cannot believe, however, that population pressure has been an important factor in the Lake States during the last 15 years.

It seems more likely that long-range movements, whether local or migratory, of a large part of the population are now an indication that the habitat is deficient in some respect. Long-range movements doubtless have a high survival value for the race, giving it a chance to find more suitable quarters at a distance. It was this capacity, probably, that enabled prairie chickens to move north so rapidly during the lumbering-off of the Lake States, with annual migrations making it possible for them to use the newly cleared land as breeding range before it became suitable year-long range. Now, however, there are few places left for prairie chickens to go; their range has largely been destroyed. Given the right kind of cover, prairie chickens could migrate to find winter food, but food without cover will not serve.

Schorger (1944: 24) has commented on the virtual isolation of the remnant flocks in Wisconsin and has suggested that "recruits from other regions" may have been an important factor in maintaining their earlier abundance. This may mean that prairie chickens reproduce well only at high population densities; it may mean that Wisconsin, north of the prairies, was always marginal prairie chicken range. In any case, recruits from outside now come in only trifling numbers.

If prairie chickens are to be restored to greater abundance in the Lake States, or if they are to be held at no more than their present low level, the problem is thus almost wholly a *local* one—food and cover well distributed, in blocks close to one another. Long-range movements may possibly take the birds to safety somewhere else; but in this region, now, long-range movement of resident flocks is more apt to mean that local extirpation is in sight. And the sum of many extirpations is extinction.

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