Richard G. Miller

1147

REPORT ON A

GAME SURVEY OF THE NORTH CENTRAL STATES

MADE BY

ALDO LEOPOLD

FOR THE

Sporting Arms and Ammunition Manufacturers' Institute

UNDER DIRECTION OF ITS

Committee on Restoration and Protection of Game

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MADISON, WISCONSIN

1931

Copies obtainable from American Game Association, Investment Bldg., 15th & K Sts., NW, Washington, D. C. at $1.00 each postpaid

PRINTED IN U. S. A.
DEMOCRAT PRINTING COMPANY
MADISON, WISCONSIN

PREFACE

THE purpose of this survey is to appraise the chance for the practice of game management as a means to game restoration in the north central region. It attempts to describe game conditions as they exist, the opportunities which those conditions offer, the human machinery available for acting on them, and the probable consequences of their further neglect.

The survey is financed by the sporting arms and ammunition industry. The motive hardly requires explanation: success in game restoration means continuance of the industry; failure in game restoration means its shrinkage and ultimate liquidation.

The method of survey was to compile and interpret the observations and experience of sportsmen, naturalists, scientists, officials, and landowners. Time permitted of only such original field investigation as was necessary to understand and appraise the significance of work already done by others. Methods had to be developed by trial and error, hence the States surveyed last are described best.

The survey concentrated on farm game, because the crux of the game problem is on the farm. Our legislatures decree game conservation; our sportsmen and nature-lovers resolve we shall have it, but our landowners do not practice it, nor are they yet offered any inducement or motive, other than altruism, for doing so. At the same time the public expects the free run of their lands, and of such game as may accidentally persist thereon. Such is our present impasse. Some more tenable relationship between the landowner, the game, and the public is obviously needed. The farm seemed the place to seek light on what it should be.

The survey began July 1, 1928. Map 3 shows routes and dates of travel. Reports on the progress of the survey have been given from time to time before the American Game Conference, Izaak Walton League conventions, and other public meetings, and published in their proceedings.

No single statement in this report is offered as final or sufficient fact. (This qualification is needless for those who realize there is no such thing.) On the contrary the whole thought and purpose is to show how much and what interesting work remains undone, and what services to conservation may result from its competent performance. The success of the survey will lie not in how long its findings stand, but rather in how quickly they are superseded by more thorough work.

Many cooperators in many fields have generously contributed their time, thought, and the accumulated results of their own labors. Their names are listed in the Appendix.

As a means of stimulating action on some of the unanswered biological questions disclosed by the survey, the institute has financed fellowships for their study at the universities of Minnesota, Wisconsin, and Michigan. These are under the advisory supervision of the U. S. Biological Survey. A further purpose of the fellowships is to demonstrate the possibilities of professional training in game management.

A companion volume to this report, defining terms and outlining principles of game management, is shortly to be published. This will incorporate a series of lectures delivered by the author at the University of Wisconsin in 1929.

December 1, 1930 ALDO LEOPOLD.

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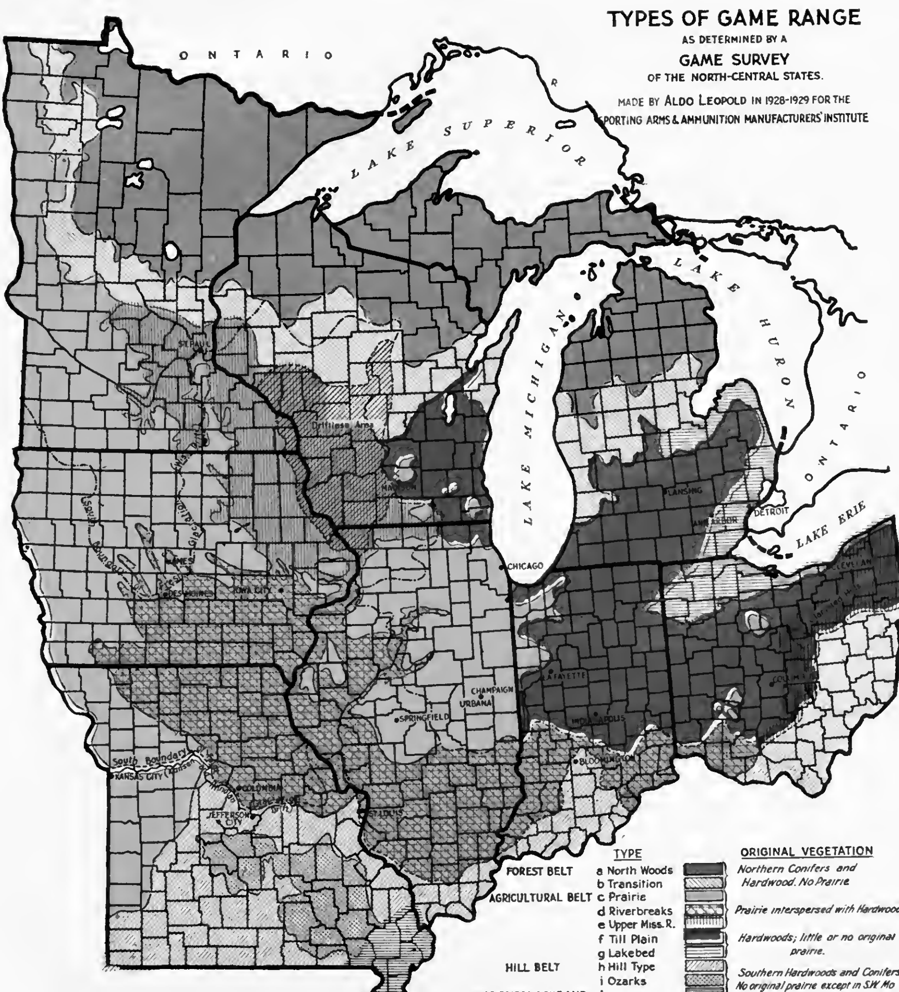


Map 1: Types of Game Range.

GAME SURVEY OF THE NORTH CENTRAL STATES

CHAPTER I

Description

TYPES of Game Range. For game purposes the north central region may be divided into four belts, and these subdivided into 10 types of game range. The distribution of these types appears in Map 1, their areas in Table 1, and their characters in Table 2.

The species and abundance of game possible to produce in any given area depends on its vegetation, culture, soil, physiography, and climate. Hence the types represent different combinations of botany, agriculture, geology, and weather.

In order to make the types as few and as compact as possible, it has been necessary to ignore many small differences known to exist on the ground.

Affection born of nativity is probably in part responsible for my conviction that no region in the world was originally more richly endowed with game than this one, quantity and quality both considered. Contrary to common belief, the cream of its game country was the prairie type, which is now the poorest. The Agricultural Belt, which stretches in a broad east-and-west band across the region, was richer in game than either the Forest Belt to the north, or the Hill Belt which parallels it on the south. Game went with rich soils, and there displayed its greatest tenacity in the face of settlement. Likewise, game restoration will be easier on rich soils, other things being equal.

Settlement preceded westward across the Agricultural Belt, beginning at its east end just after the Revolution, and reaching its western extremity after the Civil War. Lateral movements into the Lake States and the Ozarks followed, like waves from the prow of a ship, but these struck upon poorer soils, and have recently receded.

It is important to visualize these movements, because most species of game *increased with pioneer agriculture.* An increase of game rode, as it were, on the wave of settlement, but a decrease soon followed. Conversely, recessions of settlement have temporarily restored game, as is seen later. The important point is for the reader to realize that game environments, and hence game abundance, are the result of dynamic and fluctuating, not static or stationary, forces. Many of these forces can be controlled.

TABLE 1.—*Areas of Types of Game Range—North Central Region*

Belt Type	Lake States						Prairie States										Region	
	Minnesota		Wisconsin		Michigan		Iowa		Illinois		Indiana		Ohio		Missouri		Total	
	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%
FOREST BELT																		
(a) North Woods	34,700	41	17,000	30	29,300	51	—	—	—	—	—	—	—	—	—	—	81,000	18
(b) Transition	11,000	13	17,600	32	8,300	14	—	—	—	—	—	—	—	—	—	—	36,900	8
AGRICULTURAL BELT																		
(c) Prairie	28,600	34	900	2	—	—	31,000	55	25,200	45	2,200	6	400	1	13,400	19	101,700	22
(d) Riverbreaks	—	—	—	—	—	—	16,400	29	25,100	44	8,000	22	2,200	5	16,900	25	68,900	15
(e) Upper Mississippi	10,400	12	11,600	21	—	—	8,800	16	2,200	4	—	—	—	—	—	—	33,000	7
(f) Till Plain	—	—	8,900	16	16,000	29	—	—	1,000	2	20,100	56	21,900	53	—	—	68,000	15
(g) Lake Bed	—	—	—	—	4,600	6	—	—	—	—	100	0	5,200	13	—	—	9,900	2
HILL BELT																		
(h) Hill Type	—	—	—	—	—	—	—	—	3,000	5	5,900	16	11,600	35	24,000	34	44,500	10
(i) Ozarks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11,000	16	11,000	2
(j) MISSISSIPPI LOWLAND	—	—	—	—	—	—	—	—	100	0	—	—	—	—	4,100	6	4,200	1
Total	84,700	100	56,000	100	58,200	100	56,200	100	56,600	100	36,400	100	41,300	—	69,400	100	458,800	100

TABLE 2.—*Character of Types of Game Range—North Central Region*

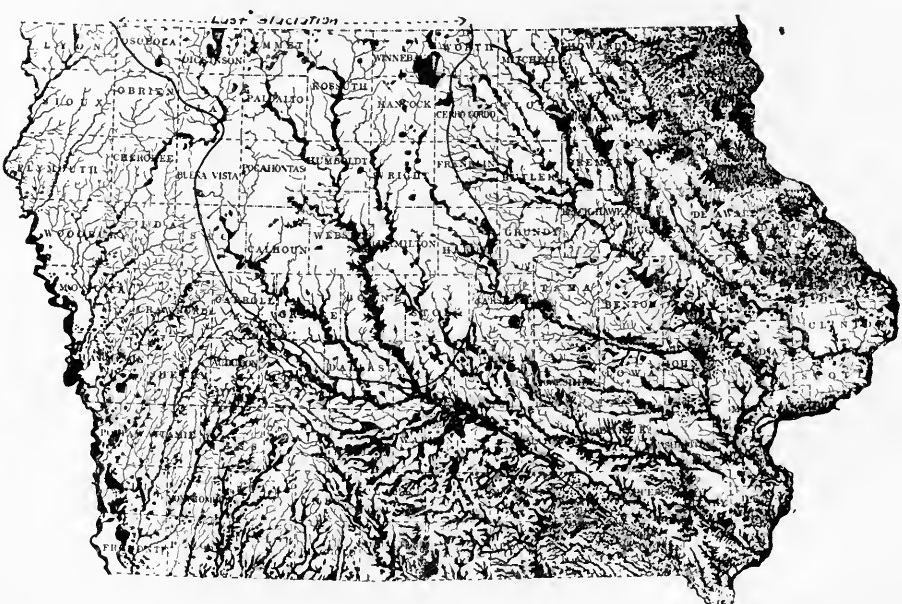
Belt and type	Original Vegetation		Present Use		Physiography		Topography	Usual Range of Land Values	Principal game species
	Prairies	Woodland	Per cent in farms	Farms reverting?	Usual Soil origin	Lakes and Swamps			
FOREST BELT—									
(a) North Woods	None	All	0–25	Yes	Glacial drift	Many	Various	$1–$2	Whitetail deer, ruffed grouse, snowshoe rabbit
(b) Transition	None	All	25–50	Yes	Glacial drift	Many	Mostly flat	$1–$10	Pinnated and sharptail grouse, ruffed grouse
AGRICULTURAL BELT—									
(c) The prairie	Nearly all	Only on streams	Nearly all	No	Drift and limestone	Where glaciated	Flat	$100–$150	Quail, pheasant, cottontail, Hungarian partridge
(d) Riverbreaks	Half (none in Indiana and Ohio)	Half	Nearly all	Few	Loess and Gray clays	Only along rivers	Partly hilly	$15–$100	Quail, cottontail, squirrel
(e) Upper Mississippi	Half (on ridges)	Half (in hollows)	Nearly all	Few	Limestone	Few	Dissected plateau	$25–$100	Quail, cottontail, squirrel, ruffed grouse
(f) Till plain	Few	Nearly all	Nearly all	Few	Glacial drift	Many	Gently rolling with moraines	$50–$100	Pheasant, pinnated grouse, quail, cottontail, Hungarian partridge, squirrel
(g) Lakebed	Few	Nearly all	Nearly all	Few	Lake silt and sand	Few	Flat	$25–$100	Hungarian partridge, cottontail, quail.
HILL BELT—									
(h) Hill type	Some in southwest Missouri	Nearly all	25–75	Yes	Various	None	Hilly	$10–$75	Quail, cottontail, squirrel, turkey, whitetail deer
(i) Main Ozarks	None	All	Under 25	Yes	Various	None	Very hilly	$5–$50	Turkey, deer, quail, squirrel
(j) MISSISSIPPI LOWLAND	None	All	25–75	No	Alluvial	Many	Flat	$100–$150	Turkey, deer, waterfowl, quail, squirrel, swamp rabbit.

Agricultural Belt. All counties in the Agricultural Belt are over 50 per cent farmed, and most of them consist almost entirely of improved farms containing not to exceed 25 per cent of woodlots, swamps, bluffs, or other "rough" lands.

The five types in this belt differ from each other in their proportion of original prairie, and in the origin of their soils.

The prairie type contained no timber except along streams, hence its present upland timber is scanty and limited to artificially planted or escaped species. The soil is deep, rich, and black. The glaciated parts originally contained many swamps and lakes, most of which are now drained. In the unglaciated parts swamps were confined to bottoms. The streams are muddy. The prairie type was the home of the prairie chicken. Parts of it now support pheasants, and parts a few quail.

The type here called "riverbreaks" was originally hardwood timber, interspersed with an infinity of prairies, large and small. The degree of this interspersion may be judged from Map 2 and 2a.



Map 2: Interspersion of Original Prairie and Timber in Iowa (compiled by B. Shimek).

By comparing these with Map 1 it will be apparent that the boundary between the riverbreak and prairie types has been arbitrarily simplified. The predominant riverbreak soils are yellow loess, and grayish clays. Evidences of glaciation are weak, or have been covered by the loess blanket. Erosion is frequently active. Old gullies stabilized by brush are characteristic of this type. Its original timber is now of course largely cleared. It may be distinguished from the prairie type by

Map 2a: Interspersion of Original Prairie and Timber in Illinois (compiled by V. E. Shelford).

its light-colored soil and by the presence of old oaks on uplands. Most of its topography is broken, but some parts are flat. The streams are muddy. This was the original turkey and deer country. The outstanding present game is quail. Pheasants do not thrive in it.

The Upper Mississippi type is like the riverbreaks in its original interspersion of numerous prairies. In that part called the "driftless area" the prairies were usually confined to long narrow ridges, the whole topography being that of a dissected plateau, undisturbed by glaciation. The original roads (and hence many of the present towns) in the driftless area were established on these prairie ridges. The timber is hardwood, and is confined to the hollows or ravines. The streams of the driftless area are clear and spring-fed, and many now contain trout. Erosion is bad.

In addition to the driftless area, some glaciated parts of northeastern Iowa and southeastern Minnesota are included in the Upper Mississippi type. The prairie ridges of the Upper Mississippi type were fine chicken country. The hollows still contain quail.

The till plain contained few original prairies. It has the irregular rounded topography characteristic of recent glacial deposits. For the same reason there are many lakes, ponds, and swamps, few but clear streams, few outcrops of native rock, but many gravelly or rocky moraines, to which the remaining hardwood timber is largely confined. All of these characters fade out southward except the presence of gravel in the soil. The till plain lacks the brushy gullies characteristic of the riverbreak type. Nearly all of the game species of the region originally abounded in the till plain. At present the principal species are pheasants in the north and quail in the south.

The lakebed type is the flat bottom of an old glacial lake. It contained some original prairie, but was mostly covered by large hardwood timber, now cleared. There are no moraines, but some coastal swamps. The soils are heavy and light-colored, interspersed with sandy strips representing old beaches. The game is like that of the till plain, but Hungarian partridges seem to thrive better than pheasants.

Forest Belt. The rich farmlands of the Agricultural Belt are bordered on the north by a transition type, characterized by the beginnings of coniferous timber and much poorer soils, often sandy. Less than half of this type is in farms, and the percentage is decreasing. The transition from the Agricultural Belt is often sudden. Jack pine or scrub-oak barrens, large defunct drainage districts, and unpainted barns are frequently to be seen. Forest, grass, and peat fires have seriously deteriorated large areas. The streams are clear and contain trout. This was originally deer and ruffed grouse country, but fire, clearings, and cultivation have now added the prairie hen and sharptail grouse.

To the north the transition type borders on the north woods, differing from it only in the lesser percentage of agriculture and the larger timber, less completely destroyed. It consists of cutover pine, hardwood, and swamp types variously interspersed, but not here differentiated. The northern parts of the forest type were originally moose and caribou country, but as a result of the northward shift experienced by all species consequent to settlement, the whole type is now deer and ruffed grouse country, while prairie chickens have successfully invaded the larger cleared and burned areas.

Hill Belt. Bordering the Agricultural Belt on the south is an unglaciated hill country which Sauer, in Missouri, has called "the Ozark border." The breaks of the Ohio in Illinois and Indiana are substantially similar—likewise the hill country of southeast Ohio, except where underlain by shale. The shale hills are inferior, as game country, to the limestones which prevail elsewhere in this type. The hill type has from 25 to 75 per cent of its area in farms, but the percentage is decreasing. The prevailing timber is hardwood, but the northerly outposts of shortleaf pine and scrub pine appear on its southerly edge. The streams are clear and spring-fed. There are no swamps. Turkey and deer were the original game. Quail and (in Missouri) turkey are the present species of outstanding value. The exotic birds do not thrive. Swamp rabbits occur on the south-flowing streams.

The main Ozarks resemble the hill type, but their rougher topography and poorer soils reduce the percentage of farms, and make turkey and deer, rather than quail, the outstanding game species. The numerous streams are spring-fed and clear, and now contain bass or trout. Words do not describe them. They must be seen to be appreciated.

Both the Ozarks and the hill type are frequently burned over, and always have been. In fact, parts of the western border were originally reduced by fire to a park-like intermixture of scattered timber and grass, so open that some called it "prairie."

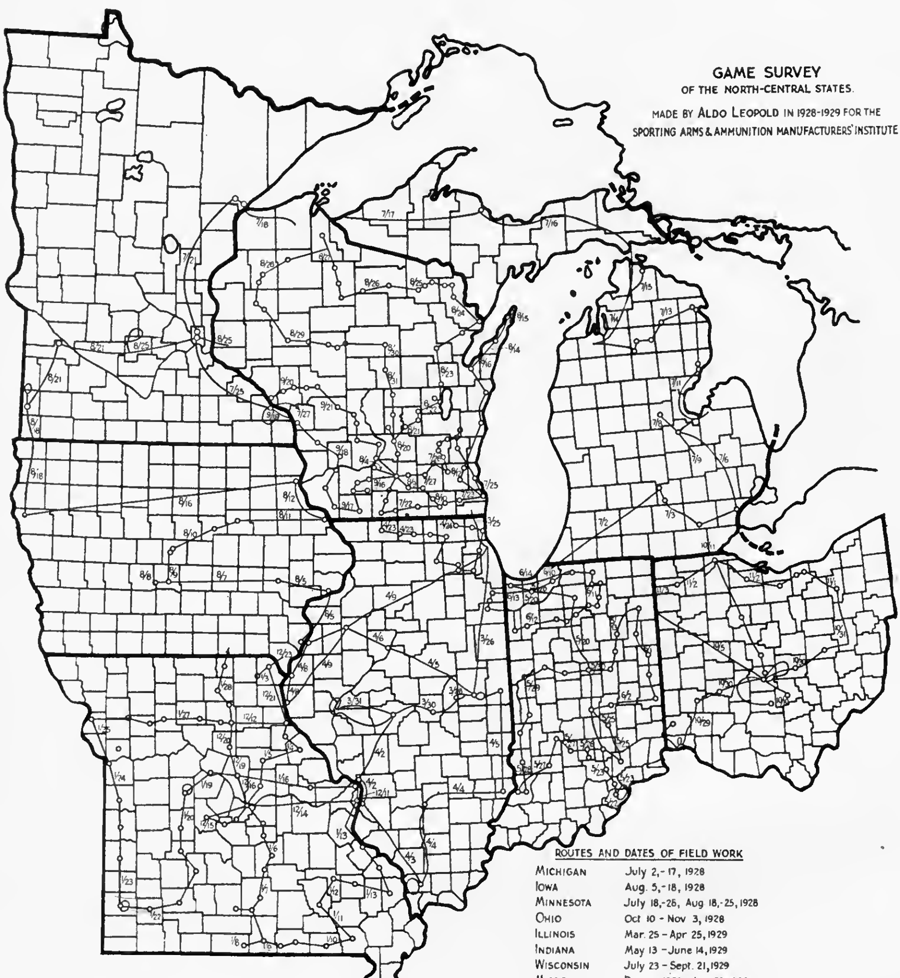
Lowland Belt. Southeast Missouri includes the northerly projection of those black gumbo bottoms which characterize the lower Mississippi. Cypress trees, cotton, canebreaks, and winter mallards proclaim this area as belonging to the southern, not the north-central, gamelands.

Although this north-central region reaches from caribou to cottonfields, we have throughout the bulk of the area an essential unity of rich soils, ample rainfall, game-killing winters, and food-bearing vegetation. No single county has left less than one native resident game species of high sporting and aesthetic value, while many counties have as high as five, in addition to a wealth of migratory game. Transecting the region we have a belt of intensive agriculture dotted with industrial cities, which fades out northward and southward to near-wilderness. In short, the region presents the whole gamut of possible opportunities for creating an orderly adjustment between "men who love sport" and the wild life resources which produce it; men who insist on conserving "Outdoor America" but at the same time insist on expanding an already unprecedented population growth and economic prosperity. Can they do both? Can wild game be produced in a motorized and moneyed democracy? Here, if anywhere, is the place to seek the answer.

Method of Survey. Each State was surveyed separately, in this order:

State	Dates in field	Year	Number persons consulted	Number localities visited
Michigan	July 2–17	1928	43	17
Iowa	August 5–18	1928	36	11
Minnesota	July 18–August 25	1928	40	11
Ohio	October 10–November 3	1928	38	23
Illinois	March 25–April 25	1929	73	30
Indiana	May 13–June 14	1929	78	44
Wisconsin	July 23–September 21	1929	184	96
Missouri	December 14–January 28	1929–30	129	58

In each State from one to two months were spent in the field, followed by the compilation of a typewritten report. These reports were sent to selected



MAP 3

local officials and sportsmen for criticism, but not published. The present report is compiled from them.

Routes traveled appear on Map 3.

The mechanics of field work in a given State, as finally evolved by trial and error, were roughly as follows: the State capital and State university were visited first, for the purpose of absorbing a general impression of the State's conditions and problems from official records, libraries, officials, and faculty. This yielded specifications of what to look for in the field, and a partial list of persons throughout the State informed on each problem. The problems and persons were then plotted on a map, a car rented, and the field travel begun. The list of persons and problems to see naturally grew as the field travel progressed. After making a round of the State, the capitol and the university were usually re-visited for the purpose of checking up on the information gathered in the field, and for advice on its interpretation.

Cumulative tabulations, charts, and maps, as well as field notes, were used to record information gathered in the field, the objective being to perceive trends during, not after, the completion of field work, and to end up the field work with the foundations of a report already completed.

One of the obstacles to accurate appraisal of problems by means of such a survey is its seasonal lop-sidedness. The mental picture of a game environment seen in summer is likely to give too optimistic an inference as to winter conditions. For this reason the investigator should either have personally lived in the general region which he is surveying, or cover it during both seasons.

CHAPTER II

BOBWHITE

History

THE Four Stages. It is important for the reader to start out with the conception that the status of any species of game is not a static condition nor a uniform trend, but rather the constantly changing result of the interplay of many forces, some of which are visible and others invisible, but all dynamic. Nothing is more fatal to straight thinking in conservation than to assume that we see everything that happens, or that causes are simple, separate, or constant.

To visualize the history of quail in the north central region, the reader must picture four distinct stages. These did not occur in all parts of the region at the same times, but they occurred in the same order, and the status of quail changed greatly with each successive one.

First comes the virgin or pre-settlement stage. Our knowledge of this is conjectural only. It seems likely that quail were confined mostly to the edges of prairies, and to open woods made park-like by frequent fires. There were probably severe fluctuations in abundance, and also distinct seasonal movements by reason of changes in weather, fire, mast, seed crops, and predators.

Next came the era of settlement and crude agriculture. The settler brought with him grain fields, civilized weeds, and rail fences. He converted an increasing area of woods into brushy stump lots, and on the prairie he added osage hedges to the quail environment. Grain, brush, weeds, and hedges stabilized the quail crop and extended the area of quail range. Clearings extended it further into the woods; hedges extended it further into the prairies; grain extended it northward into new latitudes. At the same time all these changes probably also increased the per acre population. Quail were sporadically trapped, but never shot in the early days. There was a gradual but very large increase in total numbers and in distribution, which lasted, in the greater part of this region, for more than fifty years.

Third came the era of agricultural intensification. The weedy rail fence was replaced by naked wire. Brushy woods were converted into bare pasture, and hedges were uprooted from the prairie farms. With these unfavorable changes came also bird dogs and shotguns, cheap ammunition, and increasing leisure. These processes of modernization began early on the prairies, but only a decade ago in the Ozark hinterlands. They were accompanied by a decrease in quail, frequently due to overshooting, and nearly always due to a decrease in the area of habitable range.

Close on the heels of agricultural intensification came the present era of agricultural depression, good roads and automobiles. Reversion of marginal lands created additional cover and food in some States, but this advantage was about offset by the sudden spread of good roads and motor travel, a further increase in population and leisure time, and further improvements in arms and ammunition. Out of all this comes the posted farm, the impending threat of the songbird list, and the eleventh hour rush to legislate the conservation of a shrinking resource, or to bolster it up with foreign substitutes. Finally has come the extremely recent realization that quail are a crop, the production of which can be aided by legislative enactments, but accomplished by one and only one method, namely the modification of the land to make the environment favorable.

To realize that quail are a crop does not of itself, however, answer the practical question of how to produce it. Where? Why? How many? By whom? With what help? For whom? Under what terms?

These are the questions to be untangled, in so far as may be possible, in this chapter.

Changes in Distribution and Abundance. We are accustomed to thinking of all game as unbelievably abundant before the advent of the white man, and suffering a uniform decline with the spread of settlements. The reader may not, therefore, accept without proof the assertion that there was a great increase in quail during the era of early settlement. Accordingly let us examine some of the historical evidence.

In 1882, Wheaton, Ohio's foremost ornithologist, recorded the opinion that the quail was "probably absent or at least confined to but few localities in the State at the time of its first settlement, and *has steadily increased in numbers as the forest has been cleared away.*" The italics are mine.

Wheaton quotes Dr. Howard E. Jones as saying that his great-grandfather settled near Chillicothe in Ross County in 1798, and resided there several years *before he heard the first quail.* He records this event with delight, and clearly regarded the bird as an arrival from other parts.

Chillicothe is in the heart of what has since been the best quail country of Ohio.

Hatch, the first State zoologist of Minnesota, writes in 1892 that bobwhite is

" . . . following up the progress of agriculture steadily but is nowhere yet abundant. . . . Reverend Mr. Gear . . . an army chaplain (at Fort Snelling) (says) that there were no quails here until imported . . . by sportsmen amongst the army officials on different occasions. Want of food . . . prevented their material increase . . . until the advent of general farming. Now seen at Red Lake Falls and the latitude of Ottertail."

Woodruff, in his "Birds of the Chicago Area" (1907), says of bobwhite:

"Of late years the range has been gradually extended westward along the lines of the railroads."

He probably means westward across the plains States, and implies that the quail followed the grain farms which followed the railroads.

Nelson, in "Birds of Northeast Illinois" (1877), says of quail:

" . . . still a common resident (in northeast Illinois) . . . exceedingly numerous in southern Illinois."

The most convincing witness, however, is found not among the ornithologists, but rather among the first generation of thinking sportsmen. Bogardus, in his "Field Cover and Trap Shooting" (1874), writes of quail:

"They are much more numerous now in Illinois and the other prairie States than they were formerly. I think the *cultivation of the land and the growth of osage orange hedges* have brought about the increase. . . . Last fall (1873?) there was not one quail (in Alabama, Louisiana, Mississippi, Tennessee) to a hundred . . . in Illinois."

The evidence published by authorities is corroborated by the verbal evidence of old-timers. Edward Rune, a market hunter whose parents pioneered in northeast Missouri with the Boone family, and who lived in Des Moines County, Iowa, until his death about 1905, frequently told me that quail were not especially plentiful in either Missouri or Iowa before the advent of grain and clearings. His experience was confined to the riverbreak type, which is now the cream of the quail country.

Nelson's phrasing possibly implies a decline in northern Illinois by 1877. Wheaton saw no decline in Ohio by 1882. Kumlien (1903) says that the quail of Wisconsin:

" . . . gradually decreased in numbers until about 1885, (when) they were entirely absent from many localities where they were once common. The clearing away of underbrush, and the introduction of wire fences in place of the old-fashioned rails, with their weed covered space on each side, probably had as much to do with their disappearance as too close or lawless shooting."

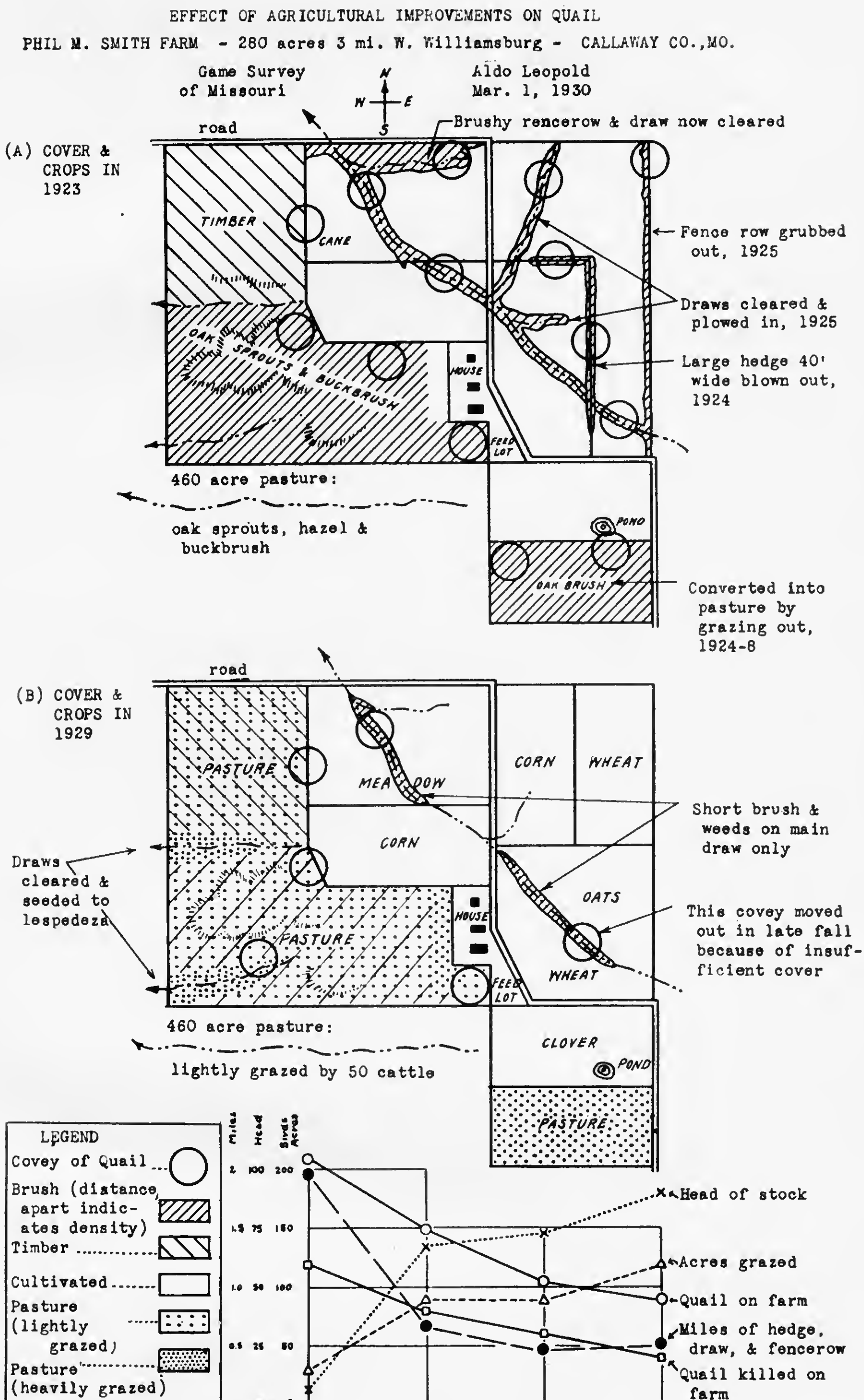
The early decline in Wisconsin is corroborated by the early closure to all hunting (about 1894).

Hatch implies a still rising trend in Minnesota in 1892. Huff thinks the decline in Southern Illinois began about 1905.

The decline had in places reached an advanced stage when Ohio was closed in 1912 and Iowa in 1917.

In general, then, the third stage, that of decline with clean farming, seems to have begun as early as 1875 in some regions, and as late as 1905 in others. In the remote Ozarks there is little farming, clean or otherwise. There the third stage is indistinguishable from the fourth.

History of Quail on a Typical Farm. The rise and fall of bobwhite in the region as a whole is more convincing when followed in detail on a specific farm. It is hard to find one with a known physical history paralleled by a known history of game. In Callaway County, Missouri, I had the good fortune to find a farm on which at least one stage (that of agricultural intensification), can be definitely traced and measured.



EFFECT OF AGRICULTURAL IMPROVEMENTS ON QUAIL
PHIL M. SMITH FARM - 280 acres 3 mi. W. Williamsburg - CALLAWAY CO.,MO.
Game Survey of Missouri
Aldo Leopold Mar. 1, 1930
N
W
E
S
road
Brushy rencerow & draw now cleared
(A) COVER & CROPS IN 1923
TIMBER
CANE
Fence row grubbed out, 1925
Draws cleared & plowed in, 1925
OAK SPROUTS & BUCKBRUSH
HOUSE
Large hedge 40' wide blown out, 1924
FEED LOT
460 acre pasture:
oak sprouts, hazel & buckbrush
POND
OAK BRUSH
Converted into pasture by grazing out, 1924-8
road
(B) COVER & CROPS IN 1929
PASTURE
MEADOW
CORN
WHEAT
CORN
Short brush & weeds on main draw only
Draws cleared & seeded to lespedeza
OATS
HOUSE
PASTURE
This covey moved out in late fall because of insufficient cover
WHEAT
FEED LOT
460 acre pasture:
lightly grazed by 50 cattle
CLOVER
POND
PASTURE
LEGEND
Covey of Quail
Brush (distance apart indicates density)
Timber
Cultivated
Pasture (lightly grazed)
Pasture (heavily grazed)
Miles
Head
Birds Acres
2 100 200
1.5 75 150
1.0 50 100
0.5 25 50
0 0 0
Head of stock
Acres grazed
Quail on farm
Miles of hedge, draw, & fencerow
Quail killed on farm
1922
1925
1927
1929

MAP 4

Phil M. Smith took over the management of his 280-acre farm near Williamsburg in 1923, soon after graduating from the Missouri Agricultural College. At that time the farm was about half timbered and practically ungrazed. It had been devoted primarily to the production of grain, and was considered a "run down" place.

During the last seven years Mr. Smith has been rebuilding the farm to fit the standards of modern agriculture. He has de-brushed the fence rows, cleared out and filled in the gullies, removed the osage hedges, and is converting the brushy woodland to pasture.

The livestock on the farm has been largely increased in order to consume the vegetable products on the ground. Rotation of crops and other measures for the conservation of soil fertility have been put into effect. Mr. Smith's technical education has probably enabled him to convert the findings of modern agricultural research to actual practice in about the way the college would like to have it done everywhere.

Incidentally he is also a keen and lifelong sportsman, with a special interest in quail. This enables him to remember with substantial accuracy the complete recent quail history of his farm.

The farm began with about 210 quail in 1923, and now has about 90. All of the hunting has been done either by Mr. Smith himself, or under his direct observation. The quail stock was probably somewhat over-shot, but since much open territory in Missouri is shot even harder and still maintains its birds, the decline in numbers of quail on the Smith farm is in my opinion the effect of the physical changes brought about by agricultural improvement. The history of these improvements and the decline in quail are summarized on Map 4, including the graph at the bottom, and in Table 3.

It is clear that the quail declined while the farm was being improved. This of course does not conclusively prove that the decline was *caused by* the improvements. The proof would be stronger if there had been no shooting, or very light shooting. The fact, however, that these two concurrent tendencies appear on thousands of similar farms throughout the cornbelt, both shot and unshot, is to all practical intents and purposes evidence of a cause-and-effect relationship.

An examination of Table 3 shows that no increase of cultivated acreage has been gained during the process of improvement, although there has been a large increase in the acreage of pasture. There has undoubtedly been a large increase in the sale value of the farm, due to the enhanced working capital of livestock, fertility, and pasture area.

The question is, however, whether this enhanced value of the farm as a productive agricultural unit could not have been attained without so heavy a sacrifice of its game-producing capacity.

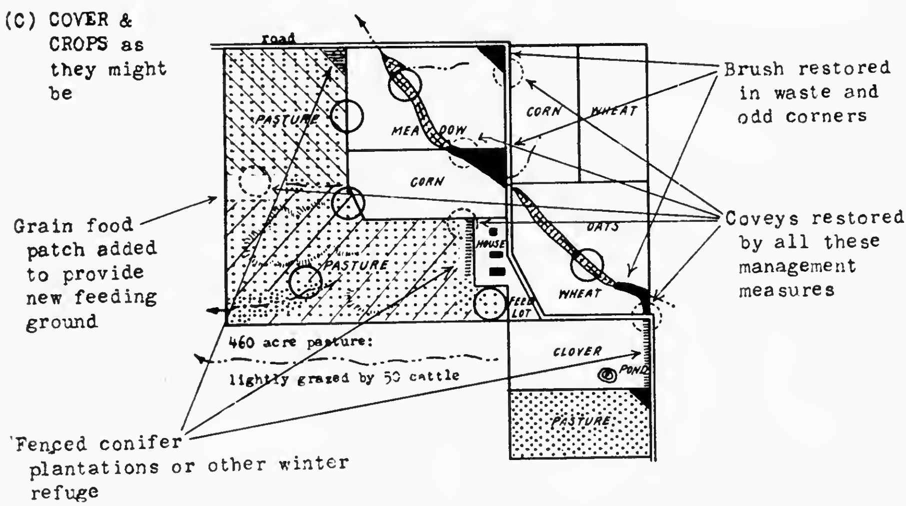
There can be no absolute yes or no answer to this question. The answer is a matter of degree.

TABLE 3.—*Effect of agricultural improvements on quail—Phil M. Smith farm—280 acres, 3 miles west of Williamsburg, Callaway County, Missouri*

Year	Cover							Livestock			Quail				
	Timber Acres	Brush Acres	Open Pasture Acres	Cultivated Acres	Hedge Miles	Brushy draws Miles	Brushy fence row Miles	Horses and Mule Head	Cattle Head	Hogs Head	Covies	Total at 15 each	Acres per quail Population	Killed	Acres per quail killed
1923	30	60 (ungrazed)	30 (ungrazed)	160	¼	1	¾	3	3	0	14	210	1.3	120	2.3
1925	30	60 (lightly grazed)	30 (lightly grazed)	160	0	½	¼	8	10	50	10	150	1.8	80	3.5
1927	30	60 (grazed heavier)	30 (grazed heavier)	160	0	¼	0	8	15	50	7	105	2.6	60	4.6
1929	30	40 (grazed hard)	50 (grazed hard)	160	0	¼	0	10	30	50	6	90	3.1	40	7.0

The question is Statewide, because thousands of farmers are doing, or will eventually do, the same thing. A powerful and extremely effective machinery is maintained in each county at governmental expense to hasten the process, and to show the farmer how. Could not this same machinery show him how to conserve at least a part of his game-producing capacity, if he cares to do so for either pleasure or profit?

Rebuilding the Quail Crop. To illustrate concretely what is meant by "conserving game-producing capacity" on an improved farm, Map 5 depicts an imaginary reconstruction of the quail coverts on the Smith farm, and the hypo-



MAP 5. Imaginary Reconstruction of Quail Coverts on the Smith Farm

thetical response in quail population. The intent is to show how "concentrated" coverts can be squeezed into odd corners without sacrifice of valuable acreage. Whether agricultural experts would approve this particular reconstruction is not known. Probably not. The major plea is that they start experiments on this question, and tell the farmers what particular measures for the benefit of game *would* meet with their approval, and what response in game might be expected.

Changes in Stock; Mexican Quail. Before proceeding to the more detailed examination of the changes which have occurred in the quail environments offered by the region, it is necessary to consider changes which may have occurred in the bird itself. Unfortunately there is a high probability that the original indigenous stock has been changed by the admixture of Mexican blood, especially in Illinois. The following table summarizes the figures gathered during the survey on the extent of Mexican importations.

TABLE 4.—*Mexican bobwhites planted*

Year	Minnesota	Illinois	Indiana	Ohio	Missouri
1916				6,000	
1925		10,975			
1926		5,000			400
1927		546			4,540
1928			400		1,180
1929		137(?)	250		192
1930	370		159		
Total	370	16,658	809	6,000	6,312

The table is probably far from complete, and not all of the plantings shown were official. Small local plantings by sportsmen's organizations and private individuals are known to have been numerous, but they are often nowhere of record, and sometimes have been forgotten by the sportsmen themselves.

It seems probable that the purest native stock remaining in the north central region is that of Wisconsin, Michigan, Indiana, and Iowa.

Nothing better illustrates the fundamental fallacy in the popular attitude toward game conservation than the repeated expenditure of large sums for Mexican quail. Such importations show, first of all, no realization of the fact that if the quail range were in good condition there would be no need for adding to the native stock except on areas entirely shot out. These areas are rare.

Such importations further show a lack of appreciation of the extreme intricacy of the adjustment between any local race of birds and its environment. In all probability the Mexican race differs from the native enough to disturb that adjustment, but not enough to hold out any probability of succeeding in an environment in which the native stock has already failed.

Stoddard found in Georgia that while the Mexican race mates freely with the native, and while the resulting broods are large and apparently vigorous, the survival after a lapse of several years of either banded Mexicans or recognizable hybrids is low compared with the survival of equal numbers of native birds. The survival in the north central region, while never measured by banding experiments, would probably be even lower. (The Missouri plants were banded, but the recaptures never compiled.) This low survival holds out a hope that no permanent dilution of our native stocks has in fact occurred.

Western Quails. Plants of various western (and probably European) quails have been made in the region. A few of these appear on Map 8. All have either failed at once, or resulted at best in the survival of a local colony, without capacity to spread, and usually disappearing within a few years. There is no evidence whatever that any exotic quail will thrive in this region under conditions which exclude bobwhite, or, in fact, any evidence that they will even survive.

This being the case, the funds spent in planting them are not only sheer waste, but also represent a diversion of energy from the real need: management of the native bobwhite.

Summary. Quail abundance has changed with changing environment.

They were originally scarce or absent both in woods unbroken by prairie, and prairie unbroken by woods.

They spread northward and southward into the woods with the advent of grain and clearings, and westward into the prairies with the advent of grain and hedges. The peak of abundance on the best farmlands was about 1880; on the marginal or retarded lands as late as 1905. The present decline is associated with clean farming.

This response to changes in the environment is not only a matter of historical record, but was seen and measured on a Missouri farm in process of "improvement."

In addition to changes in environment, the quail stock itself may have suffered deterioration in some States through the planting of Mexican quail.

Western quails show only colony-survival, and are not needed.

Status

Geographic Distribution. To define the distribution of quail, we must deal with two questions: first, the geographic limits of the territory in which there are any quail at all, and second, the localities within that territory exhibiting various degrees of abundance.

For the geographic limits of the species, the reader will have to turn forward to Map 8.

The local variations in abundance are shown on Map 6.

Map 8 will show the reader what he probably already knows, namely that quail occur in all parts of the north central region except the north woods type. The north boundary of the species, for reasons to be pointed out in a subsequent caption on "irruptions," is not stable, and hence is shown on Map 8 in straight lines which in most instances simply connect the present most northerly outpost on the east and west sides of each state. Where the present north line is extremely irregular, the shape is roughly blocked out.

Nearly Quail-less Area. Between the extreme limit of distribution, and the more southerly belt of regular or irregular abundance, there lies a strip of territory two or three counties wide, in which quail exist as scattered colonies (see crosses on Map 6) and in which no records of past abundance have come to light. The exact extent of this "nearly quail-less area" was mapped only in Wisconsin. The peculiar thing is that it does not end where the north boundary of the range joins Lake Michigan, but extends southward down the shore of the lake in a belt one or two counties wide, not only to the south boundary of Wisconsin, but also across the northeast corner of Illinois and into the extreme northwest corner of

Indiana (see Map 8). Whether it follows up the east shore into Michigan is not known. Special pains were taken to check up on the reality of this extension of the nearly quail-less area along the lake. It would be tedious to here describe all the detail of what this checking up consisted of. It is indicated on Map 7 if the reader cares to review the evidence. It must suffice here to say that neither the present observers in the area, nor the literature describing past conditions in it, reveals any convincing record that quail were ever any more abundant than they are now. There is one exception to this statement. Dr. Hoy in 1854 mentions that quail had become abundant near Racine, where they could be observed feeding in gardens. There is a clear inference of previous scarcity. It is barely possible that this lakeshore belt is subject to mild sporadic irruptions.

The crosses in southeastern Wisconsin on Map 6 possibly show half the covies that now exist. There are certainly less than half a dozen covies per county. Stoddard checked up on Waukesha County and agrees that there is a conspicuous absence of quail from terrain which looks like good quail country, and which farther west would carry a considerable population.

The discovery of the reason for this southward extension of the nearly quail-less area would probably throw important light on questions of quail productivity in the regular range.

The north boundary of the "regular" quail range in Wisconsin parallels with considerable fidelity the north boundary of the prairie soils. The extreme north boundary of the nearly quail-less area in Wisconsin parallels (except for the southward projection along the lake) the north boundary of the zone in which corn is able to reach maturity, and, less closely, the north line of the driftless area. Of these three relationships, those with prairie soils and corn may be the most significant.

Distribution of Abundance; Standards of Range Quality. Local variations in abundance throw light on two questions: first, how many quail have we left, and second, whether one range is better than another. Except where other factors are very unequal, present distribution of abundance is the best index of present productive capacity.

The best way to compare the inherent productive capacity of two ranges is of course to find out which can sustain the higher kill per unit area through a period of years. Until sustained yield is generally practiced, however, this method cannot be applied. We can only measure the present population as an index to range quality.

In the following captions rough preliminary measurements of present populations are described and compared, and an effort is made to unearth as many leads as possible as to where, when, and why these variations occur.

Census Methods. Three methods of measurement were tried out. The first was indirect. It proposed to use the number of covies found per dog per day in various localities as an index to the abundance of quail. The resulting figures proved unsatisfactory. They expressed not only the abundance of quail, but also the ability of the dog and his handler, their familiarity with the ground, and especially the amount and distribution of cover. Some "covies per day" figures are given in Table *D* of the Appendix for what they are worth.

The second method consisted of asking selected farmers and sportsmen to estimate the average number of covies per average farm in the locality best known to them. While better than the first method, this failed to express the local range of variation in abundance, and made comparisons difficult between widely separated localities because of the differing size of farm units.

The third method, which proved the most satisfactory, consisted of asking selected farmers and sportsmen the actual number of covies (or birds) on individual sample farms of known acreage. Sample farms representing the best, the poorest, and intermediate grades of abundance were asked for from each observer. Where the observer was unable to furnish an actual count of each covey, the covies were converted at 15 birds each, and the total birds then divided into the acreage of the farm to obtain the number of acres per bird. All figures accepted from sportsmen represent a thorough working of the sample area, with dogs, at the beginning of the fall season, during a normal year. Figures were accepted from farmers without specifying dog work. No figures were accepted from any individual without a preliminary conversation aimed to test his understanding of quail.

No sample of less than 100 acres was accepted, regardless of the apparent accuracy of the figures, or the qualifications of the observer. Usually 160 acres constituted the minimum area. This is an essential precaution in any method of measuring quail. The reason will appear under the discussions of "cruising radius" and "temporary concentrations."

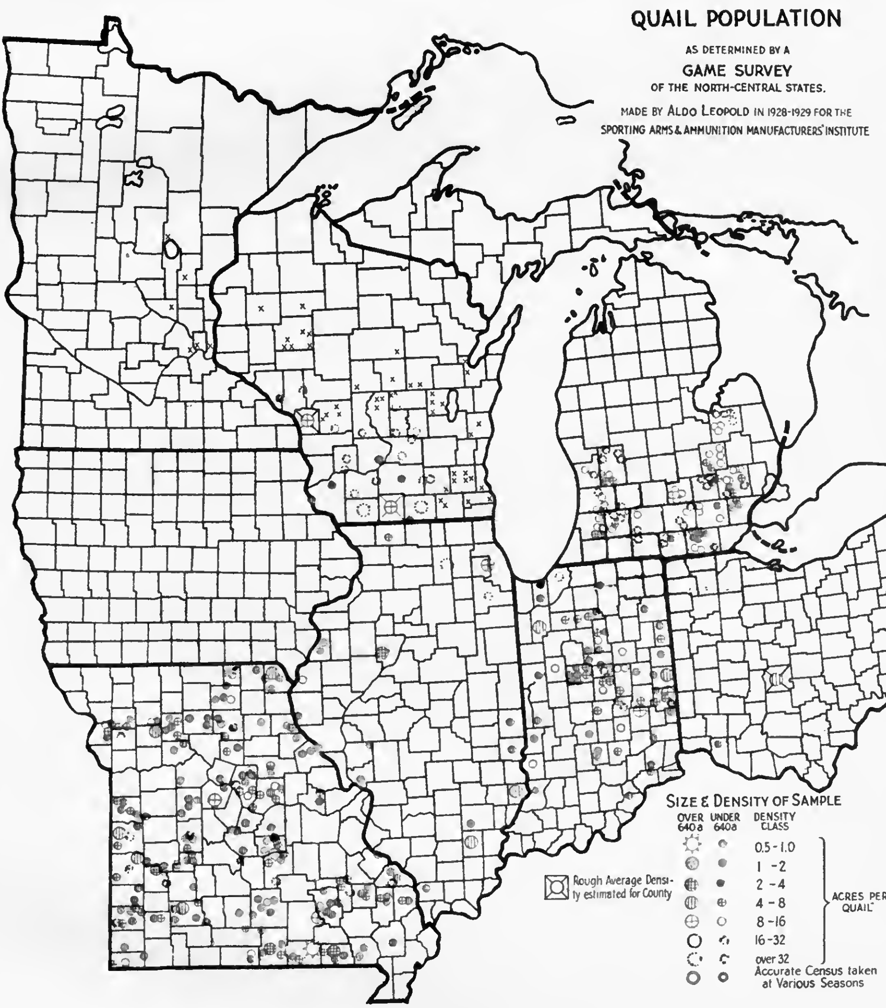
The weak point in this method is that sportsmen in good territory do not hunt poor ground, and hence cannot give samples of it. Farmers are the best source of figures for poor ground.

The ideal way to get representative samples would be to take them according to some rigid geographic pattern, such as in the center of each township or county. The time available for this survey did not permit of this refinement.

It was found that dog-trainers are the most likely source of covey-counts on large areas, that is, areas of more than 1,000 acres.

Abundance Map. All quail census figures obtained during the survey by the second and third methods are shown graphically on Map 6, and in figures in Table 5. All samples are grouped according to an arbitrary set of population density classes explained in the legend of Map 6. These classes are defined in terms of "acres per quail" instead of "quails per acre" because this avoids fractions. "Density classes" are obviously "grades" of abundance, as determined by the number of acres to each quail.

The symbols for the various classes are "staggered" in the map legend, so that a large sample containing, let us say, 1 acre per quail, appears in the same density-class as a smaller sample containing 0.5 acres per quail. The reason for this staggering is that any large tract always contains more "blanks" (or unused places) than a small tract, hence 1 acre per quail in a 640-acre sample actually indicates a denser average population *in the surrounding township* or county than 0.5 acres per quail in a 160-acre sample. It is desired that a glance at the map



MAP 6

give the reader a true impression of how abundance varies as between counties and States, without being obliged to make a mental allowance for which samples are large and which small.

Map 6 is best for Missouri, because this State was surveyed after the method had been satisfactorily developed. The samples for the other States are not numer-

TABLE 5.—*Quail abundance by States (as determined by number and per cent of samples in various density classes)*

Population density class (acres per quail)	Missouri								Indiana [1]		Michigan [2]		Illinois		Wisconsin		Total	
	Prairie type		Hill type		Ozark type		Total											
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0.5—1	5	7	6	9	4	17	15	8	2	4	0	0	3	----	0	----	20	6
1—2	15	20	22	33	5	22	42	26	11	20	4	4	1	----	0	----	58	17
2—4	28	38	19	28	7	30	54	33	17	31	5	5	5	----	2	10	83	25
4—8	21	28	16	24	5	22	42	26	16	29	21	21	1	----	3	15	83	24
8—16	5	7	4	6	2	9	11	7	9	16	32	33	0	----	2	10	54	16
16—32	2	----	6	----	1	----	9	----	2	----	25	26	0	----	4	20	40	12
Over 32	4	----	1	----	0	----	5	----	3	----	11	11	2	----	9	45	30	----
Total	80	100	74	100	24	100	178	100	60	100	98	100	12	----	20	100	368	100

[1] Part of samples taken by R. E. Yeatter during Hungarian study.
[2] Samples taken by H. M. Wight during refuge study.
To avoid distortion, percentages are not taken for the lower density classes believed to be under-represented, or for states with only a few samples.

ous enough to give a true picture of quail abundance. Those for Michigan were furnished by H. M. Wight, and part of those for Indiana by R. E. Yeatter.

Even in Missouri, however, Map 6 undoubtedly errs in presenting a heavier proportion of dense to sparse samples than actually exists on the ground, the reason being, as already pointed out, that sportsmen are unfamiliar with poor ground. There is also, no doubt, an unconscious tendency in all observers to tell about the best, rather than the worst, that their locality affords. How much to discount the map for these errors can only be guessed at.

No discount for "fish stories" need be made. In Missouri only three out of 177 samples were rejected as obvious exaggerations. The utmost good faith was apparent in the great majority of observers.

The two following captions will attempt to interpret the meaning of Map 6 in the light of other information gathered during the survey.

Analysis of Abundance Map. In order to more easily visualize the meaning of the figures in Table 5, and in order to summarize their distribution as shown in Map 6, Chart 1 has been prepared. This shows the frequency with which the various density classes occur in various States, and for Missouri the frequency with which they occur in various types.

Let the non-mathematical layman not be gunshy of the term "frequency of density classes." It means exactly what it says: how often the various densities or grades of abundance occur, that is, which is the most frequent, next most frequent, etc., and what are the highest and lowest grades of abundance which occur at all. Averages, while they might appear simpler, are not worth much for measuring stands of game which always run from good to poor. They do not tell the frequency of the good and poor stands and are likely to be misleading.

Chart 1 shows that two to four acres per quail is the most frequent density when all of the samples in all of the States are put together. For the reasons already pointed out, that is, lack of figures on poor ground, this figure represents the most common condition on the good ground rather than in the region as a whole.

The graph shows that this is also the most common condition in Missouri as a whole and in Indiana as a whole, but that in the Hill Belt of Missouri the most frequent density is one class higher, namely, one to two acres per quail. Clearly the Missouri hills are our best quail country.

Michigan, on the other hand, has 8 to 16 acres per quail as its most frequent density.

Why Michigan and the Missouri hills are thicker and thinner, respectively, than the region as a whole is readily seen by a glance at Map 6.

Although Michigan quail are thinner, Map 6 shows that they are not as thin as those of Wisconsin. Just why this should be is not clear, since the climates are roughly similar. The fact that the Michigan dairy industry is less intensively developed is the most probable reason. A greater scarcity of foxes is a much less probable one. Both States are of course closed to quail hunting.

Reverting to Missouri, it is worthy of note that the Ozark and prairie "curves" substantially parallel each other and also the curve for the State as a whole. This indicates that the figures from which all three are composed reflect the operation of some orderly system, that is, that the data are good.

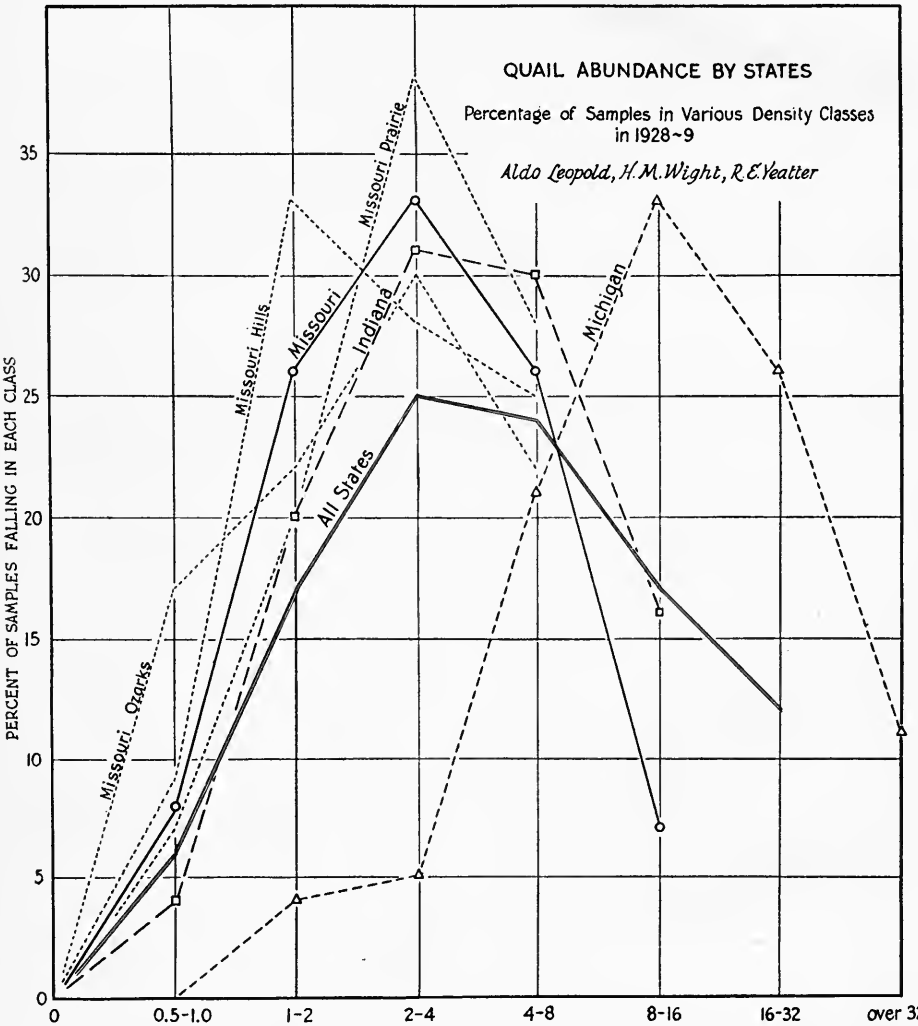


Chart 1

Chart 1 shows that the average farm in the good quail range of Missouri and Indiana has a quail for every three acres, or about three covies on the farm. Arbitrarily discounting for the error arising from under-representation of poor range, it seems probable that Missouri and Indiana as a whole actually have a quail for every five acres, or two covies per 160 acre farm.

Comparing the Ozark and prairie types in Missouri, one may deduce that the Ozark woods which are quail-less for lack of feed, about offset the prairie farms which are quail-less for lack of cover.

The most important deduction of all is yet to be mentioned, although it is apparent not only from Chart 1, but also from Map 6 and Table 5. This is the absence of samples denser than one acre per bird. The significance of this will be discussed later under the caption on "saturation point."

Abundance in Open and Closed Areas. It is unfortunate that a more thorough sampling of closed States like Ohio and Iowa cannot be presented. This would furnish an accurate measure of the extent to which quail benefit from yearlong closed seasons, and of whether this benefit extends to those counties in which cover is deficient, or the environment otherwise unfavorable. It is hoped that some other agency will gather actual evidence to show the effects of long periods of total closure.

A rough comparison follows, covering Missouri only, between (a) samples situated in counties closed to hunting for several years past under Missouri's local option law, or situated on farms and refuges permanently closed by posting; and (b) samples on the nearest adjacent territory open to hunting, and (c) the State as a whole.

Density class (Acres per quail)	(a) Areas closed to hunting	(b) Nearby areas open to hunting	(c) State as a whole
Under 0.5	0	0	1
0.5–1.0	0	1	14
1–2	2	4	42
2–4	4	(8)	(54)
4–8	(7)	5	42
Over 8	1	4	24

Look now for the highest number in each column, which tells which density class is the most frequent in each of the three classes of quail ground. It appears that the most frequent density on closed ground is thinner than the most frequent on nearby open areas, or than in the State as a whole; also that the heaviest density classes are absent from the closed ground. This apparent advantage for open ground is probably not real, however. The number of samples of closed ground is insufficient, and their poor showing probably reflects the physical "accident" that most of these samples are refuges which are poor soil and hence over-wooded, and prairie farms in closed counties where quail were gone before the county was closed, and where closure alone cannot restore quail in any event.

My general impressions are that in closed States like Ohio and Iowa quail are somewhat more abundant than in open States, where the cover and food conditions are equal, but where cover and food are deficient quail are just as scarce in the closed States as if there were no closure. These impressions, of course, are offered merely as opinion and not as evidence. There is great need of a thorough study of the effect of yearlong closed seasons unaccompanied by management.

TABLE 6.—*Samples of old-time quail populations*

Observer Present residence	Tract observed	Acreage	Year	Covies	Population at 15 each	Acres per quail	Remarks
J. M. Taylor (Columbia, Missouri)	His farm (Boone County)	160	1890?	12	180	0.9	Farm was 640 acres. This was best 160.
E. L. Schofield (Buffalo, Missouri)	His farm (Polk County)	480	1872	20	300	1.6	(Same as 1929)
			1888	40	600	0.8	This was the peak.
J. L. Head (St. Louis, Missouri)	Farm (Randolph County)	420	1885–1915	8–12	150	2.8	Overshot since 1916.
V. E. Earhart (Mulberry, Indiana)	Around his farm (Clinton County)	?	1890-92	?	?	2.0+	Cover reduced. Now 1 per 6 acres.

Trend of Abundance. After the survey was nearly complete I noticed that some old-timers seemed to retain an accurate recollection of the number of covies found years ago on their home farms or former favorite shooting grounds. It occurred to me that comparisons of mass data for former and present populations would be illuminating. Table 6 gives some fragments of old data, which could readily be enlarged into a reliable picture of former conditions.

This table is too meagre to prove anything, but it is possibly significant that I have never heard a reliable old-timer give a covey estimate which reduced to more than a bird per acre. In short, there is at least an indication that quail *never did exceed* a bird per acre.

Further evidence as to the trend of quail abundance is contained in the following summary of the opinions of selected observers. Observers competent to give specific population samples are ordinarily incompetent to judge of long-time trends. Occasionally, however, one finds particular individuals who possess the dispassionate attitude of the scientist, combined with a facility for accurate and specific recollection. Only individuals judged to be of this class are included in this table. (Except in Ohio, where the figures represent replies to a questionnaise sent game wardens. These Ohio figures are considered poor.)

TABLE 7.—*Opinion of Observers on General Trend of Quail Abundance*

State	Region	Number of observers			Period covered
		Increasing	Stationary	Decreasing	
Missouri	Ozarks	2	3	2	1920–30
	Prairie	1	2	2	
	Whole State	3	5	4	
Illinois	Southern	1		1	1912–30
Ohio	Whole State	49?	5?	8?	Not specified
Wisconsin		1	2	1	1880–30

My impression gathered during the survey is that the present trend of quail is downward in the prairie type, and in those parts of the riverbreak and till plain types subjected to heavy grazing (see Map 8). On the other hand it is my impression that the general trend is stationary in the other types and possibly upward in the most favorable parts of the Ozarks and the Hill Belt.

Saturation Point. If, as seems probable, the density of quail population on the best farms did not often exceed a bird per acre even during the peak of quail abundance, how do we reconcile this fact with the universal belief that there are fewer quail in the country now than formerly? It is clear from Map 6 and Table 5 that a bird per acre represents substantially the maximum population at the present time. (The "star" in southern Missouri appearing on Map 6 and indicating a population heavier than one acre per quail was probably a temporary concentration. It is a steer feeding farm heavily "baited" with grain, where the owner himself points out an influx of quail during the winter. Its large size, however, forced me to include it as a population sample.)

The only way to reconcile all of the foregoing considerations is to assume that there is a saturation point in the neighborhood of a quail per acre, beyond which density will not increase except for temporary periods or under confinement. This saturation point appears to limit the number of wild quail on any area. It is occasionally attained now, but was undoubtedly more frequently attained in past years. There were more quail in the past than at present, *not because the saturation point has changed, but because saturated areas were more frequent and there was a greater total acreage inhabited by quail.*

In other words, the "blanks" now caused by devegetated farms did not yet exist. The "blanks" caused by uninhabited woods of course existed then just as they do now.

The conception of a saturation point originated with Stoddard during the Georgia quail investigation.

The reasons for the saturation point are as yet unknown, and present one of the most interesting unanswered problems in the whole field of game research. It seems entirely unlikely that any ordinary factor, such as food, cover, or predators should operate in such a uniform manner over many States. All of the States in this region show the same saturation point (in the neighborhood of a bird per acre); also Georgia (Stoddard) and Mississippi (Leopold, game survey).

Some of the other possible reasons for the saturation point are:

(1) Combativeness between covies, or between pairs during the nesting season.

(2) Disease or parasites depending for their spread on the degree of crowding.

No evidence of intolerance of concentration during the nesting season was obtained. One case is presented later showing a nest per 2 acres which corresponds exactly with the saturation point. Stoddard, however, found 6 quail nests on one acre in Florida, indicating that combativeness during the nesting season can hardly be the "cause" of the saturation point. The next caption seems to exclude combativeness as between covies.

Disease is possibly the most likely hypothesis for explaining the saturation point. Knowledge of quail disease is still too deficient to make possible a guess as to the particular disease which might be its cause, or as to the manner in which it operates. A strong tendency toward disease when quail are confined in pens has long been known, and some of the causative organisms have been identified. Some of these diseases seem to prevail to a degree roughly proportional to the degree of crowding.

Temporary Concentrations. While tracts of 160 acres or over do not often exceed the saturation point of a quail per acre, much greater populations exist for temporary periods on smaller areas. Some samples of the nature and extent of such temporary concentrations are given in Table 8.

TABLE 8.—*Concentrations of quail*

Observe	County and State	Year	Observation
A. H. Willowbrand	Osage, Missouri	?	Many covies flushed simultaneously from small wheat stubble.
C. D. Via	Phelps, Missouri	1925	Flushed 200 from one 5-acre field full of grass seed.
Geo. R. Johnson	Cass, Missouri	1928	Flushed three covies from ½ mile of double hedge.
Carl R. Gross[1]	Clinton, Missouri	1929?	Flushed ten covies from 20-acre brush patch.
Will Gum	Oregon, Missouri	1929?	Saw 75 birds in one covey.
Andrew Brooks	Ripley, Missouri	?	Flushed 75 quail at once from one small field of cane and wheat.
M. M. Baker	Peoria, Illinois	?	150 on one covey in osage hedge.
H. J. Bowman	Madison, Illinois	?	81 birds counted in one covey.
D. A. Dunlevy	Clark, Indiana	?	40 birds stayed in one covey from November 15. 20 surviving in spring.
L. E. Shaw	Monroe, Indiana	?	Covies up to 40 seen in late November.
R. D. Fleming	Allen, Indiana	December ?	Covey of 50 to 60 seen in December.
Geo. W. Smith, Jr.	Fulton, Indiana	November ?	50 seen in one covey.

[1] Teacher, Agricultural high school.

I have the impression that temporary concentrations are most frequent and more intense in the southerly part of the region, and especially in Missouri. They also seem to occur in the irruptive area of Wisconsin. In Missouri, they seem to be confined to the Ozarks and to the brushy river breaks of the prairie region where the quail from the adjacent prairie congregate in winter. They doubtless usually represent temporary movement of many covies to some highly palatable food supply existing in great quantities for a short time on a limited area, or to some covert too small for the surrounding breeding area. There is no line of demarcation between concentration of several covies in one place and the combination of several covies in one covey. Abnormally large covies are believed to be simply one degree of temporary concentration. Concentrations are possibly associated with the fall "shuffle" to be described later.

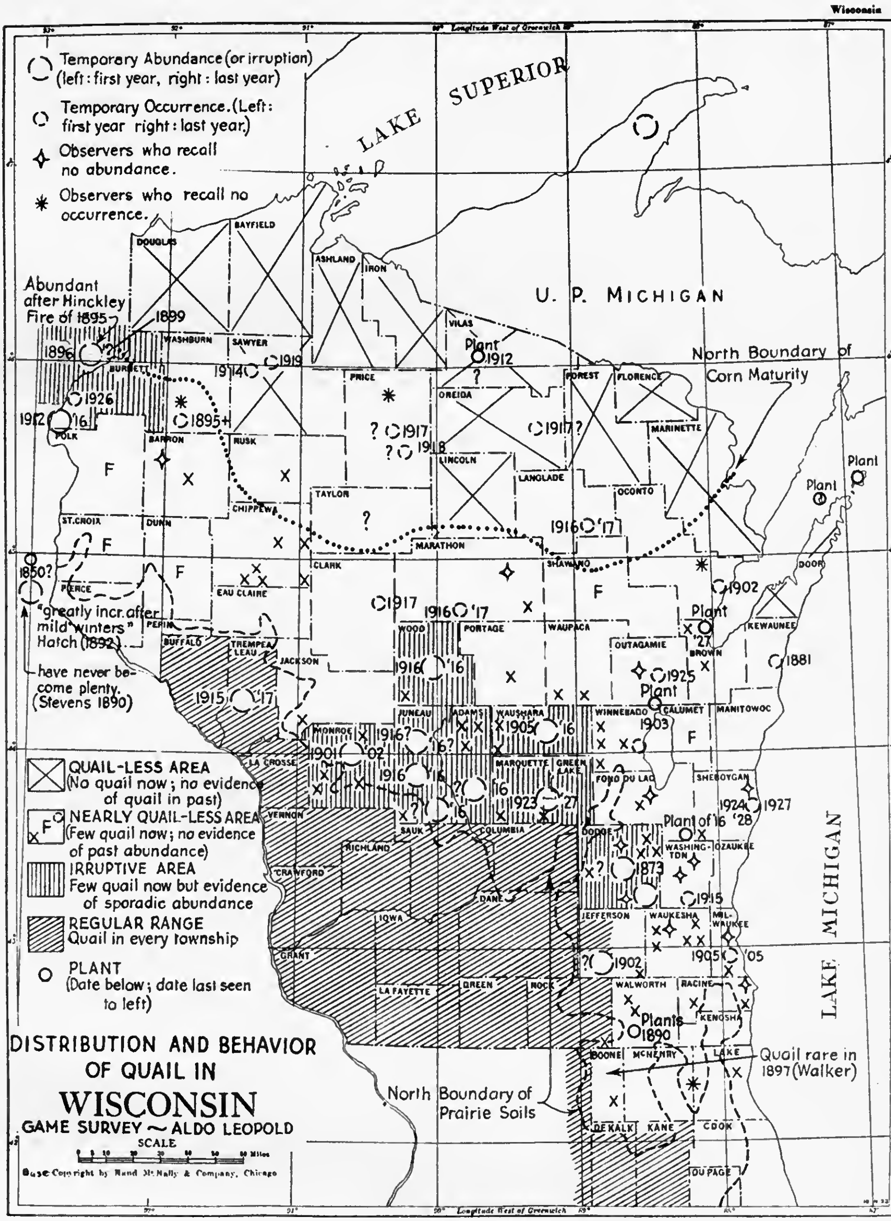
"Irruptions." As compared with cyclic species like grouse, bobwhite is the outstanding example of stability. His population curve for a series of years often approaches a straight line, the only changes from year to year being minor ones plainly traceable to bad weather, over-shooting, or other local and "visible" causes.

It is therefore of particular significance to find in central Wisconsin a belt of counties, lying between the regular quail range and the nearly quail-less area, which contains few or no quail at the present time, but shows evidence of temporary abundance of quail in the past. The degree of fluctuation is so great that the occasional periods of abundance may be called "irruptions." The location of the irruptive area and of the observers in it are shown on Map 7. The nature of the evidence on "irruptions" appears in Table 9.

TABLE 9.—*Evidence of temporary abundance of quail in the "irruptive" area*

Observer	County and State	Year	Observation
Pugh	Adams, Juneau and Woods, Wisconsin	1916–17	Thousands of quail seen while hunting prairie chickens, 1916. Quail all gone in the same territory next year.
Hart	Dodge, (Horicon), Wisconsin	1873	Saw swarms of quail one September evening, next day all gone.
Bageley	Dodge, Wisconsin	1890 or 1895	Quail common but lasted only 2 to 3 years. Only one covey lasted 4 to 5 years.
Kade	Marquette, Wisconsin	1923 to 1927	Many quail at Lake Puckaway.
Swift and Divine	Burnett, Wisconsin	1912 to 1916	35 to 40 covies along lower St. Croix. Some there now.
Worden	Waushara, Wisconsin	1905 to 1916	Quail appeared, spread all over the country, then died off, before the war.
Wessenberger	Trempealeau, Wisconsin	1915 to 1917	Very abundant in 1915 when I built this building. Cleaned out by winter 1917-18.
Lanning	Juneau, Wisconsin	1916	Remembers a year when there were a few quail at Necedah, Sprague, Fenley, and Babcock. Thinks 1915 or 1916 about right.
Hegeman	Mauston, Wisconsin	1916?	Remembers a high year just before the war. After that they all disappeared. (Now only two covies.)
Grieg	Pine, Minnesota	1896–8?	Many quail for a few years after the Hinckley fire (1895).

The irruptions most strongly supported by evidence are one in 1916 in central Wisconsin, and one in 1897 following the Hinckley fire in Minnesota. The 1916 irruption immediately preceded the killing winter of 1917–18. The best assumption is that this, as well as other irruptions, was terminated by killing winters. This assumption is further corroborated by the greatly varying length of the period of abundance, which the table shows to have been from one to four years.



MAP 7

The irruptive zone, like all other quail lines in Wisconsin, extends not east and west, but northwest and southeast.

The term "irruption" is here used in quotation marks because the phenomenon observed was probably not an irruption in the true sense of a migratory invasion of territory otherwise unoccupied. It probably consisted rather of a local increase from residual stock made possible by a succession of easy winters and favorable breeding seasons. The reason for assuming this cause is, first, that there are no records of migratory invasions or other long-distance movements on the part of this species, and second, because I found only one report of a preceding abundance in the "regular" quail range to the south and west of the irruptive area. (This was Trempealeau County, beginning 1915.) If there had been a preceding period of abundance in the regular quail range, the alternative assumption of a true irruption would have been indicated.

The significance of these irruptions does not lie in my particular hope that the irruptive area can be converted to regular quail range, but rather in illustrating the extremely rapid increase which takes place whenever environmental conditions allow. Repetitions of the event will doubtless occur in the future unless the decline of agriculture in the Sand Area, which occupies the heart of the irruptive area in Wisconsin, too far restricts available grain feed.

Sudden changes in bobwhite populations which sound somewhat like these Wisconsin irruptions have been heard of in Oklahoma, Nebraska (1880), and Texas, and also in Michigan (1863), but as far as I know they have not been investigated. The fact that these areas of violent fluctuation all occur on the border of the range of the species strongly suggests, however, that irruptive or cyclic behavior may characterize the border of the range in many gallinaceous birds, and that cycles and irruptions may be a property not of the species, but of the border environment.

Summary. In 368 samples of present quail population in the region, densities of two to four acres and four to eight acres per quail occur with equal frequency. This roughly is one quail per five acres, or two covies per 160 acre farm. The most frequent density in Missouri is a little higher, and in Michigan a little lower.

The maximum density is one quail per acre, or 10 covies per farm. This is evidently the saturation point of favorable range, and holds throughout the region. It seems to hold for former times also.

The maximum is not now attained in the Lake States, and seldom in any but the riverbreak and hill types.

Small areas closed to hunting in Missouri show sparser populations than nearby open lands with better balanced food and cover.

No State with a yearlong closed season was sampled with sufficient intensity to justify a conclusion on its effects.

Temporary concentrations of quail occur in fall and winter, especially in Missouri.

Large temporary increases or "irruptions" occur on the northern fringe. They are apparently the result of a succession of mild winters.

Movements

Movements and Management. The landowner's incentive to cultivate game crops is strengthened to the extent that the crop remains on his farm, and weakened to the extent that it moves to neighboring farms. Game crops which tend to move require cooperative neighborhood effort, which is usually harder to initiate than individual effort.

The probability of a game crop remaining on the farm depends on the condition of the farm, and also on an innate property of the species which we may call its mobility or tendency to move.

It is common knowledge that bobwhite is the least mobile of upland game species. Stoddard found in Georgia that banded bobwhites were usually recaptured within a half mile of where banded.

We do not know whether bobwhite in the north central region is more or less mobile than in Georgia. Even a slight difference might be important because of the lesser size of farm units. There is a widespread popular belief, especially in Missouri, that quail migrate to a certain extent. A brief survey such as this one could not determine whether this is true, but an attempt was made to marshal the existing evidence, in the hope that this might stimulate large-scale banding work. The actual mobility of quail in this region can be established only by banding.

If quail should prove to be more mobile in this region than in Georgia, it might somewhat weaken the landowner's incentive to practice management, but at the same time it would strengthen the effective radius of the upland game refuges now being installed in many north central States. It would also lengthen the distance from winter cover which quail may be expected to traverse to breed and nest. On the prairie this is of great importance.

Alleged Migration. The search for evidence on migration was mostly confined to Missouri. Table 10 gives the affirmative evidence found in that State, together with a few instances from other States which were encountered in the literature.

The word "migration" is here used to mean a seasonal movement of quail with a north and south orientation.

A careful reading of the table shows that—

(1) Three reliable laymen have seen quail fly southward across the Missouri or Mississippi rivers in the fall, and have seen birds fall into the water from exhaustion.

(2) No regular ornithologist trained to critical observation has seen this.

(3) There is no affirmative first-hand evidence that quail return north in the spring.

While it can hardly be doubted that these observed flights actually take place, the absence of first-hand evidence of a return flight makes it possible to ascribe the whole phenomenon to the "fall shuffle" or shift described in a later caption.

TABLE 10.—*Evidence on "Migration" of Quail*

Observer (Occupation)	Locality	Observation or contention
		I. AFFIRMATIVE, FIRST HAND
H. J. Bowman (real estate)	Alton, Madison County, Illinois	Quotation from Illinois game survey: "There is a bend in the Mississippi at Alton. Covies of quail try to fly from the apex of the bend southward across the river into Missouri. Bowman has observed these flights while duck shooting on the Missouri side. Once he saw a whole covey of 15 birds drop from exhaustion into the water. This was after they had made a half-mile flight from the Alton bluff with an initial elevation of 200 feet."
W. W. Walthers (contractor)	Booneville, Cooper County, Missouri	Told me that around 1900 he several times saw quail flying south across the Missouri above Booneville, and once picked up exhausted birds which he saw fall into the water. This was about November 1. Told me farmers believe quail move south; that he had never seen any return movement in spring.
		II. AFFIRMATIVE, SECOND HAND
Dr. A. F. Einbeck (physician?)	New Haven Franklin County, Missouri	Widmann says (page 79. "Catalog of Birds of Missouri," 1906:) "According to . . Einbeck . . a regular north and south migration is a fact well known to people living along the shores of the Missouri River, where quail are seen toward evening flying across the river, southward in September, northward in April. The river being over half a mile wide, some of the birds become exhausted and fall into the water, where they are picked up by the people along the shore."
J. R. Cunningham (investments)	Kansas City, Jackson County, Missouri	Told me a Mr. Myers, formerly of Higginsville Lafayette County, present address unknown, and a Mr. Renwick of Harrisonville, Cass County, had evidence of migration.
Fritz Gottschalk (guide and river-man)	Brunswick, Chariton County, Missouri	Told Frank DeCou, former chief warden, that quail fly across the Missouri near the mouth of the Grand River in fall, but he (Gottschalk) had never seen them go back in spring.
George Reeder (U. S. Weather Bureau)	Columbia, Boone County, Missouri	Was told by three people whose names he could not recall, that quail fly south across the Missouri, using the islands as topping places. Reeder does not vouch for this.
Samuel Blaettner (farmer)	Wyaconda, Clark County, Missouri	Told me it was generally believed by farmers that quail move down the streams of northeast Missouri in fall.

III. Evidence from other regions

A. T. Wayne........ Ornithologist)	North Carolina	Quotation from "Birds of South Carolina" (1910): "I have seen late in the autumn, upon the approach of sunset, a covey fly high in the air and depart in a southerly direction. These birds were undoubtedly migrating. If all the partridges which are annually hatched and raised were to remain on the plantations where they were bred, the crops of grain would be seriously injured."

The southerly direction observed in these flights may have been accidental. There is no evidence that the fall shuffle is oriented in any particular direction.

While the evidence does not make it necessary to accept migration as a fact, it seems not improbable that in pre-settlement days there was a movement of quail from the edges of the then bare prairies of northern Missouri to the wooded foothills of the Ozarks. Winter food and winter brush cover were doubtless both more plentiful on the Ozark border. The same purpose would have been accomplished, however, by a lateral shift to the wooded river bottoms of the prairies. A lateral movement of this kind still takes place, as will be demonstrated in a subsequent caption.

If a "migration" off the prairie once existed, it doubtless tended to decrease with the introduction of osage hedges and grain feed. This may account for the greater prevalence of a belief in migration among old-timers, and for the fact that many younger observers doubt the existence of migration at any time in any degree.

No evidence of migration, past or present, was encountered in the Ozarks or on the prairie of southwestern Missouri.

The Fall "Shuffle." While there is no conclusive evidence of an oriented seasonal movement in quail, there is abundant evidence of a short-range unoriented movement which may be described as a shift or shuffle. The evidence bearing on the date and nature of this movement is summarized in Table 11. It shows that—

(1) Not only laymen, but trained ornithologists have seen quail in cities and other unaccustomed locations, usually during October.

(2) Hunters, particularly in the Ozarks, report a marked difference between seasons as to whether quail are found in the woods or in fields.

(3) Hunters and farmers agree that prairie quail often shift to the nearest brushy river breaks or hill lands for wintering.

In addition, farmers who feed grain to stock all agree that there is an influx of quail to such grain feeding farms during the winter. Only one instance (Curtis Weeks) is given in the table, but a dozen others could be cited.

It is worthy of note that all of the cases bearing an October date are in or near northeast Missouri, while all of the cases from other sections of the State show a late fall or winter date. It is also worthy of note that the evidence of the

4

October shuffle lies mostly in the same region (northeast Missouri) yielding most of the evidence of alleged migration.

TABLE 11.—*Evidence on the date and nature of the fall "shuffle" in quail*

Observer	Locality	Date	Observation
H. J. Bowman	Alton, Madison County,	Late October; Early November	Considers the shuffle an annual event.
J. M. Taylor	Columbia, Boone County, Missouri	October	Shuffle begins in October. Last fall (1928) saw a covey on the courthouse lawn in October.
T. E. Musselman (ornithologist)	Quincy, Adams County, Illinois		Saw quail on roof of adjacent office building fall of 1929. Quail seen in Quincy every year. Thinks there is no orientation in this movement.
A. D. Stanner	Wright City, Warren County, Missouri	October	Notices moving covies in places not previously used.
Carl Leopold	Burlington, Des Moines County, Iowa	October	Almost every year in October quail are seen in the residential sections a mile or more from any nesting locations.
Andrew Brooks (dog trainer)	Doniphan, Ripley County, Missouri		There is general fall shuffling to get on a better food supply. Some years all the quail are in the woods eating huckleberry, grape, sumac, and mast.
Curtis Weeks (farmer)	Eldon, Morgan County, Missouri	Winter	Only a few covies are raised on my father's farm, but others move in when steers are fed in winter. There is more cover than on adjacent farms.
Geo. R. Johnson	Harrisonville, Cass County, Missouri	December	Am satisfied birds move off the prairie toward cover and feed. On Middleton farm (prairie with trimmed hedges) found nine covies on Thanksgiving Day, but only one covey in December after corn gathered. In December found four covies on a bottomland farm which had no birds November 1, due to floods having drowned all nests.
Carl R. Gross (teacher agriculture, high school)	Cameron, Clinton County, Missouri	December?	Quail move off the prairie farms for winter. On my brother's place, (De Kalb County) 12 covies are normally raised, but few stay.
Cole Hart	Horicon, Dodge County, Wisconsin	September, 1873.	Saw swarms of quail on our farm one evening; next day all gone. I trapped many quail from 1860 on.
Antoine Novy	Manitowoc, Manitowoc County, Wisconsin	Fall	There are breeding quail to north and south, but none here. In the fall, however, I occasionally see a covey here.

The late fall or winter shuffle, which appears to be characteristic of the other parts of the State, seems to be simply a food movement, such as already noted by Stoddard in Georgia, and which may take place at any time (except during the breeding season) that a superior food supply at any place gives occasion for moving.

While the existence of a shuffle may be accepted as a fact, its average and maximum length in miles remains totally unknown. It is the opinion of good observers that prairie quail move as much as three miles, but this is merely guess work.

Banding would quickly and convincingly give not only the average and maximum length, but also the proportion of birds and covies affected.

It should by no means be assumed by the reader that either the alleged migration, or the shuffle, affects *all* of the covies on any given area. On the contrary, the probabilities are that it affects only a small and variable proportion of the covies.

Movement of Cocks. In Wisconsin several observers in the nearly quail-less area reported hearing whistling cocks in spring, but never seeing any covies in fall or winter. In all such cases, however, resident covies were found to exist not less than one county to the southward. Thus whistling cocks were heard at the Moon Lake Refuge in Fond du Lac County, and at Kewaskum in Dodge County, but the nearest resident covies are at least 10 miles distant from either locality. These occurrences suggest that unmated cocks may move at least 10 miles in the search for mates, and that the actual breeding range is surrounded by a "whistling zone" at least 10 miles wide.

Summary. The Georgia evidence that quail usually stay within half a mile of their birthplace may be supplemented as follows for the north central region.

(1) The tradition that quail migrate is not supported by any present evidence. Such migrations may have occurred in pre-settlement days in places where prairie breeding grounds were far distant from winter cover.

(2) A distinct "shuffle", or local unoriented movement of covies, occurs annually, especially in the southwestern part of the region. This shuffle may be associated with extra dense populations or prairie range or both. It probably does not affect more than a fraction of the total covies in any locality. The distance moved is unknown, but probably seldom exceeds three miles.

(3) Unmated cocks may move 10 miles in search of mates.

The measurement of all these movements by means of wholesale banding is badly needed as a basis for intelligent management.

Miscellaneous Life History

Sex Ratio. There is a belief among some sportsmen, especially in Indiana, that an excess of cock birds occurs, and that this interferes with nesting. Some believe that the fighting males even scratch up and destroy nests.

Disturbed sex ratios are known to interfere with productivity. Thus in Australian rabbits an excess of males is deliberately created by trapping in enclosed areas, as a means of exterminating the enclosed stock.

It was attempted during the survey to find preliminary evidence of whether a disturbed ratio ever exists in bobwhite.

Opinions and general impressions are not acceptable evidence of such a condition. Several sportsmen were found, however, who had made actual counts of sexes in the bag, although they had failed to record these counts. Their recollections of these counts are:

TABLE 12.—*Sex ratio of Indiana quail (as determined by unrecorded counts of bags)*

Observer	County	Year	Recollection of— Number of birds	Recollection of— Ratio Cock : Hen
William Wiegeman	Steuben, De Kalb	1925 or 1926	32 20	94:6 80:20
R. D. Fleming	Allen (from kill of 12 hunters)	1923 1928	400 ?	66:33 50:50
Fred Ruh	Kosciusko	1926?	200	65:35

A selected list of sportsmen were asked to keep a count of their bags during the 1929 and 1930 seasons. The results are summarized in Table 13. In examining this table the reader should realize that individual counts of less than 50 birds may show a ratio which is the result of chance, rather than the reflection of actual conditions on the ground. The counts larger than 50 birds, however, probably reflect actual conditions, and these show a preponderance of males in nine cases and a preponderance of females in five. The total of all the counts, which shows 52 per cent males and 48 per cent females, is of course the most reliable figure, but is open to the objection that it is a composite of many localities. Serious local disturbances might occur without necessarily showing in the composite total.

The best datum against which to measure all the evidence is Stoddard's work in Georgia. He obtained sex ratios by counting many bags and also by counting trapped quail.

The bag count on nine Georgia quail preserves killing 2,871 quail during the 1924–5 shooting season showed a cock–hen ratio of 54:46.

Four preserves killing 2,699 quail during the following year showed a cock–hen ratio of 52:48.

Stoddard quotes Edward R. Coleman, of Lebanon, Pennsylvania, as finding 51 to 60 per cent of cocks in various years in various states.

TABLE 13.—*Quail sex ratio tally, seasons of 1929, 1930*

State	Observer	1929		1930		Total		Per cent	
		M.	F.	M.	F.	M.	F.	M.	F.
Illinois	Geo. Sangier			14	12	14	12	54	46
	L. C. Dadant	43	46	27	40	70	86	45	55
	H. L. Willis			7	3	7	3	70	30
	C. F. Mansfield, Jr.	104	104	45	42	149	146	51	49
	J. M. Olin			6	4	6	4	60	40
	H. G. Karr	25	31	18	34	43	65	40	60
	R. W. Miller	37	24	16	34	53	58	48	52
	T. A. Snell	70	86	28	18	98	104	49	51
	L. E. Troute	95	67			95	67	59	41
	V. G. Musselman	18	15			18	15	54	45
	E. Phillips	14	21			14	21	40	60
	F. Leopold	14	11			14	11	56	44
Indiana	R. E. Llewellyn	52	37	57	39	109	76	59	41
	Fred Ruh			141	108	141	108	57	43
	F. C. Mathers	18	33	24	24	42	57	42	58
	J. Hymer	41	37	20	7	61	44	58	42
	H. Decker	81	75	16	15	97	90	52	48
Minnesota	F. S. James	17	20	23	23	40	43	48	52
	W. L. Baldwin			22	12	22	12	64	36
Missouri	O. E. Gre[illegible]n			110	94	110	94	54	46
	Aldo Leopold			38	22	38	22	63	37
Total		629	607	612	531	1,241	1,138	52	48

All bag counts are open to the possible error that one sex is more likely to be killed or easier to hit than the other, and in a few cases there is doubtless a deliberate attempt to kill males in preference to females. Stoddard's trapping records eliminate this source of error. Of 1,700 quail trapped during two springs in Georgia in two areas, the record shows from 1 to 3 per cent more cocks than the bag count from the same area during the preceding fall. In other words, bag counts show a lesser percentage of cocks than actually exist on the ground.

Table 13, interpreted in the light of this information indicates that during 1929 and 1930 there was a 3–5 per cent excess of cocks in the aggregate of the 21 localities.

The individual samples, however, indicate that local conditions may depart considerably from the aggregate or average condition, and in both directions.

None of the evidence here presented is considered to either prove or disprove the alleged disturbed sex ratios in the north central region. Much more extensive bag counts are required covering several years. As in Georgia, these should furthermore be checked against trapping records before a final conclusion is reached.

Alleged Inbreeding. It is widely believed by sportsmen, throughout this region as well as elsewhere, that if quail covies are not dispersed annually by shooting, they inbreed and deteriorate in size, vigor, and abundance.

That shooting stimulates dispersal is probably a fact.

That dispersal depends on shooting is not a fact in Georgia, and probably not in this region. Stoddard proved by banding thousands of birds in hundreds of covies that shuffling of individual birds between covies begins as soon as the chicks are hatched, and continues throughout the closed as well as the open season. Covies with young of two or more sizes arise not from two successive broods from the same pair, as many sportsmen believe, but from this automatic shuffling between the broods of different pairs. The indications are (see preceding discussion of quail movements) that the natural dispersal is greater in the north central region than in Georgia.

That quail would deteriorate, even if natural dispersal were absent, is improbable. Domestic species do not do so, except where similar genetic weaknesses exist in both parents. Wild species have not been tested, but the laws of inheritance as now understood would indicate less, rather than more, damage from inbreeding in wild species than in domestic, because they represent purer strains from which the tendency toward undesirable variations has been weeded out by competition.

In short, there is not a shred of real evidence that quail inbreed if unshot, or that it would hurt them if they did. Isolated covies on the northern edge of the range might not have a chance to mix with others and thus inbreed, but these border birds (except where diluted with or supplanted by Mexican stock as in New England) are traditionally large and vigorous.

The belief in damage from inbreeding is so widely entertained, however, and management policies throughout the world are so often premised upon it, that its validity should be subjected to scientific test. This will require dividing a homogeneous sample into two halves, and inbreeding one while outbreeding the other in the same environment, for many generations. Some well-to-do sportsman could build a lasting monument to himself by financing such a test in some competent university.

The cause of sport is injured by claiming for it benefits which may not exist. Sport needs no defense if it maintains the game supply. No unsound arguments will keep it alive if it does not.

In spite of the universal fear of inbreeding, only one instance of actual action to prevent it was encountered during the survey. On the Lyter preserve in Phelps County, Missouri, annual trapping operations are carried out, and the cock birds moved to locations as far as possible from the point where trapped. A decisive increase has accompanied this practice, but so has winter feeding and very light shooting. The cause of the increase may lie in these management measures, rather than in the moving of cocks.

Relation to Other Species. What related species of game birds can be maintained on the same ground at the same time is an unanswered problem of pressing importance. It is especially necessary to know whether the planting of pheasants and Hungarians interferes with the maintenance of native species.

In all probability the question is one of combined density of population, rather than mere presence or absence of species. There is no reason to suspect an inherent antipathy between species which causes one to exclude the other, where neither approaches the carrying capacity of the range. In support of this conjecture may be cited the fact that near Cottage Grove and Deerfield in eastern Dane County, Wisconsin, there are farms containing quail, pinnated grouse, Hungarian partridge, and ringneck pheasant, each species being in an apparently thrifty condition, but in moderate numbers. The same combination, but without the prairie chickens, is found in southeastern Michigan. All four occur in St. Joseph County, Indiana, but it is not known whether all occur on the same farm. The same combination, but without the Hungarians, is found in the Kankakee marshes of Indiana. Prairie chickens, pheasants, and Hungarians occur together without visible signs of interference in the Chicago area, but quail are practically absent.

In none of these instances, however, are all of the species abundant on the same ground. They do not prove that if management or accident makes one species abundant, that it will not hurt the others. Such proof must await the accumulation of experience, and of much more life history information for all species than now exists for any.

Meanwhile, management must proceed according to the best light available. The combined maximum density of two or more species, and its relation to the separate maximum (or saturation point) for single species, has never been measured. Table (f) of the Appendix gives estimates of *relative* abundance in a few localities in Wisconsin, also estimates made by Yeatter (Institute Fellow, University of Michigan), in parts of Michigan, Ohio, and Indiana.

The survey disclosed a few instances of alleged antipathy between species. Thus Scott Patterick, a sportsman of Berlin, Wisconsin, while driving near Ashippun, Dodge County, in April, 1929, saw a cock pheasant alight near seven or eight quail. The pheasant seized a cock quail, shook it, and pulled its head off.

It is not intended to imply whether or not this instance is representative. It is recorded merely to illustrate the need for a competent study of inter-species relationships under controlled conditions.

Non-Breeding Covies. In the western species of quails the existence of non-breeding covies during drought years is an established fact.

The survey disclosed one report of a non-breeding covey of bobwhites. Harry Decker, a sportsman of Winemac, Pulaski County, Indiana, reports that a covey five miles north of Winemac remained intact throughout the breeding season of 1927. He states that the covey was observed to contain both sexes.

The local weather record was not examined to determine a possible cause of this extraordinary behavior. The game department reported 1927 as an especially good quail year for the State as a whole. Probably some local environmental factor was responsible.

There is no evidence that non-breeding covies are frequent in bobwhite. The careful study of individual instances, however, might reveal facts usable in enhancing breeding vigor of normal covies.

Diseases. Very little is known of the diseases of wild bobwhites in the north central region, or in fact any region except Georgia. With few exceptions, nothing can be said, except by analogy with Stoddard's work there.

The most suggestive single discovery is Green's (1929) report on a case of tularemia in a wild quail near St. Paul. Only one bird showed a positive reaction.

Errington (unpublished) has found dispharynx in Wisconsin quail.

In a later caption it will be pointed out that winter losses in quail frequently coincide with winter losses in grouse and with cyclic mortality in grouse. There may be some connection.

Some sportsmen recall what they took to be disease in quail. Thus in 1925 near St. Louis, quail are said to have had "white diarrhoea" in conjunction with a short crop and an undue proportion of "squealers" or immature birds. According to the weather record 1925 was an extra dry summer near St. Louis.

This report is valuable only in indicating something to look for.

Diseases, especially poultry diseases, in all probability affect quail in this region. Much more thorough research in diseases is required as one of the foundations of skillful management.

Phenology. In the planning of both management and research work on quail, it is convenient to have a record of the dates and sequence of the important events of the quail year. Information of this kind was collected during the survey, but its volume is too great to justify separate tables for each State. There follows, however, an idealized composite for an average State (let us say Illinois or Indiana). It is hoped that this will stimulate the compilation of local and more reliable phenological tables.

PHENOLOGY OF QUAIL IN CENTRAL ILLINOIS

January—Food declining due to consumption by birds and rodents and grazing by stock Feeding stations should be in operation not later than January 1. Probability of snow, sleet, and cold increasing. Possible loss during storms.

February—Same, but worse. Cover and food steadily declining. Spring burning of fencerows, roadsides, and grassland begins during warm spells.

March—Cover and food at minimum. Still danger of sleet. Predators emerge from hibernation; migration of sharpshin and Cooper's hawks begins. Spring burning continues and plowing begins. Some green food appears. This is the best month to plan future winter cover for quail. Covey may break up into smaller groups late in March, preparatory to pairing.

April—Whistling and pairing begins about April 10. Date seems to coincide with earliest green food and insects. Cover still very deficient.

May—Nesting begins. Attempts to bring off a brood continue until September, or until successful. Average clutch consists of 14 eggs laid at intervals of one day; incubation 23 days. Accidental shifting of individuals from one covey to another begins soon after hatching of broods.

June—Nesting at its height. Most first attempts are either hatched or destroyed by end of June. Plenty of cover everywhere from now until November. Rains and floods may destroy nests or young. First hay cutting destroys many nests.

July—Blackberries and mulberries ripen and eaten by growing broods. Wheat cutting destroys some "second-try" nests.

August—Small ragweed occupies unploughed stubbles and makes winter feed. Corn cultivation ceases and pigeon-grass matures. "Bobwhite" whistling ceases.

September—Last attempts at nesting; some hatch as late as September 15 where earlier attempts defeated by rain or predators. Migratory sharpshin and Cooper's hawks appear late in September.

October—Fall "shuffle" in late October; covey may move to winter location. Frost cuts off live insect food and decreases cover.

November—Hunting season November 10 to December 10. Frost gradually decreases green plant food and cover.

December—Usually an easy month. Corn husking exposes much waste corn. Still plenty of pigeon-grass and ragweed; corn not yet grazed out; still some green clover and alfalfa near ground; usually no bad storms. Standing or shocked corn for January and February must be reserved now. Another "shuffle" to winter quarters may occur this month.

The most important event of the quail year is of course the hatching of the eggs. Since incubation is known to require about 23 days, and since about 14 eggs are laid at the rate of about 1 per day, it is possible to convert many dates on nests seen into probable date of hatch. By estimating the age of very young quail seen, it is likewise possible to convert the date into the date of hatch. The only phenological data obtained during the survey were dates of early and late hatches, or other dates convertible into these. Table 14 shows the data arranged according to degrees of latitude. The data are far from sufficient to justify any conclusion, the object being to suggest a method of compilation rather than give a result. Even such meagre figures, however, seem to show a tendency to peak in the middle center. The blank place in the lower central part, if substantiated by more data, would indicate that hatching begins earlier in the spring and may take place later in the fall in the south part of the north central region than in the north part. The late hatchings of course represent repeated attempts to bring off a brood consequent upon earlier failure to do so.

TABLE 14.—*Limits of breeding season for quail as indicated by date of hatching*

Latitude	Number of broods hatched in—				
	May	June	July	August	September
42—43°	1	3	6	2	2
41—42°	1	2			
40—41°	1	1	6		
39—40°		2			
38—39°	1	4		2	4
37—38°		2			1
36—37°					1
Total	4	14	12	4	8

Weights of Quail. Weight is an important index to vigor, age, and possibly to other characteristics of quail populations. Records of weights and sex tallies could easily be kept by sportsmen, and would be a subject of personal interest as well as of scientific value. Unfortunately few sportsmen gather such information and fewer still record it.

Dr. J. C. Lyter has systematically weighed quail killed on his preserve in Phelps County, Missouri, and remembers that some weighed over 8 ounces, but no record was kept. Deputy Game Warden J. S. Melton of Moberly, Mo., weighed 5 or 10 extra large quail and remembers that they averaged over 8 ounces each. In general, 6 to 8 ounces is the normal range of weights.

I weighed two starved quail in Jasper County on January 25, 1930, one a cock and the other a hen, which weighed 4½ ounces each. W. L. Schofield, field warden in the southwestern district, weighed four starved quail in Green County that weighed 17 ounces together or 4½ ounces each. One was much larger than the other three, which brought up the average. He thinks these four were frozen to death, as they were bunched up dead in a very exposed place. Some other starved birds found by Schofield weighed as little as 3½ ounces. Roughly, quail in this region seem to starve at about half their normal weight. In Georgia, Stoddard found quail still alive at a more advanced stage of emaciation.

There is a statewide tradition in Missouri that the woods quail of the Ozarks are the heaviest, but no evidence was found to prove or disprove its truth.

There is need of determining whether the introduction of Mexican stock has affected size, weight, and plumage. An attempt to do this is now under way at the Ohio State Museum.

A graph showing changes in weight by sexes throughout the year and between years might shed important light on seasonal variations in vigor. It is an unanswered question, for instance, whether, after the snows melt in spring, quail recover good physical condition, or whether their condition remains precarious until greens and insect food become available. Weighing trapped birds would answer this question.

The weights of quail caught by predators would throw important light on the alleged elimination of weaklings. Sometimes hawks are caught in the very act of striking down a quail. Such specimens should be weighed in comparison with other birds of the same sex and age from the same covey.

There is reason to believe that weights of quail bagged may present a means of differentiating the young from the old birds, and thus of determining the success of that year's crop.

Food and Coverts

Present Changes. It has already been shown how both the distribution and abundance of quail responded to past changes in their food and coverts. The present question is: What changes are now under way, and are they favorable or unfavorable?

Five unfavorable changes are now under way, all more or less interrelated. They are:

(1) De-brushing of woodlots and drainage channels by grazing.
(2) Decreasing use of wood for fuel and fenceposts on farms.
(3) Cleaning up of cover on account of insect pests.
(4) Removal of osage orange hedges.
(5) Siloing of corn.

These changes collectively are rapidly shrinking the habitable range, and the abundance of quail within it, throughout the agricultural belt.

At the same time three favorable changes are taking place:

(1) Introduction of leguminous food plants.
(2) Feeding grain where it grows in the field.
(3) Gravelling of roads.

The first and third of these favorable changes are operative almost throughout the region, but their collective effect is of small consequence compared with any one of the unfavorable ones.

Grazing vs. Forestry in Farm Woodlots. The whole trend of farming is to convert plant crops into meat or dairy products instead of marketing them directly. This requires acreage for pasture and feed lots. Naturally the least valuable plowland is used for these purposes. The least valuable plowland is almost invariably coextensive with the remaining timber or brush land. The grazing or feeding of stock in this timber or brush land removes the reproduction and undergrowth used by quail as winter cover, and when the removal is sufficiently complete the farm ceases to be habitable for quail. The same is true for all other game requiring brush cover.

The disappearance of brush cover through grazing is so gradual that even conservationists often do not realize it is taking place, nor do they realize that the

PHOTO 1.—*Grazed vs. Ungrazed Woodlot*

By excluding undergrowth and timber reproduction from woodlots, livestock also excludes game from using them for winter cover. Indiana's woodlot tax law gives the farmer an incentive for keeping his woodlot ungrazed. (Photos by R. F. Wilcox, State Forester of Indiana.)

process must in some way be halted or offset, before other conservation measures can become effective. The process is often obscured by temporary augmentation of brush land which follows the clean cutting of mature timber. The extent to which the process has already destroyed the range cannot be visualized by city people (including many hunters) who do not go afield in winter, and do not see how bare the country is during winter snows. This bareness is further aggravated by the removal of brush from roadsides in the process of highway improvement. Its effects on all brush-loving wild life, game and non-game, is the most important single present fact mentioned in this report. All other conservation measures are at best but stop-gaps until this fundamental deterioration of environment is in some way checked.

The same grazing which removes the brush cover for game of course removes the reproduction of forest trees, and decreases the growth-rate of the mature trees which remain. Forestry, therefore, stands on all fours with game management. Neither can be practiced in grazed woods.

The woodlot, however, is not the only place of conflict. Gullies and stream banks formerly occupied by brush, and offering particularly desirable cover for game, are being de-brushed by grazing, to the detriment not only of game, but of watershed conservation, and the conservation of soil fertility.

Map 8 shows the parts of the Agricultural Belt in which grazing is the most severe. Foresters at the Central States Forest Experiment Station find that the woodlot pastures are stocked at the following rates:

Wisconsin till plain	1.5 acres per cow
Riverbreaks type	1.7 acres per cow
Unglaciated hills of Southeast Ohio	5.8 acres per cow
Ozarks and hill types of Missouri and Illinois	9.2 acres per cow

Agricultural authorities ordinarily recommend 3.6 acres per cow as the limit of safe stocking on the better farm pastures of the Middle West. When this is compared with the first two figures, the intensity of woodlot grazing in the Agricultural Belt requires no further comment.

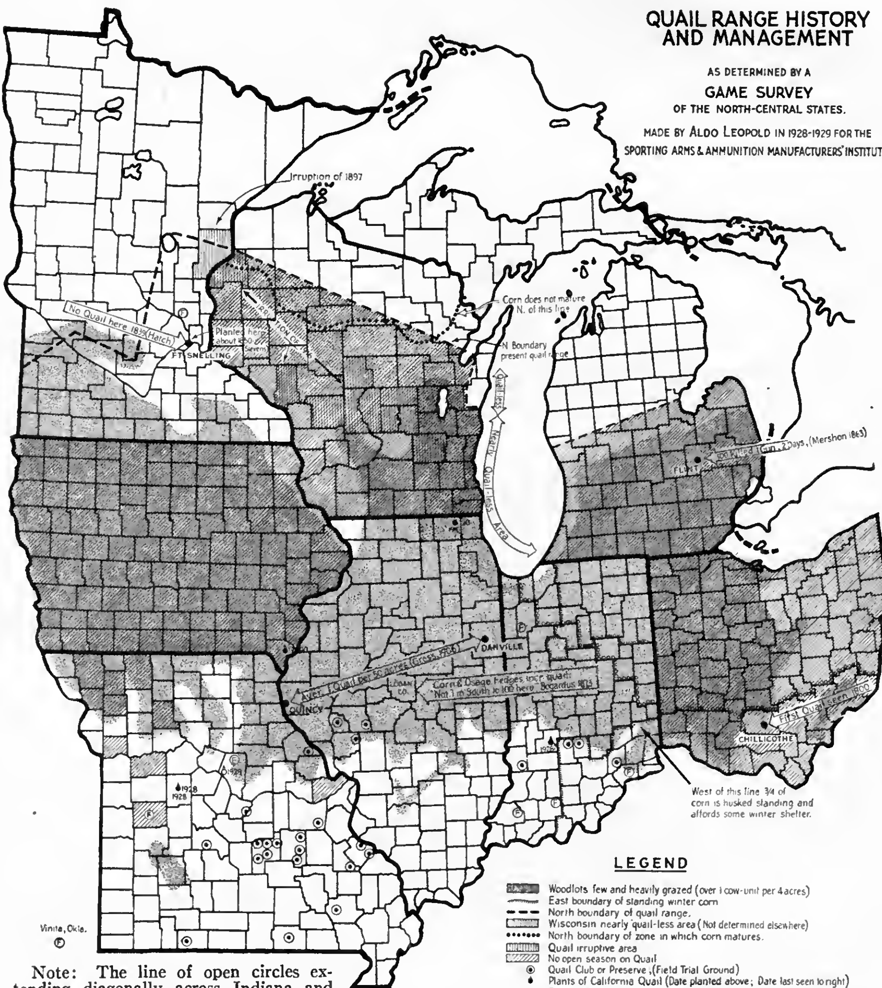
Woodlot Products. The ability of game management and forestry to compete with grazing for the use of the farm woodlot, and in fact the existence of farm woodlots, will depend in the long run on high utility and low cost in woodlot products.

The present trend is undoubtedly in the direction of lessened dependence on woodlot products. Forestry research, by enhancing their utility and decreasing their cost, can counteract this tendency. The trouble is that the forces of science have heretofore been largely concentrated on helping the synthetic competitors of the woodlot.

There is an occasional exception. Thus the cost of fuel wood from the farm woodlot has been greatly decreased by the motor saw, but wood is nevertheless losing ground as a farm fuel. The Ohio Agricultural Experiment Station reports the fuel expenses of 70 Ohio farmers in 1927 as averaging:

For coal	35.21	For gasoline	1.29
For kerosene	5.78	For wood	1.09

It is not known whether the item for wood includes the value of that cut on the farm or not; presumably not.



Note: The line of open circles extending diagonally across Indiana and thence easterly through southern Ohio is the south boundary of the corn-borer infection in 1930.

MAP 8

Conservationists would do well to demand more active help from scientific institutions supported by public funds. Thus the invention of apparatus for efficient conversion of wood into fuel gas for use on farms would generate a powerful incentive for keeping the woodlot productive, and incidentally keeping it fit for game. Yet nobody is thinking about such things.

Insect Pests and Quail Coverts. The direct insectivorous value of quail has been described by Judd (1903) and other ornithologists.

The value of quail coverts as a harborage for other insectivorous birds and for beneficial insects is probably equally great, but is seldom mentioned.

There is crying need of controlled experimentation to measure the population density of brush-loving insectivorous birds and their effect on insect pests, first on a "modern" farm and then on the same farm deliberately re-vegetated for the purpose of increasing birds. Bird houses could be used to augment coverts in further increasing the insectivorous bird population. It is hoped that some agricultural college may undertake such an experiment. The cornbelt is the place to do it. Such an experiment would have great educational, as well as economic and scientific value. For one thing, it might teach sportsmen and "protectionists" that they are wasting their time fighting each other, instead of making common cause to preserve wild life environments, without which neither can attain its ends.

Entomological research is discovering that coverts may harbor the parasites necessary for keeping pests in cherk, as well as the pests themselves. Thus C. L. Fluke, entomologist at the Agricultural Experiment Station of the University of Wisconsin, finds (1929) that the pea aphid, one of the important enemies of the commercial pea crop, is less numerous in the vicinity of ungrazed woodlots, because such woodlots harbor syrphid flies and lady beetles, which are the natural enemies of the pea aphid, and which keep it in check over a radius of one-eighth to one-fourth miles around each ungrazed woodlot. This newly discovered relationship is possibly typical of other exceptions, yet awaiting discovery, to the hitherto accepted rule that a cleanly grazed woodlot means good farming. It constitutes an example of how the requirements of good farming, good forestry, and good game management may after all be identical in many respects.

Other entomologists are beginning to suspect that the advocacy of "slick and clean" farming by agricultural authorities has been too indiscriminate. Frank N. Wallace, State Entomologist of Indiana, told me it was his opinion that fencerow coverts are beneficial rather than detrimental to Indiana farms; that the birds which find harborage in them control the insect risk to at least the same extent as would be the case if the cover were removed and there were no harborage for either birds or insects. He did not of course intend this as a generalization which would hold good for each and every combination of conditions. The advocates of "slick and clean" farming have generalized too much, and the same error should not now be repeated by conservationists. The present need is for investigations which discriminate—which measure the effects of particular covert plants with a particular distribution on particular species of birds, insects, and crops, under specified conditions. Only thus can a rational adjustment between agriculture and conservation be ultimately worked out.

One of the most important impending game problems in the north central region is whether the spread of the corn borer will necessitate cutting cornstalks in the fall and removing them from the fields. The prevalent practice as far east as Indiana (see Map 8) is to leave cornstalks standing over winter, either after husking the corn in late fall, or for the purpose of consumption *in situ* by livestock during the winter. In either event the standing stalks furnish winter cover and feed for quail and other game. On thousands of farms the remaining brush and weed coverts would be insufficient for wintering game, were they not supplemented by standing corn.

The corn borer threatens to change this agricultural custom. The only vulnerable point in the life cycle of the corn borer is its habit of wintering in the corn stalks. Agricultural authorities believe that plowing under or consuming corn stalks is the only feasible means of controlling the corn borer. The crux of the question is whether the stalks will have to be plowed under or consumed in the fall, or whether it will suffice to do this by spring. Millions of acres of game range would go out of production if the cornfields were left bare during the winter. The ultimate disposition of this question may injure cornbelt game to a greater extent than the entire conservation movement has benefitted it to date. Yet that movement does not so far concern itself with these basic questions of game environment.

One of the insect pests which has already resulted in the wholesale clearance of quail coverts is the chinch bug. The danger zone lies in a belt about five counties wide in the latitude of central Illinois, and extends eastward and west ward through the other States. Here again the campaign for clearance of coverts which might harbor chinch bugs has tended to be indiscriminate as between species of cover plants, and has not weighed bird harborage against chinch bug harborage in arriving at a scheme of farm management. The exact effect of game birds in controlling chinch bugs appears to be still in doubt, except in the case of the pinnated grouse, which is known to consume them in quantities. Unfortunately this species is too rare to have a measurable effect.

The Osage Hedge. The early settlers on the cornbelt prairies planted an enormous mileage of osage orange hedges for the purpose of fencing their fields. This wholesale hedging must have begun well before 1860, since Bogardus in 1874 speaks of them as "now full grown."

There were two reasons for these plantings. First, osage hedges cost nothing but labor, the necessary cuttings or "hedgeapples" being easily procured from some neighbor's hedge. Dropping either into a plowed furrow resulted in a fence. Not a cent of cash was necessary.

Barbed wire, on the other hand, cost cash.

Second, the hedges, when allowed to grow up, yielded extremely durable fence posts.

Hedges were planted more widely on prairies than on cleared woodlands because of the scarcity of other fence post timber. Even on cleared farms, however, many hedges were planted because of the scarcity of cash for wire.

Many hedges were unpruned. These became better and better quail coverts with each year of growth. Many a prairie "section" (one square mile) carried from two to four linear miles of excellent hedge covert, frequented alike by quail and insectivorous birds. About 1910, however, soaring land prices called attention to the fact that the spreading hedge roots reduced the yield of corn on a considerable strip of soil. Land having become scarce and high and wire having become abundant and cheap, farmers began to grub out their hedges.

This tendency was accelerated by the development of power tractors with which hedges could be pulled out without heavy hand labor, and also by the discovery that osage is a host for the San Jose scale, an insect pest of orchards. The agricultural extension service urged farmers to pull their hedges; highway departments insisted on it in widening roads; telephone companies objected to hedges because of interference with construction and maintenance of telephone lines. Within a single decade the osage hedge virtually disappared. It is not altogether an accident that this same decade saw the enactment of many "songbird" laws and severely restricted open seasons on quail.

PHOTO 2: Hedge in process of being pulled by tractor power. Note scarcity of game cover. (Photo by Courtesy International Harvester Co.)

In 1874 Bogardus wrote with pride, "Mr. Gillot . . . *being a man of great enterprise* . . . planted hedges all over his estate." In 1930 it is a sign of no enterprise at all if there remain even a single hedge on even the "back forty." Thus do fashions change. Thus also is game and wild life ever left out of account until after the change has been accomplished.

Over most of northern Illinois and Iowa the removal of hedges is already complete. In Minnesota, Wisconsin, and Michigan there were no hedges because the osage is not frost-hardy there. There were few in Ohio, and in Indiana they are confined to the riverbreak and prairie types. Hedges were common all over the prairie and riverbreak types of Illinois, Iowa, and Missouri. Fortunately the process of removal is much less advanced in Missouri than in Illinois and Iowa, except on the Black Prairie northeast of Kansas City, which is as enterprising and as hedgeless as Iowa. There is a chance to preserve at least a part of the hedges in the other parts of Missouri, where county agents estimate them as only 10 to 50 per cent removed to date.

In Missouri the osage also seems almost free from objection as a host of San Jose scale. Dr. Leonard Haseman, professor of entomology in the agricultural college, states:

"For some unknown reason the osage orange hedges in Missouri during the past 20 years have shown practically no serious infestation with scale . . . As officer in charge of quarantine work from 1906 until 1929, I never once found it necessary to condemn osage . . . in the vicinity of commercial orchards."

Fashions in fences, like other fashions, do not always weigh all of the evidence bearing on the utility of the article adopted or discarded. Why are hedges still universal in England, where land is much scarcer than with us? In the light of present agricultural over-production, is it really beneficial to make every square yard of land produce crops? As against the debit represented by land waste and harborage for pests, what credit should be allowed the osage hedge for windbreak service, post supply, and harborage of insect-eating game and song birds? Has any agricultural college ever tried to make the osage hedge into a tighter fence by improving the original placement of the stems, or cheaper of maintenance by divising a mechanical trimmer to dispense with hand pruning and thus reduce labor costs? Is not the lack of movability inherent in a living fence in part offset by its superior durability?

From the game conservationist's standpoint, all of these questions merit the same careful research which a thousand other agricultural questions are receiving as a matter of course. They also merit debate by conservation organizations. They have much more significance than the tinkering of conservation laws, the starting of game farms, or the signing of conservation pledges by citizens who own no land. More game would be produced by in some way paying the farmer a bonus on hedges, than by spending the same money on foreign birds or Kansas rabbits. The fact that questions of this kind are not discussed, not investigated, nor even mentioned, is evidence that the game conservation movement has not yet come to grips with the real fundamentals of the problem which it intends to solve.

Siloing of Corn. In dairy districts it is increasingly common for farmers to gather the corn in fall, stalk and all, for preservation as silage, or for storage at the barn.

This leaves the fields foodless as soon as the pigeon-grass and other weed seeds are exhausted, which is by December.

During the critical winter months the game must come to the barnyard or starve. The foodless condition is aggravated by the scarcity of fallow fields or weed patches in dairy country.

Scarce as brush cover is in dairy districts like south central Wisconsin, it is possible to visit covert after covert in winter without seeing a quail track, and only a few rabbit or squirrel tracks. Find a covert with adjacent corn, however, and one finds a concentration of game.

As Errington (1930) has suggested, game conservation under such conditions almost boils down to the formula "Leave a Shock of Corn."

Favorable Changes. We come now to the favorable changes in agricultural practice, the most important of which is the introduction of leguminous plants. These include clovers, alfalfa, soy beans, and lespedeza or Japan clover. They have benefited not only farm game but even forest species as ruffed grouse and deer.

The history of Japan clover *(Lespedeza striata)* in Missouri will serve as an example. Sauer (1920) states that it invaded southwest Missouri in 1896 and was introduced in southeast Missouri about 1900. It has now spread north beyond the Missouri River to Callaway and Warren Counties, and possibly farther. Its value as a quail food has been thoroughly demonstrated by Stoddard in Georgia. Its establishment as a wild plant in both woods and fields makes the future supply more or less independent of whether or not it is artificially cultivated.

No single plant has more profoundly affected the landscape of the north central region, its economic prosperity, and the environment offered to game, than Kentucky bluegrass. Sauer states that this was not found in Missouri pastures before 1850, but by 1870 it had become common in pastures and roadsides. Today its dense sods constitute the mechanism by which grazing is crowding out quail coverts throughout the Agricultural Belt. It must not be assumed, however, that the spread of bluegrass is *per se* inimical to game. Ungrazed bluegrass is a favorite quail nesting ground. Game environments are a matter of balance between environmental elements. A partial interspersion of close-cropped bluegrass sod in brushland may even be beneficial to quail, as bluegrass nesting grounds certainly are.

Many upland soils in the Agricultural Belt, but south of the glacial boundary, are from the game standpoint deficient in grit and gravel. The now universal graveling of secondary highways has abolished this deficiency, and thus brought about a fundamental betterment in the environment for quail and other game. The grit requirement of gallinaceous game does not seem to have been measured. The amounts eaten seem to be large. William F. Lodge, of Monticello, Illinois, showed me his feeding station which in March was being frequented by forty-one quail, thirty-nine pheasants, and a larger number of small birds. The station was floored with tin to exclude rodents. Mr. Lodge stated it was his custom to feed a sack of grit with each sack of grain, and my examination indicated that consumption was almost in this same ratio. There was only a little more grit than grain left at the time the station was visited.

Quail and Weeds. The seeds of many noxious weeds constitute preferred food for bobwhite. On marginal lands where grain is scarce there would be few or no quail without the weed supply furnished by abandoned fields. On better lands with more grain quail are less dependent on weeds, but even there the variety and abundance of weeds help determine the quail population.

Ornithologists have contended that quail control weeds by consuming the seed. The validity of this claim hinges on the assumption that the weed crop depends on the survival of seed, rather than on the presence or absence of favorable conditions for its growth. The most recent evidence indicates that the seeds of many weeds may be always present. An ample stock of seeds seems to remain "in storage" for long periods, ready to take advantage of any favorable combination of weather and the slackened competition of other species. To the extent that this "storage" theory holds true, the claim that quail control the weed crop fails to hold water.

One of the weeds most eagerly sought by quail is the lesser ragweed, which commonly grows in pastures, in poorly cultivated corn, in the aftermath of stubbles, and on abandoned fields. A brief discussion of it may serve to illustrate the nature of the relationship between quail, weeds, and farming.

In the first place there is conflicting opinion on just what factors determine the presence or absence of ragweed.

What determines ragweed?

Name and title	Locality	Opinion
Phil M. Smith (farmer, agricultural college graduate)	Callaway County, Missouri	Ragweed is proportional to fertility. In Saline County all the pastures have ragweed; here only the best have it.
Wallace Gibbs (county agent)	Texas County, Missouri	Ragweed is worse on the more fertile soils. Think heavily grazed pastures have more than lightly grazed ones.
W. C. Etheridge (prof. of field crops)	Missouri	Ragweed increases with intensity of grazing by cattle (not by goats, as they would eat it). There is more on poor than on rich soils. The stand also depends on previous year's seed crop.
G. B. Mortimer (prof. of agronomy)	Wisconsin	Ragweed increases with degree of infertility, intensity of grazing, and (during dry summers) low vigor of competing bluegrass sod.

The probability is that ragweed is mainly the result of slackened competition. Suitable soils probably always contain seed, ready to take advantage of openings in sod or crops, especially openings during the early summer season. That the species prefers rich soil is indicated by the heavy growth which occurs on the spots where pheasant or poultry pens have been located. Its prevalence on abandoned fields in the Ozarks, however, indicates that it will also grow on poor land, if that is the only place where it can find openings. Ragweed is most abundant in the riverbreak type on the soils of the Illinoian glaciation, and in the prairie type. It is often a pest in pastures, where it shades out the grass in late summer. Possibly its occurrence in pastures is associated with openings in the sod caused by white grubs or overgrazing. If, as is alleged in Indiana, crows are an important enemy of white grubs, we have a new chain of cause and effect in bird phenomona.

The Missouri Agricultural College advocates clipping of pastures during midsummer with a hay mower to prevent the spread of ragweed and other weeds. Clipping is widely practiced in the northern counties, especially Pike County. It of course operates against the quail, but is necessarily limited to open pastures on smooth land. Here is one more agricultural practice operating against game. The remedy would seem to lie in allowing the game crop to acquire a cash value, thus enabling it to compete with other crops in determining farm practice.

The quail in the Ozarks and in the hill type, now subsisting on ragweed in old fields, may possibly decline when the processes of plant succession have caused other plants to crowd out the ragweed. It is quite certain that ragweed occupies old fields only for a limited number of years after their abandonment, after which it is replaced by timber, grass, or other plants. This detail is mentioned to illustrate how favorable game conditions are often the result of temporary and accidental environmental changes.

In the South, running a tractor across abandoned fields renews the succession and leaves a crop of ragweed in its wake.

Tick Trefoil and Woods Quail. In the Ozarks, and in the hill type of southern Illinois and Indiana, quail hunters use the term "woods quail" to indicate covies inhabiting range composed entirely of timber. There is a tradition that these woods birds are extra large and heavy, but the survey disclosed no evidence to either prove or disprove this belief.

Woods quail are usually a temporary, but sometimes a permanent phenomenon. In the foothills of Ripley County, Missouri, during certain fall seasons, nearly all of the quail temporarily leave the fields to inhabit woods, where they are said to feed upon huckleberries, grapes, or mast. It appears, however, that these same covies shift back to the farms when the season advances and food conditions become more favorable there.

In parts of the main Ozarks, however, a thin but permanent quail population inhabits the woods yearlong. Thus in the vicinity of Deer Run State Park there are about five covies of woods quail per section on a tract of land cut over about 15 years ago. Nearby is a tract cut over 10 years ago, and this has more quail.

In the Coldwater hills of Madison County, on the other hand, woods quail are unknown to local sportsmen. The soils here are mostly formed from igneous rocks rather than limestone, and I suspect support less food-bearing vegetation. I personally observed less ragweed on the farms, and the map shows thin quail populations even on the farms.

In Texas County, the local sportsmen told me that woods quail occur where there are trefoils or "stick-tights," and implied that they do not occur elsewhere. In Benton County the game warden told me that quail did not go into the woods last fall because the "stick-tights" did not mature their seeds. These two counties are evidently like Ripley, in that quail inhabit woods only temporarily.

All of this evidence, even though it is circumstantial and second-hand, strongly suggests that woods quail are determined by tick trefoil *(Meibomia sp?)*, and possibly other leguminous plants bearing preferred foods. Frederic Dunlap, state forester of Missouri, believes that the legumes, growing as ground cover in the Ozark forests, are responsible for such value as they have for cattle range, and the same may be true of quail.

Stoddard found that these native legumes were eliminated from the woods in Georgia by summer cattle grazing, for the reason that the cattle did not allow them to bloom and mature seeds. There is a high degree of probability that grazing or fire or both determine woods quail, and also the extent to which farm quail resort to woods throughout the Ozark and hill types of the north central region. Even in Wisconsin the preliminary findings of the institute fellowship indicate that summer cattle grazing excludes trefoils, and hence quail, from timbered range.

Here again, even without the final evidence of exact inter-relationships, we may safely say that the distribution and abundance of quail is the accidental result of the distribution and nature of agricultural processes.

Winter Cover. One of the characters common to the entire range of quail in the north central region is that every farm has good quail cover from May to December, but that most farms have deficient winter cover or often none at all. By winter cover is meant cover which will harbor quail after frost has thinned out the vegetation, and particularly while snow further increases the visibility of all wild life which cannot seek refuge under ground.

Winter cover need not render quail invisible if it supplies mechanical obstacles, such as thorns or dense mats of stems, to prevent natural enemies from successfully harrying the birds. Thus osage orange is a preferred winter cover, particularly when it offers hanging branches covered with small thorns and reaching almost to the ground, even though the quail are usually visible under it. Grape vines, dense briars, dense roses, and conifers with low-hanging branches are all good as winter cover.

Bogardus observed many years ago the mechanical function of winter cover:

"The hedges . . . are of great use to the quail as places of refuge and security when pursued by hawks . . . They used to have a very hard time of it in Illinois in severe winters. There was no protection from hawks, by which they were constantly harried and destroyed; and there being next to no cover, they used to be frozen to death in bevies . . . *The hedges now afford very great protection* and preserve the lives of thousands which would otherwise certainly perish of cold and starvation in their absence. They break the force of the wind, and furnish snug lying-places for the birds in hard weather."

It is interesting that Bogardus should consider the hedgeless prairie grass of the old days as being "next to no cover." If he could see the prairie now, with neither hedges nor grass!

The present problem is to persuade farmers to restore some kind of usable winter cover, even though it fall somewhat short of the Bogardian ideal of hedges, standing corn, grass, and weeds. It must be something which the quail are willing to use, and especially something which the farmer is willing to plant or let grow. Here we may take advantage of another accident of farmer psychology. The coniferous windbreak or shelter-belt, artificially planted and consisting of exotic evergreens, is somehow regarded as an asset and an ornament to the farm, even though it consumes just as wide a strip of corn land as the largest osage hedge of former days.

Coniferous Shelterbelts. Thousands of prairie farms once had shelterbelts, usually to the windward of the house and outbuildings. Norway spruce was the most common species, although Scotch pine, white cedar, and white pine were occasionally used. From 1870 to 1890 almost every prairie farmer who took a pride in his place planted one of these shelterbelts. By 1900 the spruces had grown to the ideal size for sheltering quail. Their wide branches swept the ground, and offered a dense and prickly refuge which snow only served to make denser. At this time most of the old shelterbelts have either died, or been pruned up so as to destroy their game value.

TABLE 15.—*History of coniferous shelterbelt plantings*

	Missouri	Ohio	Indiana	Illinois	Iowa	Michigan	Wisconsin
Peak of old plantings	1870	----------	No peak	1875	?	x	1880
End of old plantings	?	Yes, 1890	----------	?	?	x	1890
Any revival?	?	Yes, 1915	Yes, 1925	?	Yes	x	Yes, 1925
Planting stock available from State	At $15 per thousand	At cost	At $10 per thousand	No	At cost for demonstrations	At cost	At cost
Conditions under which available.	Cultivation, fencing, weeding	No grazing	----------	----------	Fenced against grazing	None	None

Some State foresters are now trying, with some success, to revive interest in shelterbelt plantings. In some States planting stock is furnished at cost. Sportsmen would do well to encourage appropriations for this work, especially where the State stipulates that the plantings must be fenced against grazing. There is also an excellent chance for commercial nurserymen to capitalize the game value of evergreens, provided their salesmen learn to properly advise their customers where and how to plant trees for game purposes.

A summary of the history of shelterbelts, as reported by the State foresters, is given in Table 15.

Winter Feeding Methods. The most important device for winter feeding is the food-patch. The survey encountered no systematic provision of food patches for quail except on the Missouri State refuges and part of the Missouri quail preserves. On the Lyter Preserve in Phelps County a strip of kaffir corn is planted on the edge of fields and left uncut. Dr. Lyter says the grain keeps all winter without molding.

On the Missouri refuges, one-acre patches of mixed kaffir, milo, cane, millet, and sunflower are sown at intervals of one-half mile if possible. The millet appeared to be easily covered by snow. The sunflowers had been picked clean by small birds before snow came.

The next most important is the self-feeding station. None of these were heard of, except the experimental ones installed on the Wisconsin University Farm under the institute fellowship. These consisted of wheat bundles, inverted and suspended about 2 feet above the ground. Quail readily threshed out these bundles by jumping, and rodent wastage was effectively prevented. Rodent wastage was high, however, in the stack of reserve bundles which necessarily accompanies this method. Furthermore a bundle became exhausted in two days. The method, in short, seems to have no labor-cost advantage over ordinary feeding of shelled grain.

Another self-feeding method tried by Errington (1930) at the University of Wisconsin Farm was to simply leave an ordinary loosely-stacked corn-shock near cover. This revealed the astonishing fact that quail readily clipped away the husks and silk from even the most tightly-husked ears, and thus had ready access to nearly all the corn in the shock. If this ability to clip corn husks is a universal character of bobwhite, winter self-feeding resolves itself into the extremely simple formula: "Leave some shocks of corn."

It is believed that ordinary feeding stations (as distinguished from self-feeding) are becoming sufficiently prevalent to begin to have a measurable influence on winter survival of quail, especially in the northern States. No way of measuring the increase in feeding stations was found, because of the difficulty of differentiating accidental from deliberate, and effective from ineffective stations. The technique varies from elaborate "towers," with a roofed-over and tin-floored platform, to simply impalling some corn-ears on brush or hanging them in the crotches of bushes.

Lean-to roofs 6 by 6 feet, built of lumber and camouflaged with brush were tried in 1929–30 by the University of Wisconsin to keep feed from being covered by snow. The findings were not very favorable.

Emergency-feeding (no pre-organized station) is highly developed in Missouri, and seems to be effective and satisfactory for Missouri conditions. It is practiced not only by sportsmen, farmers, and game wardens, but by rural mail carriers, through a co-operative agreement with the postal authorities. All are furnished grain by the game department.

The field work on the Missouri game survey was under way during the hard winter of 1929–30, and gave an excellent chance to see the Missouri method in operation. The department, through its field wardens, distributes grain in unit 10-pound packages to all who are willing to put it out. This sounds as if it would be open to many abuses in actual practice, but in the course of several trips with game wardens and many conversations with sportsmen and farmers, no instance of the use of such grain for other than game-feeding purposes was encountered. On the contrary, I found several places where the department's volunteer co-operators had visited quail ground before I did, and put out the grain in an intelligent and effective manner.

The procedure used by the Missouri wardens for emergency feeding was as follows: The probable location of a covey, if not already known, was determined by looking at the cover. If the terrain included an osage hedge with drooping branches, or escaped osage bushes with drooping branches, it was almost a foregone conclusion that the covey would be there. Having found the tracks of the covey in the snow, it was almost a foregone conclusion that the covey itself would be within 50 yards or at most 100 yards of the tracks, the radius of mobility during snowstorms being exceedingly short. Some wardens used steady bird dogs to locate the covey, but it was my observation that it was just as easy to accomplish this by sighting them, and the danger of flushing was less.

Once the covey was located, the tracks would indicate their radius of action, and within this area three or four double handsful of grain were dumped in each of three or four places least subject to coverage by snow, such as shelves on gully banks, the base of an osage tree, packed snow under a log or a grape tangle, or the like. Experience had taught the wardens that such a feeding would last for two days, and would not need to be repeated until three or four days after. Food spots were preferably placed all around the covey. There was no difficulty in getting the covey to find the food. Rabbits of course get more of the grain than quail, and leave no visible grain after the first night, but they tramp grain into the snow which quail can later scratch up.

The weakness of this system is of course the amount of labor which it entails, that is, the short period for which each feeding is effective. In the northern States, where feeding weather may last for a month at a stretch or even longer, I consider it a very poor method. In Missouri, however, where blizzards are only occasional, or where they may not occur at all during a whole winter, and where, when they do occur, usually last only a week or two, I am convinced that this system has great merit in spite of its heavy labor cost. Feeding stations employing suspended weed shocks, grain buried in chaff or straw, or other arrangements necessitating less frequent visits are of course preferable, but it will probably be difficult to get landowners to exercise enough foresight to install them. On the other hand, in the face of actual emergency, it is not at all difficult to get people to put out grain.

The relation between feeding stations, feeding methods, and predators is discussed under the section on predators. It should here be said, however, that I found hawks, or evidences of quail killed by hawks, at a majority of the covey headquarters during the Missouri feeding operations. It was quite evident that these hawks did not do much execution on covies bushed up under osage or other thorny cover, and vigorous with plenty of grain feed, but it was also evident that the lack of either cover or the feed allowed of a sudden and probably serious hawk mortality.

One hundred thousand pounds of grain was purchased by the Missouri game department during the hard winter of 1929–30.

Summary. Agricultural changes are affecting quail now, as they have in the past.

The most important present changes are the grazing out of woodlots and the removal of osage hedges.

Cleaning of fencerows and roadsides is also reducing winter cover.

All these changes decrease harborage for insect pests, but also harborage for the useful birds and parasites which hold the pests in check.

Decreasing use of wood on the farm threatens to intensify these changes.

The fall-cutting of corn to control the corn-borer threatens to further increase the deficiency of winter cover and food.

The introduction of new food plants, the feeding of stock in the fields, and the gravelling of highways is partially offsetting these unfavorable changes, but the net trend of quail is downward on the best soils, and will so continue, unless counter-forces are brought to bear on the landowner.

Quail prefer certain weed seeds. Their alleged control of weed pests, however, may have been overemphasized. The factors determining the abundance of ragweed, for instance, are as yet poorly known.

Legumes often determine the extent to which quail inhabit timber. The native legumes are destroyed by summer grazing.

The revival of shelterbelt planting promises to restore some cover.

Winter feeding of quail is increasing and probably has a perceptible effect on the crop.

Quail and Weather

Kinds of Weather Losses. In so far as now known, direct killing of quail by weather occurs only in severe winters and during hard rains.

Winter losses are usually considered to be the result of starvation, but occasionally occur through freezing, imprisonment by ice or snow, and clogging of plumage by ice.

Summer losses are the result of flooding of nests or drowning of young by hard rains. Hail also occasionally kills young quail.

An attempt was made during the survey to gather evidence on the correctness of the supposition that starvation, not cold, is the primary cause of winter loss. A statistical analysis was made to determine the relation, if any, between losses recorded by ornithologists or remembered by sportsmen, and the weather bureau records for snow and cold respectively.

The statistical study also attempted to find out something about the geographic distribution, frequency, and degree of both winter and nesting loss.

The data are summarized on Chart 2.

Explanation of Chart. Chart 2 incorporates what might be a dozen separate charts, so as to bring all the information together for ready comparison. It is not easy to read. The conclusions drawn from it appear in the subsequent captions. Unless the reader is interested in checking the validity of the conclusions, he need not try to decipher it.

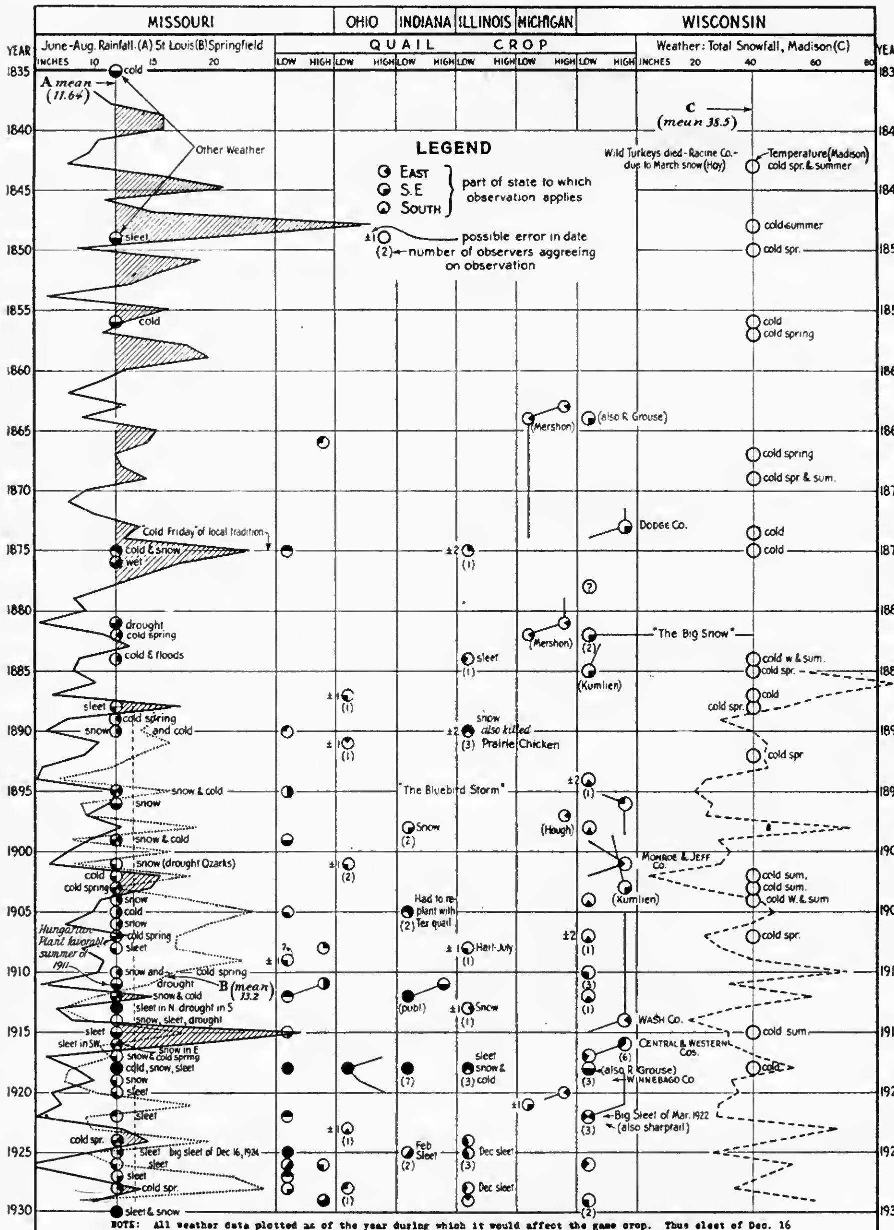
The wide columns on the right and left margins show the existing weather records for Missouri and Wisconsin respectively since 1835. The narrower columns inside these weather graphs show quail history for these two States, in so far as it is known.

The narrow columns in the center show quail history for the other States, but *not* their weather records. Occasional notes on weather are interjected, where a short crop is known to have been caused by some particular storm.

The Missouri weather column on the left shows nesting rainfall for two localities (A and B). The shading shows during what years the St. Louis rainfall was above the mean, which is the vertical line near the center of the column. The dashed line to the right of it is the Springfield mean.

On the vertical line representing the St. Louis mean are clustered a series of circles labeled sleet, cold, snow, etc. These are the years of exceptional sleet, cold, and snow for the State as a whole. The black segments indicate the part of the State to which they pertain. Some of them are not from the Weather Bureau, but from Sauer's book, "Geography of the Ozark Highland of Missouri," which describes cold winters previous to 1873, at which point the Weather Bureau's temperature records begin. All sleet symbols since 1913 are based on the records of the Southwestern Bell Telephone Company, and appear for the years showing over three-fourths inch of sleet on their wires.

The Wisconsin weather column on the right gives total snowfall at Madison (C), instead of nesting rainfall. There was no room for both, and the snowfall was considered more pertinent to a northern State. The circular labeled symbols arranged on the vertical line (mean snowfall) show the years of exceptional cold *at Madison* (hence there are no black segments to indicate the part of the State.



NOTE: All weather data plotted as of the year during which it would affect the game crop. Thus sleet of Dec. 16 1924, plotted 1925; "Big Snow" of 1881-2 plotted 1882. All weather graphs from U. S. Weather Bureau except: (1) Missouri sleet years after 1913 are from Southwestern Bell Telephone Company (years with over 3/4" ice recorded on wires); (2) some early data in Missouri from Sauer's "Geography of the Ozarks."

CHART 2

These are omitted because quail occur only in the southwest half of the State, of which the Madison climate is probably a fair sample).

The narrow columns in the center show for each State the known information on whether quail were high or low. A circle on the left side of the column indicates a low crop, and the black segment shows in what part of the State. A circle on the right side of the column indicates a high crop, and the black segment shows where located. Lines connecting the circle indicate a continuous condition or trend. The figure to the left of a circle indicates, by "plus or minus" signs, the possible error in date. The figure below a circle shows the number of observers agreeing on the high or low condition on that date.

All symbols for weather show as of the year during which they would affect the quail crop. Thus a sleet of December, 1924, would show on the horizontal line for 1925, because that is the year it would first affect the crop. A few of the short crops recorded on the chart are recorded in the literature, but most of them were obtained by compiling the recollections of sportsmen, farmers, and game wardens. Where several reports departed only slightly from the known date of a severe winter, the evidence was considered as establishing that date. Where several reports checked on a date, but the weather record showed no abnormality, the date was accepted. Where a single report was backed by neither the weather record nor other reports, it was usually dropped as unfounded.

The work was not done with equal care in all States. The check against weather records was made only in Wisconsin and Missouri. For this reason comparison between States should not be regarded as conclusive.

Historic Weather. The reader who has mastered the foregoing explanation of Chart 2 now deserves a vacation. It is desired to summarize a matter of popular interest, namely, the weather conditions affecting game which were so extraordinary that local tradition has given them names, and handed down descriptions of them which old-timers can repeat (doubtless with due elaboration). Since the weather records back up the descriptions, however, we need not doubt their reality.

The first of these was the "cold Friday" which occurred in the winter of 1874–5 in northeastern Missouri, and which consisted of a sudden and very severe blizzard remembered by all old-timers.

Next was the "big snow" of 1881–2 in southeastern Wisconsin. It evidently killed quail in Michigan as well.

Then came the "bluebird storm" of 1894–95, well-known to all bird lovers because it caught the bluebirds after their northward migration had begun. So many of them died that for several years afterward the sight of a bluebird was a rarity. Its exact extent was not determined, but I personally recall the scarcity of bluebirds in southeastern Iowa.

The "big sleet" of March, 1922, registered itself in the quail crop for both Missouri and Wisconsin, but it was especially severe in Wisconsin, where it killed not only quail but also sharptail grouse. Its effects in the form of limbs torn from trees were visible in any woodlot for several years afterward.

Another "big sleet" occurred in Missouri, December 16, 1924, and registered itself in a shortage in the 1925 quail crop throughout the State.

These extraordinary storms are worth recording not merely for their effect on quail, but because any historical investigation of game which involves compiling the recollections of old-timers will have to use them as landmarks. The old-timers will recollect, not the year of any event, but how many years before or after "cold Friday" or the "bluebird storm."

Cause of Winter Losses. Chart 2 makes it possible to compare the winter losses in Missouri and Wisconsin with total snowfall and coldest winters. In Wisconsin a comparison was also made with the record of snow on the ground at any one time. To avoid crowding, this record was omitted from the chart.

The idea behind the comparison is that if losses frequently coincide with winters which were cold but had little snow, then cold as such is indicated as a cause of loss. If, on the other hand, losses are found to coincide with snowfall, or combinations of snowfall and cold, but not with cold alone, then the indication is that cold alone is not a cause of loss.

The detailed figures expressing these comparisons will not be repeated here. It will suffice to give the conclusion, which is that depth and duration of snow, with or without cold, coincides with losses much more frequently than cold alone, and hence is the principal cause of winter losses in quail.

The analysis of the chart also shows that there is a frequent coincidence between quail-killing winters, grouse-killing winters, and grouse cycles. The details will be given in a subsequent chapter. The reason for this coincidence is not understood. There may be a tendency for protracted snow and cold to accentuate disease in both species. It is recommended that sportsmen who find winter-killed quail, or supposedly winter-killed individuals of any other gallinaceous species, submit the carcasses to competent scientists to be examined for disease. There is a possibility that the quail irruption of 1916 may have been terminated by disease, rather than by the hard winter of 1917–18.

The survey encountered only one instance where quail in good condition met death by freezing. This was observed and reported by Errington (1930). A covey of quail had sought warmth on a fermenting manure pile where their plumage got wet. Upon being flushed they scattered and froze.

Many sportsmen believe that rabbits and predators scatter quail at night, and thus induce death by freezing. No evidence was found to support this theory. 'Coon hunters report that roosting covies flush more readily at night than they do in the daytime.

There are many records in ornithological and sporting literature of roosting covies imprisoned by snow or sleet, which fell during the night and froze to the vegetation around and above the roost, thus imprisoning the birds.

The survey encountered one report of death by sleeted plumage. F. C. Gamm, a farmer-sportsman in Pike County, Missouri, found a covey in the winter of 1927–28 which could not fly because of frozen sleet adhering to their wings. They were still alive when he found them, but would doubtless have perished. Mr. Gamm thinks that they were snowed under while roosting, and that their body heat caused a drip which froze on their wings. It hardly seems probable, however, that body heat could melt snow, and at the same time allow it to freeze on the plumage, at a point closer to the bird than where it melted. It seems more likely that these birds in some way got their wings wet, after which ice could have accumulated on them in numerous ways.

The evidence of loss through hail is only circumstantial. A short crop was observed in Perry County, Missouri, in spots which had experienced a severe hailstorm in June.

The probabilities are that all weather losses except starvation and drowning of nests and broods are of minor consequence.

Distribution of Winter Losses. Winter losses predominate in the northern tier of States, and nesting losses in the southern tier. It is believed that nesting losses are most severe on flat topography and heavy soils. Winter losses do not decrease southward as much as one would expect, in view of the decreasing snowfall. The reason for this is that sleet storms increase in frequency and severity as one progresses southward. Only the Lowland Belt, in the extreme southern projection of the north central region, could be considered as south of the zone of winter losses in quail. For this reason organized winter feeding is a necessary part of quail management throughout the region.

Degree of Winter Loss; Recovery. While winter losses sufficiently severe to imprint themselves on the mind of sportsmen appear to be as frequent in the southern tier of States as in the northern, there can be no question that the period necessary for recovery, which is presumably a measure of the severity of the loss, decreases southward. In the Agricultural Belt and southward, sportsmen almost invariably report recovery of normal abundance during the second breeding season, whereas in the northern tier of States there are abundant records that quail were nearly absent for as long as 10 years, or that recovery was accomplished only by replanting. Thus Mershon (1923) states that quail were hardly heard of for 10 or 15 years after their great abundance near Saginaw about 1870. He says they would become plentiful for two or three years, and then again disappear. His description almost suggests the irruptive behavior already described in parts of Wisconsin, and suggests that on the northern edge of the range disease may combine with hard winters to produce fluctuations of such wide amplitude and long length.

The survey was unsuccessful in finding among sportsmen any actual measurements of the degree of winter loss in any single case. Estimates are easily obtained, but hardly worth printing. The University of Wisconsin, however, made such a measurement last year.

Wisconsin Study of Winter Losses. Paul L. Errington, Institute fellow at the University of Wisconsin, studied quail losses during the winter of 1929–30. He made a census of 60 covies, aggregating 1,000 birds, at the time of the first snow, and then re-counted these covies from time to time during the winter. Each covey selected for this study occupied a rather isolated range. This minimized the chance of shuffling with outside covies and distortion of the count, but also represented poorer than average environment.

Many of the original covies had to be dropped from the study because the count became confused by reason of shuffling, inability to visit them often enough, etc. About 240 birds, however, were successfully followed through the winter without anything happening to introduce any visible error into the count. Their history is summarized on Chart 3 (reproduced by permission of "American Game," in which the findings were published, November–December, 1930).

Although 1929–30 was a killing winter in Missouri, it was not especially severe in Wisconsin.

The chart shows that these covies hardly lost a bird until the middle of January, at which time severe cold occurred in conjunction with a heavy snow, and with the exhaustion of ragweed and the edible legumes on most of the covey ranges in question. The descending January curves in the lower half of the chart show that a sharp loss, amounting to annihilation in the case of one covey, immediately followed this combination of unfavorable conditions. Only those covies having access to corn remained thrifty during February. No further losses occurred up to the time when the last snow put an end to the counting in late March.

Of the 240 original birds, about 170, or 70 per cent, were surviving on April 1.

It should be emphasized that Errington is not ready to say whether this is a representative survival or not.

Frequency of Nesting Losses. The Missouri rainfall records may be analyzed directly to determine the frequency of wet nesting weather. The first question which arises is whether the loss is caused by excessive total summer rainfall, or by the violence of individual rains. We do not know, and there is no record of the violence of individual rains. We do know that Stoddard found a close correspondence between the total rainfall for June, July, and August in Georgia, and the subsequent quail crop. Hence June to August rainfall is used as a basis for the analysis. Chart 2 gives the June to August rainfall by years, and the following table summarizes the chart.

The table again emphasizes the local nature of exceptional weather. It shows that abnormalities of rainfall at St. Louis and Springfield are seldom common to both localities.

Extra heavy rainfall appears to be more frequent at Springfield than at St. Louis, whereas extreme dryness is less so.

RELATION OF FOOD, COLD AND SNOW TO WINTER QUAIL LOSSES

SOUTHERN WISCONSIN, WINTER OF 1929-30

Snow (in inches)	November 1929	December 1929	January 1929	February 1930	March 1930
During month	0.8	3.0	17.6	1.9	5.9
On ground at end of mo.	0.0	trace	8.3	1.0	trace

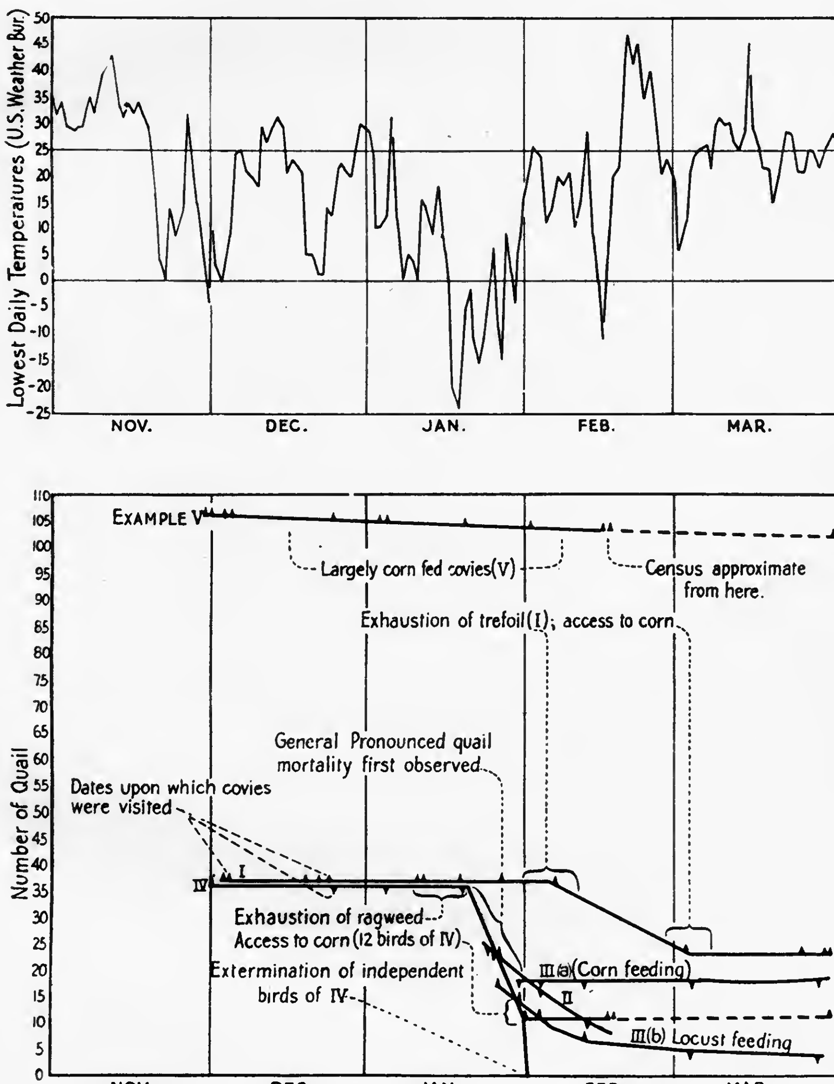


CHART 3

TABLE 16.—*Risk of wet nesting seasons (June–July–August rainfall)*

Risk of;	St. Louis (since 1837; 92 years)		Spring6eld (since 1888; 41 years)		Both St. Louis and Springfield (since 1889; 41 years)	
	No. Years	Per Cent	No Years	Per Cent	No. Years	Per Cent
Wet Years—						
Rainfall over mean	57	40	22	54	7	17
Rainfall over 15 inches	17	8	19	46	2	5
Rainfall over 20 inches	5	5	4	10	0	0
Dry Years—						
Rainfall under mean	54	6	20	49	16	39
Rainfall under 10 inches	41	45	13	32	11	27
Rainfall under 6 inches	8	9	0	0	0	0

In general, rainfall over 15 inches may be expected at St. Louis a little less than 1 out of every 10 years, and a deluge in 1 out of every 20 years, but in Springfield rainfall over 15 inches may be expected almost every other year, and a deluge once in 10 years.

It should be pointed out that the Springfield records are less than half as long as the St. Louis records, hence their general characteristics are less conclusive.

Frequency of Losses. The losses from all causes as indicated by short crops on Chart 2, when added up and compared with the total period during which they occurred, give a rough idea of the average frequency with which short crops may be expected in the future.

TABLE 17.—*Frequency of losses* (all causes)

State	No. of losses reported		Period covered		Average frequency: 1 loss every:
Wisconsin	13	in	66 years	= 1 every	5 years
Illinois	10	in	53 years	= 1 every	5 years
Indiana	7	in	49 years	= 1 every	7 years
Ohio	6	in	41 years	= 1 every	7 years
Missouri	15	in	55 years	= 1 every	4 years

It is improbable that the number of losses recorded on Chart 2 is anywhere near the actual number. This fact alone would indicate that the frequency indicated by the table (once every 4-7 years) is too low. On the other hand, it is certain, in view of the usually spotty nature of extreme weather, that many of the losses on Chart 2 were by no means Statewide. This fact alone would indicate that the frequency of 7–4 years is too high. Possibly the two errors balance, so that in any single locality a partial quail crop failure every five years is about what can be expected.

Since recovery ordinarily occurs the second year, this is sufficient to answer the question: does the risk of loss impose a prohibitive risk on the desired ventures in quail management? The answer is that it does not, that not more than one year out of five will show a crop failure, and that the degree, if not the number, of these failures, can be reduced by winter feeding and other management measures.

Quail Management

All of the preceding discussions of course bear on management, what it should be, and why. There remains to be presented a description of present practices, and a recapitulation of the principal findings of the survey with respect to quail.

Quail Hunting. Quail hunting with bird dogs is a comparatively recent development in this region. The early settlers trapped quail for food, but did not shoot them for either food or sport because of the abundance of larger game and the lack of cash for ammunition.

Widespread wing shooting of quail for sport, and also widespread trapping and shooting for market, began after the Civil War.

Market hunting of quail was by no means confined to what is now thought of as good quail ground. Mershon (1923) records systematic market hunting of quail in the Saginaw Valley of Michigan up to 1891. Market hunting in Michigan became illegal in 1894.

Bogardus was evidently marketing the quail which he killed in large numbers in the prairie counties in central Illinois in the 1870s. His shooting center was in Logan County, which is not now regarded as good quail country.

A curious fact encountered during the survey is that there was no quail shooting for sport by local residents in the Ozarks until very recently. In Texas County, for instance, I was told that no local residents shot quail for sport until about 8 or 10 years ago, whereas at the present time a large proportion of the business and professional men in the county seat own dogs and practice shooting, and some of them shoot almost every day throughout the open season. The same change is true in lesser degree of many Ozark farmers.

Quail dogs are becoming increasingly scarce in the closed States. The greatest remaining interest in quail shooting and quail dogs is in Indiana and Missouri. When a State is closed, most sportsmen sell their dogs or ship them South. It does not occur to them that the closed season is of their own making, in the sense that the restoration of an abundant crop through management would have dispensed with the necessity of closure.

Map 8 shows the States and counties now closed yearlong to quail hunting.

History of Seasons. Chart 4 shows at a glance the progressive shrinkage in opportunities for quail hunting. In 1900 Wisconsin was the only closed State. The prevalent open season in the other States was two months. About 1905 three States shrunk their seasons, possibly in part by reason of the hard winters of 1903–4 and 1904–5, which Table 15 shows necessitated the replanting of northern Indiana with Texas stock. In 1912, Indiana, Ohio, and Missouri cut their seasons in half, and Table 15 again shows preceding hard winters in Indiana and Missouri which may have emphasized the unsatisfactory crops. In 1917 Iowa closed and Minnesota cut her season in half. This however cannot be associated with hard winters, since the historic winter of 1917–18 came after

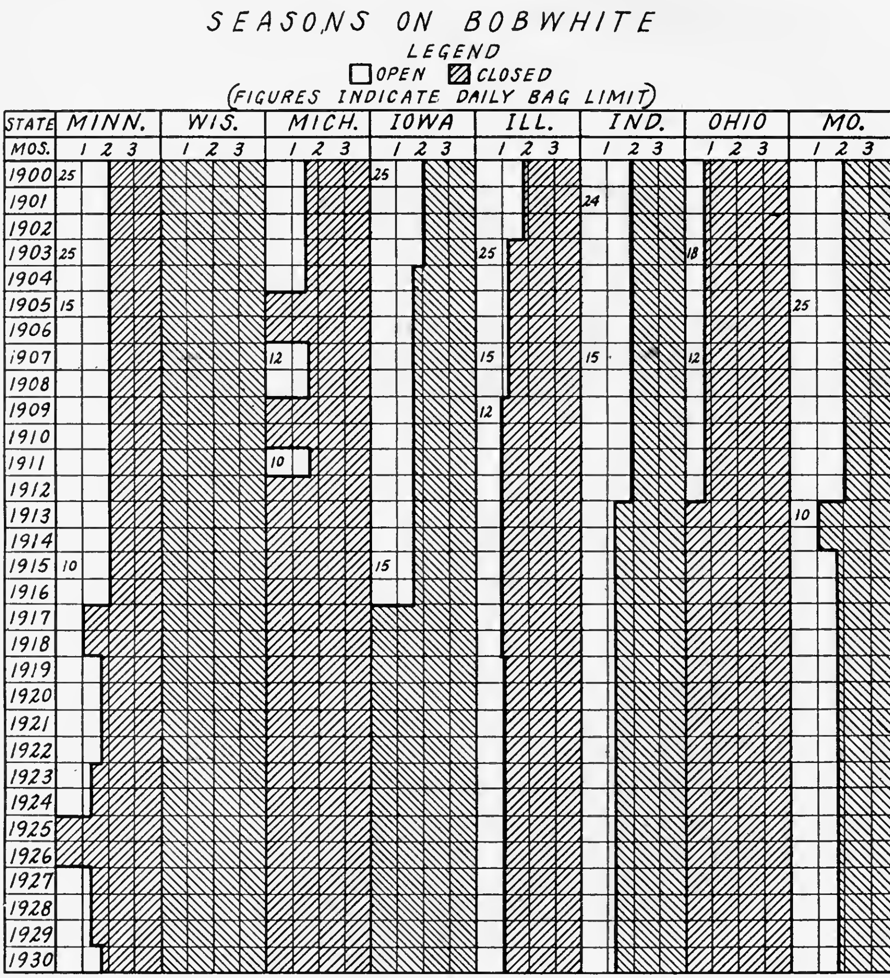


CHART 4

this action was taken. Since then an approximately stable condition, with four closed States and four open seasons of 30 to 50 days, has prevailed.

It is common knowledge, of course, that the four States still open are each under pressure to close up. If history repeats itself, the next severe winter die-off may see a part of them closed. The only sure preventative is for their sportsmen and farmers to convince the public that effective machinery for quail restoration is in working order. And this machinery must be something better than the buying of Mexican stock for replanting.

The figures inserted in the open season spaces on Chart 4 show the progressive changes in bag limits. The present limits in the open States run from 10 to 15 quail per day.

Quail Refuges. Quail refuges are the only device, other than restriction of seasons and bag limits, so far tried out in this region as a means of preventing over-killing of quail.

Each of the States in the north central region has tried out leased refuges, more or less with the idea of protecting quail. For reasons to be later discussed in the chapter on game administration, these leased refuges are not considered a fair trial of the refuge idea.

Missouri is in process of actually acquiring ownership of a system of refuges, partly with the idea of managing quail. Map 8 shows the location of this system. A circle of 10-mile radius is shown around each refuge.

The previous discussion of quail movements indicates the improbability that quail breeding stock would flow out from a refuge with sufficient freedom to restock a zone 10 miles wide each year. A 10-mile zone has been allowed, however, to give the refuge system every benefit of the doubt. A glance at the map is sufficient to show that even if the present refuge system were considerably enlarged and extended, it could hardly feed breeding stock into more than a small portion of the State. This is merely another way of saying that it is doubtful whether refuges alone are an effective device for maintaining a breeding stock of non-mobile species like quail, unless the natural flow be augmented by artificial means.

Fortunately it is entirely practicable to do this. The practice of intensive management upon each refuge would certainly produce enough stock to allow the annual trapping of as many or even somewhat more birds than could be safely shot on the same area. These trapped birds could then be shipped to restock hunting grounds wherever needed. The cost per pair of wild quail thus produced by natural methods would certainly be less than the cost per pair of quail raised in pens by artificial methods, which cost is seldom less than $5 to $6. At the same time the wild trapped stock would be much superior for restocking purposes.

Charges for Quail Shooting. Paid shooting exists in the region in two forms, each to a very limited extent: (1) leased preserves and (2) "toll" charges per man per day.

Very little information was obtained on the lease rates paid for quail preserves. Some of them are owned outright and hence of course pay no lease. The small amount of information at hand indicates that the lease rates are similar to those prevailing in the southeastern States, namely 10 to 15 cents per acre per year.

All that was learned about toll charging is summarized in the following table.

TABLE 18.—*Charges for Quail Shooting Privileges*

Locality	Leases	Tolls	Remarks
Central Missouri	10 cents per acre $25 per farm plus	$1 per day	
Sullivan County, Indiana		$5 per day	Only one farmer charges
Allen County, Indiana		$0.50 per day	For mixed hunting
Vermillion, Edgar and Clark County, Illinois		$1 to $2 per day	Also require extra low bag limit
Vermillion County, Illinois		$15 per day	Includes board and dogs

TABLE 19.—*Per Cent of Quail Killed on Tracts of Known Acreage and Population*

No.	Observer County and State	Acreage	Year	Acres per quail		Per cent Killed
				Population	Kill	
1	C. F. Mansfield, Central Illinois	2,400	Best year since 1907	1.4	1.8	
			Average year		4.0	
2	H. J. Bowman, Madison, Illinois	115	1928	0.3	1.1	28
			Best year	0.3	0.5	70
3	J. M. Olin Madison, Illinois	150	1925–27	0.8	1.0	80
4	C. E. Huff Clark, Illinois	160	1928	2.1	4.0	50
5	Frank Gentry, Brown, Indiana	640	1928	1.6	4.2	37
		640	1928	0.8	3.2	25
6	Fred. C. Dobelbower, Warren, Indiana	475	1928	2.7	15.0	18
7	J. C. Lyter, Phelps, Missouri	3,600	1929	1.2	18.0	7
8	Will Gum Oregon, Missouri	740	1929	1.0	2.5	40
9	Phil M. Smith, Callaway, Missouri	280	1923	1.2	2.3	57
			1925	1.9	3.5	53
			1927	2.7	4.7	52
			1929	3.1	7.0	44

Allowable Kill. One of the first questions in game management is the percentage of the annual crop which may be safely killed without diminishing the crop for the succeeding year. Table 19 summarizes the known kill on tracts of known acreage and population found during the survey. Few quail hunters have as yet begun to think in terms of population and productive capacity per acre, hence usable figures were found to be very hard to obtain.

Cases 6 and 7 represent intentional under-shooting. Winter influx is suspected in cases 2, 3, and 8. Winter influx is known not to occur in case 9. One covey leaves. Case 6 is based on careful census and written records.

All of the figures in the table except cases 1, 2, 7, and 9 are weak in that they do not represent the orderly harvesting of a crop through a period of years, but rather merely the known kill during a single year. The latter may be greater or less than the sustained productive capacity. Case 9 might represent sustained production, were it not for the fact that during the period covered there was a steady clearing away of coverts and corresponding shrinkage of quail population. Hence the reported kill can hardly represent sustained yield.

For the present, therefore, the possible sustained yield of quail must be guessed at by analogy with other regions. Stoddard considers a 33 per cent kill as about the limit of safety in Georgia. The table possibly contains indications that a higher limit would be safe on well-managed lands in the best parts of the north central region. Any kill of over 50 per cent, however, must for the present be regarded as unsafe.

It should not be overlooked that the bag never represents the total kill. To the bag must be added a crippling loss of unknown and variable magnitude. H. J. Bowman has kept a record of dead birds lost, and crippled birds seen to be hit, through a period of years, and says that it aggregates, on the average, 3 per cent of his bag. Judging from similar figures kept by the writer on southwestern quails, 3 per cent must be about the lowest possible crippling loss, and is probably attained only by the most conscientious sportsman with the best of dogs on favorable ground. The average crippling loss in bobwhite is estimated to run nearer 10 per cent of the bag, or even higher.

On tracts where the bag is 33 per cent of the population, it is therefore probable that an additional loss of three to ten per cent of the bag, or one to four per cent of the population, occurs through crippling and losing birds.

Figures for the total kill of quail by states are lacking except in Minnesota, where licensees are required to report the season's bag as a condition of renewal of license. The total kill of quail thus reported from Minnesota is as follows:

Year	Quail	Year	Quail	Year	Quail
1919	6,100	1923	9,100	1927	----
1920	9,500	1924	9,170	1928	----
1921	7,500	1925	----	1929	2,700
1922	4,300	1926	----		

PHOTO 3: Grazed and ungrazed sections of the same gully in Iowa. Thousands of water courses throughout the Agricultural Belt have been made gameless, and exposed to needless erosion, by the removal of protective vegetation. Photos by I. T. Bode, Extension Forester, Iowa State Agricultural College.

CHAPTER III

RABBITS

AFTER surveying eight important rabbit States, I am convinced that the characteristics of rabbit populations, and the factors determining their abundance or scarcity, are more difficult to decipher, and are receiving less thought and study from sportsmen and naturalists, than is the case in any other species of small game.

There is no unanimity of opinion, for instance, and little real evidence, on the question of whether shooting greatly affects rabbit abundance. The effects of disease and parasites on the fluctuation of rabbit populations are beginning to be discernible for snowshoe rabbits, but for cottontails remain obscure. There has been some work on what predators eat rabbits, but their net effect on rabbit populations remains an unanswered question. The survey found hardly a shred of real evidence on what constitutes a high or low population per unit area. The food of rabbits is practically unknown, especially in its seasonal variations. Their breeding habbits are comparatively unknown. The sex ratio, especially during shortages, is unknown and possibly important. The important characteristic of "holing up" in the more northerly part of their cornbelt range is not, to my knowledge, mentioned in the literature, nor often discussed by sportsmen or naturalists. The radius of mobility, and consequently the effective radius of refuges, is utterly unknown, and I have never heard it mentioned by naturalists, or by game officers who have invested large sums in refuges intended partly for rabbits.

There is almost as great a dearth of knowledge in some other game species, but its insufficiency in these other cases is beginning to be discussed. We hear of research projects, fellowships, experimental areas, surveys, and other indications of actual effort on every hand. The rabbit, however, is still regarded as a fixed fact of nature, needing control operations here or protective legislation there, but never facts on which these or other management measures can be based.

The U. S. Biological Survey has established a rabbit experiment station at Fontana, California, but its efforts so far are centered on commercial production of domesticated varieties. Possibly it can ultimately branch out and study the far more important wild species.

History and Distribution. Cottontails, like quail, evidently experienced a large increase in abundance during the period of crude agriculture. The first settlers found them scarce in what is now the center of abundance, namely the riverbreak type. Cockrum, in his "History of Indiana" (1907), says, "there are 20 rabbits here now (Gibson County) to one in 1840." He grew up with a pioneer family. If the original scarcity had been of only short duration, he would hardly have contrasted it with 1907 conditions.

It may be stated with even more confidence that the original northern boundary of the cottontail was much further south than at present, and that the cottontail like the quail and the prairie chicken, has accompanied grain farming in its invasion of the Forest Belt. Dates of arrival of the first cottontails in several northern Wisconsin counties appear on Table 19. Thus R. A. Moore remembers their arrival in Kewaunee County in 1859, while various observers in the northwestern part of Wisconsin record their arrival on various dates from 1886 to 1922. Errington observed them as far north as Red Lake in Minnesota in 1920, but their arrival there was probably earlier. There are said to be no cottontails yet in parts of the northern peninsula of Michigan, but this was not verified.

The northward spread was in some cases hastened by plantings, two of which show on the map (see Wisconsin). These plantings were made by sportsmen who desired to add the cottontail to the local game fauna.

The Rabbit Meat Industry in Missouri. There is probably more or less commerce in cottontail rabbit meat throughout the more favorable parts of the Agricultural and Hill Belts. It is far more extensive in Missouri, however, than in any other State in the region.

In Missouri rabbits are killed commercially for meat mostly by farmer boys during the slack winter season, but to some extent also by semi-professional hunters. The killing is mostly with shotguns, but some are trapped in "figure-4" box traps. The kill is collected by local produce houses for reshipment to some regional produce firm, which grades, packs, and exports the rabbits to distant markets.

The fact that each rabbit is usually handled two or three times makes it difficult to get statistics on the extent of the industry. The figures opposite the 8-pointed stars in Missouri are samples of the yearly business of several local and one regional produce dealer.

Springfield, Missouri, is the largest reshipping center. M. D. Lightfoot, who has handled rabbits since 1900, gave the following description of commercial practice:

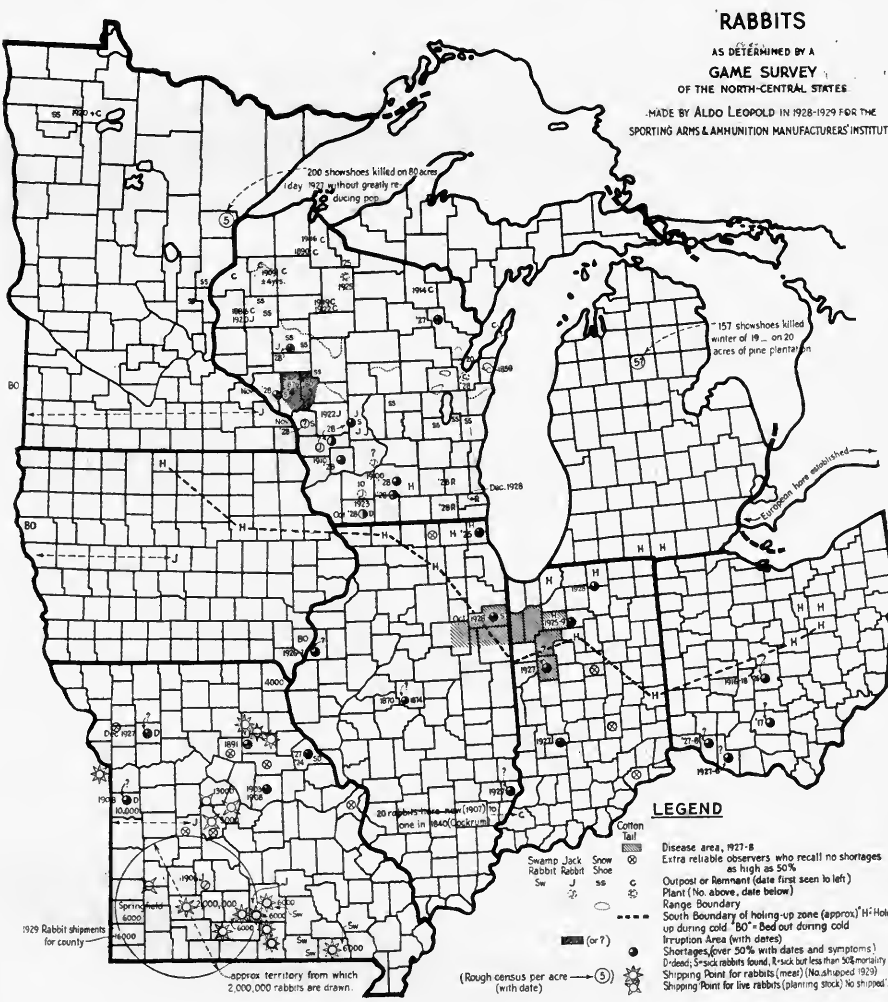
"The rabbits are received from local dealers drawn but not skinned. They average two pounds in weight. They are first graded as to size and freedom from shot wounds, the body-shot individuals being de-graded or culled. They are then packed in barrels, about 110 per barrel.

"The same price is paid for shot as for trapped rabbits. About 70 per cent of the total are shot and about 30 per cent trapped.

"Up to January 1 about 80 per cent of the shipments go east of Illinois. After January 1 most eastern States prohibit the importation of rabbits, hence the later shipments go to southern and southwestern cities. Springfield shipments formerly went through St. Louis dealers, but now go direct to consuming centers. After January 1 prices usually decline.

"The average annual output of the Springfield region (from Lebanon and Clinton east to Thayer) is 2,000,000 rabbits."

"Ozark" rabbits are said to command a premium price because of their large size and grading. Some dealers are said to promise to notify their customers



MAP 9

in the event of the appearance of disease, but they are said to have so far had no occasion to do so.

At Doniphan, Ripley County, Missouri, commercial practice differs somewhat from that at Springfield, according to H. A. Tanner, who has served as station agent in 42 Missouri counties since 1883, and has handled rabbit shipments in many of them. In 1929–30 Doniphan dealers paid 25 cents for trapped as compared with 15 cents for shot rabbits. In recent years their shipments have run about 6,000 rabbits per year, and went to Pittsburgh, Chicago, and Memphis. 1917 shipments were about 10 per cent above this normal due to favorable snows, but Mr. Tanner recalls no other large fluctuations, a very significant point, the import of which is discussed later.

Mr. Tanner states that the hedge and briar country of Pike, Lincoln, and Ralls Counties (in the riverbreak type) yields more rabbits than Doniphan (hill type), because of greater abundance and greater ease of shooting. He remembers a single drive near New London, Ralls County, about 1889 which yielded a full carload of solid stacked rabbits.

The total output of Missouri, for the reasons already given, remains a matter of conjecture. The Springfield Leader published an estimate of 3,500,000 rabbits worth $450,000 shipped east out of Missouri "for the Christmas trade" in 1928. This estimate seems not unreasonable if it be true that the Springfield region alone produces 2,000,000 annually.

The most important bearing of export figures is the light that they throw on fluctuations in abundance. Mr. Lightfoot told me specifically that the yield of the Springfield region as between years does not fluctuate more than one third above or below average. This constitutes evidence that the Springfield region as a whole has not experienced since 1900 any greater fluctuations than might be ascribed to weather.

Mr. Tanner stated specifically that he had never known of a marked rabbit shortage during his many assignments in various parts of the State.

These reports indicate that if there are rabbit shortages in Missouri, they are either so mild or so local as not to be felt by dealers drawing on areas of county-size or larger.

The Rabbit Planting Stock Industry. The commercial export of live rabbits for restocking purposes seems to be confined to certain localities in Missouri which appear as 4-pointed stars on the map. The figure opposite the star gives their 1929 output.

Planting stock is all secured by farmer boys operating "figure-4" box traps. The usual price paid dealers is about 75 cents per rabbit. Trappers are paid 25 to 35 cents for live as compared with 15 to 25 cents for dead rabbits.

No exporters of live rabbits were interviewed during the survey, but from various published records I gleaned that the magnitude of the industry is roughly as follows:

1924–25	30,000 shipped to unnamed States
1927–28	40,000 shipped to Pennsylvania, 80,000 total
1928–29	15,000 shipped to New Jersey

It appears that New Jersey bought a total of 58,000 from Missouri and Kansas jointly in 1928–29. While these figures are fragmentary, they indicate that the annual export of live rabbits runs high into five figures, and that certain mid-Atlantic States are the principal buyers.

This practice of replanting the East with Missouri rabbits sheds much light on the comparative productivity of the mid-Atlantic and Missouri rabbit ranges respectively. The reason for the difference is unknown.

Cottontail Shortages. A special effort was made during the survey to gain some preliminary information on the nature and extent of cottontail shortages. It is well known that these shortages occur, but no previous work seems to have been done to determine where, when, or why. The question is important, not only for its obvious bearing on the management of rabbits as a game animal, but because of its possible relation to the cyclic fluctuations of snowshoe rabbits and grouse.

It was found to be very difficult to get historical information because most sportsmen pay only incidental attention to rabbits. The same man who remembers similar dates for grouse or prairie chickens for a decade will have forgotten all about the abundance or scarcity of rabbits two years back.

First of all, it was necessary to define a shortage. In order to exclude as far as possible the mild local fluctuations due to weather and predators, no shortage estimated to be less than 50 per cent below normal was accepted as evidence.

Two studies were made: (1) the behavior of the 1928 shortage in Wisconsin, and (2) the history of recent shortages in Missouri. As much of the evidence as possible is summarized on Map 9. The rest is omitted for lack of space.

The location of observers contributing evidence is shown by small circles. If the observer remembers no shortages the circle contains an "x." If he does, the estimated degree (per cent below "normal") is indicated by the shaded sector of the circle. The date it began is to the left, the date it ended to the right. Symptoms seen are indicated by letter (see legend of map).

Evidence of either sickness or shortage or both during 1928 was found to be obtainable all over Wisconsin. Practically no observers reported 1928 conditions as normal. Practically all observers had experienced shortages at some time or other and knew what they were.

In southeastern Wisconsin many observers reported sickness in 1928 but none reported shortage. Apparently the sickness did not cause mortality.

In all other parts of the State mortality in excess of 50 per cent was reported. Its degree is indicated by the stippled sectors of the small circles on the map. The white sector indicates the percentage of the normal crop seen during the hunting season. A question mark above the white sector means the observer could not estimate how short the crop was, but was sure it was over 50 per cent short. The estimated mortality in the southwestern part of the State ran around 50 per cent, but in the northern parts ran up to 90 per cent.

Reports during the summer of 1929, when the survey was made, indicated full recovery in the south half of Wisconsin, but it is understood that later reports during the hunting season were less favorable. The 1930 crop also appears short.

In the southwestern part of the State the 1928 mortality seems to have occurred suddenly during the late fall and early winter months, many dead rabbits having been found by game wardens. The non-fatal sickness in the southeast, in so far as its date could be determined, was also in December.

Mortality in excess of 50 per cent also occurred in the Kankakee region of northeast Illinois and northwest Indiana during 1928, but did not occur elsewhere over any large areas in Missouri, Illinois, or Indiana. In Kankakee County, Illinois, the disease started in October, 1928. Many sick rabbits were caught there by boys during the winter of 1928–29. Further east in Indiana the shortage started as early as 1925, and was still prevalent in 1929.

This 1928 cottontail shortage came one year later than the lowest point of the general cyclic depression in northern grouse, which all agree was in 1927.

In at least some localities where cottontail and snowshoe overlap, the depression in the two species does not coincide. Thus A. E. Doolittle, superintendent of the Peninsular State Park, Door County, Wisconsin, states that snowshoes were scarce in Door County since 1925, but cottontails continued fairly plentiful until 1928. Oconto County snowshoes are said to have been fairly numerous near Mountain in 1928, but cottontails nearly absent.

The study of history of cottontail shortages in Missouri showed quite conclusively that cottontail shortages are never Statewide. This conclusion is based on the statistics of the rabbit meat industry already given, and on the fact that of about 100 observers, 11 especially competent ones could not remember any shortage in their localities.

The evidence further indicated that the duration of Missouri shortages is usually only one year. Of 21 observers, only two remembered shortages that lasted for more than one year.

The severity of the Missouri shortages is indicated by the stippled sectors of circles on the map. These agree substantially with those from Wisconsin, Indiana, and Ohio, in indicating a maximum severity of 90 per cent below "normal."

The distribution of Missouri shortages is apparently always very spotty. Several specific counties were found where short and normal crops existed in close proximity during 1929. The short spots were too small to be felt by the rabbit market.

Shortages in Missouri were traced as far back as 1891 (Monroe County). Bogardus mentions one in Logan County, Illinois, lasting from about 1870 to 1874. (See Map 9.)

The conclusions from these local and superficial compilations of secondhand evidence can be pieced together only by the addition of a good deal of purely personal conjecture. My guess is that:

(1) Cottontails were sick in most of the north central States during the last cyclic depression.

(2) Mortality from the sickness was confined to small spots in the South, but became uniform and widespread toward the north edge of the range.

(3) Cottontail shortages in the cornbelt usually last only one year but sometimes up to four years. They average distinctly shorter than the cyclic depressions in snowshoes and grouse.

(4) Shortages of apparently similar nature, duration, and distribution have occurred in years past. A severe one of four years duration occurred in Logan County, Illinois, in 1870. Whether these former shortages always coincided with grouse cycles is not determinable from this study.

Holing-up Zone. In Wisconsin cottontails invariably hole up during severe winter weather. On a really cold day it is possible to hunt all day in good rabbit country with a good dog without finding more than one or two rabbits bedded out where they can be jumped and seen. During warmer weather several dozen might be jumped during the same hunt on the same ground. Wisconsin cottontails also tend to hole up when hunted hard, or after winter rains.

In Missouri, however, the normal number of cottontails can be found bedded out even during the coldest weather. There is evidently a difference between the daytime behavior in the northern and southern parts of the north central region.

That this difference is not merely a matter of temperature is indicated by the testimony of at least two observers who say that rabbits bed out in northwestern Iowa and southeastern South Dakota in —10°F., whereas +10°F. will put them all in their holes at Madison, Wisconsin.

The evidence gathered during the survey indicates that the line of demarcation, or "holing-up line," is more distinct and more uniform from year to year than one would expect. The localities where definite evidence was found that cottontails hole up are marked "H" on the map. The localities where they bed out are marked "BO" on the map. The heavy dashed line marks the approximate boundary of the holing-up zone as indicated by the evidence.

This phenomenon is of some importance to management. In cottontails, as in quail, winter is the critical season for cover. A rabbit population which can get through the winter by substituting holes for surface cover should be more resistant, other factors being equal, than one which cannot. It should also be harder to over-kill.

South of the holing-up line cottontails bed out in standing corn and, seem to prefer it as a place for bedding out. North of the holing-up line cottontails seldom bed out in corn, even in mild weather, although they of course feed in cornfields there as elsewhere.

The Trempealeau "Irruption." Omar Emmel, of Blair, Trempealeau County, Wisconsin, reports seeing vast numbers of white rabbits, which he insists were snowshoes, between Blair and Whitehall 53 or 54 years ago, or about

1876. He has the impression that this excessive abundance of white rabbits prevailed throughout Trempealeau County. He says these rabbits were so numerous that in the spring, when the snow receded, he could look over miles of hillside "hopping with" their white forms.

H. T. Olson, a farmer near Taylor, Jackson County, says that he has seen no "snowshoes" for 25 years, but that around 1880 they were very abundant, inhabiting not only the alder swamps, but also the scrub oak in the draws on the edges of the ridges. In those days, he says, there was much less timber in west Jackson County than at the present time, due to the prairie fires which then prevailed, and some settlers had difficulty in getting enough wood for domestic use, in spite of the then thin farming population.

George Weisenberger, of Arcadia, Trempealeau County, says that there are a few "big rabbits which turn white in winter" two miles east of Arcadia near a cemetery, where he has seen them for 10 years.

In interpreting these three observations, the first question which arises is the species to which they refer. North Trempealeau and east Jackson Counties are a kind of country entirely different from any now inhabited by snowshoe rabbits. Olson and other observers make it clear that when first settled this country was so open as to approximate prairie conditions. It therefore seems likely that the observations on "white rabbits" refer to jack-rabbits, in spite of one observer's insistence that they were snowshoes. If this is correct, it probably means that jack-rabbits were indigenous to western Wisconsin, and that they are capable of irruptive behavior in this State. The 1876 and 1880 dates are probably the two ends of one and the same period of abundance.

The location of the Trempealeau irruption is shown on Map 9. The instance is important for several reasons. It is evidence of a radical change from a semi-prairie to a semi-forested condition, due to the checking of fires by settlement. It contains a warning that the jack-rabbit is capable of becoming a possible pest. If, on the other hand, the irruption involved snowshoes instead of jack-rabbits, it means their former range included a type of mixed hardwood and prairie wholly different from any range now occupied by snowshoes.

Snowshoe "Rabbit." While not an important game animal, the snowshoe is important to game conservation because of its probable role in the mechanism of the game cycle, its known importance in diverting predators from more valuable game, and because of the damage it inflicts upon forest plantations.

In distribution it has receded northward since the settlement of the country, certainly in Michigan, and probably in the other Lake States. Lee R. Dice says it once occurred at Ann Arbor, Michigan, and also in northern Ohio. Its recession from this territory is probably due to the drainage of tamarack swamps.

Fragments of the present south boundary were determined during the survey in Wisconsin, and are shown on the map.

The cyclic fluctuations of the snowshoe are very violent. No one has ever directly measured the density in favored spots during the "highs" and "lows" of the cycle, but some convincing indicators of high density are as follows:

(a) 157 snowshoes were killed on 20 acres in one season near Higgins Lake, Michigan.

(b) 200 were killed on 80 acres in one day near Cloquet, Minnesota, without any great apparent diminution of the density.

(c) One rabbit per rail (30 feet) was counted during a trip of unknown length in a railway speeder in Minnesota in the high year 1923(?), while 20 to 50 per mile were counted in auto travel at the same time in the same region. One year later (fall of 1924) scarcely a rabbit could be seen.

(d) Extreme fluctuation is indicated by the fact that Minnesota planting crews of 10 men each, covering 60 acres per day in close formation, in the low year 1924 saw "3 to 6 rabbits per day with a few more in the swampy places." This was in country where plantations had been seriously damaged the preceding winter.

It is a safe guess that the "high" populations on concentration areas run as high as five per acre, and that the fluctuation from average is well over 95 per cent or even greater. The densest populations of the last cycle seem to have occurred in Minnesota. It is said that the European hare in southeast Europe seldom runs higher than one per acre, and is not subject to cycles.

During the high periods in snowshoes it is impossible for new forest plantations to survive. Trees up to three feet high are clipped of their tips, branches, and needles. Trees over three feet high are girdled. Natural reproduction of course suffers in the same manner and to the same degree. White pine suffers worst, white spruce next, Norway and jack pine least, probably because the last two species are usually planted on the sandier soils which support less brush and hence furnish less harborage for rabbits.

It is impracticable to restrict planting operations to low snowshoe years. Forest nurseries must operate on a basis of sustained rather than irregular annual output. Moreover a plantation set out the year when rabbits die would not have grown out of danger by the next succeeding "high" (about seven years).

Methods of control cannot be efficient until the habits of the snowshoe are known, nor can the degree of control be wisely regulated until its relationships to other game are measured. What, for instance, is the radius of mobility of the individual? This can be determined only by banding. Without this information the forester cannot tell whether he must destroy the snowshoes for a block, a mile, or five miles around each area to be planted. How can the destruction be effected without undue damage to other species? How long will it last before the area fills up again? What will it cost? What density of population can be tolerated without control? All these questions are shrouded in total darkness. Here again practical conservation is blockaded by lack of biological facts.

Under the McSweeney–McNary Act, funds have been set up to support one biologist at the Lake States Forest Experiment Station, who is to devote a part of his time to the study of these questions. The present planting program for the Lake States (combined State and Federal) is over $100,000 per year. The proposed program is over $150,000 by 1934. No sane industrial enterprise would tolerate such flimsy research *insurance* for so large an enterprise, but in conservation the risk of biological ignorance is cheerfully assumed, and those who plead for research appropriations are dismissed as "impractical scientists."

Rabbits and Birds. I strongly suspect a parallelism between the behavior of rabbit and grouse populations much more far-reaching than the already prevalent assumption that ruffed grouse and snowshoes have the same cycle, and that the cycle may have a common cause.

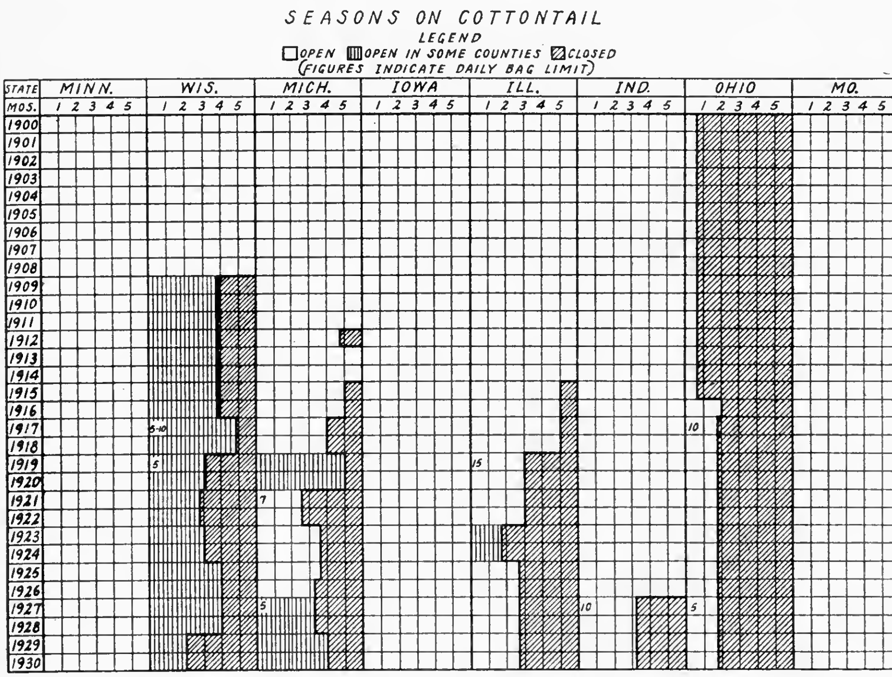


CHART 5

Taking all species of rabbit and hare together, they display a tendency to be stable in the South, and to fluctuate with increasing violence toward the North and West. This has already been described as holding good for quail, and subsequent chapters show it holds good for grouse.

Some mammalogist ought to study the cottontail in the Appalachian highlands to see if the fluctuations do not become violent there, as they do in grouse.

Reasoning backwards, the cottontail in the cornbelt and the South may be found to have a saturation point, like quail. It will be higher than quail, because they draw on a larger food supply. This saturation point may be expected to prevail wherever the cycle does not.

Rabbit Season. Ohio is the only State in this region which extended any protection to cottontails previous to 1909. All States except Minnesota, Iowa, and Missouri now limit the open season in some degree. (See Chart 5.) That protection has begun in the most easterly State of the region, and is not yet in effect in the three most westerly, is strong evidence of the increase in resistance or productivity which occurs as one moves west or south from the Atlantic seaboard. The reasons for this are unknown.

CHAPTER IV

RINGNECK PHEASANT AND EUROPEAN GRAY (HUNGARIAN) PARTRIDGE

History of Plants

INVESTMENT in Exotics. Since 1900, the investment of public and private funds in planting pheasants and Hungarians in the north central region has been:

TABLE 20.—*Investment in exotics*

	Plantings traced	Estimated untraced	Total	Cost, each (estimated)	Investment
Hungarians	56,823 birds	8,177 birds	65,000 birds	$6.00	$390,000
Pheasants	224,436 birds	75,564 birds	300,000 birds	$2.50	$750,000
Pheasant eggs	742,122 eggs	257,878 eggs	1,000,000 eggs	$0.15	$150,000
Total	466,789 birds	148,210 birds	615,000 birds	....	$1,290,000

The region's total investment in exotic planting stock for 1930 was about $120,000 which is six per cent of the total State license revenues from game plus the indivisible part of fish. It is roughly ten per cent of the State revenue from game alone.

The trend of game policy in the various States is to increase, or at least maintain, the current rate of planting exotics. Such plantings to a certain extent represent time and money taken away from other species, or other activities. It therefore is important, in view of the large sums involved, to determine the extent to which the plantings have been successful.

Success of Exotics. In certain parts of the northern half of the region the plantings have been consistently successful. They have resulted in the establishment of wild self-propagating populations.

Throughout the southern half of the region the plantings have been consistently unsuccessful.

This accumulated experience would seem to indicate that the southern half of the north central region is not suitable for these exotics, and that no more plantings should be attempted there. Such a conclusion must be qualified, however, by two additional facts.

First, pheasants thrive under wire in the southern as well as the northern part.

Second, southern plantings of both species often thrive for several years, but later disappear.

Why should southern plantings thrive under wire, or for short periods in the wild, but fail to thrive in the long run? What is the "cause" for success in the North, and failure in the South? Why does not that "cause" operate at once in southern plantings? Why does it not affect confined, as well as wild, birds? Can the "cause" be discovered, and can the southern ranges be modified so as to convert failure into success? Would the discovery of the cause make possible the modification of the northern range to make it even more successful than at present? These questions collectively constitute one of the major enigmas of American game management.

Does the establishment of exotics injure the productivity of native game species? Which species? Where? How? Under what conditions? These are likewise unanswered questions and collectively constitute one of the major issues in American game policy.

History of Pheasant Plantings. The history of plantings in so far as traced by the survey, is shown in Table 21 and Map 10.

Isolated private pheasant plantings began as early as 1900 in Iowa, when a private pheasantry blew down in a windstorm and released 1,000 birds. This accidental planting was probably the source of the present Iowa establishment, and is the earliest plant traced by the survey. Private pheasant plantings began in Missouri in 1904, and in Wisconsin in 1910.

State pheasant plantings began in Indiana in 1907, and in Missouri and Illinois in 1910. This marked the beginning of the first "wave" of State game farms, which later receded in some of the States (for instance, Missouri) until the earlier lack of success had been forgotten. A new "wave" began about 1920. Wisconsin was the last State to join in the now universal program of pheasant planting. All of the States, regardless of previous results or the lack of them, are now planting pheasants at an average rate of 6,568 birds per State per year.

State pheasant plantings of both waves usually consisted both of grown birds, and eggs distributed to farmers for incubation, rearing, and release. In Table 21, farmer-eggs are arbitrarily converted into birds released by multiplying the number of eggs by one-fourth. This is about the usual success-ratio to date. Wisconsin released birds representing 32 per cent of some 1600 eggs distributed to farmers in 1930. This is the highest reliable figure found during the survey.

The table is not complete, because the average game department does not keep permanent records. A thorough search of libraries would doubtless reveal additional old reports which were not available in departmental offices and not found during the survey.

TABLE 21.—*Ringneck pheasants planted in North Central Region*

25% of eggs are added to birds released to get total birds released. Yes = plants made but number unknown)

Year	Minnesota			Wisconsin			Michigan			Iowa			Illinois			Indiana			Ohio			Missouri		
	Pheasants	Eggs	Total	Pheasants	Eggs	Total	Pheasants	Eggs	Total	Pheasants	Eggs	Total	Pheasants	Eggs	Total	Pheasants	Eggs	Total	Pheasants	Eggs	Total	Pheasants	Eggs	Total
1900	← Few or no State plants →						← Few or no State plants. No State game farm →			1,000							← No previous State eggs →							
1901																								
1902																								
1903																								
1904																						600		
1905																								
1906																								
1907																500						432		
1908																2,000								
1909																Yes								
1910															Yes	Yes						2,000?	2,000?	2,500?
1911				← 5,000? (Pabst) →												← Few or no State plants →						10,000?	← No State eggs →	
1912																						Yes		
1913															Yes							Yes		
1914																						?		
1915																			Yes			← Few or no State plants →		
1916																								
1917															Yes									
1918							2,396	27,000	9,146															
1919	1,067	1,992	1,565				3,800	42,300	14,375															
1920	836	3,144	1,622				4,461	38,463	14,077															
1921	1,189	3,348	2,026				5,222	20,650	10,389															
1922	2,248	4,826	3,454				6,030	31,387	13,837															
1923	1,270	5,715	2,699				5,500	34,000	14,000										9,123	52,800	22,323			
1924	1,874	6,386	3,470				2,553	18,213	7,106										11,807	27,100	18,582			
1925	Yes						5,293	10,785	7,991										8,500	22,850	14,212			
1926	Yes						5,841	30,040	13,351										11,000	6,800	12,700			
1927	Yes						6,321	29,750	13,758								1,674	418	14,050	6,500	15,675		24,408	6,102
1928	0	8,000	2,000	3,000	18,000	7,500	3,350	16,235	7,409				8,080	40,492	18,203		10,040	2,510	10,940	6,500	12,565	1,500	0	
1929	700	9,253	3,013	3,000	8,000	5,000	8,753	7,714	10,681				1,500	39,628	11,407	4,998	14,248	8,560	11,005	6,500	12,630		0	
1930	3,451	5,861	4,916	8,800	18,500	13,425	8,000	6,500	9,625				?	28,452	7,113				9,871	3,693	10,794	575	24,375	6,668
Total	12,635	48,525	24,765	19,800	44,500	25,925	67,520	313,037	145,745	1,000			9,580	108,572	36,723	7,498	25,962	11,488	86,296	112743	119,481	15,107	50,783	15,760

While the present planting program seems large, it is really small when compared with the area involved. It now averages 1 pheasant per 43,000 acres of total area, or about half a pheasant per township per year. A considerable fraction of current plants are being made in territory where previous experience holds out no assurance of success. The reason for this is probably the deceptive phenomenon of "straggling," to be described later.

If it costs $2.50 to produce and plant a pheasant, and 15 cents to deliver the farmer an egg, then the cost of the present plantings is $100,000 per year for the region.

History of Hungarian Plantings. Practically all Hungarian plantings are wild trapped stock imported from Europe. Planting stock is not yet successfully produced by artificial propagation. Hence import records furnish an accurate index to planting activities for the country as a whole, but the early total imports cannot readily be divided by States.

Dr. T. S. Palmer states (1922) that systematic importation began in 1906 and reached a peak in 1914. Evidently the north central region participated in the first importation, since Illinois planted 1,060 birds in 1906. Indiana followed with a 2,000 bird planting in 1907, and Missouri with 4,000 (?) in 1910. Iowa planted Hungarians in 1910 but there is no record of the number. Col. Gustav Pabst in that year also started his long series of plantings in Waukesha County, Wisconsin, which continued until 1927 and totalled about 5,000 birds. Ohio began in the peak year of 1914.

The history of plantings, in so far as traced by the survey, is shown in Table 22 and Map 11.

Total lack of success in Missouri, together with partial failure in all the other States (see Map 11) presumably caused the subsequent decline in Hungarian plantings which lasted until 1926, when Minnesota and Michigan started new programs. Unlike pheasants, which are still being planted everywhere, the present plantings of Hungarians are largely confined to territory in which there is some assurance of success.

If it costs $6 per bird to import Hungarians, the cost of the 1930 plantings was about $30,000 for the region.

The Place of Exotics. The question of whether or not it is good public policy to establish exotic species of game is characterized by emphatic and strongly divided opinions, most of which attempt to answer the question by a single yes or no for the whole United States.

This survey is concerned more with matters of fact than with matters of opinion. The facts gathered, however, indicate that there can be no single answer to the question of exotics. They indicate that planting of exotics may be very bad or very good policy, depending on local conditions, and also that there are many intermediate conditions where the wisdom of introducing exotics may be open to various degrees of doubt.

TABLE 22.—*Hungarian partridges planted in north central region*

Year	Minnesota		Wisconsin		Michigan		Iowa		Illinois		Indiana		Ohio		Missouri	
	State	Other	State	Other	State	Other	State	Other	State	Other	State	Other	State	Other	State	Other
1900	↑ No previous State plants	↑ No previous private plants	↑ No previous State plants	12									↑ No state plants?			
1901																
1902																
1903																
1904																
1905																
1906									1,060							
1907											12,000					
1908									2,000		12,000					
1909											12,000					
1910				5,000 (Pabst)		200	Yes		12,000		16,000				4,000	
1911											↑ No state plantings				4,000?	
1912															↑ No state plants	
1913									Yes							
1914									Yes							
1915													↓ 600+			
1916													Yes			
1917									Yes							
1918									Yes							
1919									Yes							
1920									Yes							
1921									Yes							
1922				Yes									Yes			
1923				20		24										
1924									Yes?							
1925		↓							Yes							
1926		1,500														
1927		2,500				600			Yes							
1928	↓	2,600	↓	40		54							638			
1929	3,615		12	54		134							2,000			
1930	3,000		124	24	84	80					↓		2,000		↓	
Total	6,615	6,600	136	5,138	84	1,012			12,000+		12,000	?	5,238+		8,000	?
	13,215		5,274		1,096				12,000+		12,000		5,238+		8,000	

Grand total for all states: 56,823 Hungarians planted 1900-1930

East central Wisconsin, for instance, presents an almost clear case for pheasants. The swamps are too small or too few for prairie chickens; quail are excluded by reason of the "quail-less area" along Lake Michigan; there is not enough timber for ruffed grouse or other forest species. The environmental changes necessary to produce quail are unknown, and those necessary to produce prairie chickens or ruffed grouse are prohibitive in cost. It is hard to see any good argument against planting pheasants, provided the plantings are successful.

Again, in northwestern Iowa, prairie chickens have been excluded by the nearly universal drainage of swamps and plowing up of grass cover. There never was enough brush for any quantity of quail, or enough timber for ruffed grouse. Northwestern Iowa and eastern Wisconsin seem to represent the "end case," where there is a clear and conclusive justification for pheasants.

On the other hand, the sand plains of central Wisconsin present excellent chances for prairie chicken management, together with an ample seed stock of both species of chickens. The more heavily wooded sections contain ruffed grouse and deer. Agriculture is declining, and it is very doubtful whether there is enough grain for a shootable population of pheasants. No other part of Wisconsin is equally suitable for perpetuating prairie chickens on a large scale. Land values are low enough to permit state ownership of key areas. Unless it should be later demonstrated that there is no interference with prairie chickens by pheasants, it would seem very doubtful public policy to plant pheasants in this sand plains region. This may be considered as the end case where establishment of exotics is possible but undesirable.

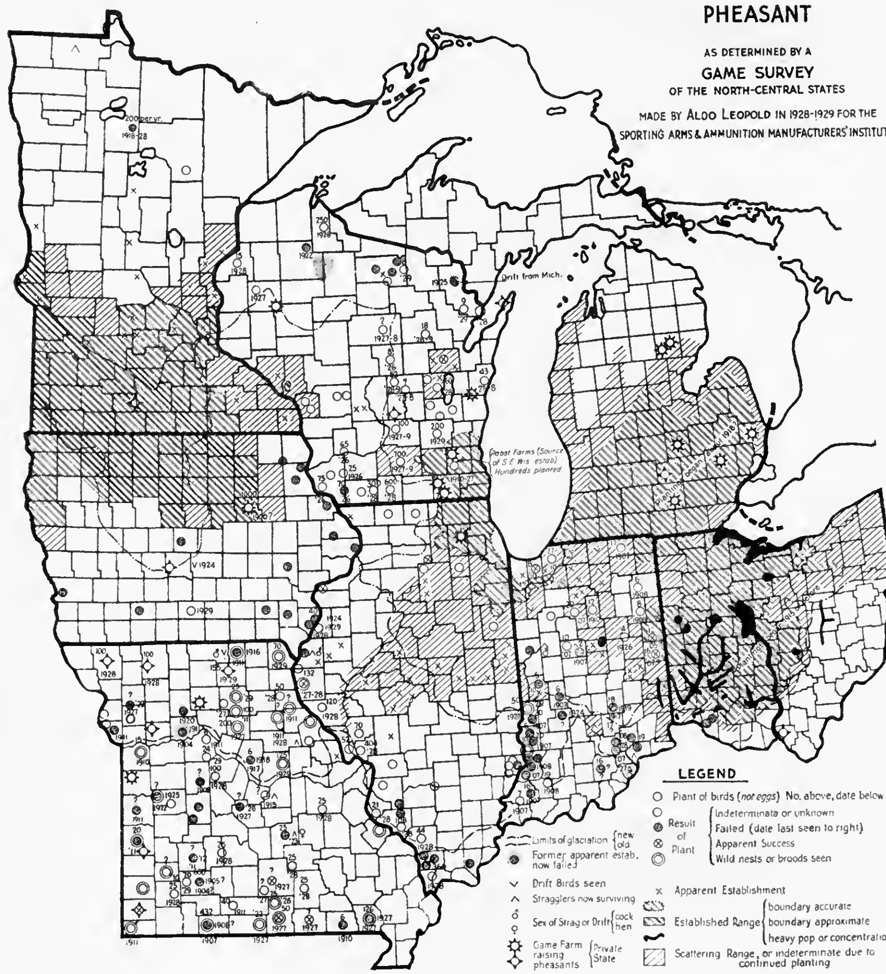
The entire riverbreak type is being or has been planted to pheasants in spite of the clear opportunity to produce an abundance of quail, and the probable interference with quail by any heavy pheasant populations. This case, however, is academic, because there is not the slightest evidence that pheasants are capable of becoming established. The only issue is one of waste of money.

Between the two end cases lie many gradations, where the introduction of exotics is more or less undesirable. This survey does not possess the information for judging where to draw the line, and it may be doubted whether that information as yet exists. The problem of exotics, in short, resolves itself largely into a problem of research. Fortunately there is no part of the north central region where pheasants cannot be controlled, or even eliminated, at will, by the proper manipulation of hunting seasons. Such manipulation constitutes the main safeguard for the future, pending the accumulation of more detailed local information on inter-species relationships.

Results of Plants

Explanation of Maps. Maps 10 and 11 are an attempt to present graphically the history and results of exotic plantings.

Due to the scarcity of records, the historical information is fragmentary, but the hatched areas are believed to represent a complete picture of establishments to date. Boundaries are accurate in some places (dots); approximate in others (dashes). Where county lines are used as boundaries it means that the boundary was only roughly determined, or is actually blurred on the ground, and hence not susceptible of sharp delineation. Some of the boundaries are expanding; others

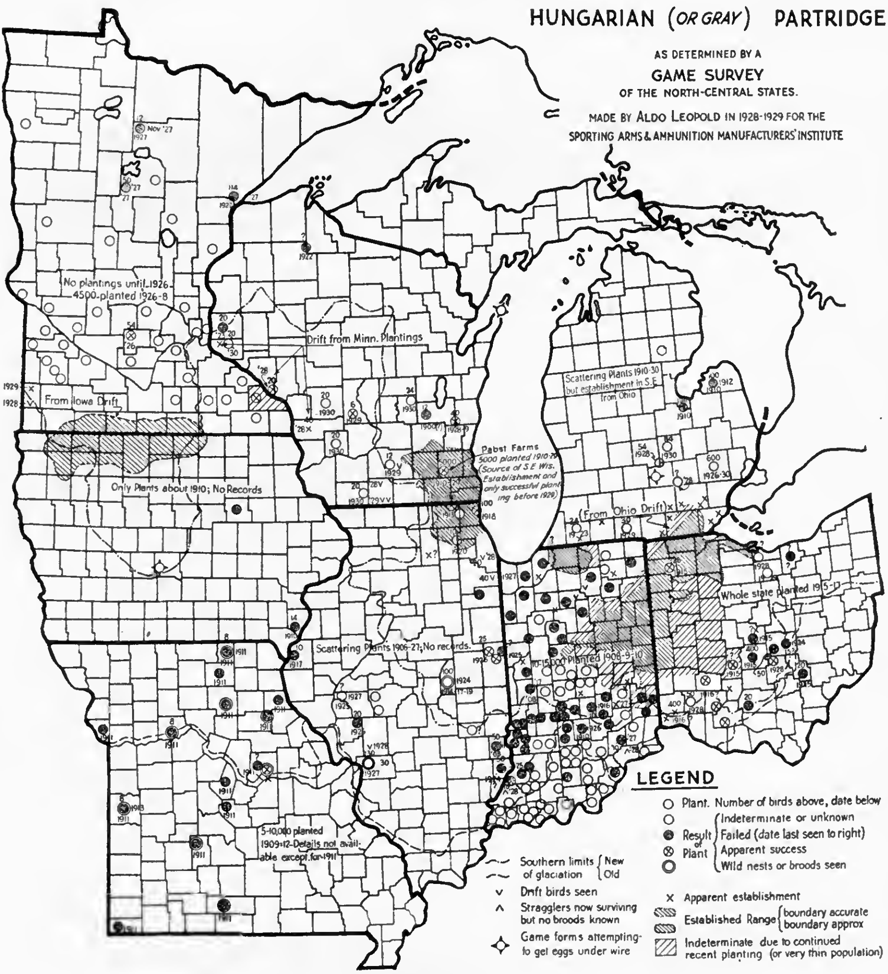


MAP 10

are shrinking; some are alternately expanding and shrinking. These characters should be determined, but there was not time to do this during the survey.

Tables 21 and 22 show some plantings which are not shown on the maps, for lack of any record of where the plants were made. Likewise the maps show many local plantings, with no corresponding figures in the tables except the word "yes" to indicate that plantings were made that year.

Historical data are largely lacking in Iowa for both species, on both maps and tables. Map detail for early pheasants plantings in Minnesota, Iowa, Michigan, and Ohio is also meager. The present pheasant distribution in Ohio, however, is especially accurate, being based on a recent survey by Hicks and McCor-



MAP 11

mick, made under the auspices of the conservation commission, and about to be published in much more detail than here appears. Their courtesy in allowing advance use of their maps is gratefully acknowledged.

Types of Success and Failure. When the survey began, I had no conception of intergradation between success and failure in game bird plantings. One put out birds, and they either lived or got killed. If they got killed, it was probably "vermin" that did it. If one planted again, failure might be coverted into success.

I likewise had no idea that success or failure were determined by anything more complex than the general climate, which one could feel or look up in the weather reports, and by those visible aspects of food, cover, predators, and law-observance which one can see with the naked eye. If the climate and the landscape resembled the native range, success was assumed to be only a matter of persistent effort.

This personal approach to the problem of exotic plantings is mentioned only to show that the facts discovered during the survey, and now to be described, were not interpreted in the light of some pre-conceived personal notion.

During the survey Dr. John C. Phillips published (1928) his bulletin, "Wild Birds Introduced or Transplanted in North America," in which four of the six types of behavior recognized in the following captions are definitely described. This, however, was not read until the survey had been completed, and until the recognition of six types had been forced upon me by the accumulation of evidence in the field. This coincidence of conclusions constitutes strong evidence of the reality of the classification first conceived by Phillips.

The types of behavior will first be defined, and their geographic distribution roughly indicated. Later examples of each type will be given in detail. Published history will be used where available; where not, my own field notes on the verbal statements of local observers will have to suffice.

Definitions. Three types of failure occur in the plants of both species so far made in the north central region.

The first is dispersal failure, in which planted birds disperse and disappear without breeding. This is common in both species along the southern edge of the region.

The second is straggling failure, in which the planted birds breed, often vigorously the first year, but with rapidly declining vigor, until after a few years only straggling non-breeding adults remain, and finally these too disappear. This type of behavior occurs in the plants of both species which do not immediately disperse. My impression is that dispersal prevails in the southern Hungarian plants, while straggling prevails in the southern pheasant plants. All plants of both species so far made in the southern part of the north central region have either straggled or dispersed. The maps show many plants in which the date last seen (which appears to the right of the "failure" symbol) is one, two, three, or even seven years later than the date of planting (below the "failure" symbol). These are the known instances of straggling. The last remnants of straggling pheasants are commonly males.

A combination of the two types, consisting of breeding followed by dispersal, is particularly common in pheasants. In this combination type, the dispersal usually occurs during the first fall, immediately after the first frost.

Thirdly, there appears to be a "colony" type of failure, in which the planted stock persists as a small breeding colony but does not spread. Eventually the colony disappears. This was noted in Hungarians, and possibly in pheasants. It seems to occur only in the northern part of the zone of failure, just below the zone of success. Possibly the environment there becomes partly favorable in spots, or during certain years.

Fourth, we have in pheasants, and possibly in Hungarians, a behavior representing partial success. The stock persists and sometimes spreads, but apparently only with the aid of new plants. This may be called "artificial establishment." It prevails over a wide zone along the edge of the established pheasant range, and coincides roughly with the area shown on the pheasant map as "scattering range."

There is a fifth type, "recessive establishment," which occurred in the Williamette Valley (Oregon) pheasants, but which was not clearly identified during the survey as occurring in the north central region. The planted stock breeds and spreads, often with extreme vigor, but later experiences a partial decline or recession, as it finds its ultimate "niche" in the local biological scheme.

Lastly, we have complete and permanent establishment, in which the planted stock breeds, spreads, and becomes a self-propagating part of the local fauna. This prevails in both species in the northern part of the Agricultural Belt (see closely hatched areas on map). The zone of complete establishment is evidently destined to be wider and less irregular in outline in pheasants than in Hungarians. Further plantings may of course alter the present boundaries. On the other hand part of the apparent establishments may later, on cessation of planting, prove to be of the recessive or even of the artificial type.

Examples of Dispersal Failure of Pheasants. Dr. N. R. Huff, of East St. Louis, president of the Southern Illinois Sportsmen's Association, told me on April 2, 1928:

"Pheasants do not thrive south of the 39th parallel. They have been planted in southern Illinois for 15 years but are not established anywhere that I know of. Twenty pheasants were planted very carefully in 1926, and also this year, at my duck club seven miles southwest of Jonesboro. They are all gone. Eight were released in 1926 in southwest Polk County, but disappeared within a year. Two plants in St. Clair County in 1926 were seen for some months, and then disappeared."

At this time I had not realized the importance of finding out whether or not any wild nests and broods had been seen, hence evidence of this distinction between dispersal and straggling is lacking in this example.

Later this evidence was not overlooked. Thus Andrew Brooks, a widely known dog-trainer and sportsman of Doniphan, southeast Missouri, told me on January 10, 1930:

"In 1910 the state planted many pheasants. Six planted here disappeared at once. No nests of young were seen."

W. J. Kirgan, a sportsman of Cincinnati, told me on November 30, 1928:

"I made three plants on my upland farm in Cleremont County (southwest Ohio). They all moved out. They have done well farther north on the river bottoms above Newton and Milford."

Dispersal Failure of Hungarians. D. R. Abernathy of Lawrenceville (southeast Illinois), told me:

"We made two plants of twenty-four pairs each in December, 1924. They were seen through the winter but disappeared before spring."

Frank Gentry, of Nashville, Brown County, (south central) Indiana, said:

"Around 1910, for a period of four years, the State furnished Hungarians, many of which I released personally. One year there were 50 pairs. I tried to find them later with dogs, but only raised two birds. They evidently never raised broods. Another plant of 500 near French Lick in 1911 were released all in one bunch after being kept in pens over winter. They were never seen again."

Straggling Failure of Pheasants. John Greyersen, an experienced Danish game keeper, now employed at the Harder Kennels at Vernon, Jennings County, (southeast) Indiana, told me on May 25, 1929:

"We planted 172 pheasants in 1924, also some in 1925. While working the dogs we saw a good many pheasants, including young pheasants up to 1927. Since then they seem to have all drifted out. I have heard of their being seen 28 miles southeast. I also saw a single straggler last fall at our training ground in Jefferson County."

John A. Gude, a professional dog trainer of Bruceville, Knox County (southwest) Indiana, told me on May, 27, 1929:

"Pheasants were heard of for several years after they were planted in this part of the State. One plant was made just below Bruceville, but it lasted only a year. No young birds were seen. A larger plant was made on the preserve south of Bucknell, but they are all gone. No broods were heard of."

C. W. Guerney, foreman of the State Forest Nursery at Henryville, Clark County, (southeast) Indiana, told me on May 22, 1929:

"Pheasants were planted here about 1918. There are still a few straggling remnants of the plant. Last winter I saw a big cock in the woods on the Clark Forest."

H. H. Hicks, formerly game warden in Lawrence County (southeast), Illinois, said:

"About 15 years ago 100 pheasants were planted at various points all over Lawrence County. There have been a few seen ever since. One was seen near Bird's Station and another near Bridgeport in 1929."

E. C. Graham, an officer of the Missouri Izaak Walton League, who lives at Poplar Bluff, Butler County, told me:

"One hundred and twenty-six pheasants were raised from eggs in 1926 or 1927. The next year one nest was found, but they are now gone."

Straggling Failure of Hungarians. Alfred L. Harder, of Vernon, Indiana, and John Greyerson told me that a few of the original Hungarian plantings (probably meaning the State plantings of 1910) had survived until 1917, during which year a few birds were seen east of Old Vernon. There are none left now except a single bird flushed while training quail dogs in Jefferson County.

Oliver Neal, game warden on the Brown County Refuge near Nashville (south central), Indiana, told me that the original plantings of Hungarians (probably meaning 1910) did well for a while; that they lived in the hills near fields. He had seen none since 1926.

John A. Gude of Bruceville, Knox County, Indiana, said:

"I saw 10 or 12 Huns in the spring of 1928 on Emerson Prairie, but none since."

These were probably straggling remnants of the original Indiana plantings of 1908–10 or, more probably, of the Lawrence County, Illinois, plantings of 1924.

Howard L. Hancock, an attorney and sportsman of Rockville, Parke County (west central), Indiana, said:

"The Huns are all gone. They did well for 5 years, but I think they were wound up by the hard winter of 1917–18."

He evidently refers to the wholesale plantings of 1908–10. It should be noted that the hard winter in question did not materially damage the successful plantings of the same year in northeast Indiana.

H. H. Hicks of Lawrenceville, Illinois, said:

"About 50 Huns were planted here 15 years ago when Wheeler was commissioner and Deneen was governor. I never heard of but one brood, which resulted in a covey on which I trained my dogs. At the end of a year, however, the birds were all gone."

Straggling Followed by Dispersal. Some of the accounts of straggling Hungarians may be interpreted as straggling followed by dispersal. This combination of the two types of failure, however, is most clearly recorded in pheasants. Widmann's "Birds of Missouri" quotes a letter from George H. McCann, of Springfield, describing a plant of 400 pheasants (part English, part Mongolian) made on his preserve in Taney County in 1907, or possibly 1906. In addition to these imported birds, 32 pheasants raised locally by hand were also liberated. Mr. McCann describes the result as follows:

"Several covies were raised on or about the preserve, but they leave after the first frost . . . where, I know not. I have labored with them for the past 10 years . . . but feel that I have made a complete failure."

The remainder of Mr. McCann's letter clearly describes sudden dispersal in the fall after a successful initial nesting period. His language clearly implies that this was a typical behavior observed during several attempts to establish pheasants, rather than the behavior of the 1907 attempt only.

His letter also states that a club at Springfield liberated 600 pheasants a few years previous.

"For a year we felt success . . . but I am unable to locate a bird in Green County."

The letter states that $6,000 was spent, and that several pair were sent to north Missouri with like results.

Curtis Rollins, of Columbia, Boone County (north central), Missouri, describes a small plant in 1917 which suddenly disappeared in the middle of October.

Colony Failure. Senator Nicolas Cave, of Fulton, Callaway County (central), Missouri, told me about two plantings of Hungarians made about 1911. One failed, but the other has persisted ever since as a small colony of four covies. His brother saw a pair with six young in 1929. There is some doubt about the identity of this colony of birds, since the sportsmen of that part of Missouri are not familiar with Hungarians, and time was lacking to run down this question of identity personally during the survey. The date, however, checks with that of the heaviest State plantings in Missouri, and Senator Cave remembers other plants made all over Callaway County at the same time, all of which failed.

A colony of pheasants is said to have resulted from a planting made in 1904 in Carroll County, Missouri. This colony showed a considerable spread, but disappeared in 1911.

It seems apparent that colony failure is usually simply an extra long straggling failure. Some of the long periods of straggling in Indiana Hungarians already described may be interpreted as colony failure. Colonies often survive for very long periods. There is said to have been one in southeastern Maine for many years.

Artificial Establishment. The coarse hatching on Map 10 represents a puzzling behavior of pheasant plants which is too favorable to be construed as failure, but which clearly does not represent full success. On the bottoms of the lower reaches of the Illinois River, for instance, many observers agreed that pheasants were common, or even abundant, until the flood of 1926 drowned them out. They are much less common now. These observers ascribe the decrease to the flood, yet the established pheasant range farther north also has floods, which result in no more than a temporary reduction of pheasant populations.

On the central Illinois uplands there are numerous local colonies, which seem to be established, but which do not spread. Reports of plants which disappeared were almost as numerous as reports of plants which persist. Nowhere in central Illinois could I find evidence of dense, aggressive pheasant populations, able to withstand those constant buffetings of circumstance which any game bird successfully outlives on its established or native range.

This behavior must be interpreted in the light of the fact that both State and private plantings have continued more or less regularly for many years. No final appraisal is possible until renewals have been discontinued, and experience has shown whether the stock persists without renewal. Meanwhile there is no way to interpret the central Illinois behavior except to consider it as intermediate between colony failure and full establishment. In all probability the stock would gradually disappear but for the new plants made from time to time.

Most of central and northern Indiana shows the same behavior as central Illinois.

Southeastern Minnesota seems to represent the equivalent case of artificial establishment of Hungarians. There is a more or less thrifty Hungarian population, but plants have been continuous since 1926. Colonies of drift birds have crossed the Mississippi and established themselves in Wisconsin. In spite of this favorable evidence, however, southeastern Minnesota does not present convincing evidence of territorial aggression and increasing density. If the plantings should cease it is possible that the stock would gradually disappear.

Full Establishments. The denser hatching on Maps 10 and 11 shows the areas on which full establishment has apparently taken place. These areas of established range are not yet stable. Thus the Wisconsin establishment of both pheasants and Hungarians is clearly moving westward. The Ohio establishment of Hungarians has been moving northward into Michigan since 1918 or before. The Indiana Hungarians seem to be spreading westward at one spot in Clinton County at the western apex of their range, and this is coincident with a shrinkage on the south side and prominent expansion on the north side of the Indiana range. The Iowa–Minnesota Hungarians are spreading northwestward, as indicated by the appearance of drift birds and outpost colonies in the Pipestone Region of Minnesota. There may also be an eastward movement, but this has been masked by the recent Minnesota plantings. The pheasants of northern Iowa are still spreading eastward and slightly southward.

In most of these established ranges it is possible to find comparatively dense populations sometimes approaching one bird per acre, and apparently maintaining this density over a period of years. Such densities are never attained in the zone of artificial establishment farther south. Populations approaching the saturation point, and maintained for a period of years, appear in fact to be characteristic of established ranges, and to distinguish such ranges from lesser degrees of success.

Interpretation. The foregoing captions describe the results of pheasant and Hungarian plants in the north central region, but do not attempt to interpret causes for their varying degrees of success.

Certain miscellaneous findings on exotic populations will next be presented.

An attempt will then be made to infer possible causes, in the light of all the evidence available, and to suggest what researches are necessary to prove or disprove the inferred causes. It goes without saying that the cause of failure must be found before the percentage of success can be greatly increased. It is unthinkable that the present investment of $100,000 per year can continue to be made in the dark.

Character of Populations

Pheasant Census and Kill. It is more difficult to make a census of pheasants than of any other American upland species. Of all our upland species, pheasants are the least given to coveying. Of all our upland species, pheasants are the most given to taking refuge in impenetrable swamp cover, to running instead of flushing, and to forming temporary concentrations. Moreover, their cruising radius appears to be greater than that of any other gallinaceous bird except pinnated and sharptail grouse. Census figures for other species are scarce enough, but for pheasants they are as yet nearly non-existent.

Table 23 gives the best samples I could find of estimated populations and kills, on large and small units of range respectively. The small units undoubtedly represent temporary concentrations. If we interpret these estimates in the light of similar data for quail, and the general ratio between temporary and permanent population densities known to exist in quail, and the kill ratio possible in quail, it seems probable that pheasants are subject to approximately the same saturation point as quail, namely about one bird per acre. This saturation point is often obscured by temporary seasonal concentrations, but it is nevertheless believed to hold good for wild populations on large units of range throughout the north central region.

As in quail, the saturation point is not often attained, due no doubt to the more or less unfavorable environment offered by the average range.

Hungarian Populations. It is almost as easy to make a census of Hungarians as of quail. The coveys vary more in size, and are a little more mobile, but otherwise the two species are equally easy to count in relation to a given area.

Table 24 gives the census data secured during the survey, and also data gathered by R. E. Yeatter, Institute Fellow studying Hungarians at the University of Michigan. These figures are of exactly the same kind as the census data on quail shown on Map 6, only the quail figures were too voluminous to show in tables, while the Hungarian figures are not sufficiently voluminous to justify a map.

When the American figures in Table 24 are summarized in comparison with Map 6 for quail, the frequency of the various density-classes appears as follows (in both birds the lesser densities are undoubtedly under-represented, especially in Hungarians):

Density class Acres per bird	Hungarians (all States)	Quail
0.5–1	2	20
1–2	4	58
2–4	6	83
4–8	10	83
8–16	7	54
16–32	0	40
Over 32	2	30

TABLE 23

(a) PHEASANT POPULATIONS AND KILLS ON AREAS OF FARM-SIZE OR LARGER

Areas	Population, acres per bird	Kill acres per bird
Concentration areas (large)—		
Champaign and Miami County, Ohio, on bottoms	2–4	----------
Above Dayton, Ohio, on Mad and Miami rivers. 3,000 Cocks killed on 12 square miles or	----------	2.5
Regular range—		
Oakland County, Michigan	32	----------
Champaign and Miami County, Ohio, uplands	10	----------
Racine County, Wisconsin, 60 wintered in 160- acre swamp; in spring dispersing over (estimate) 640 acres	10	----------
Scattering range—		
East DeKalb County, Indiana	16	----------
Southeast Henry County, Indiana	200	----------
South Wayne County, Indiana	40	----------
Other States, for comparison—		
State of Pennsylvania, on range where farmers complained of damage to crops, trapped 106 on 70 acres cultivated, plus about an equal area of uncultivated land, or	----------	1.3
State of South Dakota counted 360 nesting pheasants on 640 acres, overpopulated with pheasants	1.8	----------
Also 246 pheasants on 640 acres of normally stocked ideal range, or	4.3	----------

(b) SAMPLES OF MAXIMUM PHEASANT POPULATIONS AND KILLS ON AREAS OF LESS THAN FARM-SIZE

Concentration areas (small)—		
Northville, Wayne County, Michigan, careful census showed 40 on 30 acres (Dalke)	¾	----------
Licking River bottoms near Newark, Ohio, flushed 50 from 30 acres swamp (Harlow)	3/5	----------
Same region, twenty-one cocks killed 1 day from 10-acre swamp (with allowances for infiltration), at least	----------	1
Racine County, Wisconsin, 60 wintered in 160-acre swamp (Peterson)	3	----------

The range of density of Hungarian populations is apparently similar to that of quail, in that both tend to approach the same saturation point of one bird per acre. The most frequent density would appear to be 4 to 8 acres per bird in both species, but this is believed to be more apparent than real, in that my census figures on Hungarians tend to show the densest rather than average run of samples. Our actual Hungarian populations are thinner on the average than quail.

TABLE 24.—*Hungarian populations on areas of farm-size or larger*

State	Acreage	Year	Covies	Per covey	Birds	Acres per bird	Remarks
REGULAR RANGE							
WISCONSIN—							
Hannaford farm, Racine County	190	1928	3	6, 12, 18	36	5.3	Sample of best.
Average Yorkville and Dover Townships, Racine County, per farm	160?		1	15	15	11.0	
Lee Thomas farm, Waukesha County	160	1925	11	12–16	150	1.1	Sample of best ground in best year.
Bartlett and Seeley farm, Waukesha County	200	1928	7 or 8	10	75	2.6	
J. P. Steer farm, Waukesha County	120	1928	2	10	20	6.0	Sample of poor ground.
Galman farm, Jefferson County	160	1928			100	1.6	Best in Jefferson County
Earl Hibbard farm, Jefferson County	200	?	4–6	12–20	75	2.6	
Wm. Boese farm, Jefferson County	55	1928	5	12?	60	1.0	
INDIANA—							
Farm near Kerklin, Clinton County	160?	1928	1	22	22	7.0	
Farms in Northeast Clinton County	7,000	1928	20	25?	500	14.0	
Farm East of Montpelier, Blackford County	160	1927	?	?	200	0.8	
Sam Garrett farm, Wells County	160	1928	3	20–50	100	1.6	
ILLINOIS—							
Lake County, near Waukegan						6.0	Best farms
Lake County near Guerney						4.0	
OHIO (estimates of typical densities by Yeatter)—							
Southwest Wood County						2–4	
Southeast Wood County						4–8	
Northeast Wood County						8–16	
Central Henry County						4–8	
West Fulton County						8–16	
East Fulton County						4–8	

TABLE 24 (continued).—*Hungarian populations on areas of farm-size or larger*

State	Acreage	Year	Covies	Per covey	Birds	Acres per bird	Remarks
North Ottawa County						8–16	
South Putnam and North Putman County						8–16	
MICHIGAN (census by Yeatter)—							
Southeast Lenawee County						7.0	
ENGLAND (for comparison)—							
Aymer Maxwell says best years, on best beats, under best management will run						0.5	
Maxwell says average year, 6,000 acre tracts, good management						2.0	
Richard Page says 400 acre farm, ordinary management, will run						1.3	
Scattering Range							
INDIANA—							
J. B. Powers farm, Hancock County (southeast of Greenfield)	160	1910	2	30	60	2.7	
		1914			2	80.0	(Winter loss)
		1926	1	30	30	5.3	
J. P. Doty farm, West Marion County	200	1927	1	25?	25?	8.0	
S. W. Pickering farm, Southwest Henry County	1,200	1930			2	600	
North Huntington County						8–16	
Northwest Wayne County						Over 32	
Central Delaware County						4– 8	
Northeast Allen						6.0	
OHIO (estimates by Yeatter)—							
Allen, Shelley, and Hardin Counties, all						Over 32	

The managed Hungarian populations of England, however, are just about as dense as our best quail populations, and apparently subject to about the same saturation point.

Some of the items in the table giving populations on the same tract through a period of years, and much other evidence gathered during the survey, but too voluminous to publish, indicate that Hungarians fluctuate more between years than quail. This, too, is borne out by experience in England. In eastern Europe, however, the bird is said to be very stable as between ordinary years.

Sex Ratios. The pheasant is a highly polygamous bird, corresponding to the deer in mammals. For this reason it is highly important to know the sex ratio normal for wild unshot populations, and the extent to which this is disturbed, beneficially or otherwise, by the present laws, which usually permit the killing of cocks only. Cock laws, like buck laws, are undoubtedly beneficial within certain limits. It is important to determine what those limits are, and whether there is any danger of passing them. Pennsylvania's recent experience with deer should be ample proof of this need for facts.

Unfortunately only one of the north central States (Minnesota) requires a report of the pheasant kill, while none of the States have done any work on sex ratios in the wild.

Valuable and convincing sex-counts have been made, however, by Oscar Johnson, State game warden of the adjacent State of South Dakota. Twelve thousand wild birds were captured by "shining" in Clark, Beadle, Spink, Hand, and Faulk Counties during the winter of 1929–30. These were shipped for replanting in standardized unit lots of 15 hens and 5 cocks each. Mr. Johnson says that no surpluses of either sex were encountered in currently making up these unit shipments. Unless, therefore, the process of "shining" caught the sexes in a different ratio from that existing on the range, the ratio on the range must have been very close to 3 hens:1 cock during the winter of 1929–30. This was after the 1929 hunting season had reduced the percentage of cocks. (During 1929 the bag limit was five pheasants, of which not to exceed one might be a hen.)

Ten thousand wild pheasants were likewise captured in the same way for the same purpose during the winter of 1926–27. The ratio ran 6 to 7 hens:1 cock, after a hunting season which allowed a limit of seven pheasants, of which not to exceed two might be hens. The fall of 1926 was the first time since the opening of the season on pheasants in 1919 in which the regulations permitted taking any hens.

The method of capture in both years was to "shine" the birds on the roosting grounds at night with auto headlights. Mr. Johnson says his men did not discriminate between sexes in picking up the "shined" birds during the 1929–30 operations. In 1926–27, however, his men experienced difficulty in securing the desired proportion of cocks, so that hens were repeatedly passed up.

Mr. Johnson thinks the optimum sex ratio is 4:1 or 5:1. Previous to the partial legalization of hens in 1926 he thinks the prevailing sex ratio was 7:1 in South Dakota, instead of 3:1 as at present. If both these opinions are correct, they mean that (1) restricting the legal bag to cocks resulted in a surplus of hens; (2) a partial opening on hens, they being less wary and more easily taken, left an excess of cocks. While these conclusions arise from an assumed premise based on opinion (the desired 4:1 or 5:1 ratio) the opinion is that of a competent administrator on America's best present pheasant range. The conclusions sound logical for a species so highly polygamous. In deer, likewise polygamous, a ratio of around 5:1 has long been advocated by many authorities.

Nothing is known about the sex ratio of wild Hungarians in this region, and little elsewhere. No criteria for distinguishing the sex of living birds seem as yet to be agreed upon as being dependable. Maxwell says that game-keepers in England deliberately kill off the "old birds" (over 2 years) in spring so as to leave a breeding population of one bird per 2 to 5 acres. This implies ability to distinguish age (but not necessarily sex) in the field.

Release-Kill Ratio. On any range where natural increase is augmented by annual releases of pen-raised pheasants, it is important to know the ratio between birds released and birds killed. On the Connecticut Public Shooting Grounds, for instance, 7,500 birds were released and 20,000 cocks killed in 1929, a ratio of 1:3. This ratio, if sustained through a period of years, indicates that at least two-thirds of the kill represents wild productivity. In Pennsylvania the present release kill ratio is 1:23, indicating that practically all of the kill is wild stock.

No ratios are known for the north central States. In Minnesota the 1926 kill is given as 40,023 cocks, and in 1928 as 161,881 cocks, but the releases for the period of 1925–27 are not of record, and there was no release (except eggs) in 1928, hence ratios cannot be derived.

It is obviously desirable for all the States having open pheasant seasons to require a report of the kill from each licensee. Without this the effectiveness of their activities is not determinable.

Species Ratios. The information obtained on comparative abundance of pheasants, Hungarians, quail, and prairie chickens is all contained in Table F of the Appendix.

It seems clear from these abundance ratios, and from impressions gathered during the survey, that:

(1) The best Hungarian range is never the best pheasant range. The uplands of northwestern Ohio, for instance, have very few pheasants, while Hungarians have maintained fairly good density even under annual hunting.

(2) The best pheasant range is never the best Hungarian range. In southeast Wisconsin, for instance, this fact is so clear that the sportsmen assert the pheasants run the Hungarians out.

(3) On range inhabited by pheasants, Hungarians, and quail, not more than one species appears to approach its saturation point. (Comparatively high densities of pheasants and quail, however, have been noted by Yeatter to coexist in parts of west central Ohio.)

(4) Low populations of pheasants, Hungarians, quail, and pinnated grouse may coexist on the same farm.

Movements. Banding work has thus far been confined to planting stock in both exotic species. Obviously newly planted birds, especially pen-raised pheasants, are not normal in their subsequent movements, hence the banding returns from such birds tell us little or nothing about the movements normal for wild birds. There is urgent need for the trapping and banding of wild birds, especially on hunted areas where numerous returns are probable. Wild Hungarians should be banded in Ohio, and wild pheasants in Michigan and Minnesota.

The movement of planted stock, however, is in itself an interesting and important subject. No compilation of returns for any State in this region is known to the author. One pheasant banded on release at Appleton, Wisconsin, was recovered seven miles away three months later. Another banded on release at Beloit, Wisconsin, was killed at St. Charles, Illinois, 55 miles away, 2 years later. For comparison, it may be noted in passing that in Pennsylvania a banded pheasant was recovered 40 miles away from the place of planting five years after the plant was made. It seems reasonable to suppose that wild birds seldom move such long distances. In central Europe some authorities regard the pheasant as less mobile than the partridge.

Dalke, of the Michigan School of Conservation, who is studying pheasants, thinks that wild pheasants may breed several miles from wintering ground, which is usually a marsh. It seems certain that in this region both the daily and seasonal radius of mobility is longer than in Hungarians, and that in Hungarians it is longer than in quail.

It is common knowledge that pheasants promptly move to thick cover within a day after shooting begins. It is important to establish the length of this movement, since on it, and on the length of the seasonal movement, the maximum spacing allowable in a pheasant refuge system must primarily depend.

Food and Cover: Wintering. Wight (unpublished manuscript, 1928), and Yeatter, of the Michigan School of Conservation, are studying pheasants and Hungarians respectively, but pending publication of their findings, there is no organized knowledge on food and cover. A few fragments of suggestive information, gathered during the survey, are here given:

Both species are closely associated with corn, and pheasants are very closely associated with swamps.

W. W. Cook, of Madison, Wisconsin, has seen pheasants budding on willow. Otto Beyer, of Portage, Wisconsin, has seen them budding on blackberry. Stigelbauer, of Oconomowoc, Wisconsin, saw four cocks budding in 1929. Whether they regularly resort to buds will probably determine their ultimate northern boundary.

William Otto, of Watertown, Wisconsin, fed four covies of Hungarians through the killing winter of 1928–29, and found that 29 of the original 34 birds, or 85 per cent survived. He estimates the survival of unfed covies as 50 per cent.

Various observers in Racine and Jefferson Counties, Wisconsin believe that Hungarians resorted to dragged gravel roads for grit during the heavy snows of 1928–29.

Do Exotics Need Cover? There is a fallacious impression in many parts of this region that while native game needs generous coverts, the pheasant "has adapted himself to civilization through thousands of years in China" and can get along on bare fields.

It is important that this fallacy be refuted. It tends to prevent sportsmen from squarely facing the covert-restoration problem.

The pheasant does not get along on bare fields in China. A careful reading of Beebe's Monograph (1922) will show that typical Asiatic pheasant country has dense reed-beds along all the rivers (equivalent to our cat-tail marshes), while every paddy-field is checkered with narrow lines of cover on the little ridges used to hold irrigation water. When the reeds are cut in December, the birds leave the fields and take to the semi-timbered hills.

It is true that the pheasant uses a *different kind* of cover, that is, he uses swamps at all seasons, whereas quail use them only in winter. He may persist on standing corn and grassy swales, whereas quail ordinarily requires brush as well as grass and grain. It is certainly true that the pheasant, having a longer cruising radius than quail, will go further for cover; that is, a given covert will serve a wider area. But a devegetated country is equally hopeless for all game, especially shootable game. Pheasants while still fully protected may live on fairly bare country, but they will disappear from it under shooting unless it contains tangles from which they cannot be raised by dogs, or cornfields so large that they can escape by running.

Hungarians come nearer being able to get along without cover than pheasants or quail. Apparently they need neither brush nor woodland, but during snow they do require some heavy grass, weeds, or standing corn. This need is easily supplied by leaving patches of cover uncut. As in the case of pheasants, however, there is probably a difference between the minimum of cover which will suffice under complete protection, and that necessary to enable the birds to stand up under shooting. The unsatisfactory resistance to shooting in Wisconsin and most of Ohio, and their shrinkage without shooting in parts of Wisconsin and central Indiana, may be due to deficient cover or food. In Waukesha County, Wisconsin, the deficiency of both cover and food, due to the increase in siloing of corn, is the most probable reason for the recent decrease under complete protection.

Interpretation of Planting Experience

This discussion has been deferred in order to first present a rough picture of how established populations behave. We are now ready to attempt to decipher something about the reasons why some plantings have been a success and others a failure.

Summary of Experience. While Hungarian plantings have survived in a narrower belt of more irregular outline than that marking the survival of pheasants plantings, it seems clear that both species are alike in exhibiting the following characteristic behavior when planted in the north central region:

(1) Plants usually breed normally for at least one year, regardless of where made.

(2) In suitable portions of the northern zone, this continues indefinitely. The plants spread and become established as wild populations.

(3) In the southern zone they do not become established. Usually within three years after planting the stock has either disappeared, or has been reduced to a few straggling and apparently non-breeding adults. Sometimes the stock disperses at the end of the first breeding season.

(4) In both northern and southern zones, captive pheasants on game farms are *successfully bred for long periods.* This captive stock is of *identical origin* with the planted stock. Hungarians are not successfully bred on game farms in either zone, but this is due to their reluctance to produce eggs in captivity, and probably has no bearing on the survival of plants.

These are the facts. Behind them must lie some cause or reason. What is it?

Popular Interpretations. When sportsmen, game wardens, farmers, or even ornithologists are asked why pheasants and Hungarians have failed to establish themselves, they almost invariably allege one or more of the following reasons.

(a) The plant was shot out by law violators.
(b) The plant was destroyed by "vermin."
(c) The plants were of insufficient volume or duration.
(d) The planting stock was improperly released and did not become located.

These popular interpretations will be considered in the following analysis.

Kinds of Causes. The causes of success or failure of plants are of three possible kinds:

(1) The character or condition of the stock planted.
(2) The character of the environment in which planted.
(3) The method of planting, and the protection and care given the plant.

The character of the pheasant stock planted in the north central region is known to this extent: It consists of the hybrid birds characteristic of north

European preserves, with a certain admixture of north Asiatic species, imported either direct, or via the wild populations of the Northwest. The stock is so thoroughly hybridized, and came from so many different places, through such a long period of years, that it seems almost inconceivable that the zone of failure in the south part of the region should have received a stock materially different from that in the zone of success. If this is true, then the cause of pheasant failure cannot lie primarily in different stock.

The Hungarian stock planted in the north central region came mostly from various parts of southeastern Europe. It is quite possible that the stock imported in a certain year differed in geographic origin from that imported at some other time. Geographic origins could doubtless be run down by analyzing the records of importers. Long confinement in shipment is also well known to have produced various degrees of debilitation in Hungarian stock. In some of the States like Ohio, however, Hungarian plantings have been repeated through a long series of years, during which time geographic origins doubtless changed and debilitation varied, but behavior of plantings did not. It therefore seems improbable that the reason for failure of Hungarians lies primarily in the character or condition of the stock.

It seems certain that improper release, lack of care, and illegal shooting has been responsible for the failure of many plants of both species. It seems almost impossible, however, that these human deficiencies should be distributed in solid zones and hold consistently through a period of 30 years. Both human individuals and local human populations certainly differ in the skill and care with which they plant birds, and in the degree to which they observe the laws protecting them. A map of these differences, however, would certainly show a shotgun pattern, not a pair of roughly parallel zones extending across a third of the continent. Skill, care, and law observance are not a property of the northern, nor are the opposite qualities a property of the southern populations in this region. For this reason the skill, care and protection of plants may be dismissed as a primary cause of the phenomenon here in question.

Kinds of Environmental Defects. This disposes of the first and third possible causes. The remaining possible cause, namely, the environment in which the plants were made, may be sub-divided into three kinds of factors:

(a) Temporary factors (such as unfavorable weather).

(b) Visible factors (such as kind and amount of cover, food, predators, etc.).

(c) Invisible factors (such as diseases, parasites, quality of food, etc.).

Temporary weather conditions may be dismissed for the same reason as illegal shooting and other human deficiencies. The laws of chance would not subject a thousand southern plantings scattered over a score of years to unfavorable weather, and a thousand northern ones to the opposite kind of weather. This process of elimination brings us down to the probable meat of the question, namely, the visible and invisible characters of the environment.

First of all, it is necessary to dispose of the obvious question: Does the north central region resemble the native home of these birds?

The concensus of opinion is that the pheasant was not a native of Europe, but was introduced from Asia Minor either by the Romans, or during early feudal times. The native homes of the two pheasant species forming our hybrid stock are the region of the Black Sea, and north China, respectively. The north central region does not resemble either. It does, however, strongly resemble the north European ranges in which the same hybrid is now successfully naturalized. A close counterpart for our range of climate, cover, food and predators is found within the European zone of naturalization.

The European home of the Hungarian partridge extends from southern Scandinavia to northern Italy and Asia Minor, including west Russia. Here again the visible aspects of the environment offered by the north central States have close counterparts in the home of the species. Most of our stock doubtless came from Hungary, parts of which resemble the north central States in many outward respects.

The real question, however, is not so much whether the north central region resembles Europe, but whether *the localities in which plantings have been a success in that region are visibly different from these in which plantings have been a failure.*

If there are visible differences the survey failed to find them. A blindfolded naturalist set down to look about in north central Indiana where Hungarians have succeeded, could not distinguish the country from west central Indiana where they have failed. North central Ohio is not visibly different from southeastern Michigan, but Hungarians have failed in the former and are spreading of their own accord in the latter region. In Iowa the only visible difference between the zone of pheasant success in the north, and the zone of pheasant failure in the south, is in the origin of the soil, which only a geologist or a soils expert would be likely to detect. Neither is it possible to explain success or failure on the basis of absolute latitude alone. Northeastern Iowa, where both species have failed, has a considerably higher latitude than west central Ohio where both have succeeded. Northern Missouri, where both have failed, has the same latitude as north central Ohio, where pheasants at least have succeeded.

When we say that success lies in a northern zone, and failure in a southern zone, we admit of course a general latitudinal relationship. To offer this as a "cause," however, simply changes the label of our enigma—it does not explain it. Through what mechanism does latitude work? Why does the zone of success have, in some places, sharp edges which run north and south instead of east and west? Latitude is no answer to these questions.

Of all the visible factors of the environment, predators would seem to be the most likely to display radical variations not easily detected in a casual examination of the country. Here again, however, it would seem likely that these variations, if they actually determined success or failure, would form a patchy or "shotgun" pattern. It would seem unlikely that they would extend in a broad and almost continuous belt across four States.

Food and cover in the gross, or quantitative sense, would seem to be more abundant and just as varied in the southern zone where exotics have failed, as in the northern zone where they have succeeded. Here, too, a patchy rather than a zonal pattern would be expected, if they were the primary cause of success or failure. As already stated, food and cover seem to have a great deal to do with the abundance of both species in the area of success, and their resistance to shooting, but we are here wrestling not with questions of how well they succeed, but why they succeed at all in one zone and not in another.

Accordingly we seem to be forced to fall back on invisible factors as the place to look for causes of success or failure of exotic plantings.

Kinds of Invisible Factors: Pathology and Nutrition. It is conceivable that the zone of failure represents the range of some disease organism or parasite, or of some intermediate host which transmits a disease or parasite to these birds. The phenomenon of straggling (this is, early thrift followed by later failure) may be explained by supposing that when the plant is first made, the disease organism is scarce and hence ineffective, but that it increases with the planted birds. When it finally increases faster than the birds, it either kills them, or by destroying their fecundity or disturbing their sex ratio, it causes them to succumb to other enemies. Such reactions are well known and commonly follow transplantation in both plants and animals.

This may be called, for short, the pathological hypothesis. It would be the most probable explanation of the behavior of exotics, but for one fundamental and seemingly conclusive contradiction: the thrifty behavior of pheasants on game farms within the zone of failure. Captive birds would seem to be accessible to the same carriers or intermediate hosts as wild ones, with the possible exception of brush-inhabiting non-mobile insects, or mammals excluded by wire pens. Unless such carriers or hosts can be found, the pathological hypothesis is apparently untenable.

One other possible invisible factor has occurred to the author. This postulates some nutritional deficiency, or qualitative defect of the available food, in the zone of failure. It has been expressed in two forms, which will now be described.

Glaciation Hypothesis. While making the game survey of Iowa it was observed that successful plants of both pheasants and Hungarians were all confined within the exterior boundary of the "Wisconsin" glacier, that is, that they were confined to soils of recent glacial origin. The hypothesis was advanced that some plant growing on these soils, or some substance, such as kind of lime or gravel, contained in them, was necessary to the welfare and breeding vigor of exotics of this region.

The evidence subsequently gathered in the other States seemed at first to support this hypothesis. All successful establishments seemed to occur on glacial deposits, and most of them on the fresh glacial deposits left by the most recent (Wisconsin) glaciation. In Ohio heavy populations of pheasants were found to extend in "ribbons" along the glacial outwash streams into the unglaciated area on the southern edge of the State, while few or no pheasants were found on the immediately adjacent unglaciated soils. The recent more careful survey of Ohio by Hicks and McCormick (unpublished) fully confirms these observations, including the "ribbons." There are no thrifty pheasant populations beyond the glacial boundary and the few birds found there may be accounted for as straggling plants, and as drift from the glacial "ribbons."

Upon surveying Wisconsin, however, a recent voluntary establishment of Hungarians were found on unglaciated soil in Vernon County in the west central part of the State. This colony evidently originates from recent plantings on the adjacent unglaciated area of Minnesota. They have increased to 40 birds since their arrival in 1928. If this voluntary establishment proves to be permanent, the glaciation hypothesis must be dropped as untenable for Hungarians. It may, however, ultimately fail in the same manner as colony establishments have been known to fail in both species in the southern zone of failure.

The boundaries of both fresh and old glacial deposits appear on both the Hungarian and pheasant maps (Maps 10 and 11). With the exception of the Wisconsin colony just described, all successes with Hungarians are within the exterior boundary of the Wisconsin glacier. This is also true of the full and conclusive establishments of pheasants, but some thin or indeterminate establishments of pheasants occur on the older glacial deposits of central Illinois, or northeast Iowa, and northwest Iowa. These older deposits are more or less covered by wind-borne soils known as loess, and lie between the new deposits and the unglaciated soils. It remains true, however, that no full establishment of proven permanence of either species as yet occurs on the residual, or wholly unglaciated, soils of the north central region.

Whether or no the glaciation hypothesis ultimately holds water, it is no longer regarded as very important, except as a temporary rule-of-thumb for the guidance of planting policy. It does not explain causes. It is possible that the fresh glacial deposits contain lime or grit of a quantity or quality necessary to the welfare of these birds. This possibility is supported by the fact that their European range, in so far as I know, is likewise freshly glaciated. Beebe tells me, however, that the pheasant range of China is not. (Letter, October 10, 1928.)

It is also possible that the glacial soils support some plant or insect which contains some vitamin or mineral substance necessary to the welfare of these species. That the glacial soils support a flora often sharply different from immediately adjacent unglaciated soils is well known. The specific identity of the particular plant or insect necessary for these birds remains totally unknown.

The underlying thought of the glaciation hypothesis can, in our present state of knowledge, be better expressed in the form of a general nutritional hypothesis, to be now presented.

Nutritional Hypothesis. H. L. Stoddard and the author presented the glaciation hypothesis, and the facts of behavior noted in this chapter, to Prof. J. G. Halpin, head of poultry husbandry in the University of Wisconsin. We asked him to describe to us any experiences with poultry which might throw light on the subject of exotics, especially on the contradictory behavior of captive and wild pheasants respectively in the southern zone of failure.

Professor Halpin stated that *nutritional deficiencies in poultry often do not show up until the second or third generation.* This may be the key to the riddle. For instance, chickens deliberately fed a ration deficient in a certain respect may continue in good health, and may exhibit normal breeding, *but the progeny will lack size or vigor.* Sometimes the deficiency will not show up until the *second* generation. In one experiment a certain ration which showed excellent results at the end of three weeks, caused death at the end of 20 weeks. The poultry evidence is far from complete, but tends to show that:

(1) Good nutrition of poultry (and also of cows, pigs, and humans) appears to depend not only on chemical composition of the ration, but also on the *chemical state* of the food compounds it contains, and the *ratio between them.*

(2) Normal birds appear to *carry a reserve* of certain unidentified food substances.

(3) When the ration lacks one of these, the bird draws on its reserve.

(4) The quantities needed for vigor may be so minute that some reserve may be *transmitted to the egg,* and thus invigorate the first generation.

(5) Ultimately, however, the reserve is exhausted and a marked decline in size, vigor, or reproductive capacity results.

(6) Rations deficient in mineral substances like lime exhibit this delayed effect most clearly, but rations deficient in certain vitamins also show delayed effects.

Here, then, is a possible explanation of the contradiction between captive and wild birds. Captive pheasants on game farms often receive *imported foods,* and the stock is almost always annually replenished by the importation of breeding stock from other, and usually northern, regions, which may *transmit small reserves of deficient food substances to the eggs* and thus maintain at least a certain degree of vigor. Wallace Evans has long ago called attention to the varying size of both wild and captive pheasants in different regions, and ascribed the variations to soil. This may reflect simply different degrees of nutritional deficiency.

Planted pheasants usually come from the northern zone, because that is where most game farms are located. They may be assumed to bring with them certain nutritional reserves which allow of vigorous breeding the first year, even in the south. By the second or third generation these reserves become exhausted and the plant disappears, unless re-invigorated by follow-up plants of northern stock. A few adult stragglers may survive because their reserves lasted longer, but eventually they all disappear.

Dispersion may possibly represent an impulse, born of deficiency, to seek missing food substances.

In short, the Halpin hypothesis appears to fit all the observed facts. This of course does not prove the hypothesis. It merely proves the need for controlled experiments to find out what these assumed nutritional deficiencies are, and how to correct them. Professor Halpin thinks that the key to the pheasant riddle, when once found, may prove to be very simple.

It may at this point well be asked: Is it probable that the pheasants which fail have nutritional requirements radically different from the quail which are closely related to them, and which obviously thrive on the foods which the zone of failure provides?

Knowledge is insufficient to say that such a difference is probable, but sufficient to say that it is possible. Professor Halpin says Plymouth Rock chickens, for instance, are more susceptible to the bone malformations caused by incorrect rations than are leghorn chickens. It is also possible to say that nutritional requirements do not necessarily follow taxonomic relationships. Thus hogs are said to resemble chickens in their needs for special food substances more than they resemble cattle.

Need of Experimentation. If the foregoing logic is found, in the opinion of competent scientists, to hold water, then the following experiments are needed:

(1) Locate some southern pheasant stock, either wild or captive, which has *not been replenished by northern blood or northern foods* for a long time.

(2) If this cannot be found, "build" some stock of this character.

(3) See if this unreplenished southern stock will breed on southern foods. Follow its weight and vigor in comparison with northern stock fed on identical foods and kept under identical surroundings.

(4) If a difference is found, begin to experiment on various foods to locate its source or cause.

(5) When the source is isolated, it may prove possible to *artificially supply* the southern ranges with that they lack. Conversely, it may prove possible to increase vigor on northern ranges by augmenting the natural supply of the critical food substances.

Scientific and Practical Significance. If it should prove to be true that the artificial distribution of these two species is limited by some vitamin, mineral, or other qualitative factor of nutrition, then it follows that the natural range of other species may likewise be determined by similar factors. The sharp and arbitrary nature of species ranges, and their changes or stability in point of time, has long been a puzzle, especially in birds. Some of the western quails, for instance, have range boundaries which appear absolutely arbitrary.

It also follows that if the identity of the "cause" can be discovered, successful controls may become possible. It is thinkable that a mineral, for instance, could be artificially added to the zone of failure. It is even more probable that the vigor of both wild and captive birds in the zone of success could be increased by giving them more of what they need, rather than merely enough to permit survival.

There is another set of phenomena, ordinarily ascribed to inbreeding of game birds, which may in the end prove to be phenomena of nutrition. The empirical conclusion that inbreeding is injurious comes largely from experience with pheasants and Hungarians in England, where one or possibly both species are *not indigenous,* and where a greater or less degree of nutritional deficiency may be expected to prevail, but to be temporarily abated by the admixture of stock carrying reserves from more favorable environments.

In short, the nutritional hypothesis is of great potential import, both to science and game management.

Management of Exotics

Open Seasons. All sportsmen are interested in the time interval which must elapse between the first plantings of a new game bird and the first open season when it can be hunted. Table 25 presents the elapsed time for the north central region.

TABLE 25.—*Elapsed time, pheasants*

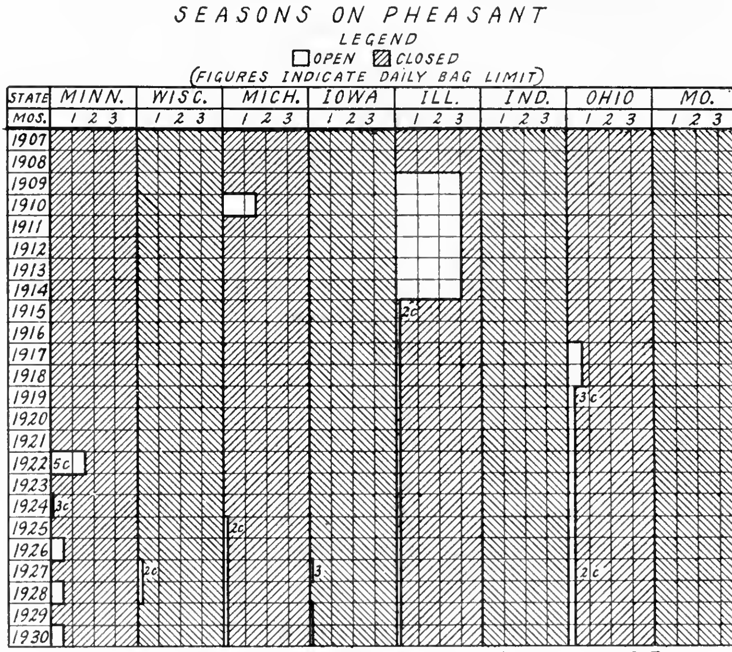
(Legend: c = cocks, ph = pheasants, x = not applicable)

	Minnesota	Wisconsin	Michigan	Iowa	Illinois	Indiana	Ohio	Missouri
Plantings began	1919	1910	1918†	1900	1910†	1907	1915†	1904
Season opened in	1922	1927	[1]1925	1927	[2]1909	x	1917	closed
Interval, years	3	17	7†	27	x	x	2†	x
Present length of season, days	15	(5)	5	3	5	x	11	x
Present daily bag limit	3c	(2c)	2c	3ph	2c	x	2c	x

[1] One previous year, 1910, was open for 45 days.
[2] The statutes show a 3-months open season "under permit" from 1909–14. The meaning of this is unknown.

Minnesota and Ohio appear to have started shooting two or three years after plantings began, but this apparently short interval is believed to be due to lack of records of date of the first plantings (see Map 10). There undoubtedly were earlier plantings in both States, records of which were not found by the survey. Moreover in the case of Minnesota, a drift of pheasants probably entered the State from Iowa before the plantings began, and possibly from South Dakota also.

The probability that the planting records are incomplete is further strengthened by the fact that Illinois had an open season on pheasants "under permit"



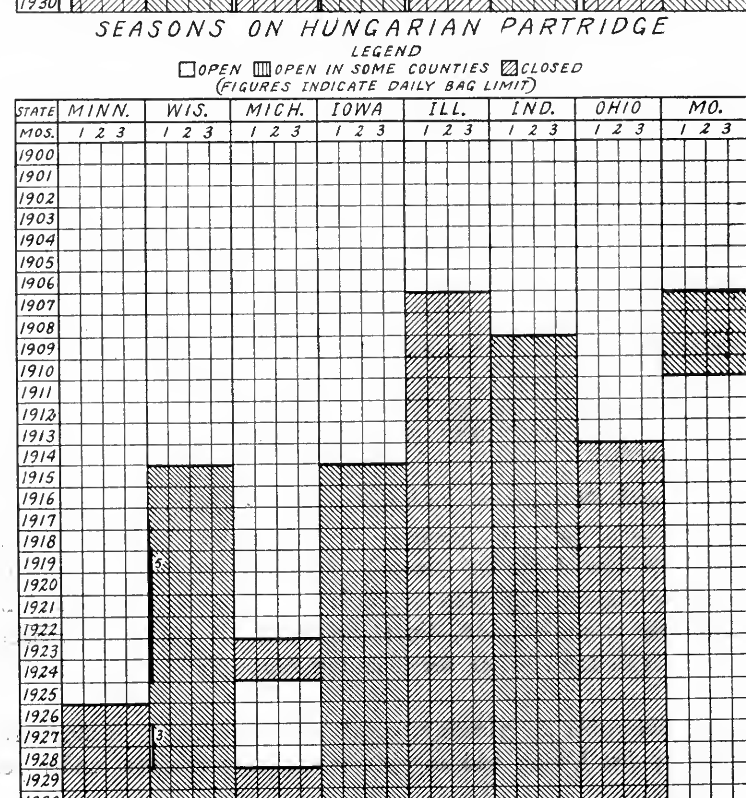


CHART 6.—*Seasons for Pheasants and Hungarian Partridges*

from 1909–14, whereas the planting record does not begin until 1910. In general, the wave of pheasant planting proceeded westward, and if Iowa was planting pheasants by 1900, the more easterly States may be safely assumed to have started planting also.

The Wisconsin elapsed time of 17 years is a clean-cut case where the date of the earliest plant is positively known. However, the Wisconsin pheasants did not stand up well under the open season of 1927–28, even though it applied to only a few townships in two counties. The open season has now been revoked, and the whole State is closed.

The Iowa elapsed time of 27 years is also believed to be free from error, but the Iowa birds are standing up well under shooting, and are spreading.

In general, there is nothing in the history to indicate that a successful planting in this region can be opened to shooting in less than 10 years, unless of course active management measures are added to the present hit-or-miss practice. In such case there is no reason why a shorter interval might not be possible.

Hungarians in Wisconsin were opened in 1921, 11 years after the Pabst plantings began. They did not stand up well, and are said to be declining in Waukesha County. There is no regular open season now.

Ohio Hungarians were opened in 1920, only five years after the first plants in 1915. They have stood up well in some of the northwestern counties, and these counties are the only place east of the Rocky Mountains successfully withstanding a regular yearly open season. Some counties to the south of these are showing a decline, and there is talk of closing them.

The history of open seasons on pheasants and Hungarians is shown on Chart 6.

Pheasant Management in Michigan. While no actual pheasant management is as yet under way in the region, a movement is on foot in Michigan which may soon result in its practice. The inception of this movement, and the circumstances which gave it birth are clearly portrayed by Lovejoy (Country Gentleman, October, 1930).

The essential circumstances are these: Michigan combines, in some of the southern counties of the Lower Peninsula, a good natural pheasant range, a closed season on alternative species such as quail, active sportsmen's associations, able leadership in the conservation department, and an extraordinary pressure of hunters by reason of the heavy industrial populations of the automobile manufacturing towns.

This combination of circumstances, in conjunction with the Horton trespass law, making it a misdemeanor to hunt on inclosed cultivated lands without the consent of the owner, produces a situation in which the farmers are increasingly irritated over the trespass nuisance, while the hunters are equally irritated over the lack of a place to hunt.

The first attempt at remedial action consisted of passing the so-called "shooting preserve statute" (P.A. 249, 1929), which recognized a distinction between managed and unmanaged pheasant lands, and gave preferential privileges to the former in the shape of a 30-day open season. Before becoming entitled to this privilege, the owner or leasee was required to apply for a license, which was granted after a game officer had certified to the release of a certain number of pheasants. The license authorized the killing of half this number, while renewal was contingent on satisfactory operation of the licensed area.

This statute was of course applicable only where artificial propagation or direct purchase of pheasants from commercial game farms produced the necessary stock to be released.

About the same time the farmers of Williamstown township, in Ingham County, evolved a solution of their farm trespass problem. They pooled their shooting privileges, posted the township as a block, provided a constable to enforce the posting, and issued hunting tickets to each farmer-member representing the estimated number of hunters his land could carry simultaneously. Such member was free to keep his allotment of tickets for his own use, or give them away as a courtesy to his friends, or sell them, but of course he was responsible to his neighbors for seeing that no ticket fell into the hands of an irresponsible person. So far the farmers have preferred to keep or give away their tickets, rather than to sell them.

Each ticket entitles the bearer to hunt anywhere within the township.

The net result of this Williamston pool is to limit the number of hunters on any one day to fixed maximum, and to eliminate, more or less, any individuals personally unknown to any member, or judged to be irresponsible. The pool as such of course provides for no game management. It deals solely with trespass and hunting.

The Ingham County chapter of the Izaak Walton League, with the help of the State division, has now proposed to the Williamston pool, and to other townships which are forming pools of the same kind, to finance food and cover improvements on the pooled areas, by paying each individual farmer for the food, cover, or other management measures agreed upon for his individual farm and installed thereon. In other words, the sportsmen contract to pay the farmer for the labor or materials he expends in management.

A management plan specifying the measures needed for each farm is being laid out by a technical committee representing the sportsman, the farmer, the State agricultural college, and the State university. The management plan will include a system of leased refuges to conserve the seed stock.

If this plan is carried out, it will constitute a system of management complete in all essential respects, except that the total kill will be only indirectly regulated through bag limits and hunting tickets. The sportsman contributing the funds will have no exclusive privileges, but will still be dependent upon receiving the courtesy of a ticket from some farmer friend. When he gets a ticket, however, he will, if the management is skillful, have pheasants to hunt, and a place to hunt them.

The whole Ingham County project constitutes an indirect method of compensating the farmer for regulated public shooting. It provides for game management by the collective action of sportsmen and farmer groups. If such a plan can be shown to be successful, there is no reason why it should not spread to other kinds of game and other States.

The Ingham County project, together with the shooting preserve statute, contain the essential machinery for the simultaneous development of private and semi-public initiative in pheasant management.

Charges for Pheasant Shooting. A perceptible tendency to charge for pheasant shooting was found in Iowa, and a few scattered instances were encountered in Illinois, Wisconsin, and Ohio. All such charging consisted of "tolls" per man per day, rather than of land rentals or leases. In no case was the charging accompanied by positive management measures to increase the crop. The rates are indicated in Table 26.

TABLE 26.—*Charges for pheasant shooting privileges*

Locality	Tolls	Remarks
La Salle County, Illinois	?	Rate not determined
Marion County, Ohio	$0.50 per day	Only a few farmers charge
Spring Valley, Green County, Ohio	$1.50 per day	Only one farmer charges
Fort Dodge, Iowa	$2.50 per day	
Sullivan Township, Jefferson County, Wisconsin	$1.00 per day	Four or five farmers charged this rate
Summit Township, Waukesha County, Wisconsin	$1.00 per day	

These instances of charging are conspicuously rare, especially when one considers the heavy pressure of hunters desiring to shoot pheasants in States like Ohio, Michigan, Minnesota, and Iowa. Evidently the theory that the farmer should not charge the public for the privilege of harvesting his pheasant crop, because the seed was originally provided at public expense, enjoys considerable credence among farmers as well as sportsmen. If this were not the case, charges would be expected to be more frequent.

CHAPTER V

THE GAME CYCLE IN THE NORTH CENTRAL STATES

BACKGROUND. Certain game species in the north central region and elsewhere are subject to extreme fluctuations in abundance.

It has only recently been generally realized that these fluctuations take place more or less simultaneously over large areas, and that they have a more or less uniform period or length. This fluctuation is common to all cyclic game, and is now coming to be known as the game cycle.

It is necessary, before an analysis of the separate species can be attempted, to first describe the cycle which affects all of them. This chapter describes their common cycle. Subsequent chapters will describe the several species.

Very little is known about the behavior of the game cycle, and still less about its mechanism and causes. An investigation of the causes of fluctuation in ruffed grouse was started by the American Game Protective Association in 1924. This investigation dealt mainly with parasites. An astonishing variety of parasites was found in ruffed grouse, but which of them cause the cycle, or whether all of them merely accompany weakness induced by some other cause, still remains an unanswered question. Several additional investigations dealing with diseases, habitat, and history of cyclic species are now under way.

When the game survey was started in 1928, it was apparent that it could not undertake to add anything to these detailed scientific studies of possible causes. Such studies require highly specialized experts, working through long periods of time. It seemed probable, however, that the experts could make a better guess as to what to look for, and could better interpret the meaning of what they found, if the game survey compiled the available evidence on the general behavior of cycles with regard to species, geography, and time. It was believed that many observing sportsmen and game wardens would recollect certain facts and dates concerning behavior in their respective localities, which when compiled and analyzed, might enable administrators to predict recurrences, and also enable scientists to eliminate certain causes as inconsistent with behavior, and thus concentrate their labors on the remainder. Until science discovers the cause and mechanism of the cycle, all efforts to manage and conserve the cyclic species must necessarily grope in darkness.

The detailed study of behavior of the game cycle was confined to Wisconsin. It is hoped that similar studies of behavior will be made in other States.

The greater part of the Wisconsin information appears on Charts 7, 8, 9, and Map 12. The principal findings of the survey will be given first, and then the methods whereby the information was collected and interpreted, and an explanation of the charts and map. The succeeding chapters on the various cyclic species will present the findings and the evidence applicable to particular species, rather than to the cyclic group of species.

Throughout the presentation of findings on cycles, the text will distinguish between (a) conclusions supported by satisfactory evidence, and (b) indications supported by less conclusive evidence, or based on mere conjecture.

None of the conclusions are offered as final. The whole purpose is to stimulate more thorough thought and effort, not to supplant it.

Wisconsin Findings

All statements under this caption pertain to Wisconsin unless otherwise specified. Conclusions appear under (a), indications under (b) in each caption.

What Species are Affected?

(a) Ruffed grouse, pinnated grouse, sharptail grouse, and snowshoe rabbits now fluctuate violently, and to a large extent simultaneously, throughout their Wisconsin range, and apparently throughout the Lake States.

(b) The spruce hen, the only other present representative of the grouse family, seems to follow the same cycle, but it is rare in Wisconsin, and the information on it too meager to be conclusive.

The cottontail, the only other representative of the true rabbits, suffered severe mortality in northern Wisconsin during the last "low," and more moderate mortality in western Wisconsin at the same time. In eastern Wisconsin cottontails were sick, but apparently did not die.

The jack-rabbit, the only other representative of the hares, was not studied It showed severe fluctuation in certain localities about 1880.

How Long Has There Been a Cycle?

(a) Alternating highs and lows for all species lumped together were traced back clearly to a low about 1908. Behind that the evidence of synchronism is conflicting, possibly because there is not enough of it.

In ruffed grouse alternating highs and lows go back clearly to a high about 1891, and dimly to a high in 1880.

In prairie chickens alternating highs and lows go back clearly to a high about 1896. Snowshoe rabbits were traced back clearly to a low in 1913. Behind that no information was obtained. (Seton's "Artic Prairies," however, contains a graph based on Hudson Bay records, showing alternating highs and lows in Canada, which are clear back to a low in 1850.)

What is the Length of the Cycle?

(a) The lumped data for all species shows 8 years between the last two highs and 8 years between the last two lows.

(b) Farther back the data are less conclusive and subject to varying interpretations. The best interpretation I can make is 11 and 9 years between preceding lows and 14 and 11 years between preceding highs.

The above conclusions and indications are based on the following:

Length of Cycle, Wisconsin

Length between highs	High	Low	Length between lows
	1923	1927	
8 years			8 years
	1915	1919	
14 years?			11 years
	1901?	1908?	
11 years			9 years
	1890?	1899	
		1882?	

There were three cyclic periods between the low of 1899, the earliest conclusively dated low for all species, and that of 1927. This covers a total of 28 years, which when divided by three gives an average of a fraction over nine years. Three periods between the highs of 1890 and 1923 give an average of exactly 11 years.

Since, however, the last period is the best supported by evidence and is shorter, the working assumption that the cycle is of uniform 9-year length is followed in the discussions and graphs. It is not considered as proven that the cycle is of uniform length, or that the length is nine years.

The popular impression that the cycle is seven years long does not necessarily contradict the nine-year length here postulated. An "overall" length of 9 years would give about seven years between the *end* of one high or low and the *beginning* of the next high or low.

Is Any Territory Exempt? Mortality by Regions.

(a) No unit of territory as large as a county was exempt from cyclic mortality during the last low. (37 out of a total of 71 Wisconsin counties were visited in person, and some information was obtained from every county).

(b) The indications are that the last cyclic mortality was universal in all four species throughout the State, but was less severe in the south than in the north, and less severe on thinly populated and isolated range than on thickly populated and continuous range.

Heavy mortality seems characteristic of large and continuous ranges; lighter mortality on small and discontinuous ranges. No single spot, however small, was found or heard of in Wisconsin where no reduction in numbers had occurred in ruffed grouse and prairie chickens. For these species, and possibly for all species, the cycle appears to have been universal throughout the State. In Michigan and Minnesota, however, it is claimed that a very few small spots suffered no conspicuous decimation.

Per Cent Mortality by Species.

(a) Four Wisconsin samples of ruffed grouse population seem to have been 3, 30, 15, and 51 times as abundant in a high or medium year, as in the next succeeding low one of the last cycle.

(b) It is believed that the fluctuation from "normal" or average population density runs as high as 95 per cent in ruffed grouse and snowshoes, and as high as 75 per cent in prairie chickens.

That the per cent of mortality is higher in ruffed grouse than in prairie chickens is corroborated by an independent investigation made by W. B. Grange, who compiled the recollections of 70 State game observers. This compilation is presented graphically in Chart 9.

Lag Between Localities.

(a) In 33 selected localities studied during the survey and scattered over Wisconsin, ruffed grouse were hit by the last cycle in 30 localities between 1925 and 1927, and in none later than 1927. Some were hit as nearly as 1922. The year 1927 was the most frequent date of the first severe mortality.

Expressed in percentages, the lag in point of time is:

1922— 3 per cent of total localities	1925—15 per cent of total localities
1923— 0 per cent of total localities	1926—36 per cent of total localities
1924— 6 per cent of total localities	1927—40 per cent of total localities

Grange's game observers likewise reported the bulk of the mortality in both ruffed grouse and prairie chickens as falling in 1925, 1926, and 1927, with some evidence of continuance (in prairie chickens) in 1928. The bulk of the lag, as indicated by the horizontal recession of figures from the curves in Chart 9, lies mostly within a period beginning two years before and ending one year after the median curve or "most frequent" date.

(b) Since the last cycle shows a lag of at least three years within Wisconsin, with the most frequent date toward the end of the three-year period, and since fragmentary information from other States indicates a similar dispersion of dates, it may be said as a working assumption that the lag is so great as to almost obscure the cycle. It is only during the year when the median shows a peak that some localities are not low, and only during the year when the median shows a trough that some localities are not high.

Order of Mortality by Species.

(a) No clear evidence of any fixed order of mortality as between species was found during the survey.

(b) Of 15 cases in which mortality in two or more species was dated in the same locality, ruffed grouse fell off first in eight and prairie chickens first in five. Rabbits were never first, but cottontails in one case fell off simultaneously with ruffed grouse. The earliest species to fall off seems usually to be only one year ahead of the last. The order of recovery seems to be the same as the order of mortality.

Grange's independent investigation (Chart 9) indicates that prairie chickens began to decrease slightly before ruffed grouse began to decrease slightly, but the heavy decrease took place simultaneously in both species. Recovery began in ruffed grouse a year sooner than it began in prairie chickens. This supports the deductions drawn from the game survey.

The highs and lows shown by both investigations compare with each other as follows:

	High		Low	
	Leopold	Game observers	Leopold	Game observers
Last cycle—				
Ruffed grouse	1922	1922	1927	1927
Prairie chicken	1923	1921	1927	1928
Next to last cycle—				
Ruffed grouse	1915	x	1919	x
Prairie chicken	1915	x	1918	x

Order of Mortality by Sex and Age.

(a) No information sufficient to support conclusions was obtained.

(b) Several hunters reported that most of the ruffed grouse remaining during the last low were males, but their ability to distinguish sexes may be doubted. If they were males, the observation would indicate differential survival.

Length of Mortality Period.

(a) The most reliable observations on single localities all agree that the decimation in any one species in any one locality is seldom or never accomplished within a single year, but usually requires at least three years. Recovery requires a similar period.

(b) The indications are that the year of heaviest mortality is always preceded and usually followed by at least one year of lighter loss. If there is an exception to this, it is in snowshoe rabbits, which may sometimes fall off all within a single year.

Almost all of Grange's game observers reported both mortality and recovery during the last cycle to have required three or more years each in their respective localities. This held good in both ruffed grouse and prairie chicken.

The period of mortality over many localities has already been described under the discussion of "lag."

Season of Mortality.

(a) Mortality as indicated by sick, dead, or heavily parasitized ruffed grouse and prairie chicken took place during the last two cycles at various seasons of the year.

(b) Sick or dead birds seem to have been found mostly during the year of heaviest loss, but heavily parasitized birds seem to have occurred at least a year before and a year after. Sick or dead cottontails during the last cycle were found mostly during early winter.

These indications are of course no proof of the season at which most of the deaths actually took place in any species. It is to be expected that sick or dead individuals are most likely to be found during the hunting season, when observers are afield, and during the winter, when snow makes them more visible. They are not even proof that the cycle arises from deaths alone. Impaired reproduction supplemented by deaths would fit the facts also.

Geographic Peculiarities.

(a) The year of heaviest decimation in ruffed grouse at the extremity of the Door County peninsula was the same as, or earlier than, the year of heaviest decimation at the base of the peninsula and on the adjacent mainland.

Two islands in Green Bay, seemingly suitable for ruffed grouse, contain none at present and it is doubtful whether they ever did. Recovery of ruffed grouse on the Door County peninsula at the present time seems to lag behind recovery on the mainland.

(b) There is possibly some property inherent in insular and peninsular range which aggravates cyclic mortality, or supplements it by other kinds of mortality.

Relation to Goshawks.

(a) Of three goshawk appearances traced in Wisconsin since 1919, two coincide with lows in the cycle.

(b) All of these appearances were local in so far as known. In many localities no reports of goshawks could be found during the last low, even among ornithologists and taxidermists. This, in conjunction with the many instances of summer mortality when goshawks are absent, and the abundant evidence of disease, makes it seem improbable that invasions of goshawks constitute a primary cause of cyclic mortality.

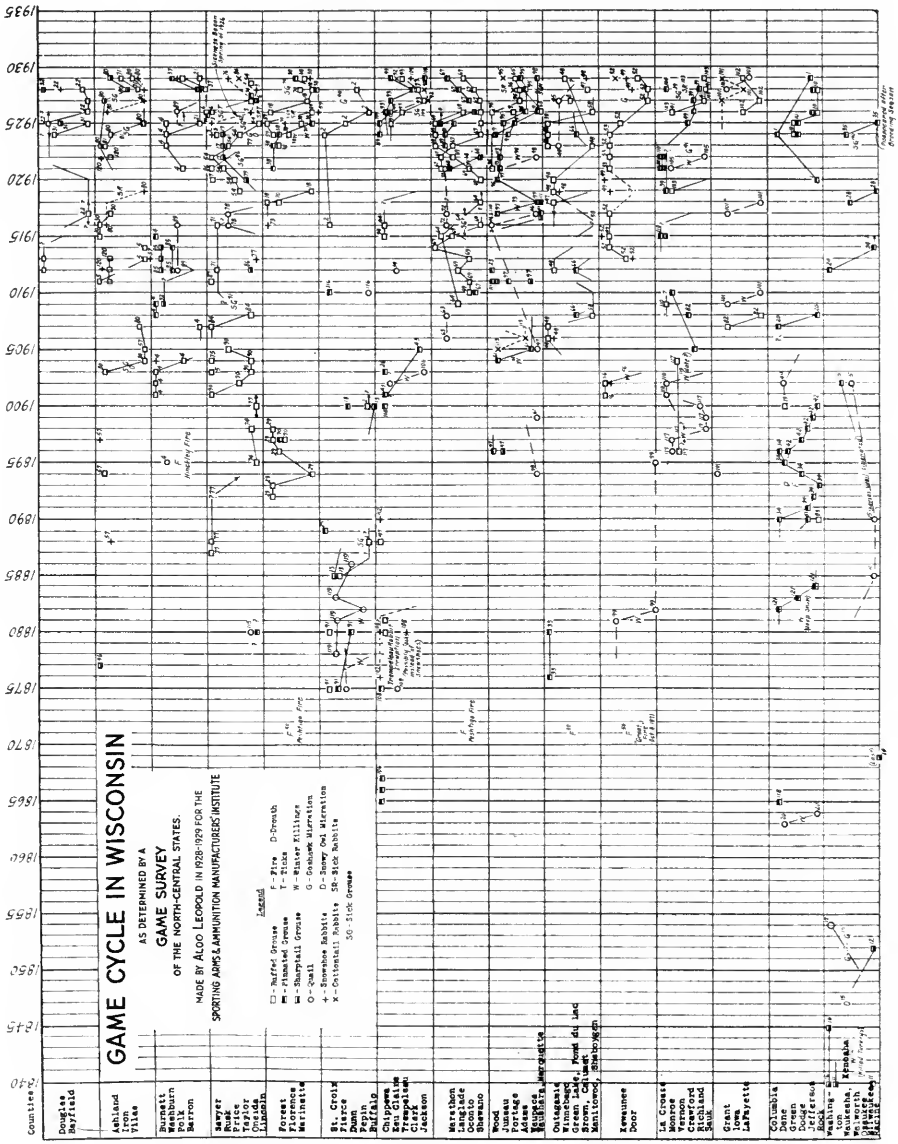
Discussion of Findings

Sources of Cycle Data: Explanation of Charts and Maps. Nearly all of the foregoing findings are drawn from the four basic charts and one map and the material to be subsequently presented in the chapters on cyclic species. The charts and map were obtained as follows:

Chart or Map	Data obtained	
	By	How
Chart 7	Leopold	Interviews with sportsmen and wardens
Chart 8	Leopold	Summation of 7
Chart 9	Grange	Questionnaire to game observers.
Map 12	Leopold	Shows geographically the sources of Charts 7, 8, and 9.

Chart 7: This merely graphs the recollections of selected sportsmen and game wardens. The recollection of good and poor hunting years was found to persist for a long time. The dating of those years was usually accomplished by cross-questioning the observer and leading him to associate them with some per-

CHART 7


GAME CYCLE IN WISCONSIN
AS DETERMINED BY A
GAME SURVEY
OF THE NORTH-CENTRAL STATES.
MADE BY ALDO LEOPOLD IN 1928-1929 FOR THE
SPORTING ARMS & AMMUNITION MANUFACTURERS' INSTITUTE
Legend
□ - Ruffed Grouse
■ - Pinnated Grouse
◪ - Sharptail Grouse
O - Quail
+ - Snowshoe Rabbit
x - Cottontail Rabbit
F - Fire
T - Ticks
W - Winter Killings
G - Goshawk Migration
D - Snowy Owl Migration
SR - Sick Rabbits
SG - Sick Grouse
D - Drouth
Counties
Douglas Bayfield
Ashland Iron Vilas
Burnett Washburn Polk Barron
Sawyer Rusk Price Taylor Oneida Lincoln
Forest Florence Marinette
St. Croix Pierce Dunn Pepin Buffalo
Chippewa Eau Claire Trempealeau Clark Jackson
Marathon Langlade Oconto Shawano
Wood Juneau Portage Adams
Outagamie Winnebago Green Lake Brown Calumet Manitowoc
Kewaunee Door
La Crosse Monroe Vernon Crawford Richland Sauk
Grant Iowa LaFayette
Columbia Dane Green Dodge Jefferson Rock
1840
1845
1850
1855
1860
1865
1870
1875
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935

sonal experience or public event of known date. Such "association datings" undoubtedly carry a probable error of one or two years, but this error probably does not increase greatly with the lapse of time. About one third of the numbered curves on Chart A are association datings.

Of the total of 119 observers, 17 based their observations on shooting journals, personal records as ornithologists or taxidermists, or published works. This constitutes about one sixth of the total.

The remainder, comprising about half of the total, are based on mere recollection. Such observations were not accepted, however, without checking the observer's statements against each other. It was found that many country people maintain a surprisingly complete mental chronology, based not on years, but on the number of years ago. The probable error in such recollections of course increases with elapsed time.

Chart 7 is divided horizontally into 15 geographic units, each consisting of a group of counties. The vertical position of any species symbol in any geographic unit indicates the status of that species during the year indicated by the vertical line. Thus a hollow square near the top of the 1912 line in the first (upper) unit means that ruffed grouse were "high" in the year 1912, while a hollow square near the bottom of the 1917 line means that ruffed grouse were low in 1917. "High" and "low" are not based on any numerical value or measurement, but rather on a general judgment of how the observer considered abundance during any certain year to compare with normal or average abundance for his locality. This is of course inaccurate, but the only way I could think of to use the recollections of observers. The scientific reader should not forget that the woodsman's daily observations at all seasons build up a much more reliable "standard" than his own sporadic "field trips." The hope was to get a sufficient quantity of observations to counterbalance the lack of a numerical scale.

Where symbols are connected by lines for a series of years, it represents consecutive observations in a single locality, either by a single observer or by several observers in agreement about that locality.

The number opposite each species symbol refers to an index giving names of observers and exact locality within the geographic unit. This index appears in the appendix, item (C). Thus the number "22" which appears on the graph above used as an example means (see Index) that Haskell Noyes is authority for it, and that it refers to the Brule River in Douglas County.

Where two or more symbols show high and low respectively in the same year in the same geographic unit, reference to the numbers will show that each pertains to a separate locality. There are any number of cases where various degrees of both high and low occurred simultaneously in the same unit or group of counties.

Where a graph begins or ends with a line having no species symbol at the end of it, it means that the observer remembered a rise or fall, but could not exactly place the time of its beginning or end.

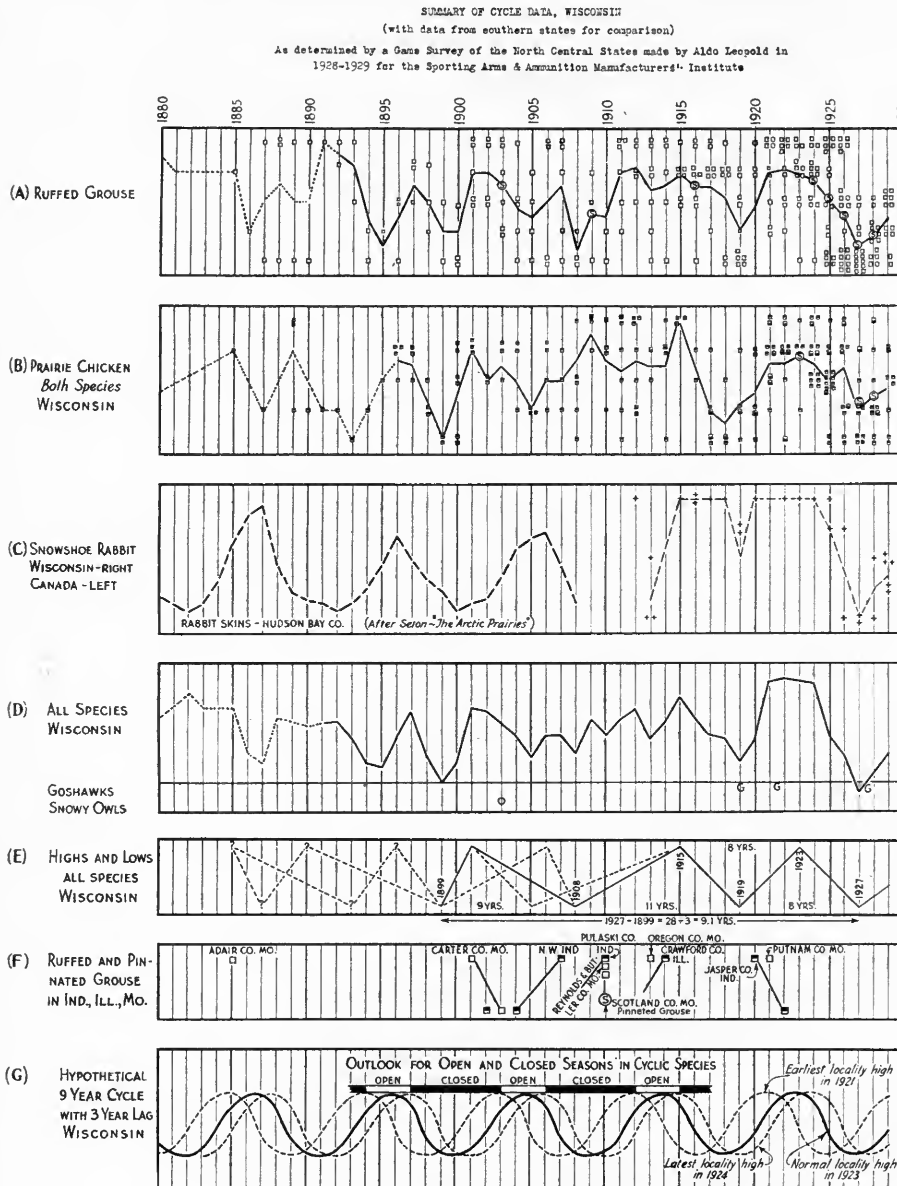


Chart 8

Chart 8: Sections A, B, and C represent all of the observations on Chart A added together and "averaged" for each year for ruffed grouse, prairie chickens, and snowshoe rabbits, respectively. The graph connects the points representing the greatest number of observations or the most frequent status reported for each particular year on Chart 7.. The extremes tend to cancel each other in a summation of this sort, and the resulting graph should not be construed as representative of any particular locality, or of the species in question for any one locality. These three sections rather represent the "net balance" for the State as a whole for each particular year, counting everything below normal as debits and everything above normal as credits.

In Section C no information was available on snowshoe rabbits back of about 1913. Hence a section of Seton's Canadian snowshoe graph is inserted for the period behind 1913 with his permission. (From his "Arctic Prairies," 1923, Charles Scribners Sons.)

Section D is a summation of all species similar to A, B, and C, for the separate species. At the bottom of Section D the known occurrences of goshawks and snowy owls are given by the symbols "O" and "G" respectively.

Section E is an interpretation of Section D, showing the alternative choices of what constitutes highs and lows, and at what point the choice begins to be in doubt.

Section F is a summary of the known status of ruffed grouse and pinnated grouse in the more southerly States covered by the survey. Its purpose is to see whether the southern States synchronize with the northern.

Section G is an idealized 9-year cycle showing the probable relation between the most frequent condition (solid line) and the lag or departure from it (dotted lines). It also shows the probable effect on open and closed seasons of the idealized or hypothetical cycle.

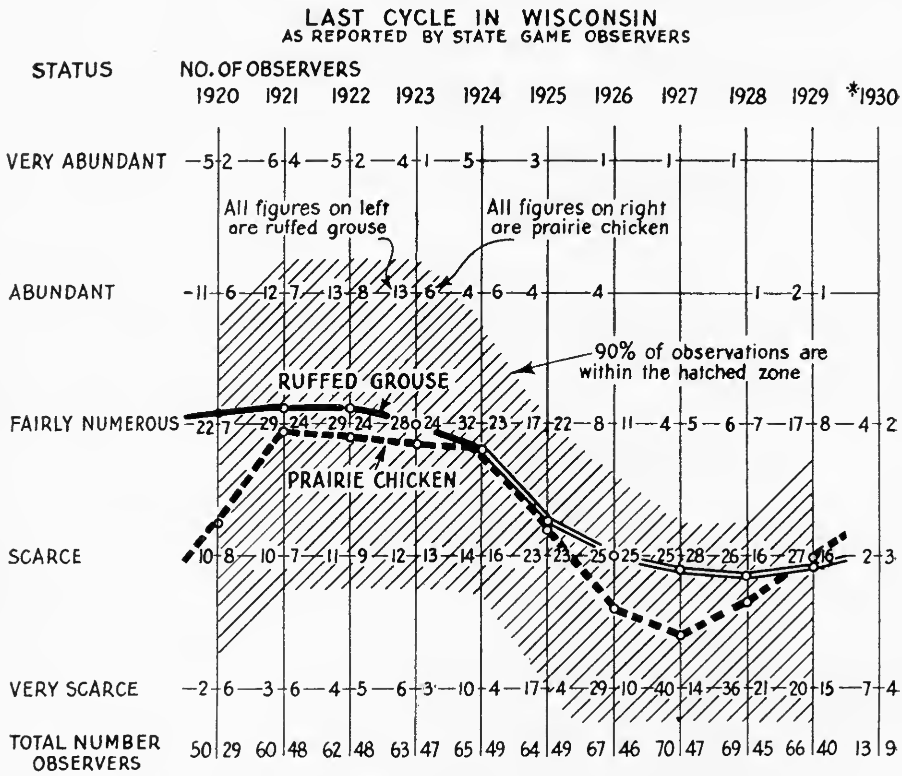
Since Chart 8 was prepared, some old reports of the State game commissioner have been found which check against Sections A and B as follows:

	Chart 8		*Old Reports*	
	Ruffed Grouse	*Prairie Chicken*	*Ruffed Grouse*	*Prairie Chicken*
1916	declining	very scarce	beginning to decline	sharp decline
1918	great increase	increasing	still declining	at lowest
1920	remarkable increase	remarkable increase	back to normal	back to normal
1924	declining	declining	beginning to decline	beginning to decline

The two records agree except as to the date of the next to the last low, which Chart 8 places in 1918 or 1919, while the old reports indicate it occurred in 1916 and 1917.

Chart 9: The numbers to the right of the vertical lines representing years show the number of observers reporting the status of prairie chickens for that year to be that indicated on the left margin of the chart. The numbers to the left of the vertical lines show the number of observers reporting the status of ruffed grouse to be that indicated on the left margin.

The heavy black lines connect the most frequent status during each year (except that a correction or "weighing" is made as explained at the bottom of the chart). Thus in 1920 five observers report ruffed grouse as very abundant, and two observers report prairie chicken as very abundant. In the same year 22 report ruffed grouse as fairly numerous, while seven report chickens as fairly numerous. The most frequent report of ruffed grouse is "fairly numerous" whereas the "most frequent" report for chickens is "scarce," hence the curves for the two species start at these two points.



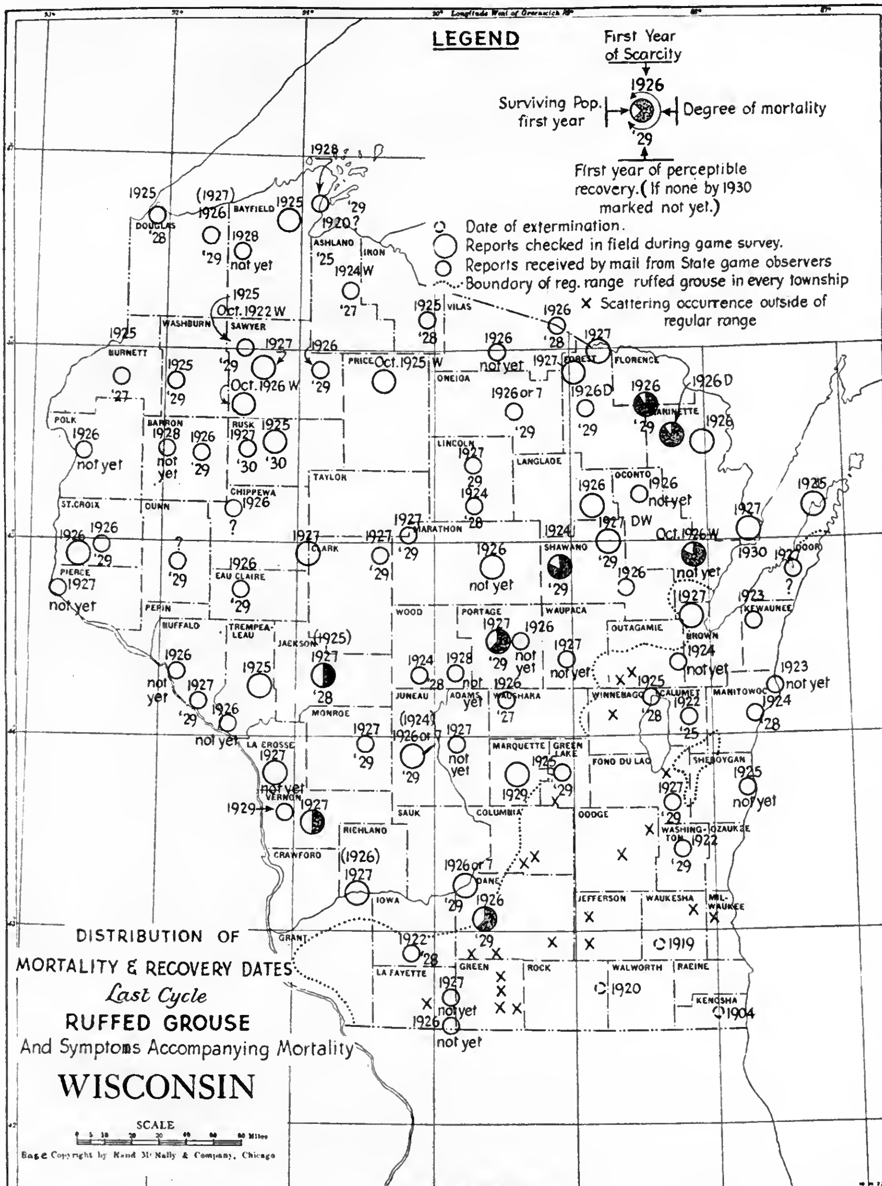
Note: Curves are weighted means. Each point calculated as follows: starting with most frequent abundance class, multiply next above by 1, next by 2, next by 3 etc. Add, divide by 4. Same for classes below. Subtract weight above from weight below. This gives departure from most frequent class.

* Very few reports covered 1930, hence data disregarded.

CHART 9

The hatched zone includes roughly 90 per cent of the total number of observations for each year. The hatched zone, in effect, indicates 90 per cent of the total lag shown hypothetically in Section H of Chart 8, but as determined by an investigation entirely independent of the game survey on which Chart 8 is based.

Map 12: This map gives some of the geographic locations from which Grange and the author obtained the data on the last cycle which are summarized in Charts 7, 8, and Map 12.



Map 12

The main purpose is to show the apparently random distribution of mortality and recovery dates, that is, the absence of any orderly progression of either mortality or recovery dates from any focus or center, or in any particular direction.

The large and medium sized circles designate the locations of my most important observers (source of Charts 7 and 8) and Grange's observers (source of

Chart 9) respectively. Only those of my observers who contributed the cleanest-cut dates, or per cent of mortality, are shown. In some cases, Grange's observers and mine were identical persons, but the approach to them was wholly separate, and these overlaps were not numerous enough to affect the validity of the statement that his findings on the last Wisconsin cycle corroborate mine on cycles in general.

The dark sectors of the large circles indicate the estimated degree of mortality, in per cent, by the end of the first year of pronounced scarcity. The remaining white sector is the estimated survival. The date above any large or medium circle is the year of first pronounced scarcity, and the date below it the first year of perceptible recovery. (From this map and the preceding charts any investigator can make his own analysis. It is hoped that some more competent biometrician will do this.) The very small broken circles are dates of extermination (see date to left, which gives the year last seen).

Map 12 repeats the boundary of the "regular range," to be given in Map 13, for the reader's convenience.

Possible Causes. Inferences on the possible cause and mechanism of the cycle are more properly drawn from continental than from State data. Accordingly the writer's reflections on this question will be presented in the proposed text on game management which is to follow this report. A preliminary discussion of possible causes and mechanism is being published by King and Leopold in a current periodical.

Present Status. The first State to reopen the season on any cyclic species after the last low was Michigan, which allowed a 11-day open season on ruffed grouse in 1929. Wisconsin and Minnesota will evidently not reopen on either grouse or chickens until 1931.

Such fragments of current information as are available at the present writing (October, 1930), indicate that recovery in both ruffed grouse and prairie chickens is more complete in Wisconsin than in Michigan and Minnesota. Ruffed grouse have also been seen this year in the Ozarks in localities not frequented in recent years.

Evidence Against Pre-1907 Cycles. As against the foregoing evidence must be set the unquestioned fact that most "old timers" do not remember old cycles, nor have the Wisconsin ornithologists recorded them. Dr. Alexander Wetmore, for instance, recalls no cycle during his boyhood in Sauk County, Wisconsin, from 1896 to 1904. This, however, is in the southern territory characterized by relatively mild fluctuations which might be overlooked, or ascribed to ordinary causes such as weather. Prof. R. A. Moore recalls no cycles in Kewaunee County from 1875 to 1895, but says that no species of grouse was ever abundant there, so that this may represent another case of inconspicuous low-amplitude cycle.

It seems probable that the non-recollection of cycles is due to human circumstances rather than to their absence in fact.

For instance, Hjalmar Blomberg, an old hunter of Prentice, Wisconsin, says that while he cannot date them, partridge cycles "go way back;" that when birds were scarce it was assumed they had "left the country" In the absence of quick communication and current periodical literature the individual observer had no way of knowing whether the birds were scarce elsewhere. For scarcity or abundance to be correctly interpreted, it must first be known whether it is local or general, and this the pioneers had no way of knowing.

To this day there are still hundreds of observers who ascribe the 1927 cycle to hunting, weather, predators, or other local causes. They are not aware of its continental proportions, or of its seeming disregard of variable local conditions, hence they are strictly within the rules of logic to accept the simpler and localized theory of causation. Once the geographic sweep of this great phenomenon is appreciated, however, the acceptance of locally variable factors as primary causes becomes intellectually impossible. In Wisconsin alone the factor of hunting, in the case of ruffed grouse, varies from very severe to none at all, yet during the 1927 depression the grouse were uniformly absent. Predators must vary widely, yet the grouse were as scarce where there are few as where there are many. Weather, indeed, is a factor often uniform over large areas, and some connection with weather has already been admitted as probable, but the shortages are too long to be readily ascribed to a single bad season, and too radical in degree to be accounted for by the failure of new broods. Moreover, it should be remembered that the cyclic shortages are the most radical in the most weather-proof of game species, namely, the bud-eating and snow-roosting ruffed grouse and prairie chicken. If weather, acting in the ordinary accepted sense, were the primary cause, why should not quail fluctuate more severely than ruffed grouse?

Cycles and Game Administration. To the extent that Section G of Chart 8 and the hatched zone in Chart 9 correctly interpret the future behavior of cycles, it indicates that an abundance of grouse may be expected to prevail only during about 3 years out of every 9, and these 3 years will be consecutive, with 6 lean years intervening. In short, Statewide open seasons will be justified only about one-third of the time.

Local abundance, possibly only of one species, may be expected for a year or two at each end of the lean period. Adjustment of the State's management policy to this extremely variable situation obviously demands not only the delegation of full regulatory powers to a competent conservation commission, but also the prosecution of a skillful and continuous game survey to keep track of local situations.

Legislative enactments fixing open seasons and closed areas on cyclic species are often out of date within a year. Thus there are certain counties in Wisconsin closed by statute for prairie chickens and ruffed grouse. These closures bear no relation to their present geographic variations in abundance. Doubtless the statute reflects some temporary aspect of the cycle in years past. Minnesota, with her alternate open years, once had a closed year fall on a cycle peak, and an open year on a year of mortality. As a result, her grouse went unshot during a year when they could amply withstand shooting, and were shot during another year when they should have been totally protected. Inflexible enactments have no place in the administration of cyclic game.

It goes without saying, of course, that Statewide closed seasons during the period of cyclic depression are absolutely necessary for the conservation of seed stock. In the southerly parts of the region, where the cycles are less violent and the cyclic species never attain widespread abundance even during peak years, a continuous closed season may be called for. Such closures, in fact, are already prevalent.

CHAPTER VI

RUFFED GROUSE

EXPLANATION of Map. The "present range" of the ruffed grouse, as shown on Map 13, is defined as range containing grouse in every township. The "scattering range" does not contain grouse in every township. The boundaries of both full and scattering range are believed to be accurate in Wisconsin except in the southwestern part of the State, where some of the regular range may possibly be better classified as scattering. The Minnesota range boundaries are accurate and are furnished by R. T. King, of the University of Minnesota. The boundaries in all other States are approximate.

In Ohio a questionnaire has been sent to game wardens by the conservation department asking them to report whether the species was present or absent in the county. A check mark indicates that they were present in 1928, the letter "N" that they were absent. This of course is second-hand information from a mixed body of observers.

Centrifugal Shrinkage of Range. This is the only non-migratory species covered in this report which originally ranged throughout all appropriate parts of the entire north central region. If its original exterior boundary entered the region at all, it did so on the prairies of northwestern Missouri and western Iowa and Minnesota. In the Ozark region its range extended across the Missouri boundary into Kansas. Widmann seems to have considered it absent from the extreme southern parts of Missouri, but the map shows that this is not now the case.

The species next most universal in distribution was the whitetail deer, but Shiras (1921) says deer were originally absent from the north shore of Lake Superior.

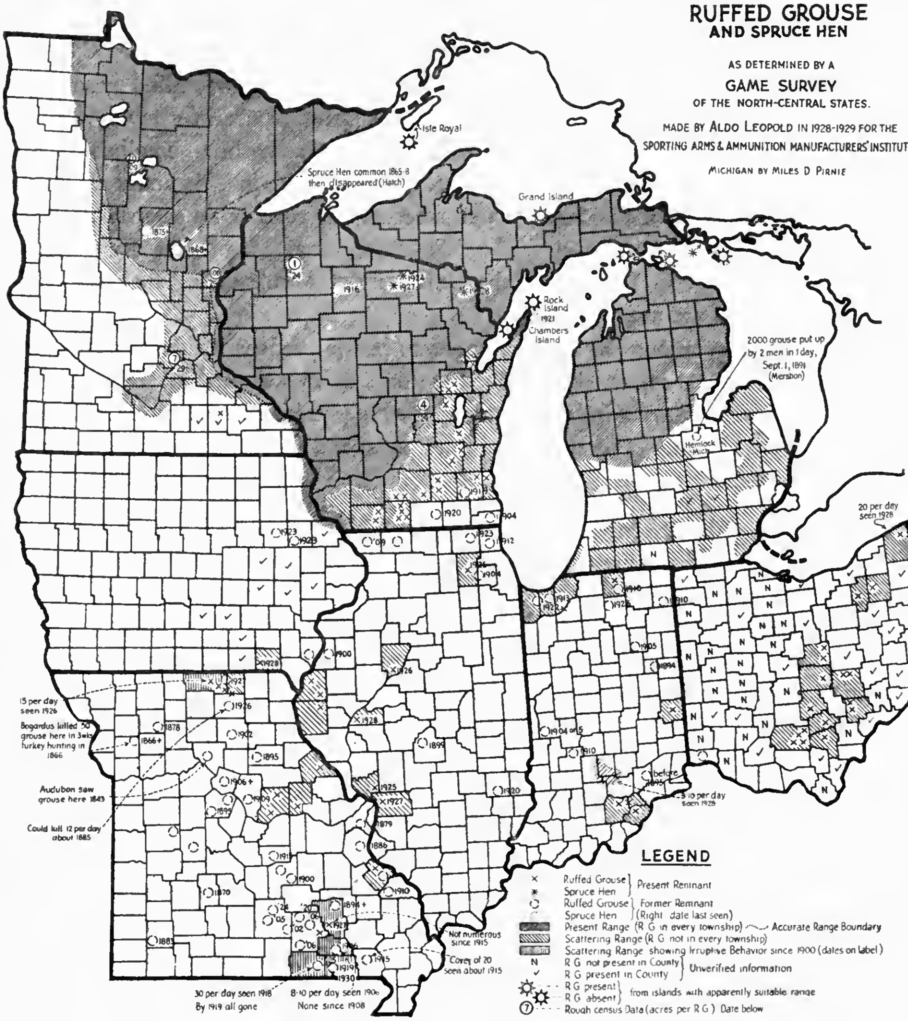
Map 13 shows that the present distribution of ruffed grouse is almost entirely confined to the northern, eastern and southern margins of its original range in this region. This centrifugal shrinkage may be of great import in the present cyclic behavior of ruffed grouse populations.

The extreme persistence of the species in the small remnants of ungrazed woodland along the river bluffs of Iowa, Illinois, and Indiana is strongly suggestive of a special "affinity" for this cornbelt range. An equal degree of deforestation in central Wisconsin would, I firmly believe, have exterminated the species long ago. I hold the opinion that the center of the north central region was the optimum range of the ruffed grouse, and that the bulk of its present distribution occurs on marginal (which is to say adverse) environments.

History. There are two questions of outstanding importance on which historical evidence is needed:

(1) How long have cycles occurred, and where?

(2) Where were the heaviest populations originally found?



MAP 13

The meager findings of the survey on the first question have already been presented in the chapter on cycles.

Of the second question it seems safe to say that ruffed grouse were originally abundant in the central part of the region where they are now scarce or absent.

Bogardus (1874) says:

"The ruffed grouse is . . . nowhere found in . . . such multitudes as the pinnated (grouse). It is most abundant in some parts of Wisconsin and the northwest part of lower peninsula of Michigan."

His definition of abundance, however, was probably a more generous one than we can now afford to entertain. In comparison with the north central region, he considers ruffed grouse as "sparse" in New York and New Jersey. He killed up to 15 per day in what is now Chicago, but infers that this represented a mere scattering. In 1866, during three weeks turkey hunting on Shoal Creek just east of St. Joseph, Missouri, he killed 50 ruffed grouse, just as a sort of incident to his major quest of turkeys.

Mershon (1923), writing of the region south of Saginaw Bay, says that 10 to 11 birds were his usual bag of a short day's hunt during his boyhood. He quotes a letter from C. E. Pettit, one of two former market hunters, who between them claim to have put up 2,000 birds in one day near Hemlock, Michigan, in 1891. Pettit recalls that if a market hunter killed less than 25 per day, he would sneak them into the store, which presumably purchased his kill, by the back door in order to avoid ridicule. The market hunter's usual bag was up to 40 birds per day per man. The traffic lasted up to 1894, when market shooting of grouse was made illegal in Michigan. They were still very plentiful in the Saginaw region in that year.

The observations of both Bogardus and Mershon fall within the central part of the range, from which the species has now been largely excluded by agricultural development. Neither author mentions periods of scarcity as prevailing in those days on this central range. Jack O'Hara, born in Rock County, Wisconsin, 1857, told me that as a boy he often found six to eight broods of ruffed grouse in a single grove or woodlot in the vicinity of Janesville, where now there would hardly be one bird to ten woodlots.

All of this evidence indicates that the ruffed grouse was once abundant in the agricultural belt, and there is at least an inference that it did not fluctuate in abundance. Constant questioning of old-timers during the survey failed to glean a single report of fluctuation in this central region, whereas hundreds of such reports were gathered for the marginal range (see Chart 7). It is only fair to say, however, that these were mostly recent, whereas the species has recently been so scarce in the central range that fluctuations might pass unnoticed.

Was the ruffed grouse originally more or less abundant in the Agricultural Belt than in the Forest Belt? On this highly significant question I have but one fragment of information. Hatch (1892) quotes Washburn as finding ruffed grouse "less abundant in those portions of the State (Minnesota) that are occupied by Canada grouse," meaning of course, the northern portions.

Bogardus' general comparison of abundance cannot be admitted as evidence here, because he was probably unfamiliar with the real north woods.

Population Density and Fluctuation. Hundreds of inquiries during the survey netted only two observations reducible to number of ruffed grouse per acre.

During the high year of 1924, W. W. Cooke made a covey count on 20 acres of his land near Spider Lake, Sawyer County, Wisconsin. He found five covies of six each, or 30 birds, or 1.5 birds per acre. The area was so small, however, that the count can hardly be admitted as valid evidence of maximum density. The count may have represented a temporary concentration of the kind common on small areas in all gallinacious birds.

During the low year 1929, Clyde Terrell estimated 25 to 40 birds on 50 acres of woodlot cover on his farm in Waushara County, Wisconsin. This is one bird per 4 to 6 acres.

TABLE 27.—*Per cent of mortality in ruffed grouse, Wisconsin*

Observer and locality	Year	Month	Description
Moore, Forest County	1924	Fall	Too numerous to count on a certain area near his cottage.
	1926	Fall	Dying.
	1927	Fall	4 birds counted.
	1928	Fall	24 birds counted.
	1929	Fall	60 birds counted.
Burr, Florence County	1925	October	Found 200 in a certain territory.
	1926	October	Found 7, mostly old cocks, in same place.
Hornberg, Portage County	1925	?	Counted 52 on 2½ miles of road.
	1927	?	Counted 18 on same road, same season.
Kinziger, Oconto County	1910	Open season	29 killed.
	1911		20 killed.
	1913		21 killed.
	1914		102 killed.
	1915		76 killed.
	1916		2 killed.
	1917–19		0 killed.
	1920		? killed.
	1921		20 killed (and 23 prairie chickens)
	1922		25 killed (and 23 prairie chickens)
	1923		[1]25 killed (and 25 prairie chickens)
	1924		[1]25 killed (and [1]25 prairie chickens)
	1925		[1]25 killed (and 21 prairie chickens)
	1926		8 killed (and 12 prairie chickens)
	1927		0
	1928		Closed

[1] The legal limit. Birds plentiful enough to have made possible a much larger kill.

During the low year 1929, R. T. King, the institute fellow at the University of Minnesota, made a census showing about one bird per 80 acres on a large tract in Pine County, Minnesota. This census is relatively accurate, but being made during a low year, it throws no light on the crucial point of maximum density.

Rough measurements of fluctuation between years are obtainable without a determination of density, and hence are more numerous. The findings are summarized in the Table 27.

The first three observers counted grouse on the same tract or route in different years. The last is a bag record, but must be interpreted in the light of the legal season limit of 25 birds, which prevents the kill figures for the high years, 1923–4–5, from showing the full difference in population as compared with low years.

The Hornberg count shows three times as many birds on the same road in a high year as in a low one, the Burr count 30 times as many on the same tract, and Prof. Moore's count as 15 times as many in a medium year as in a low one. The Kinziger journal shows 51 times as many birds killed in a high year (1914) as in a low one when hunting was done (1916), although it is improbable that the hunting was as intensive in the latter case.

These counts, taken in conjunction with a great number of general impressions gathered from less compete evidence, convince me that the cyclic fluctuation in ruffed grouse runs in excess of 90 per cent above and below normal or average, in high and low years respectively.

The vital question of whether or not the species has a saturation point must go unanswered as far as evidence is concerned. Mershon's statement, however, that market hunters saw as high as 1,000 birds per man per day, plus a good many other mental impressions, leads me to suspect that this species, which fluctuates the most violently in abundance, is the least subject, at least in the Forest Belt, to that limit of density which has elsewhere been called the saturation point.

Symptoms Associated with Mortality. The symptoms listed in Table 28 were observed by laymen, and are therefore not to be accepted as establishing the identity of any parasite or disease. The table is nevertheless valuable in indicating that diseased birds occur at all seasons of the year, and that parasites are conspicuous before heavy mortality has set in.

One other significant observation could not be expressed in tabular form: Prof. R. A. Moore, head of agronomy in the Wisconsin Agriculture College, states that during the mortality years 1925 and 1926, near his cottage at Armstrong Creek, Forest County, Wisconsin, such young birds as he saw during the summer *had not grown to normal size.* In short, he claims a stunted growth.

Peculiarities of Distribution. The cause of cyclic fluctuation in ruffed grouse is still such a total enigma that it seems worth while to set down any

TABLE 28.—*Symptoms associated with mortality in Ruffed-grouse, Wisconsin*

Observer	County	Year	Month	Description
Stigelbauer	Forest	1926	?	Dead on road. Grubs under wings
Moore	Forest	1925 1926	? ?	Found five or six dead. Found one dead.
Bietz	Marinette	1928	Early spring	Found two dead; very thin.
Schoenfeld	Price Iowa	1924–5 About 1907	October ?	Found dead partridge; also wormy ones. Found some worms in partridges. Cream colored, diameter of toothpick. 1 to 3 inches long, very sharp on ends, near lungs under backbone in body cavity.
Lackie	Sawyer	1926?	October	Found roundworms and emaciated young grouse. Young birds had more worms than old. Worms crawled out of dead bird into hunting coat. Birds not scarce till following year.
Kade	Shawano	1927	August	Saw five birds, all old, huddled up. Could catch by hand. Didn't notice ticks or emaciation. Also found two dead birds. Indians said they had seen this before.
Ledvina	Shawano	1918?	?	Partridge abundant but contained worms 2 inches long, semitransparent, with joints like a cornstalk, just under skin in abdominal walls. Intestines irritated. Some were sick—not wild or strong.
Kinziger	Oconto	1925?	October ?	Partridge very thick and full of pin worms. Some couldn't fly. Still wormy in 1927.
Robinson	Langlade?	1924?	October	Shot several partridges with swollen heads and eyes running. No ticks. All hens as near as can remember. Were poor but active. Opened these but saw no parasites.
Mrs. A. J. Robinson	Oneida	1919?	January	Her father brought her a partridge he had caught. Thin and droopy. Bird died.
Dunn	Ashland	1924	October	Partridges poor and grubby.
Swift	Sawyer	1921 1922	? ----------	Picked up weak birds which couldn't fly after being flushed once or twice. Worms noticed. These looked like spaghetti. Were sharp on both ends, firm and hard to bend. In body cavity (and stomach?).

miscellaneous peculiarities of distribution and behavior which might assist some other investigator.

Widmann, in giving the distribution of grouse in Missouri, says that the species is "never found on the wide ridges of the Ozarks." Just what he means by "wide ridges" is hard to tell. Possibly he means that it is confined to the broken slopes, but this distinction is not very evident on the ground.

The disappearance of the ruffed grouse from the northern counties of Illinois and southeast Wisconsin, compared with its persistence in the riverbreaks of west central Illinois (see Map 13) indicates a preference for broken ground in what is now the Agricultural Belt. That it has no such preference in the Forest Belt is, I take it, well known.

There is a puzzling absence of grouse from many islands in the Great Lakes which are said have the appearance of being excellent range. (See Map 13.) In Lake Superior they are absent from Isle Royale, although there are a few on Grand Island. In Lake Michigan they are absent from Mackinac, and from Chambers and Rock Islands in Green Bay. They were absent from Washington Island, until planted there in 1900 by Deputy Warden William Barnhard. In Lake Huron they are absent on Drummond and Espanore (but spruce hens formerly occurred on Espanore and are now common on Drummond). Ruffed grouse are found on Bois Blanc, Round Island, and the Les Cheneaux group. It would appear that the smaller the island and the further from shore, the less the probability of ruffed grouse. It should be noted, however, that even the small islands contain units of seemingly suitable range very much larger than the woodlots in which the species successfully persists, in apparent isolation, further south. The recent scarcity of ruffed grouse on the extreme tip of Door County peninsula, and their failure to as yet recover from the last cycle, may parallel their absence from the islands.

It seems possible that islands and peninsulas are unduly exposed to migrating hawks. On islands it is also possible that some old cycle made a clean sweep.

Skipped Cycles. According to Oscar Nelson, of the State Game Farm at Fish Creek, Door County, Wisconsin, ruffed grouse were "very abundant in Door County about 1902. They fell off, due to a hard winter, and were found dead both on and under the snow when it melted in the spring." He says they have been scarce ever since.

Speaking in terms of population curves, this behavior means that the curve fell off to a trough, and stayed there, instead of climbing back to a peak. This abnormal behavior may be designated as a skipped cycle.

The same behavior was found in Sheboygan County, where Anderson and Kade told me that ruffed grouse fell off about 1919, and have stayed down ever since. The normal high occurred in the nearby Green Bay in 1923–24, but not in Sheboygan County.

Ledvina told me that a high period near Mountain, Oconto County, Wisconsin, beginning 1909 and ending 1915, was still low in 1922. This possibly indicates that the 1924 high was skipped, although it may have been merely retarded and not yet visible in 1922.

Kean told me that the birds near Stanley, Chippewa County, fell off in 1918 and did not fully recover during the high period 1923–25.

Schueler reports that the last high near Tomah, Monroe County, was in 1909; that the birds have never been abundant since then. Evidently two highs were skipped here.

All but two (Door and Oconto Counties) of these reports of skipped cycles pertain to localities in process of recent agricultural development, which of course includes the grazing of woodlots. It may be that the phenomenon of skipped cycles is characteristic of range in process of being broken up into small parcels.

Ozark Irruptions. Map 13 shows five counties in Missouri where ruffed grouse have been at times common or even abundant. I could find no evidence, however, that these periods of local abundance held good throughout the State. Two counties showed simultaneous abundance in 1915, but otherwise the dates are all different and apparently all local. Further evidence that the species was in recent times never simultaneously abundant throughout the State is the fact that many otherwise well posted sportsmen did not know of its existence in the State.

The present Missouri behavior must therefore be designated as locally irruptive, rather than cyclic.

It is of interest to note in passing that the southern Appalachians, which contain the only other large body of habitable territory lying on the southern edge of the ruffed grouse range, are known to exhibit violent fluctuations in this species. Whether these are local and irregular, or general and periodic, is not yet known.

Ruffed Grouse and Grazing. The distribution and abundance of ruffed grouse in southern Wisconsin is in inverse ratio to the development of the dairy industry, and the woodlot grazing which accompanies it. Where the woodlots are small, few, and grazed, there are no grouse. Where the woodlots are large, frequent, and ungrazed, grouse occur. (Compare the Wisconsin grouse distribution on Chart 9 with the line of heavy woodlot grazing on Map 8).

On the other hand there is every reason to believe that the spotty grazing which occurs around the scattered farms in the Forest Belt is actually beneficial. Here grazing plants clover on the old tote-roads, provides dry open spots for use during rains, and in general increases the total mileage of boundary between woodland and open land which, as every grouse-hunter knows, is the yardstick of quality in grouse range, provided only that the soil be good.

But when this northwoods grazing becomes too universal, the grouse disappear. The numerous sheep farms now developing in the transition type of Minnesota are pushing the grouse boundary back into the timber over wide areas.

These contradictions in the effect of grazing are merely the repetition of the ancient paradox that "virtue, grown into a pleurisy, dies of its own too-much."

The happy medium is the fundamental principle of game ecology, and the basic rule of game management. The skilled manager is one who knows what the happy medium is for each species, and how to get it.

Winter Losses. A severe sleet is said by Kinzinger to have killed most of the grouse in Oconto, Calumet, and Oconomowoc Counties, Wisconsin, in 1917. 1917 was of course a year of cyclic mortality, which leaves an unanswered question whether the loss was caused by the sleet or by disease. The alleged winter loss in Door County in 1902, described by Nelson, mentions dead birds being found on top of the snow. This is some indication of disease, it being the common opinion that grouse dive into the snow to roost in very severe weather, unless prevented by crust.

Sutherland reports that near Janesville in Rock County, Wisconsin, "the winter of 1863 killed all the quail and many of the partridges (ruffed grouse). Partridges have stayed scarce ever since." As a matter of curiosity it may be noted that a nine-year cycle, projected backward from the earliest known mortality in 1881, would fall in 1872 and 1863. This conjecture of course proves nothing.

These observations collectively, however, suggest that some of the alleged winter killings may represent cyclic mortality. The ruffed grouse being an habitual budder and roosting under snow, makes it improbable that it is ever devoid of food and roosting shelter, except when heavy sleets crust the snow and also cover all the buds. Whether buds alone are sufficiently nourishing to sustain the bird over long periods remains an open question.

Predators. Superintendent Hopkins, of the Moon Lake Refuge, Fond du Lac County, Wis., removed 150 horned owls from the refuge during the past three years without perceptibly increasing the resident population of about 20 pairs of ruffed grouse.

Stoddard found the remains of many ruffed grouse killed by goshawks in Sauk County, Wisconsin, during the invasion of 1905–06 (or 1906–07). Taxidermist Ochsener, of Sauk County, mounted three goshawks in 1927–28. The largest flight he can remember yielded seven, but he cannot date this.

Harold Wilson, an experienced ornithologist, has seen but one goshawk in Door County, Wisconsin. This was in 1927.

Taxidermist Slusser remembers only one big flight in Oneida County, Wisconsin. This was 4 or 5 years ago (about 1925).

H. C. Sturdevant, an experienced ornithologist, has never seen a goshawk in La Crosse County, Wisconsin.

All known invasions of goshawks in Wisconsin are shown on Chart 8.

Since ornithologists and taxidermists are the persons most likely to know of goshawk invasions, it would appear from the scarcity of records that invasions are much too local and infrequent to account for the periodic Statewide decimation in ruffed grouse, although goshawks doubtless accentuate the shortages where and when they occur. It has already been noted that the flights tend to occur during shortages. My data do not prove this conclusion, but they support it, and it has long been recognized as a fact in other States.

Spruce Hen. The spruce hen or Canada grouse is hardly a game bird, except in the sense of being edible. Its close relationship to the ruffed grouse, however, justifies a short summary of its history and status.

That it was originally more abundant than ruffed grouse in parts of the Forest Belt is indicated by Hatch's statement, already quoted. It evidently shrunk northward at an early date, since Hatch (quoting Garrison) says that it was common on Mille Lacs, Minnesota, from 1865 to 1868, but was soon after exterminated in that locality. The most southerly recent occurrence in Wisconsin was in Door County, where it was seen in 1921.

During the past few years many writers have expressed apprehension about the extermination of this species in the Lake States. These writers fail to take into account the cycle, and the probability that the spruce hen is affected by it. In 1930 the species was decidedly common on Drummond Island in Lake Huron, following a preceding period of shortage, and also in parts of northern Wisconsin.

The cutting of pulpwood in spruce swamps, often to extremely small diameter limits, is undoubtedly seriously restricting the available range.

Seasons on Ruffed Grouse. Chart 10 shows the open and closed seasons since 1900.

The chart clearly reflects some of the conditions deduced from other and separate evidence in this and the preceding chapter. It shows, for instance, nearly universal closure during the lows of 1917–18 and 1927–28. It shows the lesser severity of the cycle in the southern tier of States. It shows how Minnesota's alternate year closure stopped hunting during the high year 1923, while Wisconsin had only a few days open during the whole period of the 1924 high, and remained open during the mortality year of 1927.

Further proof of the need of elasticity in seasons for cyclic game, and the need of continuous game surveys to keep track of field conditions, should be unnecessary.

What Nobody Knows. Until we know what the cycle is, and whether, where and when grouse have a saturation point, we cannot understand either grouse, or gallinaceous game in general, either in this region or elsewhere.

But entirely apart from these deep and admittedly difficult questions, we also lack information on the common everyday A B C's which underlie successful management.

What is the daily, seasonal, and yearly radius of movement of the individual bird? Nothing is known, nor will it be, until successful methods of trapping for banding have been developed. How can we intelligently build refuges until we do know?

What do grouse eat? Judd (1905) has compiled a general cross-section, while Allen (numerous papers), Gross (1928), and Bump (1930), have built local lists for the northeastern States, but in the north central region we must still guess. How long can grouse live on buds? At what seasons must they drink? What is the relative weight of their predatory enemies? How polygamous are

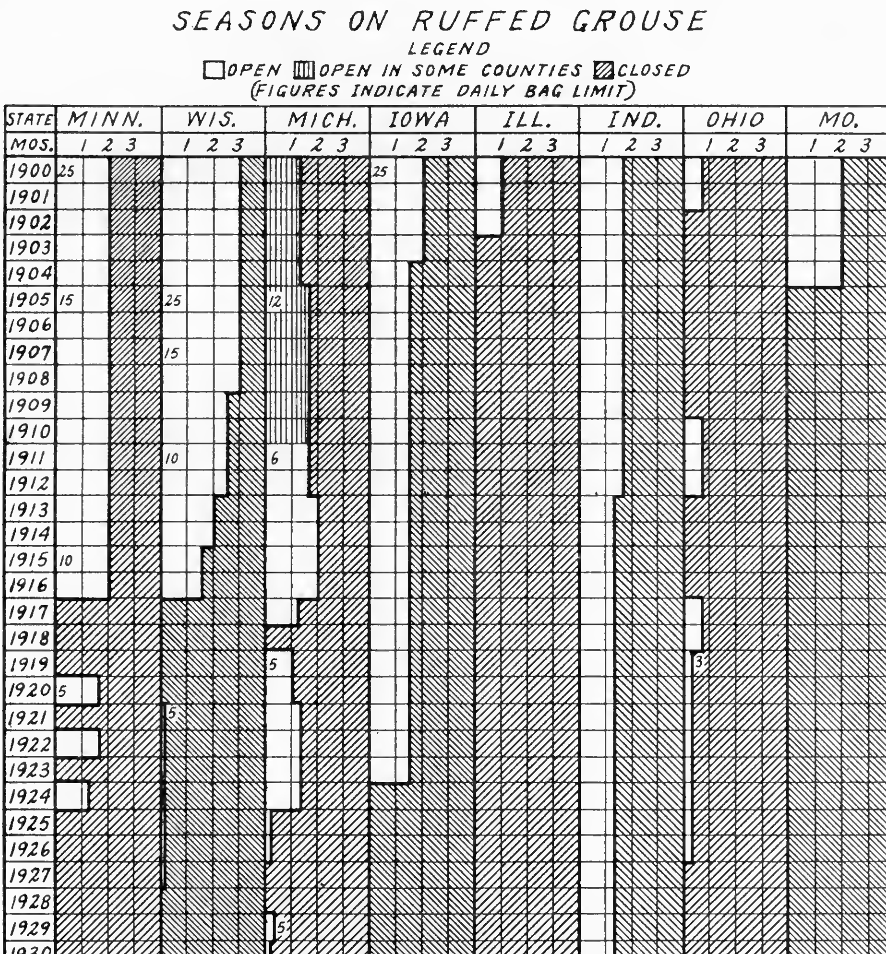


CHART 10

they? What is the composition of the ideal range? Just how does lumbering, grazing, and fire affect it? All these questions remain largely or totally unanswered. The conservation movement is barely even beginning to admit it does not know, and still devotes 90 per cent of its energies to the comparatively trivial question of how to divide up the accidental crops which nature produces in spite of our ineptitude.

Management Program. Insufficient knowledge is of course no excuse for not applying what knowledge we have. We know that for sporting qualities the ruffed grouse shares with bobwhite the top place in our list of small upland game.

We know that fire, the axe, cow, plow, and gun determine his future, and are of our own wielding.

We know that we must either own the land, or control the use of these agents on the land owned by others, to produce a grouse crop.

Public acquisition of grouse land is started in many forestry departments, but is as yet receiving inadequate support from sportsmen.

A tax differential on ungrazed woodlots is in effect in Indiana, but few sportsmen, there or elsewhere, think of it as fundamental to grouse conservation in all farming regions.

Petroleum, coal, and steel are rapidly making the woodlot a useless appendage to the farm, which must be grazed grouseless to pay its "keep." Sportsmen should realize that a wood-burning gas plant for farms, or even an efficient wood-burning furnace, would do more to keep woodlots, and hence grouse, on the map of rural America than many new laws or sermons on conservation. Industrialization can only be fought with its own weapons.

These fundamental counter-moves can well be gotten under way while we are learning the biology of grouse. Then when we know just what to do, we shall have some coverts to do it in, and tools wherewith to work.

CHAPTER VII

PRAIRIE CHICKENS

History, Distribution, and Abundance

THE term "prairie chicken" is here used in the same sense as it is used by most sportsmen, namely, as inclusive of both pinnated and sharptail grouse.
most sportsmen, namely, as inclusive of both pinnated and sharptail grouse.

Where differentiation is possible, the separate specific names are used. When the species is in doubt, the inclusive term is used. This is necessary because the information available from old-timers seldom differentiates between species.

Is the Prairie Chicken "Hopeless?" In every State of the north central region except Wisconsin, the restoration of the prairie chicken is regarded as a "lost cause." The trend of the evidence to be here presented is to the contrary. It indicates that chickens respond even more readily than other cyclic species to management measures.

The conservation movement has no right to discard these magnificent game birds when no real effort, other than ill-enforced closed seasons, has as yet been made in their behalf.

Original Distribution; Northward Shift. Kumlien and Hollister (1903) say of the pinnated grouse:

> "The prairie chicken seems to have moved westward with the settlement of the country. In the early forties it was rather rare in southern Wisconsin and at the present time has almost entirely replaced the sharptail."

Of the sharptail they say:

> "The sharptails seem to be rapidly giving way to the prairie hen (pinnated), a species better adapted for life, in a settled country. Referring back to 1840, we find that this species was the common prairie grouse of southern Wisconsin and at that time was extremely abundant."

This reliable summary of the northward shift of the two species in southern Wisconsin is based on the recollections of Kumlien's father, the ornithologist, Thure Kumlien who settled in Walworth County in 1834, but did not see any pinnated grouse until several years afterward.

Ridgeway, writing in Field and Stream for October 9, 1879, corroborates Kumlien and adds some interesting details concerning the sharptail:

> "In 1840–45 this species was abundant in southern Wisconsin and northern Illinois as far south as Chicago, always frequenting the timber, which gave it the name of 'burr-oak grouse'."

Nelson (1887) says that a covey of 14 sharptails was shot at Waukegan, Illinois, in 1853 or 1854. This marked the end of the sharptail in Illinois.

The net conclusion to be drawn from these authorities is that the two species originally overlapped in a zone extending from what is now Chicago to the south boundary of Wisconsin. North of this overlapping zone everything was sharptail; south of it everything was pinnated. The sharptail occupied the "oak openings" of the till plain; the pinnated lived on the original prairies of the prairie, riverbreak, and upper Mississippi types.

The respective boundaries farther west are not quite clear. Hatch (1892) says of the pinnated:

"When the white man first came to Minnesota these birds were by no means common. Rev. E. G. Gear . . . stated that prairie hens were seldom seen at first but after . . . (settlement) . . . increased . . . from year to year. Blackfoot grouse (sharptail) were the dominant grouse . . . but were never found on the open uncultivated prairies."

Of the sharptail Hatch says:

"Thirty years ago distributed over nearly the entire state . . . (it) withdraws before agriculture."

Unfortunately Hatch does not record just where "prairie hens were seldom seen at first," but the Rev. Mr. Gear, his informant, became Chaplain at Fort Snelling (now St. Paul) in 1839. It may reasonably be inferred that he speaks of that place and that time.

We have here then, in the locality of St. Paul, a second, albeit somewhat blurred, location of the original overlap between the two species. The pinnated was uncommon, or possibly even absent, when the St. Paul region was first settled. North of St. Paul everything was sharptail.

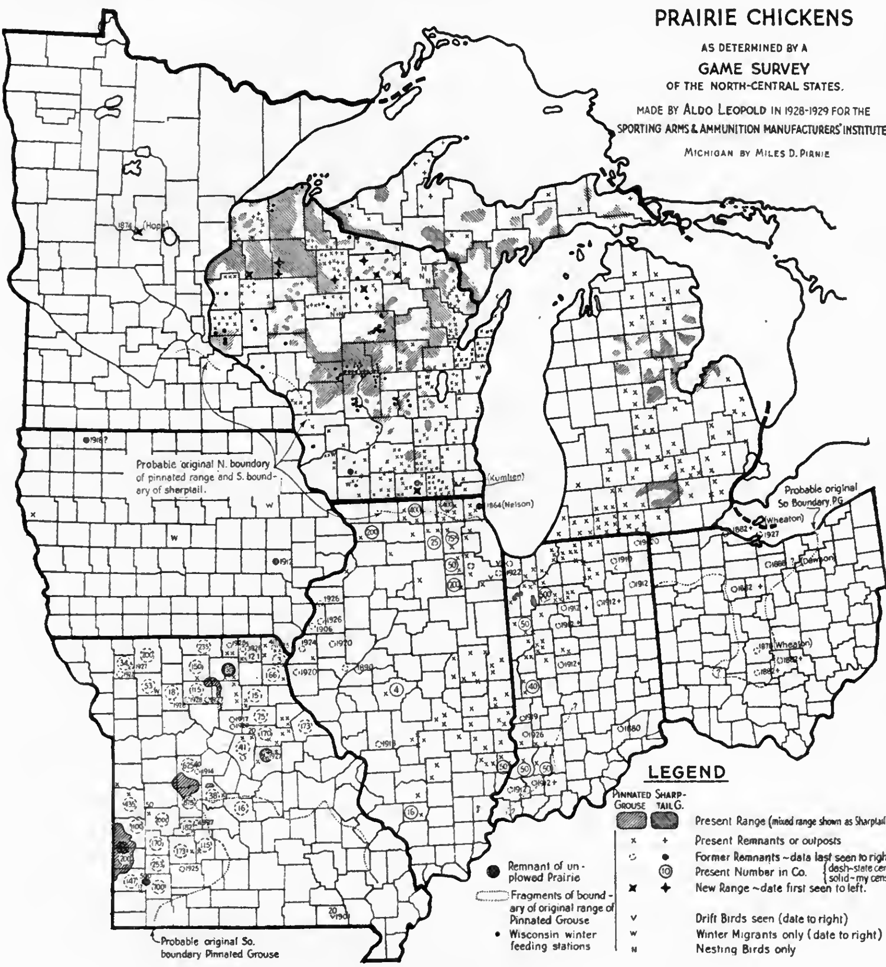
The remainder of the overlapping range is conjectural, but it probably extended westward rather than northwestward from St. Paul, since Clate Tinan (1906) implies that the pinnated was not originally found in South Dakota.

The pinnated grouse may have been native to the mouth of the Trempealeau River, opposite Winona, Minnesota. John Schmoker of Fountain City, Wisconsin, told me he had lived there since 1864, and regards it as native.

The original eastern boundary of the pinnated grouse extended east into Ohio. Dawson (1903) says it was "formerly not uncommon in the northwest . . . rare in central Ohio. Now probably extinct." Wheaton (1882) says the pinnated is a "rare resident in the northwest and central Ohio. Probably breeds." He gives the counties in which the then remaining remnants were found. These are shown on Map 14.

The original western and southern boundaries of the pinnated grouse range lay well beyond our north central region. It was found in vast numbers on the Grand Prairie near Stuttgart, Ark., in 1887. Audubon's description of it in Kentucky is well known.

This original distribution of the two species is of more than academic import. Without it we cannot distinguish acquired range from original range. This is essential in diagnosing the behavior of populations, and in appraising the opportunities for management.



MAP 14

The present distribution of the two species in Wisconsin is accurately shown on Map 14. This Wisconsin map is a combination of one drawn by Leopold, and data gathered by Gross and Schmidt for the Wisconsin Prairie Chicken Investigation, a preliminary report of which is about to be published. Both species now extend to the north boundary of Wisconsin, and both are found in suitable localities throughout Minnesota and the upper peninsula of Michigan but the distribution in Minnesota was not mapped. This extension into northern Michigan and Wisconsin represents a northward shift of over 300 miles for the pinnated grouse. Hence it is obvious that the bulk of its present distribution and numbers in this region occurs on acquired range.

A southward shift seems likewise to have followed in the wake of the clearings. Cockrum, in his "Pioneer History of Indiana" (1907), says: the prairie hen

". . . was quite common up to 40 years ago in the prairie sections of the State and in the timbered region for many miles around the prairie, but there are now very few to be seen."

Cockrum clearly means that the pinnated grouse followed the clearings into the forest, as they became large enough to offer suitable range. During the survey I learned that in 1880 this penetration had extended as far as Jennings County, which is far south and east of any original prairies. That it did not extend any farther in Indiana is indicated by the negative results of inquiries from old timers made during the survey in Bartholomew, Wells, Wayne, and Randolph Counties. A single drift bird was seen at a cranberry marsh in Jay County near Pennville near the Ohio line in 1894, by the ornithologist, Hal Coffel.

The original occurrence of buffalo in south central Ohio suggests that pinnated may have occurred there, but if such was the case no record remains. The entire southward extension of the pinnated range has now been lost.

The thoughtful reader may well ask why the original absence of pinnated grouse from southeastern Wisconsin and southeastern Minnesota is accepted as evidence of the true boundary of the species, rather than as evidence of a temporary scarcity due to the cycle.

There is no absolutely conclusive reason for regarding the testimony of Kumlien and Hatch as establishing the true boundary rather than establishing a cyclic shortage. The circumstances, however, strongly favor the former interpretation. Thus Kumlien saw no pinnated grouse from 1834 to about 1840, a period of seven years. This period is a little too long to be regarded as evidence of a cycle, unless indeed the cyclic period was longer in those days. Furthermore, Kumlien's affirmative testimony that sharptails were abundant during this period tends to strongly refute the cyclic interpretation.

Hatch, in stating that pinnated grouse were "seldom seen at first" evidently refers to a period of considerable length rather than a short period of a few years. Moreover, there is reason to believe that his informant, the Rev. Mr. Gear, had checked up his impressions about game birds by talking to the Indians. In his observations on quail he definitely cites the opinion of the Indians as corroborating his own observations. It therefore appears that the evidence as a whole supports the assumption that Kumlien and Hatch truly described the current boundary of the species, rather than some temporary shrinkage in range or numbers.

It can by no means be assumed, however, that the original boundary was an absolutely fixed line, either in prairie chickens or any other game bird. The line may have ebbed and flowed with changing weather and food conditions, and with cycles if there were any.

Increase with Settlement: Learning to Use Corn. Judd (1905), quoting Hatch, says of the pinnated:

". . . in Illinois as late as 1836 a hunter was extremely lucky if he could bag a dozen in a day. Some years later, with much less effort, one could have shot 50 in a day, and there were records of 100 to a single gun."

Here was an increase caused by, or at least associated with, the introduction of settlements and grain feed.

Audubon found the pinnated very abundant in Kentucky at a much earlier date, possibly by reason of the earlier influx of cultivation. Writing of Henderson, Kentucky, in 1810, he says:

". . . a friend of mine, who was fond of practicing rifle shooting killed upward of 40 in one morning, but picked none of them up, so satiated with grouse was he, as well as every member of his family."

Bogardus, writing in Illinois in 1874, does not even mention Kentucky as a place to hunt chickens. Evidently Kentucky had already reached the stage of too much cultivation, or shooting, or both. The prairies of Illinois, however, which Hatch describes as poor in 1836, and where Bogardus describes chickens as only "rather numerous" in 1857, had in 1874 just passed their prime as chicken country. In 1872, Bogardus says two men had killed 600 in 10 days in MacLean County. He adds as of 1874:

"Where I live (on the Sangamon in Logan County) grouse are nearly as abundant in the *latter part of the fall* as they were 17 years ago . . . but not anything like as many young grouse . . . in August or September as there used to be."

In short, the central Illinois peak must have come in 1860. By 1874 the main shooting was on late fall *migrants* from the north.

Bogardus' most interesting contribution, however, is not his tales of mighty bags, but his assertion that chickens had to learn how to use corn cover, and presumably how to eat corn as food:

"When I first came to Illinois (1857), the grouse in October and later were mostly found in the prairie-grass. There has *now been a change in their habits,* and they seem to like best to lie in corn. I suppose the reason was that as prairies were much broken up, and the quantity of land in corn rapidly increased, the grouse found out that lying in the corn was excellent, and the habit was soon formed. In the corn there is a great plenty of various kinds of food. The ground is mellow and affords excellent dusting places."

The italics are mine. This original reluctance to use corn is on all fours with Stoddard's observation that Georgia quail had to learn to eat buckwheat. It does not speak well for the agricultural enterprise of the Illinois Indians in pre-settlement days. They evidently failed to raise enough corn to teach the chickens it was a food, or else their corn patches were in the woods where chickens could not get the corn habit.

Little was learned of the early history of the pinnated grouse in Iowa. Missouri, or Minnesota. E. L. Schofield told me he remembers they were abundant on the prairies of southwest Missouri in 1870. Widmann says of Missouri: "As long ago as 1888 reports came . . . with the lamentable notation once common—now rare'."

John H. Stevens, who settled at St. Paul in 1849, says "prairie chickens were abundant, but there were few quails" at that time.

By anticipating certain information to be presented later, we may now cast up the rise and fall of the true priarie chicken, that is, its response to various degrees of settlement, in its original prairie home:

	Still scarce	Peak	Decline	Extermination
Northwest Kentucky	?	1810	Before 1860	?
Northwest Ohio	?	?	Long before 1882	1928
Southwest Indiana	?	?	1870	x
Central Illinois	1836	1860	1890, 1874	x
Northeast Illinois	?	?	Before 1887	x
Iowa	?	?	1880?	x
Western Missouri	?	1870	1888	x
Southeast Minnesota	1839	1849?	?	x

Southern Sharptails. We have already seen that sharptails, in the role of "burr-oak grouse" extended south to Chicago. What was their southern boundary elsewhere?

Alonzo Jacha told me the sharptail persisted in southern Iowa County, Wisconsin, until 1900. It occupied the large hazelbrush stumplots which the dairy industry has now largely done away with.

I encountered during the survey, but was not able to verify, a report of sharptails in Missouri. This, if true, is a matter of great ornithological interest. The alleged occurrence is on the brushy borders of a remnant of original prairie. The locality will be divulged, on request, to responsible persons who can show that they are not going to "collect" the remnant. Game departments should take special measures to conserve interesting remnants of this kind, where they exist, but unfortunately their interest too often centers on shootable species only.

In northwestern Iowa sharptails were reported to me as winter migrants. It seems probable, however, that in this case "sharptail" is just a convenient name under which to shoot winter pinnated, the latter being closed, and the former not mentioned in the game law.

Rise and Fall on Acquired Range: Skipped Cycles. We have followed the history of the pinnated grouse in its original prairie home. It remains to recount its fortunes in invading the north.

Kumlien tells us the pinnated entered Wisconsin about 1840. The survey shows that its northward progress is not yet ended. Map 14 shows five northern counties invaded in 1896, 1909, 1912, and 1917, respectively.

The decline in southern Wisconsin, of course, took place decades ago. Thus has this noble bird marched into the unknown, the settler hewing the way, and his sons in turn evicting the birds by too many improvements.

The dates of decline on the acquired range, as determined during the survey of Wisconsin, were as follows:

Observer and county	Observation
Swift, Southeast Dane County	Fell off quite suddenly about 1896. Evidently a "skipped cycle" since then.
Peters, Southeast Dane County	Fell off 1896-1900 or 1901 on Greedabeck Marsh. Corroborates the above.
Nicholson, Brown County	Gradual decline around 1900.
Gray, Marquette County	Last big crops about 1915-20. Could kill 100 per day before that.
Sinandle, Marquette County	Decline since 1918.
Chamley, Iowa County	Good shooting till about 1900.
Burg, Grant County	Up to 1900 all the ridge prairies east of Platteville offered good chicken shooting.
Gardiner, Grant County	The chickens played out about 1890-95.
Olsen, Trempealeau County	Played out since 1900.
Langenbach (Horicon), Dodge County	Last good year was 1895.
J. N. Clark, Dunn County	Sharptail declined since 1885.

It should be noted that three of these 11 instances show a sharp and sudden drop, while six others may be so construed. Do these sudden declines represent the same phenomenon as the "skipped cycles" already recorded for ruffed grouse?

I am convinced that many of them do. This conviction is based partly on impressions received from conversations with old timers which are too long to be here adduced as evidence, and partly on the fact that of a total of 20 dates of decline of chickens in the region reported to me during the survey, over two-thirds fall within one year of the lows of the chicken cycle, and the same proportion fall within one year of the Wisconsin lows for all species. In other words, 66 per cent of the declines fall within the 3-year periods of mortality which we have previously concluded accompany the trough of the cycle. Since these comprise only 33 per cent of the total elapsed years, a more than random coincidence between declines and cycles is evident.

Only *sharp* declines not followed by recovery are admitted as evidence in the above computation. These represent but a small fraction of the total number of lows on which the cycle dates are based.

The summarized result of the computation is as follows:

TABLE 29.—*Temporary lows in relation to dates of permanent decline in prairie chickens*

Lows, prairie chicken, Wisconsin	Dates of decline, prairie chickens, All States	
(Section B. Chart 8)	Number of instances falling	
	Within one year	More than one year
1880	1	0
1887	1	1
1892	1	1
1899	6	2
1905	0	1
1917	4	1
	13	6

Lows, all species, Wisconsin	Dates of decline, prairie chickens, all States	
(Section D, Chart 45)	Number of instances falling	
	Within one Year	More than one year
1895	2	1
1899	6	0
1908	1	0
1919	1	4
	10	5

All of this caption deals with both species collectively.

The coincidence between declines and lows is the more striking when one considers the fact that the "low" dates a decade or more ago are based on a rapidly decreasing number of localities, and to that extent probably do not represent true means. Thus, if there had been a decline associated with the last true mean trough of the cycle (1927), and we attempted to correlate it with one or two localities which happened to fall off early (let us say 1925), we would conclude it did not fall within the 3-year period 1926–27–28. The fact that despite this we get a 66 per cent correlation seems to me to strengthen the conclusion that sharp declines, not followed by recovery, are usually skipped cycles, that is, lows not followed by recovery.

Types of Present Range. The present habitats of the pinnated grouse clearly fall into two classes and five types:

(a) On the original prairie range the species persists:

(1) In small numbers on cleanly cultivated *"black" prairie,* without any cover other than standing corn and occasional weedy fencerows or pastures. (Examples: Champaign County, Illinois; Lafayette County, Wisconsin).

(2) In larger numbers on the *poorer prairie,* where there are occasional fallow fields, abandoned farms, or even small remnants of unplowed prairie sod. (Examples: Southeast Illinois, northeast and southwest Missouri.)

(b) On the acquired range the species is found:

(3) In considerable numbers on *till plain farms* interspersed with glacial swamp grasslands, and sometimes tamarack swamps. (Examples: Northeast Illinois, south central Wisconsin, south Michigan lower peninsula, north Indiana.)

(4) In large numbers on the *sand plains.* These were originally scrubby forests now converted into prairie or brushland by fire. This prairie is interspersed with a few farms, and large defunct drainage districts often with peaty soils. (This is the main stronghold of the species. Example: Central Wisconsin.)

(5) In large numbers on *slashings.* Original pine or hardwood forests converted into brushland or even grassland by fire. On the richer soils near highways the brush is interspersed with farming districts. (Example: North Wisconsin.)

The sharptail is confined to the brushier parts of types 4 and 5. Near farming districts the two species overlap.

The pinnated range in types 1 and 3 is shrinking as drainage and grazing gradually reduce the available cover. In type 2 the pinnated possibly is stationary, or declining only slowly. The available range is expanding due to reversion of fields on the poorer soils. Types 4 and 5 are expanding in area by reason of fire, but as farming suffers local expansions or contractions, the pinnated and sharptail, respectively, become dominant.

Recent Trend of Abundance. Disregarding the temporary fluctuations, the general trend of both species of prairie chickens collectively is unquestionably downward in the prairie type, probably downward in the till plains, and probably stationary in the sand plains and slashings. This of course is merely an unsupported personal judgment for the region as a whole. It is known to be subject to a good many local exceptions, and is applicable to the last decade only.

Over a period including the last two or three decades, the trend in all types has been sharply downward, with the exception of the slashings, which were then barely beginning to be inhabited by chickens, and where the trend since has been upward due to expanding area.

Laymen's local estimates on general trends are almost worthless because of the constant probability that temporary fluctuation rather than long-time trend is the thing measured. During the survey of Missouri, however, laymen were questioned in such a way as to eliminate temporary fluctuations to the extent that there were any. Of eight localities, two seemed to show an increase, one was stationary, and five showed decrease.

Slashings as Chicken Range. Map 14 shows the dates of arrival of chickens at various points in the Forest Belt. Evidently chickens invaded this territory, not in concentric waves with a solid front (such as Hungarian partridge show in their invasion of Michigan and Wisconsin, Map 11), but after the manner of moths invading a carpet, in a multitude of small discontinuous patches gradually spreading from many foci. Thus also did axe, fire, and plow invade the forest, and it is not surprising that the cause should display the same geographic pattern as the effect.

The Hungarian, on the other hand, is invading, from a single focus, a large continuous environment long fully prepared, hence the pattern of concentric waves.

There is a dramatic element in the chicken's conquest of the north woods which is of wider significance than the bird itself. It offers current proof that within certain limits it is not civilization, but the manner in which civilization uses the land, which determines the presence or absence of gallinaceous game. It offers also a sad commentary on American forestry that this—the heart of the white pine forest—should in a single generation have become the abode of the prairie chicken.

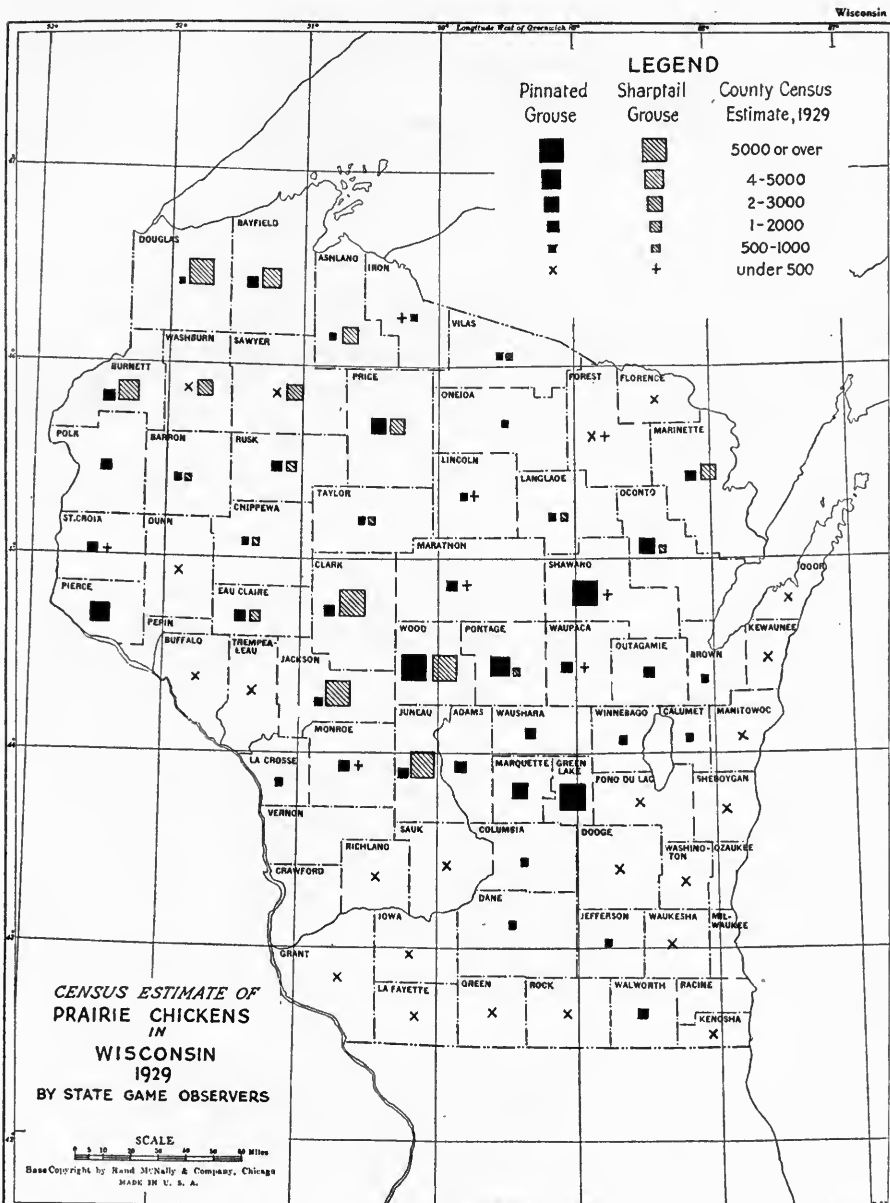
Sometimes, indeed, the metamorphosis has taken place in less time than a generation. Hardwood logging in Price County, Wisconsin, has just ceased; chickens of both species arrived about 1919, and by 1925 there was a high year during which chickens were exceedingly abundant. At this moment, of course, they are scarce but increasing. There has been only one chicken cycle here—before that there were no chickens to suffer a cycle.

In northwestern Washburn County the reverse process, that is, the recapture of the chicken range by forest, has already taken place. The Minong region, after lumbering, was full of sharptails, but of late years the jack pines have come in so thickly as to drive them out and re-establish the deer and ruffed grouse. Much of the chicken range in the Forest Belt must eventually be lost in this way.

Census. Three States have attempted a census of their prairie chickens by compiling local estimates or counts made by game wardens or volunteer observers.

TABLE 30.—*Prairie chicken census*

State (Person in charge)	Year	Per cent of counties reporting chickens	Census		Square miles per chickene in whole state
			Pinnated	Sharptail	
Indiana (Miles)	1909	3?	Only a few on Kankakee	x	------------
	1912	33	100,000	x	0.4
Missouri (Simonds)	1929	30	8,467	x	8.1
Wisconsin (Grange & Schmidt)	1929	91	54,850	55,350	0.5



MAP 15

These census estimates are probably more accurate for the isolated colonies in Indiana, Missouri, and southern Wisconsin, than for the "regular range" of northern Wisconsin. The Indiana estimate was made during the "comeback" of 1912 and is far in excess of the present number. It is interesting to observe that the Indiana "comeback" attained about the same density as Wisconsin now shows.

While the aggregate numbers may seem large, the average State-wide density of population indicated for Missouri and Indiana in the last column is pitifully low compared with the former hosts of days gone by.

The Wisconsin census of 110,000 birds of both species, divided by the area suitable for chickens as estimated in the Wisconsin report (8,100 square miles) gives thirteen chickens per square mile, or 50 acres per chicken during the medium year 1930 on the actual chicken range, as against 330 acres per chicken for the State as a whole. Both of these Wisconsin densities seem to me a little optimistic. I doubt whether there are that many.

The almost exact equality in numbers between the two species in Wisconsin probably represents a very reliable species ratio.

The distribution of density in Wisconsin appears on Map 15.

The Indiana "Comeback" of 1912. The evidence already presented in the chapter on cycles shows beyond dispute that both species of prairie chicken are now cyclic in the Lake States. It is even more important to find out whether they are or were cyclic in their original home in the Agricultural Belt. The caption on "skipped cycles" has shown strong evidence of cyclic behavior throughout Wisconsin, including the southern part, and suggestive evidence that skipped cycles or declines throughout the region coincide with the dates of the cycle for chickens and for all species.

None of this evidence, however, is conclusive of either present or past behavior in Iowa, Illinois, or Indiana.

One of the instances of sudden decline took place near Beardstown, Ill., where the chickens are said to have disappeared "all at once, like the passenger pigeon" about 1890, and are now extinct.

The question of early cycles must be left unanswered for Iowa, Minnesota, and Illinois. In Indiana, while the early behavior is unknown, there is a clear and convincing record of one fluctuation which I have called the "comeback of 1912."

Game Commissioner Miles in his 1913 report says that the 1909 legislature closed the season on chickens because there were only a very few left in the State. These inhabited the prairies adjacent to the Kankakee River. Very few people knew that there were any left at all. By 1912, he says, the birds had increased and spread eastward, repopulating 27 new counties in the brief space of four years. His report concludes that "at least one third of the 92 counties have chickens, and there are certainly more than 100,000 in the State."

Just when this period of revival ended is not so clear. The season reopened in 1915. One sportsman consulted during the survey remembered a high in Pulaski County in 1915. Two observers remembered highs in 1919 and 1925. An actual count of the chickens on the Geo. W. Smith farm in Fulton County showed a decrease from 30 to 4 birds between 1925 and 1927. During my visit in 1928 the trend seemed to be slightly upward. Putting these fragments of information together makes the consecutive fragments parallel the northern cycle, except that they show no low between 1915 and 1919. Such a low may, however, have occurred.

Several fragments of information of earlier date than the 1912 "comeback" likewise parallel the cycle. W. H. Berst told me that the chickens disappeared all at once from Turkey Prairie, Kosciusko County, about 1880. This marked a low in the northern cycle.

Cockrum, already quoted, says Indiana chickens were quite common up to the early 70s. The latest work of the University of Minnesota indicates a general low in the early 70s.

One must conclude from all this that since 1912 Indiana chickens show cyclic behavior, and that the cycle may run farther back in that State.

John A. Gude, a dog trainer, told me of a high in Crawford County, Illinois, near the Indiana line, about 1920. This corroborates the other Indiana evidence of a high between 1919 and 1925.

Movements

Former Winter Migrations: Relation to Sex. That at least a part of the pinnated grouse populations of former days performed more or less regular annual migrations admits of no doubt. We have already cited the influx of winter birds noted by Bogardus in central Illinois in 1874.

Widmann says of Missouri:

"Though as a rule non-migratory, the prairie hen of northern Iowa and Minnesota has been known to migrate (some say females only) southward into and through Missouri in November and December, returning . . . in March. Large flocks of such transients were noticed formerly."

W. W. Cook of the Biological Survey in his "Bird Migration in the Mississippi Valley (1888) says:

"In November and December large flocks of Prairie Chickens come from northern Iowa and southern Minnesota, to settle in northern Missouri and southern Iowa. This migration varies in bulk with the severity of the winter."

John Schmoker, of Fountain City, Buffalo County, Wisconsin, who has lived in the Trempealeau region since 1864, told me that during his boyhood every severe winter brought a heavy influx of chickens (pinnated) from the Minnesota prairies, over and above the abundant breeding population. Whether he actually saw the incoming flights was not determined.

W. W. Cook, of Madison, Wisconsin, says that North Dakota was almost devoid of chickens all winter in early days, and that the remaining birds were males. He has personally seen migratory flights while mallard shooting on Devil's Lake, South Dakota, in both fall and spring.

In corroboration of the Widmann and Cook observations on sex, the late Carlos Avery told me that he trapped chickens for restocking during several winters around 1919 in Roselle and Norman Counties, Minnesota. He remembers the trapped birds ran heavily to males, indicating that either the males trapped easier or that the females had gone South.

Gross has pointed out that W. W. Cooke definitely accepted the differential migration of the sexes. Cooke said:

"The most remarkable feature of this movement is found in the sex of the migrants. It is the females that migrate, leaving the males to brave the winter's cold."

Winter migrations were apparently so regular and reliable that hunters successfully intercepted the flights at certain stopping points. Edward Runge, a former market hunter, told me some 20 years ago that it was once customary for chicken hunters to go every fall to North Hill Bluff on the outskirts of Burlington, Iowa, opposite Henderson County, Illinois. This bluff projects into the Mississippi River in such a way as to catch any southward flight of birds along the river bottoms. Runge said that chickens flying southward along the bottoms would be unable to clear North Hill easily, and would accordingly alight, where they fell easy prey to hunters. A considerable number were killed there each fall by hunters who arrived at the proper dates. Runge never told me the month in which this annual flight took place.

Winter migrations were possibly not confined to pinnated. Orrin Sutherland, born in Janesville, Rock County, Wisconsin, in 1849, says that in the 50s:

". . . great flights of grouse (sharptails) arrived late in fall when the snow came, in flocks of 100 to 150, flying about 15 rods high. I did not see them stop to rest. In the spring they went back but not in continuous flights; they just strung back."

Present Winter Migrations. Migrations today seem to be less regular and less extensive. Possibly decreased food competition, due to shrunken populations, has something to do with it, or possibly the southern prairies are too bare to be preferable to northern snow.

W. W. Cooke associates the lessened tendency to migrate, already visible in 1888, with the widespread introduction of corn. He quotes J. A. Spurrell as observing that after 1880 "corn became a common crop (in Sac County, Iowa) and birds wintered as well as nested abundantly," whereas previously there had been a marked migration (see Gross, 1930).

Some movement, however, still takes place. Northern Iowa has winter chickens as far south as Ames, but no breeding birds.

Forest County, Wisconsin, has summer but no winter chickens, while Manitowoc County, 125 miles to the south, has winter but no summer birds. Parts of Winnebago County also have winter chickens only.

William Fairchild, former keeper of Chambers Island in Green Bay, off the shore of Door County, Wisconsin, saw two chickens arrive on the island, apparently from the Marinette County shore, in April, 1927. (Minimum distance 7 miles). They stayed several weeks and then flew east to Door County proper.

A. E. Doolittle, superintendent of the Peninsular State Park in Door County, saw 300 chickens (pinnated) all in one flock, fly over his house in spring, headed northeast up the shore of Green Bay. These birds were less than a gunshot high, and must have been en route for Michigan. There is no chicken range near his house.

Early Fall Flights. The Missouri flights described by Widmann had, he says, diminished greatly by 1884, due, I presume, to the reduction of Iowa breeding ranges, but had not entirely ceased even in 1901. Widmann specifically says they occurred in November and December.

Late summer or early fall flights also seem to have taken place. Thus Andrew Brooks, a very reliable observer, who trains dogs in the vicinity of Doniphan, Ripley County, Missouri, saw a flock of 20 prairie chickens on his farm in the Ozarks in the early fall of 1901. There is, and was, no chicken country nearer than two counties distant; hence the flock was certainly going somewhere. He believes the month was October, and says that it was during a drouth. Chart 2 shows that 1901 was an extra dry year, so that his dating is probably correct. Mr. Brooks says further that Ozark Ripley was with him when he saw this flock, and that after being seen once it immediately disappeared. The early fall date is puzzling. It certainly cannot represent winter migration.

In Illinois another early fall flight, of much larger proportions, was described to me by Arthur Hamilton, guide and pusher in the Beardstown ducking area on the Illinois River. This occurred about 1908, while he was a boy on his father's farm near Elmwood, in west Peoria County. The date, he says, is correct within a year or two, and the month was August, as shown from his recollection of roasting ears being about ready. Hamilton says this flight was headed southward and started in the forenoon, lasting for about an hour. "The sky was full of chickens like blackbirds." They were not flying very high, as many of them hit telephone wires. None were seen to alight. The flight must have covered a considerable front, since Hamilton heard it discussed in Yates City and Oak Hill, several miles away. These birds were said to have come back during the same year, but not in any big or continuous flight. Luke Hurff, the local game warden at that time, told Hamilton he thought the reason for the flight was that the chickens were after some kind of insect which was abundant in the direction in which they were headed.

These early fall movements may have represented shifts to take advantage of some special food. Both fall within one year of cyclic lows. Could impending mortality induce extraordinary movement? It is clear that population pressure could, but there were hardly enough chickens left in either Illinois or Missouri after 1900 to produce anything but local pressure. Possibly these movements arose from some sense of disharmony with the environment, as postulated by Elton (1930).

Radius of Mobility. All of this evidence points toward a former maximum annual mobility of several hundred miles in prairie chickens, and to seasonal shifts of scores of miles. The present annual and seasonal mobility remains cloudy, and the daily radius even more so. (On daily radius we have one dependable fragment of information to be described later: In Marathon County, Wisconsin, chickens fly five miles every day to the feeding station.)

Facts on mobility are of obvious importance to management. Banding is needed to get exact facts. Meanwhile we must construe the evidence as best we can. Taken all together, the evidence shows that prairie chickens are more mobile than any other gallinaceous game, and not permanently attached to a fixed locality to the same degree as quail. Their seasonal cruising radius is long and variable. Therefore, from the standpoint of management they partake to a certain degree of that peculiar character which necessitates special governmental intervention in behalf of migratory birds. A given State, or county, or landowner may tolerate abuses in birds of this character without promptly suffering the consequences in the form of a short crop, because the deficit is made up out of the mobile breeding stock conserved by the neighboring States, counties, or landowners.

Therefore, in the long run, the priarie chicken will be somewhat more dependent on public, and somewhat less on private, initiative than quail, because the incentive for local or private conservation is weakened to the extent that a species is migratory or mobile. This principle is abundantly proved by the present waterfowl situation in the nation at large, and by the history of the migratory bird laws.

Conversely, and for the same reason, the prairie chicken's response to public measures such as refuges and feeding stations will be the greater and the more satisfactory. In the case of feeding stations, this principle is already borne out in actual experience, as we shall presently see.

Winter Habits; Winter Feeding

Budding. Curiously enough, many people who know that ruffed grouse and sharptails bud, doubt whether the true chickens do. The following observations were compiled during the Wisconsin survey, and from Judd's classic bulletin:

TABLE 31.—*Budding by pinnated grouse*

Observer and locality	Year	Month	Observation
Aberg, Sauk County, Wisconsin	?	December	Watched three chickens (pinnated) from goose blind. Budded for two hours.
Doolittle, Chippewa County, Wisconsin	About 1885	?	Chickens (species?) resorted to birch thicket to bud on birch.
Patterick, Green Lake County, Wisconsin	?	?	Thinks chickens (pinnated) bud on tamaracks.
Drewry, Marinette County, Wisconsin	?	?	Chickens (both species?) resort to lowlands in winter to bud on poplar (aspen?) and birch, mostly poplar.
Ryd, Sawyer County, Wisconsin	1928	?	Birch catkins eaten by sharptail in winter on his farm.
Schmoker, Trempealeau County, Wisconsin	1865	?	Chickens (pinnated) budded on elm and maple.
Judd (U.S.B.S. Bull. 24, 1905)			Pinnated buds on poplar, elm, pine, apple, dwarf birch, black birch. Sharptail buds willow, birch, poplar.

This does not prove, of course, that the pinnated can subsist exclusively on buds for an indefinite period. An adequate chicken study should include the determination of under what conditions and on what plants each of the two species buds, and to what extent and for how long the crop contents show buds as a sole food. Controlled experimentation should also be conducted to get a final answer to this question, since buds constitute the one unshakable foundation of the northern game bird crop.

With such information, managers of farms and forests could then intelligently provide budding facilities and other winter feeding facilities.

Yards, Packs, and Roosting Habits. Wm. Dadant, of Hamilton, Illinois, was told by his father that in 1863 on his farm in Adams County great numbers of prairie chickens flew into the timber to roost in winter, bending the branches of the trees with their weight. He was specific in stating that this was for roosting, not budding, purposes.

Peculiar roosting habits were described to me by Wisconsin observers as follows:

TABLE 32.—*Roosting habits of pinnated grouse*

Observer and locality	Date	Remarks
Sutherland, Rock County, Wisconsin	?	Chickens (pinnated) when formerly abundant did not migrate, but formed packs and roosted in trees. Will also burrow in snow to roost.
Schmoker, Buffalo County, Wisconsin	1881	Chickens (pinnated) plunged into snow to roost but only in exceptionally bad weather. Usually roosted in trees in river bottoms.
Blomberg, Price County, Wisconsin	----------	Chickens (both sp.?) here stay the winter in blueberry swamps. Eat cranberry vines and berries. Tunnel for these foods under the blueberry brush when it is weighted with snow, and thus form regular "yards" like deer.
Hornberg, Portage County, Wisconsin	1928	Chickens (pinnated) flew into jack pine thickets just before dark. Some plunged into snow as evidenced by the hole, but some possibly roosted in the trees.

The pinnated grouse, as is well known, gathers in large packs in winter, the maximum size of which in Wisconsin is indicated by the following instances:

TABLE 33.—*Size of winter packs*

Observer and county	Month	Year	Birds in pack
Gray, Marquette County, Wisconsin	?	?	150
Robinson, Langlade County, Wisconsin	February ?	?	1,500
Hornberg, Waushara County, Wisconsin	?	1921	200–300
Leopold, Dane County, Wisconsin	November	1925	200

The pack of 1,500 was first seen by Robinson in the Spencer Marsh west of Antigo. Two weeks later he encountered one of similar size 35 miles north near Monico. These birds were in a tamarack thicket. The extreme size makes it seem likely that both observations represent the same pack. The distance travelled illustrates the extreme winter mobility of the species.

Sharptails form packs to some extent, but the details are not known to me.

The sex ratio of winter packs should be determined. If, as Widmann says, winter migration may have consisted of females only, it is not impossible that packs may consist of either the residual males, or the migrant females from farther north.

Agricultural Changes and Winter Food. The general unfavorable trend of modern farming practice needs no repetition. A special inquiry was made in Wisconsin, however, to single out the specific recent practices unfavorable to prairie chickens. They are, in probable order of importance:

(1) *The Siloing of Corn.* Siloing instead of leaving it standing or in shocks in the field. This trend is apparent throughout Wisconsin, but is especially strong in the north, where corn does not mature readily for use as dry grain (see frost line on Map 8).

(2) *Shredding Corn.* The new practice of shredding the whole corn plant works in the same direction as siloing. Both mean that there is no corn for the birds, except the waste lying on the ground, and this of course is either consumed before winter, or covered by snow if not consumed.

(3) *The Discontinuance of Rye.* Newly broken land in the north woods type was formerly planted to rye. Now that the breaking of new land has been checked by the current agricultural depression, and by the deflation of the local cutover land boom, there is much less rye than formerly. Potatoes have also tended to replace rye as a raw-land crop.

(4) *Stacking Straw at the Barn.* Some observers report that straw was formerly stacked in the fields, whereas now threshing is done near the farm buildings, in order that stock may have the food and shelter afforded by the straw stack. Quail do not hesitate to use farmyard stacks if there is cover near, but chickens usually decline to come so close to buildings.

All these changes have combined to reduce winter food and shelter for game, especially chickens. For chickens to thrive, these trends *must be offset* by food patches arranged for the purpose of wintering the birds.

Wisconsin Feeding Stations. At the initiative of W. B. Grange and Dr. Merritt Jones, of the Conservation Department, and of various chapters of the Izaak Walton League, a series of food patches and winter feeding stations has been established in various Wisconsin counties. The locations are shown as black dots on Map 14.

The extraordinary success of these stations, and their remarkably low cost, is summarized in the following table:

Year	Number of stations	Number of counties	Number of Chickens Fed		Cost per station
			Total	Per station	
1927–28	2	2	320	20–300	?
1928–29	16	7	1,000	20–300	$20–$75
1929–30	103(?)	7	1,104	80	$10–$20
1930–31	64	17	3,200	x	$15–$25

The Wisconsin stations offer living proof that winter feeding of game is not merely a matter of throwing out some grain when the snow comes. At the Rothschild station in Marathon County three successive methods of feeding, depending on the accumulating depth of the snow, were found necessary during the deep snows of 1928–29. First came buckwheat, left standing in the food-patch which had been planted in advance for the purpose. This was covered by one foot of snow, but it remained effective up to two feet of snow, the birds digging for the buckwheat after it had been covered up.

A crust then forced the birds to resort to standing corn, which had been planted and left in the field as the "second line of defence." This remained effective up to about three feet of snow.

Disappearance of the standing corn under the snow then forced the birds to resort to shocked corn, but it was found they would not open the shocks for themselves (as a pheasant will). It was necessary to gradually open the shocks so they could see and get at the grain. The shocked corn outlasted the winter.

All the while grit was fed on a canvas spread on the snow and baited with ear corn. The grit was regularly consumed.

Two years ago stacked buckwheat was tried at Rothschild, but the chickens would not open the stack for themselves. It had to be opened for them.

In Portage County, cornstalks, with ears attached, were thrust upright into the snow. This was effective, but renewals required considerable labor and haulage.

In Waushara County, corn shocks were opened gradually, and supplemented by ear corn impaled on sticks set in the snow. The latter require constant renewal.

In Grant County, where the snow is usually less deep, a 2-acre buckwheat patch sufficed for the first winter, and required no stacking or other attention. Twelve corn shocks are provided for the following year. Whether they proved more or less satisfactory than the buckwheat is not known.

The 10 Wood County stations each consist of a patch of buckwheat, sweet clover, and millet, part of the buckwheat having been stacked and opened from time to time.

The most gratifying development is the high radius of effectiveness of some of these stations.

At Rothschild chickens were observed to take wing for the feeding station from five miles distant. This indicates that a single station may serve *over 75 square miles,* or two townships.

In Portage County the birds also flew in to feed. They observed a definite schedule, remaining at the station from 8:30 to 10 A.M. and from 1:30 to 3 P.M. I understood that they flew directly from the station to the roost, which was in a jack pine thicket.

For winter food patches for all species Terrell advocates using Tartary buckwheat (*Fagopynum emarginatum*) which is listed in U.S.D.A. Farmers Bulletin 1062 as *stiff stemmed* and retentive of the grain (and is therefore better in snow). It has proved also palatable to the birds.

Berndt reports a large gathering of chickens at Stevens Point on a field of soy beans.

The drouth of 1930, with its accompanying fires, is said to have forced both species of chickens to resort to the food patches early in the fall. Consequently at this writing (November) many of them are exhausted at the season when they normally should just begin to be used.

Miscellaneous Life History

Foods. The following abbreviated summary is compiled from Judd's bulletin:

Table 34.—*Food of prairie chickens*

	Pinnated	Sharptail
Per cent animal matter	14 per cent	10 per cent
Per cent vegetable matter	86 per cent	90 per cent
Insects predominating	Grasshoppers	True bugs.
Special insect pests eaten	Locust, chinch bug, cutworm	Weevils, locust, potato beetle.
Fruits predominating	Rose hips, sumac	Rose hips, thornapple, blueberry, cranberry.
Weed seeds predominating	Smartweed, ragweed, sun flower	Smartweed, sunflower, ragweed.
Legumes	Cassia, hog peanut	Alfalfa.
Grain, in order of amount	Corn, wheat, buckwheat, barley, oats, millet	Wheat, corn.
Mast	Hazelnuts, acorns	Acorns.
Miscellaneous	Flowers of goldenrod	Leaves of cottonwood, alder, blueberry, juniper, larch, flowers of parque and dandelion.
Greens	Buttercup, everlasting, red and white clover	----------

This admirable work, however, was done 25 years ago, and is a sort of cross-section of many States and seasons. We still lack detailed local food studies in the north central region.*

Disease. Until the cause and mechanism of the cycle is known, any clear case of disease in cyclic species is worth recording, especially in the southern tier of States.

* Now partially met by Gross' "Progress Report of the Wisconsin Prairie Chicken Investigation" (1930).

TABLE 35.—*Symptoms associated with mortality in prairie chickens*

Observer (Species)	County	Year	Month	Description
Curtis (pinnated?)	Juneau	1927	September	Three or four "pinworms" in kidneys. Worm brown, hard ⅝ inch long, diameter of pin.
Stoddard (pinnated)	Waukesha (Mosquito Lake)	1923	July	Found sick hen with brood of healthy looking chicks perhaps 3 weeks old. Hen very thin and weak. Could fly only 20 feet. No visible parasites. Hen caught, banded, and released.
Laws (pinnated)	Dane (Mazomanie)	1927	August and October	While duck hunting found in prairie grass a dozen carcasses about 1 month old. Also found carcasses while haying in August.
Terrell (pinnated)	Winnebago (Butte des Morts)	1926	Summer	Dead bird picked up. No visible signs of mechanical injury.
Robinson (?)	Oneida	?	February	Farmer reported finding seven dead birds huddled together in one bunch. He thought them frozen. Said did not look thin.
Markham (?)	Langlade (Post Lake)	1928	September	Found same worm in chickens as occurs in partridge: white, stringy, sharp on ends.
Dunn (sharptail)	Ashland	1928	September	Sharptails had same worm (wireworm in intestines) as occurs in partridges. Heavy mortality between 1927 and 1928.

Schult (pinnated)	Marquette (Buffalo Lake)	1927	January	Says John Long, game warden, followed a fox track to four dead chickens in middle of a field. Fox had eaten some but could hardly have killed all four. Tracks indicated twenty-five birds in flock.
Rose (sharptail)	Monroe	1928	September	Killed a sharptail with head full of ticks. Bird three-fourths grown, thin and scrawny. Pinnated grouse in same locality had no ticks. No worms in this sharptail.
Ott (both species)	Jackson	1926	September	Found worms with sharp points in birds killed in 1926. 90 per cent decimation by 1927.
Lanning (pinnated)	Jackson	1928	September	Found ticks and white sharp worms on birds killed in 1928; had to discard some of them.
Hegeman (?)	Juneau	?	September	Last 5 years has found dead birds while hunting. These had a soiled anus like a sick fowl. Noticed no ticks. Did not look for internal parasites.
Swift and Divine (sharptail)	Sawyer	1923 or 1924	Spring	Six found frozen in spring, huddled by a cornshock. May have been caught under crust.

Such a case was described to me by L. R. Grinstead, assistant agricultural editor at the University of Missouri. He formerly operated a farm in Scotland County, Missouri. About 1915 he found the carcasses of 8 or 10 immature prairie chickens (pinnated) while cutting his hay in July. These birds were about three-quarters grown, including no adults, and had the appearance of having been dead several weeks. The fact that they were scattered over two or three hayfields practically excludes the possibility that they were shot, and the observer states there had been no chicken hunting on his place for 5 years. The unmutilated carcasses exclude the possibility that they fell victim to predators. Chart 2 shows that 1915 was a very wet year throughout Missouri. This is of interest in connection with the frequent coincidence of disease mortality and wet years in ruffed grouse. Mr. Grinstead says there was a decided local decrease in chickens during the year when these carcasses were found, he having seen as many as 25 or 30 in a bunch during the previous year, and hardly any following the occurrence. By 1927 only one chicken was left, a male which boomed in vain all the spring. This survival of a male is again circumstantial evidence paralleling the disease-history of ruffed grouse.

An even more convincing case of disease is described by Stoddard in Table 35. In this case also, the hen was the first affected.

Langenbach reports killing a large chicken (pinnated) *in very dark plumage,* on Rush Lake, Wisconsin, about 1915. This may have been the same dark phase observed by Allen to accompany heavy parasitism in ruffed grouse. The date would be right for heavy parasitism preceding the 1917 cycle.

Symptoms Associated with Mortality; Per Cent Mortality. Table 35 summarizes the observations compiled during the survey on symptoms associated with the cycle in Wisconsin. The same limitations already stated for Table 28 apply to this compilation.

Estimates of the per cent of mortality during recent cycles are as follows:

If we can assume that Miles' census of the 1912 "comeback" is anywhere nearly correct, and that present conditions in Indiana are similar to those obtaining after the "comeback" had subsided the difference would yield a very rough measure of the cyclic decimation in the State as a whole. I obtained second-hand estimates on the five principal present ranges, and on a part of the scattered colonies, and believe the number of birds in 1929 would run between 5,000 and 10,000. The latter figure is 90 per cent less than Miles' 1912 estimate.

Fire and Accidents. Two kinds of mortality from accidents are deserving of special mention.

One is the loss of winter cover from the burning of marshes in fall, and what is still worse, the loss of nests from burning marshes in spring. Marsh burning is still widespread and indiscriminate throughout the region, and in dry years is estimated to needlessly cut down the chicken cover 75 per cent below the already inadequate remnant which might harbor these birds. Mere legal prohibition is no remedy, because once in a while there is an economic justification, such as the desire to clear away the old growth preparatory to a hay crop. In such event the question is not whether to burn, but when and how much.

TABLE 36.—*Per cent of mortality in prairie chicken, Wisconsin*

Observer and county	Years compared	Description
Kinzinger, Oconto County (Shooting Journal)	1921	Killed 23 prairie chickens.
	1922	Killed 23 prairie chickens.
	1923	Killed 25 prairie chickens.
	1924	Killed 25 prairie chickens. (legal limit, could have killed more).
	1925	Killed 21 prairie chickens.
	1926	Killed 12 prairie chickens.
Blomber, Price County	1925 / 1928	Estimates 75 per cent decrease.
Hornberg, Portage County	1925 / 1927	Estimates over 50 per cent decrease.
Worden, Waushara County	1920 / 1928	Estimates 75 per cent decrease.
Ott, Jackson County	1925 / 1927	Estimates 90 per cent decrease.
Drewry, Marlnette County	1924	One hundred fed at Peshtigo Asylum feeding station.
	1928	Fifteen fed at Peshtigo Asylum feeding station. (This indicates an 85 per cent decrease.)

The really effective remedy for marsh burning is to give every farmer either a personal or a financial interest in his chicken crop.

The other loss from accident is flying into overhead wires. The pinnated grouse is more prone to do this than any other game bird. Reports of considerable losses from wires were encountered in each State containing chickens, and the literature is full of instances. In Indiana one farmer even found dead birds which had flown into an ordinary barbed wire fence. The present trend toward replacing individual telephone wires with cables is a desirable one. Owners of chicken marshes who value their bird crop should if possible stipulate cabling of wires in ceding rights-of-way across their lands.

Species Ratios for pinnated and sharptail are given in Table (e) of the Appendix.

CHICKEN MANAGEMENT

Seasons on Chickens. Chart 11 tells a story of tragic interest to those who have eyes to see; a story which reflects not only the complex biology of the prairie chicken and the drama of economic development of the region, but also, with only a little imagination added, the "personality" of the conservation movement in our diverse States. For it is plain without any table that each State, as well as the region and the nation, expresses its individual character in its conservation laws.

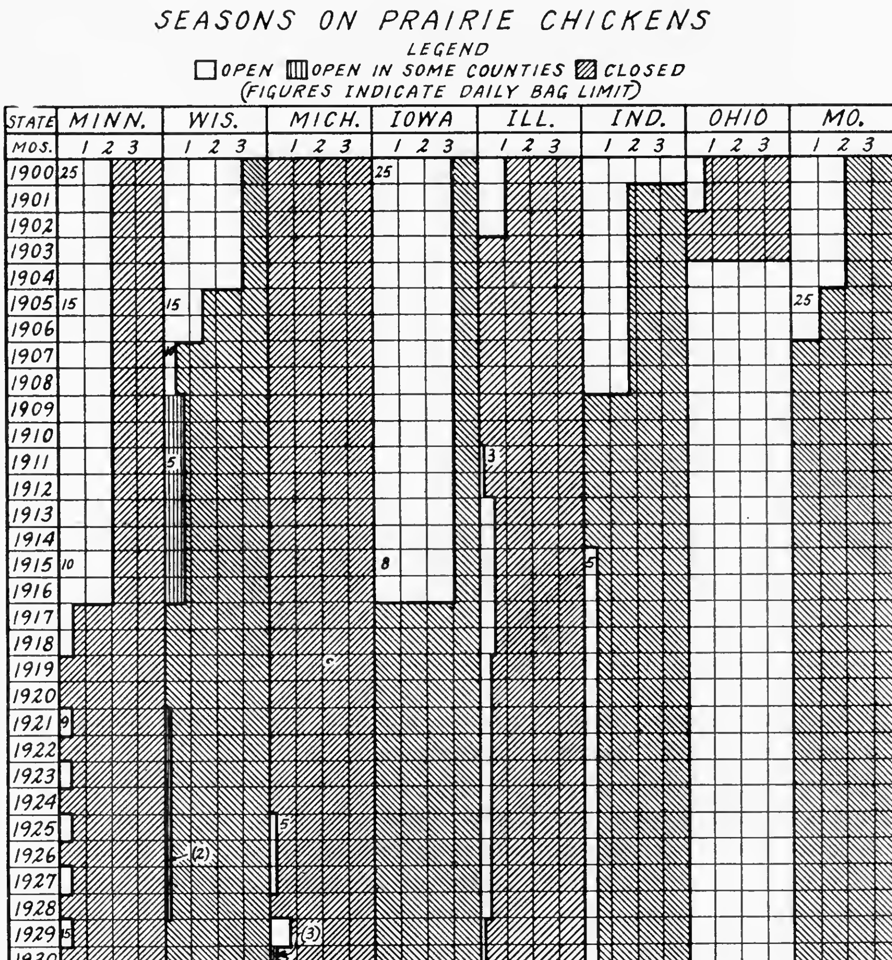


CHART 11

In the years 1900 to 1905 we see a nearly unanimous restriction of the deadly long open seasons which prevailed in the days of the "chicken trains." This is also the period of general establishment of game commissions, of anti-sale laws, and of the first game farms. It was evidently the time when the region felt the first real pinch of an impending game shortage. At this time Ohio had to write "finis" on her chickens. They were gone.

Then came the cycle of 1909. Wisconsin and Indiana tightened their belts. All the rest had already done so, except Iowa and Minnesota. Iowa waited until the cycle of 1917, and then, having no chickens left, reformed her 3-months' season into a total closure, while Minnesota shortened hers to 15 days.

In those days the word "cycle" was not abroad in the land, nevertheless every chicken State but Indiana and Illinois responded to the 1917 cycle. Indiana had just opened up, following the miraculous comeback of 1912, and besides was at that moment on the top of the Hungarian wave, with no great need of mere native birds to assure her future sport. She has since amended this view.

Since 1917 the open seasons have been so short that one must look closely to see them on the chart; nevertheless the 1927 cycle again registered in every remaining State except Indiana. In this year of grace, 1930, we have come to a virtually complete closure throughout the region, but we have not come yet to any comprehensive program in even a single State for supplying what the prairie chicken really lacks: a motive for the farmer to give him food, cover, and protection.

Need of Refuges. Chickens occur on the same kind of land as pheasants, waterfowl, and (in places) deer and ruffed grouse.

The first three are, like chickens, by their nature adapted to benefit from publicly owned refuges. With each species, a properly located refuge will tend to put a large area of surrounding land into production.

The lack of success of the "leased" refuges in the past has no bearing on this assertion. There was no control of cover and feed on these, and to this extent they were mere gestures, existing on paper but not in fact.

Furthermore, lands suitable for chicken refuges are often comparatively cheap, and hence suitable for public acquisition. In the light of the recent evidence on chicken mobility, one or two refuges per county would suffice.

In the region of impecunious drainage projects, land is often so cheap that it would further be possible to surround such refuges with public shooting grounds, and to supplement the chicken crop with a large waterfowl crop produced by reflooding suitable lands.

Here is an opportunity too good to miss. Yet no State is so far taking advantage of it on any scale. If the public does not avail itself of such chances, private enterprise eventually will, after which we will hear a great hue and cry about clubs depriving the public of its sport. In game, as in other matters, the Lord helps those who move first.

Need of Index Areas. In the States which still have any open season at all, the law usually opens certain counties and leaves the rest closed. The question of which counties to open is usually determined by public hearings before legislative committees at the time the law is passed. The resulting statute necessarily represents some temporary phase of the cycle, and bears little or no relation to the present or even the average status of the birds. Hence the law seldom fits conditions on the ground. No fixed statute can ever fit the constant local shifts and changes in abundance characteristic of cyclic game.

For this reason wide discretionary powers exercised by a competent commission are the A B C of chicken management. The commission must keep in touch with the current local status of the birds by a continuous game survey. The survey should sample each county each year by means of a series of fixed sample plots or index areas, representative of the various local chicken ranges.

Wisconsin has established such a system of index areas. It is needed in all States.

Summary of Findings. Chickens, like quail, have been the victims of clean farming. The basic objective should be to give the farmer an incentive for providing them with cover and food, and for preventing overkilling. A preferential tax status for marshlands left in suitable condition, and an income from the shooting privilege, would establish such incentive.

Chickens are the most mobile of gallinaceous game. Hence a single refuge covert and feeding station will serve a very large area. Refuges, in short, are nearly as effective for chickens as they are for waterfowl.

By reason of this same mobility, management is best undertaken by neighborhood pools rather than by individual farmers. For the same reason, a large degree of public supervision and control of management practice is, and always will be, desirable.

Chickens, like the other grouse, are cyclic. Short crops must be expected about half the time. The shortages are so spotty that extreme flexibility in fixing open and closed seasons is the only alternative for permanent closure.

CHAPTER VIII

BIG GAME

Wild Turkey

ORIGINAL Distribution. The original northern boundary of the turkey is of some importance in indicating the probable success of replantings.

The boundary in southeastern Wisconsin is definitely recorded by Kumlien, and is shown on the map. He also records the interesting fact that most of the turkeys in Racine County were killed by the hard winter of 1842.

Mershon says that the Michigan turkeys extended north to the Kawkawlin River near Saginaw, in Bay County, and persisted just south of there until 1886 or later. Hatch says:

> "Thirty-three years ago (about 1865?) the turkey was . . . not a rare bird in northwest Iowa and southwest Minnesota . . . Seen as late as 1871 in Minnesota. Now (1891) totally disappeared."

These are the three known points of the north boundary.

In addition, Schorger has discovered, and will shortly publish, some old records indicating the presence of turkeys at more northerly points in both Wisconsin and Minnesota. It is entirely possible that the north line was far from stable, and that it ebbed and flowed with changing weather and food supplies.

There are contradictions in the historical data which can only be reconciled under the ebb and flow theory. Thus Schorger's discovery of an old record of turkeys at Lake Pepin in 1766 is contradicted by Prof. John P. Bird's conclusion that they were absent from the La Crosse region, to the south of Lake Pepin, at the time of its settlement in 1842. Professor Bird, after thorough inquiry among old timers in and around La Crosse, could find no evidence of early turkeys.

There are numerous records of turkeys south of the Wisconsin River, some as late as 1872.

Comparative Persistence of Turkey and Deer. Of the various States or large parts of States originally containing both deer and turkey, but now containing neither, it is certain that turkeys usually persisted longest, except at the north extremity of their range, where the opposite was the case. The known record is:

State	Last turkey	Last deer
Southwest Minnesota	1871	?
South Wisconsin	1872	Still some
Lower Peninsula Michigan	1886	Still many
North Illinois	?	1874?
South Illinois	1928?	1910
North Indiana	1870	1880
South Indiana	1900	?
Ohio	1903	?
North Missouri	1895	1884
South Missouri	Still some	Still some

In Jennings, Tipton, and possibly Ripley Counties, Indiana, however, the deer lasted longer than the turkeys. This exceptional persistence may reflect some peculiarly favorable property in the Indiana deer range. Bogardus, too, saw a few deer on the Sangamon in Illinois, apparently after the turkeys had disappeared. In short, when measured by whole States, the turkey usually lasted longest, but in county-size units the contrary was sometimes the case.

Turkey Populations; Present Distribution. The early literature contains hundreds of allusions to the abundance of turkeys, but few which furnish any basis for estimating population density. Thus, Sweeney (1908) says that "great numbers were seen" in Marshall County, Illinois, on the east side of the Illinois River, in November, 1864. Bogardus found "turkeys and deer in large numbers" in Buchanan County, Missouri, about 1866. Such statements sometimes yield interesting dates, but seldom more. They can be found by the dozen.

Cockrum says of Indiana that in the days of early settlement in Gibson County, turkeys "were in such numbers that in one day's hunt there would be seen many flocks of . . . 50 to 75 each." This is a sample of extra specific description, but even it can hardly be reduced to population density figures.

I am so far unable to give even an estimate of what density the original turkey populations attained. In so mobile a bird, a rather large area would of course have to be enumerated to furnish a fair sample.

With the exception of a few replanted birds in Indiana and Wisconsin, and the possible survival of a single flock in southern Illinois, Missouri contains the only remaining turkey range in the north central region. The trend in Missouri as a whole is believed to be slightly upward, the lowest ebb having been reached about 1920.

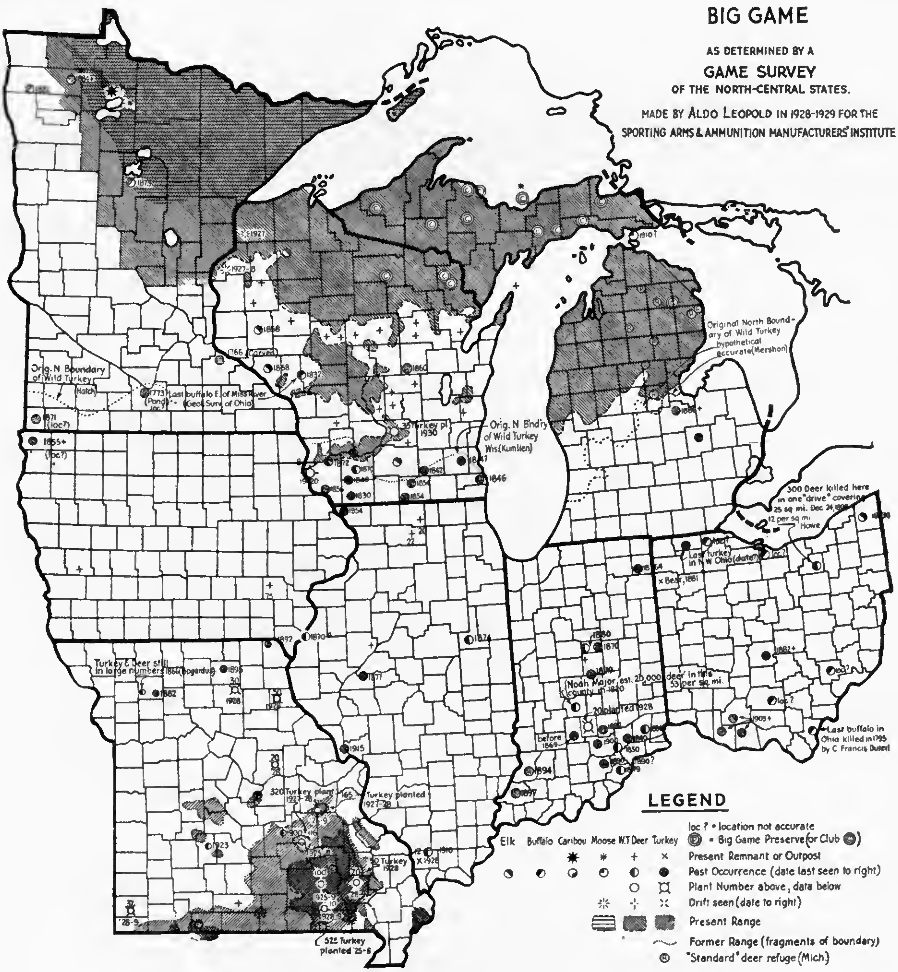
Present populations are as yet entirely too sparse to furnish evidence of maximum density.

Census and Kill; Idle Range. The recent estimates of wild turkeys, including plants, in the region are as follows:

TABLE 37.—*Turkey census*

State	Year	Census made by—	Number of turkeys	In number of counties	Annual kill
Missouri	1925	Game Department	4,024	47	612
	1927	Game Department	7,000	?	----------
Illinois	1928	E. L. Karraker	12	1	0
Indiana	1928	Conservation Department plant	20	1	0
Wisconsin	1930	Conservation Department plant	35	1	0
Region (probable present total)			7,067	50	----------

If it be estimated that half the Ozark type and a tenth of the Hill type represent the now available turkey range, then the average present rate of stocking is 1.4 square miles of range per turkey. If it be estimated that each square mile of available range might carry five birds, then our present turkey country is 86 per cent idle.



MAP 16

Plants, Refuges, Forests. The amount of effort now being made to correct this idle condition may be roughly guaged by the replantings which are being made and the number of refuges or public forests suitable for restocking. The status of these actions in the southern tier of States (the only ones possessing any appreciable areas of turkey range), is given in Table 38. The reason for the numerous question marks under "refuges" is that it is hard to determine, without personal examination of each one, whether areas labelled as refuges, forests, and parks are actually suitable for restocking with turkeys.

TABLE 38.—*Status of turkey restoration*

State	Plants		Number of State refuges and forests suitable for—	Private turkey preserves
	Year	Number		
Missouri	1925 1926 1927 1928 1929 1930	350 ? 250 695 12+ ? 1,300	10 refuges and parks	3
Illinois		0	1 ?	0
Indiana	1928 1929 1930	20 27 ?	3 forests Numerous State parks	0
Ohio	?	?	1 ?	0

Quality of Planting Stock; Wild Weights. It is doubtful whether turkey plants of partially domestic strain are effective.

The early Missouri plants consisted of crosses between wild gobblers and tame hens. Where the gobblers came from was not determined. It is understood that tame stock is no longer used.

The Indiana plant was a mixture of Arizona and Dakota birds. This indicates they were hybrids.

The Wisconsin plant was a mixture of wild and domestic blood.

In judging the purity and thrift of alleged wild planting stock, and of turkeys killed from wild populations, a record of weights of genuine wild birds, as described in the old literature, may be of some use. The following records of weights in this region were encountered during the survey.

TABLE 39.—*Weights of wild turkeys*

Observer and State	Locality	Year	Season	Number, Sex, age	Weight, each	Remarks
					Pounds	
A. H. Bogardus						
Illinois	Petersburg			2	20	
Illinois	Sangamon River	1860s	Winter	4	12–18	eight inch beard, quite fat.
Illinois	Sangamon River			1 gobbler	27	"not quite fat".
Missouri	Buchanan County			11	10–18	
W. B. Mershon						
Michigan	Saginaw†	1886	†	1 gobbler	23¾	
Michigan	Flint	†	†	1 gobbler	30 or 32	
Michigan	Hemlock†	†	Winter	1 young bird	10–11	
Michigan	†	†	†	1 gobbler	20	Scale weight."Big'

Wild Turkey Study. The following outline for a turkey study applies to Missouri, but will illustrate the paucity of knowledge of this bird:

> Determine by banding of all released stock (and later by banding trapped stock) what drift occurs from State refuges in what periods of time. Determine by banding what is the comparative survival value of half-wild and pure-wild planting stock.
>
> What kind, amount, and arrangement of cover is best for turkeys? Have they any special requirements for roosting, nesting, or refuge? How do fires, grazing, and lumbering affect these cover requirements? What modifications of forestry practice would improve turkey cover conditions?
>
> What foods do turkeys eat at various seasons? What foods enable the gobblers to be fat in spring? How are turkey foods affected by fire, grazing, lumbering, farming? What are the best crops for food patches? How big and how frequent should the patches be? Do turkeys suffer food shortage during winter storms?
>
> What diseases and parasites affect wild turkeys? How does the disease risk vary with (1) contact with tame turkeys? (2) weather? (3) season? (4) density of population? (5) contact with other animals?
>
> What predators kill turkeys and rob nests? What evidences identify the work of various predators on (1) nests? (2) kills? How do predator losses vary with density of (1) turkey populations? (2) predator populations? What percentage of nests "get by" with or without predator control? How are predator losses affected by vigor or disease?
>
> What is the normal sex ratio in turkeys? What departures from normal occur? When? Why? What is the minimum of males necessary for productivity? What are the flocking habits at various seasons of the two sexes? Does the sex ratio affect the radius of spread from refuges? Is there a saturation point in turkey populations? A cycle? What turkey and quail populations are compatible with each other on the same range?

Whitetail Deer

Original Distribution; Northward Shift. This species was indigenous to the entire region except the north shore of Lake Superior, where it was absent, and the south shore, where it occurred in summer only. Shiras (1921) records the fact that:

> "In the early days there were neither moose nor deer and very few caribou (on the Sault Ste. Marie River). . . . The whitetail, while now quite abundant, was unknown on the north shore . . . in 1870 . . . On the south shore of Lake Superior, including all of Michigan and Wisconsin, there existed a spring and fall movement of deer which possessed all the characteristics of a true migration. . . . This habit was abandoned more than 35 years ago."

The invasion of the north shore of Lake Superior by deer must have been rapid, for in each of years from 1879 to 1881, 10 years after the invasion begun, Shiras records the killing of 80,000 deer. The exact area which this figure is supposed to cover is not clear, but he says that "most of these were within 10 miles of Lake Superior."

The original scarcity of deer in the northern Lake States is supported by the testimony of an old market hunter, who told Game Wardens Swift and Divine that 40 years ago there were not enough deer at Clam Lake, Burnette County, Wisconsin, to enable professional hunters to successfully supply a lumber camp.

The converse of Shiras' testimony for the north is affirmed by Bogardus, who says of the prairies (my italics):

"It is often supposed that it (the deer) likes best to range in the vast forests, but I believe that to be a mistake. Deer are most fond of country in which there are belts of timberland and brush *interspersed with prairies and savannahs.* Much of that part of Illinois where I lived at first (Menard County) is somewhat of that character. When I first went to the State (1857) deer were exceedingly plentiful. I have seen . . . thirty in a herd, and men . . . told me they had seen herds . . . of seventy-five. In cold weather the deer went to the timber for shelter. In warm weather they . . . spent some hours before and after noonday lying in the *long grass of the prairies* near sloughs."

Early Deer Populations. In deer we find much more satisfactory evidence than in turkey of what densities were attained by the original populations.

Howe mentions a "drive" in Medina County, Ohio, on Christmas eve, 1808, which netted 300 deer killed from 25 square miles, or 12 per square mile. Probably by no means all the deer on the area were bagged, so that a population considerably higher than 12 per square mile is indicated.

Carl Sandburg's biography of Abraham Lincoln states that in 1820 Noah Major, one of the first settlers in Morgan County, Indiana, estimated there were 20,000 deer in the county. This reduces to 53 deer per square mile on the basis of the present area—an astonishing density (and incidentally the first published game census in North America). This is a higher density than now exists on the overstocked Kaibab Forest, supposedly the ultimate in deer abundance.

These heavy original densities in the central part of the region, taken in conjunction with the testimony of Bogardus that deer liked the prairie, and of Shiras that they were absent on the north edge of the region, strongly suggests that the cenral part of the region was the qualitative center of the original deer range. We have already seen that this also is indicated for ruffed grouse and pinnated grouse.

Present Populations and Kill; Plants; Trend. There is no longer any soil capable of carrying 53 deer per square mile now habitable for deer. Deer are crowded back into the poorer margins of the region; where they are now universally regarded as on the increase. Large southward encroachments are taking place in Wisconsin, and probably in the other Lake States. Some of these extend into the very edge of heavy farming districts.

There is no census for the really heavy deer States of Minnesota, Wisconsin, and Michigan. The known census figures are:

TABLE 40.—*Deer census*

State	Year	Number Deer	Number of counties
Missouri	1926	564	24
Indiana		?	1
Illinois	1929	42+	3
Iowa	1928	75+	2

In Missouri, the census of 1926 is probably now too low. Since 1925 at least 300 deer (mostly Negaunee, Michigan, stock) have been planted by the State on five State parks, and the general impression is that the species is increasing and gaining a new foothold. (Missouri deer are still only about 1/500 as thick, however, as the Morgan County, Indiana, deer of 1820.)

There are no records of the kill for States or other large areas except those compiled by Minnesota from hunters' reports. Wisconsin and Michigan make estimates of the kill, which may however be wide of the mark. The best available figures are:

TABLE 41.—*Deer kill*

State	Year	Season	Legal kill			Bucks per square mile of deer range per year
			Bucks	Others	Total	
Minnesota (hunters' reports)	1926	10 days, alternate years only	11,504	(12,187)	(23,691)	0.4 bucks (0.8 deer)
Wisconsin (estimate)	1928	10 days, alternate years only	13,200	None	13,200	0.8 bucks
Michigan (questionnaire estimate)	1927	15 days, yearly	20,000	None	20,000	0.9 bucks

The best that can be said for the accuracy of Table 41 is that it is better than nothing. Both the kill and the area are uncertain within limits of possibly 25 per cent.

The known data on the success ratio for this region show:

Place	Date	Hunters	Legal bucks	Hunters per legal buck
Minnesota	1919–26	176,192	53,154	3.3
Wisconsin (see Kilp study)		32	17	1.9
Michigan	1927	54,311	20,000	2.7

Doe Killing. There is a perennial controversy in States having buck laws on the question of whether the does illegally killed and abandoned in the woods constitute a substantial offset against the benefits of the law.

Debates on this subject are usually characterized by more heat than light.

F. G. Kilp, forester for the Negoosa Edwards Paper Company, Port Edwards, in conjunction with the forest planting operations of the company, made a complete survey of the illegal does found after the hunting season of 1928 on a single section, and a more extensive survey of deer hunting conditions on five surrounding sections. On the larger area of six sections he found the hunting conditions to be as follows:

Number of hunters	32
Man-days hunted during 10-day season	213
Legal bucks killed	17
Hunters per legal buck killed	$32 \div 17 = 1.9$
Man-days per legal buck killed	$213 \div 17 = 12$
Man-days per hunter	$213 \div 32 = 6.4$
Square miles per legal buck killed	$6 \div 17 = 0.35$
Bucks killed per square mile	$17 \div 6 = 2.8$

With this background on local hunting conditions, the illegal kill may now be examined. On the smaller area Kilp's planting crews found eight carcasses of does, four of them with some meat cut out, on that part of the square mile actually covered by planting operations (about 300 acres). Probably other carcasses lying in unplanted swamps escaped detection. From these premises the following relationships are indicated:

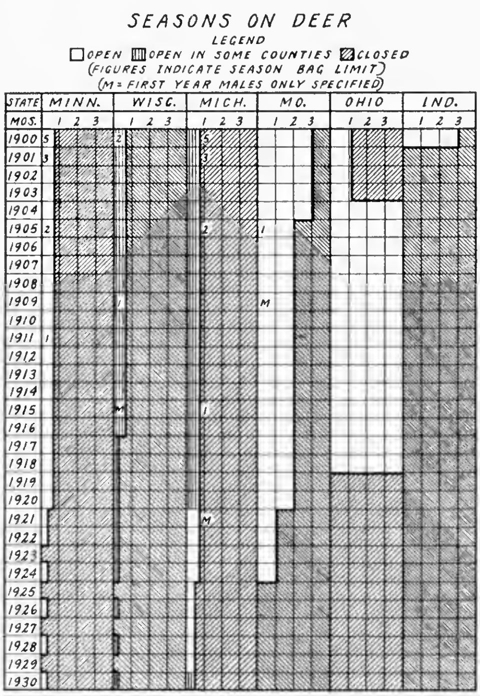
Hunters per illegal doe actually found on 1/6 of the territory they hunted	$32 \div 8 = 4$
Illegal does actually found per square mile	8
Probable illegal does per square mile	$8 \times 2 = 16$
Illegal does actually found on 1/6 of the large area per legal buck killed on the large area	$8 \div 17 = 1:2$
Probable illegal does per legal buck, if carcasses were just as thick on the entire area	$16 \times 6 = 96 \div 17 = 5:1$

It seems hard to believe that these conditions are representative. Nevertheless they demand consideration because they are evidence based on actual measurements rather than on mere opinion.

A much rougher survey, pointing to quite a different conclusion, was made by Rev. B. F. Schoenfeld, of Park Falls, Wisconsin. He questioned 32 selected deer hunters, most of whom were personally known to him, as to the dead does actually seen by them within the area on which they had all hunted. Eighteen had seen dead does, but eight had duplicated, leaving 10 out of 32 hunters who had discovered dead does in the woods. Schoenfeld assumed arbitrarily that the number of does actually killed was ten, and by comparing this with the number of bucks (100) estimated to have been killed in the same territory, arrived at the conclusion that not over 10 illegal does per 100 legal bucks had been killed and left in the woods. The trouble with this conclusion is the pure assumption that all the does were found. Kilp, after his planting crew had covered his area much more thoroughly than any group of hunters would ever cover a hunting ground, estimated that only half the actual dead does had been found.

Another rough survey, somewhat more convincing than the Schoenfeld survey, was made by Game Warden Peterson in the vicinity of Sharon, Kalkaska County, Michigan, in 1927. Peterson counted deer camps and cars on an area of four townships, or 144 square miles, and concluded that 300 deer hunters were using this area. This is two deer hunters per section. Peterson found eight abandoned does on this area after the season closed. The method of finding them was to follow fox tracks to the carcasses. This is at the rate of one abandoned doe per 16 square miles, but there is no assurance of course that all the carcasses were found.

Peterson did not determine the total legal kill of bucks, but applying the usual success ratio of about four hunters per buck, we may estimate that 300 hunters divided by four equals 75 bucks killed, which indicates a ratio of one illegal doe to each nine legal bucks.



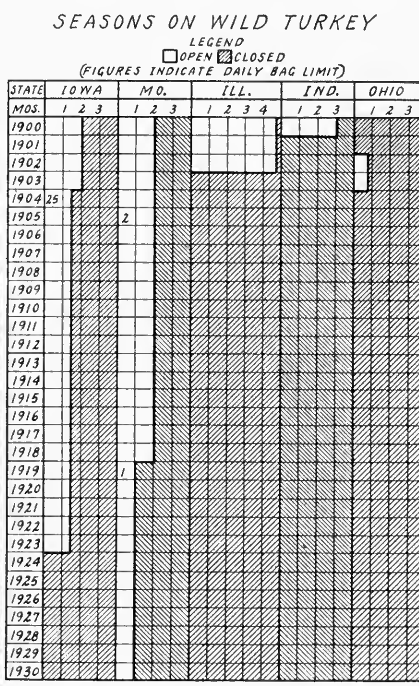


CHART 12a AND 12b.—*Deer and Turkey Seasons*

BIG GAME MANAGEMENT

Seasons. Chart 12 (a and b) gives the history of deer and turkey seasons.

All of the deer States except Minnesota now restrict the kill to bucks. It would be very enlightening to know whether the composition of the deer herd with respect to sex and age is any different in Wisconsin, with her buck law, than in Minnesota, where there is no sex restriction.

Both Wisconsin and Minnesota have open deer seasons only in alternate years. Table 41 indicates no radical differences in productivity as compared with Michigan, with her annual season.

State Refuges and Public Shooting Grounds. Michigan is the only State in the north central group which is so far embarked on a systematic program of acquiring refuges and public shooting grounds on forest lands and putting them under management. The status of the Michigan system of standard refuges as acquired to date is:

Michigan refuge units

(abbreviated from biennial report, 1927–28)

Number under development in Lower Peninsula	8 units
Gross area in refuges, 4,000—20,000 acres, average	8,000 acres
Adjacent state land within 1 mile, 2,000—10,000 acres, average	4,000 acres
Food patches in operation on	4 units
Average cost of operation and improvements, per unit per year	$3,000

This is of course the present condition, not the ultimate plan. The surrounding State-owned shooting grounds, as well as the refuges, are in process of acquisition.

The economical acquisition of great areas of land for public hunting requires a great degree of skill exercised without interference through a long period of time. It is simply impossible for an unstable or non-technical department to drive good bargains and get the right kind of lands, or for any department to do so in a hurry. Any State which wants public rather than private management of big game ranges had better provide a steady source of income, turn it over to a good staff of men, and let them alone.

There are various big game refuges in other States, including Missouri, but they do not as yet constitute a system aimed at ultimate State ownership and operation of game ranges.

Need of a Deer Study. Throughout the Lake States there is a growing apprehension lest the cutting out of swamp timber for posts, pulpwood, lumber, etc., may destroy the food and shelter necessary for winter yarding grounds for deer.

A general survey of the deer yard situation has been started by Michigan. This is a necessary preliminary to the study herein advocated. One of the elementary facts about deer yards not known is the distance a deer will travel from his summer range to his yarding grounds. Several observers seen during the survey claim to have tracked deer moving as far as five miles to a yard. In all probability the radius of effectiveness is 10 miles or more.

It is generally assumed that white cedar is the basic winter food and a necessary constituent of a successful yard. This may or may not be the case. If it is, it remains still to be determined to what extent cedar swamps are injured or benefitted by cuttings. This is a forestry research question of the kind intended for solution under the McSweeney-McNary Act.

A considerable program of coniferous forest plantations is under way in Michigan, and proposed in the other Lake States. Most of these plantations so far have been made "solid," without intervening unplanted areas. It is reasonably certain that while a small plantation offers effective cover for deer, a large solid block of plantation will ultimately exclude them. This raises the question of whether plantations could not to some degree be dispersed or "shot-gunned." It is important that the degree of dispersion constituting the most advisable combination between game and forest interests be determined in advance of large-scale planting programs.

In addition to furnishing merely ordinary cover, it is not impossible that the judicious placement of evergreen plantations may be made the means of establishing new winter yards.

None of the unanswered questions about deer management can be successfully solved without fundamental information on the composition of deer herds by sex and age classes. It is especially necessary to determine how this composition is affected by hunting, lack of yarding facilities, refuges and other factors dealt with in management. It should be remembered that the deer is a polygamous animal requiring two years to reach maturity. Accordingly every management question must deal not only with the question of how many deer, but what sex and what age. The complications attendant on this are absent in the case of smaller game reaching maturity in one year.

At the present time we do not even know how to tell the age of a deer. Michigan is engaged in a much needed study of correlation between age, dentition, and horns.

Mere abundance of deer is never proof that the species is thriving or that it is being properly managed. Pennsylvania offers ample proof of the correctness of this assertion. A competent and continuous deer study is the only available insurance against the repetition of unforeseen disasters of the kind which have now overtaken parts of the Pennsylvania range.

CHAPTER IX

WATERFOWL

THIS chapter does not purport to be a well-rounded appraisal of the waterfowl situation in the north central States. Only incidental attention was given to waterfowl during the survey. The following impressions of the situation are offered as merely a rough and incomplete picture which is in great need of being corrected and extended by a more careful survey of the region as a whole, and of the individual States.

Explanation of Map. Map 17 is a very generalized and "uneven" presentation of the waterfowl situation.

Wisconsin, Illinois, and Missouri show a nearly complete picture of the remaining grounds with their location, tenure, and status. Minnesota has more remaining grounds than any of these States, but no details were gathered and hence cannot be presented.

Iowa, Indiana, and Ohio have hardly any waterfowl grounds left, hence there is little to present. The map of these States is nearly complete.

An inventory of annual production on the larger breeding grounds is given on the map for Wisconsin, but not for Minnesota and Michigan. The southerly tier of States has few breeding grounds, so there is little to present.

All waterfowl grounds which breed any birds show as squares; those which harbor transitory birds only show as circles. Various appendages attached to each square or circle show whether it serves as a refuge, whether it is public, private, or commercial, whether any banding is done, etc. Letters or symbols within squares or circles show a few salient facts as to the species or groups represented, where this is known.

One of the most important things shown on the map is the location of the more important marshland restoration projects, and of the larger State and Federal refuges.

In general, this map will be intelligible only to those with a fairly good advance knowledge of conditions. To make all these matters clear to others would require half a dozen maps.

Trends in Waterfowl. Ten salient trends in the present situation were noted, four favorable and six unfavorable.

The favorable trends are:

(1) An actual beginning in three marshland restoration projects.

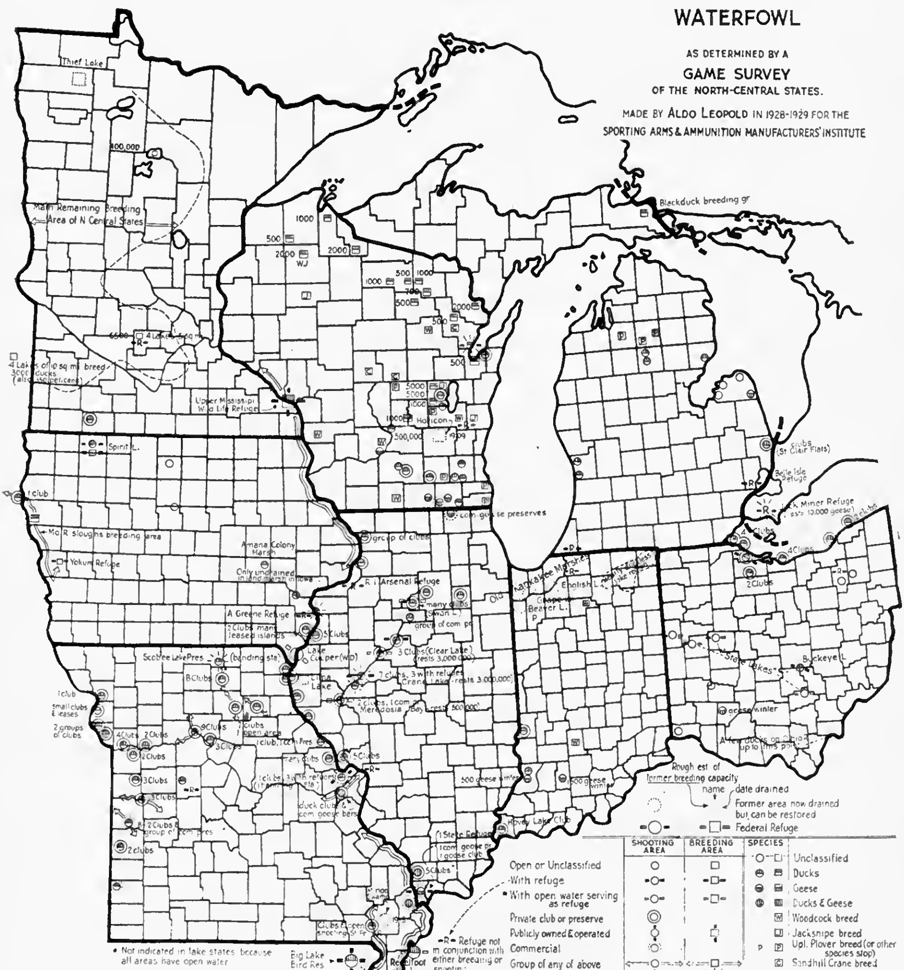
(2) One, and possibly two, instances of successful restoration of feeding grounds through carp control.

(3) The phenomenal success of resting grounds or refuges.

(4) Public recognition of the fact that drainage is not always desirable, even from an economic standpoint.

The unfavorable trends are:

(5) Rapid commercialization of waterfowl grounds, accompanied by competitive over-organization of shooting methods and equipment.



MAP 17

(6) A growing area of idle breeding grounds, evidently due to the decimation of local breeding stocks.

(7) A growing area of idle feeding grounds of second-rate quality, and a growing concentration on the few remaining first-rate grounds. The idle area is evidently due to "burning out" or overshooting.

(8) The slow spread of action on the refuge idea.

(9) The non-co-operative attitude of many States in waterfowl administration.

(10) The absence of comprehensive surveys and plans for waterfowl conservation programs.

Restoration Projects. The deliberate and purposeful restoration of important waterfowl areas unwisely drained in the past has been talked about for many years. It is therefore gratifying that at least a few such projects are actually being executed.

Wisconsin seems to have overcome a long series of legal obstacles for the restoration of Horicon Marsh, and has appropriated $25,000 for the necessary engineering works and $25,000 per year for land adjustments and acquisition. The first dam is under construction, but further legal difficulties may yet develop.

Minnesota, in co-operation with the U. S. Biological Survey, has a well-advanced plan for the restoration of Mud and Thief Lakes as a Federal refuge and as a State public shooting ground respectively.

Indiana has acquired a nucleus of land in the Old English Lake, one of the three units of the former Kankakee Marshes, with a view to restoration as a State refuge. Acquisition has also started on another area in Jasper County, which is to be reflooded.

These projects collectively do not as yet counterbalance to any appreciable degree the decline in the waterfowl resources, but if they are greatly multiplied they hold out the hope that such may soon be the case. A dozen or two projects of this kind, duly completed within the region, would constitute a material gain against the inroads of drainage and depletion.

Food Restoration; Comeback of Koshkonong. It is common knowledge that Lake Koshkonong in Jefferson County, Wisconsin, was formerly one of the best canvasback lakes in the United States. In the early days local market hunters shipped a consignment of 600 canvasbacks to New York City, as a result of which the word went abroad that Wisconsin had a canvasback lake. Many sportsmen from as far away as New York City came to shoot on Koshkonong. It appears that previous to this time eastern sportsmen believed that canvasbacks occurred only in the region of Chesapeake Bay, and did not stop in inland waters.

Many shooting clubs were formed, and became nationally known, including the Thibeaux Club and the Blackhawk Club.

I was not able to determine the date when carp were introduced, but local sportsmen say that the duck food plants and hence the shooting began to fall off about 1898, and for many years the lake was considered as hopeless. Clyde Terrell visited the lake in 1920 or 1921 and found it totally bare of feed. Soon after that date intensive seining for carp was carried out each year. Evidences of a "comeback" both in aquatic vegetation and in waterfowl were soon apparent. At the present time extensive beds of sago pondweed (*P. pectinatus*) are re-established, together with scirpus, wild millet, and giant wild rice. The shooting has been improving year by year. In 1930 the carp control is said to have been relaxed, whereupon a decline in vegetation and ducks was promptly felt.

Introduction of carp was apparently the cause of the original decline and carp control is evidently the cause of the present comeback.

A similar sequence of apparent cause and effect is said to have taken place in Lake Pomme de Terre, Stevens County, Minnesota.

These instances of course do not prove that carp were the cause of decline in duck foods everywhere, or that carp control can restore duck foods anywhere, but they nevertheless constitute important evidence that restoration through carp control is sometimes effective.

Idle Marshlands. I gathered the very strong impression during the survey that two simultaneous and seemingly contradictory changes are in process.

The first is a rapidly mounting concentration of waterfowl in the remaining high-class or extra attractive marshlands.

This shift toward concentration areas has been coincident with the virtual abandonment of many second-class marshlands. These second-class marshlands are either not used at all, or else they are used only to a limited extent at night, or during the period of the main flights, or, more frequently still, they are abandoned in fall but used to a considerable degree in spring.

The net result is that while possibly only 10 per cent of the original marshlands remain in existence, possibly only five per cent are actually used to any extent. The remainder are in effect idle range, as far as the fall migration is concerned, and also as far as breeding is concerned.

The following instances are offered in support of these assertions.

In northeastern Indiana there are about five counties dotted with numerous small lakes which have the appearance of being excellent duck waters. Years ago the shooting was good. Most of them are still used by ducks in spring, but there is practically no breeding, and the fall shooting has deteriorated to practically a mud hen proposition. Evidently these Indiana lakes are of second-rate attractiveness, and have become virtually idle through a combination of shrinking aggregate duck population, and a process of "burning out" through constant over-shooting. It is possible that the installation of refuges and the propagation of foods might to some degree restore the fall flight, and also breeding birds.

Ohio has some good marshes in the region of Sandusky Bay which still enjoy a fall flight and a few breeding birds. The pothole lakes south of Akron, however, the five so-called "State Lakes" in central Ohio, and the bottoms of the Ohio River, have all deteriorated to approximately the same status as the Indiana lakes. The same remedies might furnish the basis for improvement.

Wisconsin has hundreds of lakes, many with the appearance of good duck waters, but only a dozen or two still enjoy regular duck shooting. The remainder are virtually idle as breeders, and in fall have sunk to a mud hen status.

Breeding Grounds. The average sportsman does not realize the tremendous difference in breeding capacity (or attractiveness to breeding fowl) between the northern prairie lakes and those of the Forest Belt. Even when the woods lakes *look* similar to those of the prairie, they produce but a fraction of the birds.

In company with Alfred Peterson, of Pipestone, an ornithologist, I censused eight lakes, aggregating 15 sections, or 9,600 acres, in southwestern Minnesota in August, 1928. These lakes are only average in quality. We estimated an output of 9,500 ducks, which is an average of 600 per square mile, or one duck per acre. There was no migratory flight yet—all these ducks were raised *in situ*.

For comparison I obtained from local sportsmen estimates of the usual annual output of 18 lakes and marshes constituting the larger remaining breeding grounds in the forest belt of Wisconsin (see Map 17). The estimates total 23,700 ducks. I could not obtain all the acreages, but the total would be in six figures, and one of them alone was determined to be 24,000 acres. If its capacity were equal to that of the Minnesota lakes (one per acre) it alone would be producing as much as all the 18 Wisconsin lakes actually produce.

Another comparison: Lake Winnebegoshish in Minnesota is estimated by local sportsmen to raise 100,000 ducks per year. This is four times the output of the eighteen Wisconsin lakes, and possibly not much smaller than the present output of the whole State of Wisconsin (but not her former output. Horicon Marsh, now drained but being restored, is estimated by local sportsmen as having once produced a million ducks).

The moral is that losses of breeding grounds from drainage, or programs for restoring such losses, are questions not of acreage but of *quality*. The loss of one lake on the Minnesota, Dakota, or Canadian prairie may equal a whole eastern State.

Clyde Terrell, of Oshkosh, Wisconsin, estimates the 1930 output of eight lakes and marshes in and near Winnebago County, Wisconsin, as 17,880 ducks and 9,250 coots or mudhens. Four of the eight were included in the 18 Wisconsin breeding grounds censused by the game survey. In three of these, his census checks mine within 10 per cent; in the fourth his census is double mine.

The composition of the breeding population in Terrell's Wisconsin census (by per cent) and the game survey's Minnesota census (by order of abundance) is given in Table 42. (Breeding composition is of course different from the composition of the kill in Table 46, the latter including mostly migrating, not local, birds.)

In Terrell's census, mudhens were one-third more abundant than mallards, the most abundant duck. In my census, mudhens were not enumerated, hence they are omitted from the table.

Breeding grounds in the southern parts of the north central region have not only been radically restricted by drainage, but ducks, except woodducks, show a curious reluctance to use the ones that remain. This is true as far north as the Upper Mississippi Refuge. There is no sharp line of demarcation between the acceptable and unacceptable breeding grounds.

TABLE 42.—*Composition of breeding populations*

Ppecies	Locality			
	Eight lakes and marshs in and near Winnebago County Wisconsin. (Terrell)		eight lakes in southwest Minnesota. (Peterson and Leopold)	Four lakes in Illinois
	Per cent	Order of Abundance	Order of Abundance	Order of Abundance
Mallard	37	1	4	2
Bluewing teal	33	2	1	
Greenwing teal	8	3		
Blackduck	7	4		
Widgeon	6	5		
Pintail	4	6	2	
Woodduck	3	7		1
Spoonbill	2	8	3	
	100			

One cannot dismiss this fact as unalterable because these grounds are "too far South." In the West, since the cessation of spring shooting, mallards and other species have nested freely almost to the Mexican border.

In southern Illinois there is a tradition among rivermen that mallard decoys cannot be propagated in the bottoms—that they must be moved to the uplands, otherwise the ducklings will not survive. This sounds like some insect-borne juvenile disease. O'Roke, of the Michigan School of Conservation, is finding that survival of mallard ducklings in that State is affected by a juvenile disease carried by the black-fly. La Rue finds the survival of Michigan herring gulls affected by a parasite fatal to juveniles and carried by perch. It is predicted that many waterfowl breeding ranges will ultimately be found to be determined by particular juvenile diseases and parasites, some of which may be subject to control. Here is another virgin field for science to come to the aid of conservation.

By and large, the cumulative shrinkage in breeding grounds cannot, however, be reversed, either by more science, or by more appropriations for public acquisition. The only fundamental remedy is to recognize the fact that undrained ungrazed private marshlands perform a public service in producing migratory birds, and to give the owner an incentive for keeping, continuing, or restoring that service by according them a preferential tax status, such as is now accorded in some States to private forests, on the same principle of public service. The public can never acquire enough of the small marshes to offset the ones which are being taxed out of existence, nor can science show how to grow ducklings in a cornfield. The steam-roller of economic self-interest must somehow be steered so that it will work with, not against, the feeble palliatives so far employed to avert that spiritual calamity—a duckless America.

Refuges and Restgrounds. Baiting is not the only reason for the concentration of waterfowl on the lower Illinois. The accidental existence of large lakes, from which the ducks cannot be driven by shooting, is also a powerful attraction. Estimates of the maximum resting population on the Illinois River lakes were given me by the State and Federal wardens as follows:

Crane Lake	3,000,000 ducks
Clear Lake	3,000,000 ducks
Meredosia Bay	500,000 ducks

The more rapid decline of the shooting in Missouri as compared with Illinois may be ascribed in large part to the accidental absence of large lakes.

Small lakes and marshes are of course equally good as rest grounds if deliberately set aside and enforced as yearlong refuges. The slow spread of effective action on this well known fact is one of the most disappointing things encountered during the survey. There seem to be well over 600 clubs in the region, but as nearly as I could determine, only nine have set aside refuges. I learned of eight refuges on farm ponds, and 20 effective refuges established by States. A summary of refuges appears in Table 45, and the locations of the important refuges, in all States except Minnesota and Michigan, appear on Map 17.

The question of whether public refuges should be surrounded by public shooting grounds is frequently debated. Horseshoe Lake in Alexander County, Illinois, is a good place to study the question. This lake, upon being threatened with drainage, was purchased by the State at $73 per acre, and the whole lake (2,720 acres) set aside as a refuge. From 1,000 to 1,900 geese, and an equal number of mallards, were counted on the lake by N. R. Huff at various times during the winter of 1928–29. The goose shooting in the surrounding fields is said to have been improved a hundred per cent by reason of the refuge. But so did the *demand* for such shooting. Commercial preserves have taken up all the shooting rights on the lands surrounding the lake.

Sportsmen's associations in various States are now competing for the establishment of Federal refuges financed under the Morbeck-Andreson Act. Some of these States have absolutely no refuge system of their own. It does not seem to occur to them that a vigorous local refuge program should be one of the best arguments for Federal help, or that large Federal refuges are fully effective only when the surrounding region is well covered by numerous small local ones. These small local refuges are the State's responsibility in any event.

This situation is merely one manifestation of the need for a waterfowl survey which should map the lines of flight, the distribution of present and prospective waterfowl areas, the intensity of shooting, the presence or absence of accidental refuges, and thus determine a system of Federal, State, and private refuges distributed to meet the needs of the situation. The existence of such a Statewide plan would tend to assign responsibility among the various agencies, and tend to prevent one waiting on the other to start something.

Co-operation in Law Enforcement. No description of waterfowl conditions in the region could fairly omit to mention the apparent lack of co-operation on the part of some States in the enforcement of the migratory bird laws. There are five Federal wardens in the region, and about 350 State wardens. Each state has from 40 to 70 men.

Neither the five present Federal wardens, nor any conceivable future increase in their numbers, could possibly suffice to enforce the law. The active help of the State officers is absolutely necessary. Happily in most States it is freely given.

Shooting Practices. The most radical recent change in waterfowl shooting practices is the growth of artificial baiting. Baiting has widely divergent aspects. It has made possible such beneficent innovations as Jack Miner's goose refuge. On the other hand it has made possible the systematic commercialized killing of great numbers of ducks on absolutely dry cornfields miles from water. The intergradations between these two extremes are gradual, and show no sharp line to which legislative controls could easily be attached.

The baiting capital of America is Beardstown, Illinois. In the bottoms above and below Beardstown, clubs and commercial shooting grounds in 1928 were putting out as high as 7,000 bushels of corn per season on a 20-acre tract. The rates per acre ran up to 430 bushels per season. One baited dry-land commercial shooting preserve killed 4,000 ducks in 60 days on 40 acres, or 100 ducks per acre per year. When this kill is compared with the duck-producing capacity of even the best breeding grounds, the real meaning of the word "concentration area" becomes more apparent. This preserve breeds not even a tadpole, and would have to restore 4,000 acres of the choicest breeding grounds to be biologically self-sustaining. Its kill of 4,000 ducks is 266 limits shot by possibly 100 licensees contributing perhaps $200 to restore game. Even if this sum were all devoted to marshland restoration, it would buy possibly 20 acres producing 20 ducks per year. As a matter of fact only a very small fraction of it is devoted to waterfowl restoration. It is conservative to estimate that the biological books of this dry-land "preserve" are "in the red" some 80,000 per cent.

Commercial preserves and toll farms on the Illinois place six or even 10 guns over each "pen" of live decoys. It is frequently compulsory to shoot only at flocks small enough to be "cleaned up." One objection to dry bait grounds is that the flocks which come in are too large to be "cleaned." Pot-shooting on the water or ground is prevalent on commercial preserves and toll farms, and unfortunately even in some clubs.

Practice as to Limits and Hours. The Federal warden is authority for the statement that until the recent reduction in the Federal limit, all but one or two clubs observed the Federal limit of 25 rather than the State limit of 15.

This seems to reverse the underlying idea of the migratory bird law that the lower of the two limits should govern. I gathered that the practice met with acquiescence on the part of both State and Federal wardens.

Some of the main clubs are said to have shot 30 ducks, 15 each for hunter and "pusher."

Limits of any kind on some commercial preserves and toll farms are probably poorly observed.

There is a general verbal agreement that shooting starts at 9 o'clock. This enlightened practice is evidently generally observed.

Illinois River shooting practices are of course not representative of the region as a whole. Questionable practices are more prevalent there largely because of the greater opportunities to profit by them. The Illinois picture has its reverse side, described under the caption on refuges and rest grounds.

Cripple-Kill Ratio. What ratio exists between ducks actually bagged, and cripples or lost birds destroyed in bagging them, but not recovered? Are modern ducking equipments and practices tending to raise or lower the crippling loss?

The latter question, though of vital importance, cannot be answered because we cannot turn back the pages of history. The former could be answered by systematic observation. It should be no harder to apply research to the behavior of hunters than to the behavior of birds.

Some thinking sportsmen sense this need of finding out what we are doing to the birds. Dean Swift made a cripple count on Lake Koshkonong, Wisconsin. The lake is 3 by 9 miles. For several seasons, after the wind had been blowing from a certain direction for not more than two days, he traversed the downwind shore with trained springers, and counted what they picked up. He never found less than five cripples per mile, and as high as a dozen per mile on the same stretch of shore 2 days in succession. Unfortunately he was unable to determine the ratio of ducks crippled to ducks killed on the lake.

Two "pushers" on the lower Illinois River estimated the cripple loss as 33 per cent and 50 per cent, respectively. This is for mallard shooting over live decoys in flooded timber, with plenty of ducks, and in a locality having a lower-than-usual ethical code; the worst possible combination.

In jump shooting on the upper Mississippi bottoms I estimate the crippling loss with a good dog as 15 to 20 per cent.

On Rio Grande sandbar shooting in New Mexico my five years' written record averaged 13 per cent.

Charges and Land Value. On Illinois River commercial preserves $10 per man per day has been the going toll charge since 1914. This is now being raised to $15, or $25 for two men, with a limit kill often guaranteed. This higher rate is apparently established on the lower river. With as high as 10 guns per pen, this means a gross revenue of up to $150 per day per pen. One variation of this new rate is $1 per duck.

Rentals and Sale Values of Duck Lands. The shooting on $10 land in the Jonesboro section on the Mississippi rented, in one instance, for 10 to 20 cents. On the Illinois no rental figures were obtained.

Sale values of duck lands in the Beardstown sector, in farm-sized blocks, run from $150 to $300 per acre. At the mouth of the Illinois, duck lands run nearer

$50. A maximum price of $400 is sometimes reached in the Beardstown area. Dry land pens have sold for as high as $100 per acre in the 40-acre blocks.

In southeast Iowa, the Burlington Basket Company finds it profitable to practice forestry on a series of Mississippi River islands, and thus to assure sustained production of veneer logs for its manufacturing plant, partly by reason of ducking rentals yielded by these islands.

Even the "wilds" of the Mississippi Lowland Belt in southeast Missouri are said to be in a rapid state of transition to a paid shooting and club basis. The end of free public shooting of waterfowl on the private lands of the north central region is clearly in sight. Only the public lakes and streams remain open—so open that many of them are duckless.

Table 43 summarizes sample toll rates and duckland values found during the survey.

TABLE 43.—*Charges for duck shooting privileges and duck lands*

Locality	Toll charges	Sales of land per acre
Lower Missouri River goose bars	$4 per day	
Upper Missouri River goose bars	$10 per day with guide	
Southeast Missouri Goose stubbles	Up to $20 per day with guide	
Bates County, Missouri	$1 per day	
Kankakee River, Indiana	$0.50 per car	
Lower Illinois River, standard rate	$15 per day or $1 per duck	$150-$300 in farm-size blocks
Marshall County Illinois, baited dry land	$15 per day	$100 in 40-acre blocks
McHenry County Illinois goose pits	$15 per day	
La Salle County, Illinois	$5 per day	
Mouth of Illinois River		$50
Bear Lake, Minnesota duck pass	$0.50 per day	

Table 44 shows how deflated land values since 1918 have left many drained lands with a lower sale value and a heavier carrying charge than undrained lands of the same original character but still suitable for ducks. The disadvantage of drainage of course is offset more or less by the reduced risk of crop loss, but this risk is not absent—it is merely reduced. The levees still break occasionally. It is at least an open question whether drainage of good land has brought an economic gain to the landowner, and a certainty that drainage of poor land has not.

Distribution of Refuges and Clubs. Table 45 summarizes by States the distribution of various special classes of waterfowl areas. Incomplete information is indicated by question marks. All of the figures are approximate only, since many questions of definition, too long to discuss here, enter into any such enumeration.

TABLE 44.—*Economic history of one acre of Illinois bottomland with respect to drainage and game*

	1910	1918	1928
Sale value of one acre—			
Undrained	$40	?	If duck land, $250
Drained in 1915	$40	$250	$80
State and county taxes, per year—			
Undrained	?	?	$1.50
Drained in 1915	?	?	$1.50
Drainage payments, levee maintenance and sinking fund—			
Undrained	0	0	0
Drained in 1915	0	$6.50	$6.50
Risk of Crop loss—			
Undrained	1/3 of years	1/3 of years	1/3 of years
Drained	1/8 of years	1/8 of years	1/8 of years

NOTE.—The purpose of this tabulation is to compare the economic status of typical drained and undrained bottomlands such as are found along the Mississippi and Illinois rivers. The figures do not purport to be accurate or representative. If they are anywhere near right, however, the undrained land is the better off. It is hoped that this rough comparison may provoke a more accurate comparison by other more competent persons.

TABLE 45.—*Distribution of refuges and clubs*

	Minnesota	Wisconsin	Michigan	Iowa	Indiana	Ohio	Missouri	Illinois
Clubs	?	9	?	?	2	15	85	400
Private preserves	?	0	?	?	0	0	?	?
Commercial preserves	?	2+	?	?	0	0	?	?
Public shooting grounds	1?	0	?	0	0	0	0	1
Public refuges	1	5	?	2	4	4	1	3
Farm and individual refuges	1+	2	?	2	1	?	1	1
Club refuges	?	0	?	?	0	1	2	6

Composition of Duck Kill. There are three types of duck shooting in the region:

1. *Mallard shooting* in overflows, river sloughs, and cornfields. The lower Illinois River exemplifies this type. It is in this type that heavy baiting and use of large rigs of live decoys has become most prominent. It tends to be in the southerly, rather than the northerly half of the region.

TABLE 46.—*Composition of kill on a Missouri River sandbar, Buchanan County, Missouri*
(Compiled by J. H. McCord, Jr., St. Joseph. Mo.)

Species	1927	1928	1929	Total	Per cent
Mallard	149	174	107	430	39
Greenwing teal	58	118	36	212	19
Pintail or sprig	29	60	43	132	12
Gadwall or grey duck	8	33	15	56	5
Bluewing teal	0	14	14	28	3
Spoonbill	6	15	9	30	3
Baldpate	--------	7	5	12	1
Total puddle ducks	250	421	229	900	82
Bluebill	30	88	57	175	16
"French teal"?	4	5	5	14	1
Redhead	2	8	--------	10	1
Goldeneye	3	--------	--------	3	0
Butterball	1	--------	--------	1	0
Total deepwaters	40	101	62	203	18
Total ducks	290	522	291	1103	100
Canada geese	--------	10	1	11	--------
Snow geese	--------	--------	8	8	--------
"California geese"	1	2	1	4	--------
Total geese	1	12	10	23	--------

TABLE 47.—*Composition of kill, Green Bay, Wisconsin*
(Summary of the Hunting Journal of E. J. Nelson, Manitowoc, Wis.)

Species	1921	1922	1923	1924	1925	1926	1927	1928	Total	Per cent
Bluebill	8	-----	9	5	8	14	16	20	80	28
Mallard	11	-----	11	16	-----	2	13	4	57	20
Teal (mostly bluewing)	-----	-----	-----	11	5	4	5	5	30	10
Redhead	2	-----	-----	4	1	-----	13	8	28	10
Canvasback	-----	-----	-----	11	1	-----	5	7	24	8
Pintail	-----	-----	-----	5	1	-----	-----	8	14	5
Butterball (bufflehead)	3	-----	-----	-----	2	9	-----	-----	14	5
Whistler (goldeneye)	3	-----	-----	1	-----	6	3	-----	13	4
Hooded Merganser	12	-----	2	-----	-----	3	-----	3	10	3
Gadwall	-----	-----	3	-----	-----	4	-----	-----	7	2
Widgeon	-----	-----	1	2	-----	-----	-----	3	6	2
Spoonbill	-----	-----	-----	-----	-----	-----	5	-----	5	2
Scoter	-----	-----	-----	-----	-----	-----	-----	3	3	1
Total ducks	20	-----	26	53	20	42	60	61	291	100
Total hunts, days	8	-----	12	11	6	9	7	9	62	-----
Ducks per day	4	-----	2	5	3	5	9	7	5	-----

NOTE.—The hunting was done in the southern end of Green Bay, Brown County. A cabin is used as a base, and a motorboat for transportation, but there is no ownership or control of any land. The record probably represents what a good hunter can do on the most favorable open shooting grounds of the northeast Wisconsin lakes.

2. *Bluebill shooting* on the deeper lakes. Shooting practice in this type has not changed greatly. It prevails on the northern lakes. Wooden blocks only are used. Where celery predominates, as on Lakes Mendota and Kegonsa in Wisconsin, it may run heavily to canvasbacks.

3. *Mixed shooting* on river sandbars, shallow lakes, and marshlands. This is found in all parts of the region. Both live decoys and blocks are used.

Table 46 shows a typical local composition of the bag in type 3 shooting on the Missouri River. Table 47 shows a local composition, intermediate between types 2 and 3, in Green Bay, Wisconsin. Type 1 requires no example, since it runs almost all mallards.

A comparative summary, including the Statewide kill for Minnesota in 1929, and the kill at one of the historic Wisconsin clubs since 1877, is given in Table 48. The Minnesota figures represent a mixture of types 2 and 3; the Caw Caw Club figures are type 2.

TABLE 48.—*Comparative composition of kill in various States*

Species	J. H. McCord, Jr. Missouri River, St. Joseph, Mo. 1927–29	E. J. Nelson, Green Bay, Wisconsin, 1921–28	Caw Caw Club Lake Puckaway, Wisconsin, 1877–1907	Minnesota (whole State), 1929
Mallard	39	20	2	30
Blackduck	0	0	1	1
Greenwing	19	?	-----------	9
Pintail	12	5	-----------	3
Gadwall	5	2	-----------	-----------
Bluewing	3	10	6	13
Spoonbill	3	2	-----------	3
Widgeon	1	2	1	1
Total puddle ducks	82	41	10	60
Bluebill	16	28	16	25
Redhead	1	10	7	4
Canvasback	0	8	65	5
Goldeneye	1	4	-----------	-----------
Bufflehead	0	5	-----------	1
Ruddy	0	0	2	1
Miscellaneous	0	4	-----------	4
Total deepwaters	18	59	90	40
Total Ducks	100	100	100	100
Average bag per man day	?	5	?	-----------
Average bag per man per year	?	42	?	12
Number of ducks on which based	1,103	291	1,232	1,298,977

Decline of Jacksnipe. The original abundance of jacksnipe in the Mississippi Valley was probably beyond our present imaginative powers. Bogardus (1874) killed 340 in a single day on the Salt Creek bottoms of the

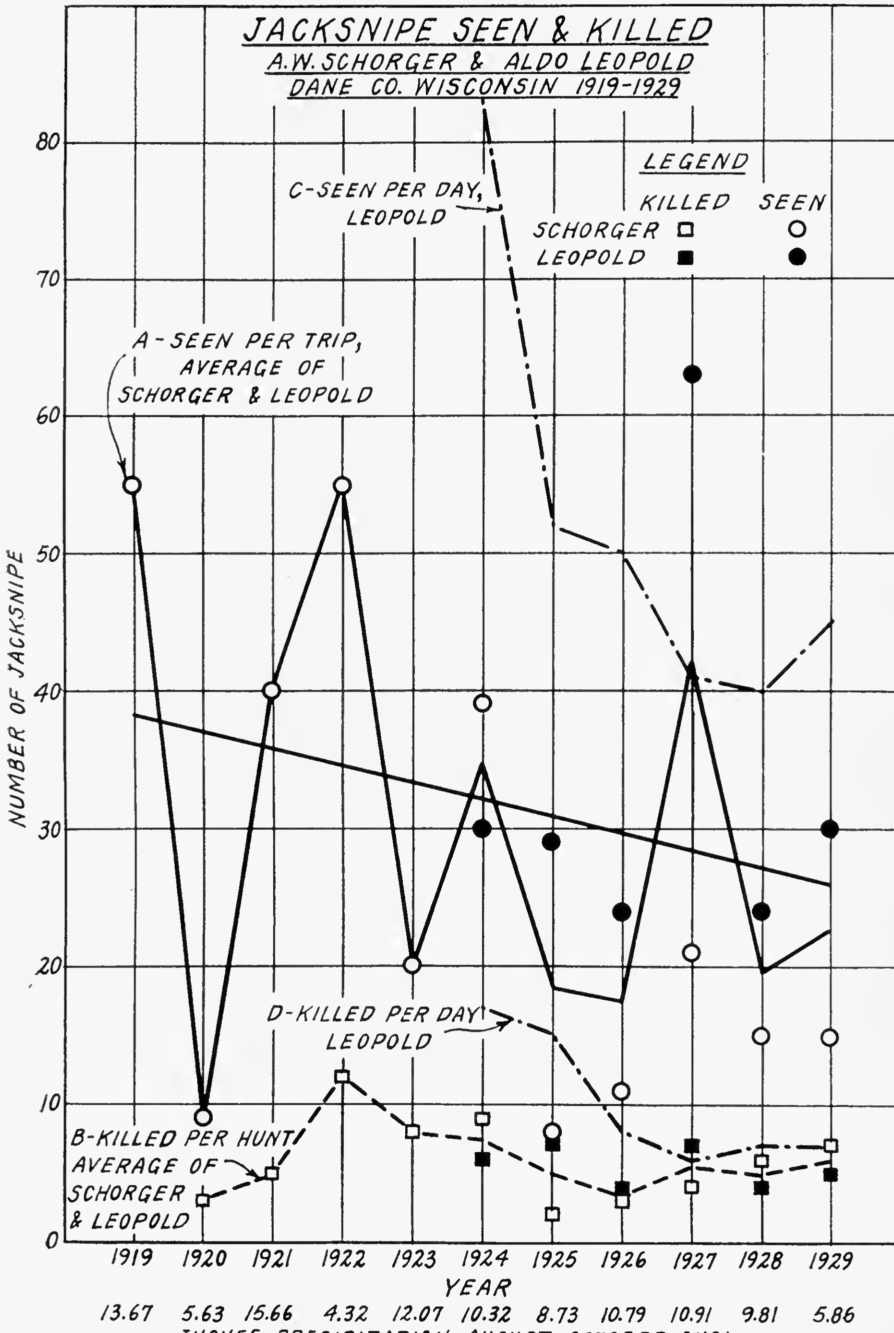


CHART 13.—*Recent Decline in Jacksnipe in Southern Wisconsin*
(Reproduced by permission of the Wilson Bulletin)

Sangamon River, and wagered to kill 100 straight in a day on this area. There were no takers. He says: "Our bag was seldom as small as 75 couple at the right time . . . Snipe are vastly more abundant in the West . . . than in the East."

Kumlien and Hollister (1903) say of the jacksnipe: ". . . still common . . . (but) . . . we should be at a loss to express its numbers in former years." This refers especially to Walworth County, Wisconsin, where Kumlien began his observations about 1868.

That there has been a strong downward trend in jacksnipe is known to all.

Chart 13 shows evidence of a sharp recent decline, possibly temporary, gathered by Leopold and Schorger in Dane County, Wisconsin. The four graphs (A, B, C, and D) represent counts of the jacksnipe seen and killed by them during weekly hunts from 1919 to 1929. The detailed methods of analysis are described in the Wilson Bulletin for September, 1930.

All four graphs show a visible downward trend.

A written journal recording jacksnipe killed, kept by Donal H. Haines, of Ann Arbor, Michigan, was compared with Chart 13, and found to coincide with it to a considerable extent as to which years were high and which low.

Twelve jacksnipe hunters in Wisconsin were also asked to give a general opinion on recent trend. Five thought there had been no perceptible change; six thought there had been a decline; one thought the recent flights had been more sporadic than formerly.

The authors conclude:

(1) That the jacksnipe in the region of Dane County, Wisconsin, has decreased perhaps 50 per cent since 1924.

(2) That this may be due to their passing over or around the region, or to a temporary abundance cycle, or to an actual decrease in the available supply.

(3) That the only reason for doubting an actual decrease in the available supply would be positive evidence that they increased or held their own in the rest of the Mississippi Valley.

The possible causes of the decrease are a matter of conjecture. One likely cause is the shrinkage in southern breeding ranges, which were possibly the most productive. Bogardus says that jacksnipe formerly bred as far south as the Calumet River and the great Winnebago Swamp in Illinois, whereas Schorger is in doubt whether they still breed in Dane County. The twelve snipe hunters whom I questioned concerning the status of jacksnipe elsewhere in Wisconsin reported their breding in Sheboygan, Winnebago, Rusk, and Sawyer Counties. The most southerly of these is Sheboygan. From this, their present known southerly limit, to the Calumet River in Illinois, their probable southerly limit in 1874, is 120 miles.

Since the publication of this paper, a decided improvement was noted in the 1930 flight in Dane County, as compared with any year since 1924. It may not be altogether fantastic to point out that the decline from 1924–29, and the upward

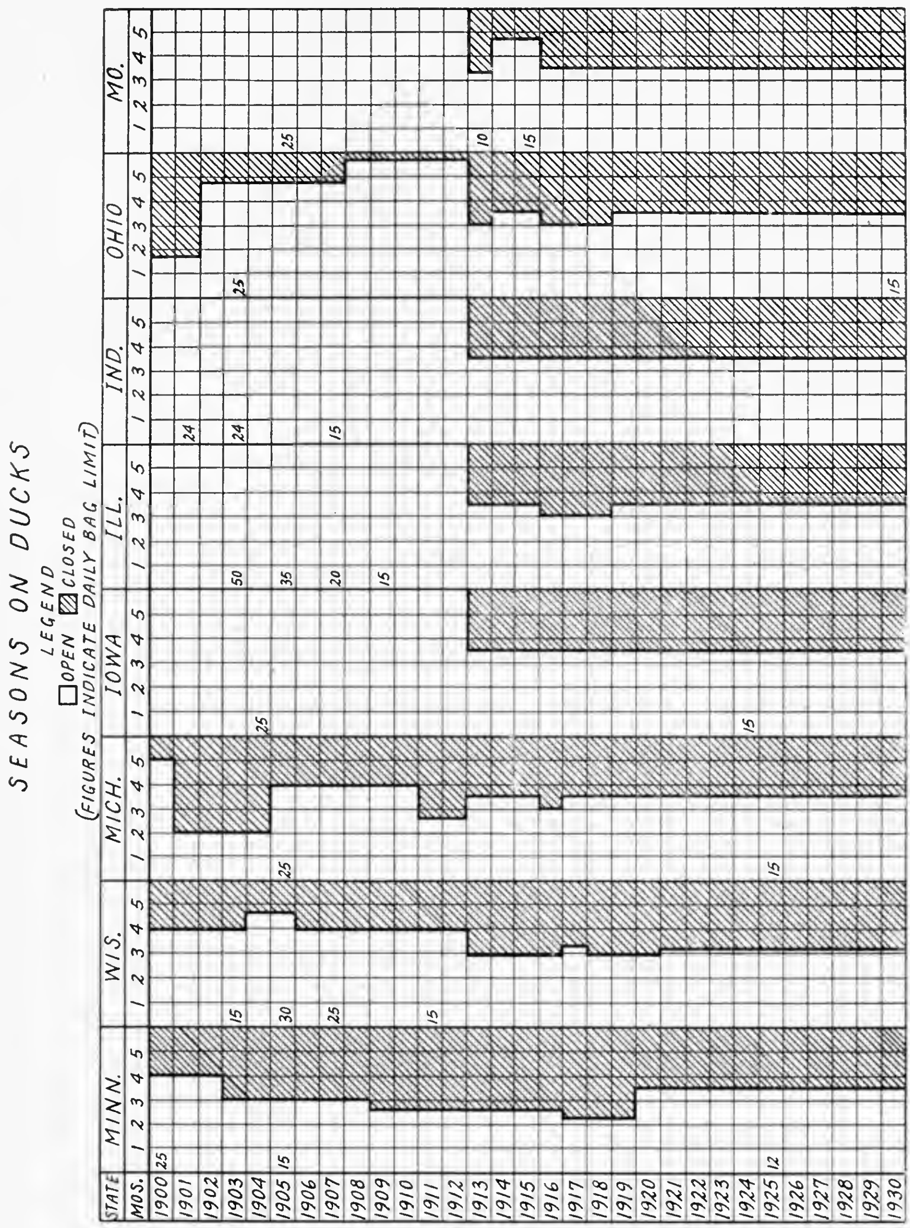

SEASONS ON DUCKS
LEGEND
OPEN
CLOSED
(FIGURES INDICATE DAILY BAG LIMIT)
STATE
MOS.
MINN.
WIS.
MICH.
IOWA
ILL.
IND.
OHIO
MO.
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930

CHART 14

trend in 1930, coincide with the trend of gallinaceous birds during the same period.

Seasons. Chart 14 depicts much human, as well as biological history. It shows the unregenerate states which would not curtail their seasons until the federal law did it for them in 1913. This is mentioned merely to re-emphasize the principle that mobile game must be protected by the whole community over which it ranges, and not left to the local units of that community. Some of these local units are always going to wait for *all* their neighbors to reform before they do.

The fact that the very states which refused to curtail their duck seasons in 1913 had long since curtailed their non-mobile resident game is shown on the other charts.

Missouri still retains her long state season on ducks, 18 years after it was superseded by the federal law.

When the new federal bag limit of 15 ducks was established in 1930, there was only one state in this group (Ohio) which had not already made the reduction on its own account.

CHAPTER XI

PREDATORS

NEED of Density Data. Most of the species of predators found in the north central region are of universal distribution, in the sense that all of the States lie within the exterior boundaries of their several ranges.

Most of them are also resident yearlong, the only known exception being the migratory hawks.

Broadly speaking, therefore, variations in the damage inflicted by predators upon game must arise largely from local variations in the density of predator populations and from differences in food habits of the various species.

Their food habits have been studied to some extent, but their variations in density not at all.

For this reason the attention of the survey was focused on an attempt to gather evidence on the density of predator populations and to discover clues as to any new factors determining such density.

Explanation of Map 18. Crow roosts were mapped only for Wisconsin, Indiana, and Missouri. Abandoned roosts were mapped only for Missouri.

The gray fox range is complete only for Wisconsin.

Red-gray fox ratios were determined in Wisconsin and Missouri only. Predator populations were obtained only in limited parts of these two States.

The reader should notice that the sample predator populations do not attempt to outline the distribution, but only give samples of the density of the several species.

Foxes

Findings on Species Ratio. It is commonly assumed, I think, even among mammalogists, that the kind and number of foxes in any locality is determined by the type of country and the degree to which it is cleared, settled, and hunted.

A corollary assumption is that if the condition of the country remains the same, the species of fox and the density of the population will tend to do likewise.

The evidences yielded by the survey contradicts the second assumption, and to a certain extent the first also. The survey indicates that:

1. Red foxes have tended to replace grays since the settlement of the country. (This is well known, and is usually ascribed to the fact that the red fox is more adaptable to civilized conditions.)

2. There are certain "foxless" areas," lying usually in the prairie, or the till plain type. These foxless areas *are not stable.* Some which were foxless 20

years ago are now heavily infested with red foxes, without any known change in their visible condition to account for the change in fox abundance.

3. The tendency for reds to replace grays has been *reversed* (that is, grays have replaced reds) *in three known instances,* without any change in the visible condition of the country. In one of these instances reds have subsequently replaced grays for the *second time.*

4. The original shift from grays to reds shows a remarkably uniform date over large areas—more uniform than the progress of settlement would seem to account for.

5. The present distribution of grays, while conforming roughly to country containing rock ledges, exhibits unaccountable exceptions, where grays are absent from country seemingly identical with other nearby localities in which they are not only present, but predominate.

These findings suggest that while the recognized factors of type, settlement, and hunting undoubtedly influence the kind and number of foxes, that other invisible factors, as yet unknown, are also at work, and may be even more potent than those ordinarily recognized. The discovery of these invisible factors is important, both from the viewpoint of fox-control as a predator, and fox-conservation as a game animal.

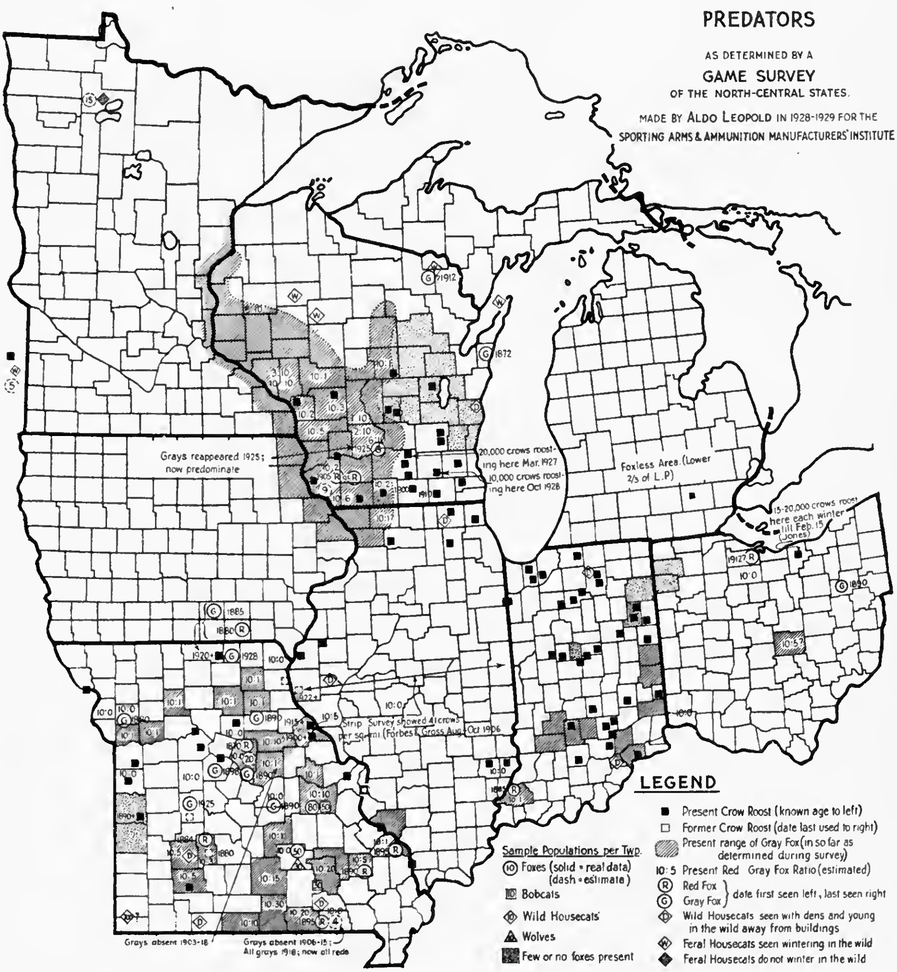
The evidence on which these five indications are based will now be set forth.

History of Red: Gray Ratio. Scattering information on the fox ratio was obtained in various States, but a special study of it was made in Missouri. Map 18 gives the present red:gray ratio by counties in so far as this was determined by inquiry among competent persons during the survey. The map also shows the date of first appearance of reds, and the date of last appearance of grays. The map is of course far from complete, even for Missouri.

The present distribution of reds in Missouri appears to be practically Statewide, with the notable exception that few or no foxes of any kind occur in Bates and Vernon Counties, which lie in the prairies of the Kansas border. This "foxless area" can hardly represent an aversion to prairies as such, because Audrain County, in northeast Missouri, which is quite as flat and bare as Bates or Vernon, has quite a few foxes of both species, the reds evidently inhabiting the prairie, and the grays the riverbreaks. Another reason for doubting whether the red fox is averse to inhabiting prairie as such is that it has recently become quite abundant on the Illinois prairie near Freeport, and it has recently invaded the marshy prairies of Sandusky County, Ohio, and of the upper Kankakee in Indiana. These invasions will be described in detail later.

The original distribution of the red fox in Missouri is unknown, but it was evidently much more restricted than at present. Table 49, to be presented later, shows six widely scattered counties which had no red foxes until the end of the last century. (As to the reliability of this information, it is my experience that fox hunters retain a very clear recollection of former conditions. By compiling more information from them, the original distribution of reds could easily be determined.)

The present distribution of the gray fox in Missouri seems to include the eastern two-thirds of the State, and also the Missouri bluffs below Kansas City. This, in general, is the rough wooded country. It may be highly significant, however, that the species is totally absent at the present time from three regions just as rough and wooded as those where it is present, namely, from the north-



MAP 18

east corner of the State, from a group of counties clustering around Howard County, and from Dent County. Dent County represents typical Ozark conditions. The absence of grays from Dent County is based not merely on the reports of local sportsmen, but also on the entire absence of grays from the 30 foxes trapped in Indian Trail Park (see Table 50).

TABLE 49.—*Dates of first appearance and predominance of red foxes*

State	Observer and county	First Reds by—	Early Ratios	All reds by—	Present ratio	Remarks
Missouri	N. Cave, Callaway	?	2:10 by 1900	1903	10:1	Grays absent 1903-18; reappeared 1918.
	Andrew Brooks, Ripley	1895	Mostly reds by 1900	1906	10:0	Grays absent 1906-15; all grays 1918; now all reds.
	L. O. Nickell, Monroe	?	?	1895	10:1	Fur dealers now get occasional gray.
	Walter McFarland, Madison	1890	2:10 by 1910	x	10:5	
	——— Pfeiffer, Perry	1895	Mostly reds by 1910?	x	10:1	
	Goldberg and Watson, Boone	1870	?	1900	10:0	Another observer says last gray 1890.
	Allen and Martin, Benton	?	?	1925	10:0	
	H. L. Baker, Macon		?	1901	10:1?	Another observer says some grays now.
	Lee Eason, Schuyler	1880	?	1890	10:0	One gray taken 1928.
	E. L. Schofield, Dallas	1884	?	x	10:3	
Indiana	——— Elrod, Clark	?	?	1919	10:0	
	Clarion News, Gibson	1885	?	x	10:1	
Wisconsin	R. A. Moore, Kewaunee			1872	10:0	
	Iowa	1895		x	10:2	
	Grant	1905		x	10:2	
	Gastro and Ochsener, Sauk	?	All reds 1924	?	6:10	Grays reappeared 1925; proportion of grays now increasing.

In Wisconsin the gray is now clearly confined to the driftless area and upper Mississippi types, both of which are characterized by limestone bluffs suitable for denning. In Iowa and Minnesota the distribution further suggests the importance of limestone ledges.

The former distribution of grays in Missouri is unknown, but was apparently nearly Statewide. (This, like the original distribution of reds, could be readily determined by compiling the recollections of the older generation of fox hunters.) The original distribution in Wisconsin is known to have included the limestone bluffs of Kewaunee County on Lake Michigan.

One of the most interesting facts gathered during the survey is the reappearance of gray foxes in Ripley County, Missouri, in 1918, and in Callaway County in 1918. A similar reappearance took place in Sauk County, Wisconsin, in 1925. These three reappearances are based on the best possible authority, namely: for Ripley County, Andrew Brooks, a fox hunter and very conservative observer; for Callaway County, Senator Nicolas Cave, an experienced fox hunter; and for Sauk County, Ed. Ochsener, a fur dealer and taxidermist trained in natural history observations and long associated with H. L. Stoddard in such work. In each case the usual shrinkage of grays in favor of reds had previously taken place. In Ripley County, Missouri, the grays, after reappearing, have since disappeared.

Table 49 gives the known dates of the first appearance of red foxes, and the dates by which they predominated.

Foxless Areas. Foxless or nearly foxless areas now exist as follows:

Location	Numper of counties	Type
Western Missouri	2	Prairie
Northeast Indiana and Northwest Ohio	3	Till plain
Southeast Wisconsin	11+	Till plain
Michigan	25	Till plain and forest
Southwest Minnesota	?	Prairie

The reality of the foxless condition in Wisconsin is attested by the bounty records, not to exceed two fox bounties having been claimed in 1928 from most of the designated counties. The boundaries of the foxless area are only approximate. It may extend farther south.

The foxless area in Michigan is not necessarily comparable to the others, nor are its exact boundaries known, hence it is not shown on the map. The information was obtained from Dr. Ned Dearborn, who says (letter Oct. 1, 1930):

> "The gray fox has practically disappeared from the state . . . The red fox has become scarce, rare, or altogether lacking in fully two-thirds of the lower peninsula . . . and in nearly all of the upper peninsula . . . excepting a narrow strip along the Wisconsin River."

It was not determined whether the foxless condition of any of these now foxless areas is recent or permanent.

It was determined, however, that two other areas not in the table, now heavily infested with foxes, were at one time foxless.

One of these lies in the region of the Sandusky Marshes in northwest Ohio. Federal Game Warden Charlton says:

"There were no foxes in northwest Ohio until 15 years ago (about 1913) when they began to move northwest and became especially numerous in the Lake Erie marshes, where they inhabit straight grassland and are a pest."

The other lies in the Kankakee Marshes of northwest Indiana. Commissioner Miles' 1913 report, in discussing the disappearance of Hungarian partridges, states that they were preyed upon by foxes, but that this could hardly have been the primary reason for their failure because they likewise disappeared "in northern Indiana where there are no foxes." Whether Miles referred to all of northern Indiana, or only to certain parts of it, is not known, but it was determined during the survey that the foxes which now infest the upper Kankakee were first noticed subsequent to the drainage of that area, which began about 1900. No present or recent scarcity of foxes was reported in any other part of Indiana, so it seems a reasonable conjecture that Miles referred to the upper Kankakee or to a region which included it.

Neither the Charlton nor the Miles reports can of course be accepted as absolutely verified fact. Nevertheless, taking both instances together, it seems probable that a foxless condition existed in certain northern counties of both States which have since become populated with foxes, the change evidently dating from about 1913.

In the Kankakee area the change might readily be ascribed to drainage, but in the Sandusky area the marshes lie at lake level and cannot be drained. No other physical change sufficient to explain the matter on an ordinary environmental basis are known to me. It seems a fairly sound conclusion, therefore, that some invisible change has made foxes abundant in two areas where they were formerly scarce or absent.

What Governs the Fox Ratio? There are two popular theories which are entertained by various observers, separately or in combination, to explain why gray foxes have been replaced by reds.

The first theory is that "the reds run out the grays." The proponents of this theory cite as evidence that even where both species still occur, they tend to occupy different terrain. The evidence gathered during the survey indicates that this is often correct, and positively so in Audrain, Madison, and Perry Counties, Missouri, and in Burnett County, Wisconsin. It may be asked, however, why the reds did not run out the grays in pre-settlement days. This refutes the theory, unless the second theory is brought to its aid, namely, that "reds thrive on civilization—grays require wild forest." It is undoubtedly true that the widespread increase in reds as compared with grays has coincided in point of time with the intensification of agriculture, and that where both species occur the grays tend

TABLE 50.—*Fox populations*

(A) As calculated from the kill

Place	Area trapped (acres)	Kill			Apparent Total population	Estimated Influx	Probable Actual population			Abundance ratio
		No.	Period	Estimated proportion killed			Total	Acres per fox	Foxes per township	
Meremac Refuge, Franklin County, Missouri	7,200	20	?	⅔	30	10 per cent	27	266	85	10 reds : 10 grays 10 fox : 6 bobcat
Indian trail Refuge, Dent County, Missouri	14,000	30	2 years	¾	40	10 per cent	36	400	57	10 reds : 0 grays 10 fox : 6 "wolf"
Grant County, Wisconsin		280	1,928	½	560	0	560	1,350	17	10 reds : 2 grays

(B) As estimated by fox hunters

Ripley County, Missouri	(Estimate by Andrew Brooks)	4	10 reds : 0 grays
Boone County, Missouri	(Estimate by W. H. Goldsburg and E. I. Watson)	20	10 reds : 0 grays

to occupy the rough, broken terrain, especially that offering limestone ledges. The second theory, however, is apparently contradicted by the reappearance of grays in Ripley and Callaway Counties, Missouri, during the *same year* (1918); by Ochsener's observation on the increased proportion of grays in Sauk County, Wisconsin, since 1925; and especially by Brooks' observation that in 1918 Ripley County was all grays, although it has since changed to all reds. There are positively no visible modifications of the terrain sufficient to explain these shifts in the ratio. Moreover, why are there no grays in Dent County, Missouri, which is almost entirely composed of the kind of range which grays are supposed to prefer?

The foregoing evidence, in my opinion, does not make it necessary to discard the two popular theories, but it does indicate very strongly that some invisible factor is at work which neither theory takes into account, and which is sometimes more powerful than either of them in determining the species ratio and species distribution. This conclusion is further strengthened by the great difference in fox populations per unit area in apparently similar environments discussed in the next caption. What can this invisible factor be?

It must be something that changes more rapidly and more often than the visible environment. There was no change in the visible environment of Ripley, Callaway, or Sauk Counties which could account for the reappearance of grays above described. The invisible factor which could most probably account for such puzzling shifts and changes is disease or parasites.

Fox Populations. Two localities were encountered in Missouri where a virtual "clean-up" had been made on foxes in the course of the state's predator-control work on refuges. Table 50 reduces the kill to a "foxes per township" figure by making certain arbitrary allowances for influx during the control period. A similar calculation was made in Grant County, Wisconsin, with the help of a local fox hunter.

Section B of Table 50 gives some estimates of "foxes per township" made by selected fox hunters in Missouri.

Locations of all these population figures show on Map 18.

Fox-Quail Ratios. The lowest fox population for Missouri shown on Map 18 is four foxes per township near Doniphan in Ripley County, and the highest is 85 foxes per township in Meramec State Park in Franklin County. Assuming these two figures to represent the two opposite extremes of fox abundance, it is evident without further argument, that the depredations by foxes on game must depend more on fox abundance than on fox habits. Chart 1 indicates that in the Ozark types the most frequent density of quail populations is a quail per four acres. If in Ripley County there is one fox per 6,000 acres, there would be 1,500 quail for each fox.

On the other hand, in Franklin County, which has 85 foxes per township and quail about the same as in Ripley, there would be one fox for each 300 acres, and only 75 quail for each fox.

It is easy to see how one fox per 75 quail might result in serious depredations, whereas one fox per 1,500 quail could hardly be felt, no matter how strong the disposition to catch quail. It should be remembered that both Franklin and Ripley Counties are typical Ozark border territory, and essentially alike in their quail population and their physiography.

It is such evidence as this that forms the basis for my opinion that the fox question is not so much one of whether foxes do more harm than good, but rather a question of what density of fox population affords the best balance between harm and good.

No data were obtained on the general trend of fox populations in the region. One hears much talk about recent alarming increases in red foxes in southeastern Iowa and northern Illinois, and of gray foxes in northeast Iowa. Andrew Brooks is certain that the total fox population in Ripley County has decreased since the period 1908–15 during which grays were unknown and reds were abundant.

This suggests the thought that all of the data on fox ratios here presented is subject to one weakness, and that is its failure to measure absolute as well as relative abundance. Small shifts in the species ratio may not always be a gain of one at the expense of the other, but may represent a change in one species without any change in the other. This error is avoided where the evidence rests on the total disappearance of one or the other. The error cannot be wholly avoided as long as absolute species population figures are practically non-existent.

Controls of Species Ratio. The human forces tending to hold the red fox in check are entirely different from those operating on the gray.

One of these forces is fur value. At the time of the survey, Wisconsin reds were bringing $25 as against $2 for grays. Any undue abundance of reds tends to create its own remedy, in the form of increased trapping and hunting. An undue abundance of grays, on the other hand, is much less likely to be controlled automatically. Control may have to be carried out for game purposes, at the expense of game funds.

Another, and to some extent contrary, force is the sporting value. The red fox is much the more highly valued, and in fox-hunting districts this results in the red being more constantly pursued. It also gives rise to active fox-conservation measures, including closed seasons, replanting of depleted stocks, and even construction of artificial dens. Fox-conservation measures are sometimes more aggressive, intelligent, and better supported by public sentiment than those for conservation of game birds.

Fox Hunting Practices; Phenology; Weights. Fox hunting is practiced as a sport in every State, especially along the southern border of the region, but its customs, standards, and technique differ radically between localities. In some places the objective is to shoot the fox; in other regions the most forcible term of approbrium which one could apply to an individual is that "he would shoot a fox." The non-shooting standard is more prevalent in the South than in the North. Non-shooting customs prevail, for instance, in Morgan County, Missouri, and in Knox, Grant, and Jennings Counties, Indiana.

In Cass County, Missouri, red foxes are propagated by making artificial plants. Similar plants are made in parts of Indiana and recently near Milwaukee, Wisconsin.

In northeast Ohio, and in Columbia County, Wisconsin, red foxes are successfully still-hunted by expert hunters who track the fox to a probable sunning or bedding ground, and there stalk him. Ditch banks or caprocks are the usual bedding places.

Closed seasons on foxes are in force in Indiana and Illinois.

A phenology of the red fox, with the best seasons for running, are given by two expert fox hunters in Table 51.

TABLE 51.—*Phenology of red fox*

	Missouri (E. L. Watson, Boone County)	Wisconsin (Antoine Novy, Manitowoc County)
Mating	December	December 30
Gestation	63 days	
Litters born in	March	March 1
Pups will not run before dogs until	September	
Run well (small circles)		November 1–December 15, February
Run poorly (large circles)		December 15–30
Do not run (that is, hole up at once)		December 30–January 31

Weights of reds and grays

(From Gastro and Ochsener, Sauk County, Wisconsin)

	Red	Gray
Maximum	16 pounds	11 pounds
Minimum	?	8 pounds
Average	12 to 14 pounds	?

HOUSECATS

Do Housecats Breed in the Wild? There is a widespread impression that the housecat upon occasion becomes a wild animal. Zoologists have coined the term "feral housecats" to describe this condition. What are the characteristics of a wild, as distinguished from a domestic, animal? When we consider this question, it is apparent that a truly wild animal must not only exist, but must also breed and reproduce his kind in the wild state, to a degree sufficient to maintain a wild population.

Evidence that housecats exist in a wild state is so abundant and so generally known as to dispense with the necessity of presenting evidence. Wild individuals exist throughout the north central region with the possible exception of a strip along the Canadian border, in which the survey revealed no evidence that they wintered in a wild condition. The most northerly reliable instances of wintering away from dwellings are shown on Map 18.

TABLE 52.—*Cats' dens with young found away from buildings*

Observer, County, State	Date	Nature of den	Young: Number	Young: Age	Miles from inhabited dwelling	Remarks
W. L. Schofield, Dallas, Missouri	March or April	Hollow log	5	3 weeks	2	
Claude Hunt, Taney, Missouri	December	Sycamore stump	6	2 months	½	Den contained remains of quail, small birds, woodpeckers, robins, rabbits.
Claude Hunt, Carter, Missouri	July	Under uprooted pine	2	Half grown	2½	Two parents, male and female, in den.
E. J. Parks, Kosciusko, Indiana	May, 1917	Hollow stump	3	One-third grown	¼	Stump had appearance of a permanent den.
John Vande Walle, Scott, Indiana	Summer, 1910	Hollow log in brush pile	7	One-quarter grown	?	Both parents were in den and were killed.
Geo. A. Dunlap, Brown, Illinois	1900	Hollow stump	3	?	?	Yellow cat, presumably the mother, chased into den by dog.
Jack Wilson, Marengo, Illinois	Summer	Hollow log	"Litter of kittens"	?	½	Says often finds toms in trees and logs, but seldom females.
—— Graham, Sheboygan, Wisconsin	September	Under decayed building uninhabited	4	1 month	⅓	On Sheboygan Game Refuge.

Evidence of breeding in the wild, however, is ever so much scarcer than that of mere existence in a wild state. Table 52 summarizes all of the reliable reports on wild breeding gleaned in the course of several hundred inquiries from trappers, game wardens, coon hunters, and farmers met during the survey. The fact that only seven out of two or three hundred especially qualified woodsmen had ever, in the course of their experience, found dens containing young, constitutes convincing evidence that breeding in the wild is so rare that it can almost be considered exceptional.

The table lists only instances where dens containing litters were actually found. An equal or greater number of instances of dens not containing litters were reported, many having the appearance of constant use, but the absence of young left room for doubt whether these may have actually been the dens of other mammals in which hunted cats were "treed." A number of dens and litters under old buildings were also reported, but these are excluded because the cats may have been abandoned by the former occupants, and could not necessarily have produced a truly wild den.

Drift from Cities. If it be true that the "feral" housecat is seldom a wild-breeding animal, where do the large number of cats known to roam wild in our woods and fields come from.

Probably most of them represent "drift" from cities, villages, abandoned dwellings, or other centers of artificial replenishment.

To support this statement, two instances are offered.

(1) The refuge keeper on the Neosho refuge near the town of Neosho, Missouri, killed 50 cats in one winter on 1,300 acres, or one cat per 26 acres. Such a population is hardly possible. A continual drift from the nearby town must have replenished the area.

(2) Clyde Terrell's father killed on an average of 100 cats per year for a long succession of years on the Terrell farm four miles west of Oshkosh, Wisconsin. This farm was about 160 acres in area. A cat population of one per 1.6 acres would be preposterous. A continual influx from the nearby town must have taken place.

Sex Ratio of Wild Housecats. Circumstantial evidence of the existence of truly wild populations is to be found in the sex ratio of apparently wild individuals. There is a contention almost universal among woodsmen in the north central region that wild housecats are mostly toms. With one exception, however, not one of these woodsmen could adduce figures of the proportion of toms to females in any given number of wild individuals seen or killed. This exception was Mr. Graham, keeper of the Sheboygan Game Refuge, Wisconsin, who killed wild housecats weighing 10, 11, and 18 pounds, in mid-October, 1929, all of which were males.

It is worthy of note that the den of young found by Claude Hunt in Carter County, Missouri, and that found by Van de Walle in Scott County, Indiana, both contained in addition to kittens, a male and a female adult, evidently the parents. This is presumptive evidence that the two sexes are not antagonistic during the breeding season.

It is possible to assume that the rarity of dens of young in the wild is due to the rarity of wild females. Keeping a sex tally on wild housecats killed is such a simple and important task that it seems too bad that no one has so far done it.

Cruising Radius of the Housecat. One of the very important unanswered questions bearing on the depredations of housecats on game is their cruising radius, or the maximum operating distance from headquarters. I have never before had the good fortune to encounter any acceptable evidence bearing on this question until E. L. Schofield, field warden for the southwestern district, cited the following case:

Harry Downes, manager of the Flower farm on the Niangua River, northeast of Buffalo, Dallas County, Missouri, and Jim Hawk of the Moon Valley farms, were out coon hunting when their dogs treed a housecat at a point four miles from the farm headquarters. When the men came up the housecat seemed to recognize them and descended the tree, purring in a friendly fashion. It proved to be a blue tomcat which headquartered at the house four miles distant.

This is conclusive proof that the cruising radius of even a non-feral cat may be up to four miles. It seems probable that the radius of feral cats, harder pressed for a living, may be greater.

Crows

Distribution and Migration. Crows are present yearlong in all parts of the north central region except the Forest Belt, which has few or no crows in winter. Thus in Door County, Wisconsin, crows do not winter except in years of beech mast.

There is a great seasonal difference in abundance, however, in all parts of the region. Thus in southern Wisconsin, crows are most abundant during migration, which occurs in February and March, and in October and November. They are less abundant during the summer, and still less so during mid-winter.

Farther south, in the central corn belt, crows are most abundant in winter, when the local populations are reinforced by migrants from the north.

These seasonal shifts are commonly disregarded in considering the control of crows as a predator. It is useless to kill crows in winter or early spring for the purpose of protecting nesting game birds which do not lay eggs until long after a majority of the winter crows have gone north, and until after there has been an entire reshuffling of the crow population.

Sometimes the crow migration takes place en masse. One day in the spring of 1898 Dr. Lynds Jones saw a great migrating host, numbering hundreds of thousands of crows, flying north near Oberlin, Ohio. When they came to the south shore of Lake Erie, they turned east, evidently seeking some narrower place to cross the lake.

Abundance and Trend. There has been at least one attempt to actually measure crow populations. Dr. A. O. Gross, from August to October, 1906, counted all birds on a strip of land extending across the State of Illinois from Danville to Quincy. On this transect he counted an average of forty-one crows per square mile, or one crow per 16 acres. He found that crows constituted 7.1 per cent of all the birds observed. Quail constituted 1.4 per cent of all the birds observed. In other words, he observed about six crows for every quail. He worked without dogs, however, and thus may have missed a good many quail, whereas the extreme visibility of the crow made it impossible to miss any. This difference in the ease of counting may have distorted the crow-quail ratio.

The evidence on the general trend in abundance of crows is confusing. There are clearly some localities where crows have decreased. In others they are alleged to have increased.

Jack O'Hara, of Janesville, Wisconsin, told me that crows are far more abundant in Rock County now than they were when he began to hunt there in the 60s.

Widmann believed that a decrease had occurred in Missouri at the time his book was published in 1906. He says of the crow: "Constant warfare . . . has greatly thinned its ranks during the last 20 years."

Wheaton records a notable decrease in crows which took place near Columbus, Ohio, in 1883, but Dawson in 1903 records them as abundant in the same region.

The most logical interpretation of such contradictory evidence is that the crow, being a mobile migratory bird, free to follow fluctuations in the food supply, is normally subject to heavy fluctuation in local abundance. It is more logical to impute these fluctuations to movement than to any net change in the crow population of the region as a whole.

Arguing from general premises rather than detailed recorded facts, it is logical to assume that the grain feed introduced by settlement produced an upward trend in crows just as it did in most game birds, but that this increase has since been offset to a greater or less extent by crow shooting.

Crow Roosts as an Index to Abundance. An attempt was made during the survey to map all crow roosts used by 1,000 or more birds. This mapping was done only in Indiana, Wisconsin, and Missouri. Possibly half the actual number of roosts were mapped. Map 18 shows these roosts as black squares. Sometimes it was possible to ascertain for how many years a roost location had been used. Where a date appears to the left of the roost symbol it indicates the known age of that roost.

I am convinced that the phenomenon of roosts is closely associated with abundance of crows. Thus during the Missouri survey, winter crows were observed to be most abundant along the bottoms of the Missouri and Mississippi, somewhat less so on the prairies, and not at all abundant in the Ozarks. A glance at the map will show that the roosts closely follow this distribution of abundance. This can be explained on the assumption that there is some biological advantage in a large roosting aggregation, but that when the distance which it is necessary to travel to form a large aggregation is too great, this advantage is nullified and no large roosts are formed.

In general, roosts appear to be more frequent and larger on the richest land or in the regions of the heaviest corn, which is simply another way of saying that they occur where abundant food supplies induce heavy winter crow populations.

Stability of Roosts. In Missouri former roosts, now abandoned, were also mapped. These show as hollow squares. Where the date of abandonment is known, it appears to the right of the roost symbol.

If it be true that roosts are associated with abundance, then it may be true that abandoned roosts constitute evidence of decrease. It is my impression that abandoned roosts are much more frequent in Missouri than in Indiana or Wisconsin. I am unable to suggest any reason why crows should decrease in Missouri more than elsewhere. The amount of crow shooting there is if anything lighter than in other States.

Some crow roosts have maintained the same location for long periods of time. Thus there is a roost near Stebbinsville in northwest Rock County, Wisconsin, which local sportsmen say was occupied 30 years ago and has been used continuously ever since. Near Spring Prairie in Walworth County, Wisconsin, a single roost was used steadily for 20 years, but recently it has been shot out.

Steady shooting, especially night shooting, forces a shift of roost location.

In Pike County, Missouri, are two roosts known to have been occupied since 1900 and 1915, respectively. In southeast Bates County, Missouri, there is a roost occupied since 1890.

While roosts may persist through a long period of years, they are not always stable through the various seasons of use. In northern Illinois, for instance, fall roosts and spring roosts are said to often differ in location. Likewise the roost at McFarland in east central Dane County, Wisconsin, is reported to be used in fall, but not in spring. In the vicinity of Oberlin, Ohio, Dr. Lynds Jones told me there is a winter roost of about 20,000 birds. About February 15 this roost progressively breaks up and scatters into smaller units. By March 15 a dozen roosts of 1,000 to 1,200 birds each are formed. In late March these dissolve into nesting pairs, and there is no more gregarious roosting until the following fall.

Radius of Roosts. There is room for some very interesting field research to determine the radius of feeding territory covered from a single roost. This could be ascertained by plotting on large maps the time and direction of evening flights. Ordinary observation shows that the territory must often be as large as a county. The last arrivals in the evening sometimes do not arrive at the roost until after dark. At the Sun Prairie roost in Dane County, Wisconsin, which I visited several times in March, 1927, long strings of crows began to arrive at 3:30 o'clock in the afternoon, and the strings were still coming in when they could only be seen by moonlight. This late hour of arrival of course argues for a very long radius for the particular roost in question.

Size of Roosts. Three observers, including myself, counted sample strings of crows arriving at the Sun Prairie roost just described, and by multiplying the count by the number of strings, estimated that between 20,000 and 40,000 birds were present. This size was not attained until March, nor have these numbers been equalled in any subsequent year.

Ruzicka counted one of the strings entering the roost at Watertown, Wisconsin, in October, 1928, and then, by multiplying by the number of strings, arrived at an estimate of 10,000 birds in the roost.

Widmann says that hundreds of thousands of crows roosted on Arsenal Island south of St. Louis in November and December previous to the publication of his book in 1906. These birds occupied a willow thicket on the island. In very cold weather they roosted on the ground in the snow, where the imprints of their bodies were observed next day.

Disease. Dawson says that winter crow roosts in Ohio are subject to epidemics of "roup" which inflame the eyes, pharynx and nasal passages, and give rise to the popular belief that the eyes "freeze shut" in cold weather. The belief arises from dead crows picked up under roosts with frozen discharges about the eyes.

Crow Control. There is undoubtedly an increasing tendency for crows to be systematically hunted for sport. This arises in part from the scarcity of other shootable game, in part from a desire to control crows as a game conservation measure, and in part from the invention of the crow call and the development of live and mechanical decoys as an aid to crow shooting.

Where crows are abundant, these modern methods of crow hunting are sometimes phenomenally successful. Two men are said to have killed 5,962 crows in Green, Montgomery, Clinton, and Preble Counties, Ohio, in one winter by the systematic use of decoys and calls. In Indiana crows are also systematically hunted in many localities. Organized crow hunting is coming to be frequent in southern Wisconsin, but here the methods used include the use of flashlights in the crow roosts at night. Judge George W. Wood says that three men killed 4,000 crows in northeastern Iowa during the past year, and that no roosts exceeding 1,000 birds are left in that part of the State.

While game research may show that it is advisable to control crows, especially during the breeding season in areas where they are most abundant, there is room for doubt over the desirability of an indefinite growth of organized crow hunting, particularly the demolition of roosts by night hunting. It seems likely, however, that any tendency toward excessive crow killing will in the long run tend to regulate itself because highly organized methods are no longer feasible after abundance has been reduced below a certain point. Desultory unorganized crow hunting will probably never greatly affect the supply.

Indiana has a State law which authorizes the counties to pay a standard bounty of 10 cents per head on crows. Only part of the counties, however, avail themselves of this authorization. The bounties are paid from the county treasury.

Ohio similarly authorizes a 25-cent bounty on crows. Hamilton County paid out 1,200 in 1927, indicating a kill of 4,800 crows.

CHAPTER XII

GAME LANDS AND GAME ADMINISTRATION

FINANCING of State Game Departments. Most State game funds are derived from the sale of licenses.

It is impossible, for a number of reasons, to present an accurate summary of the financing of State game work in the various States. First of all, both game income and game expenditure is inextricably interwoven with fish income and fish expenditures. This is true in every State.

Secondly, the methods of accounting are so varied, as well as the degree to which detailed conservation budgets are published, that the figures from one State seldom parallel those from another.

Thirdly, much confusion is produced by the reappropriation of incomes, and by balances carried over. It would be feasible to summarize the total conservation budget by States, but meaningless because of the wide variations in the subject matter or inclusiveness of conservation departments.

The only simple way to present a generalized picture of State game finance is to reproduce the figures annually reported to the U. S. Department of Agriculture as game income. These figures include not only indubitable game income, but also indivisible income from combined hunting and fishing licenses. For this reason, the figures in Table 53 are somewhat larger than the true game income. The magnitude of this error varies somewhat by States, depending on what combination licenses are offered.

TABLE 53.—*Game Income of State game departments*

State	Returns from hunting licenses	Area of State (acres)	Returns per acre
Minnesota	$107,700	54,196,480	$0.002
Wisconsin	148,900	35,363,840	.004
Michigan	400,500	37,107,200	.01
Iowa	175,100	35,934,080	.005
Illinois	335,800	36,265,600	.009
Indiana	298,600	23,266,560	.01
Ohio	382,300	26,240,000	.01
Missouri	303,500	44,428,800	.007
Total	$2,152,400	292,802,560	.057
Average			$0.008

The game income is not believed to differ markedly from game expenditure, since legislative diversion of game funds are fortunately no longer prevalent. The last ones heard of during the survey were a diversion of approximately $250,000 of accumulated game funds by the Ohio legislature in 1927, and an annual diversion in Iowa by reason of a statutory limitation on the amount to be spent for game. In 1928 this diversion was about $60,000.

The game income for the season of 1928–29 was reported by the States to the U. S. Department of Agriculture as follows:

The outstanding fact shown by this table is that the present resources of the State game departments permit of the expenditure of one cent per acre per year for game conservation in only three States.

No one knows as yet what actual game management should cost. Game is a low-yield, low-cost crop. We may safely infer that game management, if it is to meet the recreational needs of our growing population, must be practiced on a large proportion of the total area of each State. We may also safely infer that it cannot be practiced for one cent per acre per year, nor probably for less than five or ten times that amount. It would therefore appear that even after the State game departments are more amply financed (as they should be) there will be little hope of their assuming the entire cost, or even any large part of the cost, of the desired Statewide practice of management.

Per Capita Expenditures. Before proceeding further with the analysis of the State's function, it is well to gain the additional perspective of what the average citizen invests in game and fish conservation. (Every one knows what the average hunter invests. It is the dollar or two which represents the cost of his hunting and fishing license.)

Game Commissioner Keith McCanse made an analysis of per capita expenditures for game and fish conservation in Missouri in 1927. The total hunting and fishing license income from each county was divided by the number of inhabitants. The resulting per capita expenditure figures are subject to one error: a hunter may live and busy his license in one county but do his hunting in another. There is no way to correct this, so that it must be arbitrarily ignored. Proceeding on this basis, the analysis shows:

(1) The lowest per capita investment was three cents. It occurs in a group of five rich farming counties on the black prairie northeast of Kansas City. This region has the least game of any part of Missouri, presumably by reason of the fact that there is no cover to go with the food.

(2) The highest per capita investment was 17 cents and occurs in Cole County, which contains the State capital, and in Phelps County. Both contain cities and are characterized by a thorough interspersion of timbered hills affording cover, and thrifty farms affording food. Practically the same rate of expenditure also obtains in two groups of counties around St. Louis and Springfield, respectively.

(3) In general, southern Missouri expenditures run much higher than northern Missouri. Expenditures follow the game rather than the human population.

This is merely another way of saying that the average citizen hunts if there is something to hunt for, but when there is not, he unfortunately ceases to hunt, rather than create for himself a suitable game supply. The whole hope of game management rests on the assumption that this has been so because the average citizen has not heretofore realized that the creation of a game supply is possible.

In money, the average citizen of Missouri spends per year for game and fish production through public channels not to exceed one tenth the cost of a box of shells, and often less than it takes to run his automobile one mile. He spends less per year for game than he spends per hour for a baseball game or movie show.

The average citizen, as well as the hunter, has a stake in wild life. It is his property, and the social value of hunting and other recreations depending on wild life affects his individual welfare. He supports parks, schools, museums, etc., not because he uses them personally, but because of their value to society. Why should he not help support wild life conservation?

The Function of State Game Administration. The State's expenditure per acre convincingly proves that no State can afford to be its own game manager on all of its game lands.

The low expenditures per capita indicate that the average citizen could afford to help carry the cost of conservation as a public welfare activity. The low expenditure per hunter indicates that he could compensate the landowner for producing game without making hunting more expensive than his other recreations.

If these conclusions are correct, it seems sound to conceive of the State as the leader rather than the doer in game matters; as a teacher of methods rather than as a manager of lands or resources; as the agency responsible for striking the shackles of inactivity from both sportsman and farmer, rather than as the paternal benefactor which raises game for the hunter. The State must indeed undertake to demonstrate what management is, and how it can be practiced; it can advantageously own and administer key lands like refuges and game farms, and cheap lands usable for forestry as well as game production; it must intercede and provide for inter-State and inter-county game species for which no one landowner can be held responsible; lastly, it must unearth facts about game which the individual private citizen cannot afford to unearth for himself, just as it now unearths facts about agriculture which the individual farmer cannot afford to unearth for himself. Nevertheless the guiding idea behind all State game activities should be the realization that its financial resources are so limited, when compared with the vast extent of the game problem, that its proper function is to do only what its citizens cannot or will not do.

In short, State game administration (on all but the cheapest land) is the art of fostering and regulating the practice of game management *by* its citizens. This is the direct opposite of the now prevailing conception that State game administration is the art of practicing game management *for* its citizens.

If the proper function of a State game department is to act as a leader and teacher of game management, we are confronted at once with the basic problem of whether the State game departments are organized in a way that attracts competent leaders and teachers, and which enables them to work effectively. Good organization alone will not produce such men, but good organization is necessary in order that the State may successfully compete for their services, and in order to enhance their output after such services are obtained.

Organization of Conservation Departments. No two States of the north central region are exactly alike in the organization of their conservation work, but each of them falls into one of four types of organization.

For brevity in discussion it will be necessary to coin names for these four types.

First, there is the original "State game and fish warden" type that once prevailed in nearly all States, and which constitutes the "ancestral form" from which later and more specialized forms have evolved. It has the merit of great simplicity. The governor simply appoints a State game and fish warden (often called game and fish "commissioner") as the executive officer in charge of game and fish work. This executive sets up an office staff and a field organization. There is no special provision for co-ordination with the State's other conservation activities; if any regulatory powers are granted they are usually exercised through the governor; there is no provision for continuity of policy. The usual outcome is that the warden, and sometimes also the field and office organization, change with each change in State administration.

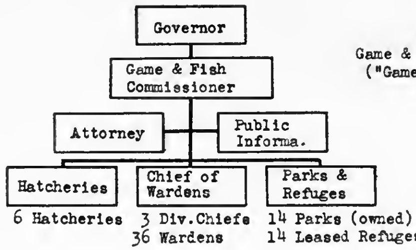
Some able work has been done under this form of organization, but this occurred perhaps in spite of, rather than because of, the merits of the form as such. Its fundamental defect is its inherent instability. Able men are seldom attracted to an organization which may suffer a complete turn-over every two or four years.

This first type of organization prevails in Minnesota, Iowa, and Missouri. The organization diagram for Missouri illustrates the type.

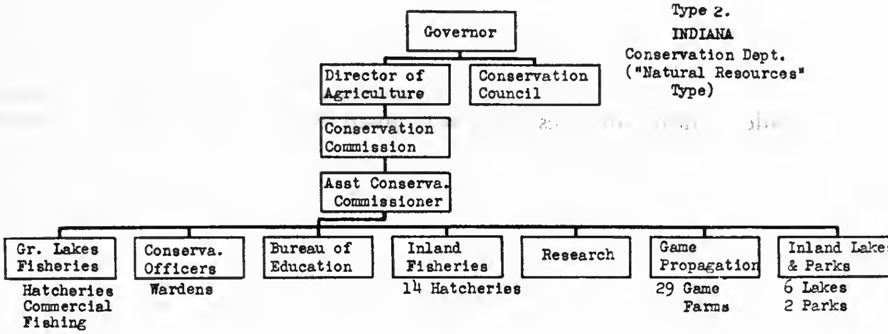
A second type of organization may be called the "department of agriculture" type. In this type, conservation activities form one branch of the State department of agriculture. In the north central region this type occurs only in Ohio.

There is, of course, a fundamental and powerful logic in affiliating game with agriculture. In practice, however, the actual game programs under type 2 have not differed materially from those undertaken where no such affiliation exists. The affiliation has created no disposition, for instance, to come to grips with the land issue; that is, to encourage landowners to regard game as a crop. The degree of co-ordination between game and other conservation activities is not as great as the name would suggest. Thus in Ohio the State forester is not in the department but rather on its conservation council, which has only an advisory function. He is attached to the Agricultural Experiment Station, which works

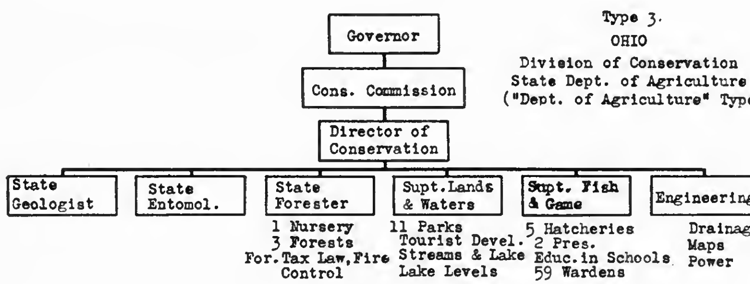
Type 1.
MISSOURI
Game & Fish Department
("Game Warden" Type)



Type 2.
INDIANA
Conservation Dept.
("Natural Resources" Type)



Type 3.
OHIO
Division of Conservation
State Dept. of Agriculture
("Dept. of Agriculture" Type)



Type 4.
WISCONSIN
Conservation Dept.
("Commission-Director" Type)

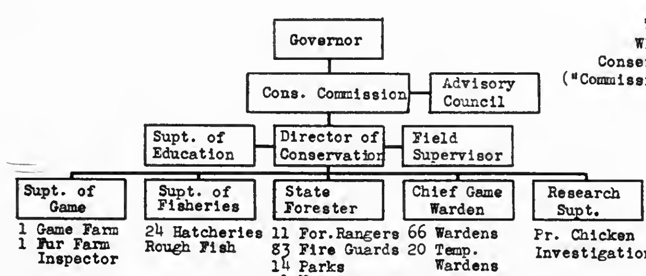


CHART 15

with the university rather than with the U. S. Department of Agriculture. In short, there is as yet no more co-ordination between game and forestry under type 2 than occurs in the "game warden" type of organization.

In practice the fundamental weakness seems to be that State departments of agriculture are unstable. Their outlook is accordingly more political than technical.

The third type of organization may be called the "natural resources" type. In it the inorganic (as well as the organic) resources of the State are placed, with respect to their conservation, under a single jurisdiction. Indiana is the only State in the north central region which employs this form, although it is becoming more or less common elsewhere. In Indiana, mineral resources and water power are included with game, fish, forestry, parks, and agricultural entomology as bureaus of the conservation department. The overhead in the Indiana organization follows the commission-director type to be later described, and hence is comparatively stable.

The "natural resources" type of organization frequently includes the promotion of tourist business, the promotion of mineral developments, and other functions bordering on those of a State chamber of commerce. From the writer's standpoint, there is a fundamental incompatability between game management and such promotional functions, and likewise between the administration of renewable organic resources and non-renewable mineral resources.

Nevertheless, the very comprehensiveness of the "natural resources" type has in itself a certain merit. In Indiana it has effected a greater co-ordination between game and forestry, for instance, than that usually prevailing in other States.

Fourthly, we have the "commission-director" type found in Michigan and Wisconsin. In this type the governor appoints a group of unpaid commissioners. By reason of their overlapping or "staggered" terms, no one governor ordinarily has the opportunity to appoint the whole commission. The commission supplies continuity and exercises regulatory powers. It in turn appoints a director of conservation, who is the chief executive, and who appoints various bureau chiefs in charge of the various conservation activities. In Wisconsin these bureaus include only organic resources such as game, fish, forestry, and parks, but in Michigan a State geological survey is included. To this extent Michigan verges toward the "natural resources" type.

The "commission-director" type of organization, as developed in Michigan and Wisconsin, closely approximates the "corporation" type in industry. The commission corresponds to the board of directors, and the director of conservation corresponds to the general manager.

Theoretically the "commission-director" type is freer of fundamental defects than any other type found in the north central region. It of course goes without saying that no form of organization assures an able administration of conservation affairs by reason of the form as such.

Illinois has a form of organization which superficially resembles the "commission-director" type, but which actually belongs in the "State game warden" type. There is a "director of conservation" to whom various division chiefs (including game, fish, and forestry) report, but there is no commission standing between this director and the governor. The governor has a conservation advisory board, but this board does not appoint the director, and hence does not assure continuity, nor does it constitute a body fitted for the exercise of regulatory power. The whole organization is essentially unstable to the same degree and in the same manner as the "game warden" type.

The situation in the north central region may be summarized as follows: Minnesota, Iowa, Missouri, and Illinois employ the "game warden" type, relying on an unstable executive appointed by the governor. Ohio employs the "department of agriculture" type. Indiana employs the "natural resources" type. Wisconsin and Michigan employ the "commission-director" type.

Conservation Programs

Law Enforcement. The enforcement of the game laws is rightly regarded as foundational to any workable system of game conservation. The reason it is not more frequently mentioned in this report is that it is one of the few points on which opinion is unanimous.

There is no satisfactory yardstick by which the status of law enforcement can be compared for the various States, or measured against an ideal condition. Percentage of convictions, or convictions per unit area, or per warden, are not satisfactory indices because they do not indicate the amount of educational work accomplished, or the degree to which each conviction represents the co-operation of public sentiment and public officials. Nevertheless convictions are the only measuring stick easily applicable to the records customarily kept. The following table is offered for what it is worth.

Table 54.—*Status of game and fish law enforcement*

State	Year	Arrests (number)	Convictions		Number of counties	Convictions per county
			Number	Per cent		
Minnesota*	1930	2,415	650	91	87	7.4
Wisconsin	1929–30	2,093	1,883	90	71	26.5
Michigan	1928	3,860	3,511	91	83	42.3
Iowa	1928	1,448	1,336	93	99	13.5
Illinois	---	---	---	---	102	---
Indiana	1929	2,153	1,988	93	92	21.5
Ohio	1929	1,235	1,141	92	88	12.3
Missouri	1929	1,341	1,239	92	115	10.7

*Small game only.

The table of course includes offenses against the fish laws as well as against the game laws, and fish cases undoubtedly preponderate in number. No satisfactory data on the kinds of offenses represented in the table were obtained. It is probably a safe conjecture to say that in the average north central State not over five or ten convictions for offenses against the game laws are secured in the average county in a year.

The number of convictions seems to be growing at least as rapidly as the number of licenses. In Indiana they have grown more rapidly:

Year	Game and Fish Licenses	Game and Fish Convictions	Licenses per conviction
1918	90,000	347	230
1928	320,000	2,472	129
Increase	230,000	2,125	
Per cent	255	609	

In Michigan they have grown at the same rate (although the figures are not exactly comparable, the licenses representing game only and the convictions both game and fish).

Year	Game Licenses	Game and Fish convictions
1921	270,786	2,530
1927	360,511	3,305
Increase	89,725	775
Per cent	33	30

The experience of the U. S. Forest Service in enforcing the fire laws on the National Forests has a bearing on the present problem of the several States in enforcing their game and fish laws. The individual effectiveness of forest officers in law enforcement was greatly enhanced by a system of training camps organized for the purpose of giving instruction in the technique of law enforcement and other work. A few State conservation departments in this region have begun to realize the possibilities of training camps, but they have so far been conducted indoors rather than in the field. Thus Wisconsin, Missouri, and Illinois have begun to assemble game wardens indoors for purposes of instruction. Wisconsin issues a manual for the concise presentation of information bearing on their duties.

State Refuge Policies; Public Shooting Grounds. In this region, as elsewhere, a "game refuge" may mean anything. It may be a spot on a map, which looks well in a report but cannot be distinguished on the ground. Or it may be a real and indispensable cog in the machinery of game production. There are all intermediate gradations.

Refuges of the latter category, in so far as they occur in the region, are described in the previous chapters under the species principally served. It is here in place, however, to review in a broad way the administrative policies of the several States with respect to the establishment and ownership of refuges, and the acquisition of public shooting grounds.

Minnesota has a system of leased refuges for upland game, a few very large big-game refuges on the National Forests and State Parks, and a growing system of small leased waterfowl refuges, some operated in co-operation with

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sportsmen's associations. Of the three classes, the last is by far the most significant. The State and private waterfowl refuges of the Hutchinson community, in McLeod County, are a model which might be widely copied with profit. In addition Minnesota is just embarking on the acquisition of a large public shooting ground for waterfowl in the region of Thief and Mud Lakes, in conjunction with the proposed Federal refuge there.

Wisconsin has a system of leased upland refuges, but it is not extensive. Few of these are of any consequence. There are a few waterfowl refuges on public lakes which are of real value, and this system is now being extended. There is also talk of acquiring large blocks of land in the Sand Plain area for a system of public refuges and shooting grounds for prairie chickens, waterfowl, and deer.

It is worthy of note that neither Minnesota nor Wisconsin has begun to acquire forest lands for combination State forests, deer refuges, and public shooting grounds, on the "Pennsylvania Plan." Michigan has made an excellent start.

Michigan has the usual system of leased upland refuges, and has made an analysis of their character and the manner in which they operate. A summary of this analysis is presented in a later caption. Michigan also has in process of acquisition eight standard refuge units, each consisting of a State-owned deer refuge surrounded by a State-owned public shooting ground. This system, while by no means complete, is the most significant development of the region in the category of State refuges for upland or big game. It is described in the big-game chapter.

Iowa has a few waterfowl refuges on State-owned lakes, and a few refuges incidental to State Parks.

Illinois has a valuable State-owned waterfowl refuge at Horseshoe Lake, and a few other miscellaneous holdings classified as refuges and public shooting grounds, but of small consequence. The State also has 30 leased refuges aggregating 10,000 acres, called "preserves." Illinois is voting on a very large bond issue for the acquisition of a system of refuges, public shooting grounds, and recreation areas throughout the State. This system is to include both uplands and lowlands suitable for waterfowl. Since the bond issue is not yet passed, and since its provisions are changing from time to time, no detailed description is here in order.

Indiana has the usual system of leased refuges, and has in process the acquisition of two waterfowl refuges to be surrounded by public shooting grounds in the Kankakee Marshes and Jasper County, respectively. There is also a game "preserve" in Brown County, which is so far operated as a game farm rather than as a refuge. It has a large system of State parks, some of which have game value.

Ohio has the usual system of leased refuges. It also has a small but valuable system of State-owned waterfowl refuges on public lakes. Its "Roosevelt Game Preserve" serves only as a game farm and public amusement park.

Missouri has the usual system of leased refuges, some of which are operated as game farms. The State also is acquiring a valuable system of State Parks, part of which have positive value for game purposes. These are being planted with deer and turkey and subjected to management, and are in fact serving as workable big game refuges.

Classification of Refuges. The Michigan Game Division has evolved a classification of big-game refuges, with respect to kind and function, which may be of value to other States. The principles apply to all kinds of game. The classification is not officially approved or adopted, and should not be construed as committing the commission. Five kinds of refuges are proposed:

1. *Incidental.* In this class the refuge area is originally and dominantly a military reservation, State park or the like. The refuge function in such cases may or may not be important.

2. *Standard.* The official specifications as to size call for 4-10 sections inside the refuge. It is to be more or less surrounded with state-owned public hunting grounds, so located and blocked as to insure that private parties will be unable to acquire lands on or near the boundaries so as to exclude the public from free access to the first fruits of the refuge.

These "standard" units are being located in districts where there are really large areas of wild land, so that there can and will be a ready and steady spread of game in all directions; also an opposite concentration during the hunting season, and, often, for wintering.

Such "standard" units are being located within 20 miles of each other, or less, and in a geographic pattern carefully worked out in accordance with the pattern of the cover types, and "breaks" such as settlements, bare plains, large water bodies, and the like.

It will often be found practicable and desirable to combine standard units with State and National Forests, large State Park units, etc.

3. *Local.* These are to function in the same manner as the "standard" units, but will, as a rule, be smaller, and will be fitted into relatively small areas of wild land which tend to be over-hunted. It will be realized from the first that there can be no general or long distance radial shifting of big game.

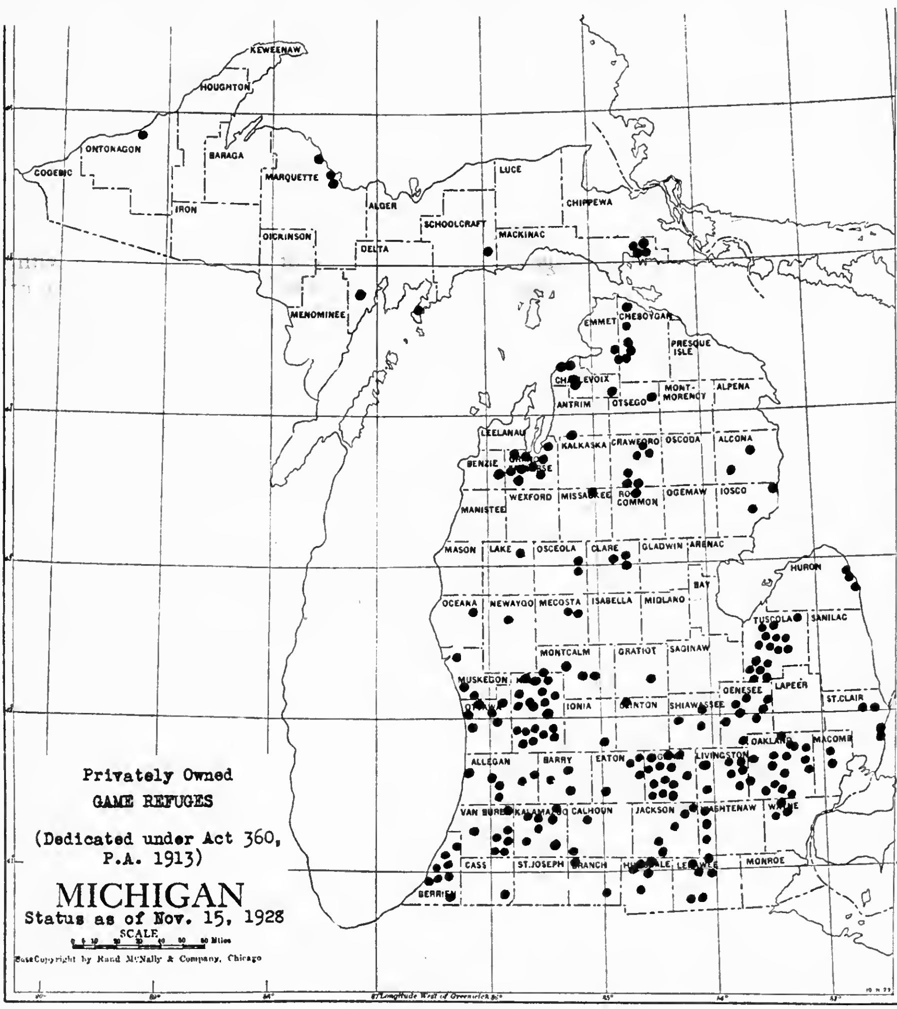
4. *"Dodge-ins" or "Hide-outs."* These will correspond to the "safety-zones" put in for humans where street traffic is heavy and dangerous.

It will be realized, in advance, that during the bulk of the year the unit cannot carry much wild life. It may have no wintering facilities whatever. During the summer season it may carry very few deer. But it will contain heavy cover of some sort, water, and some feed. In many cases such units will be located so as to utilize pine plantations 10 to 25 years old.

Such units may well be a square mile or less in area, and may well be spattered about between the "standard" units at intervals of a few miles, and the heavier the concentration of hunters, the more numerous the "hide-outs" should be. Their function is to insure enough unhuntable and non-drivable territory to prevent the essential breeding stocks of deer from being depleted below a safe level.

In general such "hide-outs" would hardly tempt private parties to acquire and post adjacent lands, but where practicable they may best be located within large tracts of State-owned lands or in State or National Forests.

5. *Sanctuaries.* These will have little or no relation to game and guns. Their function will be to provide typical areas of each important type of country or cover or habitat or of wild-life associations which may be kept "forever" in status naturae—"plumb wild" and uncontaminated to the extent this may prove practicable. Ripe timber may rot under its moss, arbutus wither unpulled . . . Units of this type will be "refuges" in a special sense, but their prime function will be aesthetic and scientific, rather than game management.



Map 19

Analysis of Leased Refuges. Most of the north central States have sought to build up large systems of small refuges cheaply, by offering farmers a nominal rental, and also the use of State refuge signs, in exchange for complete closure of designated holdings.

Michigan's system of leased refuges will serve as a sample. H. M. Wight, of the Michigan Conservation School (1928, unpublished), made for the Conservation Department a careful survey of 194 leased refuges in the southern peninsula of Michigan. He found the average area to be 168 acres. His map of the system (Map 19) indicates no particularly logical pattern in the location of these refuges. The motives of the owner in seeking a refuge are of course mixed, but Wight found protection from hunters to be a more frequent motive (98 per cent) than conservation of game (82 per cent) or improvement of hunting (8 per cent). The proportion of refuges on which positive management measures had been undertaken by the owner was very small, and these measures consisted mostly of ill-advised or excessive predator-control, and seldom of improvements in food or cover. While Wight reaches a more optimistic conclusion, his analysis shows little accomplished by the system which would not have followed ordinary private posting of the same areas.

Missouri and Indiana have used leased refuges as foci for stocking operations. This is a real and legitimate function, justifying State-sanctioned posting, provided the refuges offer suitable habitat for the species to be stocked.

Ordinarily, however, it appears poor principle for the State to sanction posting *not followed by management*. There is enough such land already, and it will increase without State help.

Public Lands Available for Management. The State-owned refuges and public shooting grounds already discussed probably do not aggregate over 150,000 acres for the region as a whole. (An exact figure is impossible because of varying definitions of what is a refuge, etc.)

For the reader to have a clear picture of public management the conditions in the region, and the outlook for public management, it is next necessary to examine what other publicly owned lands are available for game production. Parks will here be excluded. They often perform a valuable function, but they are not production areas.

The bulk of the additional publicly administered land available consists of State and National Forests. Here again we encounter diverse definitions. The Forestry Almanac for 1929 lists the following:

State	Public forests			
	State Forests		National Forests	
	Number	Area (acres)	Number	Area (acres)
Michigan	12	373,000	1	179,000
Minnesota	?	70,000	2	1,005,000
Wisconsin	?	173,000	3	(325,000)
Indiana	1	5,000	0	x
Ohio	?	38,000	0	x
Missouri	0	x	0	x
Total	------------	549,000	------------	1,509,000

All of these forests are under organized administration, usually by technically trained men. All of them might be said to be under some rudimentary degree of game management, and this could easily be intensified and increased.

To this forest area must be added about 156,000 acres in the Upper Mississippi Refuge, and about 150,000 acres in State refuges and public shooting grounds, mostly in Michigan. All taken together, there appear to be about 2,275,000 acres of land under public administration, and either managed for game, or readily placed under game management.

Since the great bulk of the area ultimately under public game management will doubtless be in forested regions, we may compare this figure first of all with the total forested area (excluding woodlot forests). The region contains about 68,000,000 acres of forest land. It would appear therefore that about 3 per cent of the area suitable for public game management is in some degree being administered for game at the present time.

A much larger percentage is actually under public ownership in the form of reverted tax lands, scattered State holdings, and the like, but such lands cannot be placed under management until consolidated into solid blocks and placed under field administration.

Fire Control. Space forbids more than a brief description of this important subject, and its many ramifications with the game problem.

The first question of fact affecting game management is the extent to which forest fires still prevail. Forest fires are least under control in Missouri, where the larger part of the forested areas burn yearly, and sometimes even twice a year. Some of these fires are deliberate, some burn by suffrance, practically all are man-caused. The State maintains no widespread control organization.

In the Lake States forest fires still burn considerable areas in drouth years.

The greatest aggregate damage to game, however, probably arises not from true forest fires in the Forest Belts, but from the spring and fall fires in marshlands, fence rows, and woodlots in the Agricultural Belt. These are not yet usually regarded as harmful, but they harm game more than forest fires do because the latter are under partial public control, whereas the former are still as customary as in the days of Daniel Boone, and occur where there is already a radical shortage of game cover.

The organized burning of roadsides by highway departments and railroad right-of-ways by railroad companies further lessens the wintering and nesting cover in the Agricultural Belt. As States we pay our highway officials to destroy what we pay our game officials to maintain. Where highway clearing and burning is necessary for highway purposes, it is of course justifiable, but many a brushy fence row, especially along secondary roads, is burned or cleared more often or more completely than seems necessary. State game officials would often create more game by arranging a *modus vivendi* with highway departments, than by planting expensive game stock on denuded land.

By and large, the fires affecting game in the north central region are under partial control only in the northwoods type of the Lake States. Of these States, Michigan easily leads in the effectiveness of her control machinery.

The physical fire hazard (that is, the burnable material on the land) is undergoing important changes in certain parts of the region. In the Forest Belt of the Lake States repeated burning is converting large areas from timber to brush, and from brush to grass. This transition to grass is accompanied by an extreme increase in the length of the fire season, and in the rapidity of potential spread.

On the other hand, in the Agricultural Belt, the grazing of woodlots is rapidly decreasing the physical hazard. The grazing and cultivation of drained marshes has a like effect, but to a lesser degree.

Education aimed to decrease the human risk is now organized to some extent in each State, but the actual reduction of that risk by changing the public's attitude toward fire can hardly be said to have fairly begun.

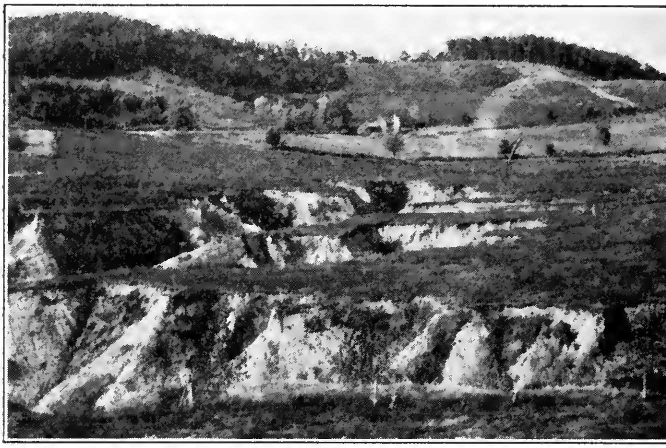
One of the most significant educational moves so far tried is the so-called Ellington experiment, organized by the State Forester in Reynolds County, Missouri. He induced the local tie and timber companies to subscribe a fund, and to offer each of the local school districts one dollar for each of certain designated forties which remained unburned at the end of the spring season. Up to 20 forties were designated in each school district, so placed as to checkerboard the district. The idea behind the offer was that such a cash bonus might create a local incentive to discourage fires. These Ozark school districts are much in need of cash, and every outside dollar reduces local taxes.

The result of the offer was that only 16 per cent of the designated forties burned over in 1927, as compared with 20 per cent of the county. The total area of designated forties was 1,600 acres, but a total of 30,000 acres received the benefit. Counting this larger area benefited by this protection, the cost per acre per year was one cent. (A more detailed description of the plan was published in the Proceedings of the Southern Forestry Congress for 1921.)

To sum up: Uncontrolled fire destroys an important proportion of the available winter cover and nesting cover each year, and this destruction is most serious to game, not in the Forest Belts where the fires are larger, but in the Agricultural Belt where cover is deficient.

Erosion Control. The most important and least supported of all the fields of conservation activity is that dealing with the control of soil erosion. Deterioration or removal of the soil inevitably reduces the farm, forest, or game crops which can be produced upon it. Deficient land crops can be improved within relatively short periods, but deteriorated land may require centuries for its rehabilitation.

The north central States are just beginning to realize the fundamental importance of protecting land against deterioration through abnormal erosion. Several agricultural colleges and experiment stations have begun to study the sub-



A new gully eating the heart out of a field. The vegetation starting in the bottom of this gully may heal it and also make game cover if left ungrazed.

A neglected gully which has cut deep and become so steep that stock cannot graze its walls. Accordingly a little protective vegetation has started, but the field will be ruined by its lateral extensions.

A healed gully with game cover partially restored and protected from grazing.

PHOTO 4. *The Progress of Erosion in Southwestern Wisconsin*
Photographs taken by Lake States Forest Experiment Station and reproduced through its courtesy.

ject. Thus Mosier and Gustafson (University of Illinois, 1928), show that an area of 5,365 square miles in 62 counties surveyed, or 15 per cent of the State, consists of broken and hilly land subject to serious damage from surface washing. Some of this is already completely ruined. An additional 15 per cent of undulating land is not badly damaged yet, but is in danger.

All of this 30 per cent of threatened land area lies in the river break type, which is the cream of the quail country. Restoration of vegetative cover in the drainage channels would greatly enlarge the quail crop, and greatly reduce the soil loss.

M. L. Fisher, in his "Washed Lands of Indiana" (1919) shows various degrees of land deterioration in almost every county of the State. He emphasizes improved methods of cultivation as a remedy, but in my opinion underestimates the possibilities of deliberate revegetation as a means of control.

Carlos Bates, in his "Soil Erosion" (1930), measured erosion in the driftless area of southwestern Wisconsin. He found the run-off rate in forests (and hence probably the rate of erosion) to be only about one-eighth as great as in corn fields. Pasture, hayland, and small grain were intermediate. A third of the southwestern counties he finds, are losing an inch of their richest topsoil every 20 years. Replacement of this inch through geological processes is estimated to require 1,000 years. Methods of prevention are specified, one being the restoration of cover in gullies and drainage channels. Bates says:

"The sportsman's interest demands that cover for game be increased and the stability and purity of streams be protected by an increase in the natural growth of timber and brush in proximity to small streams and gulches."

Present damage from erosion in the north central region is most prominent in the Hill Belt, and in the river break and upper Mississippi types of the Agricultural Belt. Part of the damage arises from careless methods of cultivation and failure to conserve soil humus, but another and very important part arises from the wholesale removal of brush, timber and grass cover from creek banks, drainage channels, and steep hillsides. These processes of devegetation have been accomplished by grazing as well as by cutting, and have accompanied the intensification of agriculture on practically all of the richer lands of the region. In previous chapters the necessity of restoring at least part of this vegetation has been pointed out as necessary for the production of game crops. It must here be emphasized that its restoration is equally necessary for the conservation of the land. Game conservation, conservation of soil fertility, and conservation of watersheds are jointly threatened by devegetation, and have a common interest in the reversal of the present trend. It may be said without exaggeration that if the cover needed for watershed conservation were restored to the drainage channels and hillsides of the north central region, the upland game problem would be half solved.

There is something almost absurd in the expenditure of hundreds of millions for navigation and flood control in the large rivers which drain from the north central region, without even an attempt to influence agricultural practices on their watersheds. The engineering personnel in charge of navigation and flood control seem either oblivious to the biological mechanisms which help determine the behavior of rivers, or else take the attitude that because unsound claims have in times past been advanced as to their effects, that therefore they have no effects. It should be realized that more sound research has been accomplished on watersheds in the past five years than in the preceding fifty.

One of the most far-reaching changes which the game conservation movement in this region could advocate would be the addition of a competent ecologist to the Mississippi River Commission.

Game Lands

Posting. Many estimates of the per cent of lands posted against hunting in various counties were gathered during the survey, but these data are so voluminous that it seems best to here present only a general summary by states.

In Iowa in 1928, 50 to 75 per cent of the riverbreak farms were posted, but few upland prairie farms were posted, apparently because there is no game on them. The pheasant district in northwestern Iowa prairie is an exception to this. The most recent condition in this district is not known.

In Ohio in 1928, 10 to 50 per cent of the till plain farms were posted. The condition in the hill country was not determined.

In Illinois in 1929, 60 to 90 per cent of the farms were posted. Unlike Iowa, posting seemed to prevail on the prairies, as well as in the river breaks. Around Chicago posting is practically complete.

In Indiana in 1929, 30 to 70 per cent of the farms were posted, including the marginal farms in the southern part of the State. Around the industrial district of northwest Indiana posting of farms was complete.

In Missouri in 1930, 20 to 50 per cent of the more valuable farms were posted. The Ozark farms are not usually posted, but owners expect hunters to ask permission. Forest lands in the Ozarks are not posted.

In southern Wisconsin in 1929, 30 to 90 per cent of the farms were posted. In the pheasant district of southeastern Wisconsin, entire townships are posted by action of the township board, highway signs indicating points of ingress to and egress from the township. In the Forest Belt, unfarmed areas are not posted, but the Edward Hines Lumber Company proposes to post its extensive holdings of cutover lands during the deer season. If this is successful, the precedent may bring about a change in the present open condition of the deer and ruffed grouse hunting grounds.

The posting situation in Michigan and Minnesota was not determined by the survey, but a relatively accurate size-up of posting on wild lands in upper Michigan was made by the Conservation Department as of July 1, 1929. The status of 37 counties north of Town 20 was found to be:

TABLE 55.—*Posting in upper Michigan*

Land	Acres	Per cent
All Land		
Total land area	17,742,240	100
Total area wild land	14,185,622	80
Wild land closed to every one (mostly refuges)	129,442	1
Wild land closed to public but open to private hunting (mostly clubs)	584,665	3
State Land		
Total area State-owned wild land	1,317,600	100
State-owned wild land closed to everyone (State refuges)	97,315	7
State-owned wild land open to everyone	1,220,285	93

In short, four per cent of upper Michigan is posted, three per cent by clubs, and one per cent on account of refuges and other causes. There are fewer clubs, and probably less posting, in the wild land districts of northern Wisconsin and Minnesota.

The situation for the region may be cast up in this way:

(1) Posting is on the increase everywhere.

(2) It is not yet customary to post unoccupied forest lands except where acquired for private preserves. These constitute less than five per cent of the wild land areas.

(3) Farm lands are from 20 to 100 per cent posted. The more valuable the land and the nearer to centers of population, the heavier the posting. This trend possibly reverses itself where the land is so valuable and so intensely farmed that there is no game on it.

(4) Individual permission to hunt on posted lands is often given on request. It is possibly more commonly given toward the south of the region than toward the north.

(5) Land values and population density being equal, posting is possibly less where the principal game is partly State-propagated (namely, pheasants) than where the principal game is self-propagated (namely, quail).

(6) All the foregoing statements apply to upland and big game. Private farm marshlands containing waterfowl are almost completely and universally posted throughout the region.

Charging. It is presumably a logical economic sequence for posting of land to be followed by a charge for the privilege of hunting on it. The amount and nature of the charges made for hunting are described under the chapters describing the several game species, for the hunting of which the charges are made. It must here be emphasized, however, that the custom of charging is still decidedly exceptional. The aggregate area on which it is customary for landowners to charge for hunting is certainly *less than one per cent* of the area of the region, and probably less than a tenth of one per cent. On the other hand I estimate, on the basis of the figures in the preceding caption, that at least 20 per cent of the region is posted against hunting. In other words, charges for hunting are made on not over five per cent of the posted lands, and more likely on less than one per cent of the posted lands. That is to say, charging is prevalent on an almost negligible acreage, although it is undoubtedly on the increase.

It is very clear that charging is more prevalent for migratory than for upland game. This is exactly the reverse of what the economic logic of game management would call for. Migratory game is ordinarily a fluid crop, in the production of which the individual landowner, on whose lands it may be found during migration, has taken no part. He is charging, not for something he has produced, but for a chance to compete in the harvesting of what somebody else has produced. The logical justification for charging for migratory bird hunting is that as long as marshlands bring their owners an income, they are less likely to be extinguished by drainage, and their owner has an incentive for improving them and making them more attractive.

Charging for upland game, on the other hand, might presumably develop an incentive for the owner of each farm to improve its condition, and thus enhance its production.

Viewing the country as a whole, it is clear that the custom of charging for upland game hunting has become established more readily in the South than in the North. This trend is possibly perceptible within the south edge of the north central region. The leasing of land for quail preserves in Missouri is somewhat more extensive than leases for pheasants, prairie chickens, or other upland game in the northern tier of States, although both are rare.

Posting and Management. Even in those rare cases where posting has been followed by charging for the hunting privilege, charging is as yet seldom accompanied by management. The only deliberate private measures found during the survey for enhancing the wild game crop by improving its environment were on the Missouri private preserves, and here the management was practiced by the leasee more often than by the owner. One instance of collective practice of management by farmers is proposed for pheasants in Ingham County, Michigan, and is described under the pheasant chapter.

The situation may be summed up by saying that the small amount of private management so far being practiced in the north central region is confined to private game preserves, and even there it is usually rudimentary. The almost universal condition is that:

(1) Lands are being posted against public hunting.
(2) Sometimes a charge is made for hunting on such lands.
(3) Management to justify the charge is as yet practically non-existent.

Attitude Toward Posting and Charging. All State game departments in the region either discourage both posting and charging in their official reports and publicity releases, or else they avoid commitment. They make no distinction between posting as a preparation for management, and posting for the mere exclusion of the public. This attitude of course merely reflects the attitude of the average hunter, from whom their financial support is derived.

Most State game departments and many hunters impute a sort of moral obligation for the farmer to allow public hunting in exchange for the restocking of his land at public expense. This attitude disregards the fact that restocking alone will not produce a game supply, and that under the license system no State can possibly restock even pheasants at a rate sufficient to produce an adequate supply. One license will only buy one pheasant, or one-third of a quail, whereas it permits the owner to kill from a dozen to a hundred of each.

The average State game department has no program for relieving the farmer from vandalism or over-shooting except the "education" of the shooting public. It is probably something more than a mere personal opinion to here observe that even if such "education" constitutes a sufficient cure for vandalism (which is doubtful) it can hardly constitute a means for limiting the total kill on each unit of land to its productive capacity. Only management can do that.

The attitude of farm organizations is of course favorable to posting. The individual farmer, however, seems to feel some personal reluctance to post, and an even greater personal reluctance to charge, else both these practices would be more prevalent than they actually are at the present time. The evidence already presented on the prevalence of posting and charging seems to indicate that the individual farmer posts only after he is driven to it, that is, only after the number and behavior of unpermitted hunters become intolerable.

The individual and group attitude of farmers toward management can not as yet be stated, except by pure conjecture. As a rule they do not know what management is. Here is one of the most astonishing incidents observed during the survey: I was introduced to a highly educated dirt-farmer, who was so keen for game conservation that he drove 20 miles to town each week to attend a meeting of his local chapter of the Izaak Walton League. I asked him how the game fared on his farm. He replied that he had hardly any, in spite of the fact that he allowed no shooting. I asked him about the cover, and learned he had recently cleared off the only remaining cover on his place—a strip of brushy timber along a creek bank. It was apparently a revelation to him that this had anything to do with his game crop. He apparently regarded his prohibition of shooting as the only thing he could do for his game.

The attitude of the non-shooting conservationist is clearly in favor of posting, but probably opposed to charging. Very few protectionists realize that game is determined by anything but shooting and artificial feeding.

Trespass Laws. Nothing more forcibly illustrates the opportunism of the average hunter than his attitude toward trespass laws.

If we want the farmer to raise a game crop, it is A B C logic to encourage him to prevent overshooting of his seed stock. This is true quite regardless of one's views on the moot question of whether and how the farmer should be compensated for the shooting privilege.

If the farmer is to prevent overshooting, he *must* have the right to say who is to hunt on his land, when, and how much. Otherwise control of overshooting is a physical impossibility.

Trespass laws give the farmer the legal sanction of the State for exerting this control. They require the hunter to obtain the farmer's permission before hunting on his land. The statutes of the various States differ in what constitutes "permission," and for what kind of land permission is required.

One would expect intelligent sportsmen to support reasonable legislation toward this end because it constitutes the first step toward the practice of game management on farms. In actual fact, however, many sportsmen and even sportsmen's organizations have opposed such legislation on the grounds that it restricts free public hunting and imposes an inconvenience on the hunter.

Table 56 summarizes the trespass laws of the region.

TABLE 56.—*Summary of trespass laws*

State	Year passed or last amended	Essential Provisions
Minnesota	?	No person shall at any time enter upon any land not his own with intent to take or kill wild animals after being notified by the owner or occupant not to do so. Such notice may be given orally or by posting.
Wisconsin	1929	Any person who shall enter upon the enclosed or cultivated lands of another, or woodlots connected therewith, for the purpose of hunting, fishing, trapping . . . without the consent of the owner or occupant thereof, shall be punished by a fine, etc.
Michigan	1927	No person shall hunt with firearms or dogs, or in any other manner, upon any farm lands or farm woodlots connected therewith or within the enclosed lands of any hunting club or game preserve without the consent of the owner or leasee of such land or lots.
Iowa	1898	The license shall authorize its holder to . . . hunt . . but not on private waters, or on enclosed or cultivated lands without permission of the owner or tenant.
Illinois	1923	Unlawful to . . . hunt . . . where notice that hunting is forbidden, is posted.
Indiana	1905	Whoever hunts . . . or shoots . . . upon any land without first securing the consent of the owner or tenant thereof shall, upon conviction, be fined, etc.
Ohio	1919	No person shall hunt . . . upon any lands . . . or thereon shoot . . . without obtaining written permission from the owner or his authorized agent (Sec. 1437). The conservation commissioner . . . shall enforce the laws against trespassing . . . for the purpose of hunting.
Missouri	1911	Every person who shall be found hunting, with gun or dog, upon the enclosed, improved or cultivated lands of another, or shall enter the same to catch or kill game of any kind, without the consent of the owner or person in charge of such lands, shall . . . be fined, etc.

Sunday Laws. One aspect of the farm trespass situation illustrates with particular force the prevailing tendency to resort to indirect expedients, instead of squarely facing the issue. This is the growth of Sunday hunting laws.

By and large, laws prohibiting or limiting Sunday hunting are characteristic of the South rather than the North. In the north central region, Missouri, Indiana, and Michigan have statutes on the subject. The Michigan law, which dates back to 1905, was evidently the forerunner of the Horton trespass law quoted in Table 56, and passed in 1927. It provides:

"It shall be unlawful for any person to hunt for game with firearms, dogs, or otherwise, on Sunday on any lands or premises of another in Oakland County . . . without consent of the owner or leasee."

Oakland County lies just outside of Detroit. The fact that the law is limited to one county and that it does not prohibit hunting provided the landowner consents, is plain evidence that the motive was to strike indirectly at the farm trespass nuisance, rather than to deal with any question of ethics.

Reversion of Lands. One of the most important economic changes affecting game lands and game administration in the north central region is the tendency for marginal farms and cutover timber holdings to revert to the State or county by reason of non-payment of taxes.

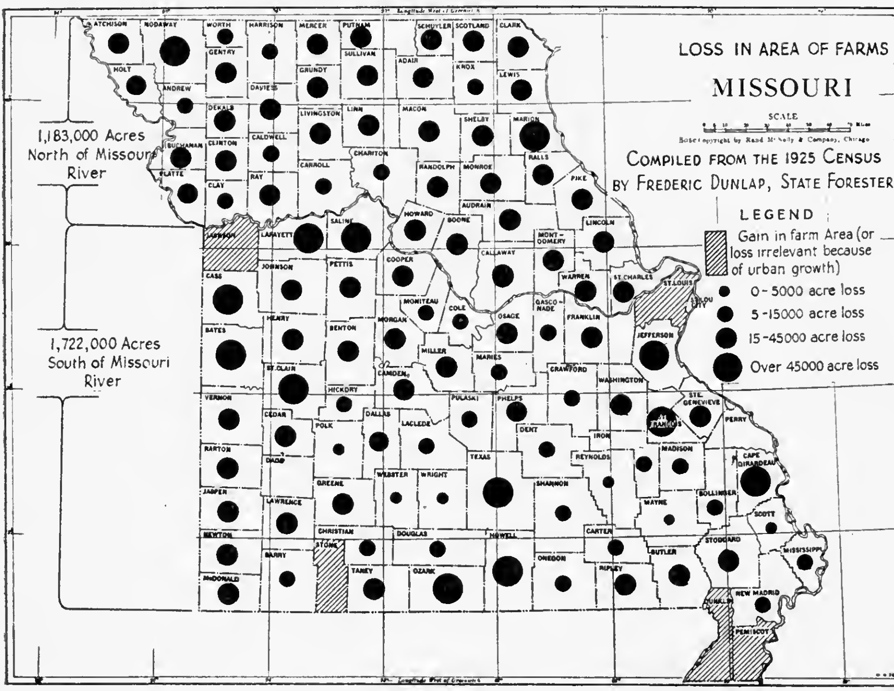
The abandonment of cultivation on reverted farms affects game favorably or unfavorably, depending on the kind of game, the length of time for which the lands remain uncultivated, whether or not they become subject to annual fires, and most of all whether the reversions occur in solid blocks of large size, or in isolated pieces interspersed with land still in cultivation. By and large, reversion increases game cover, but decreases game feed, especially if it continues long enough for the initial growth of weeds to be supplanted by grass or trees. A spattering of small pieces is usually favorable to small game, but solid blocks are unfavorable.

Reversion is naturally most prevalent in the types containing the poorest soils. In the north central region it is most prominent in the forest and transition types of the Lake States, and in the hill belt along the southern edge of the region. It is also occurring, however, in the poorer parts of the riverbreaks type in northeast Missouri, southern Illinois, and southern Indiana, and in the poorer parts of the till plains, especially in the neighborhood of the automobile manufacturing towns in southern Michigan. Near these towns the high wages prevalent in manufacturing plants are forcing the abandonment of farms because they return a much lower wage to their owners than they are able to earn in a factory.

The reversions in the Forest Belt of the Lake States now occur in such large blocks that they are probably unfavorable to prairie chickens by reason of the diminution of grain feed. They may, however, be favorable to deer.

The reversions in the southern Hill Belt are almost certainly unfavorable to quail, by reason of diminution in grain feed. Those in the till plain and river break type, however, are so far probably favorable to all species of small game because they have increased cover, and at the same time do not lie in such large blocks as to cut off access to grain feed on adjacent farms.

Missouri and Indiana will serve as samples to illustrate the magnitude of the reversion process. Map 20 shows the net gain or loss in farm area for each Missouri county during the census decade ending in 1925. The trend may be summarized by saying that only three Missouri counties showed a net gain in farm



MAP 20

area. The 78 remaining counties lost from a few acres to over 80,000 acres each during the 10-year period. The losses run as high as 8,000 acres per county per year, or 50 farms.

In Indiana between 1910 and 1925, 18 southern counties lost an aggregate of 405,000 acres in farm area. From 19 to 47 per cent of these 18 counties now constitutes woodland and wasteland. The loss ran as high as 3,000 acres per county per year, or 18 farms.

The aggregate of taxes collected in 29 southern Indiana counties in 1928 was less than the taxes collected in Marion County alone (Marion County contains Indianapolis). This poor showing is in spite of the fact that these 29 counties, together with four others, contain a quarter of the population and a third of the land area of Indiana. Furthermore each of them receives direct financial aid from the State for the support of schools. This subsidy of course further accentuates their unsound economic status.

An even more unfavorable economic situation exists in the Forest Belt of the Lake States, although here cutover lumber company holdings form a larger proportion of the aggregate reversions than in Indiana and Missouri. In 17 counties of northern Wisconsin, for instance, two and a half million acres were tax delinquent in 1928. These cutovers usually revert only after an unsuccessful attempt has been made to develop them for agricultural purposes.

Very recently a reverse process, arising from enhanced values of lands for resort or tourist purposes, has been perceptible both in the Lake States and in the Ozarks. This reverse process has not become sufficiently extensive, however, to change the net trend, nor is it likely to become so. It affects mostly lake shores, stream banks, and other strategic locations which do not add up to any considerable proportion of the total area.

The one obvious remedy for this unsound economic situation on marginal lands is to encourage the practice of forestry and game management upon them, and to desist from any further effort to compete in agricultural markets now universally admitted to be over-supplied. Their rehabilitation through game management is particularly important for two reasons: (1) Game, unlike forests, is an almost immediate rather than a deferred crop; (2) the immediate revenues from a game crop can help to preserve the solvency of their owners pending the regrowth of a forest crop.

The reversion of marginal lands is also important because of the opportunity which it affords for the inexpensive acquisition of public forests, public shooting grounds, and public game refuges. The same opportunity is of course open for the acquisition of private game preserves or private forests.

Forest Taxation. Each of the three Lake States has recently enacted special forest tax laws which are aimed to encourage the practice of forestry. These laws seek to lighten the tax burden on timber during the immature stage, and to substitute for it a yield tax levied when the mature timber is cut. Special State aid is extended to the counties in lieu of the current tax revenue from immature timber.

The holdings registered under these tax laws do not as yet aggregate any large area except perhaps in Wisconsin. They have an important bearing on the future of game in the Forest Belt, but experience has shown that they have no considerable effect on the farm woodlot, the preservation of which is, from the game standpoint, the crucial question at this time. The procedure necessary to take advantage of them is too complicated to appeal to the farmer, and his woodlot is often too small to qualify under their minimum acreage limitations.

From a game standpoint, the outstanding need is for *woodlot* tax laws which will recognize the public benefits accruing from the ungrazed woodlot, and which will enable the farmer, by some very simple procedure, to escape the prohibitive taxation which has so far caused a steady shrinkage in woodlot area through their conversion into pastures.

Indiana has enacted such a law. It extends to registered woodlots a flat valuation of $1 per acre, against which the current local tax is applied in the usual way. There is no yield tax. The owner pays for the survey, which usually costs about $10, and must agree not to pasture. The minimum tract eligible for registry is three acres. Although the law was enacted seven or eight years ago, only 600 tracts, totalling 6,000 acres, were registered in 1929, but this registration must surely increase as the facilities of the new law become more widely known.

This law, and its future extension to woodlots generally, is of fundamental importance to game, especially quail, for the obvious reason that each permanent ungrazed woodlot means from one to five permanent covies which would otherwise tend to disappear under the inroads of grazing and cutting. This woodlot tax law, if widely adopted, holds out more future assurance of perpetuating quail than would a yearlong closure on quail shooting.

CHAPTER XII

THE CONSERVATION MOVEMENT

Game Research and Education

ANY appraisal of game research and education at this particular moment must inevitably consist in part of a mere sketch of things hoped for, as distinguished from a recital of things accomplished. Research aimed deliberately toward the production of game crops is barely in its swaddling clothes, much less out of them. Likewise education in the idea that game is a crop is hardly yet a going concern, although education in game biology, and in the idea of preserving the remnants of the virgin resource, is an activity of long standing.

The motive power for both game research and education must arise first of all from sportsmen's organizations.

Sportsmen's Organizations. A high tide in the number and distribution of sportsmen's organizations was reached shortly after 1925. There were, for instance, in Indiana alone at one time over 150 chapters of the Izaak Walton League, and over 100 other sportsmen's organizations, not including those primarily interested in fishing. The average ran almost three game organizations per county.

The number and membership of such organizations throughout the region has since somewhat receded, although this recession has doubtless been accompanied by some qualitative improvement in programs, and in the average member's understanding of what it is all about. Map 21 shows the present distribution of sportsmen's organizations in the region, in so far as this could be determined.

The map shows some peculiarities of distribution. One is the frequency with which a chapter of the Izaak Walton League coexists in the same town with some other sportsmen's association. In Wisconsin it was determined that a frequent cause of this condition lies in the relatively high dues of the Izaak Walton League. The second organization is maintained to transact local work with local finances. The two often work in close co-operation.

Another peculiarity is the tendency for Izaak Walton chapters to occur in or near industrial centers, as distinguished from rural communities.

Organization Programs. The present objectives of sportsmen's organizations in the region fall into two classes, (1) legislative work, and (2) local betterments.

The legislative projects show extreme diversity in skill and leadership. In some States the sportsmen have selected a single well-chosen objective, such as the reorganization of the conservation department, and directed their combined strength toward its accomplishment, often through a period of years. The highest grade of volunteer legal, technical, and political skill has been mobilized, and the resulting enactments constitute permanently usable foundations for building up State leadership in conservation work.

In other States great quantities of useful energy have been expended in minor tinkering of the game laws, and even in factional disputes.

The local work of sportsmen's associations shows a like diversity in skill and effectiveness. Some have tended to become merely social clubs, others have successfully executed valuable educational campaigns and established refuges, plantings, rearing ponds, winter feeding stations, and the like. Plantings of pheasants and fish preponderate very heavily in the present programs of local activity.

It is worthy of note that with the exception of the Ingham County project of the Michigan Izaak Walton League (described in the pheasant chapter) no original work has been done toward the establishment of a productive relationship between sportsmen and farmers. This would seem to be the most suitable of all activities for a sportsmen's organization. In fact, no other kind of agency is fitted to undertake it at all. The neglect of this vital opportunity is possibly in part responsible for the recent decline in volume of the sportsmen's movement. It may at least be true that to initiate a really vital and suitable activity of this kind would serve to recoup the recent losses in membership.

It is also worthy of note that until very recently sportsmen's organizations have not interested themselves in the promotion of fact-finding through research. Such projects are now being sponsored by Wisconsin, Michigan, and Missouri organizations.

Other Organizations. One peculiarity of the sportsmen's movement has been its reluctance to seek the co-operation of other more or less parallel conservation bodies. Each of the States contains organizations, often powerful, devoted to the promotion of forestry, bird study, country life, better agriculture, preservation of landscape beauty, and other subjects which must eventually be dovetailed with game management and with the recreational use of game resources. The locations of the State headquarters of some of these organizations are indicated on Map 21.

In addition there are the manifold farmer organizations, which may collectively be designated as granges, and which represent the economic interest of the landowner. Lumbermen, stockmen, and the pulp and paper industry, likewise maintain organizations which parallel the granges.

The co-operation of all these almost incredibly numerous bodies will ultimately be necessary for the solution of the game problem, but the organized sportsmen are not as yet in touch with them.

Conservation Schools. At the village of MacGregor, in Clayton County, Iowa, directly opposite the mouth of the Wisconsin River, there assembles each summer a "school of wild life protection." This school was founded in 1919 by the late Rev. George Bennett, of Iowa City. The faculty consists of the outstand-

MAP 21

ing naturalists of the State, including both university professors and amateurs. The student body consists of anyone interested in the subject matter of the instruction, which includes ornithology, botany, geology, forestry, landscaping, archaeology, and astronomy. The faculty serves without pay, and the students pay only a nominal fee. Instruction is by lectures and field excursions.

A noteworthy spirit of genuine enthusiasm for conservation is immediately felt by any visitor to this school. The instruction of course follows the general idea of preservation, as distinguished from cultivation and management, of outdoor resources. The idea of management could, however, be effectively conveyed to the public through such an institution, and within limits would be compatible with its present objectives and personnel. Certainly the idea that restrictive legislation must be supplemented by the preservation of suitable environments could be taught, and interesting demonstrations of the idea set up in the surrounding countryside. The idea of controlling environment is the fundamental thing for game management to contribute to the conservation movement. Shooting and all the other aspects of game utilization are simply things which become possible when environments are kept favorable.

Courses in fish and game are offered as an adjunct to forestry courses at the agricultural colleges at Purdue, Indiana, and at Ames, Iowa. Although the control of "wild" environments is the very essence of the forester's silviculture, the corresponding idea is nearly absent from the game courses taught in forest schools.

The outstanding development in game education is the recent conversion of the forestry school at Ann Arbor, Michigan, into a school of forestry and conservation. Both graduate and undergraduate courses in applied zoology are offered.

Courses in game management are also being organized at the University of Minnesota, and at the Michigan Agricultural College.

Research Agencies. The components of successful game research are:

1. A skillful investigator.
2. The money to pay him.
3. A place to work near a group of men whom he can ask things about fields of science which he does not know.
4. Land to work on.

All of these components usually exist in the average agricultural college, except the money, and expert knowledge of game as such. The U. S. Biological Survey is supplying agricultural colleges or other institutions, when they ask for it, with the advisory service of men having expert knowledge of game.

The mobilization of game research in this region, therefore, boils down to a question of money and initiative.

The present purpose is to examine the question of what institutions can conduct game research, providing the money and the initiative be found.

Each State in the north central region has a large and well-equipped agricultural college, either separate or in conjunction with its university. Each of these institutions has men on its faculty skilled in the subjects on which game research workers may need advice. These subjects commonly include ornithology, mammalogy, botany, forestry, entomology, parasitology, agronomy, agricultural engineering, soils, land economics, and watersheds.

TABLE 57.—*Current game research projects*

State	Institution	Research worker	Project	Financed by—
Minnesota	U. of M.	R. G. Green	Diseases of grouse and rabbits	In part by State game commissioner
	U. of M.	R. T. King	Ruffled grouse	S.A.A.M.I. fellowship
	U.S.B.S. and U.S.F.S.	(Vacant)	Snowshoe rabbit	McSweeney-Mc Nary Act
Wisconsin	Conservation Department	F. Schmidt	Prairie chickens	Conservation department
	U. of W.	P. L. Errington	Quail	S.A.A.M.I. fellowship
Michigan	U. of M.	H. M. Wright	Refuges (mainly pheasants	Conservation department and U. of M.
	U. of M.	Paul Dalke	Pheasants	U. of M.
	U. of M.	R. E. Yeatter	Hungarian Partridge	S.A.A.M.I. fellowship
	M. A. C.	L. E. Bradt	Pheasant management	M. A. C. and I. W. L. A.
	M. A. C.	Poultry department	Mechanical Incubation	Conservation Department
	Conservation Department	Miles D. Pirnie	Waterfowl foods	Conservation department
	Conservation department	Victor Cahalane	Deer	Conservation department
Iowa	None			
Illinois	None			
Indiana	None			
Ohio	U. of O.	L. Hicks and N. McCormick	Distribution of game birds	Conservation department
Missouri	None			

SUMMARY

Number of full-time workers	8
Number of part-time workers	6
Total man-power in game research	14

Game research need not be confined, however, to the agricultural colleges and larger universities. Each of the north central States has in addition from three or four to a dozen smaller colleges, independent museums, biological laboratories, normal schools, or other institutions already engaged in biological work, and competent to investigate some appropriate project in game conservation. Many of these institutions are supported by public funds, and all are responsive to public interest in the solution of any particular public problem.

It is merely plain common sense that conservation organizations and State conservation departments should attempt to interest all these institutions in game research. It is not at all uncommon for such institutions to be actually looking for things to work on which have both a local and a scientific significance. It is also merely common sense for State game officials to seek the help of their State-supported institutions in finding the answers to the biological game problems with which they deal every day, and which they cannot answer themselves.

Research Projects. A very small fraction of the institutions competent to help have as yet made even a start on the game problems of the north central region, nor has anybody asked them to do so. Almost all of them conduct biological research as a contribution to science, but few of them have seen the opportunity for applied science in the game field. But a start has been made. In 1927, to the best of my information, only one institution in the north central region had even a single man conducting research directly applicable to game management. Table 57 indicates that at the present time about 14 men are so engaged, and the number seems to be rapidly increasing.

In addition to projects bearing directly on game management, much purely scientific work is being bent in directions valuable to the future development of game. For example, the Baldwin Bird Research Laboratory at Gates Mills, Ohio, is beginning to explore the physiology of birds, a subject still obscured in nearly total darkness. Without knowledge of physiology, the more "practical" investigations of their diseases, foods, production, and relation to environment must ultimately end in blind alleys.

Many volumes would not suffice to describe the scientific researches which repose on the shelves of our university libraries, and which are potentially valuable to game conservation in this region, but which cannot be used until the hiatus between the library and the land is filled in. We have collected, largely at public expense, a million bricks for our conservation structure, but there they lie in idle piles, all for lack of a little mortar and the will to build. The "pure" scientist is too absorbed in more bricks to tell the public what they are for. The "practical" sportsman and the crusading protectionist have been alike oblivious to any need for bricks.

Extension. Many facts on how to make land produce game are already known, but each one is usually known to only a few persons.

With the hoped-for expansion of game research, many additional new facts will become known each year, but each one will be known and understood by only a few persons.

To bring about the widespread practice of effective game management, it is essential that the available stock of facts be kept in circulation, and particularly that they be circulated to the man who can apply them to the land, namely, the farmer. It is almost equally important that the landowner's actual experiences be circulated to other landowners, and to sportsmen and research workers who lack direct contact with the land.

In agriculture and forestry this job of keeping facts in circulation is known as extension work. A great organization, far larger and more skillful than the average citizen appreciates, spreads its network of skilled workers over the entire country. It undertakes not merely the circulation of the facts on farming discovered by the agricultural colleges and the U. S. Department of Agriculture, but also the vocational education of rural inhabitants of all ages. It relies in part on printed matter and classroom work as the vehicles for conveying thought, but to an even greater extent it relies on actual physical demonstrations to describe new discoveries and approved techniques. It is no mere "uplift" machine. It is a nation-wide "rural exchange," covering all aspects of rural life, in which any rural citizen may, if he wishes, be both pupil and instructor.

Its subject matter includes all manner of farm by-products, except game, and all manner of incidental farm activities, except game management.

The physical magnitude of the farm extension organization in this region may be judged from this table:

TABLE 58.—*Agricultural extension organization*

State	Number of Smith-Hughes Agricultural high schools	Number of couny agricultural agents
Minnesota	62	65
Wisconsin	94	56
Michigan	144	62
Iowa	112	82
Illinois	188	--
Indiana	139	--
Ohio	197	--
Missouri	137	--
Total	1,073	616

An agricultural high school is a rural high school of any sort where one or more of the faculty teach vocational agriculture, half their salaries being contributed by the Federal Government under the authority of the Smith-Hughes Act, and the rest by the county or State.

A county agent is a trained agriculturist maintained jointly by the county and the Federal Government for teaching and demonstrating improved agricultural methods. He acts as liason between the farmer and the agricultural college.

The table shows that, broadly speaking, there is an agricultural high school and also a county agent in each county of the north central region. Taken collectively, these extension officers are three times as numerous as game officers, and much more highly trained. They are in active touch with the farmers, with whom game management must begin, whereas game wardens are in touch only with the sportsmen. By and large, it would be easier to convey to a county agent an understanding of game management, than to convey to a game warden an understanding of farm management. Many county agents are themselves sportsmen. It seems only common sense that in the long run the farm extension organization must take a leading part in bringing about the desired cropping of farm lands for game.

The farm extension organization already has its hands more than full. It is not likely that any large measure of activity in game matters will be possible without special authority and additional funds granted by Congress. The U. S. Biological Survey, which is the center of technical information on game, is a co-ordinate branch of the Department of Agriculture, in which farm extension activities are centered. It is A B C logic for the game conservation movement to work toward an habitual co-operative relationship between the U. S. Biological Survey, which is the source of biological facts about game, and the Extension Service, which is in touch with the farmer who can apply them.

CHAPTER XIII

CONCLUSIONS

THE findings of this survey were made available from time to time to the committee drafting the *Game Policy adopted by the American Game Conference, December 2, 1930. The "seven basic actions" proposed in that policy for the country as a whole are also, in my judgment, the basic actions needed for game restoration in this region. The manner of their application is indicated in the following captions.

> 1. *Extend public ownership and management of game lands just as far and as fast as land prices and available funds permit. Such extensions must often be for forestry, watershed, and recreation, as well as for game purposes.*

The largest opportunity for public ownership and management of game lands lies in the extension of national, state, and county forests in the Forest and Hill Belts. Acquisition of public forests is gathering headway in the Forest Belt, but not in the Hill Belt. Missouri is the "key log" in this jam. Her traditional opposition to public forests might well be reconsidered. Her sportsmen, as well as her lumbermen, should have a voice in this matter.

The next largest opportunity lies in the public acquisition of migratory bird lands. Minnesota and Wisconsin have made a small-scale start, which needs to be greatly enlarged in all the states.

Minnesota, and to some extent Wisconsin, Michigan, and Missouri, have a fast-fading opportunity to acquire wilderness game lands. No action is as yet visible except in Minnesota.

Michigan is the only state so far to apply real game management to her public holdings. A rapid development in this respect may be expected to follow the crucial first step of acquisition.

> 2. *Recognize the landholder as the custodian of public game on all other land, protect him from the irresponsible shooter, and compensate him for putting his land in productive condition. Compensate him either publicly or privately, with either cash, service, or protection, for the use of his land and for his labor, on condition that he preserves the game seed and otherwise safeguards the public interest. In short, make game management a partner-*

* Copies are obtainable from the American Game Association, Investment Bldg., 15th & K Sts., NW, Washington, D. C.

ship enterprise to which the landholder, the sportsman, and the public each contribute appropriate services, and from which each derive appropriate rewards.

This is regarded as the crux of the game problem in the region. Not one of the eight states has as yet extended any positive recognition to the farmer. The laws requiring the farmer's permission to hunt constitute a negative recognition of his right to regulate trespass, but positive recognition that he furnishes the land for the game enterprise, and that its success depends on the condition of that land, is as yet totally lacking. The Indiana woodlot tax law may be construed as an indirect (and doubtless unintentional) premium on well-conditioned game lands.

Recognition of the landholder entails such a complete reconstruction of our game policy that only a few of the necessary steps can be predicted with confidence. One is to withdraw the official pressure against posting, and against private ventures in upland game management, and substitute for it a policy of licensing, regulating, and guiding private practice, as distinguished from the present policy of discouraging all private initiative in upland game. This holds good whether private initiative takes the form of clubs, toll farms, preserves, cooperative farm-pools, or other forms as yet untried. The guiding idea should be to *supplement* private ventures by a generous public land program, rather than *discourage* them and do nothing.

3. *Experiment to determine in each state the merits and demerits of various ways of bringing the three parties into productive relationship with each other. Encourage the adoption of all ways which promise to result in game management. Let the alternative ways compete for the use of the land, subjecting them to public regulation if this becomes necessary.*

Michigan is the only state in this region yet embarked on the process of experimentation to develop practicable mechanisms for encouraging private initiative by or in cooperation with the farmer. Her "Williamston Plan" is trying out one form of sportsman-farmer pool; her "Shooting Preserve Statute" is trying out one form of private preserve.

One knotty problem, as yet unsolved, is how to reward private initiative in states where shooting seasons have been so shortened as to hold out insufficient inducement. The Michigan plan of preferential seasons for managed areas may not prove acceptable to the public. Some state should try the other alternative of closing all territory which cannot stand up under a reasonable season. This might prove a powerful spur to action.

Some state should experiment in regulating practice on private migratory bird lands. This logically falls to Illinois, but a strong and technically-minded Department would be a pre-requisite.

Some state should try state-leased public shooting grounds on farm lands to determine their practicability.

4. Train men for skillful game administration, management, and fact-finding. Make game a profession like forestry, agriculture, and other forms of applied biology.

Systematic training for game research is available at the Michigan School of Forestry and Conservation, and through the growing system of fellowships. Training for game wardens and game administration is still lacking.

5. Find facts on what to do on the land to make game abundant.

The beginnings of fact-finding are under way for quail, ruffed grouse, prairie chicken, pheasant, and Hungarian partridge. A start is being made on deer and snowshoe rabbits.

Cottontail, wild turkey, and moose still offer a virgin field.

In only one species—pheasant—is there as yet any proving ground for testing the practical application of research findings.

6. Recognize the non-shooting protectionist and the scientist as sharing with sportsmen and landowners the responsibility for conservation of wild life as a whole. Insist on a joint conservation program, jointly formulated and jointly financed.

Cooperation between sportsmen and protectionists is strongest in Michigan, Wisconsin, and Minnesota.

It is weakest in Ohio, Iowa, and Illinois.

7. Provide funds. Insist on public funds from general taxation for all betterments serving wild life as a whole. Let the sportsmen pay for all betterments serving game alone. Seek private funds to help carry the cost of education and research.

Private funds for game work are so far available only in Michigan.

Industrial funds are used for game work in Michigan, Wisconsin, and Minnesota.

A logical division of conservation liabilities between sportsmen and the general public is as yet lacking in all the states.

APPENDIX

(a) Persons Consulted During the Game Survey.

(b) Bibliography.

(c) Key to Chart 44, "Game Cycle in Wisconsin."

(d) Table—Covies Raised by 1 Man (on foot) with 1 Dog Per Day as an Index of Quail Population.

(e) Pheasant and Prairie Chicken Population in Wisconsin, 1930. Table.

(f) Abundance Ratios.

(g) Index.

APPENDIX (a)

PERSONS CONSULTED DURING THE GAME SURVEY

Illinois

Name	City	Address or Connection	Capacity
Abernathy, D. R.	Lawrenceville	Hardware Store	Sportsman
Adams, Dr. J. M.	Belvidere		Pres. I. W. L. A.
Akester, Dr. John	Chicago	5101 Winona Ave.	Sportsman
Baker, M. M.	Peoria		Sportsman
Bffine, Dr. Fred W.	Springfield	1409 N. 9th	
Bowman, H. J.	Alton		Sportsman
Bradford, Ralph	Springfield	Capitcl	Director of Conservation
Brewer, W. C.	Grays Lake	Route 1	Farmer
Buckler, Z.	Kankakee		I. W. L. Z.
Burton, Van	Butaven		Sportsman
Cahn, Dr. Alvin R.	Urbana	Zoology Dept.	Ornithologist
Conrad, Paul	Peotone	Hardware Store	Sportsman
Dadant, L. C.	Hamilton	Dadant & Sons	Sportsman
Dunlap, Geo. A.	Springfield	1716 S. 5th St.	Sportsman
Eldredge, Chas.	Richmond		Dist. Game Inspector
Evans,	St. Charles		Evans Game Farm
Forbes, Dr. S. A.	Urbana	Natural Hist. Bldg.	Chief, Natural History Survey
Gerber, W. D.	Urbana	57 Chemistry Bldg.	Sanitary Engineering
Graham, J. R.	Ingleside	Hercules Powder Co.	
Hamilton, Arthur	Meredosia		River Guide
Heidrich, Arthur G.	Peoria	Com'l Nat'l Bank Bldg.	Sportsman
Hicks, H. H.	Lawrenceville		Ex-Game Warden
Hottes, Dr. C. F.	Urbana	Nat. Hist. Bldg.	Head, Botany Dept.
Huff, C. E.	Danville		Dist. Inspector
Hughes, Frank	Ingleside		Sportsman
Karraker, Ed.	Jonesboro	First Nat'l. Bank	Farmer
Kennicott, Harrison	Des Plaines		Sportsman
Knowlton, Kenneth	Freeport	Knowlton State Bank	Sportsman
Knox, J. H.	Springfield		Sportsman
Korsgard, Arthur	Des Plaines		Cook Co. Forest Preserve
Lashbrook, Fred	Meredosia		Game Warden
Leighton, M. M.	Urbana	305 Ceramics Bldg.	State Geologist
Lenth, Walter F.	Champaign	18 Taylor St.	Sec'y I. W. L. A.
Lewis, A. D.	Springfield	Capitol	State Director of Minerals
Lodge, Wm. F.	Monticello		Farmer
Luthy, Ferdinand, Jr.	Peoria	Merchants & Illinois National Bank	Sportsman
Luthy, George	Peoria	Merchants & Illinois National Bank	Sportsman
Mansfield, C. F., Jr.	Springfield	Leland Office Bldg.	Sportsman
Metcalf, C. E.	Urbana	Old Law Building	Entomologist
Miller, C. R.	Centralia	Spadts Store	Sec'y I. W. L. A.
Miller, R. B.	Springfield	Capitol	State Forester
Mueller, Wm. S.	Shelbyville	(Agric. College, Univ. of Wis.)	
Musselman, T. C.	Quincy	Quincy Business Col.	Ornithologist
Musselman, V. G.	Quincy	Quincy Business Col.	Sportsman
Nodelhoffer, Joe	Guerney		Farmer
Oldfield, S. A.	Springfield	111 S. 5th St.	Pres. I. W. L. A.
Olin, John M.	East Alton	Western Cartridge Co.	Chairman, Game Committee, S.A.A.M.I.
Phelps, Roy L.	Beardstown		Dist. Game Inspector

Name	City	Address or Connection	Capacity
Pickel, Geo. W.	Urbana	202 Highway Lab.	Drainage Engineering
Radebaugh, Gus	Urbana	701 W. Elm St.	Ex-Director of Conservation
Regal, William	Tolono		Farmer
Rehm, Percy R.	St. Charles	Florist	Sportsman
Rigney, Stephen	Freeport	609 S. State St.	Dist. Game Inspector
Rowan, Warren	Belvidere		Dist. Game Inspector
Sargent, E. T.	Waukegan	Hardware	Pres. I. W. L. A.
Smith, R. A.	Urbana	208 New Agric. Bldg.	Soils
Sparks, Chas. A.	Danville	8 Cronkhit, Avenue	Sportsman
Sparks,	Meredosia		Fish Station
Stevens, J. B.	Waukegan		Sportsman
Sutton, J. G.	Quincy	Box 138	Drainage Engineer, B. P. R.
Trefs, Chr s	Chicago H'ghts	Kappmeyer's C gar Store	Sportsman
Tull, Dr. R. E.	Rockford	Rockford N. B. Bldg.	Ex-Pres., Rockford I. W. L. A.
Tuttle, Dr. H. H.	Springfield	Ill. Nat'l Bank Bldg.	Ex-Pres., I.W.L.A.
Wakeley, Guy	Harvard	Clothing Store	Pres. I. W. L. A.
Ward, Dr. Henry B.	Urbana	Natural Hist. Bldg.	Pres. I. W. L. A.
Ward, Dr. Henry B.	Urbana	Natural H st. Bldg.	Pres. I. W. L. A. Head of Zoology Dept. Univ. of Ill.
Warren, Paul	St. Charles	Baker Hotel	Sportsman
Wetzel, Earl	Sycamore	Wetzel Jewelry Store	Pres. I. W. L. A.
Wheeler, Harry H.	Kankakee	Attorney	Sportsman
Willis, H. T.	Champaign	G. C. Willis Store	Sportsman
Williams, H. R.	Danville	514 Commercial Ave.	Pres. I. W. L. A.
Williams, J. C.	Rockford	Burr Sporting Goods	Sportman
Wilson, Jack	Marengo		Farmer
Wyman, B. A.	Sycamore	Furniture	Sportsman

Indiana

Name	City	Address or Connection	Capacity
Allison, John	Rochester	Druggist?	Sportsman
Anter, Thomas	Attica		Farmer
Arnold, J. D.	Bluff Point	Store	Merchant
Baker, Chas. L.	Richmond	1213 N. 13th St.	Game Warden
Berst, W. H.	Leesburg	Hardware Store	Old Settler
Biederwolf, Chas.	Indianapolis	219 State House	Ex-Pres. State I. W. L. A.
Bozarth, Peter	Valparaiso	Attorney	Sportsman
Burtsfield, Frank	Lafayette	Supt. of Schools	Sportsman
Cass, George	Nappanee	Western Cartridge Co.	Sportsman
Charles, F. M.	La Fontane		Farmer
Crowner, E. C.	Spencer		Game Warden
Daugherty, R. H.	Frankfort	Sporting Goods	Sportsman
Decker, Harry	Winemac	Ford Garage	Pres. No. Ind. Field Trials
Decker, John	Bluffton	Decker & Vaughn, Attorneys	Pres. I. W. L. A.
Dietrich,	Henryville	Garage	Sportsman
Dobelbower, Fred C.	Lafayette	719 N. Main St.	Sec'y. Ind. I.W.L.A.
Dunlevy, D. A.	Henryville		Sportsman
Elrod,	Henryville		Coon Hunter
Fleming, Rodney D.	Fort Wayne	Lincoln Highway W.	Chief Warden, northern district
Furnish, H. J.	Scottsburg		Sportsman
Gentry, Frank	Nashville	R. R. No. 5	Sportsman
Goodrich, John	Winchester	People's Guar. Trust	Sportsman
Greyerson, John	Vernon	Harder Kennels	Sportsman & Trainer
Gude, John A.	Bruceville		Dog Trainer

Name	City	Address or Connection	Capacity
Guernsey, O. W.	Henryville	Clarke Forest	In charge, State Nursery
Hancock, Howard L.	Rockyville	Attorney	Sportsman
Harder, Alfred L.	Vernon	Harder Kennels	Sportsman and Dog Trainer
Hilgeman, Harry H.	Fort Wayne	403 Standard Bldg.	Ex-Pres. I. W. L. A.
Hoover, Thomas	Rochester	Hotel	Sportsman
Hunt, Dr. Geo.	Richmond	201 N. 7th St.	Sportsman
Isley, Clement	Attica		Sportsman
Jamison, Elmer	La Porte	181 E. Lincoln Ave.	Sportsman
Kaylor, J. F.	Indianapolis	133 State House	Asst. St. Forester
Keith, V. O.	Shelbyville	Keith Furniture	Sportsman
Konya, Andrew	South Bend	Sporting Goods Store	Sportsman
Lieber, Col. Richard	Indianapolis	State House	Director of Conservation
Llewellyn, R. E.	Terre Haute	Terre Haute Nat'l Bank	Pres. Terre Haute I. W. L. A.
Lyons, R. E.	Bloomington	Univ. of Indiana	Sportsman
Mannfield, George N.	Indianapolis	State House	Chief, Fish & Game Division
Mathers, F. C.	Bloomington	Univ. of Indiana	Sportsman
Mauzy, Chas.	Warsaw	Sporting Goods	
Murray, Arthur	Sullivan	Fire Dept., City Hall	Sportsman
Neal, Oliver	Nashville		Supt. Brown Co. Game Preserve
Nelley, M. L.	Marion	2319 W. 9th	Game Warden
Newsome, H. D.	Columbus	R. R. No. 10	Farmer
Nietzgar, H. J.	Dunlap	Janitor, Dunlap School	
Parks, E. J.	Nappanee	Cement Contractor	Sportsman
Perkins, S. E., III	Indianapolis	701 Inland B. K. Bldg.	Ex-Pres. Ind. Audubon Society
Phillips, Horner	Seymour	Fishmarket	Sportsman
Powell, Dr. E. H.	Valparaiso	Physician	Sportsman
Prentice, Burr. N.	Lafayette	Horticulture Bldg.	Prof. of Forestry
Pressler, Ivan	Tipton		Sportsman
Purdue, Calvin	Shelbyville	Security Trust Bldg.	County Agent
Ruch, Joe	Milford		Sportsman
Ruh, Fred	Rochester	Druggist	Sportsman
Seipel, D. H. O.	Valparaiso	Physician	Pres. I. W. L. A.
Settle, Wm. H.	Indianapolis	Lempce Bldg.	Pres. Indiana Farm Bureau
Shaw, L. E.	Bloomington	Bloomington Coal Co.	Sportsman
Shields, C. U.	La Porte	Attorney, Andrews Bldg.	Sportsman
Shinn, E. R.	Mentone	Postmaster	Sportsman
Simpson,	Indianapolis	State House	Asst. State Geologist
Sims, Dr. S. B.	Frankfort	214 Ross Bldg.	I. W. L. A.
Skinner, J. H.	Lafayette		Dean of Agriculture
Smith, Geo. W. Jr.	Kewanna		Farmer
Smith, Ray	Rennsalaer	Wright Fine Kennels	Dog Trainer
Stanzel, G. T.	Valparaiso	Police Department	Sportsman
Stephenson, Don K.	South Bend	Stephenson Underwear Co.	Sportsman
Stephenson, George	South Bend	Stephenson Underwear Co.	Sportsman
Stull, F. R.	Columbus	Hardware	Ammunition Dealer
Tapscott, Ralph	Greenville	Ford Garage	Sportsman
Test, L. A.	Lafayette	Chemistry Dept., Purdue	Ornithologist
Vandewalle, John	Seymour	Crosley Radio	Sportsman
Wallace, Frank N.	Indianapolis	State House	State Entomologist
Weigeman, Wm.	Fort Wayne	1011 Edgewater Ave.	Sportsman

Name	City	Address or Connection	Capacity
Wilcox, R. F.	Indianapolis	133 State House	State Forester
Wilkerson, Sol	Nashville		County Sheriff
Wright, Don	Rennsalaer	Wright Fine Kennels	Dog Trainer
Yost, C. O.	Indianapolis	State House	Asst. State Entomologist

Iowa

Name	City	Address or Connection	Capacity
Allen, A. F.	Sioux City	5th & Douglas	Editor, Sioux City Journal
Allen, C. J.	Milwaukee	P. O. Box 738	Sportsman
Benda, Chas.	Iowa City	Chief of Police	Coonsville Club
Bickel, W. F.	McGregor		Sec'y Wild Life School
Bode, I. T.	Ames		State Extension Forester
Bolton, A. H.	Sioux City	417 Frances Bldg.	Ex-Pres., I.W.L.A.
Bullock, D. J.	Ames	Bullock Hardware	Taxidermist
Darling, J. N.	Des Moines	Register & Tribune Bldg.	Pres. Iowa Cons. Association
Dill, Homer	Iowa City	University Museum	Curator
Drake, Dr. Carl J.	Ames		State Entomologist
Ewinger, Wm.	Burlington	Leopold Desk Co.	Crystal Lake Club
Guthrie, Dr. J. E.	Ames		Prof. of Zoology
Kay, Dr. Geo. F.	Iowa City	Liberal Arts Bldg.	Director, State Geological Survey
Lazell, Dr. F. J.	Iowa City	Journalism Bldg.	Amateur Ornithologist
Leopold, Carl S.	Burlington	Leopold Desk Co.	Crystal Lake Club
Leopold, Frederic	Burlington	Leopold Desk Co.	Crystal Lake Club
Lepley, Chas. R.	Clive	State Game Farm	Asst. Game Keeper
Luscombe, Joseph	Iowa City	9 Dubuque St.	Amateur Ornithologist
MacEwen, Dr. E. M.	Iowa City	335 Medical Lab.	Sportsman
Merckens, W. C.	Des Moines	State Capitol	Sec'y Executive Council & Bd. of Conservation
Pommel, Dr. L. H.	Ames	McGregor School	Prof. of Botany
Rhoads, Mrs. I. C.	Des Moines	State Capitol	Sec'y Fish & Game Dept.
Rosen, W. M.	Boone	McGregor School	Pres. Iowa Ornith Association
Scales, A. N.	Iowa City	124½ E. College St.	Sportsman
Schantz, O. M.		McGregor School	Botanist, Chicago
Sheldon, Robert W.	Sioux City	2557 S. Cedar St.	Sportsman
Shimek, Dr. B.	Iowa City	Botany Bldg.	Will H. Dilg League
Stevens, Dr. T. C.	Sioux City	Morningside College	Prof. of Biology
Stromston, Dr. F. A.	Iowa City	318 Zoology Bldg.	Limnologist
Sunderson, Harry	Sioux City	Kneebler Ins. Co.	Ex-Pres. I. W. L. A.
Taff, Paul C.	Ames	25 Morrill Hall	Asst. Chief Agric. Ex.
Walton, Harry	Sioux City	Wetmore Auto Co.	Sportsman
Weber, J. J.	Keokuk	Sporting Goods	Alexandria Gun Club
Whiting, S. B.	Iowa City	124½ E. College St.	Sec'y Local Dilg League
Willford, A. C.	Waterloo	820 Lafayette St.	Pres. Iowa I.W.L.A.
Wood, Judge Geo. W.	Waterloo		Ex-Pres. Iowa I. W. L. A.

Michigan

Name	City	Address or Connection	Capacity
Allen, Shirley	Ann Arbor	School of Forestry & Conservation	Extension Forester
Andrews, H. J.	Lansing		Chief Fire Warden
Aubrey, Wm.	Roscommon	Higgins Lake Forest	Superintendent
Bartlett, I. H.	Lansing	Conservation Dept.	Deeryard Survey
Beamish, Russell	Sanford	Midland Refuges	Keeper in Charge
Bishop, G. E.	Marquette	Upper Peninsula Development Bureau	Sec'y-Manager
Black, Harry B.	Flint	Genessee Bank Bldg.	Chairman, Kiwanis Forestry Com.
Burley, George	Lewiston	Montmorency Refuge	Keeper in Charge
Cosgrove, D. J.	St. Ignace		Co. Conservation Officer
Cowles, C. L.	Saginaw	Chase Building	I. W. L. A.
Dana, S. T.	Ann Arbor	Univ. of Mich.	Dean, School of Forestry & Conservation
Doepp,	Marquette		Co. Conservation Officer
Doyle, Earl C.	Lansing		Sec'y State I.W.L.A.
Ellsworth, R. E.	Alpena	Silver Creek Rearing Farm	In Charge
Failing,	Grayling	Grayling Refuge	Keeper in Charge
Gillespie, R. J.	Flint	901 Smith Bldg.	I. W. L. A.
Harper, Harry F.			Pres. State I.W.L.A.
Hogarth, Geo. R.	Lansing		Dirctor of Conservation
Hunsicker, W. J.	Saginaw	Second Nat'l Bank Bldg.	Ex-Fish Com.
Kirk, R. J.	Fairgrove	Farmer	I. W. L. A.
Lamont, Donald	Mason	State Game Farm	Head Game Keeper
La Rue, Dr. Geo. W.	Ann Arbor	Univ. of Mich.	Parasitologist
Lovejoy, P. S.	Lansing	Conservation Dept.	Chief of Game Div.
Lowe, Dr. John	Marquette	Northern State Teachers College	Prof. of Biology
McMurry, G. K.	Ann Arbor	Univ. of Mich.	Geography Dept.
Mershon, Wm. B.	Saginaw	Second Nat'l Bank	American Game Protective Association
Mershon, Wm. B., Jr.	Saginaw	Second Nat'l Bank	
Mitchell, O. A.	Flint	Buick Co.	Pres. Genessee Co. Cons. Wardens Club
Morey, C. F.	Alpena	Alpena State Forest	Superintendent
Peterson, Peter	Sharon		Special Game Warden
Pirnie	Lansing	Conservation Dept.	Ornithologist
Savage, H. A.	Saginaw	200 N. Hamilton St.	I. W. L. A.
Schaaf, Marcus	Lansing		State Forester
Schreck, R. E.	East Tawas	Michigan N. F.	Supervisor
Snow, W.	Lansing	Conservation Dept.	State Land Office
Spear, Frank B.	Marquette		Pres. Marquette Rod & Gun Club
Stevenson,	Lansing	Conservation Dept.	Inspector, Game Div.
Sullivan, D. A.	Saginaw	Chase Bldg.	Organizer for I. W. L. A.
Titus, Harold	Traverse City	Conservation Dept.	In charge, Forests & Fire, Author
Trudell, Peter, Jr.	Negaunee	Post Office	Pres. Northern Mich. Sportsmen's Assn.
Tuttle, John	Iosco?	Iosco Refuge	Keeper in Charge
Whitney, Alvin C.	Ann Arbor	Univ. of Michigan	School of Forestry & Conservation
Wight, H. M.	Ann Arbor	Univ. of Mich.	School of Forestry & Conservation
Woods, Norman A.	Ann Arbor	University Museum	Curator of Birds
Yeatter, R. E.	Ann Arbor		Institute Fellow
Zettler,	Roscommon	Higgins Lake Nursery	Superintendent

Minnesota

Name	City	Address or Connection	Capacity
Adams, A. W.	Rosy		
Aldrich, S. A.	Carlton		Co. Agric. Agent
Anderson, Sam C.	Hutchinson	Lawyer	Pres. Minn. Game Protective League
Brickner, Joe	St. Paul	Old Capitol	Chief Deputy Game Warden
Conzet, Grover	St. Paul	Old Capitol	Commissioner of Forests
Cox, W. T.	Winona	P. O. Building	Supt. Upper Mississippi Refuge
Eheim, Joe	Hutchinson	Barber	Ornithologist, botanist
Foley, W. T.	St. Paul	55 E. 10th St.	Atty. Farmers Protective League
Goering, Dr. E. H.	Duluth	Alworth Bldg.	Duluth I. W. L. A.
Gould, J. F.	St. Paul	Old Capitol	Former State Game Commissioner
Hansen, Shantz	Cloquet		Director, Cloquet Forest Expt. Sta.
Hicks, H. W.	Winona	P. O. Building	Forester, Upper Miss. Refuge
Hoar, Crosby	Duluth	Federal Building	Inspector, U.S.F.S.
Horn, Chas. L.	Minneapolis	Evanston Bldg.	Pres. Federal Cartridge Co.
Hornby,	Cloquet		Pres. Cloquet Lbr. Co.
Hotchkiss,	Winona	Postoffice Bldg.	Miss. Wild Life Refuge
Jackson, Fred G.	Winona	Owl Motor Co.	Sportsman
James, Dr. F. S.	Winona	Choate Building	Pres. Winona I.W. L A.
Kauphanger, O. L.	Bloomington	Station F, Route 1	Paid Sec'y, Minn. I. W. L. A.
Kelly, Geo. W.	Duluth	Christy Bldg.	Dairy Farmer
King, Ralph T.	St. Paul	Administration Bldg.	Institute Fellow
Kilgore, Dr. Wm.	Minneapolis	U. M. Zoological Museum	Ornithologist
Kittredge, Jos.	St. Paul	University Farm	Silviculturist Expt. Station
Lewis, Selmer	Granite Falls	Schneider Motor Sales	Is organizing I. W. L. A.
Lind, John	St. Paul	700 N. Y. Life Bldg.	Ex-Governor
McCullough, Geo.	Minneapolis		
Marshall,	Cloquet		Forester, Weyerhauser Cos.
Mendenhall, Warren	Duluth	125 Superior St.	Director, Minn. I. W. L. A.
Oberholtzer, Ernest	Ramer		Pres. Quetico-Superior Council
Oppel, A. F.	St. Paul	Old Capitol	Deputy Commissioner of Forests
Peterson, Alfred	Pipestone	Rock Island R. R.	Naturalist
Pimley, A. E.	St. Paul	State Forest Service	In charge, Fire Control
Purdee, John Stone	Duluth		Writer
Roberts, Dr. T. S.	Minneapolis	U. Minn. Zoological Museum	Ornithologist
Starkweather, E. R.	Hackensack		
Stedman, Alfred	St. Paul	Old Capitol	With Pioneer Press
Swanson, W. L.	Hutchinson		Dist. Game & Fish Warden
Vibert, Fred	Duluth		Sec'y-Mgr. Arrowhead Association
Warren, Frank M.	Minneapolis	First Natl. Bank Bldg.	Pres. Minneapolis I. W. L. A.
Willard, E. V.	St. Paul		Drainage Commission
Zon, Raphael	St. Paul	University Farm	Director, Forest Expt. Station

Missouri

Name	City	Address or Connection	Capacity
Allen, John	Warsaw	Sheriff, Courthouse	Ex-Game Warden
Allen, Robert D.	Butler	Editor, Times	Sportsman
Baker, H. L.	Callao	Baker Drug Store	Sportsman
Barmeir, Harry	St. Louis	4947 Schollmeyer Av.	Federal Game Warden
Bennett, B. B.	Jefferson City	Game & Fish Dept.	Chief Clerk
Bermit, Rudolph	Columbia	218 Lefevre, U. of Mo.	Prof. of Zoology
Blaettner, Elora	Wyaconda		Hornaday medalist
Blines, Jasper	Alexandria		Co. Historian and Naturalist
Bolt, Benj. F.	Kansas City	225 E. 46th St.	Ornithologist
Bornemann, Julius	Kirksville	Attorney	Sportsman
Bowman, F. C.	Kahoka	Game and Fish Dept.	Game Warden
Branson, E. B.	Columbia	101 Geology, U. of Mo.	Prof. of Geology
Brooks, Andrew	Doniphan		Dog trainer, sportsman
Brooks, S. D.	Columbia	Univ. of Missouri	President
Cave, Nicolas	Fulton	State Senator	Sportsman
Clapp, Chester E.	St. Louis	1020 Syndicate Trust Bldg.	Sportsman
Collins, Harry A.	St. Louis	506 Security Bldg.	Sec'y I. W. L. A.
Cordier, Dr. A. H.	Kansas City	415 Benton Blvd.	Ornithologist
Covitz, L. I.	Sedalia	321 S. Engineer	Warden
Cunningham, J. R.	Kansas City	1103 Waldheim Bldg.	I. W. L. A.
Curtis, W. C.	Columbia	110 Lefevre, U. of Mo.	Prof. of Zoology
Dunlap, Frederic	Columbia		State Forester
Dunn, Paul	Ellington		District Forester
Eason, Lee	Lancaster	Jeweler	Sportsman
Edde, Roscoe	Preston	Banker	Sportsman
Engerbrecht, Julius	?	Farmer	
Faherty, L. P.	Perryville	Insurance	Sportsman
Fairchild,	Perryville	Agric. Exten. Service	Co. Agent
Ferguson, Claude	Willow Springs		Game Warden
Fullgraff, Chas. W.	Clayton	Landscape architect	Sportsman
Gamm, F. C.	Bowling Green		Farmer
Gates, Elmer T.	Chillicothe	Moore Hdwe. Co.	Sportsman
Gibbs, Wallace	Houston	Agric. H. S.	Principal
Girth, Harry A.	Perryville	Editor	Sportsman
Goldsburg, W. H.	Columbia	Real Estate, Exchange Bldg.	Fox Hunter
Graham, E. C.	Poplar Bluff	Drug Store	Sportsman
Grecian, O. E.	Kansas City	123 Manufacturers Exch. Bldg.	Sportsman
Grimstead, L. R.	Columbia	Agric Hall, U. of Mo.	Asst. Agric. Editor
Gross, Carl R.	Cameron	Agric. H. S.	Prof. of Agric.
Gum, Will	Alton?		Cattle Rancher
Haseman, L.	Columbia	107 Whitten, U. of Mo.	Entomologist
Hayes, M. W.	St. Louis		U. S. Weather Bureau
Head, J. L.	St. Louis		Ex-Remington Arms Co.
Holland, E. R.	Poplar Bluff	Bank Bldg.—Broker	Sportsman
Hopkins, Dr. Ross	Jeff. City	Capitol	State Health Dept.
Hornback, Dr.	Hannibal	Physician	
Howell, Albert	Houston		Sportsman
Huls, Dr.	Kirksville		Sportsman
Hunt, Claude	Jeff. City	Game & Fish Dept.	Supervisor of Game
Huskey,	Fredericktown	Ford Garage	Sportsman
Hutchinson, L. B.	Vienna	District Attorney	Sportsman
Jeffrey, A. A.	Columbia	Agric. Hall, U. of Mo.	Agric. Editor
Johnson, Geo. R.	Harrisonville	County Clerk	Sportsman
Keith, W. J.	Harrisonville	Sporting Goods	Sportsman
Kemper, Ray	Macon	Ford Garage	Sportsman

Name	City	Address or Connection	Capacity
Krusekopf, H. H.	Columbia	136 Agric. Hall, U. of Mo.	Prof. of Soils
Leigh, B. F.	Nettleton	Filling Station	
Lewis, Martin A., Jr.	Jeff. City	Capitol	Chief of Parks, G. & F. Dept.
Lightfoot, M. D.	Springfield	Lightfood Bldg.	Rabbit Dealer
Lindsay, Dr. J. L.	Poplar Bluff	Ferguson Bldg.—Dentist	Sportsman
Logan, E. A.	Columbia	U. S. Dept. of Agric.	Crop Estimates
Long, John T.	Springfield	1044 McGee Ave.	Game Warden
Lyster, Dr. J. C.	St. Louis		Pres. Conservation Club
McCanse, Keith	St. Louis	224 Mayfair Hotel	Sec'y Conservation Club
McCaw, Harry A.	Rolla	Furniture	Sportsman
McCollum, Elmer D.	Chillicothe	Postoffice, Agric. Ext. Service	Co. Agent
McCord, J. Hamilton	2702 Lovers Lane		Sportsman
McFarland, Walter	Fredericktown	County Clerk	Fox Hunter
McKell, Dr. L. D.	Moberly	Physician, Tedford Bldg.	Pres., Randolph Co. H. & F. Assoc.
Maddox, Dr. J.	Moberly	Physician, Tedford Bldg.	Sportsman
Maitland, E. P.	La Plata	G. & F. Dept.	Game Warden
Martin, Earl	West Plains		Sportsman
Martin, E. R.	Warsaw	Courthouse	Sportsman
Melton, J. A.	Moberly	G. & F. Dept.	Game Warden
Miller, M. F.	Columbia	135 Agric. Hall, U. of Mo.	Prof. of Soils
Murrell, C. F.	Kirksville	Attorney	Sportsman
Myers, Joe	Queen City	% Postoffice	Ex-Game Warden
Neal, Dr. M. P.	Columbia	Medical School, U. of Mo.	Sportsman
Nichols, Guy L.	Kansas City	4901 Glendale Road	Western Cartridge Co.
Nolan, T. W.	Mt. Grove	State Poultry Expt. Station	Director
Norman, Glenn	Nevada	Mfr. Sheet Metal	Sportsman
Norton, J. E.	West Plains		Sportsman
Pfeiffer,	Perryville	Furniture	Fox Hunter
Pitford, James	Wayland		Farmer
Price, Dr. J. P.	Hannibal	Physician, Trust Bldg.	I.W.L.A. Council
Pritchett, Coe	St. Joseph	Courthouse, Agric. Ext. Service	County Agent
Ralls, Dr. L. B.	Ellington	Physician	Sportsman
Reavis, Geo. W.	Jeff. City	Smith-Hughes	Director, Vocational Education
Redmond, Robert	Carthage		Sec'y, Sportsman's Protective League
Reeder, George	Columbia		U. S. Weather Bureau Sportsman
Rehm, Dr. H. S.	St. Genevieve	Dentist	Sportsman
Renie, E. E.	Columbia	Hardware	Sportsman
Richhart, P. F.	Carthage	G. & F. Dept.	Game Warden
Rollins, Curtis	Columbia	Boone Co. Bank Bldg.	Sportsman
Rollins, Harry	Carthage	Editor, Carthage Press	Sportsman
Ross,	Jeff. City	G. & F. Dept.	Chief Warden
Schofield, E. L.	Aldrich		Field Warden, S. W. Division
Schwartz, Earnst	Jeff. City	F. & F. Dept.	Taxidermist
Shartel, Stratton	Jeff. City		Atty. General
Simons, Delph	Jeff. City	Capitol	State G. & F. Commissioner

Name	City	Address or Connection	Capacity
Slaughter, I. S.	Eldon	Agric. College	County Agent
Smith, Phil M.	Williamsburg		Farmer
Smith, S. R.	St. Louis	S. W. Bell Tel. Co.	General Manager
Smoyer, W. W.	Versailles	G. & F. Dept.	Dist. Game Warden
Spicer, Chas. B.	St. Louis		Hercules Powder Co.
Stamer, A. D.	Wright City	Merchant	Sportsman
Steele, Wm. P.	Sedalia	Farmer	U. S. Deputy Warden, Game Farmer
Stone, Hugh	Houston	Barber	Sportsman
Taft, R. E.	Mexico	G. & F. Dept.	Game Warden
Talbot, W. W.	Springfield	Gov't Bldg.	Director, U. S. Weather Bureau
Tanner, H. A.	Doniphan	Mo. Pacific R. R. Co.	Express Agent
Taylor, J. M.	Columbia	Taylor-Estes Lbr. Co.	Sportsman
Tollerton, Jesse A.	Springfield	Pierce Petroleum Co.	Ex-Game Commiss-r
Via, C. D.	Rolla	5 & 10c Store	Sec'y I. W. L. A.
Walthers, Wm. W.	Boonville	408 E. High St., Contractor	Sportsman
Warnscott, L. F.	Rolla	Agric. Ext. Service	County Agent
Watson, E. I.	Columbia	Editor, Tribune	Fox Hunter
Weber, Henry L.	Nevada	Tailor	Sportsman
Weeks, Curtis	Eldon		Farmer
Wells, Arthur	Cabool	Cabool Produce Co.	
Wilcke, R. M.	Houston	Ford Garage	Sportsman
Williams, Graham	Bowling Green	Hardware	Sportsman
Willowbrand, A. H.	Freeburg	Merchant	Sportsman
Wilson, Walter	Ironton	Proprietor, Com'l Hotel	Sportsman
Wimmer, Walter	St. Louis		Pres. St. Louis I. W. L. A.
Woods, F. H.	Columbia	218 Lefevre, U. of Mo.	Asst. Prof. Zoology
Wylder, L. Newton	Kansas City	Attorney, 508 Scarrett Bldg.	Sportsman
Wylder, T. Earl	Caulfield		Cattle Rancher

Ohio

Name	City	Address or Connection	Capacity
Bartner, W. H., Jr.	Cincinnati	500 Kieth Bldg.	V. P. Fish & Game Assn. of S. W. Ohio
Bowersox, D. M.	Cincinnati	2281 Vine	Game Protector, Cin. Dist. Deputy U. S. Warden
Caton, Harry A.	Coshocton	149 N. 15th St.	Master, O. St. Grange, Board of Trustees, Ohio State Univ.
Charlton, M. A.	Columbus	2106 Summit St.	Federal Game Protector
Davidson, Dr. H. S.	Akron	Corach Bldg.	Pres. Akron I.W.L.A.
Dugan, Jas. N.	Cincinnati	5263 Eastern Ave.	Ex-Pres. Fish & Game Assn. of S. W. Ohio
Falcover, J. I.	Columbus		Agric. Economics
Fitzgerald,	Columbus		Deputy Federal Ward.
Gilmore, Tiffin	Columbus	Capitol Annex	Sportsman, Marshall of Supreme Court
Gleason, C. H. Jr.	Oberlin	51½ Professor St.	Graduate Student
Harlow, Fred	Akron		Dist. Game Protector
Heer, Fred J.	Columbus		Publisher, Hunter-Trader-Trapper.
Hicks, Lawrence	Columbus	U. of O.	Ohio Game Survey
Hirsch, Albert	Lancaster		Supt. Boys Industrial School
Jones, Dr. Lynds	Oberlin	Oberlin College	Prof. of Zoology

Name	City	Address or Connection	Capacity
Keller, Carl	Dayton	864 River Row Ave.	Dist. Game Supervisor
Jones, Dr. Lynds	Oberlin	Oberlin College	Prof. of Zoology
Keller, Carl	Dayton	864 River Row Ave.	Dist. Game Supervisor
Keller, T. Haze	Cincinnati	First Nat'l Bank Bldg.	Peters Cartridge Co.
Kellogg, L. F.	Columbus	Horticulture Bldg.	Jr. Forester, Exp. Sta.
Kirgan, J. W.	Cincinnati	503 First Nat'l Bank Bldg. (Insurance)	Ex-Pres. Fish & Game Assn. S. W. Ohio
Lockett, R. E.	Columbus		Sportsman
McCarthy, E. F.	Columbus	Horticulture Bldg.	Director, Central States Forest Expt. Station
McPherson, Dr. Wm.	Columbus	106 University Hall	Dean, Graduate School
Mason, Capt. Paul	Columbus	Pure Oil Building	Pres. Cen. O. Anglers & Hunters Club
Meyer, Dr.	Columbus	Horticulture Bldg.	Ecologist, Forest Expt. Station
Nicholas, E. M.	Columbus	20 E. Broad St. (Real Estate)	Sportsman (authority on woodcock)
Osborne, Dr. Herbert	Columbus	Zoology Bldg.	Chief, State Biological Survey
Osburn, Dr. Raymond C.	Columbus	Zoology Bldg.	Head of Zoology Dept.
Overbeck, Geo.	Cincinnati	Powell & Clements (Sporting Goods)	Sportsman
Parks,	Columbus		Extension Entomologist
Pfleuger, Jos. E.	Akron	Enterprise Mfg. Co., 217 Ash St.	Ex-Pres. Ohio I. W. L. A.
Porter, Ira	Oberlin	Peoples Bank	Oberlin Rod & Gun Club
Sherman, C. E.	Columbus		Civil Engineering Dept
Stever, Fred C.	Defiance	Merchants Nat'l Bank	Sportsman
Swing, Richard	Cincinnati	711 Fourth Nat'l Bank Bldg. (Attorney)	Sportsman
Thompson, Dent O.	Columbus	Capitol Annex	Chief, Division of Fish & Game
Trautmann, Milton	Columbus	618 S. 5th St.	Amateur Ornithologist
Walker, Chas. F.	Columbus	Ohio State Museum	Asst. Curator
Wickliff, E. L.	Columbus	Capitol Annex	Research Bureau, Div. of Fish & Game
Wolf, Frank J.	Fremont	322-4th St.	State Game Supervisor Dist. 2, U. S. Dep. Game Warden

Wisconsin

Name	City	Address or Connection	Capacity
Aberg, W. J. P.	Madison	Gay Building	Former Prse., Wis. I. W. L. A.
Adamson, Wm.	Cottage Grove	Lumber Yard	Sportsman
Anderson, A. J.	Sheboygan	Sporting Goods	Sportsman
Bageley, Geo. M.	Neosho		Sportsman
Barkhausen, W. L.	GreenBay		Sportsman
Benson, A. O.	Madison	Forest Products Lab.	Forester
Berndt, Herman	Fond du Lac		Pres. Wis. I.W.L.A.
Beyer, Otto	Briggsville		Game Farmer
Bierman, Geo.	Sheboygan	Sporting Goods	Sportsman
Bietz, Joseph A.	Dunbar		State Forest Ranger
Bird, John P.	La Crosse	904 Cass St.	Naturalist
Bishop, Will M.	Dodgeville	Courthouse	County Clerk
Blomberg, Hjalmar	Prentice	Sheriff	Trapper
Blum,	Monroe	District Attorney	Sportsman
Boese, Wm.	Ft. Atkinson		Farmer

Name	City	Address or Connection	Capacity
Bolus, Wm. G.	Rhinelander		Taxidermist
Bradford, A. S.	Appleton	110 South Oneida St., Lawyer	Sportsman
Bremer, Louis	Shawano	Lawyer	Sportsman
Brockway, Dan	Necedah	Route 3, Box 25	Farmer
Burg, Wm.	Platteville	Clothier	Sportsman
Burmeister, Oney	Briggsville		Farmer
Burr, Harold	Breen Bay	Grocery	Au Sable Club
Buss, A. J.	Barneveld	Agent C. & N. W. Ry.	Sportsman
Caesar, A. E.	Menominee Falls	Tinsmith	Sportsman
Cameron, W. I.	Shell Lake	Asst. County Clerk	
Case, Roy I.	Racine	1755 Main St.	Sportsman
Chamley,———	Mineral Point	Royal Hotel	Sportsman
Cheyney, L. S.	Barron		Biologist
Cole, Frank	Ft. Atkinson	Badger Lunch	Sportsman
Cooke, W. W.	Madison	E. Monroe St.	Sportsman
Cortine, ———	Milwaukee		Sportsman
Coyner, J. M.	Madison	2225 W. Lawn	Ex-Co. Agent, Jefferson County
Criddle, H. C.	Belleville		Sportsman
Curtis, J. C.	New Lisbon	Prin. High School	Sportsman
Curtis, Scott	Viroqua		Game Warden
Curtis, W. T.	Jonesdale		Farmer
Damon, Harold	Wausau		Sportsman
Davies, Kirk	Hayward		
Dickson, J. D.	Madison	Univ. of Wisconsin	Plant Pathologist
Divan, E. L.	Monroe	Courthouse	Co. Agric. Agent
Divine, Barney	Hayward		Game Warden
Dixon, Guy	Racine	Dixon Sporting Goods	Sportsman
Doelle, Mrs. Wm.	Marquette		Caw Caw Club
Doolittle, A. E.	Fish Creek		Supt. State Park
Drewry, C. B.	Marinette	Agric. High School	County Agent
Dunn, J. H.	Mellen	Hardware Store	Sportsman
Edick, James	Crandon		Game Warden
Elliott, Wm.	Whitewater	101 Case St.	Game Warden
Emmel, Omar	Blair	Insurance	Sportsman
Errington, P. L.	Madison	Biology Bldg.	Institute Fellow
Ernsperger, Dr.	Portage	Dentist	Sportsman
Evans, N. W.	Oconomowoc	Attorney	Sportsman
Fairchild, ———	Fish Creek		Ex-Keeper, Chambers Island
Fluke, C. L.	Madison		Entomologist
Foster, J. W.	Brandon	Foster Bank	Sportsman
Freeman, Dr.———	Wausau		Sportsman
Fuller, W. H.	Cumberland	Attorney	Sportsman
Gardiner, D. J.	Platteville	Lawyer	Wis. Hist. Soc.
Goodman, Robt. B.	Marinette	Sawyer-Goodman Co.	Lumberman
Graass, Frank	Sturgeon Bay		State Secretary, Wis. I. W. L. A.
Graham, W. J.	Sheboygan		
Grange, W. B.	Madison	Conservation Dept.	Former Supt. of Game
Gray, Wayne	Marquette		Farmer
Grimmer, F. W.	Madison	Conservation Dept.	Supt. of Game
Gross, Dr. A. O.	Brunswick, Me.	Conservation Dept.	Prairie Chicken Surv.
Grover, Frank A.	La Crosse	Linke Bldg.	Sportsman
Grover, Otto	Hayward		County Surveyor
Hall, A. W.	Darlington		Game Warden
Hart, Cole	Horicon		Sportsman
Harwood, C. H.	Waukesha	240 Wis. Ave.	Sportsman
Hegeman, Harry	Mauston		Sportsman
Hennel, E. J.	Mellen	Jeweler	Sportsman
Hoard, ———	Ft. Atkinson	Hoard's Dairyman	Sportsman
Homberg, F.	Stevens Point		Game Warden

Name	City	Address or Connection	Capacity
Hopkins, Frank	Pewaskum		Supt. Moon Lake Game Farm
Hurd, R. L.	River Falls		
Jackson, ———	Mineral Point		Farmer
Jirday, F.	Cottage Grove		Sportsman
Johnson, Fred	Richland Center		Game Warden
Johnson, Harry	Fish Creek	State Game Farm	Game Keeper
Johnson, Martin	McFarland		Sportsman
Jones, Dr. M. L.	Wausau		Sportsman
Kade, Arthur	Sheboygan		Pres. I. W. L. A.
Kay, J. V.	Green Bay		Refuge Keeper
Kean, J. R.	Stanley	Hardware	Sportsman
Keeler, John C.	Fennimore		Game Warden
Keeler, R. M.	La Crosse	Newburg Bldg.	Pres. I. W. L. A.
Kipp, Duane	Madison	Conservation Dept.	Supt. of Education
Kirziger, Jack	Lena		Sportsman
Kratschwill, Al	Muscoda	Ford Garage	Sec'y I. W. L. A.
Kutcheon, Dr. V.	Green Lake	Owner, Maplewood Hotel	Conservationist
Lackie, H. M.	Ft. Atkinson	James Incubator Co.	Poultry Expert
Langenbach, A. G.	West Bend	West Bend Aluminum Co.	Sportsman
Langenbach, Robt.	Mayville		Sportsman
Lanning, Wm. P.	Blk. Riv. Falls		Dist. Game Warden
Lebricht, Paul	Belleville	Hardware Store	
Ledvina, Ed	Oshkosh	Mgr. Telphone Co.	Sportsman
Leicht, C. A.	New Lisbon		Sportsman
Luck, Wm.	Rhinelander		Sportsman
Lynn, E. N.	Cumberland		Game Warden
McCommons, G. D.	Delavan	Packard Garage	Sportsman
MacDonald, Phil	Spooner		Forest Ranger
MacFarlane, K. J.	Janesville		Game Farmer
McNall, Preston E.	Madison	Univ. of Wisconsin	Agric. Economics
Main, John S.	Madison	2210 Van Hise Ave.	Ornithologist
Markham, Lew	Rhinelander	Clothing Store	Sportsman
Miller, Robert	Marquette		Resort Owner
Moore, R. A.	Madison	Univ. of Wisconsin	Prof. of Agronomy
Moore, W.	Pickett	Route 27	Sportsman
Mueller, John	Ft. Atkinson	Hatchery	Sportsman
Neal, C. C.	Mineral Point	Mineral Pt. Zinc Co.	Sportsman
Nelson, E. J.	Manitowoc		Sportsman
Nelson, Oscar	Fish Creek	State Game Farm	Predator Control
Nicholson, Dan	Green Bay	Nicholson Hardware	Sportsman
Nicholson, Harry	Green Bay	Nicholson Hardware	Sportsman
Niemi, Emil	Owen		
Novy, Antoine	Manitowoc	712 Chicago St.	Sportsman
Noyes, Haskell	Milwaukee	491 Jefferson St.	Conservation Com.
Odegard, Ole	Hayward		Taxidermist
Oehaffen, Wm.	Tripoli		Indian Trader
O'Hara, Jack	Janesville	Janesville Gazette	Naturalist
Olsen, H. T.	Taylor		Farmer
Olstrom, Ole	Owen		Sportsman
Ott, Royal	Blk. Riv. Falls		Sheriff
Otto, W. M.	Watertown	N. Water St.	Sportsman
Pabst, Col. Gustav	Milwaukee		Owner, Pabst Game Farm
Paine, Wm.	Wausau		Sportsman
Patterick, Scott	Berlin	Truesdell Fur Coat Co.	Sportsman
Patterson, Matt	Madison		
Perkins, I. J.	Milwaukee	Public Museum	Ornithologist
Perwitz, Ferd	Lake Mills	Garage	Sportsman
Peters, Carl	Stoughton	Butcher Shop	Pres. I. W. L. A.
Peterson, Arthur	Racine	3815 Linderman Ave.	Sportsman

Name	City	Address or Connection	Capacity
Postwell, F. W.	Muscoda	Ford Garage	Sportsman
Premi, John	Janesville	Sporting Goods	
Priestley, Wm.	Mineral Point	Lawyer	Sec'y, I. W. L. A.
Pryor, J. W.	Barneveld	Druggist	Sportsman
Pugh, Harold	Racine	W. H. Pugh Coal Co.	Sportsman
Radke, Louis	Horicon		Vice-Pres. Wis. I. W. L. A.
Rasmussen, N.	Oshkosh	Nursery	Farmer
Reed, Howard E.	Oshkosh	Asst. to Clyde B. Terrell	Aquatic Farm
Reodan, Ronald	Rhinelander	Drug Store	Sportsman
Robertson, Robt.	Arlington		Farmer
Robinson, A. J.	Rhinelander		Game Warden
Robinson, N. S.	Milwaukee	Attorney	Sportsman
Rose, Geo. B.	La Crosse	Jeweler	Sportsman
Ruzicka, F. J.	Burlington	Attorney	Sportsman
Sample, Arthur	Dalton		Road Foreman
Sarett, Lew	Laona		Writer, Sportsman
Schoenfeld, B. F.	Park Falls		Sportsman
Schorger, A. W.	Madison		Ornithologist
Schram, Dr. C. F. N.	Beloit	Physician	Sportsman
Schueler, A. G.	Tomah		Sportsman
Schult, Gus	Westfield		Sportsman
Schultz, Frank	Madison	Ritter Garage	Sportsman
Schumaker, John	Fountain City		Sportsman
Slusser, Chas. E.	Rhinelander		Taxidermist
Smith, O. W.	Oconomowoc		Sportsman, Author
Steinman, F. H.	Monticello		Sportsman
Stickney, Gardiner	Milwaukee	912 Wis. Trust Bldg.	Ornithologist
Stiglbauer, F. A.	Oconomowoc		Game Warden
Stocking, Dan	Ft. Atkinson	Gunsmith	Old Settler
Stone, F. R.	Rhinelander	Clothing Store	Sportsman
Storm, Archie	Manitowoc	Aluminum Goods Co.	
Strubel, Fred	Phillips		Sportsman
Sturdevant, H. C.	La Crosse	C. & N. W. Ry.	Ornithologist
Sinandle, ———	Marquette		Resort Owner
Sutherland, C. G.	Janesville		Sportsman
Sutherland, Orrin	Janesville		Sportsman
Swift, Dean	Edgerton	Drug Store	Thiebeaux Club
Seift, Ernest	Hayward		Game Warden
Terrell, Clyde B.	Oshkosh		Owner Aquatic Farm
Tobin, John	Elkhorn		Farmer
Townsend, Allen	Racine		Sportsman
Trakel, Chas.	Waukesha	Drug Store, So. St.	Pres. I. W. L. A.
Trouesdale, J. W. T.	Brodhead		Pres. I. W. L. A.
Vanderwalle, R. J.	Park Falls		State Forest Ranger
Van Buren, ———	Chippewa Falls	Chippewa Printery	Sportsman
Wagner, George	Ellison Bay		Sportsman
Walters, A. S.	Poynette	Standard Oil Co.	Sportsman
West, M.	Monroe	Courthouse	Sheriff
Weisenberger, Geo.	Arcadia	Photographer	Sportsman
Wetmore, Dr. A.	Washington, D. C.	National Museum	Ornithologist
Wilson, Harold C.	Ephriam	Real Estate	Ornithologist
Wood, Tom	Rhinelander	Hardware Store	Sportsman
Worden, Jack	Plainfield		Game Warden

APPENDIX (b)

BIBLIOGRAPHY

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APPENDIX (c)

KEY TO CHART 44, GAME CYCLE IN WISCONSIN

(The numbers opposite species symbols in Chart 44 indicate the name and location of the observer as given in the following list.)

No.	*Name of Observer*	*Location of Observer*
1.	J. M. Coyner	Jefferson Co.
2.	W. W. Cooke	St. Croix Co.
3.	W. W. Cooke	Sawyer Co.—Spider Lake
4.	W. J. P. Aberg	Shell Lake—Washburn Co.
5.	J. G. Peters	Trout Lake—Vilas Co.
6.	J. R. Graham	Hayward—Sawyer Co.
7.	J. R. Graham	Rhinelander—Oneida Co.
8.	A. A. Allen	Green Bay—Brown Co.
9.	A. Leopold and H. Weiss	Juneau Co.
10.	A. Leopold and H. Weiss	Dane Co.
11.	Thure Kumlien	"S. Wis."—Delavan
12.	Dr. Hoy	Racine
13.	J. N. Clark	Dunn Co.—Kumlien & Hollister
14.	Kumlien & Hollister	Janesville—Rock Co.
15.	Kumlien & Hollister	General—but probably apply to home at Delavan
16.	Robt. Ridgeway	"S. Wis. & N. Ill."
17.	W. J. P. Aberg	Ladysmith—Rusk Co.
18.	John Tobin	Butternut Lake—Forest Co. (Elkhorn)
19.	Jack O'Hara	Rock Co.
20.	Orrin Sutherland	Rock Co.
21.	Guy Dixon	Webster—Burnette Co.
22.	Haskell Noyes	Brule—Douglas Co.
23.	C. Allen	L. Puckaway—Green L. Co.
24.	Cortine	Oconomowoc—Waukesha Co.
25.	N. S. Robinson	River Falls—Pierce Co.
26.	N. S. Robinson	City Point—Jackson Co.
27.	N. S. Robinson	White Lake—Langlade Co.
28.	Gustav Pabst	Ottawa Twp.—Waukesha Co.
29.	Gardiner Stickney	Centre of Florence Co.
30.	Gardiner Stickney	E. Vilas & N. E. Oneida Cos.
31.	Gardiner Stickney	Bayfield Co.
32.	Gardiner Stickney	Bayfield Co.—(Stockton Island)
33.	Gardiner Stickney	W. shore L. Winnebago
34.	A. G. Langenbach	Horicon Marsh—Dodge Co.
35.	A. G. Langenbach	Kewaskum & Theresa—Washington Co.
36.	H. L. Stoddard	Sauk Co.
37.	Alfred Stedman	Wis. line E. of Hinckley, Minn. (Burnett)
38.	C. B. Drury	Co. Agent, Marinette Co.
39.	Bert Laws	Mazomanie Bottoms & Sauk Co.
40.	M. A. Deutsch	Shakopee, Minn. opposite Pierce Co.
41.	Ed. Ochsener	Prairie du Sac—Sauk Co. 3 birds
42.	Carl Peters and Dean Swift	Gredsbach Marsh—S. E. Dane Co.
43.	Carl Peters	Eagle Prairie—Chippewa Co.
44.	John Mueller	Ft. Atkinson—Jefferson Co.
45.	Arthur Kade	Kingston—Green Lake Co.
46.	Harold Pugh	Adams, Juneau & Wood Cos.
47.	A. J. Anderson	Sheboygan Co.
48.	Antoine Novy	Manitowoc Co.
49.	Harry Johnson	Door Co.
50.	H. R. Holland	History of Door Co.
51.		
52.	A. E. Doolittle	Peninsula Park—Door Co.
53.	H. C. Wilson	Ephraim—Door Co.
54.	W. B. Grange	N. W. Ladysmith—Rusk Co.
55.	Wm. Fairchild	Door Co. mainland

No.	*Name of Observer*	*Location of Observer*
56.	Oscar Nelson	Door Co. mainland
57.	A. E. Doolittle	Vilas Co.
58.	Harold Burr	Brown Co.—N. W. side Green Bay
59.	Harold Burr	Armstrong Cr.—Forest Co.
60.	Harold Burr	Oconto Co.
61.	Oney Burmeister	Douglas Twp.—Marquette Co.
62.	H. M. Lackie	Sawyer Co.
63.	Ed. Ledvina	Kelley Lake & Pewaukee—Oconto Co.
64.	Ed. Ledvina	W. Oconto, S. E. Forest, N. W. Marinette
65.	Clyde Terrell	Plainfield—Waushara Co.
66.	Clyde Terrell	Butte des Morts Lake—Winnebago Co.
67.	Alfred S. Bradford	Outagamie, W. Shawano, & Forest Cos.
68.	L. C. Brunner	Shawano
69.	Jack Kinziger	Oconto & Marinette
70.	Joseph A. Bietz	Dunbar—Marinette Co.
71.	Mr. and Mrs. Alfred J. Robinson	Oneida & Langlade Cos.
72.	Alfred J. Robinson	Elton & S. Langlade Co.
73.	James Edick	Crandon—Forest Co.
74.	Jalmar Blomberg	Prentice—Price Co.
75.	Fred Strubel	Phillips—Price Co.
76.	Wm. Oehhaffen	Tripoli—Oneida Co.
77.	Wm. Oehhaffen	Tomahawk—Lincoln Co.
78.	Alfred T. Robinson et al.	Langlade, Price, Oneida Cos.
79.	Ronald Reardon	Rhinelander—Oneida Co.
80.	J. H. Dunn	Mellen—Ashland (& Bayfield) Cos.
81.	B. F. Schoenfeld	Park Falls—Price Co.
82.	B. F. Schoenfeld	Barneveld—Iowa Co.
83.	B. F. Schoenfeld	Beaver Dam—Dodge Co.
84.	Kirk Davies	Hayward—Sawyer Co.
85.	Barney Devine	Burnett Co.
86.	Barney Divine and Earnest Swift	Sawyer Co.
87.	Barney Divine and Earnest Swift	Washburn—Burnett Co. line
88.	Barney Divine and Earnest Swift	S. Douglas Co.
89.	Barney Divine	Lower St. Croix—Burnett Co.
90.	Ole Odegard	Hayward—Sawyer Co.
91.	Ole Odegard	Dunn Co.
92.	Van Buren	Prairie Farm—Barron Co.
93.	J. R. Kean	Stanley—Chippewa Co.
94.	Ole Elstrom	Atwood—Clark Co.
95.	F. Hornberg	Portage Co.
96.	F. H. King	"Geology of Wisconsin" (Lac du Flambeau)
97.	Jack Worden	Plainfield—Waushara Co.
98.	Gus Schult	Westfield—Marquette Co.
99.	R. A. Moore	Kewaunee Co.
100.	H. L. Stoddard	Mosquitoe Lake—Waukesha Co.
101.	A. W. Hall	Lafayette Co.
102.	Al Kratschwill	Muscoda—Grant Co.
103.	F. A. Grover	La Crosse
104.	Geo. B. Rose	Monroe Co.
105.	Scott Curtis	Vernon Co.
106.	John Schmoker	Trempealeau Bottoms
107.	Omar Kemel	Blair—Trempealeau Co.
108.	H. T. Olsen	Taylor—Jackson Co.
109.	Royal Ott	Jackson Co.
110.	A. G. Schueler	Tomah—Monroe Co.
111.	B. P. Lanning	Juneau Co.
112.	B. P. Lanning	Jackson Co.—Northfield Twp.
113.	J. C. Curtis	New Lisbon—Juneau Co.
114.	Henry Hegeman	Mauston
115.	F. H. King "Geology of Wisconsin"	River Falls—Pierce Co.
116.	H. L. Stoddard	Pierce Co.
117.	Dr. Alexander Wetmore	North Freedom—Sauk Co.
118.	Cole Hart	Horicon—Dodge Co.

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APPENDIX (d)

Covies raised by 1 man (on foot) with 1 dog per day as an index of quail population

State	County	Type	Observer	Ave.	Min.	Max.	Remarks
Iowa	Des Moines	Riverbreaks	F. & C. Leopold	7	5	10	
Ohio	Cleremont	Riverbreaks	Jos. Kirgan			9	
	Adams	Hill	Horace Lytle			16	
	Defiance	Lakebed	Fred Stiver	5			
	Greene	Till Plain	R. Swing			11	
Illinois	Madison?	Riverbreaks	H.J.Bowman			(27)	In 1924*
	Lawrence	Riverbreaks	D. R. Abernathy			13	In 1928
	Marion	Riverbreaks	C. R. Miller	8		10	
	Winnebago	Upper Miss.	J. C. Williams			3	
	Boone	Till Plain	W. Rowan	2		3	
Missouri	Phelps	Ozark	J. C. Lyter			15	
	Callaway	Riverbreaks	N. Cave			(10)	4 men, 3 dogs
	Phelps	Ozark	C. D. Via	8		10	
	Buchanan	Prairie	J. H. Mc Cord, Jr.	2		3	
Minnesota	Winona	Upper Miss.	F. S. James	(3)		(9)	Used care to visit many localities.
Michigan	Oakland	Till Plain	H. M. Wight			10	

NOTE: This index was tried out during the early stages of the survey, but later abandoned when it became apparent that figures on actual covies per farm were more accurate and just as easy to get. The above figures are offered, however, as of possible interest to dog men, even though they are not regarded as a valuable index to abundance.

*Not sure if only one dog.

APPENDIX (e)

PHEASANT AND PRAIRIE CHICKEN POPULATION IN WISCONSIN, 1930

Based on game observers' reports. Compiled by Franklin Schmidt.

County	Pinnated Grouse	Sharptail Grouse	Pheasant*	County	Pinnated Grouse	Sharptail Grouse	Pheasant*
Adams	1,000	----	----	Marathon	1,000	50	200
Ashland	500	2,000	700	Marinette	1,000	2,000	60
Barron	200	400	60	Marquette	2,000	----	50
Bayfield	1,000	4,000	200	Milwaukee	----	----	----
Brown	500	----	400	Monroe	1,000	50	200
Buffalo	200	----	50	Oconto	3,000	500	150
Burnett	1,000	4,000	50	Oneida	500	----	100
Calumet	500	----	250	Outagamie	1,000	----	1,000
Chippewa	500	500	50	Ozaukee	----	----	----
Clark	1,000	5,000	20	Pierce	4,000	----	600
Columbia	500	----	200	Polk	1,000	------	100
Crawford	----	----	----	Portage	4,000	500	40
Dane	500	----	600	Price	2,000	2,000	25
Dodge	50	----	50	Richland	100	----	500
Door	100	----	300	Rock	100	----	2,000
Douglas	500	5,000	50	Racine	----	----	------
Dunn	200	----	----	Rusk	1,000	1,000	25
Eau Claire	1,000	1,000	200	Sawyer	100	3,000	25
Florence	50	----	----	Shawano	5,000	100	300
Fond du Lac	400	----	1,000	Sauk	100	----	500
Forest	100	50	50	St. Croix	1,000	50	500
Grant	100	----	200	Sheboygan	250	----	50
Green	400	----	400	Taylor	500	500	20
Green Lake	5,000	----	1,000	Trempealeau	100	----	200
Iowa	100	----	200	Vernon	----	----	50
Iron	100	500	----	Vilas	500	500	----
Jackson	500	5,000	100	Walworth	1,000	----	1,000
Jefferson	500	----	1,000	Washburn	500	2,000	200
Juneau	1,000	5,000	200	Washington	100	----	1,000
Kenosha	50	----	1,000	Waukesha	50	----	2,000
Kewaunee	100	----	----	Waupaca	1,000	50	100
La Crosse	500	----	200	Waushara	2,000	----	100
Lafayette	100	----	500	Winnebago	500	----	500
Langlade	500	500	----	Wood	5,000	10,000	----
Lincoln	500	100	100	Pepin	----	----	----
Manitowoc	100	----	300				
Totals					54,850	55,350	21,015

*Estimated before 1930 releases were made.

APPENDIX (f)

ABUNDANCE RATIOS

Locality	Quail	Hungarian	Pheasant	Chicken	Sharptail	Ruffed Grouse
Wisconsin						
Rusk	1			100	100	
South Chippewa	1			100	100	
Trempealeau	50			1		100
Buffalo	100			1		10
South Green Lake	100			10		1
Iowa	100			1		
Jefferson	1	100	40			
Waukesha	1	100	50			
West Walworth	1	100	2			
Racine (Yorkville and Dover Townships)	0	100	25	0	0	0
Michigan—						
Lenawee	100	70	40			
Southeast Lenawee	15	100	1			
Northwest Lenawee	100	10	50			
Monroe		30	100			
Illinois—						
North Lake	0	100	50	?		
South Lake	0	50	100	?		
North McHenry	?	10	100			
Indiana—						
East De Kalb	100	25	37			
North Adams	100	50	0			
South Adams	100	100	?			
North Jay	100	20	?			
South Jay	100	7	1			
Central Jay	100	100	10			
North Randolph	100	20	10			
Central Randolph	100	50	25			
South Henry	100	1	2			
Southeast Henry	100	1	3			
North Hancock	100	0	0			
Southwest Madison	100	10	0			
South Central Madison	100	2	0			
Northwest Madison	100	2	0			
Central Hancock	100	2	1			
North Madison	100	50	10			
Central Delaware	100	2	0			
Central Hamilton	100	0	5			
North Hamilton	100	0	1			
North Central Tipton	100	100	0			
Northeast Hamilton	100	5	0			
Central Tipton	100	2	1			
East Central Tipton	100	50	10			
North Central Tipton	100	5	1			
Central Clinton	100	0	0			
North Central Clinton	100	0	0			
West Clinton	100	0	0			
East Central Clinton	100	75	0			
West Central Clinton	100	0	2			
South Central Clinton	100	0	1	1		
North Central Clinton	100	4	0			
Southwest Howard	100	4	1			
West Howard	100	5	0			

Locality	Quail	Hungarian	Pheasant	Chicken	Sharptail	Ruffed Grouse
Indiana (Con't.)—						
Southwest Franklin	100	0	5	-------	-------	-------
East Central Union	100	0	10	-------	-------	-------
North Wayne	100	5	0	-------	-------	-------
Southeast Randolph	10	100	1	-------	-------	-------
Central Randolph	100	50	30	-------	-------	-------
South Miami	100	0	?	-------	-------	-------
South Central Miami	100	1	0	-------	-------	-------
Central Miami	100	0	0	-------	-------	-------
West Central Wabash	100	3	3	-------	-------	-------
Ohio—						
Ott, Sandusky	?	30	100	-------	-------	-------
Champaign						
Logan	?	3	100	-------	-------	-------
Miami						
Shelby						
Allen	?	5	100	-------	-------	-------
Putnam	?	100	50	-------	-------	-------
Wood						
East Fulton	?	100	3	-------	-------	-------
Henry	?	100	10	-------	-------	-------
West Fulton	?	30	100	-------	-------	-------

APPENDIX (g)

INDEX

GAME SURVEY OF THE NORTH
CENTRAL STATES

by Aldo Leopold

GAME SURVEY OF THE NORTH
CENTRAL STATES

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