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Proceedings of Perdix III: Gray Partridge and Ring-necked Pheasant Workshop

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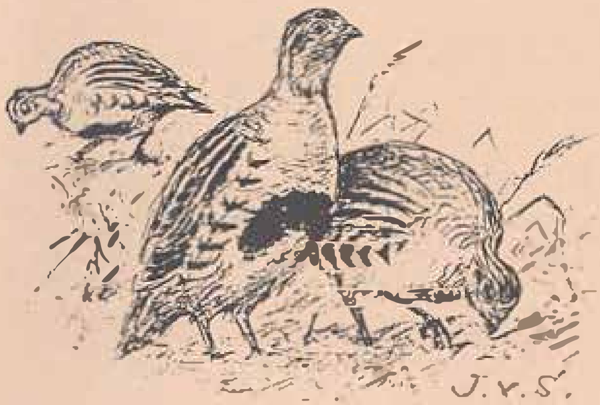
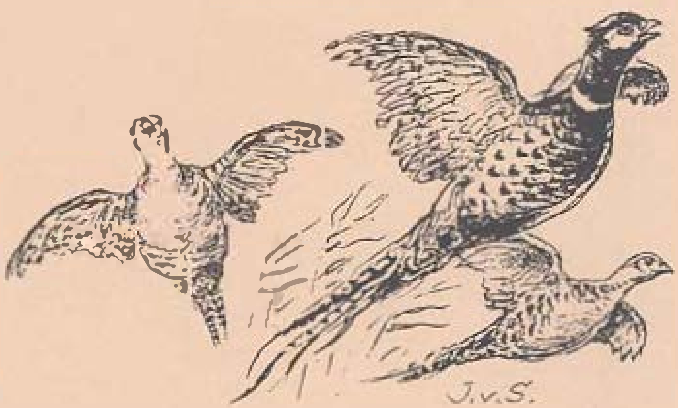
PERDIX III

GRAY PARTRIDGE
and
RING-NECKED PHEASANT
WORKSHOP





Co-sponsors:
Wisconsin Department of Natural Resources
University of Wisconsin — Green Bay

28-30 March 1983
Campbellsport, Wisconsin

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FOREWORD

Upland game biologists from the U.S., U.K. and Canada convened at an education center near Campbellsport, Wisconsin, 28-30 March 1983, to exchange research and management experience. The retreat setting provided ideal conditions for formal and informal discussions of habitat improvement practices, population dynamics, range extension, landowner and hunter attitudes, interspecific interactions, impacts of emerging agricultural trends,and many other issues. Despite blizzard conditions, attendance reached 98 persons (note listing of registrants and a group photo herein).

Partridge biologists had met twice previously --Perdix I, 1977, North Dakota and Perdix II, 1980, Idaho. These workers convene every 3 years to review recent accomplishments and evaluate management/research needs. A national management/research strategic plan provides the foundation for their deliberations, and conference proceedings are prepared to document progress.

Pheasant biologists had not assembled since 1978 as the Midwest Pheasant Council although a core group had discussed management problems at informal meetings held in conjunction with the Midwest Fish and Wildlife Conference. Pheasant biologists meeting at the 1980 conference in St. Paul concluded that significant new research and management experience with pheasants had accrued in recent years to merit a formal gathering. The Perdix III workshop planned for Wisconsin in 1983 offered an excellent opportunity for sharing common problems and potential solutions for 2 important farmland game birds.

The Perdix III workshop featured field tours of partridge and pheasant range, a special session on habitat appraisal models, invited presentations on the socio-economic concerns with farmland habitat management and probable impacts of agricultural pesticides on pheasants and partridge, a recognition dinner for pioneer pheasant and partridge biologists, state and province reports by each representative, and a business meeting. Thirty-one papers were presented; 29 appear in these proceedings as a full paper, synopsis, or abstract. The presentations on socio-economic issues by Thomas Heberlein, University of Wisconin-Madison and agricultural pesticides by Louis Locke, U.S. Fish and Wildlife Service were not reproduced herein.

A high point of the workshop was the recognition dinner for 7 pioneer pheasant and partridge workers (see list of registrants). The evening consisted of formal introductions with mention of accomplishments and story-telling, a fine prime rib meal, G.R. Pott's partridge movie,and reminiscing by the fireside. The guests enjoyed reading letters from invited contempories who were unable to attend, but sent best wishes.

Authors were given the option of having their presentations published as a full paper, synopsis, or abstract. Completed projects were most often offered as full papers while preliminary findings were documented by a synopsis or abstract. Four invited papers are included in these proceedings. R. Linder and R. Stiehl provided papers on the critical habitat components for pheasants and partridge, respectively. R. McCabe presented the opening remarks and E. Frank concluded the final session on habitat management with thoughts on "state of the art".

These proceedings are structured in 4 major sections: Gray Partridge

Ecology and Management, Ring-necked Pheasant Ecology and Management, Farmland Habitat Modeling and Management, and Associated Workshop Activities. The latter section contains reports on a questionnaire survey which produced updated range maps and current management strategies for partridge and pheasants, and a field survey of the 1983 set-aside lands. The questionnaire survey was coordinated by R. Kahl, Wisconsin Department of Natural Resources, and summarizes responses from 49 states and provinces. The set-aside survey was coordinated by A. Berner, Minnesota Department of Natural Resources, and was included in these proceedings by requests of conferees attending the workshop business meeting.

Artwork enhancing these proceedings was obtained from several contributors and sources. Our sincere gratitude is due J. McEvoy for preparing original line drawings for the Gray Partridge and Farmland Habitat Modeling title pages. Photographs and drawings from other sources were offered by G. Chambers, F. Hallet, R. Reif, and C. Schwartz. Finally, artwork from Wisconsin Department of Natural Resources files, especially that contributed by J. Sivers, appears on the cover and elsewhere in these proceedings.

The production of these proceedings was possible because of excellent cooperation by the authors and invaluable assistance by R. Hine and the production staff at the Wisconsin Department of Natural Resources. Thanks is also due the administrators for the University of Wisconsin - Green Bay and the Wisconsin Department of Natural Resources for authorizing staff time and expenses to assemble and publish these proceedings.

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OPENING REMARKS

HOW FAR HAVE WE COME . . .

ROBERT A. McCABE, Department of Wildlife Ecology, University of Wisconsin, Madison, WI 53707

Gray hair or no hair at all is one of the associated badges of advanced age--I won't dwell on senility. Such a badge implies wisdom that the years have provided. If not wisdom, then a desire to reminisce about what was, should have been, what is, and what ought to be. In part this is my assignment. I will use the pheasant as the game bird to focus on, although my affection lies with the gray partridge (Perdix perdix).

The ring-necked pheasant (Phasianus colchicus) is as habitat-adaptive as any game bird to fall to a scatter gun, is pleasing to the eye and the palate, is able to reproduce and thrive in captivity, and among other attributes provides as much or more recreation hours afield than any other game bird living in the same region.

From early successes such as the 1881 introduction of Chinese pheasants in the Willamette Valley, Oregon, to the heyday of pheasant abundance across its range in the early 1940's, this game bird has established itself in suitable range across North America. Population levels vary among the geographic segments of its range, and the fact that pheasant numbers fluctuate in any one segment has been reason for research and management.

The northern and southern range limits have been investigated and reasons for their location postulated. Factors associated with low density have been treated likewise.

Results of investigations on factors which limit range or population size have been varied and sometimes contradictory. Researchers often seek or ultimately present simple cause and effect relationships in their results. They uncover fundamental biological principles only to find that, if correct, they were profound only in time and place and the elusive quarry, our ring-necked pheasant, remains only vaguely predictable.

One of our problems in understanding pheasant ecology is the fact that the term "carrying capacity" has been used too casually often to suit a given hypothesis or position. Frequently, it is regarded as a static condition of the environment to be manipulated by man at will. One needs only to look at the enormous population irruptions of the Dakota's in the 1940's or of Pelee Island in the 1950's to learn of the elasticity of carrying capacity in a given environment.

Throughout the midwest pheasant range, we have used these irruptions as benchmarks for the ideal population. Much of our effort has been geared to bringing back the good old days. It might be possible if we could create an economic depression for 10 years and a concurrent drought to drive people off the land so that it could revert to wild food and cover. Then organize a war (fate forbid) to create a need for farm crops so as to put the land gradually back into cultivation, thus creating optimum nesting and winter survival conditions. And, voila! We are back to the "good old days."

This is nonsense, of course, but not completely. The Soil Bank program of the 1960's in the Midwest produced, in a limited way, part of the nonsense-return to abundance. It was short lived. Today's need for agricultural production is not likely to encourage land retirement through government subsidy, although the PIK program has that potential. Without a subsidy private parcels of land will not be volunteered. Thus, we are back to researching for the management of bits and pieces of a highly diversified pheasant range.

The research literature on pheasants is substantial, much of it concerned with simple life history. One could categorize our research efforts as:

(1) Information provided to a pheasant data bank for eminent uses, biological or social.

(2) Esoteric information also for the data bank with little likelihood of retrieval for management purposes.

(3) Basic principle information for universal application, rooted in physics, chemistry, or mathematics.

(4) Information as it relates to current problems of management.

Data bank information cannot easily be faulted, but it is often the by-product of a search for basic principles, or what is left over from a failure to achieve the primary research objective.

Basic principle pursuit is often associated with academic institutions where the pheasant is another test animal, and where peer and colleague appraisal often have preference over useful application of the end results.

Research on current management problems is by definition short-term. Without a knowledge of the literature and a diagnosis of how accumulated data relate to the problem at hand, the effort is likely to be organized to placate rather than to resolve.

Wildlife management, buttressed and girded by research, is a scientific exercise in prediction. When we attempt to manage a species, we hope to increase or decrease its numbers by some manipulation of the habitat, the animal itself, or the user (i.e., the wild or the civilized predators). By such manipulation, we can hopefully anticipate and, therefore, predict the result in terms of increase or decrease of the species in question. Thus far, our manipulations and predictions have been less than awe inspiring and often less than necessary.

There is virtually no aspect of pheasant biology that has gone unscrutinized, including habitat and land-use evaluations, hunting and stocking appraisals, pheasant genetics and behavior, the effects of pesticides, disease and parasites, weather factors, vitamins, and vital elements.

The one major interaction about which there is still some doubt, at least in my mind, is the role of predation. Like many other intellectual efforts in the field of wildlife management, we have been prone to pigeonhole or be all encompassing in viewing the way predation effects our management efforts.

For many years, we have accepted, often uncritically, the concept that predation is not a primary controlling factor among vertebrate animal populations. The concept was put forward from research with muskrats (Ondatra zibethica) and bobwhite quail (Colinus virginianus). Confined to those species the concept was very likely correct. More recent studies, particularly with snowshoe hares (Lepus americanus) and ruffed grouse (Bonasa umbellus), indicate predation may be a primary controlling factor. In a zealous effort to be all-inclusive because research results on particular species are singularly convincing, we have failed to see that predation may be exerting a continuum-like pattern among vertebrates. Predation in one species may have little, if any, regulating influence, whereas at the other end of the continuum, predation may exert the key or major regulating influence.

Exactly where the pheasant fits into the continuum will doubtless depend on more intensive studies in time and place.

Another blind spot in understanding the pheasant as a game bird is the relationship of game farm stocking to habitat improvement. Stocked pheasants are, as advertised, artificial and there are data and estimates to show the costs for bagging such a bird. But how do these costs compare with costs to bag a wild bird? And more particularly, where are the cost/benefit data on habitat creation or improvement for pheasants? I know of no enlightening investigations on this critical comparison. Mind you, I am not selling stocked pheasants or game farms, but before one can accept a "natural only" as opposed to "artificial" approach, we should have facts and data to evaluate.

There are old concepts that need to be constantly challenged and other facets of pheasant understanding that need to be re-examined.

In our efforts to operate from a scientific base in our understanding of the ring-necked pheasant as a game bird, we have conducted research--some descriptive, some analytical, and some experimental. The quality of research, and the results it obtains, is primarily a function of our field techniques. In dealing with any wild animal in its wild habitat, research is often based on inventory, capture, and marking.

Direct counting, indices of abundance, and sampling are the key methods of inventory. Space does not permit a detailed assessment of these techniques. However, one of the most successful was the rural mail carrier reports that produced pheasant population indices for the Dakotas, Nebraska, Minnesota, Kansas, and Iowa.

Bait traps, drive nets, nest traps, and night lighting accounted for most of the birds captured for research purposes.

Marking with paint, leg bands, backtags, and radio transmitters allowed birds to be recognized as individuals or as capture or age cohorts. Physiological techniques were also developed for insights into pheasant ecology. For example, the counting of ruptured follicles in the ovary as an index to egg production, embryo growth and moult as an indication of age, and the unsuccessful attempt to develop a "super pheasant" for release on public hunting areas and game preserves all contributed to our understanding.

A major breakthrough in technique occurred in 1939 with Carl Gower's rediscovery of a thymus-like pouch in the cloaca of pheasants that disappeared at the onset of the first breeding in males and females. This anatomical bursa was first discovered in 1621 by the anatomist Fabricus in a detailed study of the barnyard chicken. The presence of this bursa allows birds of the year to be distinguished from adults during the fall hunting season. This ancient bit of avian anatomy led to the population turnover studies pioneered by Aldo Leopold and his students.

The Bursa of Fabricus along with plumage and embryo growth changes allowed us to examine age ratios within populations, but even here the length of time during which the technique could be used was questioned. I investigated this aspect in the late 1940's and found that the mean cutoff date ($P = 0.05$) in Wisconsin was 15 January.

If we were to draw a line under our research efforts in the Midwest, the sum of our knowledge on the credit side of our ledger would read something like this:

(1) Pheasants cannot be stockpiled over time because of the rapid turnover rate.

(2) Pheasants cannot, under normal cock pheasant hunting, be overshot because the "law of diminishing returns" leaves a sufficient supply of cocks for adequate breeding.

(3) Predation of pheasants is not completely understood.

(4) Mortality, in both winter and summer, contribute to low pheasant populations.

(5) Weather factors have direct and indirect influences on pheasant populations.

(6) Midwest pheasant populations are associated with wetlands and wetland preservation.

(7) Changes in farming practices and government programs related to agriculture have been beneficial and detrimental to pheasant welfare.

(8) Management programs on small units are not always suited to county or statewide application.

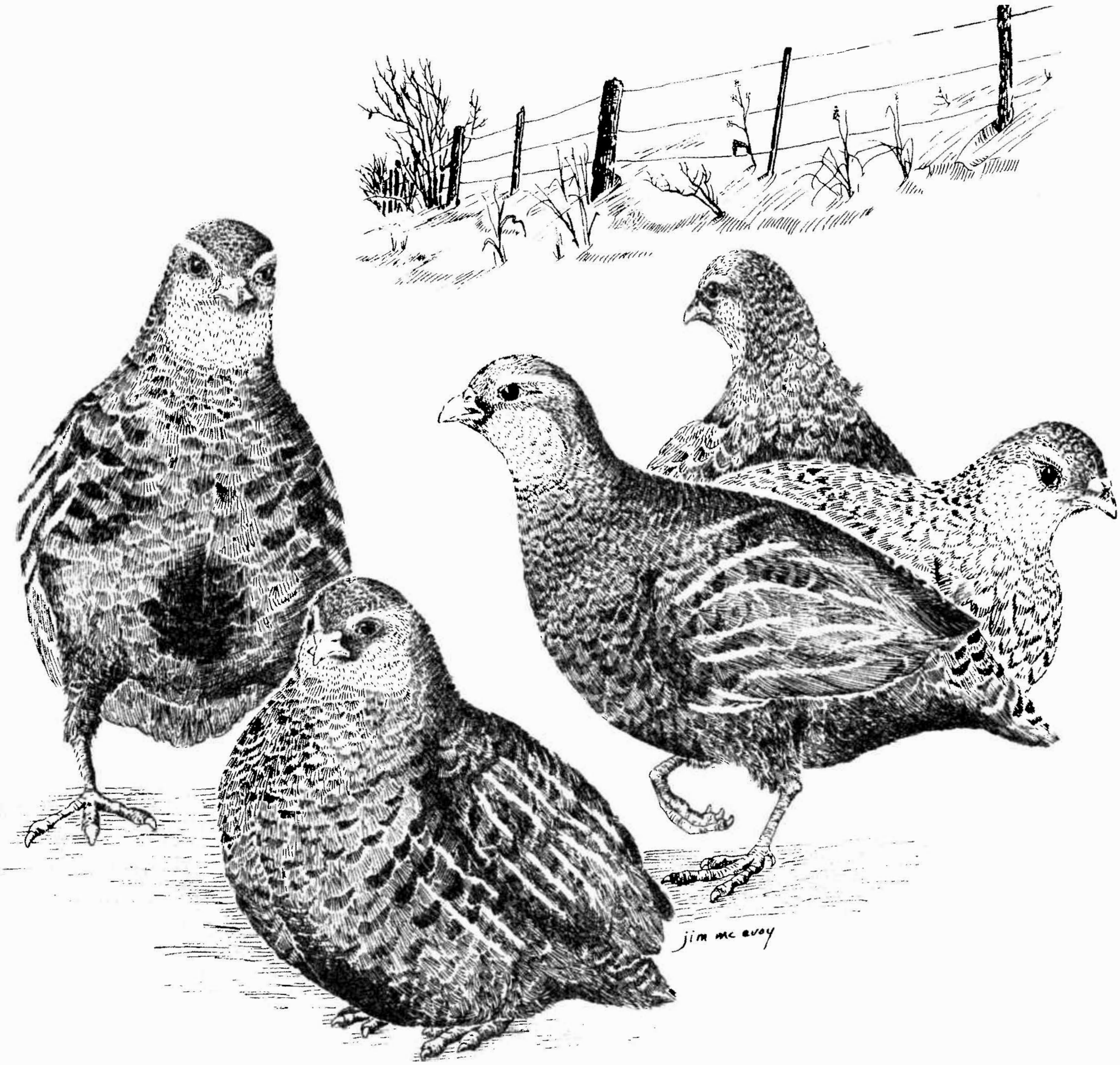
(9) Food availability, and wintering and nesting cover remain important aspects of pheasant survival.

Some conclusions may appear to be self-evident but each needed to be established and quantified to be meaningful. Sadly, the momentum in pheasant research conducted during the 1950's and 1960's has been lost, when today it is needed more than ever.

Another accountant may view the ledger differently. Those of us who have worked with upland game birds have had difficulty in recent years gearing research to the exceedingly rapid changes in land-use, hunter participation, and dwindling habitat. Our efforts are compromised by dwindling financial support.

In spite of such limiting conditions, if we remain scientists with rationale based on sound research, we will serve our profession, ourselves, the administrative decision makers, and most importantly the resource.

Gray Partridge Ecology and Management



GREY PARTRIDGE POPULATION DYNAMICS: COMPARISONS BETWEEN BRITAIN AND NORTH AMERICA

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Abstract: Information from 15 studies of the grey partridge (Perdix perdix) in the U.S.A. and Canada was examined to estimate nest densities, brood production and chick survival rates, and annual adult 'survival'. After allowing for the effects of nest density, the brood production rates were found to be much lower than in Britain. On the other hand chick survival rates were higher, and unlike in Britain, have not declined. In both continents annual adult 'survival' is lower following high breeding success, partly because of emigration of first-time breeders prior to nesting. In Britain such emigration is reduced as the proportion shot the previous autumn increases and, in general, there is a dynamic equilibrium established between productivity and emigration around a population density set by the habitat. From these results, it is concluded that top priority should be given to the provision of more and better quality nesting cover. A synopsis of the requirements of such cover is given; hedgerows of the kind often found in Britain are ideal.

The basic idea of a blueprint approach to management has been pioneered by the Agricultural Extension Services in Britain. Their aim has been to provide an idealized plan which integrates all the existing research findings. Costs are secondary considerations which can be pruned according to individual circumstances or as various parts of the blueprint are proved redundant or counter-productive. The method has been useful in several crops, notably winter wheat, where yields have far out-stripped the maximum predicted on theoretical grounds.

The recently published blueprint for the survival of the grey partridge in Britain (Potts 1983) concentrated on the provision of nesting cover, predator control, careful use of pesticides in cereals, and correct rates of shooting. The aim of this short paper is to examine whether the blueprint can be applied to North America.

I am very grateful to the International Foundation for the Conservation of Game for their travel grant which enabled me to attend Perdix III, and to K. Church for his help in many ways.

METHODS

Sources of Data

Extensive partridge data exist from studies made in Britain. The data base starts with a detailed populations study from 1902 to 1914 and includes a National monitoring scheme set up at the Game Conservancy in 1933. Also included are experiments on predator control, varying shooting rates, provision of nesting habitat, and extensive studies of the diet and ranging of radio-tracked broods in cereal crops with differing pesticide inputs. All this information was incorporated in a high fidelity simulation model which was used to calculate sustainable yields and to compare various limiting and inimical factors (Potts 1980).

A literature search revealed 15 grey partridge population and nesting success studies from the U.S.A. and Canada. For each, the breeding density, brood production rates (BPR), chick survival rates (CSR), and adult survival were estimated wherever possible. The data are clearly incomplete for many of the studies but the same methodology has been applied to all, with the aim of discovering the broad relationships. The sources used were: Michigan, Yeatter (1934), Iowa, Green and Hendrickson (1938); Washington, Yocum (1943) and Knott et al. (1943); Wisconsin, McCabe & Hawkins (1946); Utah, Porter (1955); Wisconsin, Gates (1973); Saskatchewan, Hunt (1974); Iowa, Bishop et al. (1977); Montana, Weigand (1980); Idaho, Mendel and Peterson (1980); South Dakota, Hupp et al. (1980); Iowa, McCrow (1982); Saskatchewan, Melinchuk (in litt); Wisconsin, Church (this volume). One source, for chick survival only, was from Ohio (Hart 1945). I have not used the results of the Rural Mail Carrier Surveys in this paper since they require a rather different approach.

Use of Data

Few of the measurements used here are given by the above authors themselves, their data have been extensively reworked using the methods used in the building of the grey partridge population dynamics simulation model. For example, BPR is defined as the number of broods hatched per female in the breeding population or, in the absence of that statistic, the same per male surviving at the time fledged broods were counted. It is therefore possible to calculate BPR by interpolating from spring densities, CSR, and post breeding densities. CSR is calculated from geometric mean brood size; when geometric means are not available the arithmetic mean -1 is used. In all cases, the rationale for these procedures stems from the findings of our studies in Sussex, U.K., described in Potts (1980).

The slope of the density dependence in brood production can be measured on the assumption that the intercept of BPR on the y-axis (i.e., when breeding density is zero) is in all cases 0.82 (Potts 1980, Fig. 1).

Annual adult 'survival' is the ratio of the adults (males x 2 at counts of broods aged about 6 weeks or alternatively spring pairs) to the total density (young and old) when the brood counts are made. It is recognized that some loss will be due to emigration hence 'survival'.

RESULTS

The relationship between the slope of density dependence in brood production rate and breeding density is given in Fig. 1. Most of the U.S.A. and Canada data fall on the same line as those from Britain but the BPR's and breeding densities are much lower than would be expected from our experience in Britain.

Chick survival rates are currently much higher than in Britain ($P<0.001$) partly because they have not declined (Fig. 2). The overall mean of 51% survival compares to the estimate of 50% for the best areas before the decline in the U.K. and the <30% found in recent years.

In Britain, variations in annual adult 'survival' are partly a function of breeding success since losses are known to be higher in young birds, mainly due to spring emigration and density dependent mortality. The relationship is basically similar in North America (Fig. 3). There is no evidence that the much colder winters contribute to higher annual

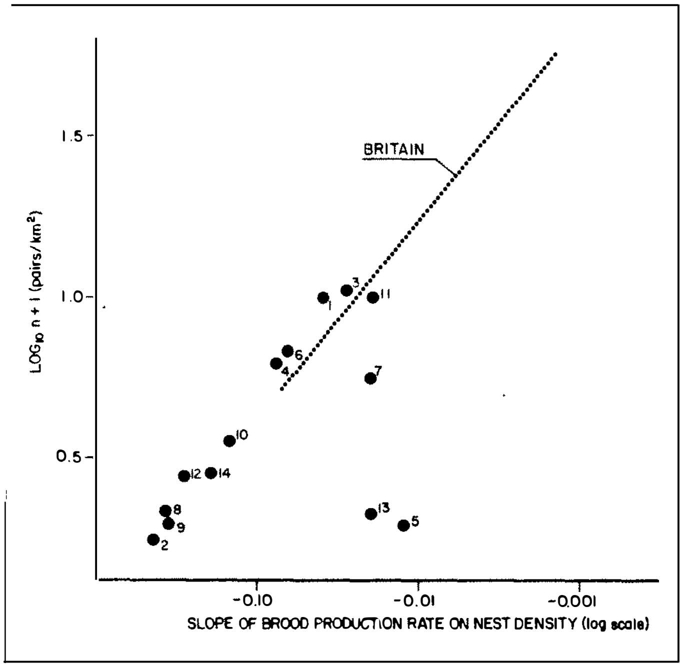

FIGURE 1. Effect of density dependence (slope) in brood production rate on mean level of breeding stock: a comparison of data from North America and Britain.

Sources: (1) Michigan, Yeatter (1934); (2) Iowa, Green and Hendrickson (1938); (3) Washington, Yocum (1943) and Knott et al. (1943); (4) Wisconsin, McCabe and Hawkins (1946); (5) Utah, Porter (1955); (6) Wisconsin, Gates (1973); (7) Saskatchewan, Hunt (1974); (8) Iowa, Bishop et al. (1977); (9) Montana, Weigand (1980); (10) Idaho, Mendel and Peterson (1980); (11) South Dakota, Hupp et al. (1980); (12) Iowa, McCrow (1982); (13) Saskatchewan, Melinchuk (in litt); and (14) Wisconsin, Church (1983).

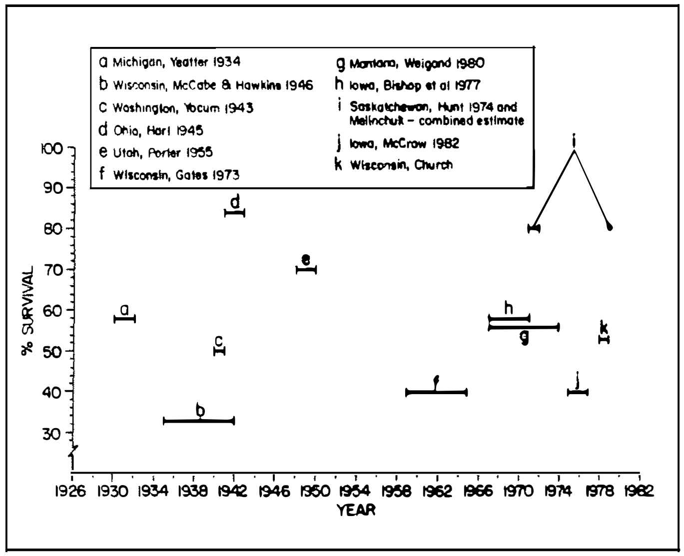

FIGURE 2. Some estimates of grey partridge chick survival to age c (6 weeks) calculated from mean brood sizes (weighted mean=51%).

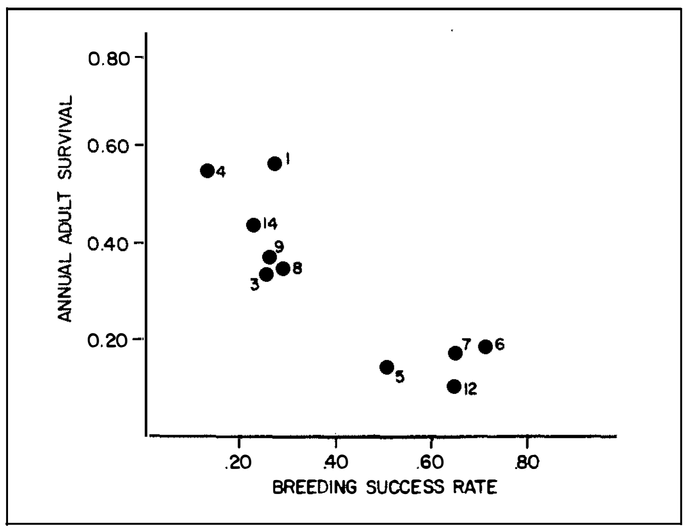

FIGURE 3. Relationship between estimates of breeding success (brood production rate x chick survival rate) and annual adult survival.
Sources: See FIGURE 1.

mortality. In Britain, a higher proportion are shot, but overall losses are higher in North America. Indeed, the inverse relationship between survival and breeding success (Fig. 3) implies a strong ability to compensate for shooting mortality and also to offset lower breeding success.

DISCUSSIONS

At the Game Conservancy, we have given considerable attention to chick survival rates because they have declined significantly and are rather low. The situation in North America is much better, but studies and measurements of insect availability should be made since this factor is the major determinant of chick survival in Europe.

Brood production rates were found to be the key population regulating factor of grey partridge populations in Britain because of density dependent predation on incubating females and eggs. Providing that nesting habitat was not limiting, predator control was very effective in building nesting stocks. Predator control did not reduce the rate of nest loss, but rather enabled stocks to increase without an increase in predation rates.

The important point here is that brood production rates in North America are lower than they are in Britain in areas without predator control. This is expected given that nesting habitat is better in the mostly hedged areas of the U.K. and that such nesting cover gives good protection from predation, at least up to 4 km of linear nesting cover/km^2 (Potts 1980). The average amount of nesting cover in our study areas in Britain is 5 km/km^2 compared to 7 km in the 1930's. By contrast, probably the best nesting cover in the North American studies was the 4 km/km^2 reported from an unusually well hedged area of Saskatchewan (Hunt 1974). Indirect evidence that nesting cover is comparatively poorer in North America is the higher proportion of nests which are lost in mowing. This happens when birds are forced to nest in crops because of poor inter-crop cover (Potts 1980). Hupp et al. (1980) in South Dakota and Church in Wisconsin (Church, this volume) and in northern New York State (Church in litt) and the general opinions expressed at Perdix II, support the conclusion that the partridge decline was partly a result of reductions in nesting cover.

Nesting cover in the U.S.A. and Canada is below the threshold which, in Britain, predator control becomes essential. This is important because there is obviously a widespread reluctance to reinstate predator control in North America.

If increases in winter loss are correlated with increases in emigration (Church et al. 1980), then the distribution and quality of nesting cover, which determines the population level of an area, is of prime importance in adult survival (Potts 1980, Rands 1983).

CONCLUSIONS

The Blueprint

All the evidence from this short review points to the need to improve the distribution and quality of nesting cover. The section of the blueprint for Britain which deals with this is reproduced below. It is taken mainly from the work of M. Rands on Game Conservancy study areas (Rands 1982).

Nesting Cover Requirements

Nesting cover requirements were investigated in 3 separate ways: first, spring emigration rates were compared to the distribution and quality of nesting cover; second, the choice of nest sites was compared to that expected based on the assumption of random choice; third, nest losses, particularly nest predation, were related to nest site characteristics including the vegetation around the nest. All 3 lines of inquiry produced the same ranking of nest site characteristics.

In Britain, the optimum length of nesting habitat is 8 km/km^2 with predator control or 4 km/km^2 without predator control because increases in cover above 4 km/km^2 may tend to benefit predators as much as partridge. Nevertheless, up to 8 km/km^2 of nesting cover provides a progressive increase in potential for holding breeding stocks. Even distribution of cover is important since partridge establish territories throughout available nesting cover. For a well camouflaged bird, spreading out is one of the best defenses against nest predation.

There are several aspects of nesting cover quality which are often as important as the overall quantity of nesting habitat. Hedges seem to be best, but those which are less than 1 m wide or greater than 2.5 m wide tend to be avoided by nesting pairs. High hedges, > 3 m, and evergreens are not suitable as they discourage grass growth and therefore predation rates increase. Ideally, the nesting cover should be on a slope at least .4m above the level of the surrounding crops. This prevents waterlogging in very wet weather.

At least 25% of the hedge should have a residual grass understory for nesting cover. The best hedges have the top and sides cut every other year in an 'n' shape. Of course, it is important that the cutting is not carried out during the nesting season. Trees tend to be avoided, but the effect is not serious until there are more than 10 for every 1 km of linear nesting cover.

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CHANGES IN THE COMPOSITION OF THE AUTUMN FOOD OF THE PARTRIDGE IN W. FINLAND OVER 20 YEARS

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Abstract: The compositions of the crop contents of 622 partridges killed in October 1962-64, 1968-70, and 1979-81 were studied. There were no sex or age-related differences in the food eaten. The composition of the food remained unchanged from 1962-64 to 1968-70. The main components were grain, seeds of *Galeopsis* spp., seeds of other plants, green matter, and animal matter. The crop contents also included 0.4 % grit. Considerable changes took place from 1968-70 to 1979-81. The proportion of grain increased by about 20% and the proportion *Galeopsis* seeds decreased by more than 20%. The proportion of green matter was 2.7% during 1968-70 and 4.3% during the 1979-81. The proportions of animal matter were 0.04% and 1.2%, respectively. I conclude that the decrease in the proportion of seeds (*Galeopsis* spp. and weed species) in partridge diets is due to increased use of herbicides and intensification of other agricultural practices.

The gray Partridge (*Perdix perdix*) migrated to Finland from eastern Europe (Merikallio 1946). In addition, introductions from central Europe were made on several occasions. The species is found only in the southern half of Finland, where cultivated areas in the western portion are particularly suitable (Pulliainen 1970). Studies carried out in the early 1960's showed that partridge of the western plain ate large amounts of weed seed in October, thus indicating that agricultural practices had not eliminated these seeds by that time (Pulliainen 1965, 1966). Those studies were continued, and the purpose of this report is to describe changes in the autumn diet of partridge in this area over the last 20 years.

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STUDY AREA AND METHODS

The study was carried out in southern Ostrobothnia, W. Finland (Fig. 1), an area of plains characterized by large cultivated areas and patchy forests. Hay, barley (*Hordeum sativum*), and oats (*Avena sativa*) are cultivated every year, but poor harvests have often drastically reduced the cultivation of wheat (*Triticum aestivum*) and rye (*Secale cereale*).

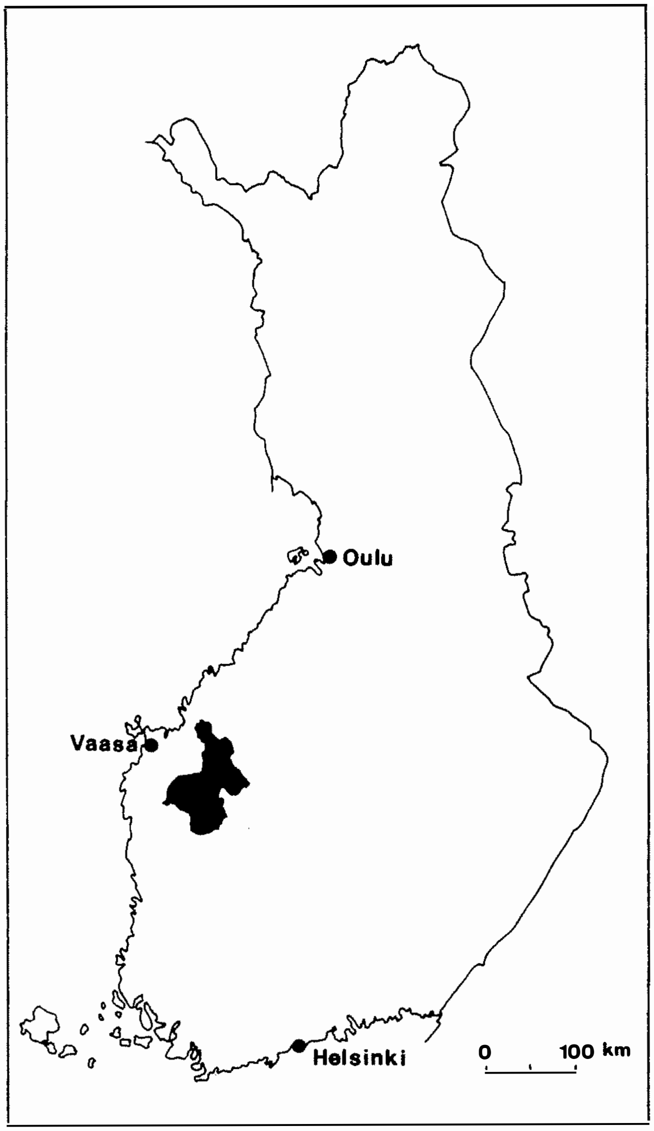


FIGURE 1. The study area in Ostrobothnia, West Finland.

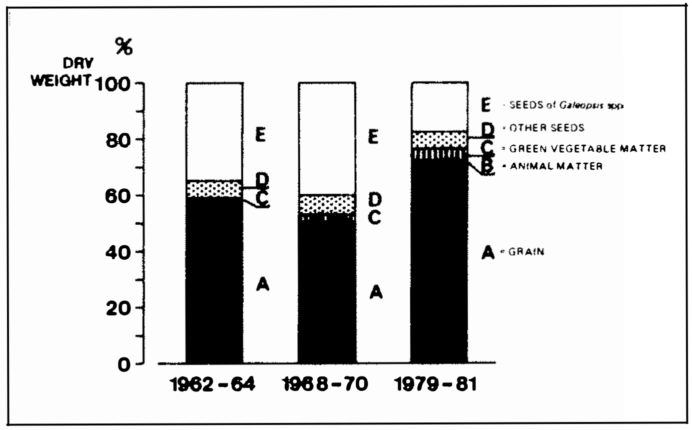


FIGURE 2. Composition of the diet of partridge in Ostrobothnia, W. Finland, in October in 1962-64, 1968-70, and 1979-81. A = grain, B = animal matter, C = green vegetable matter, D = seeds of plants other than *Galeopsis* spp. (mainly weeds), and E = seeds of *Galeopsis* spp.

The compositions of the crop contents (dried at 65 C) of 156 partridges killed in October 1962-64, 397 specimens killed in 1968-70, and 69 killed in 1979-81 were studied. The various food items were sorted and identified, and their amounts calculated on a dry weight basis. The birds were also aged and sexed (for methods, see Pulliainen 1968).

RESULTS

Table 1 shows that there are no sex or age-related differences in the foods eaten in October; consequently, no distinctions of age or sex are made here.

The composition of the food was unchanged from the first period (1962-64) to the second (1968-70), the main components of the diet being grain (barley, oats, wheat, and rye), seeds of *Galeopsis speciosa* and *bifida*, seeds of other plants (mainly weeds), green vegetable matter, and animal matter (Fig. 2). The crop contents also included 0.4% grit. The most important species in the weed group were *Spergula arvensis*, *Polygonum* spp., *Chenopodium album*, *Stellaria* sp., *Viola* spp., and *Phleum pratense*. The vegetable matter group consisted mainly of pieces of grass leaves, and the animal matter group, principally insects and gastropods.

A considerable change in food composition took place from 1968-70 to 1979-81. The proportion of grain increased by approximately 20% and the proportion of *Galeopsis* spp. seeds decreased by more than 20% (Fig. 2). During the 1968-70 period all 4 cereals occurred in the crop contents, whereas during 1979-81 only barley and oats were found since wheat and rye were not available. Barley occurred in 47.4 % of the crops sampled in 1968-70, whereas it occurred in 67% in 1979-81. The percentages of *Galeopsis* spp. seeds were 71% in 1968-70 and 39%

Table 1. Crop contents of partridge by sex and age classes, Ostrobothnia, W. Finland, October 1968-70 (*N*=397).

Food items	Dry weight (%)[a]			
	Juv. female	Juv. male	Ad. female	Ad. male
Barley, *Hordeum sativum*	25.3	22.2	32.4	13.2
Oats, *Avena sativa*	13.0	20.2	19.4	27.8
Wheat, *Triticum aestivum*	6.7	5.5	0.0	2.7
Rye, *Secale cereale*	2.6	3.5	2.6	5.4
Cereals combined	47.6	51.4	54.4	49.1
Seeds of *Galeopsis* spp.	42.7	37.7	36.4	41.9
Other seeds	6.5	7.3	6.1	6.1
Leaves	2.6	3.0	2.4	2.3
Other green matter	0.1	0.1	0.1	0.1
Animal matter	0.05	0.04	0.02	0.01
Other matter (incl. grit)	0.5	0.5	0.4	0.5

[a] Dried at 65 C.

Table 2. Crop contents of partridge, Ostrobothnia, W. Finland, October 1979-81 (*N*=69).

Food items	Dry weight[a] g	Dry weight[a] %	Occurrence %
Barley	45.259	42.7	66.7
Oats	29.765	28.1	40.6
Seeds of *Galeopsis* spp.	18.655	17.6	39.1
Seeds of:			
Spergula arvensis	3.625	3.4	36.2
Polygonum lapathifolium	0.114	0.1	11.6
P. aviculare	0.321	0.3	14.5
P. convolvulus	1.262	1.2	18.8
Chenopodium album	0.166	0.2	8.7
Viola sp.	0.092	0.1	5.8
Myosotis sp.	0.006		5.8
Stellaria sp.	0.161	0.2	13.0
Rumex acetosella	0.055	0.05	2.9
Leontodon autumnalis	0.001		1.4
Phleum pratense	0.117	0.1	4.3
Poa sp.	0.006		2.9
Unknown seeds	0.219	0.2	5.8
Leaves	4.513	4.3	68.1
Other green matter	0.043		2.9
Animal matter	1.273	1.2	20.3
Grit	0.331	0.3	17.4

[a] Dried at 65 C.

in 1979-81. The frequency values for barley and the seeds of *Galeopsis* spp. were significantly different from 1968-70 to 1979-81 (X^2=8.769, P< 0.01; X^2=26.78, P < 0.001, respectively), while those for oats, 48.6% (1968-70) and 40.6% (1979-81), were not (X^2=1.52). A significant difference was also recorded for the seeds of *Spergula arvensis* (X^2=23.29, P < 0.001), with a frequency of occurrence of 66.8% in 1968-70 and 36.2% in 1979-81. The proportion of green vegetable matter was 2.7% in 1968-70 and 4.3% in 1979-81; corresponding frequencies of occurrence were 68.0% and 68.1%. The proportions of animal matter were 0.04% (1968-70) and 1.2% (1979-81); the frequencies of occurrence were 12.3% and 20.3%, respectively. The latter values did not differ significantly (X^2=3.17).

The number of samples obtained in 1968-70 was 5.7 times greater than that for 1979-81, and should be considered when assessing the occurrence of rare food items during the 1979-81 period. The following food items occurred in the crop contents during the earlier period but were not recorded in the latter samples (Table 2): *Triticum aestivum, Secale cereale, Viola canina, Vicia cracca, Ranunculus* sp., *Bidens tripartitus, Brassicaceae* sp., *Cerastium arvense, Erysimum cheiranthoides, Thlaspi arvense, Deschampsia* sp., *Bromus secalinus, Rhinanthus* sp., *Potentilla palustris, Polytrichum* sp., *Compositae* sp., *Empetrum nigrum*, and *Fumaria officinalis*.

DISCUSSION

Finland is at the northernmost limit of gray partridge range (Westerskov 1964). To survive, it has adapted to the harsh winter conditions. Scratching through a soft snow cover 50 cm thick has been reported (Pulliainen 1967). To minimize heat loss, a covey rests in a bunch with one member always watching for an approaching predator (Pulliainen 1965). Partridge also accumulates subcutaneous and visceral fat reserves in autumn, thus differing from most other gallinaceous birds. On the other hand, the Finnish agricultural landscape has historically offered adequate food and shelter for overwintering partridge (Pulliainen 1970).

A number of factors are known to affect the composition of the diet of gallinaceous birds: (1) the food-plant preferences of the species, (2) local availability of preferred food items, (3) the nutritive value of available food items, (4) the physiological condition of the bird, (5) the physical structure of the vegetation, and (6) interspecific competition (Moss & Hanssen 1980). Genetic variation is important in food selection in hybrids of gallinaceous birds (Pulliainen 1982*b*). On the other hand, Pulliainen (1965) has shown experimentally that partridge tend to avoid rapid changes in their diet. Food selection may also be affected by the nutritional demands of the bacteria of the caeca (Pulliainen 1982*a*).

Seeds of *Galeopsis* spp. made up approximately 35% of the October diet of partridge in the study area in 1962-64, but their nutritional value was probably greater than this due to a seed fat content of more than 40% (Pulliainen 1965). It is likely that it was this food item that contributed to the accumulation of fat reserves, since it is one of the preferred dietary elements (Pulliainen 1965). Changes in availability of *Galeopsis* spp. should be reflected in its occurrence in the diet. From 1962-64 to 1968-70, no substantial changes took place in its proportion. Over the next 10 years its occurrence in the diet decreased by more than 20%, and the proportion of grain simultaneously increased by approximately 20% (Fig. 2). The number of weed species consumed also decreased during this period. Importantly, in 1962-64, the proportions of *Galeopsis* spp. seeds in the diet of partridge were low (24-27%) in the southern and southwestern parts of Finland where agricultural practices were at that time more intensive than in the Ostrobothnia range (Pulliainen 1965).

In places where seeds of Galeopsis spp. are unavailable, the composition of the autumn diet differs markedly from that observed in Finland. In England, for instance, the proportion of grain in the diet increased from 67% in 1933-37 to 93% in 1968-77, while the proportion of weed seeds decreased from 31% to 4% (Middleton & Chitty 1937, Potts 1970, 1980). The proportion of leaves, roots, etc. remained at 2%. This situation may reflect the agricultural development now occurring in Finland.

As in this study (Table 1) Kobriger (1980) found no sex or age-related differences in the composition of the autumn diet of partridge in North Dakota. Grain (with wheat as the most important item) accounted for approximately 1/2 of the diet (49.1%). The other 1/2 consisted of non-cultivated components. The proportions of green vegetable matter (6.5%) and animal matter (10.7%) were high compared with the corresponding values in the present area in 1979-81 (4.3% and 1.2%) (Table 2). Finnish studies suggest that partridge, especially in an edemic state, eat considerable amounts of animal matter (mostly insects) to obtain animal proteins (Pulliainen 1965). In the study area, the proportion of animal matter increased 30-fold from 1968-70 to 1979-81, although it was still no higher than 1.2% even during the latter period (Table 2).

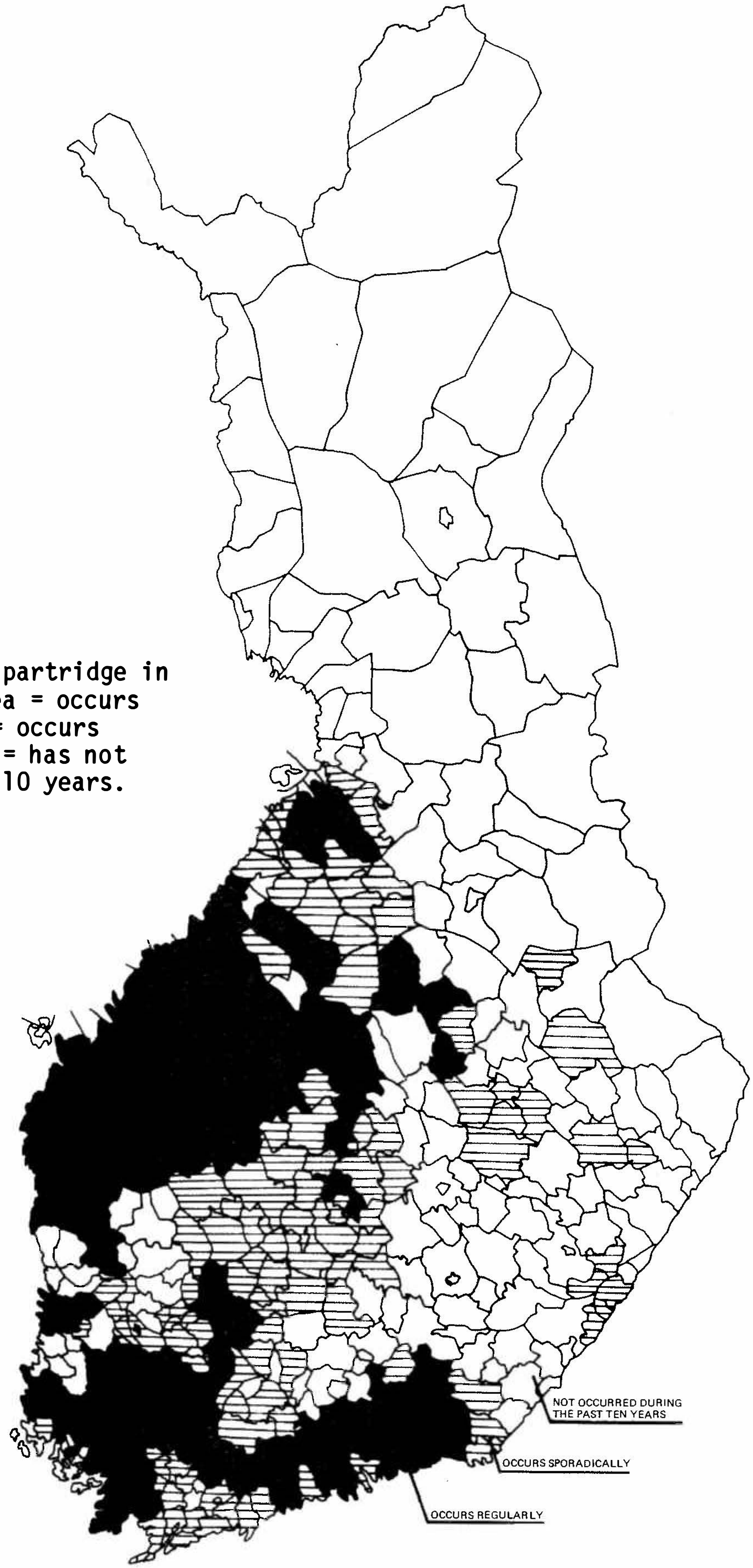
Agricultural practices can affect the occurrence of weed species in different ways. The large-scale use of combines for harvesting the spring cereal crops began in Finland in the early 1950's. Combines tend to return more weed seeds to the field in the process of harvesting the crop. Thus, the numbers of Chenopodium album and Galeopsis spp., for example, are considerably higher in fields which are frequently harvested in this manner (Mukula et al. 1969). On the other hand, the continuous use of herbicides acts in the opposite direction (Mukula et al. 1969, Schubert et al. 1975), and Galeopsis spp. are especially sensitive to MCPA (a-methyl-4- chlorophenoxyacetic acid), which is the type most commonly used in Finland (Raatikainen and Raatikainen 1975, 1979). The increased use of herbicides is prevalent on the study area at the present time. Additionally, open ditches have been replaced by field drains and the use of fertilizers and calcium (which help the cereals in their competition with weeds) has increased, as has the amount of area cultivated (J. Uola, pers. comm.).

Observations from different areas may provide a pattern for the manner in which partridge populations decline in intensively cultivated fields. The chicks consume animal food during their first weeks of life (Potts 1977), and since the density of insects is reduced by the use of insecticides, the chicks will move away from the cereal crops, exposing themselves to predation (Potts 1980).

If the chick survives until the autumn, it will be exposed to agricultural practices (harvesting and plowing) and the effects of herbicide use. Potts (1980) observed autumn dispersal flights of whole coveys, which may result from the removal of food during stubble ploughing. The number of weed species and the decrease in the amount of Galeopsis spp. seeds may lead to further deterioration in the living conditions for the partridge. Under Finnish conditions, the disappearance of Galeopsis spp. may be fatal to these birds, if fatty seeds are the main source of their fat reserves.

Before agricultural intensification, when the partridges had to leave the fields, they did find food and shelter at the edges, where Galeopsis spp. was also growing (Raatikainen 1981). Recently, however, these important food plants have been disappearing from these narrow zones (Raatikainen 1981). Now the only choice for partridge is to inhabit forests, as

FIGURE 3. Occurrence of partridge in Finland, 1982. Black area = occurs regularly, hatched area = occurs sporadically, white area = has not occurred during the past 10 years.



the ring-necked pheasant (Phasianus colchicus) has done in Finland (Raitasuo 1977), but partridge have not shown that kind of adaptation yet.

Intensification of agriculture in the sense described here can be expected to lead to the disappearance of gray partridge at least from the most intensively cultivated areas. Its distribution has already become patchy in the extreme south of Finland (Fig. 3), and its future may well be summed up in the words of Potts (1980) that "modern farmland is fast becoming an ecosystem constrained by the laws of pesticide chemistry rather than of ecology".

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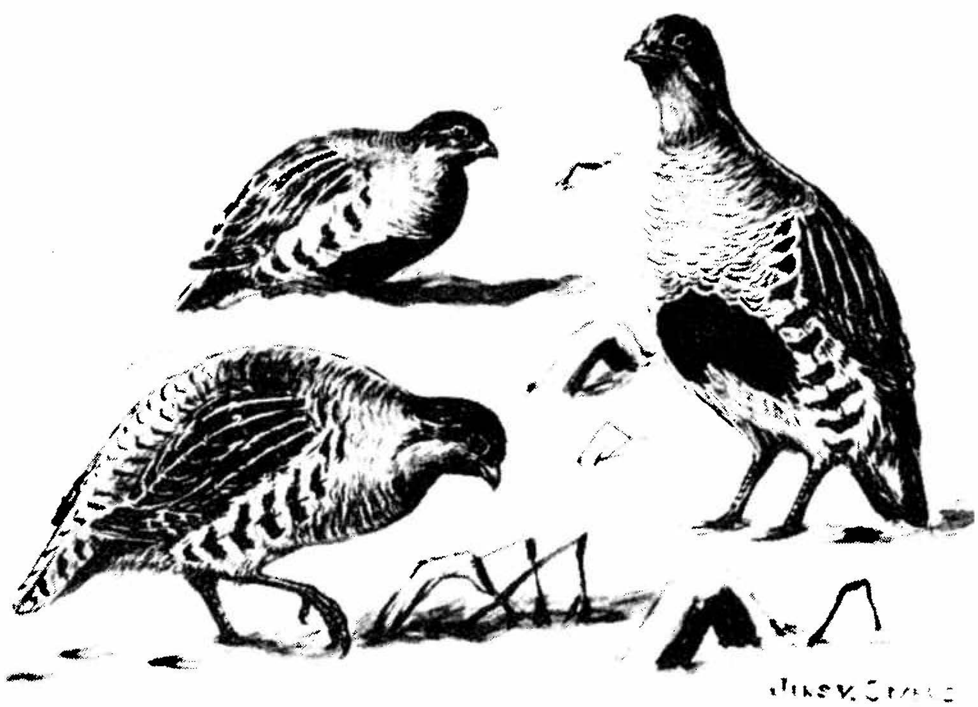

BODY CONDITION OF GRAY PARTRIDGE DURING FALL AND WINTER IN SASKATCHEWAN

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Abstract: The influence of weather on body condition of gray partridge (*Perdix perdix* L.) was investigated in south-central Saskatchewan from August 1979 to March 1980. Male and female partridge exhibited a similar pattern of body weight fluctuation during the study period. Body weights of male and female partridge peaked in January and are among the highest recorded in North America. Lipid reserves appear to be of significant metabolic importance to gray partridge. Peak fat reserves (29% dry body weight) occurred in January among males and in December (30% dry body weight) among females. Subcutaneous fat deposits constitute the largest fat reserve in partridge, comprising 53% and 48% of total body fat in males and females, respectively. Carcass protein levels in both sexes were relatively constant. Weight of the abdominal fat depot represents a practical, easily obtained and relatively accurate predictor of total fat reserve. The implications of these findings to partridge management are discussed.

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Relatively few studies have focused on the physiological aspects of winter survival of gray partridge. The consequences of suboptimum body condition (defined primarily by body weight) have been demonstrated in the ring-necked pheasant (*Phasianus colchicus*). The physical condition of pheasants entering the reproductive period is partially controlled by the severity of weather the previous winter (Edwards et al. 1964). Female pheasants with below normal body weights in later winter experience delayed attainment of maximum spring weights, delayed onset of egg production, lower body weights throughout egg laying, and higher mortality rates (Gates and Woehler 1968). Siivonen (1956) reported that a deterioration in partridge body condition during the winter ultimately led to a reduction in clutch size which in turn contributed to a population decline.

This study was designed to document the seasonal changes in body weight, fat, and protein of gray partridge in Saskatchewan and the influence weather has on the dynamics of these body constituents. An additional objective was to develop an index for determination of body condition during the fall and winter that would be useful in predicting subsequent reproductive performance. The term body condition in this study refers to body weight plus total fat and protein reserves.

STUDY AREA

The 207 km^2 study area was located in south-central Saskatchewan near the Village of Tugaske (106° 10'N, 50° 49'W). Topography is flat to gently undulating except for the steep slopes of the Qu'Appelle River Valley and its tributary drainages. Soils in the area are primarily fine sandy loams located within the Dark Brown soil zone (Moss 1965). Cereal crops, mainly spring wheat and barley, occur in approximately 75% of the study area although only about 1/2 of this land is seeded annually (i.e., the other 1/2 is summer fallow). The balance of the area is comprised of native grasses and shrubs. Native plant communities are dominated by speargrass (Stipa comata), green needlegrass (Stipa viridula), wheatgrasses (Agropyron spp.), and blue grama (Bouteloua gracilis). Crested wheatgrass (Agropyron cristatum) is the most common species on disturbed sites. Shrubs commonly found in the area are western snowberry (Symphoricarpos occidentalis), rose (Rosa spp.), chokecherry (Prunus virginiana), and saskatoon (Amelanchier alnifolia) (Coupland and Rowe 1969, Leiffers 1977).

METHODS

Between 22 August 1979 and 26 March 1980, 118 gray partridge were collected on the study area. One hundred fourteen birds were shot, 2 were live-trapped and 2 were obtained as roadkills. At the time of collection, partridge were weighed to $\pm$ 1.0 g on a 500 g capacity Pesola scale then placed in a plastic bag and frozen for subsequent carcass analysis. Partridge were thawed at room temperature for 12-15 hours before necropsy.

Thirty-three juvenile partridge ($\leq$ 17 weeks of age) (McCabe and Hawkins 1946) were omitted from this analysis due to variations in body weight, structure, and growth rate inconsistent with those of older birds. Adult ($\geq$ 52 weeks) and subadult (>17 weeks and < 52 weeks) partridge (Weigand 1980) were pooled for statistical analyses based on the lack of significant differences ($P > 0.05$) in body weight or carcass weight; although in some cases sample sizes may have been too small to detect such differences. Body weight is the weight (g) of partridge at the time of collection minus weight of the contents of esophagus, crop, proventriculus, gizzard, and intestines (Wishart 1979). Carcass weight is the weight (g) of partridge after grinding and homogenation and excluding wings, tarsus, foot, feathers, and contents of the digestive tract (Melinchuk 1983).

Fat deposits located on the breast and lower neck, back, axillary region, flanks, legs, heart, intestines, cecae, gizzard, and abdominal-cloacal area were subjectively evaluated employing a relative scale of 0 (no fat) to 4 (maximum observed fat). Scoring was relative and based on previous examination of extremely fat birds.

Fat, protein, and moisture determinations were conducted for each bird by the University of Saskatchewan Feed Testing Laboratory using standard methods (Horwitz et al. 1975). In preparation for these analyses, the feathers were removed with electric clippers, the carcass (excluding feet, wings, and feathers) ground in an electric meat grinder then homogenized in a food processor and weighed. A 15-20 g sample of each specimen was placed in a glass jar and refrozen until chemical analyses were conducted. A 1 g subsample was used for each fat, protein, and moisture determination.

An Atmospheric Environment Service (AES) climatological station at Tugaske provided current and historical temperature and precipitation data for the area. Snow stations were established in 3 representative habitats occupied by gray partridge on the study area: native grassland, grain stubble, and summer fallow. Snow pack characteristics were measured semi-monthly at each station.

Statistical analyses followed Sokal and Rohlf (1969) and Zar (1974) and were performed using the Statistical Analysis System (SAS) (Helwig and Council 1979). Significance was assumed at $\underline{P} < 0.05$ unless otherwise stated. Duncan's Multiple Range Test was employed to determine if means were significantly different.

RESULTS AND DISCUSSION

Weather Observations

The winter of 1979-80 was characterized by lower snow depths and a longer snowfree period than normally occurs in this area (Fig. 1). Mean monthly temperatures during the period of study were similar to the 30 year mean for the area (Fig. 2). Snow cover was not permanent until mid-January, after which 8-20 cm of snow persisted in most habitats (Fig. 3). By the third week of March, only patches of snow remained.

Partridge are able to survive extreme cold provided they have access to an adequate food supply (Siivonen 1956, Westerskov 1964, 1966, Pulliainen 1965, Hunt 1972). Temperatures were not severe during the study and partridge mortality was only 9.4% during December to February (Melinchuk 1983:86). It was unlikely temperature had any detrimental effect on partridge during the study period.

Partridge feed exclusively on the ground, hence snow depth strongly influences the availability of their winter food. Siivonen (1956) regarded snow depth as the decisive factor in determining the trend of partridge populations in Finland. Population growth followed winters in which the maximum snow depth was less than 15 cm whereas snow depths greater than 15 cm led to a decline in the population. Field observations by Hammond (1941) revealed that partridge were capable of digging through 6 inches (15 cm) of snow on stubble fields without

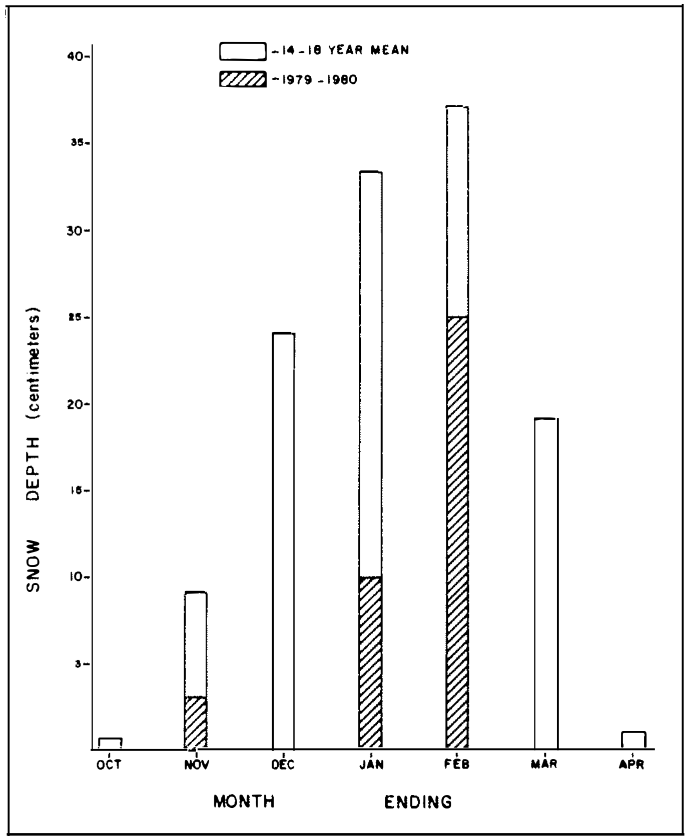

FIGURE 1. Mean month end snow depth (cm) as recorded by the Atmospheric Environment Service at Tugaske, Saskatchewan.

difficulty. The snow depths observed during this study were not considered a barrier to foraging by partridge.

Seasonal Changes in Body Weight and Carcass Weight

There are no significant ($\underline{P} > 0.05$) differences among mean monthly body weights of male partridge during the course of this study (Fig. 4). Female partridge weights increased significantly ($\underline{P} < 0.05$) from September to January, then declined through March (Fig. 4). Although male partridge were slightly heavier than females during August to March, both sexes exhibited a similar pattern of body weight fluctuation.

Mean carcass weight fluctuated in a pattern similar to that of body weight in females, but among males, carcass weight peaked in December rather than January (Fig. 4). Mean carcass weight

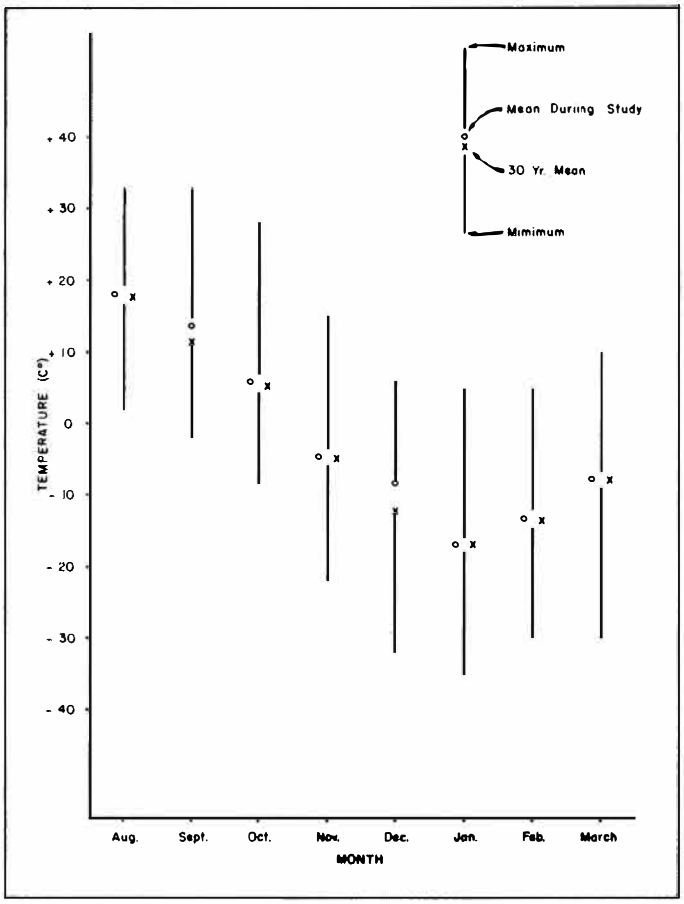

FIGURE 2. Mean daily temperature (C) on the study area August 1979 to March 1980.

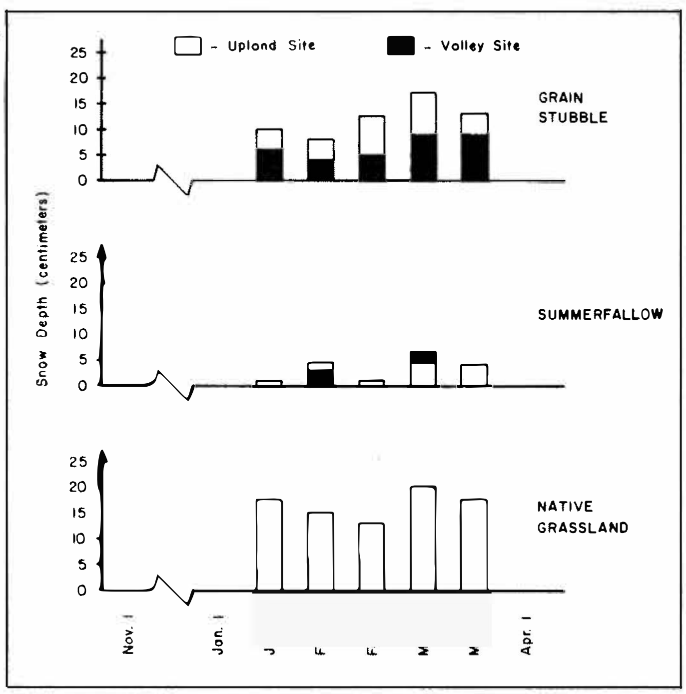

FIGURE 3. Snow depth (cm) in 3 habitats on the study area November 1979 to April 1980.

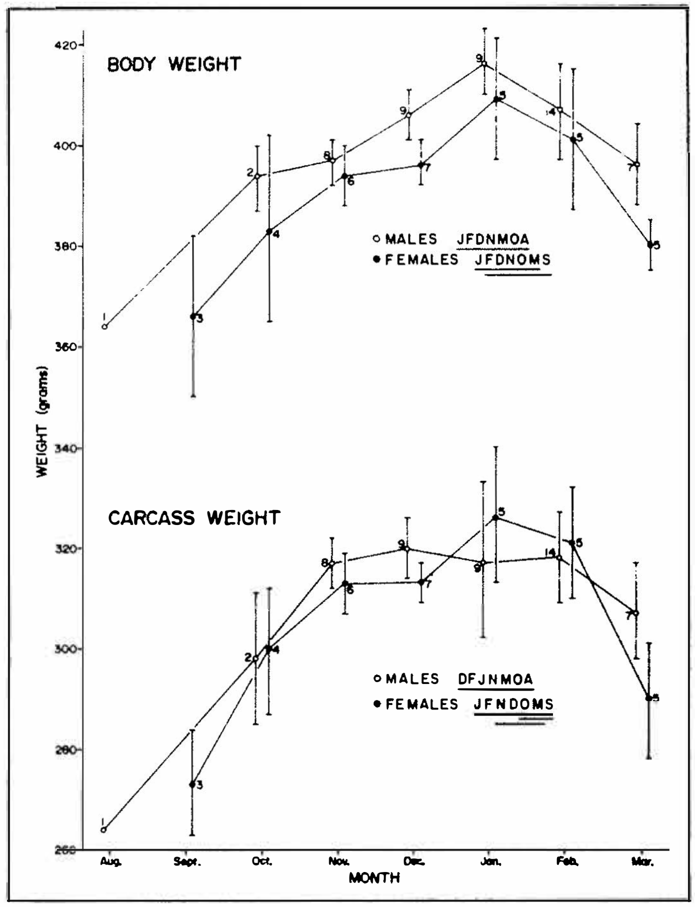

FIGURE 4. Mean (+ SE) monthly body and carcass weight (g) of gray partridge (adults and subadults combined) for August 1979 to March 1980. Numbers refer to sample size. Months sharing a line beneath them were not significantly different.

of males varied less than 3 g from November to February. Female carcass weights fluctuated 13.4 g during the same period.

Maximum body weights (including gut contents) reported in this study were among the highest recorded in North America (Table 1). The weight decline observed in December-January through March appears typical of partridge populations in northern latitudes and may be characteristic of the species. This conclusion is supported by the fact that a weight decline occurred despite mild weather conditions and a readily available food source.

On the basis of body weight alone, male partridge appeared to have a

Table 1. Weight of gray partridge in North America.

Location	Age/Sex[a]	Weight (g) Mean	Maximum	Reference
North America	AM	396	454	Johnsgard 1973
	AF	379	432	Johnsgard 1973
Wisconsin	Unk.	385	493 (Dec)	McCabe & Hawkins 1946
Montana	A/SM		493 (Dec)	Weigand 1980:22
	A/SF		508 (Apr)	Weigand 1980:22
Michigan	AM	382		Yeatter 1934:38
	AF	375		Yeatter 1934:38
Washington	AM	386		Yocom 1942:12
	AF	367		Yocom 1942:12
North Dakota	AM	418	483 (Jan)	Kobriger 1980
	All	429	485 (Dec)	Kobriger 1980
Alberta	F	385		Westerskov 1965
	M	425[b]		Keith 1962
	F	418[b]		Keith 1962
Saskatchewan	A/SM	439 (Jan)	495 (Feb)	This study
	A/SF	429 (Jan)	470 (Jan)	This study

[a] A = Adult, S = Subadult, M = Male, F = Female.

[b] Approximated from Keith 1962:336 (Fig. 1).

slight survival advantage over females, although the heaviest bird is not necessarily in the best condition. Roseberry and Klimstra (1971) drew a similar conclusion for bobwhite quail (*Colinus virginianus*). Latham (1947) found male partridge lived 39% longer than females during survival studies. Assuming partridge succumb once they have lost approximately 40% of body weight (Gerstell 1942, Kendeigh 1945, Keith 1962, Kobriger 1980), male and female partridge in January in Saskatchewan have critical weight minima of 246 g and 250 g, respectively.

Seasonal Changes in Fat Reserve

Total Body Fat

There was no significant difference ($P > 0.05$) in mean monthly total body

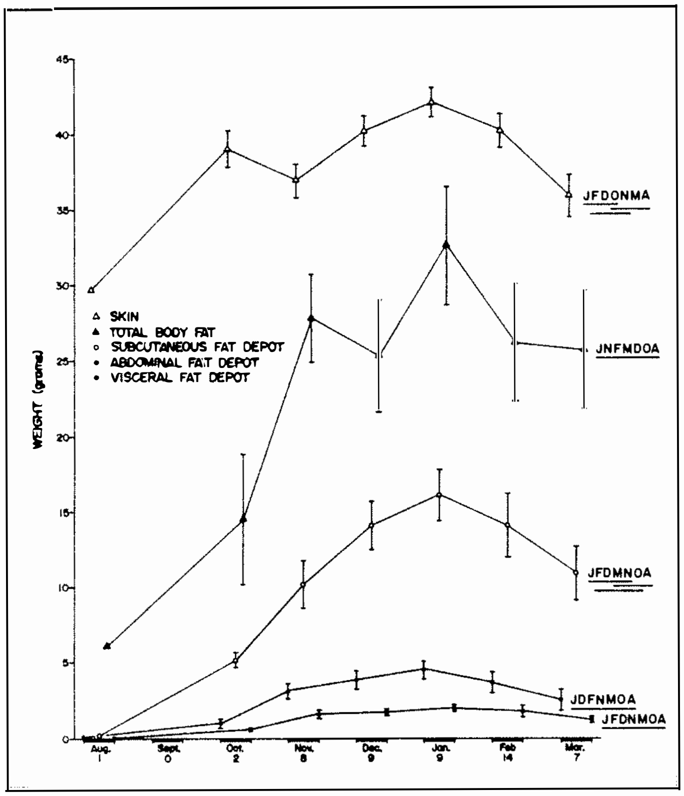

FIGURE 5. Mean (+ SE) monthly weight of skin, total body fat, subcutaneous, abdominal and visceral fat depots of male gray partridge (adults and subadults combined) August 1979 to March 1980. Numbers refer to sample size. Months sharing a line beneath them were not significantly different.

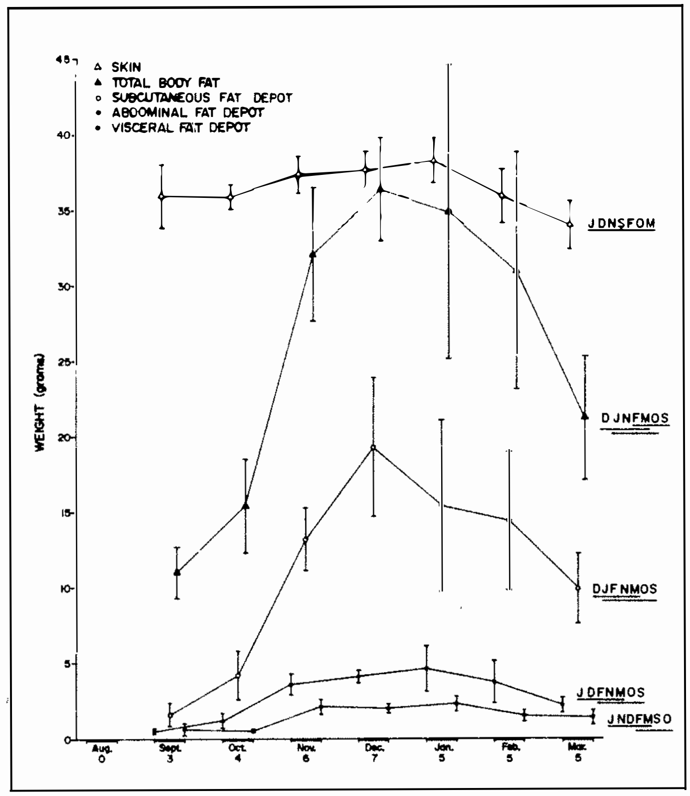

FIGURE 6. Mean (+ SE) monthly weight of skin, total body fat, subcutaneous, abdominal and visceral fat depots of female gray partridge (adults and subadults combined) September 1979 to March 1980. Numbers refer to sample size. Months sharing a line beneath them were not significantly different.

fat of male gray partridge (Fig. 5). Total body fat reached a maximum in January (Fig. 5). Total body fat increased significantly ($P < 0.05$) among female partridge between September and December (Fig. 6). Body weight of female partridge peaked in January. However, maximum fat accumulations occurred one month earlier (Fig. 6). Male fat reserves declined sharply, but not significantly in February and remained at this level throughout March (Fig. 5). The decline was continuous and more gradual in females (Fig. 6). The general decline in female fat reserves likely continued through July due to the energetic demands of egg production, incubation, molting, and brood rearing as documented by Szwykowska (1969).

Partridge on the study area accumulated fat reserves during the fall presumably in preparation for the environmental stresses associated with winter. Based on similarities in body weight, subadult and adult partridge entered the winter with equivalent energy reserves. Szwykowska (1969) recorded peak fat accumulations in gray partridge in Poland during November (29.7% dry weight). The 1-2 month differential in peak fat accumulation between Poland and Saskatchewan was likely the result of differences in temperature, snowfall, and food availability on the 2 study areas. Among bobwhite quail, ether-extractable fat content reached a peak (20.13 + 1.69% dry weight) in January after which levels gradually declined until March (Robel 1972).

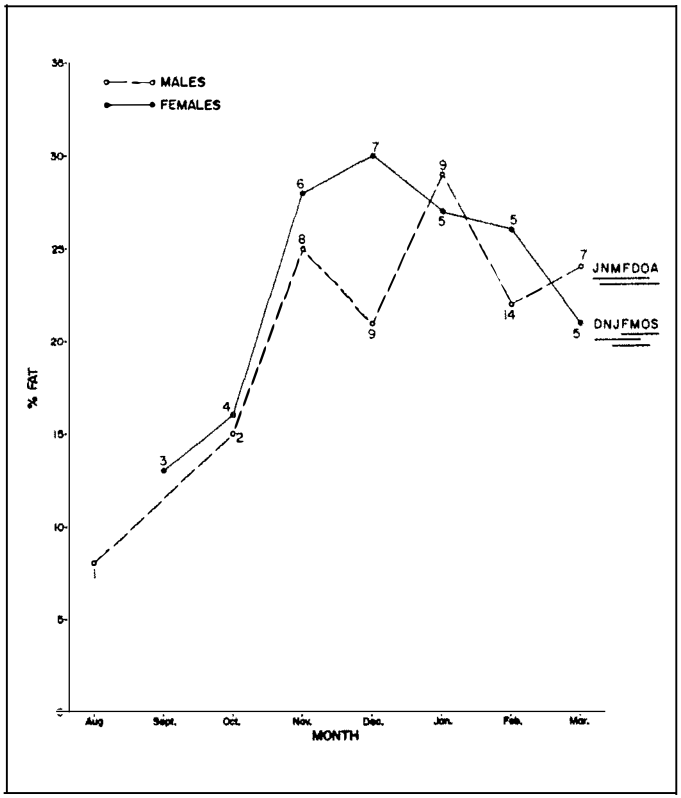

FIGURE 7. Mean monthly fat content (% dry weight) of gray partridge (adults and subadults combined) collected August 1979 to March 1980. Numbers refer to sample size. Months sharing a line beneath them were not significantly different.

Fat constituted 29% and 30% (dry weight basis) of male and female peak body weight, respectively (Fig. 7). There did not appear to be any sexual advantage in survivability among gray partridge based on the volume of fat reserves. Robel (1965) reported no differential mortality between male and female bobwhite quail under winter conditions. Lipids did not constitute major energy reserves (5.9 - 9.2% dry weight) of ruffed grouse (Bonasa umbellus) during the winter in Ontario (Thomas et al. 1975). Similar findings have been reported for willow ptarmigan (Lagopus lagopus) (West and Meng 1968), rock ptarmigan (L. mutus rupestris) (Thomas and Popko 1981) and sharp-tailed grouse (Pediocetes phasianellus) (Schmidt 1980). Based on the relatively high proportion of body fat and the continual accumulation of energy stores prior to winter, fat reserves appear to be of significant metabolic importance to gray partridge in Saskatchewan. Adoption of a high-energy fall and winter diet (Melinchuk 1981) facilitates the preparation and maintenance of body fat and protein reserves. Several behavioral and morphological adaptations (Westerskov 1965) also contribute to the winter survival of partridge.

Fat Depots

Subcutaneous fat deposits constituted the largest fat store in gray partridge; the mean and SE were 12.8 ± 0.9 g and 12.4 ± 1.7 g in males and females, respectively. Extensive deposits of fat were located in the interclavicular, axillary, flank, and leg region. In both sexes, weight of subcutaneous fat deposits and body weight peaked simultaneously. Subcutaneous fat deposits in males approximated 16 g (53% of total body fat) in January (Fig. 5). In females, the subcutaneous fat depot attained a maximum weight of 19 g (48% of total body fat) in December (Fig. 6). The accumulation of subcutaneous fat was continuous and rapid in both sexes. Extensive subcutaneous fat deposits serve to insulate against heat loss during periods of low ambient temperature and to provide a source of reserve energy during periods of high energy demand (Westerskov 1965). In Canada geese (Branta canadensis), subcutaneous fat is the first to be metabolized, followed by visceral and abdominal fat reserves (Hanson 1962). Assuming this relationship holds true for partridge, the presence of subcutaneous fat reserves suggest that gray partridge were not subject to significant nutritional stress during the period of study.

The abdominal fat deposit was the second largest fat reserve in gray partridge, comprising 20-25% of the large subcutaneous fat depot. Changes in abdominal fat were less pronounced than those of subcutaneous fat but did exhibit monthly fluctuations (Fig. 5, 6). The visceral fat depot was the

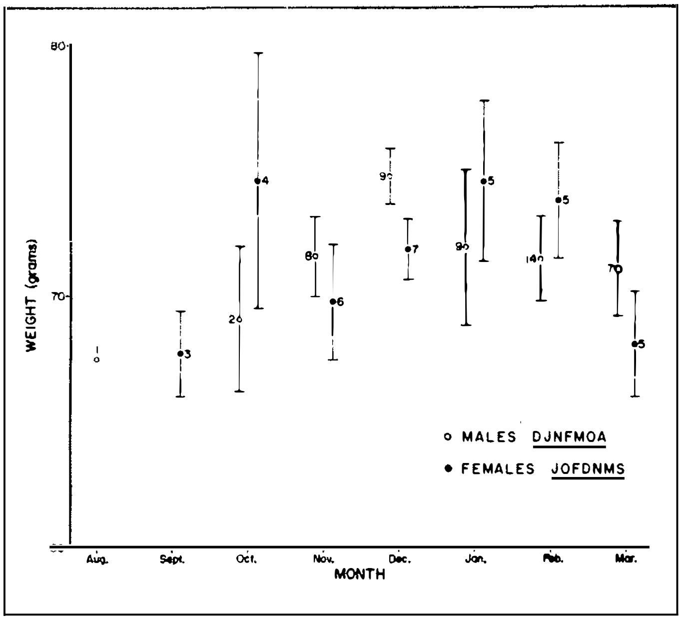

FIGURE 8. Protein content (g dry weight) of partridge (adult and subadult combined) August 1979 to March 1980. Indicated are mean (± SE) weight and sample size. Months sharing a line beneath them were not significantly different.

smallest and least variable of the depots examined (Fig. 5, 6).

Seasonal Changes in Protein Reserve

Carcass protein levels in both male and female partridge were relatively constant during the study period (Fig. 8). The percentage of protein in male partridge ranged from 76.0% in October to 65.0% in January, with the exception of August (Table 2). Female protein levels fluctuated between 60.6% in December and 80.5% in October. Monthly protein levels in partridge from Poland varied little throughout the year, ranging between 57.9% in January and 70.2% in June (Szwykowska 1969). Thomas and Popko (1981) reported carcass protein levels of 62.9%-65.8% in wintering rock ptarmigan in northern Ontario.

It is generally agreed that fat and protein reserves cannot be preferentially utilized within the body (Hanson 1962, Cahill 1978) although they may be utilized disproportionately (Barrett and Baily 1972). There were no significant differences in the monthly protein content of partridges during this study, suggesting a lack of environmental or reproductive stress. Hence, protein reserves probably were not reduced to a detrimental level.

Prediction of Body Reserves

Body Fat Reserve

The best correlate of total body fat in gray partridge was the multiple-regressed weight of fat from the abdominal, subcutaneous, and visceral fat depots. The combined fat weight explained 89% and 62% of the variation in total body fat of females and males, respectively (Table 3). Baily (1979) found over 93% of the variation in total body fat of redheads (*Aythya americana*) could be accounted for by the measurement of fat in these 3 depots. The best single predictor of total body fat in partridge was the subcutaneous fat depot (Table 3); however, to obtain the weight of this fat depot involved considerable time to skin the bird and separate the fat tissue from the internal skin surface. The abdominal fat depot represented a similarly accurate yet practical and easily-obtained estimate of total body fat. This fat depot was also the most useful correlate (r^2 = 0.83) of total body fat in wigeon (*Anas americana*) (Wishart 1979). A high correlation (r^2 = +0.95) between omental fat (similar to abdominal fat + visceral fat in this study) and total body fat was also reported in red-billed teal (*Anas erythrorhyncha*) (Woodall 1978). Baldassarre et al. (1980) found subcutaneous fat (r^2 = 0.92) and omental fat (r^2 = 0.80) the best independent variables for predicting total fat in mallards (*Anas platyrhynchos*).

Protein Reserve

Protein reserves of males and females were most accurately assessed from carcass weight and body weight, respectively (Table 4).

Table 2. Carcass protein (% dry weight) content of gray partridge (adult and subadult combined), August 1979 - March 1980.

	Male			Female		
Month	Mean	SE	N	Mean	SE	N
Aug	91.9		1			0
Sep			0	79.4	3.5	3
Oct	76.0	7.4	2	80.5	2.7	4
Nov	65.2	2.9	8	63.2	2.8	6
Dec	66.3	1.4	9	60.6	2.3	7
Jan	65.0	1.9	9	63.0	3.8	5
Feb	65.1	2.0	14	66.3	5.1	5
Mar	70.4	2.3	7	71.7	4.1	5

Table 3. Regression of total body fat (y) of partridge on independent variables (x) (adult and subadult values combined).

Independent variables (x)	Male[a]		Female[b]	
	r^2	F value[c]	r^2	F value[c]
AFD + VFD + CFD[d]	0.62	24.7	0.89	83.5
VFD + CFD	0.59	34.3	0.87	106.9
AFD + CFD	0.60	34.9	0.87	105.3
AFD + VFD	0.61	37.0	0.87	57.2
CFD	0.57	63.4	0.79	125.1
AFD[e]	0.57	63.9	0.76	105.6
VFD	0.52	52.1	0.55	40.6
% Moisture	0.36	26.8	0.77	110.6
SFI[f]	0.38	29.0	0.59	45.8
Carcass weight	0.35	25.6	0.51	34.8
Body weight	0.31	21.4	0.39	21.4
Skin weight	0.16	9.2	0.40	21.1

[a] N = 50 except for SFI, N = 49.
[b] N = 35 except for SFI and skin weight, N = 34.
[c] P = 0.0001 for all values except male skin weight, P = 0.0039.
[d] AFD - abdominal fat depot, VFD - visceral fat depot, CFD - subcutaneous fat depot.
[e] Most efficient and accurate single indicator of total body fat, regression equation for males ($\hat{Y} = 11.68 + 4.34x$) and females ($\hat{Y} = 10.23 + 5.65x$).
[f] Subjective fat index.

These variables explained 72% and 60% of the variation in protein in males and females, respectively. Wishart (1979) found carcass weight divided by body length + wing length the best predictor of protein in wigeon, but could account for only 60% of the observed variation.

CONCLUSIONS

Fat stores may be depleted during midwinter in response to factors other than climate. Food availability was not restricted during the study period and winter conditions were unchanged or slightly improved by midwinter. Concomitant with the onset of breeding activity was a universal reduction in the body fat reserves of both sexes. It is probable that fat reserves continued to decline in both male and female partridge through August as a result of the energetic demands associated with egg laying, territorial defense, and broodrearing.

It is further hypothesized that the seasonal pattern of body weight change documented in this study is consistent from one year to the next. During winters of limited food availability or severe weather, peak weights may be lowered and body energy reserves reduced. Consequently, the rate of fat and protein depletion after January may be accelerated resulting in suboptimum energy reserves prior to egg laying and ultimately lowered reproductive output.

Evidence to support this contention was obtained during the relatively severe winter of 1981-82 in Saskatchewan during which partridge food supplies were restricted by deep snow and ice crusts. This environmental stress was manifested in a reduction in peak abdominal fat weight, a relatively substantial (79%) and rapid decline in abdominal fat (hence total body fat) reserves and a mortality rate of approximately 32% (Melinchuk 1983). Poor physical condition upon entering the breeding season may account, in part, for the reported fluctuations in partridge populations in Saskatchewan. However, the high reproductive potential of the

Table 4. Regression of protein reserve, g dry weight (y) of partridge on independent variables (x) (adult and subadult values combined).

Independent variables (x)	Male[a]		Female[b]	
	r^2	F value[c]	r^2	F value[c]
Weight				
Body[d]	0.42	32.0	0.60	50.0
Carcass[e]	0.72	123.7	0.57	44.1
Fat-free	0.32	23.1	0.44	26.0
Breast muscle (BMW)	0.35	25.7	0.33	45.9
Leg muscle (LMW)	0.31	22.1	0.33	16.2
Gizzard (GW)	0.00	0.0	0.02	0.5
BMW + LMW + GW	0.43	11.1	0.63	17.4
BLG[f]	0.41	32.2	0.63	53.4

[a] N = 50 except GW, BMW + LMW + GW, and BLG, N = 48.
[b] N = 35 except GW, BMW + LMW + GW, and BLG, N = 34.
[c] P = 0.0001 for all values except female LMW, P = 0.0003 and male and female GW, P > 0.48.
[d] Most accurate indicator of protein reserve for females ($\hat{Y}$ = -1.57 + 0.19x).
[e] Most accurate indicator of protein reserve for males ($\hat{Y}$ = 19.37 + 0.17x).
[f] BLG = combined wet weight of breast, leg and gizzard muscles.

species should enable populations to rebound relatively rapidly following years of poor reproduction.

MANAGEMENT IMPLICATIONS

Gray partridge body condition, as evidenced by body weight, total body fat and depot fat levels, declines after January even in mild winters. Under severe winter weather conditions, implementation of feeding programs should be considered to increase partridge (and possibly other game bird) survival and ensure optimum reproductive output the following spring. It is imperative that such feeding programs be continued throughout the prebreeding and egg laying period should natural food supplies remain unavailable.

Partridge live-trapping, stocking, and transplanting activities should be undertaken prior to January when partridge are best able to withstand the stress of capture, handling, confinement and adaptation to new surroundings.

Gray partridge hunting seasons in Saskatchewan normally end in mid November. Extension of the season into December would yield birds of high carcass quality and culinary appeal. Landowner attitudes, partridge population responses, and possibly other factors may have to be evaluated prior to implementing such a season.

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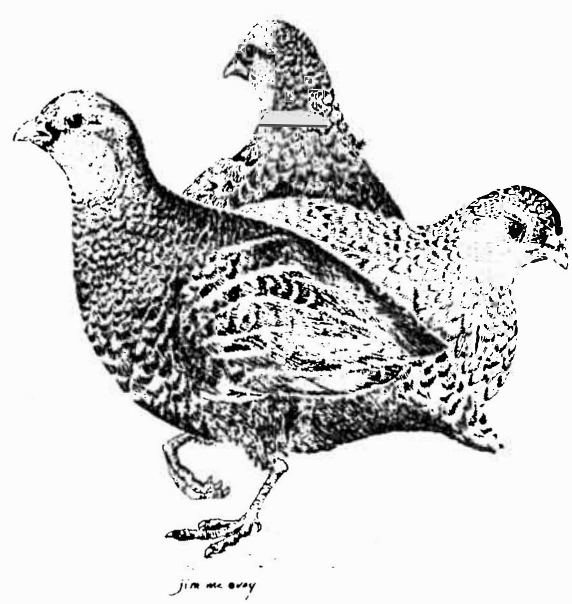

GRAY PARTRIDGE OCCURRENCE IN RELATION TO LAND USE IN NORTH DAKOTA

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Abstract: Aerial photography was used from July 1979 to July 1981 to determine land use and habitat diversity surrounding gray partridge sightings along late summer roadside brood counts in North Dakota. Idle areas on farmsteads, idle grass areas, and pasture were variables which accounted for variance in census data. Farmstead size, percent idle area of farmsteads, idle grass areas, and natural basin wetlands differed significantly between locations where birds were recorded and sites where no partridge were observed. Partridge were found in higher than expected frequencies in areas composed of 37% to 75% cropland, and 12% to 49% pasture. Partridge showed no preference in inhabiting vacant or active farmsteads and idle areas in farmsteads where partridge were known to occur were dominated by grass. A diversity index proved unsuitable for evaluating gray partridge habitat.

The gray partridge (*Perdix perdix* L.) is an exotic species in North America and was introduced in several locations in North Dakota in the mid-1920's (Upgren 1970). It has adapted to varying land use and climate and now nests in all 53 counties of the state -- our most widely distributed upland game bird (Stewart 1975). Partridge have become the state's number 2 game bird in numbers harvested (Wiehe 1977), even though they are hunted incidentally to sharp-tailed grouse (*Tympanuchus phasianellus* L.) and ring-necked pheasant (*Phasianus colchicus* L.) (Johnson 1956, Schulz 1976).

Past studies have shown that partridge prefer open, active agricultural areas (Yeatter 1934, Gerstell 1940, McCabe and Hawkins 1946, Murtha 1967). However, changes in land use associated with modern agricultural practices include a decrease in the number of farms and areas devoted to livestock and an increase in farm size and acreage of cultivated land. These changes correlate with decreased partridge population levels (Dumke 1977, Mendel and Peterson 1977, Weigand 1980).

Land use changes that reduce fencelines, field borders, and shelterbelts, reduce the "edge" habitat consistently identified as one of the most important components of partridge habitat.

This research was initiated to provide additional information on the relationship between partridge

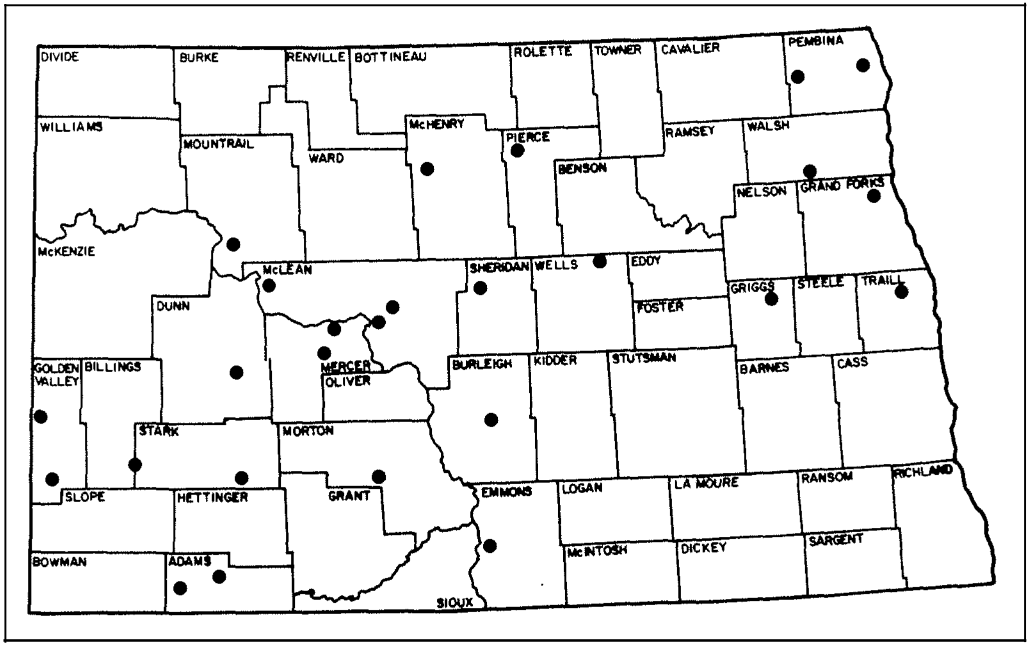

FIGURE 1. Locations of late summer roadside brood routes for censusing upland game bird populations, North Dakota.

abundance and land use. In addition, there is a need to couple our understanding of land use and wildlife populations with a rapid, definitive method of evaluating habitat.

The objectives of the study were to: (1) determine land use along routes where broods were observed in late summer and attempt to use land use differences to explain variation in gray partridge population levels; (2) compare land use between areas known to support gray partridge populations and areas where partridge have not been recorded; (3) explore and identify critical features of farmsteads located within a 0.4 km radius of gray partridge observations; and (4) evaluate the viability of a diversity index as an evaluation technique for gray partridge habitat.

METHODS

Twenty-six roadside brood survey routes, each 20 miles in length, were selected as potential study sites (Fig. 1). The routes, traversed between 15 July and 31 August, are currently used by the North Dakota Game and Fish Department to census upland game populations. This study was conducted July 1979 through June 1981 and used census data for 1975-81.

Brood surveys began 1/2 hour after sunrise and were completed within 2 hours, driving between 15 and 20 mi/hour. Numbers of ring-necked pheasant, sharp-tailed grouse, mourning dove (Zenaida macroura L.), whitetail jackrabbit (Lepus townsendii L.), cottontail rabbit (Sylvilagus spp.), raptors, and tree squirrels were recorded in addition to gray partridge. When adults or young were seen, observers stopped and flushed the birds by clapping their hands while walking through nearby vegetation. Numbers of adults and juveniles were recorded. Surveys were not conducted in threatening weather or if precipitation was falling. Surveys were cancelled if fog reduced visibility to less than 1 mile.

Selection of routes was nonrandom. Priority was given to routes where birds were consistently seen and where cooperators had a history of conducting surveys 3 times/year. An attempt was made to choose routes throughout the state.

Data regarding land use were ascertained from 1:7920 scale aerial photographs taken in 1978. Seven hundred twenty seven air photos were examined and data were recorded in ha or percent land use for statistical analyses. An effort was made to sample all sections along each route. Of the initial 26 routes, 7 were missing 8 or more photos and were excluded from route analyses. A compensating polar planimeter was used to measure cover types along census routes for an area extending 0.4 km laterally from sides of the roadway. Land use was classified as in Table 1.

Habitat diversity was measured in belts 1.6 km long and 0.4 km wide. A modified version of the interspersion index developed by Baxter and Wolfe (1972) was used to obtain a diversity value (Fig. 2). A diagonal line was drawn on a transparent overlay across each 1.6 km by 0.8 km rectangle formed by combining the 0.4 km belts on opposite sides of the roadway. Two diversity values were obtained for each section by counting habitat changes along this transect. One value accounted for changes in strip-cropping (DICROP) and the other (DILINE) did not include those changes.

Because importance of farmsteads was suggested from data collected during the 1979 field season, additional data were gathered on farms adjacent or close to the roadway along study routes surveyed during summer 1980. Questionnaires answered by landowners provided information pertaining to farmstead operation, partridge use of cover types, presence or absence of livestock and waste grain, shelterbelt composition, and vegetation types surrounding farmsteads.

Data were recorded in a form compatible with computer coding. Statistical analyses were conducted with Statistical Analysis System (SAS) (Helwig and Council 1979).

Table 1. Land use classification for gray partridge census routes, North Dakota.

- Cropland
- Noncultivated land
  - Pasture
  - Idle grassy area
    - Fenceline
    - Right-of-way
    - Grass waterway
  - Wooded area
    - Shelterbelt
      - Windrow (single row)
      - Multi-row
    - Woodlot
    - Farm
    - Riparian woodland
    - True river woodland
    - Woody draw
  - Wetland area
    - Dugout
    - Natural basin wetland
    - Impoundment
    - Lake
  - Miscellaneous

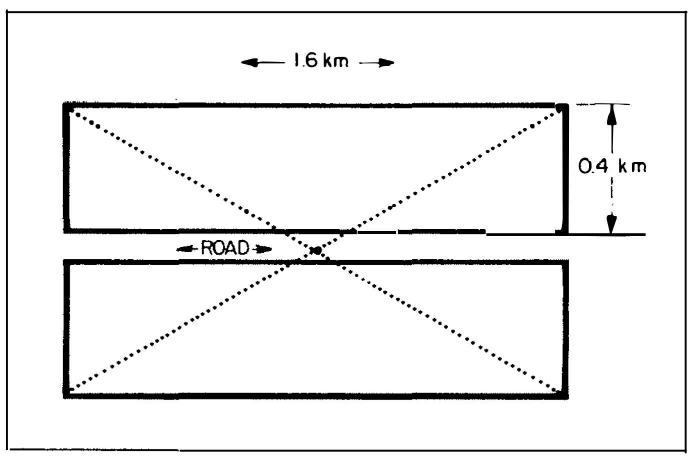

FIGURE 2. Habitat diversity index calculated by counting habitat changes crossed by the diagonal lines overlayed on aerial photographs.

Mean values of the diversity index and land use variables -- farmstead, cropland, pasture, natural basin wetland and idle grass areas -- were entered for each route as independent variables. Values of right-of-way, grass waterway, windrow (single row shelterbelts) and multi-row shelterbelt variables were combined to form an idle grass area category (Idle) to minimize the number of independent variables entered into stepwise regressions.

The number of partridge observed per 1.6 km served as the dependent variable. Routes were first analyzed by year from 1975 to 1981 (N = 56) then by using only the maximum value or the highest count for ~~each~~ route recorded during the 7 years (N = 19).

Linear regression analysis was used to test the viability of the 2 diversity indices (DILINE and DICROP) as predictors of all yearly and maximum census data. The diversity indices were also tested by Student's t tests to define differences in mean values for miles where gray partridge had been observed and miles where partridge had not been seen.

These t tests were also conducted for habitat types entered into stepwise regression models to test for mean differences in land use between sites where partridge had and had not been recorded. Student's t tests were used to test for differences in variables constituting idle grass areas between localities with and without partridge populations.

Cropland and pasture land use was categorized in 12% increments and the random occurrence of partridge over all categories was tested by chi-square goodness-of-fit.

Categorical data were collected for farmsteads occurring within 0.4 km of partridge observations (Ferris 1966, McCrow 1977). These data were tested using generalized least squares to produce minimum chi-square estimates (Grizzle et. al. 1969). Shelterbelt density was classified as 1 for very sparse to 4 for very dense. Ground cover was categorized as percent grass composition with respect to bare ground and forb occurrence; from 1 for 0-25% grass, to 4 for 75-100%. Number of rows constituting shelterbelts was recorded as 1 for 0-1 row, 2 for 2-8 rows, and 3 for 9+ rows. Farmsteads were also grouped according to the presence (1) or absence (0) of a source of waste grain or livestock. The relative frequency of gray partridge occurrence on vacant and active farmsteads was tested using chi-square goodness-of-fit.

RESULTS

Census Routes

When all yearly censuses were utilized (N = 56), pasture was the only variable which accounted for a significant portion (P = 0.038) of the variance in survey data (Table 2). Even though significant, the R^2 value was small, accounting for only 7.1% of the variance. When maximum census values for each route were utilized (N = 19), the overall R^2 increased from 0.071 to 0.65 (Table 3). Farmstead (P = 0.037, R^2 = 0.218) and idle grass areas (P = 0.001, R^2 = 0.193) accounted for significant variation in survey data when regressed on maximum census values. Although not individually significant, wetland (P = 0.056) and pasture (P = 0.062) were also entered into the stepwise regression with an overall level of significance (P = 0.004).

A negative slope for the variable farmstead was surprising because of the documented importance of farmsteads to wintering partridge in North Dakota (Schulz 1980). No differentiation was made between vacant and active farmsteads and measurements included surrounding shelterbelts, idle areas, buildings, and yard.

Stepwise analyses were conducted with the value for percent idle area

Table 2. Land use variables accounting for variance of all survey data for gray partridge census routes, 1975-81.

Variable	B value	F	P	R^2
Intercept	0.092			
Pasture	0.006	4.49	0.038	0.071

Table 3. Land use variables accounting for variance of maximum survey values for gray partridge census routes, 1975-81, N = 19.

Variable	B value	F	P	R^2
Intercept	0.146			
Farm	-0.207	5.30	0.037	0.218
Idle	0.187	15.54	0.001	0.193
Wetland	-0.108	4.32	0.056	0.134
Pasture	0.010	4.12	0.062	0.105
Overall		6.39	0.004	0.650

Table 4. Land use variables accounting for variance of maximum survey values for gray partridge census routes, 1975-81, N = 16.

Variable	B value	F	P	R^2
Intercept	-0.910			
Idle Farm	2.190	5.85	0.032	0.299
Idle	0.147	9.17	0.010	0.224
Pasture	0.015	11.71	0.005	0.184
Overall		9.65	0.002	0.710

on farms substituted for farmstead size (Table 4). Additionally, proximity of Game Management Areas could mask the effects of overall land use along census routes, therefore, routes transecting more than 8.0 km of state game management areas were excluded from these analysis. About 71% of the variance of maximum survey data was accounted for by percent idle area of farmsteads (P = 0.032, R^2 = 0.299), idle grass areas (P = 0.001, R^2 = 0.224), and pasture (P = 0.005, R^2 = 0.184).

Diversity Indices

The 2 diversity indices (DILINE and DICROP) were tested as predictors of maximum census data (Table 5) and with all yearly survey values (Table 6). Neither DILINE (P = 0.837) nor DICROP (P = 0.227) were accurate predictors of maximum census data or all yearly census figures (DILINE P = 0.67 and DICROP P = 0.92). There was also no significant difference when mean values of DILINE (P = 0.841) and DICROP (P = 0.633) for miles with known sightings of partridges were tested against miles where partridge had not been seen (Table 7).

Land Use Surrounding Gray Partridge Sightings

Land use types were compared for localities with known partridge populations and sites where partridge had not been recorded (Table 8). Sites where partridge had been seen had significantly greater area devoted to idle grass (P< 0.05), a higher percent idle area on farmsteads (P< 0.05), and larger farmstead size (P< 0.01). Localities where birds had been sighted also contained less area in natural basin wetlands (P< 0.001). Cropland, all noncultivated land, multi-row shelterbelts, and windrows did not differ significantly (P< 0.05).

Partridge use of cropland was nonrandom (P< 0.01) as determined by chi-square goodness-of-fit (Fig. 3). Gray partridge occurred in greater than expected frequencies in areas

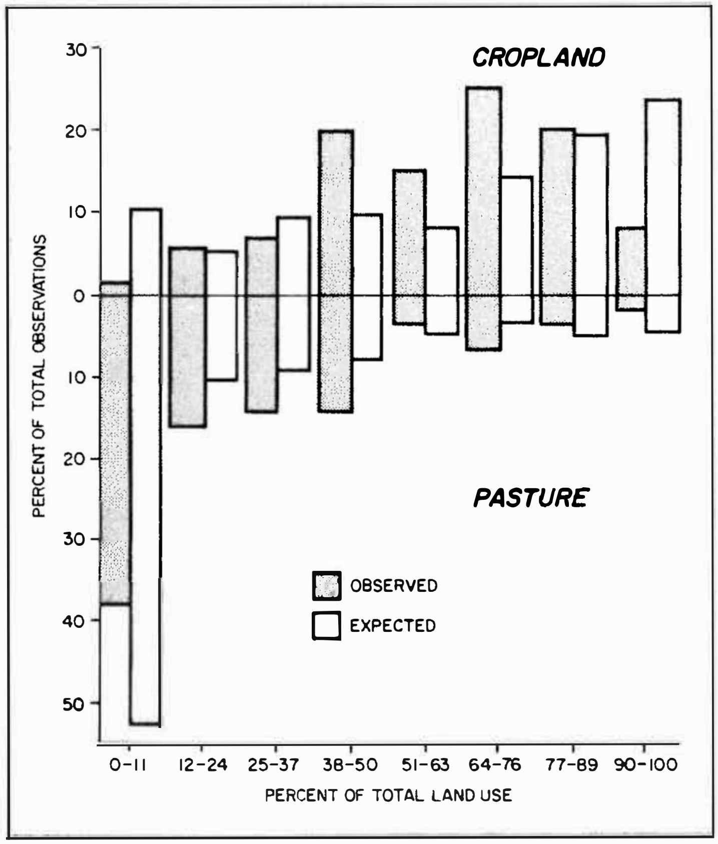

FIGURE 3. Observed and expected frequencies of gray partridge sightings in cropland and pasture.

having 37% to 75% cropland and lower than expected frequencies where cropland accounted for <11% or >90% of all land use.

Chi-square goodness-of-fit also indicated nonrandom use of pasture habitat (P< 0.01, Fig. 3). Use at greater than expected frequencies were found when pasture comprised 12% to 49% of all land use. Lower than expected values were recorded for areas composed of <11% or > 90% pasture.

Farmsteads

Of 637 farmsteads surveyed, 103 had recorded gray partridge observations. The farms with known partridge observations had significantly higher than expected frequencies of 75% to 100% grass composition in associated idle areas (P = 0.018). Shelterbelt density (P = 0.873), presence-absence

Table 5. Simple linear regression analysis of 2 diversity indices, DILINE and DICROP, as predictors of maximum census data for gray partridge.

Variable	N	Estimate	F	P	R^2
Intercept		0.624			
DILINE	19	-0.023	0.04	0.837	0.263
Intercept		-0.100			
DICROP	19	0.067	1.56	0.227	0.082

Table 6. Simple linear regression analysis of survey data with 2 diversity indices DILINE and DICROP, as predictors of yearly survey values for gray partridge.

Variable	N	Estimate	F	P	R^2
Intercept		0.322			
DILINE	77	-0.016	0.18	0.67	0.002
Intercept		0.199			
DICROP	77	0.001	0.01	0.92	0.000

Table 7. Minimum, maximum, and mean values of 2 diversity indices, DILINE and DICROP, in locations where partridge were observed (Partridge) and locations where no partridge were observed (Other).

	Minimum		Maximum		Mean	
Variable	Partridge	Other	Partridge	Other	Partridge	Other
DILINE	1.8	0.0	11.2	13.2	4.7	4.6
DICROP	1.9	0.0	17.5	20.6	6.2	5.5

Table 8. Minimum, maximum, and mean land use percentages for locations where partridge were sighted (Partridge) and locations where no partridge were observed (Other).

Variable	Minimum		Maximum		Mean	
	Partridge	Other	Partridge	Other	Partridge	Other
Crop	0.0	0.0	95.6	100.0	60.1	64.5
Noncultivated	4.4	0.0	100.0	100.0	39.9	35.5
Idle areas	2.8	0.0	31.5	48.4	10.3	8.7*
Farms	0.0	0.0	6.7	20.0	2.4	1.3**
PCTI Farm	0.1	0.0	0.8	0.8	0.2	0.1*
Natural	0.0	0.0	11.3	37.1	0.5	1.6***
Shelterbelts	0.0	0.0	11.0	19.8	0.9	0.8
Windows	0.0	0.0	5.4	6.9	0.2	0.2

* $P < 0.05$; Partridge vs. Other.

** $P < 0.01$; Partridge vs. Other.

*** $P < 0.001$; Partridge vs. Other.

Table 9. Variables measured for farmsteads with reported partridge sightings and farmsteads without partridge observations.

Variable	Estimate	X^2	P[a]
Intercept	1.47	63.82	0.001
Waste grain	0.02	0.01	0.914
Grass cover	0.43	5.54	0.018
Shelterbelt density	0.03	0.03	0.873
Rows in shelterbelt	0.19	1.04	0.308

[a] All possible interaction terms were insignificant.

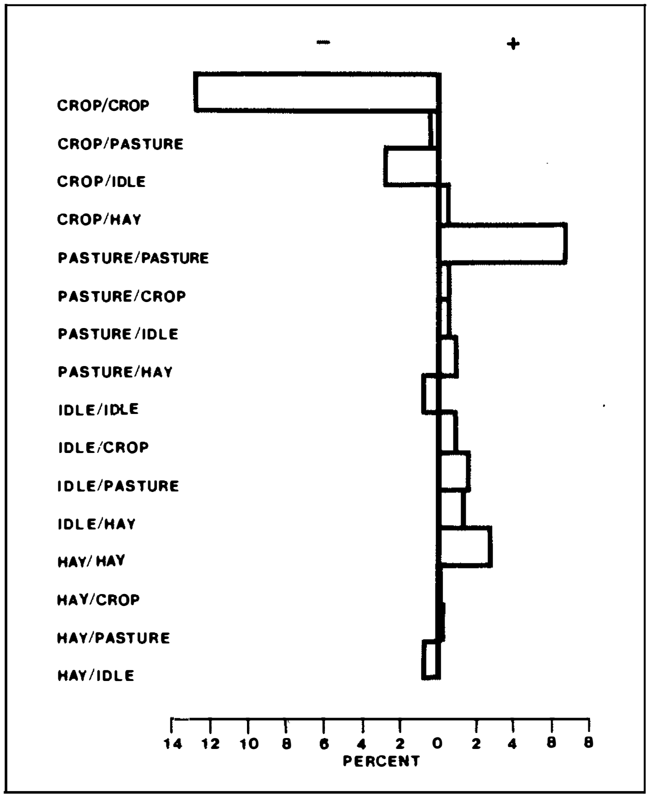

FIGURE 4. Percent deviation of the 2 nearest land use categories adjoining farmsteads (within 0.4 km) where gray partridge were observed from all farm sites surveyed.

of waste grain (P = 0.914) and number of rows composing shelterbelts (P = 0.308) did not differ ~~significantly~~ (Table 9).

Gray partridge used vacant and active farmsteads in proportion to their occurrence ($P > 0.05$) as determined by chi-square analysis. Statistical analyses were not conducted on land use surrounding farmsteads because of low cell frequencies (Zar 1974). The occurrence of the nearest 2 land use types adjoining farms where partridge were recorded were compared with values for all farms studied (Fig. 4). Farmsteads bordered by large fields of cropland appear to have been utilized less frequently by partridge. Farmsteads bordered by pasture on at least 1 side seem to have been inhabited more frequently by gray partridge.

DISCUSSION

Census Routes

Variation in survey data precluded attempts to define an optimal set of land use conditions. However, the use of maximum survey values for each route and substitution of idle area on farms for farmstead size increased the amount of variance accounted for from 7.1% to 71.0%. Using maximum values may have reflected potential partridge numbers under optimal breeding conditions, but this was unlikely, because partridge were not observed in a majority of sections along census routes. In most cases, partridge coveys were seen in 1 to 3 locations per route, leaving 17 to 19 sections along each survey route in which partridge were not seen. Because all sections were used to determine mean land use values for a route, critical values which appeared in the area or areas in which birds were seen could easily be hidden or overshadowed by land use in the remaining sections.

Land Use Surrounding Gray Partridge Sightings

The variables of importance to partridge included pasture, idle grass areas, idle areas on farms, and wetlands.

Differences in habitation of cropland was not significant. Undoubtedly, different small grains or row crops influence the density of partridge in an area and food analysis studies have shown seasonal preferences in foods utilized by partridge (Hicks 1936, Porter 1955, Westerskov 1966, Kobriger 1977, 1980, Hupp 1980, Weigand 1980). Multi-row shelterbelts had grass cover that could be beneficial to partridge, especially if areas were not clean tilled. Snow buildup on the leeward side of single row windrows has been utilized by partridge for winter storm protection in North Dakota (Schulz 1974), but multi-row shelterbelts probably offer more suitable cover for gray partridge for nesting and for winter survival.

Farmsteads

In this study, idle cover with a grass component of 75% to 100% seems to be the variable determining farmstead use by partridge. Although interaction terms with density and number of rows of shelterbelts were not significant, grassy tracts were most prevalent with sparse canopy cover of shelterbelts or in young plantings. Partridge use probably would be concentrated along outward edges of farmsteads except during periods of inclement winter weather when birds probably utilize any available resource. Deep, compacted or ice-crusted snow will likely increase the energy expenditure needed to search and obtain food. During these periods, farmsteads may be of paramount importance in providing a source of waste grain, shelterbelt cover close to food, and access to grit since bare ground is exposed due to continuous disturbance of snow cover by livestock and human activity (Schulz 1980).

Montana (Weigand 1980) and North Dakota (Schulz 1980) studies suggest that farmsteads are utilized by gray partridge during periods of harsh winter weather. Because of recurrent severity of North Dakota winters, farmsteads may serve as critical habitat for partridge.

Diversity Indices

Diversity indices similar to those of Baxter and Wolfe (1972) are easily and quickly calculated. Habitat evaluation techniques of this sort may be better suited for evaluation of an area's value for wildlife in general and caution may be needed for application to individual species.

The diversity index did not prove useful as a habitat evaluation technique for gray partridge. The monotypic nature of modern agricultural areas resulted in a clumping of diversity values between 6 and 10. Scores lower than this range usually resulted from a combination of tilling rights-of-way and field size approaching 100% of the study belt. Diversity values higher than 12 often resulted from repeated scoring of a particular habitat type, such as a creek winding along the diversity transect.

The inclusion of all habitat types may have reduced the accuracy of the diversity index. Not all types of land use were of equal value to gray partridge. Sections where wetland or riparian areas were principal contributors to diversity scores did not reflect as high quality habitat as sections with idle grass areas interspersed within cropland.

Changes due to strip cropping did not have a significant effect in predicting gray partridge numbers or in differentiating mean values in miles with bird observations from miles where no birds had been sighted.

CONCLUSIONS

Although one can obtain an overall picture of land use surrounding partridge sightings from aerial photography, little interpretation regarding quality, frequency, and seasonal use of habitats can be determined using methods employed in this study.

Gray partridge occur on agricultural lands and have maintained steady populations in spite of radical changes in farming intensity and techniques. Because partridge occur on private lands, management effort for this species will need to be concentrated on changing landowner values. Providing information about gray partridge life history and habitat management options may aid in changing these attitudes and behaviors. Management options could include preservation of grass cover around shelterbelts and farmsteads, along fencerows and rights-of-way, in idle corners, and through land leasing programs to develop herbaceous cover.

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NESTING BIOLOGY OF GRAY PARTRIDGE IN EAST-CENTRAL WISCONSIN

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Abstract: I studied gray partridge (*Perdix perdix*) nesting biology in the primary range of east-central Wisconsin, 1978 and 1979. The mean date of nest initiation was 26 May, clutch sizes averaged 16.6 eggs, egg hatchability was 88%, and 29% of all nests were successful. Because of persistent renesting, 41% of all females produced a brood. Results indicate partridge have a higher reproductive potential (first clutch size of 19 eggs) than reported previously. Partridge preferred to nest in idle uplands and avoided all other habitat types. Partridge management in intensively cultivated landscapes should attempt to improve the quantity and quality of linear cover.

Past studies of gray partridge in Wisconsin suggest that fall populations are strongly influenced by factors operating during the reproductive season (McCabe and Hawkins 1946, Gates 1973). However, data are lacking on partridge reproductive biology for populations on primary range (Dumke 1977). Management strategies derived elsewhere and under different environmental conditions may not be applicable. My objective was to investigate gray partridge nesting biology on primary range in east-central Wisconsin.

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STUDY AREA

The Calumet Study Area (CSA) is 72 km^2 of private farmland in east-central Wisconsin (Fig. 1). Winters are cold and snowy with an average January temperature of -8 C and mean annual snowfall of 111 cm. Summers are warm and humid (Table 1). Soils are loess and calcareous clay overlying dolomitic and glacial tills (Otter 1980). The topography is flat to gently undulating, at 300-374 m

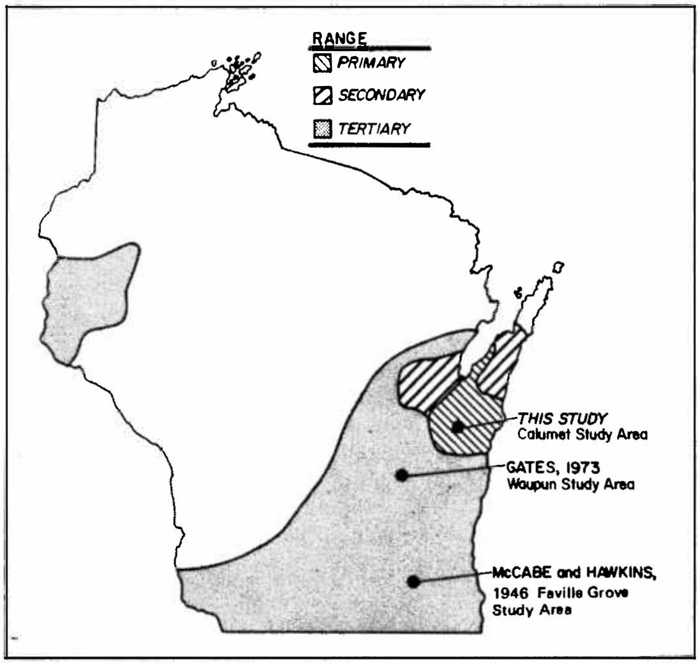

FIGURE 1. Gray partridge distribution and relative abundance in Wisconsin (modified from Dumke 1977), and location of 3 study areas.

above mean sea level. The growing season is approximately 138 days. Land use is predominantly rotation dairy farming. Except for field corn, most crops are cool-season varieties (Table 2).

METHODS

Nesting data were gathered on the CSA from 17 subadult female partridge captured during the winter (Church 1980a, Church et al. 1980). Birds were sexed, aged, and fitted with radio transmitters (Church 1980b). Radio-tracking was conducted January through September, 1978 and 1979. Estimates of the date of hatching were also obtained from non-radioed brood observations (Church 1980a).

I defined a nest as a bowl with at least 1 egg. Dates of nest initiation were calculated according to McCabe and Hawkins (1946). Hatching dates were determined from radio-tracking during nesting, and by estimating ages of non-radioed broods (Church 1980a). Nesting habitat preference values (HPV) were derived with the formula:

$$HPV = [(\%Obs. - \%Exp.)/\%Exp.] \times 100;$$

with positive values associated with preference and negative values with avoidance of habitat types (Church et al. 1980). Clutch size was determined for incubated nests only. Egg hatchability and fertility were the proportion of all eggs in successful nests which hatched or showed embryonic development, respectively. Nest success was expressed as the percentage of nests in which at least 1 egg hatched. Causes of nest failure were usually interpreted from sign at the nest site. Percent daily rates of nest mortality (m) were calculated:

$$m = -(\log_e P)/t;$$

where P is the proportion of nests surviving a stage (i.e., early-laying, late-laying, incubation), and t is the number of days in a stage (Ricklefs 1969). Brood production was expressed as the percentage of radioed females present 1 May which successfully nested in that year.

RESULTS AND DISCUSSION

The mean date of nest initiation was 26 May (range: 25 Apr-11 Jul). Fifty percent of all nests were started by 15 May, and 75% by 10 June (Fig. 2). Five nests of the radioed cohort hatched 25 June-5 July, and 1 each on 29 July and 13 August. Eleven (31%) of 35 non-radioed broods hatched 1-15 July, and 8 (23%) 16-30 June (Fig. 3). Although nesting chronology can vary annually, the peaks of nesting (mid to late May) and hatching (late Jun to early Jul) I observed are similar to those in other portions of the midwest (cf. Yeatter 1934, Michigan; McCabe and Hawkins 1946, and Gates 1973, Wisconsin; Bishop et al. 1977, Iowa; Hupp et al. 1980, South Dakota).

Nests were not distributed ($P < 0.01$) in proportion to available habitat types (17 in idle uplands, 4 in hay, 2 in pasture, 1 in corn). Partridge preferred nesting in idle uplands,

Table 1. Temperature and precipitation (from Otter 1980) during the gray partridge nesting season on the Calumet Study Area, Wisconsin.

	Mean daily temperature (C)		Precipitation (cm)	
Month	Minimum	Maximum	Mean monthly total	Days with >0.3
May	6.1	20.3	7.1	7
Jun	11.9	25.7	9.6	8
Jul	14.7	28.0	9.0	6
Aug	14.4	27.7	8.3	6

Table 2. Land use patterns during the gray partridge nesting season on the Calumet Study Area (72-km^2), Wisconsin, 1978 and 1979.

Land Use	Percent of total area[a]
Hay	38.0
Corn	32.1
Small grains	10.0
Cash crops	4.4
Cropland total	84.5
Woodlands	4.4
Residential/commercial[b]	3.4
Wetlands	3.1
Idle uplands[c]	2.5
Pasture	2.1
Noncropland total	15.5

[a] Land use patterns were similar ($\underline{P} > 0.1$) for 1978 and 1979, so data are pooled means.

[b] Area dominated by man-made structures, e.g., active farmsteads, road and railroad surfaces, feedlots, and gravel pit.

[c] Relatively undisturbed old fields, abandoned farmsteads, fencelines, and right-of-ways.

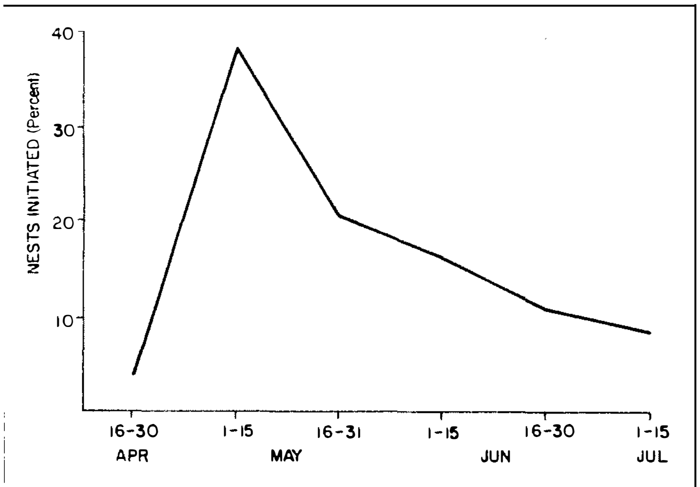

FIGURE 2. Nest initiation dates for radio-tagged gray partridge on the Calumet Study Area, Wisconsin, 1978 and 1979 (N=24).

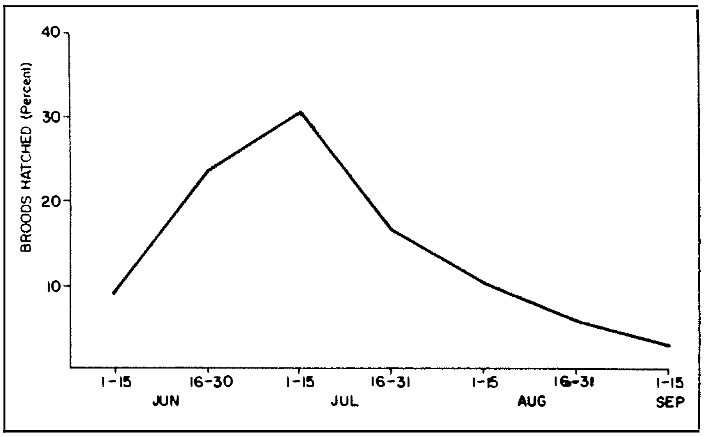

FIGURE 3. Brood hatching dates for non-radioed gray partridge on the Calumet Study Area, Wisconsin, 1978 and 1979 (N=35).

while tending to avoid other habitat types. Studies conducted during the 1930-40's found most nests (34-76%) in hay (Yeatter 1934, Green and Hendrickson 1938, McCabe and Hawkins 1946). However, use-availability analysis of recent studies (Table 3) showed limited use of hay, and a strong preference for idle uplands characterized by relatively undisturbed grass cover. In the United Kingdom, Rands (1982:v) stated "Grey partridges nested where amounts of dead grass were greatest". My data are too limited to test this hypothesis adequately, but are supportive.

The mean size of incubated clutches was 16.6 eggs (range: 7-25), which is similar to other studies (Table 4). The relationship between clutch size and the nest initiation date indicated maximum size was attained early in the nesting season (Fig. 4). Approximate initiation dates and clutch sizes for nest attempts were: first (initial), early May and 19 eggs; second, late May-mid June and 14 eggs; third, late June-early July and 9 eggs, respectively. In addition, several authors (e.g., Yeatter 1934, Green and Hendrickson 1938) have attributed larger clutches (>20 eggs) to intraspecific nest parasitism. Although difficult to ascertain, I found no evidence of more than 1 female laying in a nest, and agree with Yocum (1943) that 2 females rarely lay in the same nest.

Eighty-eight percent (N=139) of all eggs hatched, 8% experienced embryonic failure, and 4% were infertile. Similarly, McCabe and Hawkins (1946), Gates (1973), and Hupp et al. (1980) reported 85-91% hatchability. However, McCabe and Hawkins (1946) noted an appreciably higher infertility rate of 14%. The proportion of eggs that hatched increased (r=0.859, 6 df, P<0.01) with clutch size. This relationship may be misleading since clutch size is not independent of season. Yeatter (1934) reported 92% hatchability for nests hatched in June and 68% for nests after 1 July. Klimstra and Roseberry (1975) demonstrated clutch size and season influenced hatchability separately in bobwhite (Colinus virginianus), further concluding infertility increased as the season progressed. Likewise, seasonal increases in infertility have been noted for ring-necked pheasant (Phasianus colchicus) (Stokes 1954), and ruffed grouse (Bonasa umbellus) (Bump et al. 1947).

Twenty-nine percent of the nests (N=24) were successful. This is comparable to success reported in

Table 3. Comparison of nesting habitat preference values (after Church et al. 1980) derived from data provided in recent North American studies. Positive values are associated with preference and negative with avoidance of habitats.

	Habitat preference value			
Region-source	Idle uplands	Hay	Small grains	Misc.[a]
Wisconsin-Gates (1973)	1090**	170**	-81**	-100**
Iowa-Bishop et al. (1977)	692**	-50	24	-100**
South Dakota-Hupp et al. (1980)	1150**	-100**	-100**	-100**
Wisconsin-this study	2700**	-56	-100	-79*

[a] All habitats other than idle uplands, hay, or small grains.

* Use different ($P<0.05$) from available.

** Use different ($P<0.01$) from available.

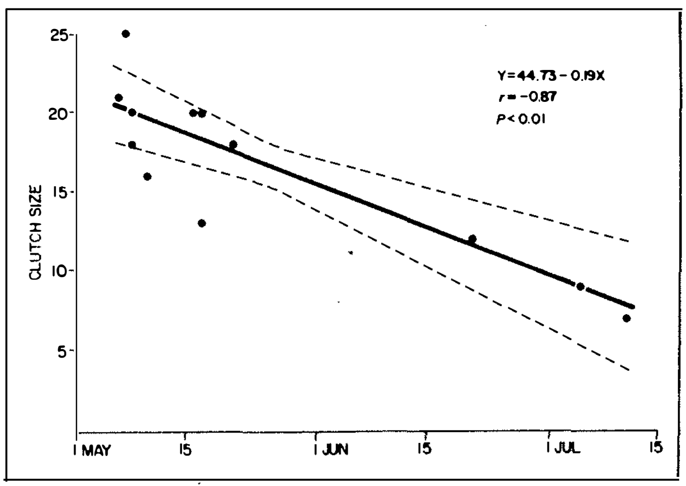

FIGURE 4. Relationship between the size of incubated clutches and nest initiation dates for radio-tagged gray partridge on the Calumet Study area, Wisconsin, 1978 and 1979 (N=12). Dashed lines represent 95% confidence limits.

other North American studies (Table 4). Most unsuccessful nests were terminated during the late-laying stage (Table 5), enabling females to renest. Eight nests failed because of predators (included are 3 females killed while away from their nests), 6 due to farming activities, and 3 from abandonment. In other studies where partridge preferred to nest in idle uplands and avoided hayfields (e.g., Bishop et al. 1977, Hupp et al. 1980), predation was the major cause of nest failure. However, where hay was also preferred and relatively abundant (e.g., Gates 1973), farming activities (hay-mowing) were most important.

In general, if a nest was terminated during laying, the female survived and renested (2 females each laid a total of 40 eggs in 3 nest attempts). Females renested in 8 ± 6,0 days ($\bar{x}$ ± SE) and moved 150 ± 96.7 m between nest sites. Forty-one percent of all breeding females produced a brood. Westerskov (1957) observed 66% of adult females with broods, despite a 42% nest success rate. Likewise, Hunt (1974) and Weigand (1980) reported 82% and 66% pair success, respectively, and 40% nest success rates, attributing the difference to renesting. I found renesting accounted for 25% of all chicks hatched and thus was important to reproduction. Similarly, Paludan (1954), Westerskov (1957), and Hunt (1974) estimated 25-36% of partridge production was the result of renesting.

Table 4. Gray partridge clutch sizes and nest success rates for North American studies.

Region-source	Mean clutch size	Percent nest success
Michigan-Yeatter (1934)	15.7	32
Washington-Knott et al. (1943)	16.7	37
Washington-Yocum (1943)	17.3	32
Wisconsin-McCabe and Hawkins (1946)	16.5	32
Wisconsin-Gates (1973)	14.9	16
Saskatchewan-Hunt (1974)	15.6	40
Iowa-Bishop et al. (1977)	14.2	24
Montana-Weigand (1980)	15.5	40
South Dakota-Hupp et al. (1980)	17.8	37
Wisconsin-this study	16.6	29
Overall mean	16.1	32

Table 5. Daily rates of mortality (after Ricklefs 1969) for radio-tagged gray partridge nests on the Calumet Study Area, Wisconsin, 1978 and 1979.

Stage	Number of nests			P^a	t^b	m^c
	Beginning	Lost	Surviving			
Early-laying (1-9 eggs)	24	4	20	0.833	9.9	1.8
Late-laying (10+ eggs)	20	10	10	0.500	8.4	8.3
Incubation	10	3	7	0.700	25.0	1.4
Total	24	17	7	0.292	43.3	2.8

[a] P is the proportion of nests surviving a stage.

[b] t is the number of days in a stage; based on an egg-laying rate of 1.1 days/egg and a 25-day incubation period (McCabe and Hawkins 1946), and a mean clutch size of 16.6 (this study).

[c] m is the percent daily rate of nest mortality.

CONCLUSIONS

The nesting biology of gray partridge in the primary range of Wisconsin is similar to that in other portions of the Midwest. However, my results indicate partridge have a higher reproductive potential (first clutch size of 19 eggs) than reported previously. Differences may be due to methods of data acquisition. I studied individual nesting histories of a winter-trapped radioed cohort, and was therefore able to document "trial" nesting behavior (Westerskov 1949:249). Others (e.g., Gates 1973, Bishop et al. 1977, Hupp et al. 1980) used various nest searching procedures less likely to detect such behavior. Furthermore, persistent renesting throughout the nesting season may not exhibit a bimodal distribution of nest initiation dates typical of renesting in other Phasianidae (cf. Gates 1973:4). As a result, previous workers may have underestimated size of the first clutch and the frequency of renesting.

This study emphasizes the importance of idle uplands (i.e., linear cover) for nesting. Thus I agree with Church et al. (1980), Hupp et al. (1980), and Smith et al. (1982) that partridge management in intensively cultivated landscapes should attempt to improve the quantity and quality of linear cover. Moreover, the provision of undisturbed residual grass cover from May through July will ensure secure sites for first nest attempts and consequently increase chick production.

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PROCEDURES FOR INTRODUCING GRAY PARTRIDGE INTO UNOCCUPIED RANGE IN NEW YORK

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Abstract: Gray partridge (*Perdix perdix*) were introduced into unoccupied range as part of a range expansion program in New York, 1981-83. Techniques used for winter livetrapping, transporting, and releasing are described and preliminary findings discussed. Procedures for similar introductions are also recommended.

Despite the numerous introductions of gray partridge into North America during the past century, information pertaining to procedures for such efforts is generally lacking. Our purpose is to (1) briefly describe winter livetrapping, transporting, and releasing techniques used in New York, and (2) recommend procedures for similar introductions.

We appreciate the cooperation and suggestions of New York State Department of Environmental Conservation (NYSDEC) wildlife personnel in Regions 5-9. This work was funded in part by the State of New York Research Foundation and the NYSDEC.

NEW YORK RANGE EXPANSION PROGRAM

The NYSDEC has the responsibility of establishing wildlife where its presence will be compatible with the environment and human needs. Although gray partridge have been established in northern New York since about 1930 (Austin 1980) extensive forest (Adirondack Forest and Tug Hill Plateau) prevents the natural expansion of this population into potential range elsewhere in the State (Fig. 1). Moreover, comparisons of

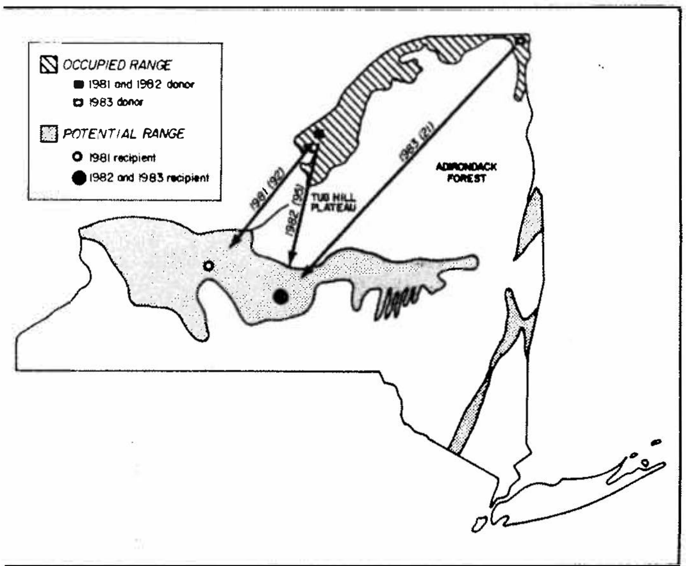

FIGURE 1. Gray partridge donor (occupied range) and recipient (potential range) areas for the 1981, 1982, and 1983 introductions in New York. Numbers of gray partridge trapped and transferred each year are in parentheses.

land use and agricultural trends indicate that portions of the potential range may be more suitable partridge habitat than the occupied range. If established in the potential range, partridge could mitigate the loss of recreational opportunities resulting from declining ring-necked pheasant (Phasianus colchicus) populations. Therefore, a gray partridge range expansion program was initiated in 1981 as part of a statewide partridge management plan (DeGraff et al. 1983).

METHODS

Gray partridge population data from the occupied range (Austin 1980) were used to identify 2 donor areas from which birds were trapped and removed. Agricultural and climate data for the potential range (DeGraff et al. 1983) were used to select 2 recipient areas for introductions. Public meetings were held in both ranges prior to the start of field activities. In addition, program status reports were periodically mailed to participating landowners and interested persons.

Winter Livetrapping

Three-person trapping crews were assigned to donor areas during January-February, 1981-83. Crews located coveys and contacted landowners to obtain permission to trap on their farms. Trapping techniques generally followed those described in Church (1980) for baited walk-in traps (for a review of capture techniques see Upgren 1968). Efforts were made to capture entire coveys or at least 1 adult/covey. Traps were checked 2-5 times a day. Nightlighting with a portable backpack unit was also used during 1983.

Transporting

After removal from traps, partridge were placed directly into transport crates. Crates consisted of 12 individual compartments (15 x 20 x 20 cm) lined with cardboard and partially filled with wood shavings. When possible, birds were kept in dark surroundings under ambient temperatures. Before being transferred to release locations, birds were sexed, aged, weighed, and leg-banded. Transporting was done by truck or aircraft.

Releasing

A different release strategy was employed during each of the 3 winters. In 1981, 92 birds were released in Ontario County at 2 locations 2 km apart. In 1982, 95 partridge were released in Cayuga County at 1 location. To augment this introduction, an additional 21 birds were released at 3 locations in Cayuga County during 1983. These release locations were chosen relative to the winter carrying capacity of a 26 km^2 area, as estimated using the habitat evaluation model described by Church and Viola (this volume). In all cases, intra-covey members were released simultaneously from the transport crates, and within 200 m of shrub escape cover.

RESULTS AND DISCUSSION

Public information and education activities generated support for the range expansion program. Approximately 250 landowners were involved in the program. Most landowners in donor areas accepted the removal of at least 1/3 of the available coveys on their farms.

A total of 208 partridge were introduced into potential range. Ninety percent were captured in baited walk-in traps from 28 January to 10 February. In general, the proportion of a covey captured increased with the number of days the birds fed on bait prior to trapping. Nightlighting was used during the relatively snow-free winter of 1983. This technique was limited by low partridge density and subsequent opportunities, and the tendency for coveys to night-roost in shrub cover.

Partridge were held in crates for 6-36 hours and incurred only minor scalping and feather-loss. Covey members usually called after being released until they regrouped approximately 0.5 hours later. Coveys without adults tended to call even after regrouping. On 4 of 9 occasions calling was observed to have attracted predators. No mixing of winter covey members was observed until pairing. Ninety-five percent of the breeding pairs consisted of inter-covey mates. During breeding seasons there were supernumerary males ("floaters") but no evidence of unpaired females.

Results of the 1981 and 1982 releases were similar at 1-year post-release. Both populations declined approximately 50% and no winter coveys were observed >2 km from release locations. These release strategies tended to concentrate birds at unusually high densities in the vicinity of release sites. This resulted in functional and short-term numerical responses by raptors (K.E. Church, unpubl. data), similar to those described by Petersen (1979) and Kenward (1982) for areas where pheasants are stocked. Furthermore, high winter densities increased pair dispersal distances and subsequently decreased productivity (cf. Church et al. 1980). Results of the 1983 release are inconclusive. However, we believe the more equitable winter distribution reduced density-related problems.

RECOMMENDATIONS

Based on this preliminary analysis, we make the following recommendations relating primarily to gray partridge introductions in the Great Lakes portion of its North American range (Johnsgard 1973), but which may have applicability for other gamebird introductions under similar circumstances:

(1) Wildlife agencies should develop public support for introductions with information and education programs prior to field activities.
(2) Winter bait-trapping should be concentrated in areas with >5 birds/km^2. The use of alternative capture techniques which do not rely on stressful winter conditions (e.g., nightlighting) should be considered.
(3) Efforts should be made to trap and release complete coveys, or not <5 birds including 1 adult.
(4) The goal of winter stocking should be to establish a May breeding density of >1.5 pairs/km^2 over a 26 km^2 area.
(5) Areas should be stocked with >200 birds in 1 year, or with not <100 birds/year for 2-3 consecutive years.
(6) Birds should be released over an area of 15-26 km^2 in proportion to the winter carrying capacity of 2.6 km^2 units.
(7) Introduced populations should be monitored to provide estimates of the rate of increase or decrease.

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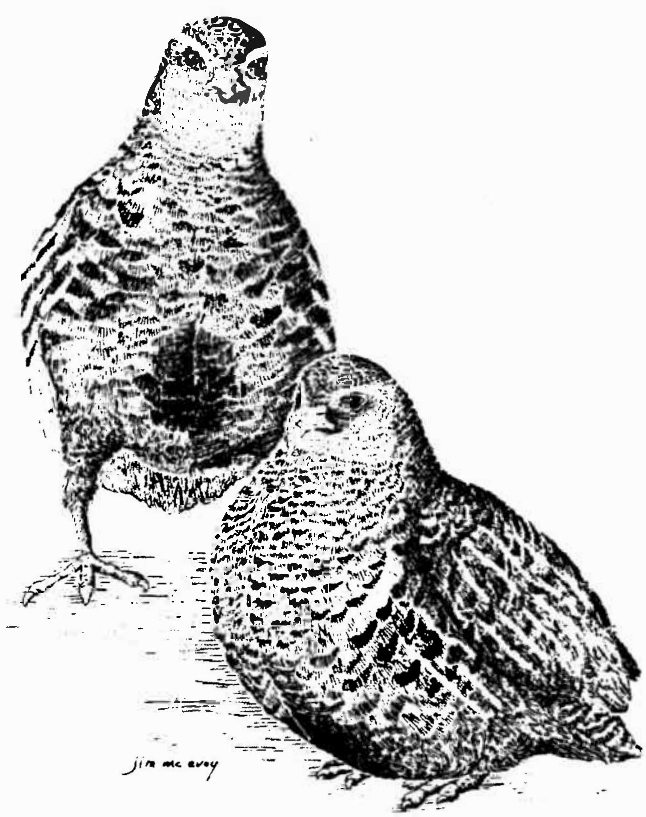

LANDOWNER AND HUNTER ATTITUDES TOWARD GRAY PARTRIDGE HABITAT IMPROVEMENT STRATEGIES, INCENTIVES, AND HARVEST MECHANISMS: A SYNOPSIS[1]

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Gray partridge (Perdix perdix) are an underutilized game bird in Wisconsin, with a harvest rate of only 10% during 1977 and 1978 (Wisconsin Department of Natural Resources 1979). New options for population and habitat management are being explored and information on landowner and hunter attitudes toward partridge are needed. Interest in promoting partridge as an important game species has been renewed recently because of the bird's ability to adapt to both intensively farmed areas and severe winters. This investigation obtained a preliminary assessment of the human dimensions components for management evaluation models (Dumke et al. 1980:117,185). Ultimately, the probability of acceptance of various management options must be obtained to guide decision making.

Questionnaires of parallel structure were mailed to 625 small game hunters and 1,086 landowners living in a 4-county area in east-central Wisconsin (Fig. 1). These counties have the highest partridge densities in the state (Dumke 1977). Questionnaires were designed to assess opinions on: (1) the value of partridge as a game bird, (2) the availability and abundance of partridge, (3) the relationship between hunters and farmers, and (4) the condition and management of partridge habitat. The response rate for the hunter questionnaire was 65% (408 usable returns) and 49% (530 usable returns) for the landowner questionnaire.

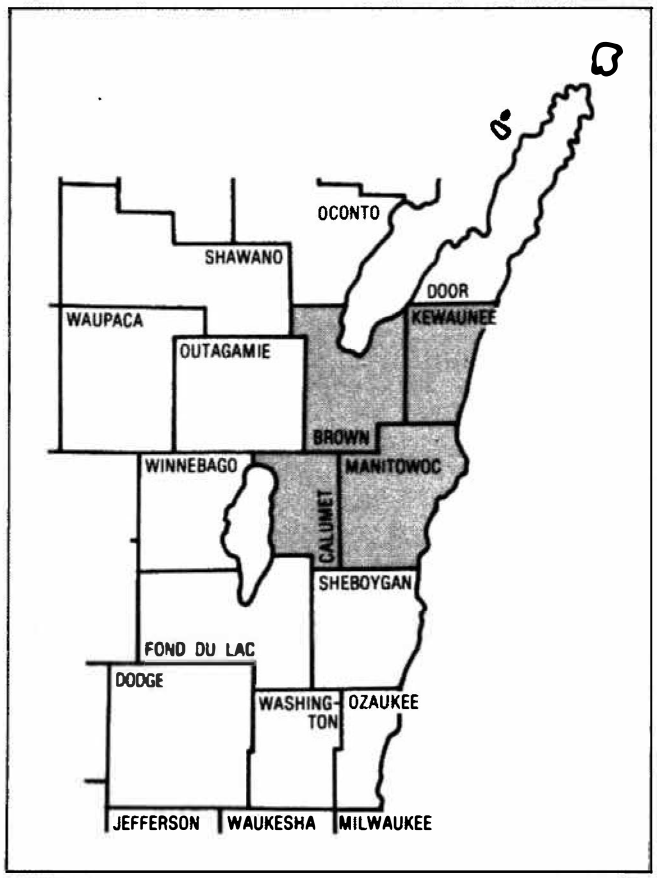

FIGURE 1. Location of counties (shaded) sampled for small game hunter and landowner attitudes toward gray partridge in Wisconsin, 1981.

[1]Final report published as Duffey, T. A. and R. B. Stiehl. 1984. Attitudes toward gray partridge and their management in east central Wisconsin. Wis. Dep. Nat. Resour. Res. Rep. No. 118, 40 pp.

Table 1. Reaction of landowners to various management strategies for improving partridge populations, east-central Wisconsin, 1981.[a]

Management strategy	% Favoring
Improving wild partridge populations	31
More restrictive hunting season	30
Renew stocking of partridge	26
DNR encouragement of farmer interest in partridge	18
Increased management of partridge	17
Less DNR encouragement of hunter interest in partridge	13
Increased research on partridge	12
DNR encouragement of hunter interest in partridge	12
Less DNR encouragement of farmer interest in partridge	11
Less restrictive hunting season	6

[a] Landowners were asked "which of the following would you rather see?" and advised to "check those that apply." $\underline{N}$ = 530.

Hunters in this survey appeared to have only a moderate interest in partridge. Most (77%) preferred to hunt pheasants, although partridge were regarded as a worthwhile game bird. Hunters preferring pheasants did so because they felt the pheasant was a larger, trophy bird, while partridge were preferred because they provided more of a hunting challenge. The present harvest level of pheasants is maintained by a stocking program in east central Wisconsin where wild populations have declined primarily because of intensive farming. Partridge, on the other hand, are better adapted to the intensively farmed areas and are able to withstand the severe winter weather. If partridge populations are maintained or increased, hunter interest could evolve toward partridge.

Landowners were asked questions relating to success or failure of partridge and pheasant populations on their land. Respondents believed that partridge populations were stable in their areas. Eight-three percent of the landowners surveyed had partridge on their farms, with a January average of 3 coveys/farm. The landowners (77%) also considered partridge habitat conditions as satisfactory to excellent; however, responses of low habitat ratings were attributed to early hay mowing and intensified land use.

Potential management strategies for improving partridge populations received marginal consideration by landowners (Table 1). Because partridge numbers are stable in their areas, landowners may feel it is not necessary to manage for this bird. The hunters, on the other hand, rated current partridge numbers and habitat conditions as slightly less than satisfactory. Increased cultivation was believed to be the primary factor adversely affecting wildlife habitat. The small proportion of respondents who acknowledged the effect of intensified land use on partridge and other wildlife is cause for concern. An effort needs to be made to provide better information on the relationship between wildlife and agricultural practices.

Landowners felt (58%) that pheasant populations had declined on their farms in the previous 5 years. When asked to estimate the number of pheasants on their farm during the 1980 hunting season, the average estimate for the pre-hunting season was 7 cocks and 8 hens/farm, while the post-season estimate averaged 3 cocks and 6 hens/farm. Thirty-three percent indicated they were unable to estimate the pre-season pheasant population on their farm and 48% were unable to estimate the post-season population.

The 4 counties surveyed are considered poor pheasant range (L. R. Petersen, WDNR unpubl. data 1982). The decline in pheasants has been attributed primarily to habitat loss (Kabat 1978), however landowners do not seem to associate habitat losses with the decline on their farms.

A poor relationship between hunters and landowners has been noted as a major problem for hunter access to private land (Heberlein 1978, Jackson 1978, Decker et al. 1979, Jackson and Norton 1979, Henry and Grau 1981, Sheriff et al. 1981, Jackson and Anderson 1982). Gray partridge are found predominantly on agricultural land. If hunters are going to increasingly utilize partridge as a game bird, they will need access to private land. Only 6% of the landowners hunt regularly on their farm. The majority (55%) do not hunt at all, while an additional 32% hunt occasionally. Yet, 54% of the landowners would allow others to hunt on their land with permission.

The manner in which landowners respond to others hunting on their land depends on their past experience with hunters. They generally felt that hunters had no respect for their property. It is apparent that hunters asking permission prior to hunting is important to the landowner. Hunters and landowners were asked to rate the farmer's present attitude toward hunting and toward allowing hunter access to their property. Both felt the landowners attitude toward hunting and hunters was less than satisfactory.

Hunters and landowners alike are disturbed by irresponsible acts of game law violation and trespassing on posted land (Jackson 1978, Jackson and Norton 1979, Jackson and Anderson 1982). Items representing unethical or careless behavior were listed for the hunters to rate in terms of their effect on the "quality" of the hunting experience (Table 2). Both hunters (89%) and landowners (75%) were in favor of stricter enforcement of game laws. Landowners suggested opening the small game hunting seasons simultaneously to reduce out-of-season violations.

A partial solution to the violations and unethical behavior could be improved hunter education and safety classes. Hunters overwhelmingly (95%) felt hunter safety and education courses added to a quality hunting experience. Most landowners (84%) also considered hunter education courses a good idea. Courses sponsored by the Wisconsin DNR could reduce irresponsible acts by hunters and alleviate a major source of conflict existing between the 2 groups.

Project Respect, a WDNR sponsored program, could help alleviate some of the existing conflicts between hunters and landowners. This program encourages hunters to ask permission to hunt on privately owned land and helps identify landowners who are receptive to allowing respectful hunters on their lands. Unfortunately, 58% of the hunters and 74% of the landowners were not familiar with the program. The lack of awareness was not surprising since the program has been promoted in only 1 (Brown County) of the 4 counties in the study block. There, efforts were made by WDNR personnel to distribute information on Project Respect to the Agricultural Stabilization and Conservation Service (ASCS), the Soil Conservation Service (SCS), and the University of Wisconsin - Extension (UW - Ext) offices. If a similar

Table 2. Hunter's evaluation of unethical or careless behavior which may detract from the hunting experience, east-central Wisconsin, 1981.[a]

Unethical or careless behavior	Detracts (%)[b]
Being careless while hunting	95
Seeing other hunters behave carelessly	93
Seeing other hunters violate common courtesy	92
Someone in your party being careless or discourteous	91
Seeing other hunters break game laws	90
Seeing hunters using alcohol before or while hunting	83
Shouting at a hunting dog	58
Having license checked by DNR official	20

[a] Hunters were provided a list of 71 items which may add or detract from the hunting experience. Each item was scaled from 1 to 7 with 1 representing "highly detracts", 4 indicating "neither adds nor detracts", and 7 representing "highly adds". Only items pertaining to unethical or careless behavior are included in this table.

[b] % of hunters indicating 1 or 2 on the 7 point scale. N = 388.

effort was undertaken in other counties, familiarity with the program may have been higher.

If Project Respect or similar programs are to be effective, an improved method of informing potential users must be established. It has been demonstrated that hunters and landowners often lack knowledge of Wisconsin DNR activities. Better department visibility could encourage landowners and hunters to seek advice and technical assistance and, in general, create a more cooperative relationship.

Landowners (83%) expressed interest in receiving more information on managing wildlife populations. Likewise, hunters (81%) were interested in learning more about the habits of game animals. Hunter participation in habitat improvement projects could accomplish this. By actually working to improve habitat for wildlife, hunters could learn firsthand the needs of game animals. Both landowners and hunters considered projects with hunter involvement useful, although landowners preferred that the projects be on public land. Hunters (93%) rated hunter participation projects as a good activity for improving bird hunting. Incorporating hunter involvement in Project Respect could improve habitat conditions, provide a learning experience, and promote better cooperation among hunters, landowners, and the Wisconsin DNR.

Landowners were asked to rate various practices which would improve wildlife habitat on their land. Those practices involving a restriction on current farming procedures were rated negatively by a majority of the landowners (Table 3). When asked about fencerow removal, 59% of the landowners stated they had not removed any in the past 5 years and 76% stated they were not planning to remove any in the next 5 years. Most felt their activities had little impact on game bird populations (41% stated "no effect"). When asked what they were doing to maintain or increase game

Table 3. Landowner's evaluation of restrictions on current farming procedures to improve wildlife habitat, east-central Wisconsin, 1981.[a]

Restriction	Bad (%)[b]
Requiring percentage of farm be managed for wildlife	75
Limiting herbicide use	56
Limiting insecticide use	52
Restricting mowing along fencerows or right-of-ways	49
Restricting burning along fencerows or right-of-ways	32

[a] Landowners were provided a list of 31 incentives which can be used to provide/encourage habitat improvements on private land. Each incentive was scaled 1 to 7 with 1 representing "very bad", 4 indicating "okay", and 7 representing "very good". Only items restricting current farming procedures are included in this table.

[b] % of landowners indicating 1 or 2 on the 7 point scale. $\underline{N}$ = 413.

Table 4. Landowner practices to maintain or increase game bird populations, east-central Wisconsin, 1981.[a]

Practices	% Employing
Less or no burning	52
Winter manure spreading	47
Maintaining existing habitat	47
Nothing	26
Allowing hunting	21
Not hunting	16
Leaving areas fallow	13
Removing predators	12
Grazing woodlands or creek bottoms	8
Delaying early mowing	7
Restocking	4

[a] Landowners were asked "What are you doing to maintain or increase game bird populations?" $\underline{N}$ = 530.

Table 5. Reaction of hunters and landowners to potential monetary incentives for improving wildlife management on private lands, east-central Wisconsin, 1981.[a]

Incentive	% Favoring[b]	
	Hunters	Landowners
Acreage left idle for wildlife:		
Tax credit	53	24
Cash payment	31	15
Crop portion left unharvested:		
Tax credit	51	23
Cash payment	31	33
New fencing or maintenance on existing fencelines:		
Tax credit	18	15
Cash payment	13	15
Encouragement of private land leasing by:		
Individuals	27	20
Hunting clubs	25	16

[a] Hunters and landowners were provided a similar list of incentives which can be used to provide/encourage habitat improvements on private land. Each incentive was scaled 1 to 7 with 1 representing "very bad", 4 indicating "okay", and 7 representing "very good." Items pertaining to monetary incentives are included in this table.

[b] % of respondents indicating 6 or 7 on the 7 point scale. N = 357 hunters, 424 landowners.

bird populations on their farm, the activities most frequently cited tended to be part of normal farming practices (Table 4). Apparently, farmers have little interest in improving wildlife habitat and game animal populations because they believe the critical habitat components are already provided and do not require extra effort for improvement.

Any effort which benefits wildlife populations on private lands must first be cost-effective (Hamor 1968). Landowners and hunters were provided with potential monetary incentives for improving wildlife conditions (Table 5). Overall, landowners tended to rate most incentives as negative. Monetary incentives may not be the type of incentives landowners desired or needed. Hunters tended to favor all of the suggested incentives except those for either new fencing or maintenance of existing fencelines.

Considerable information is available to the public through agencies such as the WDNR, UW-Ext, the SCS, and the ASCS. Unfortunately, much of the public does not realize this information is available. Landowners and hunters wanted better public information on managing wildlife populations more effectively. Hunters favored (88%) more biological studies on game bird populations. The problem remains as to how to let the public know what is available and where to find the information. Karbon and Trent (1977) suggested greater use of mass media by the WDNR. Perhaps using mass media to inform the public about what is available and where it can be obtained would be a good starting point.

In summary, hunters in east-central Wisconsin possess little knowledge of, and interest in, gray partridge. Landowners in this region consider partridge populations to be stable and apparently not in need of extra "management efforts". For partridge to be fully utilized as a game bird, the present hunter/landowner relationship needs improvement. Modifying Project Respect to include hunter participation in habitat development projects could be a start in improving the present relationship. In addition, greater visibility of WDNR personnel could increase awareness of current management efforts and encourage management efforts still needed in habitat development. Improved cooperation among WDNR, hunters, and landowners is necessary if huntable partridge populations are to be fully utilized.

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FIRST INVITATIONAL GUSTAV PABST HUNGARIAN PARTRIDGE SHOOT

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Abstract: Surveys show most gray partridge are shot by hunters while hunting other upland game. To promote public awareness of this exciting game bird, the First Invitational Gustav Pabst Hungarian Partridge Shoot was undertaken. With a touch of European class, 44 invited shooters gathered on 2 December 1982, in Morrisson, Wisconsin, for a full day of festivities. Shooters were assigned to 4-person teams which drew for estates averaging around 700 acres. Following a soggy day of "bum-thumping", the shooters returned to the headquarters to tally the day's results. Eleven teams (44 hunters) flushed 24 coveys (221 birds) and harvested 14 partridges. The event ended with a formal toast to the "Hun" and an elegant Bavarian dinner at a picturesque German supper club in Morrisson.

How do you get hunters interested in gray partridge? Invite them on a hunting trip, of course.

That was the main purpose in organizing the "First Invitational Gustav Pabst Hungarian Partridge Shoot" in Wisconsin. An equally important objective was to offer an alternative experience to pheasant hunting on crowded public hunting grounds by emphasizing the equally exciting "Hun" found mostly on private lands. It was also a great opportunity to bring together the "best in the business" of Hungarian partridge research and management. After all, as Pabst helped make Milwaukee famous for beer, the "Hun" made east and central Wisconsin famous for the pursuit of partridge.

THE PLAN

It appeared from the beginning that we had everything going for us to put together an exciting event. We had the birds, plenty of birds, the best populations in Wisconsin. Locally, we had descendants of people who hunted gray partridge in the "old country". The township of Morrisson, Brown County, is a strong German-Hungarian settlement of hard-working cheesemakers and farmers. We had a quaint old town hall with a huge, potbellied woodstove to serve as a headquarters for the Invitational. The cornerstone said 1908, the same year Huns were first imported from Europe for stocking in Wisconsin. And, we had a picturesque Bavarian supper club a few miles away to serve as a place to toast the dog, Hun and gun after the day's hunt. A German dinner of knockwurst, wienerschnitzel

Phillip M. Lepinski

First Invitational Gustav Pabst Hungarian Partridge Shoot.

and sauerbraten was easily arranged, as was lots of good, dark European ale.

The Northeast Wisconsin Spaniel Club and the Wisconsin Department of Natural Resources (WDNR) co-sponsored the event. Invitations were sent out to about 50 people, and 44 responded accepting the challenge. We tried and were successful in our goal of getting a good cross-section of people to attend. There were university professors, graduate students, attorneys, and a Chief Circuit Court Judge. There was an insurance agent, fishery biologist, retired vinegar maker, dentist, veterinarian, professional dog trainer, sport shop owner, TV anchorman, retired game manager, and the publisher-editor of a popular sports magazine (Wisconsin's Sportsman). No single vocation dominated the event.

For some who gathered at the town hall, it was just another hunting trip for partridge. For others, like Dr. Robert Ellarson, it was a return to partridge country that he had not visited for 25 years. And for a few it was their first time pursuing Huns. For all, however, a sense of anticipation and interest was growing by the minute.

The date selected was 2 December 1982. There was considerable risk and chance involved in choosing a date that late in the season. Normally, winter could cast its first fierce blow with heavy snow and bitterly cold temperatures around that time. As luck would have it, the temperature was close to 70° with thunderstorms and torrential rain. Those who ventured onto plowed ground were quickly mired down in the heavy clay soils.

THE HUNT

The morning began with hot coffee, warm apple cider, and plenty of freshly baked apple strudel. It was a warm reunion for some of the oldtimers, and new acquantances were quickly made by others.

As an introduction to the Hun and its habitat, University of Wisconsin-Green Bay student Don Nelson and Professor Richard Stiehl presented a slide program on the natural history of gray partridge. The question session afterward elicited a humorous query from Jim Moore, "Where do you find Huns when it's raining?" The entire group howled.

In an attempt to follow European tradition, the participating farms in the area were lumped together to create large "estates" averaging around 700 acres (283.3 ha). Fifteen estates were developed providing more than 10,000 acres (4047 ha) of land avialable for hunting. Most of the land was property included in the WDNR "Project Respect" program, which is comprised essentially of rural landowners who agree to allow hunting, by request only, with verbal or written permission. Prior arrangements had been made for the hunt, with no landowner turning us down.

The group was divided into 4-member teams, selected for compatibility (interests, background, etc.) as far as possible. No complaints were raised about the selection, save for one snide remark about "lousy shooting."

To assure fairness in estate selection, a peg was drawn by each leader with a number corresponding to an estate. No favorite estates were held back--it was the luck of the draw.

Following the drawing of the estates, the hunters were given a bag lunch consisting of shaved ham stacked a mile high on home-made dark Bavarian rye, a huge dill pickle, an apple and a cookie. A photographer was on hand to record for posterity each group attending the Invitational.

In high anticipation of encountering Huns, the groups dispersed to "shoot the estates." We adapted the term "shoot" from European tradition--it was not the intent to promote driven game shoots at this event. The name was catchy and we used it. All groups hunted Huns; there were no beaters. One term that did have European application was "bum-thumping." I understand it means the mopping up after driven shoots. It focuses on the true meaning of hunting, not shooting.

The groups were immediately welcomed by thunderstorms and heavy rain. By noon, however, skies cleared and made the day a bit drier and much brighter. The hunters returned to headquarters as late afternoon approached, to tally the day's results and prepare for the evening's festivities.

For the record, 44 shooters (11 teams) flushed 24 separate coveys (30 covey rises), counted 221 individual birds, and brought 14 Huns to the gun. One highly respected ethical hunter was booed heartily for shooting a pheasant. Not all that bad--and if we could blame any one factor, it would certainly be the weather.

THE AFTER-GLOW

Fifty-five rather worn-out guests gathered at Das Manor House in Morrisson to finalize the day's activities. Cocktails and a dozen imported beers made for marvelous conversation, all directed at determining which dog performed the best, who was top gun, and the sporting quality of the Hun. Dinner was followed by brief but highly entertaining comments from 4 special guests--talented speakers who reflected upon their experiences and encounters with Huns:

DAVE OTTO, outdoor writer for the Green Bay Press Gazette - "Is Writing About Huns Easier than Hunting Huns?" Dave's reply to his own question was a resounding yes.

HAROLD SHINE, retired Game Manager, Wisconsin Department of Natural Resources - "Twenty Years of Managing Huns." Harold's comments included "I don't think we really ever did manage Huns; they were there in spite of habitat improvements . . . I remember in the 1950's receiving reports of Huns moving along the lakeshore from Sheboygan to Washington Island . . . some concentrations included more than a thousand partridge."

DAVE DUFFEY, nationally known outdoor writer and professional dog trainer - "From Sheboygan to Saskatchewan." His counsel, "If you are going to be successful at hunting Huns, you have to make up your mind to walk -- and walk a lot -- I guess today we didn't walk far enough."

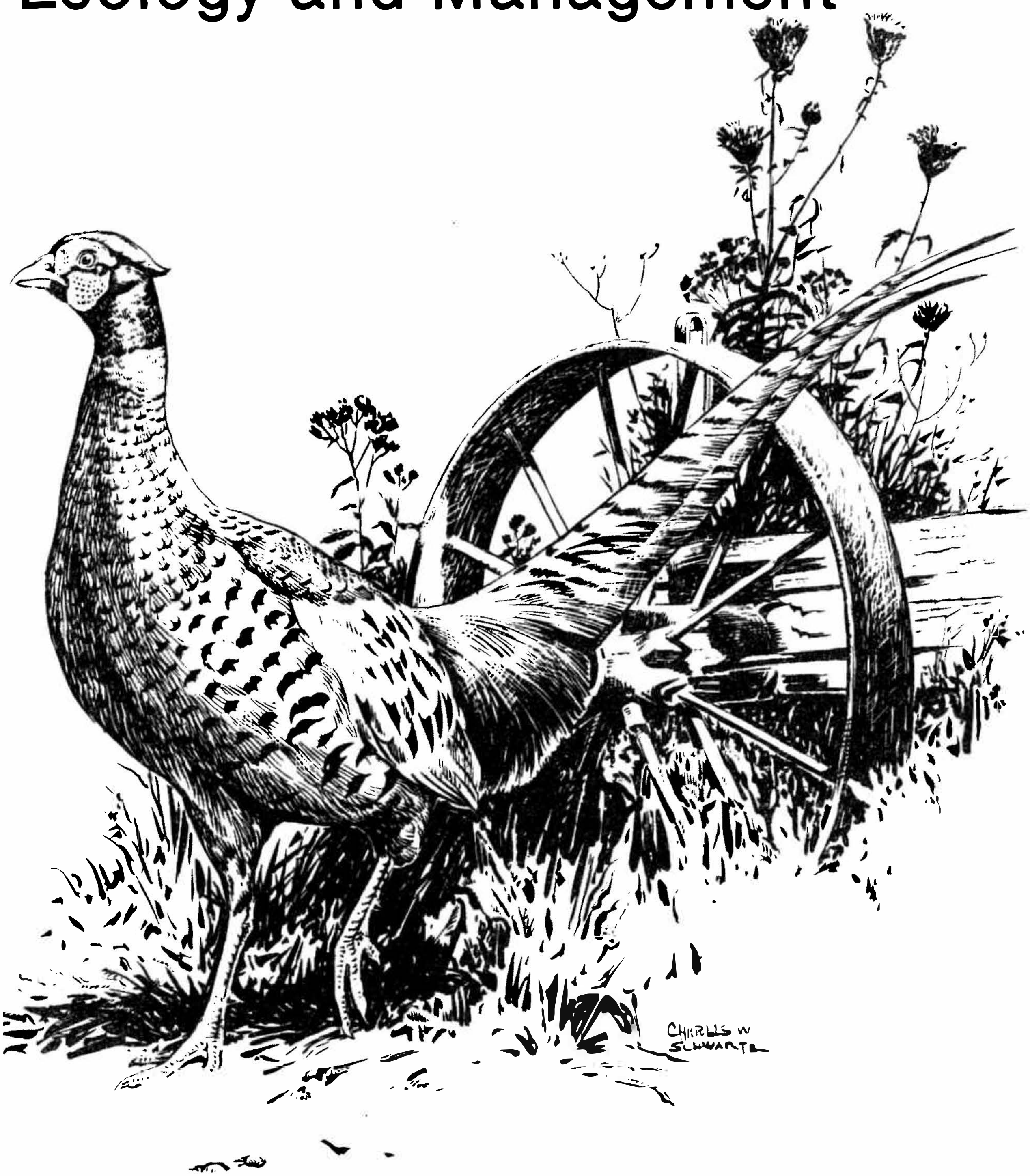
DR. ROBERT McCABE, Professor, University of Wisconsin - Madison, Department of Wildlife Ecology - "Before 1943 to 1982 and Beyond." Bob told us, "I have had opportunities to virtually travel around the world and thus observe Hun country. I think the Hun country I've seen here . . . is as good as anywhere in the world. The Hungarian partridge was my project under Aldo Leopold in the early 1940's. We lived with the birds, day and night, through the seasons. They are truly remarkable game birds."

And so it was. As a final recognition to those in attendance, a drawing was made for a door prize. Russ Breitenbach donated a superb print from his Wilderness Memories art gallery. It was a signed limited edition painting of Huns, "Breaking Away," by Terry Redlin.

The name pulled from the hat was that of Dr. Robert McCabe. It had to be fate that Bob would go home with that beautiful print. After all, it was 40 years ago that he chose the Hun for his doctorate -- and he still maintains the same high degree of interest in Huns today.

A few more schooners of beer were drunk, and a few more stories told. Dogs were long since bedded down. The Inn was starting to empty out. It was time to go home and plan the "Second Invitational Gustav Pabst Hungarian Partridge Shoot."

Ring-necked Pheasant Ecology and Management



EARLY ACP AND PHEASANT BOOM AND BUST! — A HISTORIC PERSPECTIVE WITH RATIONALE

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Abstract: The booming pheasant populations typical across much of North America in the late 1930's and their subsequent bust in the 1940's have been an enigma to wildlife biologists. Data developed recently for the Federal Agricultural Conservation Program (ACP) of cropland retirement operative in the 1930's and 1940's are presented. This program was apparently overlooked by the early wildlife biologists. The pattern evident in the 1930's and 1940's was repeated in the Soil Bank years of the 1950's and 1960's. The boom years were associated with a combination of favorable land use, extensive ACP grasslands, and generally clement weather. The bust years were characterized by intensified land use, loss of ACP grasslands, and inclement weather. The early ACP is seen as having been extensively significant to pheasants in the eastern cornbelt and locally significant elsewhere. The primary factors determining the range within which the abundance of pheasants has fluctuated are clearly land and land use related.

One of the enigmas of pheasant ecology has been the boom of wild pheasant populations across most of their range in North America in the late 1930's and their subsequent bust in the 1940's. The scale of that fluctuation is difficult to conceive. Biologists accepted the increase and came to no consensus as to why the bust occurred. A set of land use data for that era was recently developed from published U.S. Department of Agriculture statistics (1938-1978). These data relate to grassland seedings made under the Federal Agricultural Conservation Program (ACP) initiated in 1936 and continued at large scale through 1942. Data are presented for the early ACP, and their significance is discussed relative to changes in pheasant abundance.

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BOOM

Beginning about 1937, pheasants and pheasant harvests in North America showed spectacular increases that persisted through the early 1940's (Leedy and Dustman 1947, Kimball 1948, Shick 1952, Allen 1953, Kabat et al. 1955, MacMullan 1960, Wagner et al. 1965). Einarsen (1942) estimated the density of pheasants to be 470/100 acres on Protection Island, Washington, in 1942. Nelson (1946) estimated an average density of 100 pheasants/100 acres in the South Dakota prime range in 1945. Kimball (1948) concluded that from 1941 through 1945 fall densities ranged from 300 to over 1,000 pheasants/mi^2 over what became known as the "pheasant island" that included much of northern Iowa, northeastern and central Nebraska, eastern South Dakota, southeastern North Dakota, and southwestern Minnesota. On the Sand Lake National Wildlife Refuge in South Dakota in 1945, there were an estimated 500 pheasants/100 acres (Nelson 1946).

In 1944, Michigan had 26,000 mi^2 of pheasant range, a population of 4,000,000 pheasants (about 24 pheasants/100 acres), and a harvest of 1,400,000 (8.4 pheasants/100 acres) (Dale 1956:38, 39). Leedy and Hicks (1945) estimated a harvest of about 14 cocks/100 acres in northwestern Ohio in 1937; game wardens long familiar with the area (T. Reigle, R. Mann, H. Langstaff, C. F. Blakeman, and others) expressed to me the opinion that the population of wild pheasants in northwestern Ohio in 1942 may have been twice that of 1937. Gerstell (1938) reported harvests of 14.5 and 20.8 cocks/100 acres on a 1,112-acre study area in Lehigh County, Pennsylvania in 1936 and 1937.

BUST

The booming pheasant populations characteristic of the late 1930's and early 1940's were taken for granted. Contributors to a significant early book on pheasants (McAtee 1945) gave little indication that biologists anticipated extensive declines in pheasant numbers. In the east, the bust probably began in 1943. By 1944, a definite shrinking of the better range in the eastern part of the pheasant island of the northern prairie states had occurred although high densities persisted somewhat longer over much of east-central South Dakota (Kimball 1948). There the decline apparently did not begin until 1945 or 1946.

In many states the low was reached in 1946 or 1947; in South Dakota it was apparently not reached until 1950 (Kimball et al. 1956, McCabe et al. 1956). The pheasant harvest for Minnesota in 1942 was an estimated 1,749,000 -- in 1947 the season was closed to protect a low population! South Dakota had an estimated harvest of 7,507,000 in 1945 but only 507,000 in 1950! In Michigan, the decline was from an estimated 1,401,076 pheasants taken in 1944 to 452,934 in 1947. Declines appeared greatest in the best range.

The bust of the 1940's was discussed by numerous workers, notably Leedy and Dustman (1947), Kimball (1948), Shick (1952), and Allen (1953, 1956). Factors given as possibly responsible for the bust included: intensified land use; cold, wet spring weather; high mortalities of eggs, young, and nesting hens; heavy hunting pressure, including legal hunting of hens; cyclic phenomena; and recession of abundance of an introduced species on new range. Kimball (1948) considered blizzards of local as opposed to regional significance and thus not a factor in the rangewide bust of the 1940's. Although several factors were repeatedly implicated, none was consistently dominant across the range.

RECOVERY

In the late 1940's and early 1950's pheasant populations, decimated in the mid 1940's, showed general recovery. Blouch and Eberhardt (1953) indicated that by 1952, pheasants in Saginaw County, Michigan, had recovered to about 75% of their former abundance. However, on the Prairie Farm in that county, recovery was only about 15%. Blouch (1956) estimated the statewide harvest of pheasants in Michigan to have been 1,226,990 in 1953. Pheasant harvest in Wisconsin increased approximately 65% between 1947 and 1952 (Kabat et al. 1955:6, Figure 1).

Although pheasant numbers were up in northwestern Ohio in the early 1950's, it was the impression of long time employees of the Ohio Division of Wildlife that the abundance of pheasants was not nearly as high and the prime range was not nearly as extensive in northwest Ohio as 10 years previously. To a person, they spoke of the loss of "cover", but none referred to ACP.

Trends in pheasant harvests in the early 1950's were apparently upward over much of the range. A general feeling among pheasant biologists was that south of the 41st parallel, the decline of the 1940's was not quite so pronounced and the recovery was somewhat better than north of the 41st parallel. This pattern of relative strength in more southerly ranges appeared to hold in the mid 1950's, when declines were again evident, and also during the strong recovery of the late 1950's and early 1960's.

EARLY FEDERAL CROPLAND DIVERSION PROGRAMS

In attempting to find a rationale for the bust in pheasant populations of the mid 1940's numerous workers pointed out the possibility of increased intensity of land use as a contributing factor (Leedy and Dustman 1947, Faber 1948, Kimball 1948, Wandell 1949, Allen 1953, Blouch and Eberhardt 1953, Stokes 1954). Today, attention would quickly focus on statewide land use. But the profession was young. Biologists were just learning how to census pheasants. The dominant events were the depression, the dust bowl years, and World War II. ACP apparently went unnoticed by wildlife managers. The only reference that I have seen regarding the significance of the early programs of cropland diversion and conservation to pheasants is in Wiegand and Janson (1976) for pheasants in Montana.

John Steinbeck called it "The Grapes of Wrath" -- the combination of the "Great Depression" and the "Dust Bowl". In an attempt to create farm markets and stabilize rural economies, the first cropland diversion program was initiated under the Cropland Adjustment Act (CAA) of 1934. That program lasted 2 years, 1934 and 1935, and it was a major program in the corn belt (Table 1). Over the 2 years, a total of 37,367,000 acres were taken out of production; 29,495,000 acres, almost 80% of those acres, were in 12 midwestern states. Acres retired under CAA were equivalent to about 8% of the acreage harvested in those years. There apparently was no provision in the act for seeding a cover crop to protect the diverted acres from erosion.

The wind blew. The Soil Conservation and Domestic Allotment Act of 1936 was passed. This act provided the enabling legislation for the formation of the Agricultural Stabilization and Conservation Service (ASCS) -- the farmer's friend in Washington -- and with it the U.S. Soil Conservation Service (SCS) -- his friend down on the farm. The cornerstone program of ASCS and SCS was the Agricultural Conservation Program (ACP), initiated in 1936. The program was aimed at strengthening farm markets through cropland diversion and at soil protection. The latter was accomplished by seeding diverted, fallow, and idle croplands with biennial or perennial legumes and grasses, or their mixtures, to prevent soil erosion. It was operative at large scale through 1942 (Table 1, Figure 1).

From 1936-42, ACP payments were made for 252,401,000 acres of so-called "permanent" seedlings, an average of 36,059,000 acres annually. Again, the cropland diversions were greatest in the corn belt states, where payments were made for 153,060,000 acres, or about 60% of the U.S. total -- an average of 21,866,000 acres/year, or 1,822,000/state/year, in the Midwest. Over the 7 years, payments in the Midwest were made annually for diversion of the equivalent of almost 12% of the acreage of all crops harvested.

ACP was not, however, uniformly distributed among states. Michigan, Ohio, Indiana, Illinois, Wisconsin, and Iowa had consistently greater percentages of diverted acres than Kansas, Nebraska, and the Dakotas, where wheat and cattle were more significant to the agricultural

Table 1. Acres diverted from agriculture under federal subsidy, 1934-1947 (acres x 10^3).[a]

Year	U.S.	Midwest	MI	OH	IN	IL	WI	MN	IA	KS	MO	NE	SD	ND
1934[b]	20,486	16,493	107	558	789	1,722	194	701	2,567	2,867	1,456	2,253	1,568	1,711
1935	16,881	13,304	75	358	569	1,349	152	754	1,977	2,125	1,215	2,251	1,404	1,075
1936[c]	28,458	20,324	1,299	1,816	1,786	2,164	2,035	2,164	3,605	407	1,818	1,081	825	1,324
1937	29,072	17,180	1,124	1,973	1,231	1,480	2,208	1,873	2,446	291	2,364	717	496	983
1938	30,013	15,285	927	1,265	1,339	1,908	1,451	1,363	2,640	246	2,121	171	419	1,435
1939	41,500	25,175	1,599	1,964	2,096	3,516	1,995	2,517	4,502	465	3,207	891	795	1,628
1940	42,449	25,508	1,480	1,880	1,860	3,161	2,143	3,105	4,587	652	3,061	1,047	873	1,659
1941	42,597	25,347	1,310	1,875	2,094	3,480	2,072	2,504	4,512	716	3,578	1,253	848	1,105
1942	38,312	24,241	1,614	2,090	2,085	3,356	2,090	1,870	3,962	1,145	3,016	1,180	1,046	787
Subtotal	252,401	153,060	9,353	12,863	12,491	19,065	13,994	15,396	26,248	3,922	19,165	6,340	5,302	8,921
1943[d]	3,119	2,794	240	161	145	367	297	374	256	263	401	165	68	57
1944	6,356	4,709	397	456	434	528	298	264	562	584	704	208	150	124
1945	4,108	3,392	234	253	155	390	539	365	610	294	158	255	84	55
1946	2,699	1,974		317	257	184		263	146	370	180	134	63	60
1947	1,551	848		94	68	120			29	402			81	54
Total	307,601	196,574	10,406	15,060	14,908	23,725	15,474	18,117	32,395	10,827	23,279	11,606	8,720	12,057

[a] Agricultural Statistics, U.S. Government Printing Office, Washington, D.C. Annual Summaries for 1936-1949.

[b] Acres x 10^3 diverted from the production of corn and soybeans, 1934-35.

[c] Acres x 10^3 diverted from production with provision for seeding of grasses and legumes, 1936-42.

[d] Acres x 10^3 with subsidy paid for harvesting grasses and legumes for seed, 1943-47.

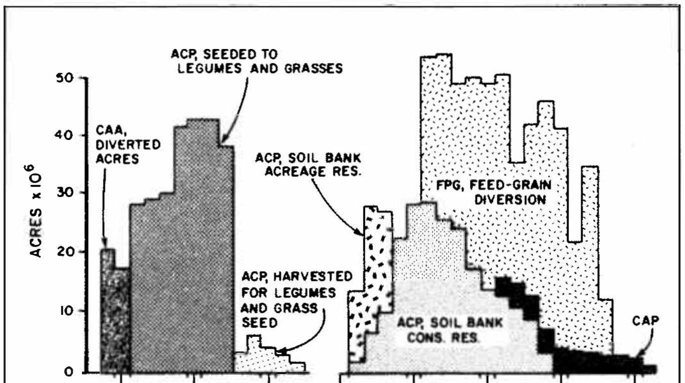

FIGURE 1. Summary of agricultural land in the United States diverted from crop production under subsidy of the Agricultural Stabilization and Conservation Service, 1934-76 (U.S. Department of Agriculture 1938-1978).

economy (Table 2). In the east, the annual ACP diversions averaged almost 18% of total acres harvested. In the plains states, ACP was equivalent to about 5% of the acreages of crops harvested. Drought that increased "idle" land was no doubt a contributing factor in the western corn belt.

In Illinois, 7.1% of all ACP grassland acres were seeded; 4.9% were seeded in Ohio. In Ohio, for example, total farmland was estimated at 15,688,000 acres in 1940. From 1936-42, a total of 15,060,000 acres was under ACP -- 1,835,000 acres/year in that small state. That was equivalent to about 75 acres/mi^2 of farmland per year over those 7 years!

As noted, ACP was proportionately more prevalent in areas of cash grain farming. It is probable that in the then prime pheasant range of northwest (Wood and Henry counties) and central Ohio (Marion County), ACP grasslands averaged well in excess of 100

Table 2. Acres diverted from cropping under ACP, 1936-42, in relation to cropland harvested (acres x 10^3)[a].

State	Mean acres harv. 1936-42	Total ACP acres 1936-42	Mean ACP acres 1936-42	Mean ACP acres as % mean harv. acres
MI	7,786	9,353	1,336	17.2
OH	10,083	12,863	1,838	18.2
IN	10,202	12,491	1,784	17.5
IL	18,126	19,065	2,724	15.0
WI	10,032	13,994	1,999	19.9
MN	18,624	15,396	2,199	11.8
IA	21,310	26,248	3,750	17.6
KS	20,177	3,922	560	2.8
MO	12,102	19,165	2,738	22.6
NE	18,482	6,340	906	4.9
SD	11,890	5,302	757	6.4
ND	15,477	8,921	1,274	8.2
Midwest	174,291	153,060	21,866	12.5

[a] Agricultural Statistics, U.S. Government Printing Office, Washington, D.C. Annual Summaries for 1935-44 and 1980.

Table 3. A comparison of principal agricultural land-use categories in the United States and in Illinois for 1934, 1939, and 1978 (acres x 10^3).[a]

Agricultural Land	Total U.S.			Illinois		
	1934	1939	1978	1934	1939	1978
In all farms	1,054,515	1,060,852	1,049,063	31,661	31,033	29,095
Total harvested, all crops	295,624	321,242	325,427	17,567	18,270	23,151
Reported as idle or fallow	56,030	56,929	21,008	1,848	1,718	652
Crop diversion--ACP	20,486	41,500		1,722	3,516	
Corn harvested for grain	62,247	77,432	70,275	6,890	7,511	11,170
Soybeans harvested for grain	(NA)	4,274	63,343	621	1,304	9,240
Wheat harvested for grain	41,943	50,526	56,942	2,080	1,868	1,000
Oats harvested for grain	28,621	32,307	11,426	2,629	2,972	420
All hay harvested as hay	68,625	65,979	61,515	3,230	2,644	1,205

[a] Agricultural Statistics, U.S. Government Printing Office, Washington, D.C. Annual Summaries for 1936, 1941, and 1980.

acres/mi^2, 1936-42.[1] In Illinois, the total was 22,136,000 CAA/ACP contract acres over the 9 years 1934-42 -- an average of 2,460,000 acres/year. From 1939-42, Illinois averaged 3,378,000 ACP acres annually.[1] That, too, was equivalent to about 75 acres/mi^2/year, but in Illinois the period of high occurrence lasted only 4 years.

The data (Tables 1 and 2) suggest that ACP was most prevalent in areas where corn was produced for sale as grain and fat cattle and hogs dominated the economy, and less so where wheat, range cattle, and drought were more important. In the areas of early cash grain farming for corn, ACP and pheasants were most abundant during the boom years. ACP was certainly not the only aspect of land use favorable to pheasants in what, by today's standards, was a relatively diverse agriculture, one in which hay and oats were well represented (Table 3). Today, of course, oats and hay -- and the pheasants as well -- are essentially gone from most of the once prime pheasant range, now the biological desert of corn and soybeans.

As previously discussed, during the period of the late 1930's and early 1940's, the abundance of pheasants in South Dakota was legendary. The presence of ACP was undoubtedly felt in that state, but not so strongly as in states to the south and east. South Dakota, a large state, had a total of 8,720,000 ACP acres, equivalent to 2.8% of the total area of the state. This acreage was about 40% of the ACP acreage in Illinois and 60% of that for Ohio. In only 3 years (1934, 1935, and 1942) did South Dakota have more than 1 million acres diverted. Pheasants had a lot more going for them than ACP in South Dakota, and no doubt in the northern plains states as a whole, in the early years of cropland diversion. It was to the east and south, where row cropping was already relatively intense, that ACP was most concentrated and of most benefit to pheasants -- in states like Ohio, Michigan, Wisconsin, Illinois, and Iowa -- but certainly too in areas of cash grain farming in Minnesota, Nebraska, Kansas, and the Dakotas and probably elsewhere as well.

In 1942, with the advent of World War II, the country and the world needed feed grains. From 1943-47, ACP in the corn belt was limited to payments to subsidize the harvest of legumes and grasses for seed (Figure 1). This phase of ACP was only equivalent to about 1/8 of the previous cover seeding phase. In all

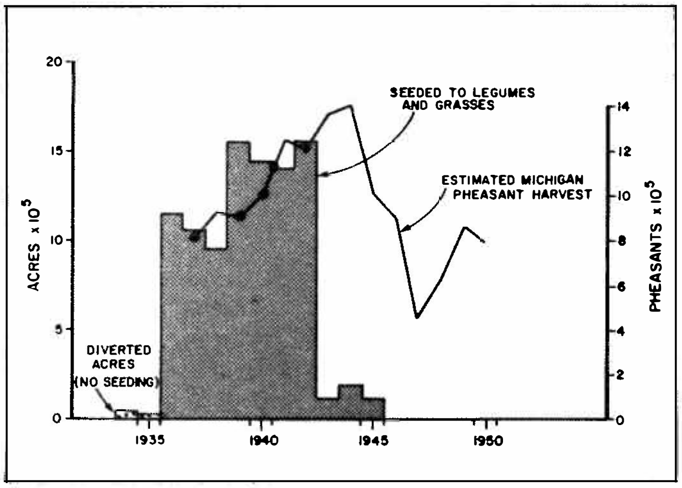

FIGURE 2. Summary of agricultural land diverted from cropping under Agricultural Stabilization and Conservation Service subsidy and estimated pheasant harvests in Michigan, 1934-50 (U.S. Department of Agriculture 1934-1953, MacMullan 1960:21).

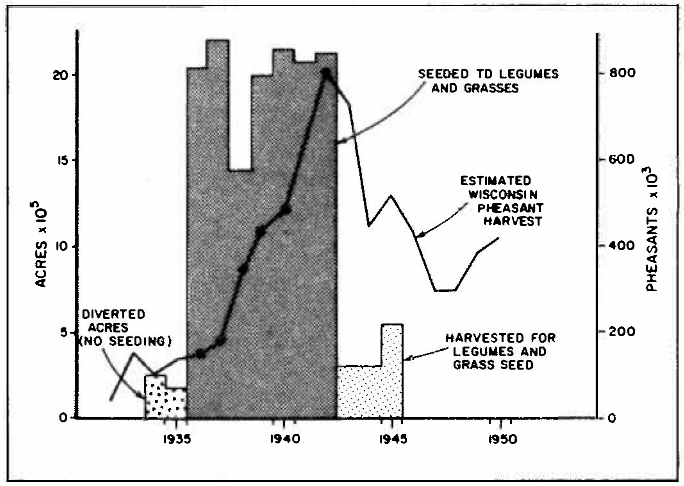

FIGURE 3. Summary of agricultural land diverted from cropping under Agricultural Stabilization and Conservation Service subsidy and estimated pheasant harvests in Wisconsin, 1932-50 (U.S. Department of Agriculture 1934-1952, Kabat et al. 1955).

probability, the seed harvest provision was most used on less productive soils, those that tended not to be the best for production of grain or of pheasants. The transition from conservation to full production was abrupt. The bust in pheasant numbers that followed was abrupt.

Clearly, the discontinuation of ACP in 1942 would have been less significant to total land use in South Dakota than in states such as Ohio, Michigan, and Illinois in the eastern corn belt. Had Kimball (1948) and the other early workers perceived the impact of ACP, they could perhaps have given a better answer to the riddle of the "bust" of 1943-44 that started in the eastern part of the midcontinental pheasant range and proceeded westward. The greatest acreage of ACP was to the east of South Dakota, and that is where the results of the discontinuation of ACP were most apparent. Although the data are weak, over much of the midwest the bust was probably commensurate in scale to the loss of ACP grasslands.

How long any effects of ACP persisted on the land and in pheasant abundance we cannot say. Long-term data sets for pheasant harvests in Michigan and Wisconsin suggest that the effects of ACP persisted 2 or 3 years at most (Figures 2 and 3). Something happened, possibly several events coincided, to cause a rapid, extensive decline in pheasant numbers. We know that an abrupt change occurred in regional land use related to available grasslands and ACP. It is difficult and illogical not to recognize a dependent relationship for the ringneck relative to ACP. The program was too big and too dominant a factor on the land not to have had some affect on pheasant populations. If we ignore ACP as a factor in the dynamics of pheasants, we must be prepared to deny the significance of the Soil Bank program to pheasants. The Soil Bank was ACP's stepchild.

THE SOIL BANK

The Soil Bank had 2 phases. The Acreage Reserve phase, operative 1956-58, did not require permanent seedings and was of comparatively little value to wildlife. The Conservation Reserve phase, operative 1956-72, required seedings and offered

Table 4. Land management programs funded by the Agricultural Stabilization and Conservation Service (USDA) of probable significance to wild pheasants in the United States for the years 1951-76.[a]

Year	ACP[b] Perm. cover	Soil Bank[c] Acreage reserve	Soil Bank[c] Conserv. reserve	Feed Grain[c] Corn	Feed Grain[c] Total	CAP[c]
1951	242					
1952	192					
1953	121					
1954						
1955						
1956		12.0	1.4			
1957		21.4	6.4			
1958		17.2	9.9			
1959			22.5			
1960			28.7			
1961			28.5	19.1	25.2	
1962			25.8	20.3	28.2	
1963			24.3	17.2	24.5	
1964			17.4	22.2	32.4	
1965			14.0	24.0	34.8	
1966			13.3	23.7	34.7	2.6
1967			11.0	16.2	20.3	4.0
1968			9.2	25.4	32.4	4.0
1969			3.4	27.2	39.1	3.9
1970			0.1	26.1	37.4	3.9
1971			T	14.1	18.2	3.8
1972			T	24.4	36.6	3.3
1973				6.0	9.4	2.8
1974						2.7
1975						2.4
1976						2.1
Totals	555	50.6	215.9	265.9	373.2	35.5

[a] Agricultural Statistics, U.S. Government Printing Office, Washington, D.C. Annual Summaries for 1974:522 and 1976:518.

[b] Acres x 10^3.

[c] Acres x 10^6.

significant help for wildlife. Many wildlife workers today see the value of the Conservation Reserve of the Soil Bank. From 1956-70, that program resulted in 215,900,000 acres of seedings (Table 4). Although impressive, that total is only 70% of that of the early ACP. Moreover, the Soil Bank program was operative at large scale for 11 years as opposed to 7 for ACP. Thus, during peak years, less than 60% as much grassland was provided on an average under the Soil Bank as was provided under the earlier ACP. If the Soil Bank was good for pheasants, what must a program almost twice as big have meant to them in the 1930's and early 1940's!

The grasslands provided under the Conservation Reserve of the Soil Bank (U.S. Department of Agriculture 1938-1978) were closely associated in time and space with the rise and fall of pheasant populations in the late 1950's and 1960's (Table 4, Figure 1). Their probable significance to pheasants and pheasant hunting was generally recognized (Schrader 1960, Dahlgren 1967, Bartman 1969, Weigand and Janson 1976).

In South Dakota, where the early ACP seedings had gone unnoted, biologists were quick to note the response of pheasants to the Soil Bank. Schrader (1960) pointed out that the early data sustained the view that the Soil Bank contributed to successful nesting. Dahlgren (1967) attributed the bust in South Dakota pheasants in 1964-66 to loss of Soil Bank grasslands. The association of pheasants and Conservation Reserve acreages of the Soil Bank in that state was demonstrated by Erickson and Wiebe (1973) (Figure 4). In Colorado, Bartman (1969) concluded that during peak years of the Soil Bank, 85% of the successful pheasant nests were on seeded diverted acres.

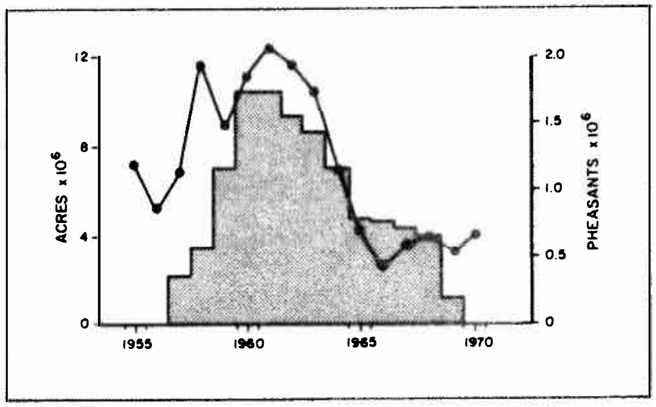

FIGURE 4. Summary of agricultural land diverted from cropping under the Conservation Reserve and Soil Bank programs of the Agricultural Stabilization and Conservation Service and estimates of fall abundance of pheasants in South Dakota, 1955-70 (U.S. Department of Agriculture 1957-1972, Erickson and Wiebe 1973:23; Figure 1).

FEED GRAIN

The Emergency Feed Grain Program (EFG) of the 1960's and early 1970's (Table 4) contributed to pheasant production (Joselyn and Warnock 1964, Gates and Ostrom 1966). However, the EFG was based on annual contracts with no provision for seeding perennial grasses and legumes. The resulting habitat tended to be of low quality for pheasants (Harmon and Nelson 1973). But the EFG program was big and it was popular! Over 13 years, 373,200,000 acres were diverted from the production of feed grains -- 28,708,000 acres diverted/year. Yet, on an annual basis, the EFG program was roughly 7% smaller than the earlier ACP! What might EFG with provision for seedings have meant to pheasants in combination with the Soil Bank!

However, on the basis of size alone, the EFG certainly must have been beneficial. Joselyn and Warnock (1964) concluded that in Illinois 38.8% of successful nests in 1962 and 27.5% in 1963 were in acreages diverted under the EFG. Gates and Ostrom (1966) concluded that at least 17% of all successful nests in 1961-65 occurred in fields diverted under the Emergency Feed Grain Program. They estimated at least a 10% increase in pheasant production in Wisconsin during those years due to that program.

CAP

The Cropland Adjustment Program (CAP) initiated in 1966 offered 5- to 10-year contracts for cropland retirement, cost sharing for seeding of perennial cover, and specified payments for allowing public recreation, including hunting (Table 4). This program was developed, in part, through the efforts of the member biologists of the Midwest Pheasant Council. During 11 years, an average of 3,227,000 acres of seeded grasslands were provided under CAP. This amount is a little less than 10% of that under

ACP. CAP had a significant potential that was comparatively unrealized because of farmer preference for annual contracts then available under the Feed Grain Program. The EFG program allowed farmers more flexibility of response to fluctuating grain markets and field conditions.

Machan and Feldt (1972) reported 4 times the hunting pressure and 3 times the pheasant harvest on CAP lands compared with those on non-CAP lands in Indiana. Nason (1971 *in* Weigand and Janson 1976:64) estimated 58,400 hunter trips on 111,000 acres of Nebraska farmland opened to hunting through CAP. Weigand and Janson (1976:64) estimated that in the peak year for CAP, 1967, there were only 189 CAP contracts covering just 34,811 acres in Montana. Of those, only 32 leases for 8,769 acres included the provision for recreation.

DISCUSSION

How a program of the magnitude and duration of the early ACP could go unnoted by wildlife biologists of that era is difficult to perceive today. It is necessary to recognize that in 1934, the United States was in the throes of the "Great Depression". The profession and science of wildlife management were in their infancy. Funds for wildlife research were limited -- the Pittman-Robertson (P-R) legislation was not enacted until 1937. Management stressed stocking, transplanting, predator control, strict law enforcement, and winter feeding (McAtee 1945). Attention was on food and cover on individual farms -- "islands" as opposed to "landscapes" and land use in the broad sense. ACP had already been in operation several years when serious research on pheasants began -- spawned largely by booming pheasant populations, funds from P-R, and students of Aldo Leopold. As indicated, emphasis in the 1930's and 1940's focused on "habitat" -- cover for nesting, escape from predators, loafing, and roosting -- and, in Ohio, on refuge management (Leedy and Hicks 1945). The ASCS had simply not yet been recognized as *the* dominant force in the lives and times of wild pheasants. Perha~~ps it~~s importance is yet to be fully recognized.

ACP effectively died on December 7, 1941. From 1942-45 most biologists (there were not many) and hunters were carrying Garands, not Model 12's. There was a good market for corn and soybeans. In 1946, when the biologists and hunters came home, the pheasants were gone -- at least comparatively speaking.

Thanks largely to P-R, the wildlife profession grew rapidly after World War II. A number, not many really, of papers on the significance of diversion programs of the 1950's and 1960's were published. Most have been cited here. However, no truly comprehensive historical evaluation of pheasants relative to federal crop diversion programs has been attempted on a regional scale. It should be. That it has not been done is regrettable. Perhaps the 1983 diversion program coupled with recent low pheasant densities only now put pheasant population fluctuations in perspective for such a study.

Acknowledging that exceptions of scale, time, and space have occurred, the record indicates that since the introduction of pheasants into North America 100 years ago, 2 major population booms and busts have occurred extensively across the midcontinental pheasant range -- in the early 1940's and again in the early 1960's. These booms and busts were extensively associated in time and in space with the establishment, presence, and destruction of seedings of forage legumes and grasses. It would, however, be simplistic to believe the equation for pheasant abundance is as simple as "grass equals roosters", although such a notion may be primary (Labisky et al. 1964, Wagner et al. 1965, Joselyn et al. 1968, Warner 1979).

The regulation, or limitation if one prefers, of pheasant abundance is clearly complex, beyond the purpose here. From today's perspective, it appears that the factors relating to the booming pheasant populations of the 1930's and early 1940's were a fortuitous combination of favorable agriculture, grasslands extensively developed and maintained under ACP, and generally clement weather, all perhaps in phase with a 10-year high of the wildlife cycle, and which may have equated with a low predation rate (Grange 1948, Allen 1953, Kimball et al. 1956, Dumke and Pils 1973).

Conversely, the declines in pheasant numbers of the mid-to-late 1940's were associated variously in time and space with greatly intensified farming, rapid losses of grasslands established under ACP, inclement weather, and the decline phase of a 10-year cycle. The general pattern of events of the late 1930's and 1940's was repeated in the Soil Bank years of the late 1950's and 1960's. Although the availability of grasslands must be a prerequisite, we will probably never find -- nor is it reasonable to expect to find -- a simple, single answer to the enigma of pheasant boom and bust. We can be confident, however, that pheasant abundance will continue to fluctuate and that the general limits of abundance will be determined largely by land use. Pheasant populations must be regarded as unstable because environmental conditions change and fluctuate. Regardless of the presence or absence of any cyclic influences, the primary factors determining the general range within which pheasant abundance fluctuates are land and land-use related.

One lesson above all others is clear. Large scale federal cropland diversion programs, where they have specified seedings of biennial or perennial grasses and legumes, have resulted in "booming" pheasant populations. In the primary range in 2 eras with such programs we have seen fall populations well in excess of 200 pheasants/mi^2 develop in a relatively few years (5-7) over extensive areas of the Midwest. Population "busts" followed quickly when those programs ended. Programs based on annual diversions did not result in booming pheasant populations. The relative costs per acre-year of annual diversions and multi-year programs like the Soil Bank are little different.

When future cropland diversion programs are contemplated, wildlife biologists should fight hard for contracts of 2 to 3 years duration, or longer, that specify seedings of biennial or perennial legumes and grasses. Organized farm groups can be expected to object to such contracts, but the fight should be waged. Unfortunately, annual lease payments are sufficiently high making it impossible to justify the leasing of prime cropland by state wildlife agencies for the production of pheasants. Such leasing was tried in Ohio in the late 1940's and early 1950's. It was too costly then. It would be more costly now -- \$10,000+/mi^2/year -- to begin to approach ACP or Soil Bank acreage payments in potentially prime pheasant range in the Midwest today!

Our principal hope in pheasant management, beyond harvest regulations, lies in structuring federal and state agricultural and highway programs to minimize the negative and maximize the positive in terms of "undisturbed" grasslands.

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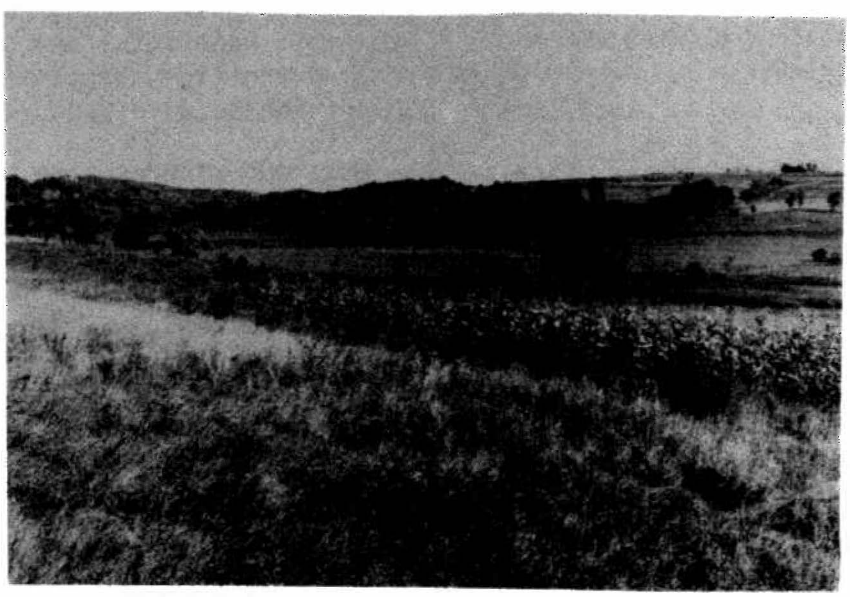

DNR

HEN PHEASANT HABITAT USE DURING REPRODUCTION IN NEW YORK'S LAKE PLAIN

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Abstract: Radio-location telemetry techniques were used to obtain 2,495 locations of 32 hen ring-necked pheasants (*Phasianus colchicus*) from 15 April to 15 August, 1979 and 1980. The cover type at each location was determined. Vegetation was analyzed at 949 locations to determine a height-density index for herbaceous cover, and to quantify percent herbaceous cover, percent shrub cover, and percent open ground. Old fields, strip cover, and shrubland represented only 13% of the study area, yet contained 52% of all radio-locations. Variations in the use of vegetation structures and cover types were apparent between seasons, diurnal time periods, and reproductive stages. Old fields were also important for brood production, containing 68% of 28 hatched clutches. Hay mowing was not found to be a major factor limiting pheasant populations. Recommendations are made for improving pheasant nesting and brood-rearing habitat.

Habitat plays an important role in determining the success of a species. The abundance of ring-necked pheasants, with their high reproductive potential, can be determined to a large extent by the availability of suitable nesting and brood-rearing habitat. Hence, an understanding of habitat requirements for reproduction is critically important in their management. The objective of this study was to obtain habitat use data that will improve this understanding. Such information will be useful to wildlife managers who wish to initiate habitat improvements for pheasant population enhancement. By concurrently studying the habitat use of both nesting and brood-rearing hens, a better understanding of differences and similarities in their needs is possible. With this understanding, the most beneficial and perhaps most cost-effective habitat management plans can be developed.

Numerous studies have been made of habitats used by pheasants for nesting (Hartman and Sheffer 1971, Gates and Hale 1975, Dumke and Pils 1979, and many others [see Olsen 1977 for review]). However, the habitats used by nesting hens for other activities, such as roosting, loafing, etc., have not been adequately investigated. Hanson and Progulski (1973) collected relevant data in South Dakota, but pooled it with data of brood-rearing hens thus obscuring its value. Dumke and Pils (1979) reported the percent of radio-locations found in various cover types for prelaying and laying hens in Wisconsin, but the data were only for April. Hence, a more complete understanding of seasonal and diurnal habitat use patterns for these birds is needed. Brood habitat use has attracted more attention, particularly in the north-central states, with contributions by Kozicky (1951), Hanson (1971), Hammer (1973), and Warner (1979). However, before this study, no detailed information had been published on habitat utilized by pheasant broods in the Northeast.

Boyd and Richmond (1980) presented preliminary findings on habitat use of nesting and brood-rearing hens. Additional data were collected and the combined results are presented here.

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STUDY AREA AND METHODS

The study was conducted in portions of Avon, Lima, and Livonia townships, Livingston County, New York (Fig. 1). Located 30 km south of Rochester, this 3,900 ha site is a complex of prime farmland and small towns. Topography is largely the result of glacial activity with elevations ranging from 183 to 335 m. The pheasant population had declined from 1972 to 1979 (Slingerland 1980a). Pheasant density in spring 1979 was estimated to be 4-10 birds/100 ha (Austin 1979). A density estimate for spring 1980 was not obtained due to a lack of snow accumulation in March.

Hens were captured from January to mid April using baited funnel-traps (Gates 1971) and nightlighting (Labisky 1968). A radio transmitter, 28-31g in weight, with a mercury activity switch, was attached to each hen by a shoulder harness of commercially available elastic tubing (similar to that described by Dumke and Pils 1973). Hens were released in the area of capture.

A vehicle-mounted null-peak antenna system was used for radio-location. Average azimuth error was ± 1-2 degrees. Usually 2-3 azimuths were used to fix a location. To minimize location errors, efforts were made to remain as close to the hen as possible without influencing her behavior (usually 50 to 400 m), record azimuths within 2-3 minutes time, and have azimuths intersect at approximately right angles.

Location data were collected for 4 days in each 2-week period between 15 April and 15 August. Hens were located at approximately 2 hour intervals, locating the first hen 1/2 hour before sunrise and ending when all the hens had been located once after dark. Locations were plotted by triangulation on acetate overlays of aerial photographs (scale 1 cm = 79.2 m).

Each location was categorized into 1 of the 15 cover types indicated in Table 1. The percentage of locations in each cover type was calculated for each hen. To obtain an overall picture of cover type use on the study area by the hen pheasant population, mean percentages of locations occurring in each cover type were calculated for specified time periods. The mean percentages were weighted by the proportion of each hen's locations in the sample.

Availability of each cover type was estimated for monthly intervals by July cover mapping, estimating the

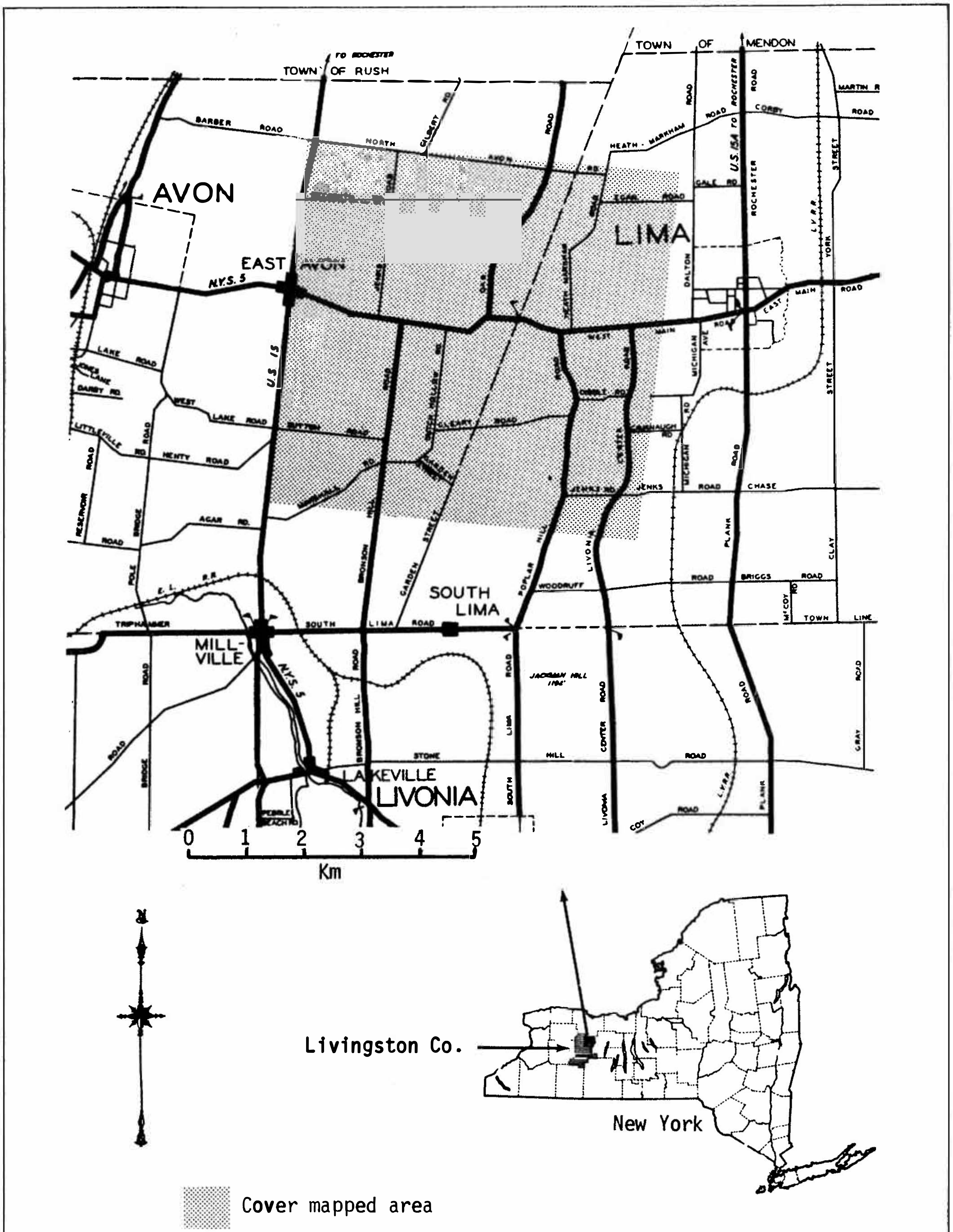

FIGURE 1. Location of the Avon study area, Livingston Co., N.Y.

Table 1. Seasonal cover type availability (% of area) on the Avon study area, New York, 1979 and 1980.[a]

Cover Type	15 Apr - 14 May	15 May - 14 Jun	15 Jun - 14 Jul	15 Jul - 14 Aug
Cropland				
Hay	12	12	12	12
Pasture	4	4	4	4
Wheat	8	8	8	4
Oats	0	3	5	4
Small-grain stubble	6	1	0	5
Corn stubble	14	2	0	0
Plowed	21	19	3	2
Corn	1	15	29	30
Beans and potatoes	0	3	6	6
Noncropland				
Old field	7	7	7	7
Strip cover	1	1	1	1
Shrubland	5	5	5	5
Woodland	9	9	9	9
Residence	8	8	8	8
Others	3	3	3	3

[a] Data for July adapted from Slingerland (1980b) and Smith (1981). Data on plowing, planting, and harvesting were used to calculate availability for remaining times.

extent of fall plowing, and noting the progression of spring plowing, planting, crop development, and harvest. Cropland dominated the landscape. Noncropland cover types were old fields, shrubland, woodland, strip cover, and residence. Old fields represented a variety of vegetation types, ranging from recently retired cropland to a successional stage with 20% shrub canopy. Vegetation of most old fields was dominated by perennial forbs, e.g., goldenrod (*Solidago* spp.) and aster (*Aster* spp.) and perennial grasses, e.g., orchardgrass (*Dactylis glomerata*), timothy (*Phleum pratense*) and bluegrass (*Poa* spp.). Shrubland refers to areas with shrub canopies exceeding 20%, but tree canopies less than 50%. The most common shrubs were dogwood (*Cornus* spp.), blackberry (*Rubus* spp.), grape (*Vitis* spp.), and hawthorn (*Craetaegus* spp.). Strip cover included hedgerows, ditches, and roadsides. Residence included residences, industrial sites, and highways.

The chi-square 1-sample test (Siegel 1956) was used to determine cover type preference or avoidance, by comparing frequency of locations in each cover type to frequency expected if distributed randomly. Expected frequencies were calculated by multiplying total locations by percentage of area in each cover type.

A more general and simplified analysis of habitat use patterns was provided by focusing on 3 structural forms of vegetation: herbaceous, shrub, and open (less than 50% of ground covered by vegetation). This reduced the number of cover types from 15 to 3 and allowed assessment of the importance of specific vegetative structures.

Approximately 60 radio-locations during each 2-week period were randomly selected for vegetation analysis. Sample sites were located in the field by pacing along a compass bearing from the closest object that was easily observed on the photo and the ground. Transects were established that extended 20 m north, south, east, and west from the suspected location site. Percent herbaceous cover, percent shrub cover, and percent open ground were quantified using the line intercept method (Canfield 1941). Because shrub canopies can occur above herbaceous vegetation or open ground, it is possible to obtain plot sums of all 3 components that are greater than 100%. A height-density index (HDI) (Robel et al. 1970) was determined for herbaceous cover by averaging HDI readings taken at 4-m intervals along the transects only where herbaceous cover occurred. The average plot value of each cover component was calculated for each hen, and then calculated for all hens to obtain an estimate of cover component use by the hen pheasant population. This value was weighted by the proportion of plots for each hen in the sample.

Seasonal patterns of prelaying and laying hen habitat use were studied by grouping use data into approximately 31-day intervals (15 April-14 May, 15 May-14 June, and 15 June-21 July).

Diurnal patterns of habitat use were analyzed for 4 time-of-day periods: (1) morning (0515-0816), the first 20% of the 1/2 hour before sunrise to sunset period; (2) midday (0817-1720), the middle 60% of the 1/2 hour before sunrise to sunset period; (3) evening (1721- 2022), the last 20% of the 1/2 hour before sunrise to sunset period; and (4) night (2023-2324), after sunset. See Boyd (1981) for a discussion of daily time period designations.

Diurnal and seasonal habitat use data for laying hens represent only those locations when hens were not at nest sites. When on the nest, they are not selecting habitat but are merely responding to nest stimuli.

Kolmogorov-Smirnov 2-sample tests (Siegel 1956) were used to detect significant differences in use of a cover type between years, brood age-classes, and use of a vegetation structure component between brood age-classes. Kruskall-Wallis 1-way ANOVA tests (Siegel 1956) were used to detect significant differences in use of a vegetation structure component and cover type among time periods. Dunn's multiple comparisons test (Hollander and Wolfe 1973) was used to identify samples with significantly different HDI's. The significance level for all comparisons was $\underline{P} \leq 0.05$.

RESULTS AND DISCUSSION

Thirty-two prelaying and laying hens provided 1,381 radio-locations from 16 April to 21 July. Four of these hens were killed by predators in late April to early May, before nesting attempts could be documented. The remaining 28 hens established 55 known nests. Twenty-eight clutches hatched between 19 May and 15 August. Four hens hatched 2 clutches during the same year. Eighteen hens with broods 1-6 weeks of age provided 1,114 radio-locations from 19 May to 13 August. Data for incubating hens were not analyzed because they were nearly always inactive and on nests.

Seasonal Cover Type Availability

Cover types which comprise pheasant habitat were very dynamic through the study period (Table 1). Old field, strip cover, shrubland, woodland, hay, pasture, and residence cover types remained constant in area, although their appearances changed greatly. Corn, beans, and potatoes, which began sprouting in early May, were developing on about 1/2 their eventual acreage by 1 June and were fully

Table 2. Use and preference/avoidance of cover types by prelaying and laying hens during 1979 and 1980, Avon study area, New York.

Cover type	Locations (N) Observed	Expected[a]	X^2
Old field	373	101	790.3*
Strip cover	129	14	954.3*
Shrubland	130	69	56.8*
Hay	153	162	0.6
Pasture	48	59	2.1
Wheat	64	113	23.1*
Oats	39	33	1.1
Small-grain stubble	33	33	0.0
Corn Stubble	128	80	30.6*
Plowed	80	212	97.1*
Corn	95	188	53.3*
Beans and potatoes	27	37	2.8
Woodland	26	127	88.5*
Residence	28	116	72.9*
Others	28	37	2.2
Total	1381	1381	

a Expected number of locations was obtained by multiplying the average percentage of available area (from the first 3 columns of Table 1) of each cover type by the total number of observed locations.

* $P < 0.001$ (chi-square 1-sample test, 1 df).

available in early June. Oats developed slightly before row crops. Availabilities of corn stubble and small-grain stubble were highest in late April and absent by mid June. Small-grain stubble reappeared when wheat and oats harvest was initiated in late July. Approximately 50% of spring-planted fields were plowed the previous fall. Plowed fields remained high in availability to early June.

Prelaying and Laying Hen Habitat Use

Seven cover types received important use ($\geq 5\%$) during the 1979 and 1980 nesting seasons (Table 2). Old fields received the greatest use (27%), followed by hay (11%), shrubland, strip cover, and corn stubble (each 9%), corn (7%), and plowed (6%). Old fields, strip cover, shrubland, and corn stubble were utilized more than predicted from their availabilities if locations were randomly distributed ($P \leq 0.001$). Although plowed and corn cover types received substantial use, their use values, along with those of wheat, woodland, and residence cover types, were less than expected ($P \leq 0.001$). Use values of remaining cover types were not significantly different from availability values.

Seasonal Patterns. Vegetation structure at radio-location sites differed for 30-day intervals during the nesting season (Fig. 2). Herbaceous vegetation was the dominant form of ground cover during all

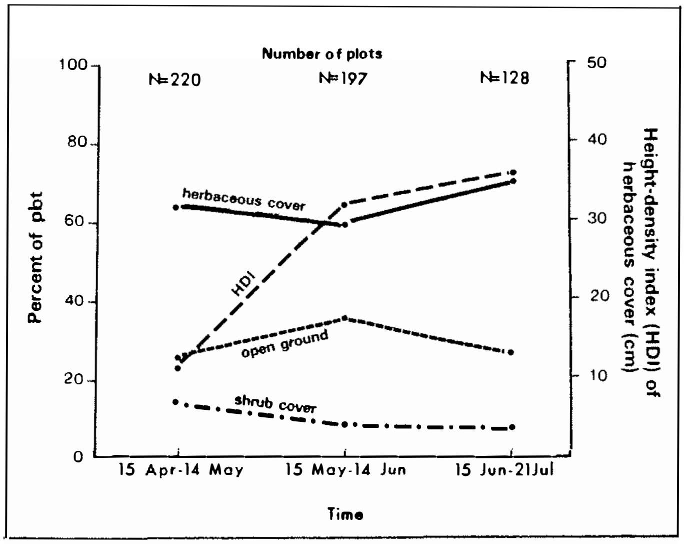

FIGURE 2. Vegetative characteristics of habitat used by prelaying and laying hens during 30-day periods.

seasonal periods (mean = 63%). Open ground also was an important component of the average plot through the period (mean = 29%). Percent herbaceous cover and percent open ground did not vary among seasonal periods ($P = 0.37$ and $P = 0.22$, respectively). Height-density of herbaceous cover and percent shrub cover varied among seasonal periods ($P < 0.001$ and $P = 0.04$, respectively). HDI was lowest in the 15 April-14 May period (12 cm; $P \leq 0.05$). Significant differences were not found between the last 2 periods (mean = 34 cm). Percent shrub cover was highest in the 15 April-14 May period (14%; $P \leq 0.05$). Significant differences were not found between the last 2 periods (mean = 7%). The data suggest an inversely proportional relationship between HDI and percent shrub cover. Perhaps shrub cover was selected in the late-April to early-May period to compensate for inadequate cover in herbaceous vegetation.

Hens were located in different cover types to varying degrees during the nesting period and between years (Tables 3, 4, and 5).

The 15 April-14 May period was characterized by heavy use of old fields (mean = 32%), corn stubble (mean = 16%), shrubland (mean = 14%), and strip cover (mean = 10%) (Table 3). Hay, small-grain stubble, plowed, and woodland cover types also received some use.

Differential use of strip cover and shrubland was apparent between years. Strip cover use was higher in 1980 ($P = 0.04$). Ten of 19 hens in 1980 used strip cover for >10% of their locations, *vs.* 3 of 13 hens in 1979. Although not significant ($P = 0.16$), use of shrubland was highest in 1979. Nine of 13 hens in 1979 used shrubland for >10% of their locations *vs.* 6 of 19 hens in 1980.

These differences may be related to the severity of the preceding winter. The winter of 1978-79 was severe, with exceedingly cold temperatures from January through February and snow cover exceeding 15 cm until 12 April. In comparison, the 1979-80 winter was mild, with warmer temperatures and virtually no snow accumulation. Gates and Hale (1975) studied the movements and cover utilization of Wisconsin pheasants under similar winter conditions and found that during winters of snow accumulation, pheasants moved to "traditional" wintering sites composed primarily of heavy shrub cover. However, during mild winters with little snow, pheasants remained in more open uplands. In this study, shrubland provided most of the winter cover during the severe winter. Hence, in spring 1979, pheasants were concentrated around these areas. Our sample of hens and their locations predictably reflects high use of shrubland. In contrast, hens in the spring of 1980 were not as concentrated around shrubland and were primarily using strip cover.

Six cover types received substantial use in the 15 May-14 June period (Table 4). Old fields (mean = 18%), hay (mean = 17%), wheat (mean = 11%), plowed, strip cover, and remaining corn stubble (each with a mean = 10%) accounted for most radio-locations.

Pasture, corn, and shrubland also received considerable use.

During the last month of the nesting season, old fields (mean = 31%), corn (mean = 17%), and hay (mean = 10%) dominated cover type use (Table 5). Also important were shrubland, strip cover, oats, beans and potatoes, and residence.

Changes in cover type use among seasonal periods were found for shrubland, corn stubble, plowed, corn, and oats ($P \leq 0.03$). Use was greater in shrubland from 15 April-14 May, in corn stubble from 15 April- 14 June, in plowed from 15 May-14 June, and in oats from 15 June-21 July. In corn, use was greater in each successive third of the nesting season than the previous period ($P \leq 0.05$). Although not significant, use appeared to decrease in small-grain stubble ($P = 0.08$), and increase in beans and potatoes ($P = 0.09$).

Dynamics of cover type preference with respect to 30-day periods are shown in Table 6. Old fields and

Table 3. Percentage of radio-locations of prelaying and laying hens for 15 April-14 May by cover type and year, Avon study area, New York.

Cover type	1979[a]	1980[b]	P[c]
Old field	31[d] (10-77)[e]	33 (0-83)	0.98
Strip cover	4 (0-12)	14 (0-27)	0.04
Shrubland	22 (0-61)	9 (0-100)	0.16
Hay	7 (0-25)	6 (0-67)	0.82
Small-grain stubble	4 (0-22)	7 (0-44)	0.77
Corn stubble	22 (0-55)	12 (0-29)	0.46
Plowed	4 (0-67)	5 (0-28)	1.00
Woodland	3 (0-16)	5 (0-33)	1.00
Others	4[f]	10[g]	

[a] N hens = 13, N locations = 213.
[b] N hens = 19, N locations = 304.
[c] Kolmogorov-Smirnov 2-sample tests comparing 1979 distribution of individual hens vs. 1980 distribution.
[d] Percent of total locations for all hens combined (weighted mean).
[e] Range for individual hens.
[f] Pasture (2%), wheat (1%), residence (1%).
[g] Pasture (2%), wheat (1%), residence (3%), others (4%).

Table 4. Percentage of radio-locations of prelaying and laying hens for 15 May-14 June by cover type and year, Avon study area, New York.

Cover type	1979[a]	1980[b]	P[c]
Old field	10[d] (0-19)[e]	25 (0-70)	0.07
Strip cover	7 (0-16)	12 (0-25)	0.87
Shrubland	3 (0-11)	7 (0-27)	1.00
Hay	21 (0-39)	14 (0-55)	0.83
Pasture	2 (0-7)	10 (0-41)	1.00
Wheat	19 (0-93)	4 (0-26)	0.78
Corn stubble	16 (0-38)	5 (0-83)	0.83
Plowed	9 (0-28)	11 (0-27)	0.32
Corn	5 (0-100)	7 (0-36)	1.00
Others	8[f]	5[g]	

[a] N hens = 6, N locations = 209.
[b] N hens = 11, N locations = 273.
[c] Kolmogorov-Smirnov 2-sample tests comparing 1979 distribution of individual hens vs. 1980 distribution.
[d] Percent of total locations for all hens combined (weighted mean).
[e] Range for individual hens.
[f] Oats (2%), small-grain stubble (1%), beans and potatoes (1%), woodland (1%), residence (1%), others (2%).
[g] Oats (3%), beans and potatoes (1%), residence (1%).

Table 5. Percentage of radio-locations of prelaying and laying hens for 15 June-21 July by cover type and year, Avon study area, New York.

Cover type	1979[a]	1980[b]	P[c]
Old field	34[d] (0-67)[e]	29 (0-47)	0.66
Strip cover	4 (0-11)	13 (0-29)	0.40
Shrubland	10 (0-45)	8 (0-24)	1.00
Hay	6 (0-20)	15 (0-53)	0.40
Oats	8 (0-55)	6 (0-37)	1.00
Corn	20 (0-43)	13 (0-50)	0.66
Beans and potatoes	4 (0-29)	7 (0-19)	1.00
Residence	1 (0-5)	6 (0-11)	0.86
Others	13[f]	4[g]	

[a] N hens = 7, N locations = 201.
[b] N hens = 6, N locations = 180.
[c] Kolmogorov-Smirnov 2-sample tests comparing 1979 distribution of individual hens vs. 1980 distribution.
[d] Percent of total locations for all hens combined (weighted mean).
[e] Range for individual hens.
[f] Pasture (1%), wheat (3%), plowed (3%), woodland (1%), others (5%).
[g] Pasture (2%), wheat (2%).

Table 6. Cover type preference/avoidance by prelaying and laying hens for different seasonal periods, 1979 and 1980, Avon study area, New York.[a]

Cover type	15 Apr - 14 May	15 May - 14 Jun	15 Jun - 21 Jul
Old field	P*	P*	P*
Strip cover	P*	P*	P*
Shrubland	P*	N	P*
Hay	A*	P*	N
Pasture	N	P*	N
Wheat	A*	N	A*
Oats	N	N	N
Small-grain stubble	N	N	
Corn stubble	N	P*	
Plowed	A*	A*	N
Corn	N	A*	A*
Beans and potatoes	N	N	N
Woodland	A*	A*	A*
Residence	A*	A*	A*
Others	N	N	N

[a] P = preference, A = avoidance, N = neutral, chi-square 1-sample tests were used to determine significance of difference between observed number of locations (from Tables 3, 4 and 5) and expected number of locations (based on percentage of total area from Table 1) for each cover type.

* $P \leq 0.001$ (1 df).

strip cover were preferred over all time periods. Preferences were indicated during portions of the nesting season for shrubland (15 April-14 May and 15 June-21 July), and hay, pasture, and corn stubble (15 May-14 June). Woodland and residence were avoided over all periods. Use was less than expected for corn (15 May-21 July); plowed (15 April-14 June); wheat (15 April-14 May and 15 June-21 July); and hay (15 April-14 May). Use did not differ from availability during any seasonal period for oats, small-grain stubble, beans, potatoes, and others.

Diurnal Patterns. Vegetation characteristics of plots used by prelaying and laying hens for different daily time periods are shown in Fig. 3. Differences among time-of-day periods were found for percent herbaceous cover, percent

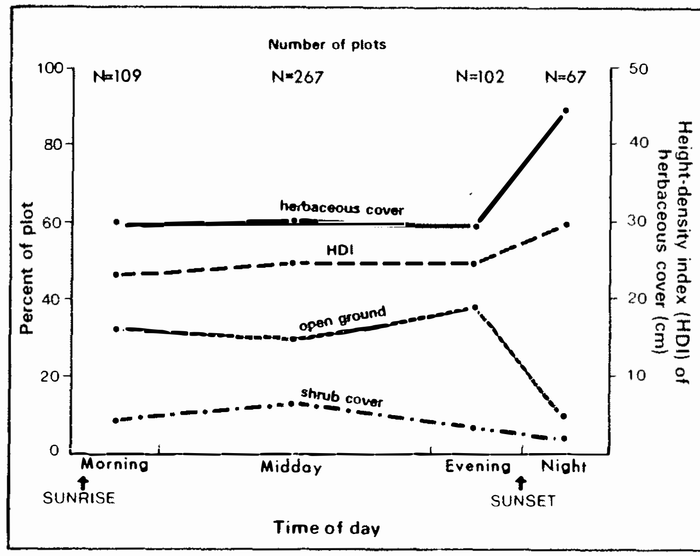

FIGURE 3. Vegetative characteristics of habitat used by prelaying and laying hens during diurnal periods.

Table 7. Percentage of radio-locations of prelaying and laying hens by cover type and diurnal period, Avon study area, New York.

Cover type	Morning[a] 0515-0816	Midday[b] 0817-1720	Evening[c] 1721-2022	Night[d] 2023-2324	P[e]
Old field	27 [f]	25	26	39	0.66
Strip cover	9	11	8	5	0.01
Shrubland	8	12	7	7	0.16
Hay	10	9	10	26	0.15
Pasture	4	3	4	3	0.73
Wheat	5	5	4	6	0.92
Oats	3	3	2	1	0.38
Small-grain stubble	1	2	3	3	0.68
Corn stubble	10	10	11	2	0.00
Plowed	6	6	9	1	0.00
Corn	9	7	8	2	0.09
Beans and potatoes	3	2	2	2	0.66
Woodland	1	2	2	0	0.00
Residence	2	2	3	1	0.06
Others	3	2	2	1	0.40

[a] $\bar{N}$ hens = 29, $\bar{N}$ locations = 279.
[b] $\bar{N}$ hens = 32, $\bar{N}$ locations = 687.
[c] $\bar{N}$ hens = 31, $\bar{N}$ locations = 263.
[d] $\bar{N}$ hens = 28, $\bar{N}$ locations = 152.
[e] Kruskall-Wallis 1-way ANOVA tests comparing ranks for individual hens among the 4 time-of-day periods.
[f] Percent of total locations for all hens combined (weighted mean).

shrub cover, and percent open ground ($P < 0.01$). No differences in amount of herbaceous cover were evident on plots used during daytime periods (mean = 60%); but herbaceous cover was significantly greater on plots used at night (mean = 89%; $P \leq 0.05$). HDI of herbaceous cover followed a similar pattern (daytime mean = 24 cm, night = 29 cm), but the differences were not significant ($P = 0.43$). Sites selected by hens at midday had higher percent shrub cover (13%) than night time locations (4%), and daytime sites had higher percent open ground (32%) than night time locations (9%) ($P \leq 0.05$). In general hens roosted in herbaceous vegetation with higher HDI's and away from edges with open ground and shrubby vegetation. During morning and evening courtship and feeding periods, more open habitats were selected. Midday plots were similar to morning and evening plots, but had increased shrub cover.

Significant differences in cover type use among daily time periods were found for corn stubble, plowed, strip cover, and woods ($P \leq 0.01$; Table 7). In general, when cover types were grouped on similarity of ground cover characteristics, 3 patterns emerged:

(1) Dense stands of herbaceous vegetation (e.g., old field and hay) received fairly constant use throughout the day, with a noticeable (but insignificant) increase at night.

(2) Open ground (e.g., corn, corn stubble, and plowed) were used most during morning and evening, at slightly lower levels in midday, and at significantly lower levels at night ($P \leq 0.05$).

(3) Cover types with a shrub component (e.g. shrubland, strip cover, and woodland) had the highest use during midday. Night period use was lowest for strip cover and woodland ($P \leq 0.05$). Nighttime use of shrubland was not significantly different from other time periods, probably because of a herbaceous cover component which makes it suitable for roosting.

Nest Site Selection and Nest Success. Cover types used for nesting were similar to the herbaceous cover types frequented most during each of the seasonal time periods (Table 8). No major differences between years were demonstrated. All first-nests were established between 13 April and 11 May. Of 23 nests established between 13 April and 14 May, 19 (83%) were in old fields. The residual herbaceous cover on old fields may account for early nesting. Strong stemmed grasses, such as orchardgrass and timothy, were most important components. Bluegrass, quackgrass (*Agropyron repens*), and reed canarygrass (*Phalaris arundinacea*) also provided nesting cover. From 15 May-14 June, 16 nests were located in a greater variety of cover types including 3 (19%) each in old fields, hay, wheat, and shrubland. Four (25%) were in strip cover comprised of herbaceous covered ditchbanks. From 15 June-14 July, 8 of 11 nests were established in old fields. Oats, shrubland, and others each contained 1 nest. Sixty percent of all nests were in old fields, and 10% each in hay and shrubland.

The value of old fields as a pheasant producing cover type is demonstrated in Table 8. Old field nest success was 63.3%. This characteristic, coupled with its full-season availability and preferred use resulted in 19 of 28 hatched clutches (68%) being located in old fields. Three hatched clutches were in shrubland, 2 in wheat, and 1 each in hay, oats, strip cover, and woodland. Two of 4 hay field nests were disrupted during the first mowing of hay.

Dumke and Pils (1979) found similar trends in nesting phenology and seasonal cover type usage for nest establishment by Wisconsin pheasants. All first nests in their 4 year study were initiated between 6 April and 24 May. Retired cropland and wetlands (perhaps similar to old field and shrubland of this study) contained over 50% of nests during all months of the nesting season. Nest success in

Table 8. Number of pheasant nests and nest success (N hatched) by cover type and period of establishment, Avon study area, New York, 1979 and 1980.

Cover type	13 Apr-14 May		15 May-14 Jun		15 Jun-14 Jul		Total	
	N nests	N hatched	N nests	N hatched	N nests	N hatched	N nests	N hatched
Old field	19	11	3	2	8	6	30	19
Hay	2	1	3	0	0	0	5	1
Wheat	0	0	3	2	0	0	3	2
Oats	0	0	0	0	1	1	1	1
Strip cover	0	0	4	1	0	0	4	1
Shrubland	1	0	3	2	1	1	5	3
Others	1[a]	1	0	0	1[b]	0	2	1
Total	23[c]	13	16	7	11	8	50[c]	28

[a] Nest in woodland.
[b] Nest in disturbed vegetation along a highway construction site.
[c] Five additional nests were documented from radio-data, but due to early nest disruption the cover type was not determined.

these cover types was 34% vs. 63% in our study where 60% of all successful nests were found in old fields. Hay field nesting was higher in their study, with 19% of 6 April-15 May and 27% of 16 May-15 June nests established there vs. 7% and 19%, respectively, at Avon.

Due to the low level of nesting in hay at Avon, only 2 of 55 total nests were destroyed by mowing.

Habitat Use by Broodrearing Hens

Old fields contained 43% of all brood-rearing hen locations (Table 9). Substantial use was also recorded in hay (15%) and shrubland (11%). Wheat (9%), strip cover, and corn (each 6%) were less important. In relation to availability, old fields, strip cover, shrubland, and hay were preferred ($P < 0.001$). All other cover types were avoided ($P < 0.001$), except wheat, small-grain stubble and corn stubble, for which there were no differences.

Brood Age-Related Patterns. Average values for plot vegetation

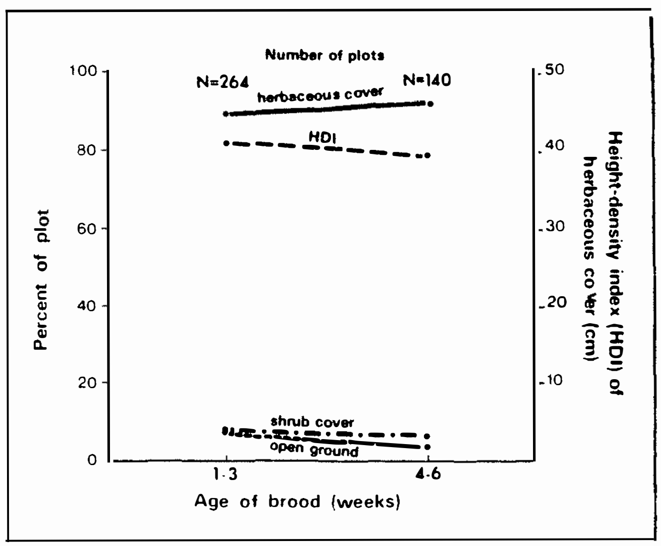

FIGURE 4. Vegetative characteristics of habitat used by hens with broods of different ages.

characteristics of different aged broods are found in Fig. 4. Values for percent herbaceous cover, HDI, percent shrub cover, and percent open ground did not vary between age-classes ($P \geq 0.49$). Herbaceous cover with large HDI's dominated the plots (means = 91% and 40 cm, respectively).

Table 9. Use and preference/avoidance of cover types by brood-rearing hens during 1979 and 1980, Avon study area, New York.

Cover type	Locations (N) Observed	Expected[a]	X^2
Old field	484	81	2162.3*
Strip cover	70	11	319.6*
Shrubland	121	56	79.4*
Hay	167	130	11.9*
Pasture	26	48	10.5*
Wheat	98	76	6.8
Oats	13	42	20.8*
Small-grain stubble	21	22	0.0
Corn stubble	0	7	7.0
Plowed	5	86	83.0*
Corn	64	276	216.5*
Beans and potatoes	24	54	17.5*
Woodland	4	102	103.6*
Residence	13	94	76.2*
Others	4	29	22.1*
Total	1114	1114	

[a] Expected number of locations was obtained by multiplying the average percentage of available area (from the last 3 columns of Table 1) of each cover type by the total number of observed locations.

* $P < 0.001$ (chi-square 1-sample test, 1 df).

Table 10. Percentage of radio-locations of hens with broods 1-3 weeks old by cover type and year, Avon study area, New York.

Cover type	1979[a]	1980[b]	P[c]
Old field	42[d] (0-85)[e]	45 (0-95)	0.89
Strip cover	6 (0-30)	6 (0-22)	0.40
Shrubland	19 (0-71)	7 (0-46)	0.74
Hay	16 (0-85)	13 (0-79)	1.00
Wheat	4 (0-21)	18 (0-98)	0.99
Corn	2 (0-4)	5 (0-65)	0.99
Others	11[f]	6[g]	

[a] N hens = 8, N locations = 297

[b] N hens = 10, N locations = 420

[c] Kolmogorov-Smirnov 2-sample tests comparing 1979 distribution of individual hens vs. 1980 distribution.

[d] Percent of total locations for all hens combined (weighted mean).

[e] Range for individual hens.

[f] Oats (1%), small-grain stubble (3%), beans and potatoes (4%), plowed (1%), residence (2%).

[g] Pasture (4%), oats (1%), woodland (1%).

Table 11. Percentage of radio-locations of hens with broods 4-6 weeks old by cover type and year, Avon study area, New York.

Cover type	1979[a]	1980[b]	$\underline{P}$[c]
Old field	58[d] (0-83)[e]	32 (0-76)	0.64
Strip cover	6 (0-14)	10 (0-33)	0.49
Shrubland	18 (0-84)	3 (0-24)	0.97
Hay	3 (0-12)	25 (0-93)	0.78
Wheat	0	5 (0-42)	1.00
Small-grain stubble	1 (0-5)	5 (0-35)	1.00
Corn	8 (0-20)	11 (0-21)	1.00
Others	6[f]	9[g]	

[a] $\underline{N}$ hens = 5, $\underline{N}$ locations = 160.

[b] $\underline{N}$ hens = 8, $\underline{N}$ locations = 237.

[c] Kolmogorov-Smirnov 2-sample tests comparing 1979 distribution of individual hens vs. 1980 distribution.

[d] Percent of total locations for all hens combined (weighted mean).

[e] Range for individual hens.

[f] Pasture (1%), oats (1%), beans and potatoes (2%), residence (1%), others (1%).

[g] Pasture (3%), oats (3%), plowed (3%), beans and potatoes (1%), residence (1%).

Eighteen hens that produced 22 broods provided data for the 1-3 weeks age-class (Table 10). Old field (mean = 44%) was the most used cover type. Also important were hay (mean = 14%), wheat (mean = 12%), shrubland (mean = 12%), and strip cover (mean = 6%). The extreme ranges in use for old field, hay, wheat, and shrubland indicate strong preferences by individual hens for each of these cover types.

Plant species diversity within wheat fields appeared to affect use of these fields. Two hens encountered wheat each year. In 1979, 1 brood produced in wheat, spent 67% of its time in a 1 ha old field located in 1 corner of the wheat field (2-6 July). After a hay field it had been using was mowed (19 July) a second brood moved into a wheat field briefly, before moving and staying in an old field. In 1980, a brood produced in wheat spent 98% of its time there (14-29 July). A second brood, produced in shrubland, moved into a wheat field and was there 73% of its time (7-15 July). Old fields were within 100 m of the nests in both cases. A factor that could account for the apparent difference in use was that portions of the fields used in 1980 contained more weeds. The first field had a dense understory of annual weeds, primarily common ragweed, _Ambrosia artemisifolia_. In comparison, the wheat fields encountered by broods in 1979 were dry and relatively weed-free. Insects, which are the major food source of young chicks (Hill 1976), may have been more abundant in the green weeds found in the wheat.

Hens with broods 4-6 weeks old were found most often in old fields (mean = 42%), hay (mean = 16%), and corn (mean = 10%) (Table 11). Shrubland and strip cover were also important. Of 13 hens, 7 spent most time in old fields, 3 in hay, 1 each in shrubland and wheat, and 1 spent equal time in oats and pasture.

The only significant difference in cover type usage between age classes was the increased use of corn for 4-6 week-old broods (P = 0.01). Only 1 of 18 broods 1-3 weeks old used corn ≥10% of the time, vs. 7 of 13 broods 4-6 weeks old. Warner (1979) reported increased use of row crops after broods reached 6-7 weeks of age.

Boyd and Richmond (1980) indicated that use of hay fields decreased as brood age increased. Re-examination of the data shows that the 2 hens with young broods associated with hay in 1979 had changed their use of cover type due to mowing or renesting. In 1980, 2 hens that did not renest and were not associated with disturbed hay fields, exhibited opposite trends in hay field use based on the age-class of the brood. One spent more time in hay with 4-6 week-old chicks (46%) than with 1-3 week-old chicks (2%). The other demonstrated the opposite trend (79%, 1-3 weeks vs. 49%, 4-6 weeks). Hence, differential use of hay was questionable for broods of the ages studied. Warner (1979) found hay field use to decrease after broods were 6 weeks of age.

Only 1 of 2 hens using wheat consistently was studied with both age-classes of broods. Although decreased use was demonstrated (98%, 1-3 weeks vs. 42%, 4-6 weeks), brood age was probably not the important factor. The wheat was harvested when the brood was 4 weeks old, and the hen remained in the newly established wheat stubble.

In relation to cover type availability, few differences in cover type preference were found between age classes (Table 12).

Diurnal Patterns. Overall, the data indicated that hens with broods of the ages studied did not select different habitats with respect to time-of-day. The high use (up to 98%) of single cover types by individual hens (Tables 10 and 11) lend support to this conclusion. Warner (1979) came to a similar conclusion for 1-10 week old broods in Illinois. However, he did find an increase in row crop use during afternoon, with a corresponding decrease in the use of strip cover. Hay and oats were used most at night. Hammer (1973) found that broods in Nebraska, studied from 19 July to 22 October, used hay, pasture, and wheat stubble primarily for roosting, and grain sorghum (structurally similar to corn) during morning and midday. Both of these studies were conducted later in the summer and included more data from older broods than the present study.

Only the percent shrub cover varied among time-of-day locations (P = 0.01). It was higher during midday (8%) than at night (3%) (P ≤0.05) (Fig. 6). The percent open ground had a similar trend, but differences among periods were not significant (P = 0.09). Herbaceous cover with large HDI's dominated the plots, without significant differences among time-of-day periods (P = 0.07 and 0.81, respectively) (Fig. 5).

Time-of-day trends in cover type usage are found in Table 13. No

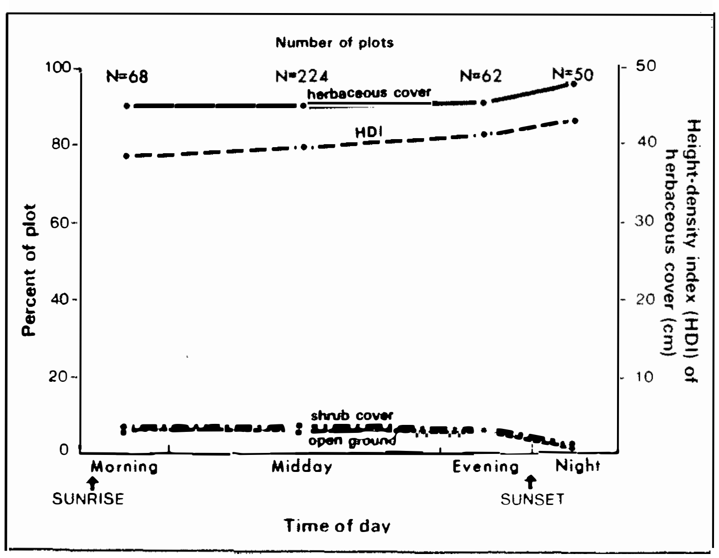

FIGURE 5. Vegetative characteristics of habitat used by broodrearing hens during diurnal periods.

Table 12. Cover type preference/avoidance by brood-rearing hens for different brood ages, 1979 and 1980, Avon study area, New York.[a]

Cover type	1-3 weeks	4-6 weeks
Old field	P*	P*
Strip cover	P*	P*
Shrubland	P*	P*
Hay	N	N
Pasture	N	N
Wheat	P*	N
Oats	A*	N
Small-grain stubble	N	N
Plowed	A*	A*
Corn	A*	A*
Beans and potatoes	N	N
Woodland	A*	A*
Residence	A*	A*
Others	A*	N

[a] P = preference, A = avoidance, N = neutral, Chi-square 1-sample tests were used to determine significance of difference between observed number of locations (from Tables 10 and 11) and expected number of locations (based on average percentage of available area from the last 3 columns of Table 1) for each cover type.

* $\underline{P} \leq 0.001$ (1df).

differences among time periods were detected ($\underline{P} \geq 0.06$).

CONCLUSIONS

Important habitat components for reproduction of a pheasant population in New York were determined by considering hen pheasant habitat use in relation to year, season, time-of-day, reproductive stage, nest site selection, nest success, and vegetation availability.

Habitat Use

Prelaying and laying hens used a more diverse association of vegetation types than did brood-rearing hens. Courtship and feeding activities of prelaying and laying hens were associated with open ground, primarily during morning and evening. Herbaceous vegetation and/or shrubs provided cover during daylight hours and herbaceous vegetation was particularly important for nesting and night roosting. Shrubs were important for midday cover, particularly in the early nesting season when the cover value of herbaceous vegetation was low. Hens with broods 1-6 weeks of age used mainly herbaceous cover.

Old fields, strip cover, and shrubland were the most preferred cover types. Overall, these cover types occurred on 13% of the study area and contained 52% of 2,495 radio-locations. Old fields and strip cover were preferred during all reproductive stages and periods of the nesting season. Shrubland also was

Table 13. Percentage of locations of brood-rearing hens by cover type and diurnal period, Avon study area, New York.

Cover type	Morning[a] 0515-0816	Midday[b] 0817-1720	Evening[c] 1721-2022	Night[d] 2023-2324	P[e]
Old field	45[f]	43	41	49	0.82
Strip cover	8	6	6	4	0.22
Shrubland	10	12	12	5	0.69
Hay	15	14	16	21	0.97
Pasture	2	3	2	3	0.11
Wheat	9	9	10	8	0.88
Oats	2	1	1	3	0.83
Small-grained stubble	1	2	2	1	0.75
Plowed	1	0	1	1	1.00
Corn	5	7	5	4	0.06
Beans potatoes	3	2	2	1	0.80
Woodland	1	0	0	0	0.57
Residence	1	1	1	1	0.60
Others	0	1	0	0	0.30

[a] N hens = 18, N locations = 198.
[b] N hens = 18, N locations = 627.
[c] N hens = 18, N locations = 185.
[d] N hens = 18, N locations = 104.
[e] Kruskall-Wallis 1-way ANOVA tests comparing ranks for individual hens among the 4 time-of-day periods.
[f] Percent of total locations for all hens combined (weighted mean).

preferred except during the middle third of the nesting season. Old fields were preferred for nesting throughout the nesting season and contained 68% of all hatched clutches. Strip cover and shrubland were not as important for brood production, being used most as nesting cover only during the middle third of the nesting season. Also, nest success in strip cover was low. Together, shrubland and strip cover contained 14% of all hatched clutches.

Hay and wheat were important habitat components during specific periods, but were preferred only in the middle third of the nesting season when most renesting occurred. These cover types occupied 19% of the area, contained 16% of all locations, 16% of all nests, and 8% of all hatched clutches. Both cover types were strongly preferred by some hens with young broods. The value of hay was limited by mowing. First-mowing of hay coincided with peak incubation and brood-rearing periods in that cover type. Robeson (1957), Hartman and Sheffer (1971), Gates and Hale (1975) and many others have documented that hay mowing is an important limiting factor in pheasant reproduction. However, during our study only 2 of 55 nests and 1 of 28 young broods were destroyed during hay mowing. Hence, it appears that hay mowing was not significantly limiting pheasant populations at Avon during our study.

Corn stubble, presumably as a food source, received preferential use during the first two-thirds of the nesting season. Pastures, if lightly grazed, were used by prelaying and laying hens and hens with broods, but no nests were established there.

Cover provided in oat fields was preferred only in the last third of the nesting season. One nest was found in oats and the field was used heavily by the brood that was produced there.

Plowed, corn, woodland, and residence cover types were avoided. However, plowed and corn cover types were used to some extent by prelaying and laying hens, and corn by hens with older broods. Woodland and residence, which comprised 18% of the study area, were seldom used. Essentially, their area represents a rough measure of the amount of non-pheasant habitat that exists at Avon.

MANAGEMENT IMPLICATIONS

Maintaining or increasing the quality and quantity of old fields, strip cover, and shrubland should be the highest priority for improving spring and summer pheasant habitat. Old fields and hedgerows currently are decreasing in availability at Avon due to rural housing construction and intensification of agricultural practices. Old field area decreased almost 13% in 1979 alone (Slingerland 1980b).

Quality of old fields, particularly those that are old enough to be bordering on shrubland classification, could be improved by adding a strong-stemmed perennial grass component to increase the amount of early spring residual cover available for nesting and roosting. Orchardgrass, timothy and reed canarygrass were used heavily for these activities by radio-tagged hens and should be considered in the plantings.

An increase in the availability of old field habitat may be best achieved by retiring hay fields. However, further research is needed to determine the best species composition of these fields in terms of establishment costs and stand longevity. Consideration should also be given to field size and its juxtaposition with other important cover types.

To reduce the possibility of destroying hens, nests and young broods, hay mowing should occur no earlier than 1 July and preferably not until 15 July. An increase in weedy wheat acreage and a decrease in hay acreage may improve the chances of renesting success in areas where delayed hay mowing is impractical.

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COMPARISON OF TECHNIQUES USED TO MEASURE PHEASANT PRODUCTIVITY IN WESTERN NEW YORK

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Abstract: Four survey techniques for measuring pheasant productivity are compared: (1) a mail survey of farmers' observations of nests and broods, (2) a road survey of adult birds and broods, (3) observed productivity of radio-marked hens, and (4) age ratios derived from legs of harvested cocks. Productivity indices derived from these surveys were correlated with each other as well as with population densities and hunter success rates. The farmer and road surveys proved to be accurate predictors of population trends and hunting success. The leg survey and radio-tracking produced comparable measures of net productivity. The relationship of these surveys to each other and their relative advantages and disadvantages for pheasant management in New York is discussed.

A sharp decline of the wild ring-necked pheasant (*Phasianus colchicus*) population in the Ontario Lake Plains region of western New York ~~occurred~~ during the 1970's. In response to pressure from organized sportsmen and our own concern, we expanded our pheasant research and management activities in 1975. This program became formalized in 1979 with the adoption of a "Long Range Ring-Necked Pheasant Management Plan" by the New York Division of Fish and Wildlife. One program objective was the development and evaluation of pheasant population monitoring techniques. Most surveys we used measured some aspect of pheasant productivity; all but one produced index values. That one, radio-tracking, attempted to actually measure net productivity.

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STUDY AREA

New York primary pheasant range, an area of about 21,000 km^2, is located in a portion of the Ontario Lake Plains. It covers 101 towns in portions of 13 counties between the cities of Buffalo and Syracuse. Intensive radio-tracking research was conducted on the Avon Study Area which is in the center of this range just south of Rochester.

The Ontario Lake Plains is the principal grain producing area of New

York. Land use in the Avon Study Area is typical of much of the Lake Plains. In the summer of 1982, 70% of the land area was cultivated -- corn (31%), small grains (18%), hay (12%), and other crops (9%). The non-cultivated land use was woodland (9%), fallow or old fields (6%), brush (5%), residential (9%), and miscellaneous (1%).

METHODS

Survey Techniques

Four surveys were employed which together provided a total of 8 indices of pheasant productivity (Table 1; surveys 1-4). In addition, a hunter success index and winter population density were obtained (Table 1; surveys 5 and 6). A brief description of each follows:

Radio-Tracking. An estimate of net productivity was obtained from observations of 10 to 14 hens annually. Birds were intensively radio-tracked during 4 nesting seasons on the Avon Study Area. Telemetry procedures have been described (B. Penrod, unpubl. final rep. New York Fed. Aid Proj. W-81-R-30, Job III-5, 20 pp, 1983).

Leg Collection. Legs from wild cock birds have been collected from hunters through both mail surveys and personal contact. Between 150-450 legs were collected annually, most from the 13 county Lake Plains area, except 1976 and 1977 when only 2 counties (Livingston and Niagara) were sampled. Legs were aged using spur criteria (Taber 1969). A sample of these legs were also aged by leg sectioning (Stone and Morris 1981). Agreement between the 2 techniques was

Table 1. Description of pheasant surveys and their respective indices, Livingston County and Ontario Lake Plains, New York.[a]

Survey	Period	Indices used
1. Radio tracking	1979-82	Chicks at 3 weeks/hen alive in spring
2. Leg collection	1975-82	Juvenile males/adult male
3. Farmer inventory	1975-82	Broods/observer Nests/observer
4. Road survey	1976-80	Broods/100 km Adult hens/100 km All age birds/100 km Average brood size
5. Hunter survey	1976-82	Males shot/hunter/season
6. Winter census	1976-82[b]	Birds/km^2

[a] All surveys were employed in Livingston County; only the leg collection, farmer inventory, and hunter survey were used in the Ontario Lake Plains region.

[b] Winter periods 1976-77 to 1982-83.

94.2% overall for both juveniles and adults. State game farm reared pheasants and day old chicks distributed to cooperators were eliminated from the sample by the presence of leg bands and toe-marks, respectively. Private farm-reared birds were not marked but most of those were released on shooting preserves, which were not sampled.

Farmer Inventory. This survey of farmers originated in 1945 as a means of indexing pheasant population trends in our primary ranges. It is the only long-term pheasant population survey we have. The survey has been conducted twice a year -- spring and summer. The 2 indices reported here are from the summer surveys. About 1000 farmers from townships in the primary range are presently cooperating; approximately 10 farmers/township.

Road Survey. A summer brood survey was conducted in the Avon Study Area from about 1 July to 15 August. There were 8 replications of 1 route in 1976, and from 1977-80, 20 to 60 replications were made on 2 to 4 routes each summer, based on Wooley et al. (1978) procedures for August Roadside Routes. All broods and hens observed from the road were flushed. Results of this survey were reported by Austin (1982; unpubl. Final Report, New York Fed. Aid Proj. W-81-R-29, Job III-9, pp 1-7, mimeo).

Hunter Mail Survey. An estimate of hunting success has been obtained annually since 1976. About 1000-1500 pheasant hunters have responded to this survey from the Lake Plains region each year.

Winter Census. A count of wintering pheasants was made annually in December or January except for 1976 when it was made in March of 1977. About 10.1 km^2 in the Avon Study Area were searched by crews of men and dogs during periods of snow cover. An estimate of the total number of birds present was based on the combination of flushes and track counts. To calculate density, 85% of the land area searched was considered to be pheasant range (10.1 km^2 x 0.85 = 8.6 km^2).

Survey Comparisons

A correlation coefficient, r, was calculated for each pair of indices with 3 or more years of concurrent data (Table 2). We could not compare the radio-tracking with the road survey indices, since they were concurrent only 2 years. The r values were arranged in 2 matrices, 1 for data collected over the entire Ontario Lake Plains and 1 for data collected from all of Livingston County and the Avon Study Area. Remaining evaluations of the productivity techniques were of a more subjective nature.

RESULTS AND DISCUSSION

Calculated r values for the Ontario Lake Plains data are shown in Table 3; those for Livingston County and the Avon Study Area data are in Table 4. These are evaluated along with other factors for each of the 4 productivity surveys.

Radio-Tracking. One of the greatest values of radio-tracking hen pheasants, despite the high cost ($60,000 annually), was our ability to relate natality and mortality to habitat condition (B. Penrod, unpubl. final rep. New York Fed. Aid Proj. W-81-R-32, Job III-13, in prep., 1984). We obtained measures of most reproductive parameters (except poult survival after 3 weeks) and hen mortality rates. This measure of net productivity was significantly correlated with fall age ratios (r=0.966, $P<0.01$), which lends circumstantial support for our continued use of the fall leg collection to monitor pheasant productivity.

Leg Collection. This relatively inexpensive survey ($1300/year) can be easily accomplished through central mailing and applied to both large (rangewide) or small (county-sized)

Table 2. Ring-necked pheasant survey data, New York.

Index	Area[a]	1975	1976	1977	1978	1979	1980	1981	1982
Chicks/hen	ASA					1.8	4.5	2.8	0.4
Juv males/ad male	OLP	5.9	13.4	7.1	2.6	3.8	6.5	5.5	3.5
Juv males/ad male	LC	4.2	11.3	7.5	2.2	3.7	4.6	4.3	3.5
Broods/observer	OLP	2.0	2.0	1.2	0.5	0.4	0.9	1.2	1.0
Broods/observer	LC	1.5	3.4	1.8	0.8	0.6	1.3	1.1	1.7
Nests/observer	OLP	1.8	1.3	0.9	0.4	0.3	0.5	0.8	0.9
Nests/observer	LC	1.6	1.6	1.6	0.9	0.4	1.0	1.1	1.3
Ad females/100 km	ASA		8.1	3.7	1.9	1.2	1.2		
Broods/100 km	ASA		12.4	2.5	1.9	1.2	1.2		
Birds/100 km	ASA		96.3	22.4	22.4	11.8	6.8		
Avg. brood size	ASA		7.0	3.9	7.1	6.3	5.8		
Males shot/hunter	OLP		1.0	0.8	0.5	0.5	0.6	0.6	0.5
Males shot/hunter	LC		1.7	1.3	0.8	0.6	0.9	0.7	0.7
Birds/km^2	ASA		25.1	17.0	12.4	10.8	12.0	10.4	6.6

[a] ASA-Avon Study Area, LC-Livingston County, OLP-Ontario Lake Plains.

areas. Some of the significant *r* values we found, appear to have limited value. For instance, the high correlation with hunter success *r*=0.959 for Lake Plains, *r*=0.946 for Avon Study Area and Livingston County) cannot be used to predict hunter success prior to the season; it may be used to explain changes in hunter success after the season. The most significant finding was the apparent agreement with the radio-tracking survey as an annual index to productivity. We recognize there are potential biases due to the possible presence of farm-reared birds in the harvest and to the differential hunting mortality of adults and juveniles. The survey is not as useful for sampling a local population, particularly at low harvest or population levels because obtaining an adequate number of legs is difficult.

Farmer Inventory. Like the previous survey, this survey is relatively inexpensive ($1300/year), can be handled by centralized mailing, and is applicable on either a rangewide or county basis. The high positive correlation between hunter success and broods/observer (*r* = 0.893 for Lake Plains, *r* = 0.897 for Avon Study Area and Livingston County) has allowed us to predict hunter success in a timely fashion via news releases prior to the

Table 3. Pheasant survey data correlation matrix, Ontario Lake Plains.

Correlation coefficients (r)

	Juv males/ad male (6 df)	Broods/observer (6 df)	Nests/observer (6 df)
Broods/observer (6 df)	0.733*		
Nests/observer (6 df)	0.490	0.944**	
Males shot/hunter (5 df)	0.959**	0.893**	0.805*

* $P < 0.05$.

** $P < 0.01$.

Table 4. Pheasant survey data correlation matrix, Avon Study Area and Livingston County data.

Correlation coefficients (r)

	Chicks/hen (2 df)	Juv males/ad male (6 df)	Broods/observer (6 df)	Nests/observer (6 df)	Ad females/100 km (3 df)	Broods/100 km (3 df)	Birds/100 km (3 df)	Avg brood size (3 df)	Males shot/hunter (3 df)
Juv males/ad male (6 df)	0.966*								
Broods/observer (6 df)	-0.200	0.905**							
Nests/observer (6 df)	-0.102	0.590	0.742*						
Ad females/100 km (3 df)		0.931*	0.963**	0.767					
Broods/100 km (3 df)		0.872	0.934*	0.622	0.969**				
Birds/100 km (3 df)		0.842	0.911*	0.615	0.969**	0.995**			
Avg brood size (3 df)		-0.130	0.045	-0.362	0.147	0.359	0.383		
Males shot/hunter (3 df)	0.741	0.946**	0.897**	0.768*	0.944*	0.862	0.850	-0.112	
Birds/km^2 (5 df)	0.884	0.912**	0.789*	0.555	0.995**	0.952*	0.947*	0.076	0.949**

* $P < 0.05$.

** $P < 0.01$.

season. This finding applies to both the entire Lake Plains and Livingston County. Some of the data from Livingston County correlated significantly ($\underline{P} < 0.05$) with the road survey data, and also with the winter census (Table 4). One disadvantage with the former survey is an observer bias. We know farmers report (spring survey) fewer hens than are in the population and suspect they report fewer broods and nests also. Also, we periodically must contact new landowners to maintain our sample size which consumes about 1 man-day for every 10-15 farmers contacted.

Road Survey. The road survey cost was about $4400 year. We found high correlations of road survey indices with hunter success and winter densities. Of the 4 road survey indices, the adult hen index provided the strongest correlations. Average brood size was not significantly correlated to any of the other indices tested ($\underline{P} > 0.05$). The survey provided valuable circumstantial support for the observed double brooding of hens (Penrod et al. 1982). The technique, however, may miss young broods (usually those under 4 weeks of age) and late broods (those hatched after mid July). It is also labor intensive; the principal reason it was discontinued. At current low population levels that result in a high degree of variability the cost/benefit ratio is particularly high. However, the road survey may be useful in the future for measuring the productivity of local populations of pheasants.

CONCLUSIONS

The foregoing analysis supports our decision to continue the Farmer Inventory as a population index and a predictor of hunting success. The fall leg collection appears useful for monitoring trends in net productivity and will be continued. The effectiveness of any habitat management program could be measured by these surveys. Future habitat management proposals for pheasants will be based on results of the radio-tracking study.

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PHEASANT NESTING SUCCESS WITH DELAYED HAY MOWING IN PENNSYLVANIA: PRELIMINARY RESULTS[1]

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Abstract: Pheasant populations have declined in Pennsylvania. To demonstrate the effect that hay mowing has on pheasant nesting success, a 3-year program was initiated in 1981 in primary pheasant range. In this program, farmers were paid $35/acre to delay hay mowing until after 20 June and $50/acre not to mow. Most of the mowing delayed (DM) fields were timothy, red clover, brome grass, or mixtures. On the 6,070 ha study area, there were 95.1 ha of DM fields in 1971 and 148.9 ha in 1982. We compared pheasant nest density and nest success between DM fields and control fields which were mowed on a normal schedule. Both types of fields were searched intensively for nests. Nest success was 57% (1981) and 50% (1982) in DM fields, but 3.4% (1981) and 11.5% (1982) in control fields. If mowing is delayed until 27 June nest success might increase to 70-80%. The edge effect of nest location in hay fields was demonstrated.

[1]This paper presents the results from the first 2 years of a 3-year pilot study.

Since the mid 1970's, ring-necked pheasant (*Phasianus colchicus*) populations have decreased drastically in Pennsylvania. Field estimates suggest that some areas have experienced decreases of 60-90%. Statewide, hunter postal surveys show a 40% decrease in pheasant harvest from the early 1970's to 1982. Apparently these decreases have been precipitated by consecutive severe winters (1976-77 and 1977-78) which may have retarded reproductive efforts (Hartman 1976). Adverse winter weather, coupled with nesting conditions (e.g., hay mowing) that were more unfavorable than usual throughout the period, probably dealt the primary blow to pheasant populations. When roadkills, and changing land-use and farming practices (e.g., more corn and soybeans and less small grain) are added to weather and nesting conditions it seems the pheasants are surviving only due to their own innate ability to perpetuate.

Two examples from primary pheasant range in Pennsylvania demonstrate this decline. In October 1982, a fall roadside census was conducted under ideal census conditions on the Lebanon County study area. Only 1 cockbird was seen. In the 1960's and early 1970's, normally 50-130 pheasants would be counted. During the 1982-83 winter, a check of winter cover on the York County study area located 50 pheasants. In the past this same cover held 400-600 pheasants in the winter.

Previous pheasant studies (Hartman 1976), noted the importance of safe nesting cover for the perpetuation of pheasant populations. Management programs were designed to ensure safe/quality nesting cover (Hartman and Sheffer 1971). However, at that time pheasant populations were high and there was little interest in specific management programs. When ringneck numbers declined in the mid 1970's, concern for pheasant habitat management developed.

In 1981, the Pennsylvania Game Commission (PGC) began a 3 year pheasant nesting project to determine how much pheasant nesting success could be increased by delayed hay mowing. This paper reports the results of the first 2 years of that project.

We gratefully acknowledge the cooperation and participation of D. E. Sheffer, J. I. Sitlinger, and J. H. Doebling who provided necessary administrative guidance; S. Fletcher, C. Falco, L. Anderson, and the wildlife biologists, wildlife technicians, District game protectors, land management personnel, and Youth Conservation Corps people who walked the many miles in checking hay fields for nests; and E. Diehl who made the important contacts with landowners. Landowners provided the necessary partnership.

STUDY AREAS

This pilot project was undertaken on 2 types of landownership situations: (1) public State Game Land (SGL) in Berks County and (2) private land in Cumberland County. Both study areas are in primary pheasant range.

Berks County. This 499 ha study area (SGL #280) is located in southeastern Pennsylvania. The rolling terrain is contour farmed with corn, hay, and small grains as the main crops. Some idle land and brushy and wooded areas occur on the SGL. The control area is more intensively farmed private land that lies just to the west of the SGL. Idle land is less abundant and there are numerous wooded areas, especially on the ridges.

Cumberland County. This 6,070 ha study area is part of Farm Game Project #153 (FGP) in southcentral Pennsylvania. A FGP is a cooperative program between private landowners and the PGC. In this program, landowners agree to keep their land open to hunting and the PGC provides: law enforcement contacts, seedlings, a free subscription to the Pennsylvania Game News, and wildlife management advice and practices. This relatively level land is farmed intensively for corn, hay, small grains, and some soybeans. Most cover is in the form of fencerows, woodlots, and brushy-wooded areas on limestone outcrops.

The DM hayfields are scattered throughout the study area and range from 1.2 ha to 10.5 ha (avg. = 3.8 ha). Likewise, a similar number of control fields (hayfields with normal mowing schedules) are located throughout the study area.

Approximately 20% (1,218 ha) of the study area is hayfields. The DM fields comprise ±12% (about 150 ha) of the hay fields, and consist of either timothy/clover, timothy, brome, brome/timothy, red clover, or alfalfa. Although alfalfa is a common crop on the area, farmers preferred to put other types of hayfields into the program since the delay in mowing these crops is not as detrimental to their quality as it would be to alfalfa.

METHODS

Mowing operations on the SGL (Berks County) were controlled by PGC policy. In the first year (1981), sharecroppers could not mow hay until after 15 June. A longer delay was not possible because of contract arrangements. In 1982 contracts were renewed with a no hay mowing clause.

On the private land (Cumberland County), farmers were paid $35/acre to delay hay mowing in specific fields until after 20 June and $50 acre to not mow a field. Each year, $12,000 was allocated from the PGC fund to pay farmers. Because of a larger land base and greater potential benefits for wildlife (i.e., pheasants) on private land, our attention was focused on the private land study area.

Effects of delayed mowing were evaluated by searching control and DM hay fields for pheasant nests after mowing. This procedure made it easier to locate nests and to determine their fate. Nest searching was conducted from mid May to mid July. Both types of hay fields were checked as soon as possible after harvest. The fate of each nest and hen, along with other biological and habitat data, were recorded on forms and maps.

The nest data (e.g., hatched, destroyed by mowing) and fate of the hen were the principal criteria used in determining the effects of delayed mowing. Winter censuses were used as an additional source of data. In winter, pheasants concentrated in winter cover sites and populations are more accurately assessed.

RESULTS

Effects of Delayed Mowing

Berks County. The delay in hay mowing until after 15 June 1981 on the SGL study area resulted in slightly less nest destruction than on the control area, but similar hatching success (Table 1). Predation of clutches on the study area reduced nest success. More than 1/2 of the nesting hens on both areas were killed by mowing in 1981 (Table 1).

A check of hay fields on the control area in 1982 showed continued high nest destruction and hen mortality rates and a low pheasant nest hatching rate. Decreased nest density was also noted in 1982. This decrease may have resulted from delayed nesting and/or

Table 1. Pheasant nest search results for hayfields with mowing delayed until after 15 June (State Game Lands) and for hayfields with normal mowing schedules (control), Berks County, 1981 and 1982.

	State Game Lands[a]	Control	
	1981	1981	1982
Fields checked (N)	11	13	33
Area searched (ha)	19.2	32.0	118.2
Nests found (N)	11	10	29
Ha/nest	1.7	3.2	4.1
Nests destroyed by mowing (%)	81.8	90.0	96.6
Nests destroyed by predation (%)	9.1	0.0	0.0
Clutches hatched (%)	9.1	10.0	3.4
Nesting hens killed by mowing	62.5	55.6	42.9

[a] Delayed hay mowing was not practiced in 1982.

Table 2. Pheasant nest search results for hayfields with mowing delayed until after 20 June and hayfields with normal mowing schedules (control), Cumberland County, 1981 and 1982.

	Delayed Mowing		Control	
	1981	1982	1981	1982
Fields checked (N)	26	39	31	47
Area searched (ha)	95.1	148.9	111.3	165.1
Nests found (N)	30	20	58	26
Ha/nest	3.2	7.4	1.9	6.4
Nests destroyed by mowing (%)	30.0	20.0	94.8	88.5
Clutches hatched (%)	57.0	50.0	3.4	11.5
Nests destroyed by predation (%)	7.0	0.0	1.7	0.0
Nests Abandoned (%)	0.0	5.0	0.0	0.0
Nests fate unknown (%)	7.0	25.0	0.0	0.0
Nesting hens killed by mowing (%)	16.7	25.5	33.3	47.8

decreased nesting activity associated with cold, wet weather in April and a mid April snowstorm.

In 1982, no hay was mowed on the study area. Nest searching was not conducted on the study area in 1982 because unmowed fields are difficult to search and a large time commitment is required. However, the 1982-83 winter census (40 pheasants) was 28% higher than the 1981-82 census (29 pheasants).

The effect of edge on nest placement was evident in the study area fields in 1981, when 63.7% of the nests located were within 10.5 m of the edge of a hay field. In the control fields, the results were variable, probably due to the small sample size (32 ha) in 1981. In 1981, 10.0% of the pheasant nests located were within 10.5 m of the edge of the hay field; in 1982, 48.3% were within 10.5 m of the edge.

Cumberland County. Reduced nest destruction and hen mortality and increased nest success due to delayed hay mowing is summarized in Table 2. Nest destruction in control fields was 3 to 4 times greater than in the DM fields. Nest success was 5-16 times better in DM fields and hen mortality in DM hay was 1/2 that in control fields.

The effects of inclement weather in April 1982 was also evident here in that fewer nests were located. Of the DM fields which contained nests in 1981, 54% had nests in 1982. Likewise, the 5 fields which contained no nests in 1981 also had none in 1982.

We noted a prominent edge effect in the location of pheasant nests in 3 of

4 hay fields in Cumberland County. In the DM fields, 34.8% (1981) and 55% (1982) of the nests found were within 10.5 m of the field edge. More variation was noted in the use of edge in control fields. In 1981, 38.0% were within 14.2 m of the edge and in 1982, 11.5% found were in this zone.

Winter census data for the Cumberland County study area suggested an 18% decrease in the pheasant population in the 1982-83 winter from the previous winter. In the 1981-82 winter, the estimated number of pheasants on the study area was 131 (1 pheasant/5.5 ha). In the 1982-83 winter the comparable estimate was 107 pheasants (1 bird/6.8 ha).

Broods and Hatching Periods

The effects of the cold, wet, snowy April of 1982 appear to have had a noticeable effect upon pheasant nesting: (1) fewer hens nested; (2) those that did nest, nested later; and (3) brood size was smaller. Although more area was searched for nests in 1982 than in 1981, fewer nests were found in 1982. However, it is not clear whether a lower percentage of hens nested in 1982 or if the population was that much lower. No winter census data are available for the 1980-81 winter; however, pheasant populations were thought to be at low levels also.

Back-dating broods on study and control areas showed that the 1982 hatching period was 3 weeks (control area) to 4 weeks (study area) later in Cumberland County and 3 1/2 weeks later in Berks County than in 1981. Later nesting is further illustrated by the time of nest initiation. In 1981, 83% of the successful nests were initiated before 2 May. This figure was only 29% in 1982.

Although clutch sizes were similar for those clutches which were considered complete in 1981 and 1982, the average brood size in 1982 was less. In Cumberland County, the average clutch size was 9.3 (1981) and 9.7 (1982) for DM fields and 10.5 (1981) and 11.3 (1982) for control fields. In Berks County, the average clutch size was 8.3 (1981) and 8.9 (1982) in the control fields.

The average brood size was 4.8 (N = 29) in 1981 and 4.2 (N = 19) in 1982 for the Cumberland County study area, and 5.6 (N = 31) in 1981 and 3.1 (N = 7) in 1982 for the Berks County study area.

DISCUSSION

With 2 years' data available in this 3 year pilot program of pheasant nesting success in DM hay fields, the results are dramatic. In hay fields where mowing was delayed until after 20 June, pheasant nest success increased tremendously -- at least 50% of the nests hatched. Using the age of embryos as a guide, a delay of another week (after 27 June) might result in nest success reaching 70 - 80%. A 15 June delay date is not late enough to increase nest success beyond that normally found. In addition, although no nest searching was conducted on the SGL in 1982 because of a no-mow policy, winter pheasant counts indicated a 38% increase in the wintering pheasant population. This increase may have resulted from no mowing.

In this study, the low rate of nest success in hay fields mowed on the normal (early) schedule is comparable to the senior author's pheasant work in primary pheasant range in the 1960's and early 1970's (Hartman and Sheffer 1971). In that study, pheasant nest success in alfalfa was 4.6% and in mixed hay 9.5%.

Of equal importance, nesting hen mortality was reduced by 1/2 in DM fields. Reduced hen mortality could be important in maintaining or increasing the pheasant population if delayed mowing were practiced on a large scale. Hartman and Sheffer (1971) noted a similar hen loss (35%; range 20-60%) due to harvesting equipment with a direct relationship between length of incubation and hen fatality due to mowing. From 13 days incubation to hatching, 80% of the nesting hens succumbed to mowing mortality.

The effect of edge on nest placement was evident in this study, but not to the degree found by Hartman and Sheffer (1971). In Lebanon County, they found 68% ($\underline{N}$ = 235 nests) of the nests within 7.5 m of the field edge. The type of edge effect considered here is simple, not the edge effect based on proportion of the total acreage within the same zone (Nelson et al. 1960). When this study is completed, this zone factor may be considered. Some fields, especially in Cumberland County, are relatively wide and ideal for an evaluation of the edge effect.

An interesting fact, worthy of speculation, is revealed by data in Table 2. In Cumberland County, although the area searched for control fields increased in 1982, the number of nests found decreased by 55% and density of nests decreased by 243%. Likewise, but by a much lesser amount, the area of DM fields increased in 1982, however, the number of nests found decreased by 33% and the density of nests decreased by 136%. There was less of a decrease (difference=40%) in number of nests in DM fields than in control fields. This implies that reduced hen mortality due to mowing and/or better hatching success in DM fields after the initial nesting year may have resulted in homing by the experienced hens to the same field to nest in succeeding years. If so, this is another benefit of delayed mowing. As support, more than 1/2 of the DM fields that contained nests in 1981 also had nests in 1982. Similarly, no nests were found in 1982 in 5 of the fields which contained no nests in 1981. Gates and Hale (1974) noted that adult hens almost invariably returned in spring to where they formerly bred and that spring dispersal of young hens was a relatively unoriented process.

The effects of adverse weather in April 1982 are perplexing and noteworthy, but an evaluation is beyond the scope of this program. Nonetheless, several items are apparent: (1) fewer hens nested in 1982, (2) the 1982 hatching period was 3-4 weeks later than in 1981, (3) 1982 average clutch sizes were similar to those of 1981, and (4) the average brood sizes were less than in 1981. Adverse April weather may have caused hens to nest elsewhere or not nest at all. A decrease in brood size may indicate increased chick mortality, smaller clutches, or simply not enough brood data for drawing conclusions.

The clutch size for complete nests in this study is similar to those recorded in earlier pheasant research in Pennsylvania (Hartman and Sheffer 1971). In the 1960's, the average clutch size was 9.0 (range, 7.6 - 11.5).

Extending the 1981 nesting data to a larger base, we theorize that 404.7 ha of DM hay fields could produce 260 more pheasants than 404.7 ha of hayfields with normal mowing schedules.

The third year (1983) of field work will be as intensive as the previous 2. Based on the current satisfactory results of this program, it is scheduled for expansion, possibly into other counties in 1984. Our data strongly suggest that only those fields containing pheasant nests should be retained in succeeding years of the program. The program has been beneficial to wildlife/pheasants, and landowners have been pleased to participate.

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RESPONSES AND IMPACT BY PHEASANTS ON PRAIRIE-CHICKEN SANCTUARIES IN ILLINOIS: A SYNOPSIS

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Illinois' current prairie-chicken (*Tympanuchus cupido*) project began in 1962 when the first sanctuary was acquired by the Prairie-Chicken Foundation of Illinois (PCFI). Continuing research has emphasized population dynamics of prairie-chickens, nest ecology, and responses to habitat manipulation. Data on the response and impact by pheasants (*Phasianus colchicus*) on the prairie-chicken sanctuaries have been incidental to the primary objectives.

Prairie-chickens in Illinois numbered about 400 in the spring of 1982, compared with the millions occurring there in the 1860's. The remnant flocks of prairie-chickens occur principally in Jasper and Marion counties where 2 sanctuary systems are located. The Bogota area in Jasper County was, until the recent establishment of a pheasant population, the most promising site for preventing the extinction of native prairie-chickens in Illinois.

The pheasant range in Illinois encompasses approximately the northern 60% of the state (Warner 1981). A pheasant range extension project--the Neoga Project and others--during the late 1950's and early 1960's, did not extend the pheasant range south in Illinois (Ellis and Anderson 1963, Anderson 1964). Ellis and Anderson (1963) concluded that "factors affecting survival of the pheasants from late summer to the following breeding season were apparently more critical in suppressing the establishment of these populations than factors affecting reproduction".

The pheasant population discussed in this study is located on the extreme southern edge of the Illinois pheasant range (Warner 1981). It may have originated from releases made by local sportsmen, from natural range extension, or both. Pheasants were rarely observed in the area prior to 1969, after which pheasants and their nests and broods became increasingly evident on the developing prairie-chicken sanctuaries.

This paper provides an overview of factors related to the increasing pheasant population at Bogota, and briefly updates our observations on the interactions of pheasants and prairie-chickens, first described in Illinois by Vance and Westemeier (1979). Further, I wish to share some of our observations which may serve as hypotheses for further study.

Several present and former Illinois Natural History Survey staff have worked with the project including J.E. Buhnerkempe, D.R. Vance, and numerous summer assistants. W.R. Edwards and G.C. Sanderson provided supervisory, editorial, and technical support. R.E. Warner reviewed the first draft of the manuscript and provided helpful suggestions. I also thank J.A. Ellis and W.L. Anderson of the Illinois Department of Conservation for reviewing the manuscript.

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STUDY AREA AND METHODS

The prairie-chicken sanctuaries near Bogota in Jasper County totaled 405 ha in 8 tracts, ranging in size from 7 to 94 ha and scattered over 8 contiguous sections. The sanctuaries near Kinmundy in Marion County, totaled 259 ha in 5 tracts, ranging from 32 to 65 ha on 5 sections more scattered than those at Bogota. The sanctuaries are the result of a cooperative effort involving mainly the PCFI (disbanded since 1973), The Nature Conservancy, the Illinois Department of Conservation, the Illinois Natural History Survey, and several private conservationists. The landscapes in both counties are similar, with mosaics of soybeans, corn, and wheat--mostly for cash grain--plus some livestock farming.

Typical spring vegetation on the sanctuaries in Jasper County comprised 71% nest cover, 7% new cover seedings, 12% soybeans and wheat (used to renovate old sods and provide lek sites), and 10% woods and miscellaneous types. For the 288 ha of nest cover present in 1982, most (173 ha) was a mixture of redtop (Agrostis alba) and timothy (Phleum pratense); about 1/4 (74 ha) was prairie grass, consisting of switchgrass (Panicum virgatum), big bluestem (Andropogon gerardi), and indiangrass (Sorghastrum nutans); and smaller amounts were brome (Bromus inermis), weedy grass-forb mixtures, and wheat stubble-red clover mixtures. Average field size is held to about 4 ha on the sanctuaries; this field size is large enough for a stable lek site and practical for sharecropping and providing sharp edges for nesting and brooding.

The methods employed in this study were described by Vance and Westemeier (1979). The population estimates for pheasants through 1980 are probably conservative. They were derived incidentally during annual censuses of prairie-chickens conducted mainly during early April on the 82-km^2 Bogota Study Area. Standard methods for censusing pheasants were employed at Bogota beginning in 1981. During late April and early May, the peak crowing season for pheasants, efforts to triangulate all crowing cock pheasants were intensified. Nest searching techniques were described by Westemeier (1972) and Westemeier and Buhnerkempe (1982).

RESULTS AND DISCUSSION

Pheasant Populations

According to rural mail carrier surveys conducted at 5-year intervals beginning in 1958, pheasant densities in Jasper County have remained low (Warner 1981). Pheasants observed per 160 km in Jasper County by the mail carriers were 1.0 in 1958 and only 0.1 in 1978, when the last such survey was made. In Smallwood Township, where the prairie-chicken sanctuaries are located, the mail carrier counts were 1.4 pheasants in 1958, and surprisingly, mail carriers have not reported pheasants there since then. On the 4.0 km^2 of prairie-chicken sanctuaries, however, the 32 pheasant cocks censused in the spring of 1981 represent a density of 8.0 cocks/km^2. Preno and Labisky (1971:17) reported a grand mean of 8.5 cocks/mi^2 (3.3 cocks/km^2) for game region 4 of east-central Illinois from 1955 through 1969. However, on 77.9 km^2 of private land surrounding the sanctuaries, the 16 cocks censused in 1981 amount to only 0.2 cock/km^2. Densities of pheasants were virtually unchanged in the spring of 1982 both on and off the sanctuaries. Thus, the pheasants at Bogota appear to be strongly dependent upon sanctuary habitat.

By 1981, there were probably more pheasants than prairie-chickens at Bogota (Fig. 1). In contrast, by 1981, the prairie-chicken population near Kinmundy, where pheasants are not established, had increased and surpassed the population near Bogota, despite the smaller area in sanctuaries at Kinmundy. On the basis of (1) habitat, (2) the "cyclic" highs occurring at Kinmundy and on areas in

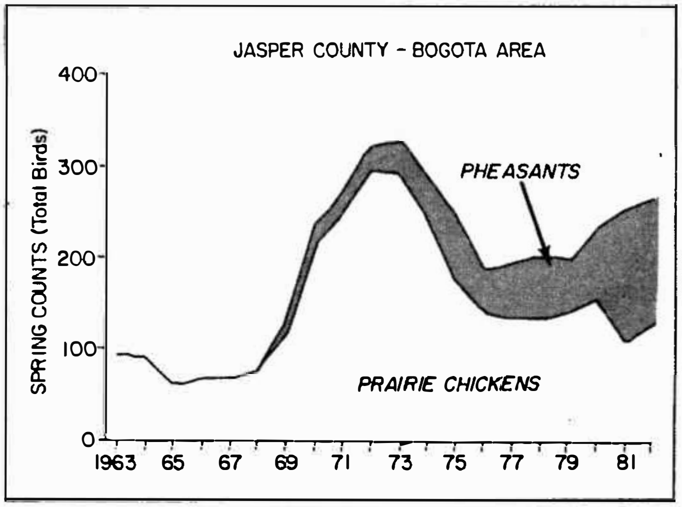

FIGURE 1. Spring counts of prairie-chickens and pheasants on the Bogota Study Area, Jasper County, Illinois, 1963-82. Pheasants are represented by the shaded area above the line depicting the prairie-chicken population.

at least 2 other states that have essentially no pheasants, and (3) the phenomenally high populations of prairie-chickens 10 (and perhaps 20) years earlier, the population at Bogota had been expected to increase to perhaps twice the levels that existed there in 1981-82.

Habitat Use By Pheasants

Nesting. The mean nest density of pheasants on sanctuaries increased from 0 prior to 1969 to 0.49 nests/4 ha of nest cover in 1981 and 1982. For 116 pheasant nests found during the annual nest searches, 1969-82, on sanctuaries at Bogota, the high-to-low ranking for densities of established nests (nests/4 ha) by cover type was: brome (0.45), weedy grass-forbs (0.33), prairie grass (0.31), timothy (0.24), redtop (0.15), and wheat stubble-red clover (0.11). Differences in chi-square values for pheasant nest densities among brome, redtop, and wheat stubble-red clover cover types were highly significant ($P<0.01$). Although pheasants avoided recently burned areas, the nesting frequency was not significantly different ($P>0.05$) among stands that were undisturbed, rotary mowed, grazed lightly, hayed, or harvested for grass seed during the year preceeding a spring nesting season.

For 112 pheasant nests of known fate observed during the 13 years, success averaged 42.9%. Mean clutch size was 12.5 ± 0.5 (SE) eggs for 42 incubated clutches, judged to have been complete. The mean number of eggs hatched per successful clutch was 10.7 ± 0.6 for a sample of 30 nests. These parameters of reproduction are high for pheasants in North America (Ellis and Anderson 1963, Anderson 1964, Labisky 1968a) and may have contributed to the pheasant increase at Bogota.

Roosting. Pheasants at Bogota have shown preferences among cover types used for diurnal and nocturnal roosting. As reported by Westemeier and Buhnerkempe (1982), "A mean of 1.1 pheasants/ha (minimum counts) were flushed during prescribed burning of 15 fields totaling 66.8 ha of prairie grass during the winters of 1979-81. The only field from which no pheasants flushed had been rotary mowed during the previous August; all other fields were tall, dense, undisturbed stands of prairie grass. No prairie-chickens were flushed from any of the 15 fields of burning prairie grasses."

During January and February 1983, 71 ha were searched by nightlighting (Labisky 1968b) on the sanctuaries at Bogota in an attempt to capture pheasants and learn more about night roosting cover preferences. A mean of 1.9 pheasants/ha were flushed during the nightlighting of tall, dense stands of prairie grass, compared with 0.3 pheasant/ha flushed from redtop-timothy meadows. Flushing rates in unmowed cover was 1.2 pheasants/ha, compared with 0.2 pheasants/ha in meadows that had been rotary mowed or harvested for grass seed.

Although limited, these data suggest that pheasants prefer tall, dense cover for diurnal activities and nocturnal roosting. Use of tall, dense cover may enhance the fall and winter survival of pheasants. Ellis and Anderson (1963) and Anderson (1964) believed winter survival to be a critical factor limiting the southern extension of pheasants in Illinois. Over-winter survival is also enhanced because pheasants on the sanctuaries have a relatively limited vulnerability to hunting. The increasing numbers of pheasants may also be a result of relatively high productivity.

Although the sanctuaries near Kinmundy in Marion County are only about 16 km farther south of the established pheasant range than are those at Bogota in Jasper County, stands of tall, dense cover have generally not been available on the Marion County sanctuaries. The absence of such cover may, in part, explain pheasant scarcity on the sanctuaries near Kinmundy. Thus, the tall, dense cover at Bogota is seemingly more critical to pheasant survival than are such factors as limited hunting or high productivity.

Pheasant and Prairie-Chicken Interactions

The adverse impact of pheasants on prairie-chickens at Bogota may be summarized as follows: (1) Harassment of courting and mating prairie-chickens by pheasants has become relatively common (Vance and Westemeier 1979). (2) The population and nesting effort of prairie-chickens have become increasingly concentrated on the 2 central sanctuary units (the best habitat), with the 5 peripheral units (more marginal habitat) largely abandoned or little used. Pheasants, however, are well dispersed over all available habitat. (3) The nesting effort of prairie-chickens, defined as the number of nests found divided by the number of hens observed on leks, appears to have been lower in several recent springs. (4) Among the prairie-chickens that do nest, there has been an increasing likelihood of parasitism by pheasants, resulting in desertion, predation, or if hatching occurs, a parasitic brood and the probable loss of the prairie-chicken brood. From 1970 to 1982, 28 prairie-chicken nests were found that contained eggs from both species; hatching success was significantly lower ($P < 0.05$) for these nests than for prairie-chicken nests that were not parasitized. In 2 cases, the pheasant eggs were hatched and the prairie-chicken eggs contained dead, nearly full-term embryos. The incubation period for pheasant eggs is about 2 days shorter than the incubation period for prairie-chicken eggs. (5) Even when parasitism does not occur, the probability of nest abandonment is increased, apparently as a result of the presence of pheasants. (6) If parasitism and desertion do not occur, increased embryonic mortality at Bogota currently results in fewer than normal prairie-chicken chicks hatched per clutch. A comparison of the Bogota data with the data from Marion County suggests altered behavior of nesting hens, such as reduced attentiveness during incubation due to harassment by pheasants, which may cause the increased embryonic mortality noted at Bogota. (7) The sex ratio of prairie-chickens appears to be highly skewed in favor of males, perhaps 2:1. This skewed sex ratio may reflect a wider dispersal of hens as a result of interspecific competition.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Pheasants must be regarded as a potential threat to the survival of prairie-chickens in Jasper County. It remains to be determined whether the present phenomenon will result in coexistence of the 2 species, perhaps with attendant depressed populations of both species, or if competitive exclusion of prairie-chickens will result. It seems doubtful that prairie-chickens can long withstand the harassment and depressed reproduction caused by pheasants at Bogota, when added to other factors such as predation, weather, and intensified land use. There are likely other interactions between the 2 species that we have not observed.

Interactions between the 2 species are academically intriguing. It would be interesting to "let things alone" to see if pheasants could totally exclude prairie-chickens from Jasper County. Interspecific competition might in evolutionary time lead to character divergence (Ricklefs 1973:210, Pianka 1974:151-154)--increased ability of prairie-chickens to compete with pheasants--but this possibility seems remote. The overriding responsibility of the prairie-chicken project must be the preservation of the species in Jasper and Marion counties. A sustained program of pheasant control is clearly needed.

A habitat-manipulation approach to pheasant control on prairie-chicken sanctuaries currently includes mowing fields to a height of approximately 30 cm in late summer or fall and conducting prescribed burning of prairie grass in fall, instead of late winter or spring, to deprive pheasants of preferred winter loafing and roosting habitat. Small patches of tall, dense cover ("bait cover") are occasionally left undisturbed on each sanctuary to attract pheasants for live trapping. Controlled hunting of pheasants on sanctuaries, while possible, is not consistent with the concept of a sanctuary, and hen shooting would probably be unacceptable to local hunters and others.

Conversely, in areas where increased pheasant abundance is desired, the findings attest to the importance of providing a scatter pattern of tall, dense (undisturbed) cover, such as switchgrass, to enhance fall and winter survival. Field size need not, perhaps should not, be larger than about 4 ha to maximize edge and still be practical for conventional equipment. Periodic disturbance of stands is desirable and often essential to control succession. A 3-year management rotation might include: first year - no disturbance, second year - March burn (possibly followed by July haying or light grazing), third year - light grazing, rotary mowing, or seed harvesting (by combine) in late summer or fall. Nest cover may include brome, timothy, redtop, and legumes seeded in mixtures and managed in a similar manner to the rotation suggested for prairie grass.

Perhaps 400 ha of managed grasslands would suffice to sustain a local population of pheasants whose numbers might be expected to fluctuate in the range of 100 to 400 depending on local conditions. It would be desirable to have these grasslands dispersed over 6-10 contiguous sections with at least the central section as a sanctuary.

Historically, the loss of the native prairie-chicken and the gain of the exotic ring-neck throughout the eastern tall grass prairie region was apparently not entirely a matter of habitat change. Competitive exclusion of prairie-chickens by pheasants may have occurred in many areas. The findings suggest (1) the difficulties encountered in establishing prairie chickens in areas occupied by pheasants and (2) the danger of introducing pheasants in occupied prairie-chicken range. Both such efforts continue in areas of the Midwest. Pheasants and prairie-chickens occupy the same general areas in parts of Kansas, Nebraska, and South Dakota, but at much lower densities and on far more extensive habitat than at Bogota. The opportunity for adverse interactions may be much reduced in these states.

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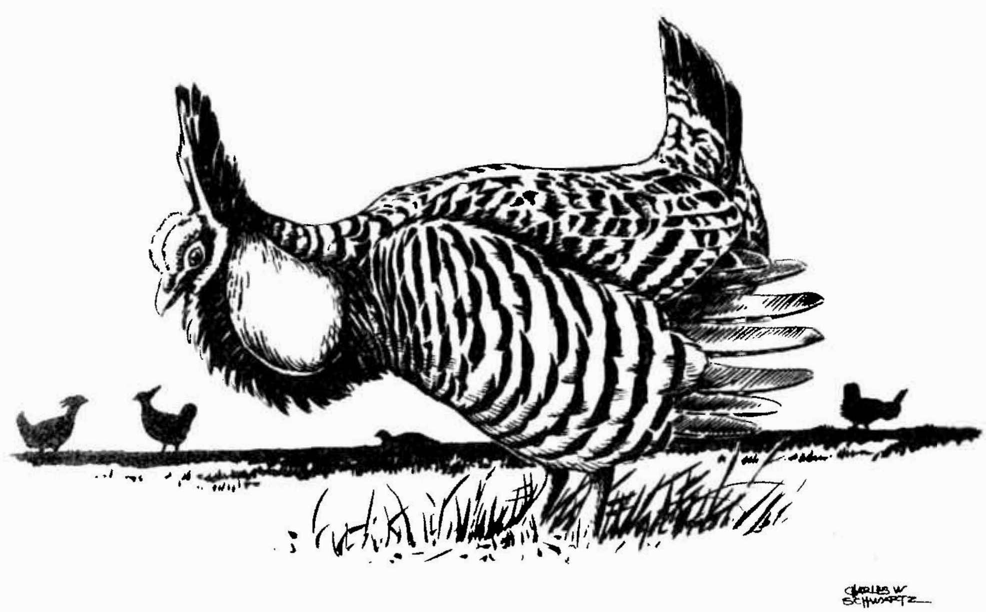

PHEASANT NESTING ECOLOGY IN RELATION TO WHEAT FARMING

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Abstract: Ring-necked pheasant (Phasianus colchicus) hens were radio-marked and monitored during the nesting seasons of 1979 (N=30), 1980 (N=34), and 1981 (N=42) to investigate preferences for nesting habitat. The study area in northeastern Colorado was dominated by biennially-cropped dryland winter wheat. Most early spring nests were placed in either wheat stubble or green wheat, and placement was proportional to the relative height-density qualities of available nesting cover. Nests in stubble, if not depredated, were nearly all destroyed by stubble field cultivation. Initial cultivation of stubble in April or early May before incubation was attained promoted renesting in green wheat where most nests hatched before July wheat harvest. Mid-May to early June stubble tillage destroyed incubated clutches, and physiological preparation for egg laying delayed renesting in wheat. Most renest attempts in green wheat were unsuccessful due to forced abandonment or destruction during July wheat harvest.

PHEASANT NESTING ON RESTORATION PLOTS AND ASSOCIATED COVER TYPES IN SOUTH DAKOTA

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Abstract: Through the cooperation of landowners and county ASCS offices, 26,000 acres of pheasant nesting cover have been established in South Dakota. The Department of Game, Fish and Parks is evaluating the cover development and wildlife use on these "restoration acres" in Codington and Tripp counties. In each county, 100 ha of each of 5 cover types were searched for pheasant nests in 1978-81. Data have been summarized only for 1981 to date. Restoration acres averaged 44 and 46% of the nests, roadsided 31 and 36%, alfalfa fields 7 and 16%, small grain fields 3 and 9%, and pastures 4 and 4% in Codington and Tripp counties, respectively. Nest success averaged 42 and 45% for restoration acres, 15 and 26% for roadsides, 24 and 25% for alfalfa, 0 and 60% for small grain, and 0 and 25% for pastures in Codington and Tripp counties, respectively. Vegetation identification, relative plant composition, and plant density data were collected on each restoration area. Land use was cover mapped on 4mi^2 around each restoration area. Pheasant nest site selection will be evaluated relative to these vegetation parameters and surrounding land use.

PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop
28-30 March 1983, Campbellsport, Wisconsin

DECLINING SURVIVAL OF RING-NECKED PHEASANT CHICKS IN ILLINOIS

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Abstract: The mean number of ring-necked pheasant (*Phasianus colchicus*) chicks in broods observed annually along standardized census routes in Illinois declined from 1946-81. The average number of chicks per hatched nest did not change ($P > 0.05$) during the 1954-81 period. The survival of chicks to 5-6 weeks of age was 79% during the early 1950's, 71% during 1956-59, 64% during 1960-64, 61% during 1965-69, 51% during 1970-74, and 54% during 1975-81. Mean survival of chicks from hatch to early August, declined about 28% between the early 1950's and the mid-1970's. The amount of Illinois farmland annually receiving hydrochlorinated compounds, 1956-81, was not correlated ($P > 0.05$) with mean brood size. The amount of row crops over the entire Illinois pheasant range (1956-80) and near Sibley (1954-81) was significantly ($P < 0.001$) correlated with observed brood sizes and was associated with about 60% of the variation in mean brood size. The use of cover and patterns of movement were compared for broods radio-monitored in east-central Illinois in proximity to relatively diverse farming systems ($N = 8$, 1972-73), and in corn-soybean monocultures ($N = 5$, 1975-81). Compared to movements of broods radio-tracked in diverse cropping patterns, broods in corn and soybeans moved significantly ($P < 0.05$) greater distances and ranged over larger areas during the first 4 weeks of life. Reduced availability of habitat for insect foraging, in conjunction with increased travel and attendant increases in energy demands, may have contributed to declines in the survival of pheasant chicks in Illinois during recent decades.

HABITAT USE AND MOVEMENTS OF WISCONSIN PHEASANTS DURING FALL AND WINTER

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Abstract: Diurnal activities of 56 hen pheasants (*Phasianus colchicus*) were monitored via radio telemetry from October-April, 1968-71 on or near a large public hunting area. Major habitat types used were: herbaceous wetlands (28%), corn (20%), strip cover (10%), retired croplands (10%), and shrub-carr wetlands (9%). Use of corn, retired cropland, and herbaceous marsh declined from fall to winter, while use of brush areas increased. Use of woods, food patches, and shrub-carr wetlands was greatest in mid-winter, while use of strip cover was greatest in late winter and April. Habitat use was related to year, snow depth, and age of hen, but not hen survival ($P > 0.05$). Use of food patches appeared to be suppressed during the 36-day hunting season. Monthly home range area was related to hen age, but not to year or hen survival ($P > 0.05$). Largest range areas and movements occurred from mid-October to mid-November, and correlated positively with pheasant hunting pressure and corn harvesting ($P < 0.05$). Smallest range areas and movements occurred from early January to early February and correlated negatively with depth of snow cover ($P < 0.05$). Hen age, survival, and ambient temperatures were not related to movements. Movements from the fall range to winter cover began in late September, prior to snowcover, hunting, or major corn harvesting; the latter 2 factors appeared to accelerate the moves.

Farmland Habitat Modeling and Management

CRITICAL HABITAT COMPONENTS FOR GRAY PARTRIDGE

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There are many good papers reporting the factors which appear to be important life requisites of the gray partridge (Perdix perdix). However, much of the literature is specific to a particular area of North America, and has been published in state or provincial research reports. An excellent overall summary of gray partridge biology is presented in Johnsongard (1973), but there have been some modifications in the range and species information since the early 1970's.

This paper is not intended to replace any of the published material but rather to present a brief sketch of the current knowledge of gray partridge critical habitat components so the reader has a background to better appreciate the following papers in this conference. The material was collected from personal observations, a literature search, and information contributed by other partridge researchers in North America. I am indebted to Ralph Denny (Oregon Department of Fish and Wildlife), John Weigand (Montana Department of Game), James Wooley (Iowa conservation Commission), Kevin Church (New York State University), and Robert Dumke (Wisconsin Department of Natural Resources) for valuable information on partridge in their respective areas.

Johnsgard (1973) considered gray partridge in North America to be distributed in 4 distinct populations. A more recent range map (Questionnaire Results, this volume) revealed that there have been changes in distribution; Johnsgard's "Maritime" population and the southern portion of the Great Lakes population are less extensive than previously reported. Additionally, there appears to be some range expansion in the Central population. The shifts in range may reflect changes in agricultural use of the land including larger field size, increased herbicide and insecticide use, different crop type or variety, and altered crop phenology. Currently, there are 3 geographic populations of gray partridge in North America (Table 1).

The general habitat used by each geographic population is similar. The exception appears to be the type of nesting habitat (as measured by foliage height) in the Saskatchewan portion of the Central population. Nesting hens from other gray partridge populations of North America avoid wooded habitats. In the Canadian prairie population however, dense,

Table 1. Major populations of gray partridge in North America.

Population	Geographic Location
Western	Washington, Oregon, Idaho, Nevada, Utah
Central	Alberta, Saskatchewan, Manitoba, Montana, Wyoming, North Dakota, South Dakota, Minnesota, Iowa
Great Lakes	Wisconsin, Ontario, New York

tall (5 to 7 m) hedgerows of caragana (Caragana arborescens), green ash (Fraxinus campestris), and Manatoba maple (Acer negundo var. interius) form a vital part of gray partridge nesting cover (Hunt 1974). Gray partridge also nest in hedgerow cover in England (Blank et al. 1967). I suspect that the departure from the type of nesting cover used by other North American partridge is a result of the length and the severity of the winter in the most northern portion of the North American range. Aside from this difference in selection of nesting habitat, the habitat used by the gray partridge populations in North America appears to be a function of the climate which affects the general type of land use, major agricultural crops, and types of predators present. Differences in major agricultural crops are reflected in the food habits whereas the major predators affect the specific cover used by the populations.

Gray partridge appear to be quite hardy and their diets and cover preferences reflect the major agricultural crop of the area. It appears that the presence of some type of agricultural grain crop probably is the most critical habitat component for gray partridge in North America. Grain crops provide a food source, and for some populations, brood cover. With a 15% increase in the total croplands in the U.S. from 1969 to 1980 (Council on Environmental Quality 1982), there may be good reason to expect the range of the gray partridge will also increase.

Increased use of agricultural insecticides and herbicides may result in lower productivity and offset the benefits of increased cropland. Between 1971 and 1976 (the latest published records available), insecticide use on U.S. cropland increased by 5.2% from 7700 T to 8100 T, and an additional 18 million acres were treated (Council on Environmental Quality 1982). Although this resulted in a net decrease in the application rate (2.7 to 2.2 lbs/acre), the types of insecticides used now may be more toxic at lower application rates. Since the importance of insects in the diets of partridge chicks has been well established (Southwood and Cross 1969, Potts 1971, Kobriger 1977, Weigand 1980) the increased use of insecticides, if only in the acreage treated, could adversely affect partridge.

The trends in herbicide use in the U.S. during the same period are much more disturbing to me. There was a 25% (+ 39 million acres) increase in the farm acreage treated with herbicides between 1971 and 1976, and a 76% (11,200 to 19,700 T) increase in the total amount used nationwide (Council on Environmental Quality 1982). In contrast to insecticides, application rates of herbicides increased in the same period from 1.4 to 2.0 lbs/acre. With the increased interest in "no-till" or "min-till" agriculture in North America it is reasonable to expect herbicide use will increase even more. Although definitive studies of the effects of heavy herbicide application on insect abundance are lacking, Potts (1977) suggests an inverse relationship. Additionally, field edges which appear to be important nesting areas in some localities would have decreased cover value as the vegetation is reduced through increased herbicide use.

Residual cover for nesting and brood cover is another obvious critical habitat component. In all of the North American populations, residual cover is the preferred nesting cover. Not only is the presence of some residual cover necessary, but the quality of the cover also appears to be important. If the cover is too "rank" (as measured by stem density), it is not acceptable as nesting cover. Yet sparse cover does not offer sufficient protection from predators. The amount of residual cover on North American agricultural lands has diminished as field size has increased. As fields are harvested earlier in the growing season, vital brood cover may become scarce. Perhaps the availability and quality of nesting or brood cover will be a primary limiting factor for gray partridge in North America in the future.

Given then, that there is some grain crop in the agricultural rotation and that there is sufficient residual cover for nesting and brood rearing, the land is probably suitable for gray partridge. The manner in which the populations of gray partridge in North America differ in their responses to the varying land use patterns can be examined as a function of other critical habitat components. In this paper, I will consider only: (1) the major food, (2) the principal cover type used for nesting, brood rearing, and winter cover, and (3) the major predators for each of the North American populations.

FOOD HABITS AND DIET

Throughout the North American range, gray partridge diets consist primarily of small grains. When available, small grains are the preferred food for all populations. The particular type of small grain used is related to the major agricultural crop of the area. In the western population, winter wheat is favored. If winter wheat is unavailable, partridge prefer seeds of cheatgrass (Bromus tectorum), weeds, and forbs. Green leaves of common dandelion (Taraxacum officinale) have also been reported in the diet of partridge in the western population.

The diet of birds in the Central population consists of winter wheat, barley, oats, and corn. The use of corn increases in the south eastern portion of this range as the primary agricultural crops change in importance. Green plant parts and forbs are eaten in the summer only, but weed seeds are considered to be a secondary food if grains are not available. The utilization of corn extends from the eastern portion of the Central population into the Great Lakes population. However, partridge from the eastern portion of this population also consume the cereal grain of agricultural importance in a given locality. Researchers from the Great Lakes area did not report any green vegetation in the diet of partridge, but did mention the secondary use of weed seeds.

It can be concluded then that cereal grains provide preferred foods and weed seeds provide foods of secondary importance for partridge. The increases in agricultural cropland in North America may positively affect partridge distribution, but the increased use of herbicides may diminish the availability of weed seeds in the future.

NESTING COVER

In the Western population, partridge tend to nest in field edges. Bunchgrass/wheat complexes seem to be most suitable for nesting, but nests can be found in areas as diverse as "pure" grain fields (edges especially) to open areas dominated by cheat grass. Nests may also be found in areas with low interspersion of cover types. In these cases the distance from a nest site to another type of cover is quite large. In the Great Plains population the preferred nesting cover varies. In northern areas, idle agricultural lands dominated by grasses are preferred, although nests also have been found in older pasture lands and hayfields. Presence of overstory is important in the Canadian provinces and a weak overstory appears important in Montana, but this may be due to the lack of other suitable nesting cover rather than a selection of the overstory cover. Farther south, the presence of an overstory is not considered a prominent feature of suitable nesting cover. Most nests in Iowa are found in idle areas adjacent to roadsides and fencerows. These areas are typically dominated by a bluegrass (Poa sp.)/brome (Bromus sp.) complex. Progressing east and south, the interspersion component of nesting cover increases, but this may be due to a generally smaller field size rather than to a biological need of the partridge. Nesting cover in the Great Lakes population is described as fencerows and odd areas in Wisconsin and undisturbed grassy residual cover dominated by brome, orchard grass (Dactylis glomerata), quackgrass (Agropyron repens), and bluegrass in New York. Residual hay fields provide secondary nesting cover throughout the area. Interspersion is generally greater in this part of North America and accordingly, the distance from a nest to a different cover type is less than in the Great Plains and Western populations. This appears to be more of a function of habitat diversity rather than behavioral selection by partridge.

Critical habitat types that provide nesting cover primarily include idle land and field edges. Overstory importance increases as the degree of interspersion decreases. As the trend toward larger fields sizes continues, not only is there less edge available for nesting but there also may be an increased need for a denser overstory. There appears to be an optimum density for quality nesting cover. Typically, an area with "dense nesting cover" (DNC) that is considered "prime" for waterfowl nesting, may not be acceptable for partridge since the vegetation may be too dense to allow movement or to allow chick-parent visibility. We need to critically re-evaluate suitable nesting cover for partridge especially the long-term role of idle areas that may indeed be "too rank" for partridge. Field edges appear to be the prime nesting areas and the decrease in linear cover associated with larger field size may critically limit partridge nesting success.

BROOD COVER

Gray partridge in the west choose brood cover which is similar to the cover used for nesting. This may reflect either a behavioral preference or result from the large field size found in the western partridge range. There is however, greater use of alfalfa fields by partridge broods. Perhaps alfalfa provides improved cover; but alfalfa is an irrigated crop in the west, that may support relatively abundant insect populations, and thus an abundant food source. Partridge broods of the Great Plains population also use the same general cover type as that used for nesting cover. There is a slightly greater use of pasture lands, but idle agricultural land remains most important. In the Iowa portions of the Great Plains, roadsides constitute the primary brood cover although oat fields provide secondary habitat. The Great Lakes population shows the widest diversity in the type of brood cover used. In Wisconsin, oat fields are favored as brood cover. The vertical component and overstory of oats offers good predator protection while at the same time allows easy movement. In New York, brood cover is the same as nesting cover, with some use of idle areas, hay, and grass fields. The age of the broods appears to affect cover selection, with larger chicks favoring denser cover. In New York, food is perceived by researchers as more important than cover quality in the selection of brood habitat.

There appears to be some disagreement among partridge biologists over the primary function of the habitat type used by broods. Perhaps in this light, the term "brood cover" is misleading. There is agreement that the habitat tends to be more diverse than nesting cover but whether the diversity provides better predator protection or more food is debated. In that faunal diversity is positively correlated with vegetation diversity, it seems difficult to separate the 2 factors, and perhaps brood habitat is selected for both. The availability and abundance of insects for chicks appears to be a critical habitat component and any habitat type that provides this primary requirement as well as at least a minimal amount of concealment may suffice as brood cover. Thus, the increasing use of herbicides and insecticides may affect partridge populations in the future if it has not already done so.

WINTER COVER

The distribution of partridge in North America and their ability to withstand the rigors of the Canadian prairie provinces in winter, attests to the hardiness of the species. It appears that the severity of the winter determines the type of cover used during the period. In mild winters, such as the 1982-83 season in Wisconsin, partridge were often seen in open grain fields. During seasons with harsh weather conditions, such as deep snow, strong winds, and very low temperatures, partridge seek some type of shelter. Most researchers cite "shelter belts" as the primary cover type used by partridge during such conditions. A shelter belt usually consists of a fencerow with some brushy cover. Trees and woodlots are avoided by most of the populations except for the Saskatchewan portion of the Central population as discussed previously. Both the type of cover used and the regularity of use also appear to be associated with winter food availability. In years of sufficient winter food availability, there appears to be less reliance on winter shelter.

We can conclude that given the availability of sufficient winter food, the amount of winter cover available is not a critical factor except during the more severe winters. The same cannot be said of winter cover quality. As average field size increases, more "edge-to-edge" plowing is practiced and more herbicides are used, the amount of winter cover available may become a critical factor. If these changes are accompanied by more efficient harvesting of crops, the quality and quantity of winter cover may lead to more reductions in range.

PREDATORS

There is a dearth of information available on predation rates and predators of gray partridge. In the Western populations, Cooper's hawk (Accipiter cooperii), prairie falcon (Falco mexicanus), and golden eagle (Aquila chrysaetos) are major avian predators. In the Central population, northern harrier (Circus cyaneus), Swainson's hawk (Buteo swainsoni) [summer only], rough-legged hawk (B. lagopus) [winter only], and great horned owl (Bubo virginianus) are cited as the major avian predators. Both Western and Central researchers report ground squirrel (Spermophilus sp.) predation of eggs. The Great Lakes population researchers reported heavy avian predation by the great horned owl, red-tailed hawk (B. jamaicensis), goshawk (A. gentilis) [winter], and rough-legged hawk [winter]. Although the extent of mammalian predation has not been investigated thoroughly, red fox (Vulpes vulpes) is suspected to be an important predator, especially in winters when snow is crusted or wind packed.

Eastern researchers stressed the importance of domestic dogs and house cats as nest predators. The importance of these species as predators increases in the eastern portion of partridge range, but this is probably due to the generally smaller farm size, and therefore increased density of farmhouses with associated pets.

Predator management in North America has typically been limited to terrestrial predators. with "education" of the general population on the value of raptors, and the awareness of the role of predators resulting from the 1970's "ecology movement", there may now be higher populations of raptors in North America than in the past 2 decades. Potts (1980) demonstrated significant increases in brood production rates in areas of predator control in the United Kingdom but again, aside from crows (Corvus sp.), the primary targets of predator management were fox, stoat (Mustela erminea), and feral cat. I doubt that the public nor the Federal government would approve a raptor management plan in North America for gray partridge, and in this light, perhaps our efforts would best be directed at some nonlethal form of predator management (i.e., a deterrent) to reduce predation, especially of nesting hens and eggs.

CONCLUSIONS

Critical habitat components for gray partridge in North America include the presence of cereal grains, abundance of insects for broods, and residual cover for nesting and in some cases, brood rearing. Cereal grains provide fall and winter food, but weed seeds also appear to be important in gray partridge diets. More efficient harvest of grain crops may also affect the ability of partridge to withstand severe winter weather. The importance of insects in chick diets has been stressed by several authors, and it is this component which may limit the distribution of partridge in North America in the future. The apparent decreases in the amount of residual cover for nesting may account for the recent reductions in partridge range. As farms continue to increase in size, the amount of cover available, especially for nesting, may become critical. The increased use of herbicides and insecticides in the U.S. may affect both the availability of insects and suitable residual cover. This increased use may confound the effects of increased farm size. Gray partridge appear to have a broader set of habitat variables than do ring-necked pheasants (*Phasianus colchicus*). The most serious threat to partridge is the continued intensified use of the agricultural lands they inhabit.

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CRITICAL HABITAT COMPONENTS FOR RING-NECKED PHEASANTS

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Components of pheasant habitat have been studied by numerous workers over the years (Baskett 1947, Linder et al. 1960, Baxter and Wolfe 1973). There has been general agreement concerning critical components and a quote by Hicks (1932) referring to Ohio in the 1930's still reflects our thoughts today. He wrote "Elimination of roadside mowing by farmers, county or township trustees, or the state highway department before 10 July, is urged as a recommendation of great importance. In most sections of the state, suitable locations for nests are few in number in May and early June. Clean agriculture has destroyed many situations formerly available." The quote continues "...the past tendency toward specialized and clean agriculture is deplored, as many areas are almost without food or cover."

From the literature, it appears that nesting cover has been most widely considered as the cover in short supply (Kimball 1948, MacMullan 1961), especially residual cover used in early spring (Gates 1971, Dumke and Pils 1979). Residual cover provides alternative cover to alfalfa for early nesting (Frank and Woehler 1969).

I telephoned wildlife biologists responsible for pheasant management and research in 13 states to obtain opinions about critical components of pheasant habitat. A large majority of those biologists think that nesting cover remains a big problem and is most critical in supply. Many qualified this assertion by saying that in some parts of their state, winter cover, brood cover, or food was as great a problem as nesting cover.

I want to thank the following biologists for supplying me with information concerning pheasant habitat: William Baxter and George Nason (Nebraska), Alfred Berner (Minnesota), Robert Boyd and John Henry (Ohio), Larry David (Illinois), Edward Frank (Wisconsin), Fred Hartman (Pennsylvania), William Rybarczyk (Iowa), Randy Rodgers (Kansas), Warren Snyder (Colorado), Kenneth Solomon (South Dakota), Lowell Tripp (North Dakota), and John Weigand (Montana).

NESTING

There was agreement that herbaceous nesting cover is needed, preferably residual cover that is standing in the spring and attracts early nesting hens from unsafe or non-productive cover such as alfalfa. Residual cover is not overgrazed pasture, but vegetation that maintains a height of 10-15 inches in the spring. Mid season nesting cover, such as hay or grain, is also needed.

Workers do not restrict their thinking to particular species of plants. Brome-alfalfa provides good cover in Illinois but not in North Dakota. A wheat grass-alfalfa mixture or dense nesting cover is desirable in the Dakotas. In Colorado, southwest

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Nebraska, and Kansas, wheat stubble provides good residual cover. This stubble out-competes green wheat for early nests, but spring tillage begins early and destroys them. A question appears to be, should management promote early disturbance of wheat stubble, thus forcing hens into green wheat or should the stubble be left undisturbed? Rodgers (1983) in Kansas reported that weed undercutters without mulch treaders left 53% of the nests of 7 bird species intact, permitted survival of many flightless young, and caused no known injury to incubating adults during minimum tillage to control weeds in wheat stubble.

Biologists from Nebraska credit recent increases in some pheasant populations to ecofallow. Pheasant populations decreased in areas of the state where ecofallow was not practiced. However, some people wonder about the effect on wildlife of extensive herbicide use to control weeds. Weed control also reduces the amount of cover, possibly leading to increased predation.

In many states, roadsides provide the most important cover type for nesting. In prime agricultural lands of Iowa, Illinois, and Minnesota, the importance of roadsides was stressed. Biologists feel that roadsides are about the only land left with potential for public management.

BROOD COVER

A number of biologists expressed concern about brood cover. Herbaceous cover desirable for nesting often suffices for brood cover. In Illinois, Warner (1979) pointed out that hay and oats were used extensively for brood rearing. He suggested that with the increase in corn and soybeans, it was possible that availability of insects and succulent weedy forbs and grasses as foods for young chicks may have reached a critical point.

WINTER COVER

Winter is another critical period for pheasants. Winter cover, though, is difficult to assess. It must be dispersed throughout the region and have food nearby. In South Dakota, wetlands and some shelterbelts suffice. North Dakota pheasants require wide, dense shelterbelts that provide adequate cover despite drifting snow. Narrow shelterbelts may be death traps. Shelterbelts in eastern Montana are composed of mature decadent trees and are often grazed. These shelterbelts, occur throughout most of the Northern Plains and are not being replaced with better wildlife cover.

Standing herbaceous cover may be adequate for winter cover in the more southern latitudes of pheasant range. In Kansas and Colorado, wheat stubble, with nearby shrub cover such as a plum thicket, is used. In Wisconsin, wetlands offer good winter cover, at least during normal winters. Winter cover in northern Iowa may be limiting since vegetation in many shelterbelts and farmstead wind breaks have been removed or have matured and no longer provide adequate cover. Warner and David (1982) concluded that the establishment of linear woody vegetation (particularly deciduous vegetation) for windbreaks should not be promoted as a practice to prevent pheasant mortality in severe winter storms in Illinois. In central Illinois they reported that widespread mortality of pheasants from winter storms was rare.

COVER QUANTITY VS. QUALITY

Along with specific cover requirements for different phases of the pheasant's life cycle, cover types must be interspersed in order that all types are available. A number of studies have shown that pheasant populations have decreased as land use has changed. In Minnesota, field size has increased and hay and small grain fields have been converted to row crops leaving only about 5% of the area in hay or small grains in some regions. There are also fewer areas with residual cover. Taylor et al. (1978) showed a sharp decline in interspersion on a Nebraska study area between 1955 and 1976 with a concurrent sharp decline in pheasant populations.

A change in the degree of interspersion or field size has not always occurred where pheasant populations decreased substantially. On a South Dakota study area, the pheasant population declined 90% while cover type acreages and an interspersion index remained unchanged from 1958-59 to 1977-78 (Vandel and Linder 1981). They proposed that game managers should look at quality as well as quanity of game cover in farmlands. In South Dakota, farming practices are more intense, fields are cleaner, and there is less waste grain in recent years. Herbicides are also changing plant species composition resulting in diminished habitat quality.

HABITAT MANAGEMENT

There seems to be general agreement concerning what comprises adequate cover throughout the year. The critical question is how this cover can be obtained and maintained. For example, we need many acres of well-distributed nesting cover to maintain statewide pheasant populations. Many states have instituted habitat development programs to establish nesting and wintering cover. For example, in South Dakota the Pheasant Restoration Program -- funded through a pheasant stamp -- offers payment to farmers for establishing and maintaining cover on cultivated land for 6 years. Funding, however, limits the number of acres that can be put into the program. An additional benefit is that improved public relations have been fostered by the program. Pheasant numbers have increased on the cooperating farms and the neighboring farmers see that increase. Habitat management for South Dakota pheasants has engendered a positive attitude toward the resource management agency and the pheasant in that state, in large part because of the Pheasant Restoration Program.

The attitude of many pheasant managers seems to be that the only solution to the pheasant cover problem is some type of federal program such as Soil Bank. This program idled land for more than a 1-year period and pheasants responded dramatically to the increased cover (Dahlgren 1967, Erickson and Wiebe 1973). Recent federal set-aside programs have not benefited pheasants because they idled land on an annual basis and did not require a cover crop. The current Payment-In-Kind (PIK) program has potential for pheasant management if it required that adequate cover be established and that contracts lasted longer than 1 year.

OTHER MANAGEMENT

The need for predator management was also mentioned a number of times by the pheasant workers. With cover occurring in "clumps" or small isolated areas, nests on these islands of cover are particularly vulnerable to many predators. Decimating factors such as predation must be considered in our pheasant management programs. Predator control would probably increase production on specific areas, but predator control on a large area is costly and probably not practical.

Perhaps stocking should be looked at anew. Grode (1972) evaluated use of penned hens bred by wild cocks for increasing pheasant production in Nebraska. This system could be used by individual farmers without much expense or labor for improving hunting on their farms.

CONCLUSIONS

It appears that most components of pheasant habitat are known and their importance recognized. Of these critical components, adequate productive nesting cover is most frequently in short supply. One aspect that must be recognized in future pheasant management is that such management must also be compatible with agricultural practices. Ecofallow and minimum tillage practices show promise for providing pheasant habitat while saving time, energy, and soil moisture for the agriculturalist. Mutually beneficial programs such as this would appear to hold the most promise for pheasant management.

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A GRAY PARTRIDGE WINTER HABITAT MODEL FOR THE GREAT LAKES REGION

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Abstract: We explored the relationship between environmental characteristics and gray partridge (*Perdix perdix*) winter distribution. Twenty-nine habitat variables were measured, partridge densities were estimated, and a radioed cohort was monitored during the winter of 1978-79, on a 56-km^2 area in east central Wisconsin. Factor pattern interpretation and multiple regression analyses were used to identify a "best" set of 5 habitat variables accounting for 72% of the linear variation in partridge densities (r=0.85, P=0.0015). We believe this mathematical function and corroborative radio-tracking data support the conclusion that winter habitat selection and subsequent distribution are a result of partridge antipredator and foraging behavior. This information was used to construct an evaluation model (PATREC) for predicting winter habitat suitability. The PATREC model consists of 5 habitat parameters and can be readily applied to regions with cereal-hay-corn agriculture in the Great Lakes portion of the gray partridge range in North America. The model is currently being used in New York to identify areas for partridge introductions.

A DRAFT HABITAT SUITABILITY INDEX (HSI) MODEL FOR GRAY PARTRIDGE

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Abstract: This paper presents a draft habitat evaluation model for gray partridge (Perdix perdix). The model is based on 2 assumptions: (1) habitat can be characterized numerically, and (2) any defined area can be compared to assumed optimum conditions to yield an index of quality. The availability of food and suitable cover/reproduction habitat are identified as the key components of gray partridge habitat. An example application of the model is presented to illustrate the relationship between habitat variables and habitat values. The model is a first attempt to formalize information concerning the habitat requirements of this species. It is hoped that this paper will stimulate interest in the development of a more detailed model that can be used for more precise evaluations of habitat quality for gray partridge.

There is an increasing need in the wildlife profession to more fully understand and quantify the relationships between wildlife species and their habitats. The use of standardized evaluation methods that focus on habitat can lead to more effective habitat quality assessment and communication between biologists, thereby promoting better fish and wildlife management. In addition, standardized habitat evaluation methods provide a framework around which species-habitat research can be focused. The U.S. Fish and Wildlife Service has developed the Habitat Evaluation Procedures (HEP) for use in impact assessment and project planning (U.S. Fish and Wildlife Service 1980). The HEP process uses habitat units to describe the potential value of an area for the wildlife species selected. Habitat units are the product of estimates of the quality and the quantity of a habitat. Habitat quantity can be estimated by standard mapping techniques employing aerial photographs to determine the area which can be potentially used by the species. Habitat quality is estimated through the use of a species-habitat model that results in a Habitat Suitability Index (HSI).

The HSI is a comparison between existing conditions on the study site and perceived optimum habitat conditions for the species. The index is a unitless value that ranges from 0.0 (no habitat suitability for the species) to 1.0 (optimum habitat conditions). A habitat suitability index model is used to obtain an HSI for a specific habitat or study area by identifying the habitat characteristics most needed by a species. A major assumption is that model output is positively correlated with potential long term habitat carrying capacity for the species (U.S. Fish and Wildlife Service 1980).

This paper discusses the development and potential use of a draft HSI model for the gray partridge. Model variables have been restricted to those for which information could be obtained through aerial photography or existing map data. Our objectives are to: (1) present the concepts and assumptions used in the development of a simple habitat model for the gray partridge, and (2) make the draft model available for review and improvement by individuals familiar with the ecology and habitat requirements of the species. It is our hope that the model can become a useful tool in the management decision-making process by presenting a systematic approach to the collection and analysis of habitat information.

METHODS

We have attempted to develop a habitat model that is based on easily obtainable habitat measurements yet yield outputs that correspond to estimates of gray partridge use of selected sites. This approach required the identification of variables functionally linked to life requisites for the species. Model variables and their assumed relationships to habitat quality were derived from a review of the available literature.

MODEL VARIABLES AND FUNCTIONAL RELATIONSHIPS

Based on a review of the literature, suitable food and cover/reproduction habitat appear to be the life requisites that determine habitat suitability for gray partridge. Food availability is assumed to be a function of the proportion of the evaluation area that is cropland. Cover/reproduction habitat is assumed to be a function of: (1) the proportion of the habitat that provides vegetative cover of sufficient height and density to meet the cover requirements of the gray partridge, and (2) the distribution of cover throughout the study area. Figure 1 illustrates these relationships between specific habitat variables, life requisite values, and the final HSI for the species.

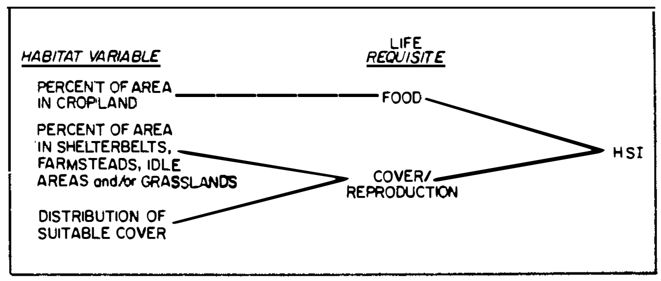

FIGURE 1. Relationships of habitat variables, life requisites, and the habitat suitability index in the gray partridge HSI model.

Life Requisite Values

Food. Populations of gray partridge thrive in regions where intensive agriculture occurs on the majority of the available habitat. Generally, studies throughout the range of gray partridge indicate a positive correlation in partridge population and the production of grain crops. For example, Weigand (1980) reported cultivated grains to be the staple food item of gray partridge throughout the year in Montana, and summer the only season in which grain consumption was less than 90% of the diet. Gray partridge in North Dakota fed on whichever grain crop was most available, while green plant material and insects were a small proportion of the diet on an annual basis (Kobriger 1970, 1977).

Because agricultural crops, primarily grains, provide the major portion of the diet of the gray partridge, we assume that other dietary requirements are met if adequate agricultural crops are available. Also, we assume that if 40% or more of the evaluation area is in crop production, optimum forage conditions for gray partridge are met. An evaluation area totally devoid of agricultural crops is assumed to have minimum (SI = 0.1) food value for the species. This information can be used to define the relationship between any existing value of the variable and a suitability index for the variable. Figure 2a illustrates the assumed relationship between cropland abundance and a food suitability index for the gray partridge.

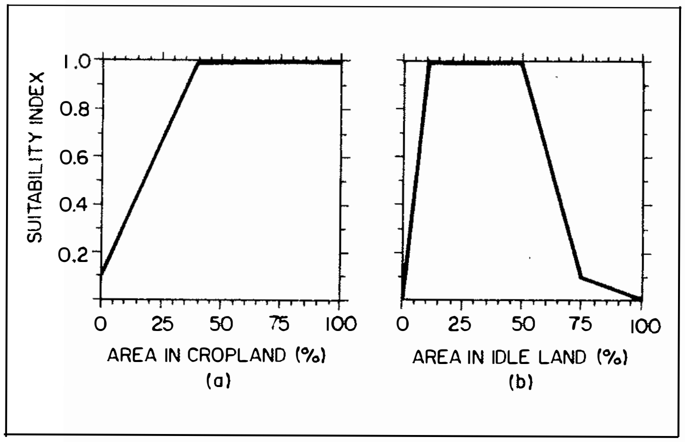

FIGURE 2. Habitat variables used for determining life requisite values for the gray partridge HSI model.

Cover/reproduction. Ungrazed idle lands, interspersed or adjacent to cropland, provide adequate reproductive and winter cover. The highest densities of gray partridge are most likely to occur in areas devoted to grain production and interspersed with small units of grassland, weeds, and brushy patches (Trippensee 1948). Idle areas (e.g., shelterbelts, farmsteads, and ungrazed grasslands) interspersed with agricultural lands, are believed to be an important component of winter habitat for the gray partridge in North Dakota (Schulz 1980) and Montana (Weigand 1980). Adequate winter cover for partridge in Wisconsin is provided by cover associated with fencelines and roadside ditches (Gates 1973). Row crop residues and pastures are also used as winter cover for gray partridge, although such cover is not believed to be preferred winter habitat (Smith et al. 1982).

Grass-dominated vegetation is the most prevalent cover selected by gray partridge for nest sites in Iowa (Bishop et al. 1977), Montana (Weigand 1980), North Dakota (Stewart 1975, Lokemoen and Kruse 1977), South Dakota (Hupp et al. 1980), and Wisconsin (McCabe and Hawkins 1946, Gates 1973). Conversely, forb-dominated vegetation provides poor nesting cover (Hupp et al. 1980, Weigand 1980).

Most gray partridge nest sites in North Dakota were located in residual vegetation from the previous growing season where roadside ditches, field edges, and idle land contained 52% of the partridge nests located (Lokemoen and Kruse 1977). Similarly, fencelines, roadside ditches, and hayfields accounted for 93% of the nest sites located in Wisconsin (Gates 1973). McCabe and Hawkins (1946) reported that preferred nesting cover is at least 45.7 cm tall. The average height of vegetation at nest sites in North Dakota was 44.1 cm (Lokemoen and Kruse 1977).

The cover/reproduction component of the gray partridge HSI model is based on the assumption that optimum conditions occur when 10-50% of an evaluation area is ungrazed nonagricultural land. Figure 2b illustrates the assumed relationship between the percent of the evaluation area that is potentially suitable cover/reproduction habitat and a suitability index for the variable. The suitability of an area is assumed to decrease as the percent of the area in potential cover increases above 50%. Extensive areas (over 50%) of ungrazed nonagricultural habitat provide a minimum of the edge habitat preferred for nesting.

Although the total amount of potentially suitable cover/reproduction habitat may be in the optimum range (10-50%), the juxtaposition of cropland and suitable cover may have a significant effect on the overall cover value for the species. Areas of cropland, well interspersed with suitable cover, are of higher value as gray partridge habitat than areas where the cover is concentrated as a large homogeneous unit or as only a few isolated sites. One way to evaluate the interspersion of cover and cropland is to divide each 2.56 km^2 of the evaluation area into 64 equal subareas, each 4 ha in size. This can be done with a grid overlay on an aerial photograph or cover type map of the evaluation area. We assume that a 4 ha unit of habitat is the minimum area that can effectively be managed to increase gray partridge production. Each one of the 64 cells on the overlay represents a 4 ha area with a potential index value of 0.0156 (i.e., each grid cell represents 1.56% of the total area). An index for the distribution of suitable cover on any area can be determined by identifying the total number of grid cells that contain or border potentially suitable cover and then multiplying the total number by 0.0156. Cells that do not contain, or do not border, potential cover/reproduction habitat have a value of zero. An area with potential cover/reproduction habitat available in every 4 ha grid cell will have a cover distribution suitability index of 1.0.

The abundance and distribution of potential cover/reproduction habitat are assumed to be of equal value in determining a final suitability index for the cover/reproduction life requisite. These 2 habitat variables are assumed to be compensatory. For example, a small percentage of an evaluation area providing cover/reproduction habitat may be offset if the existing cover is well interspersed throughout the area. Conversely, the cover/reproduction suitability index may be relatively low if the cover is concentrated in 1 block, even when the total percentage of the evaluation area in suitable

Table 1. Field data values, suitability indices, and the resulting overall habitat unit values for 3 hypothetical evaluation areas.

Area	Cropland (%)	SI[a]	Shelterbelts idle areas, or grassland (%)	SI[b]	Distribution[c] suitable cover	SI[d]	Life requisite values (HSI = minimum value): Food	Cover/reproduction[e]	Habitat area (ha)	Habitat unit (area x HSI)
1	95	1.00	5	0.50	14	0.22	1.00	0.33	256	84
2	95	1.00	5	0.50	62	0.97	1.00	0.70	256	179
3	20	0.55	80	0.08	50	0.78	0.55	0.25	256	64

a SI values for this variable are based on the relationships presented in Figure 2a.

b SI values for this variable are based on the relationships presented in Figure 2b.

c The total number of 4 ha grid cells per 2.56 km^2 that contain potential suitable cover.

d Determined by multiplying the number of grid cells that contain cover by 0.0156. Each grid cell equals 1.56% of 2.6 km^2.

e The food life requisite value equals the SI obtained from Figure 2a. The cover/reproduction life requisite value = (SI of % area in shelterbelts, idle areas, etc. x SI of distribution of suitable cover)$^{1/2}$.

cover is of optimum value. The geometric mean of the indices (i.e., the square root of the products) for abundance and distribution of cover equals the suitability index for cover/reproduction habitat.

HSI determination. The final HSI for the gray partridge is equal to the lowest value obtained for food or cover/reproduction, based on the limiting factor concept.

APPLICATION OF THE MODEL

Table 1 illustrates the relationships between field data, model variables, and the final HSI for gray partridge on 3 hypothetical evaluation areas. Area 1 consists of 95% cropland, with 5% of the area in land use other than agriculture. The suitability index (SI) for food is 1.0, while the SI for abundance of cover/reproduction habitat is 0.50. However, because potential cover is contained in only 14 of the 64 possible grid cells, the index for cover distribution is 0.22. Therefore, the final cover/reproduction index is 0.33 (i.e., $[0.5 \times 0.22]^{1/2}$). Because the HSI is equal to the lowest suitability index obtained for food or cover/reproduction, the HSI is 0.33, even though the SI for food is 1.0. The area under evaluation (256 ha) is multiplied by the HSI (0.33) to yield the number of Habitat Units (84 HU's) for the gray partridge in Area 1. The Habitat Units value indicates that the equivalent of 84 ha of optimum gray partridge habitat is present on the 256 ha area being evaluated.

The cover type composition of Area 2 is identical to that of Area 1. However, the distribution of potential cover/reproduction habitat is more extensive, resulting in a cover/reproduction index of 0.70. The final HSI equals 0.70 in this example, which results in a total of 179 HU's, more than twice the amount in Area 1.

Evaluation Area 3 contains 20% cropland and 80% nonagricultural land. The food index in this example equals 0.55. The evaluation area that is potentially suitable cover/reproduction habitat is distributed in 50 grid cells, resulting in a distribution index of 0.78. However, the index for abundance of cover/reproduction habitat is low (0.08), because the total amount of potential cover exceeds the assumed optimum conditions (10-50% of the area). The final cover/reproduction index equals 0.25. It should be noted that, even though the food value in this example is lower than in previous examples, the final HSI is determined by the cover/reproduction value, which is the lowest life requisite value. Therefore, the HSI for Area 3 is 0.25, resulting in 64 Habitat Units.

DISCUSSION

We have presented a simple model for the evaluation of gray partridge habitat that is intended for use with data obtained through remote sensing. The model, in its present form, can be used to identify overall habitat quality and rank sites in terms of their habitat potential for the species. Higher resolution evaluations can be made with the development and use of a more detailed habitat model. For example, the current HSI model considers only the presence of cropland in determining the food value for an evaluation area. A more precise estimate of habitat potential can be obtained by evaluating the type of crops present and overwinter crop management practices. Similarly, the presence of ungrazed land may not accurately reflect the potential of an area as cover/reproduction habitat. A more accurate estimate can be made by including such variables as the species composition of woody and herbaceous vegetation, height and density of herbaceous vegetation, and vegetation management practices in the model. The technique for measuring the distribution of suitable cover was developed specifically for the gray partridge HSI model. Other estimates of edge, or habitat diversity, may be more accurate indices of cover distribution.

Habitat Units can be used for several purposes. The Habitat Evaluation Procedures provide a framework in which HU's can be compared. Comparisons can be made for a single area at various points in time or for several areas at a given point in time. HU's can be used as a tool for predicting the impacts of various land uses, the formulation of mitigation plans, and the evaluation of the results of management activities. HEP provides biologists with a useful tool; however, the models used for species-habitat evaluation must be acceptable to the users.

Habitat models do not need to precisely mimic animal abundance to be of value in land use planning (Farmer et al. 1982). HSI models provide a format for the systematic use of habitat information in making value judgments about the effects of various management options. The operational acceptance of a model is dependent on whether or not the model provides useful information for land use decision-making. This level of acceptance can be attained through improved communication among model builders, users, and biologists familiar with the ecology of the species. We view this presentation as an attempt to improve this communication. The goal is to build and use HSI models that are useful tools for management and decision-making processes. Constructive criticism is welcome and extremely useful in developing meaningful models. Input is particularly useful when it comes from individuals who are familiar with the habitat needs of a given species.

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Glenn D. Chambers

PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop
28-30 March 1983, Campbellsport, Wisconsin

PHEASANT HABITAT ASSESSMENT AND THE PATREC MODEL

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Abstract: A pattern recognition model (PATREC) for assessing habitat quality for ring-necked pheasants (*Phasianus colchicus*) in the central High Plains, including eastern Colorado, was developed. PATREC infers recognition of patterns of habitat features that are associated with different levels of long-term population density. The model included 13 quantified components, including soil type, precipitation, composition of vegetation, and land use, which are considered essential to pheasant abundance in the central High Plains Region. The model can be used to (1) estimate long-term pheasant carrying capacity of a given unit of land, (2) identify habitat features which may, if manipulated, improve habitat quality and increase pheasant density, and (3) permit a quantified assessment and comparison of habitat values among selected land units.

THE COOPERATIVE DEVELOPMENT OF A PRIVATE LAND WILDLIFE HABITAT APPRAISAL GUIDE FOR MISSOURI: A SYNOPSIS

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Nearly 95% of Missouri's 44 million acres of land is in private ownership and management of this land base is critical to the state's wildlife resource. The conversion of woodland and marginal lands to more intensive uses, such as cropland, grassland, and urban areas, has reduced the wildlife habitat base in Missouri and resulted in increased soil erosion.

The Soil Conservation Service (SCS) and the Missouri Department of Conservation are the 2 principal agencies that provide direct technical assistance to the private sector on land-use and management. Since field personnel from both agencies can influence management decisions that affect wildlife habitat, a standardized habitat appraisal system was necessary. Both agencies needed a procedure to measure the quality of existing wildlife habitat, display the effects of alternative land-use recommendations and identify the effect of planned and implemented management proposals on habitat.

The Wildlife Habitat Appraisal Guide (WHAG) for Missouri is a field evaluation procedure designed to measure the quality of habitat for a selected wildlife species. Twelve appraisal guides were developed including bobwhite quail (Colinus virginianus), white-tailed deer (Odocoileus virginianus), wild turkey (Meleagris gallopavo), cottontail rabbit (Sylvilagus floridanus), mallard (Anas platyrhynchos), giant Canada goose (Branta canadensis), fox squirrel (Sciurus niger), gray squirrel (Sciurus carolinensis), prairie-chicken (Tympanuchus cupido), mourning dove (Zenaidura macroura), ruffed grouse (Bonasa umbellus), and ring-necked pheasant (Phasianus colchicus), which represent the species of greatest interest to private landowners. The appraisal system, derived from an earlier SCS guide and the Fish and Wildlife Service Habitat Evaluation Procedures (U.S. Dep. Int., Fish and Wildl. Serv., Div. Ecol. Serv., Washington, D.C. 1980), is based on the assumption that habitat quality can be described by a numerical habitat suitability index. The index is a measure of how well existing and planned habitat conditions compare to optimum conditions for a species. Index values were calculated with species habitat models derived from "A Handbook for Terrestrial Habitat Evaluation in Central Missouri" (Basket et al., U.S. Dep. Int., Fish and Wildl. Ser. Resour. Publ. 133, 1980). The appraisal guide displays, in matrix form, structural components or habitat characteristics, along with numerical scores needed to calculate a habitat index for individual fields or woodlands, or entire farms by species. Copies of the appraisal guides are available from the authors.

PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop
28-30 March 1983, Campbellsport, Wisconsin

INTERPRETATION OF PHEASANT HABITAT USING SATELLITE IMAGERY

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Abstract: Landsat digital data were used to map land cover to evaluate ring-necked pheasant (*Phasianus colchicus*) habitat in northwestern Missouri. Imagery data for 4 counties (633,980 ha) were interpreted using computer processes and ground reconnaissance. The land cover classification resulted in 7 to 12 classes in Atchison, Harrison, Nodaway, and Worth counties. Overall map accuracy of 93% and 94% were achieved for Atchison and Nodaway counties, respectively. A significant correlation ($P < 0.05$) was found between audio indexes from 1980 and percent row crop within 3 counties. Percent available winter cover (grasses or weeds in field/forest edges, drainages or pastures) correlated positively ($P < 0.05$) with total pheasants observed by 7.5 minute quadrangles in all 4 counties. The mean total pheasants observed for 1979-81 correlated significantly ($P < 0.05$) with available nesting cover in Harrison County only. Landsat digital analysis was considered an effective technique for mapping vegetative cover classes important to ring-necked pheasants. Costs for mapping were estimated at 0.82 cents/ha.

Ring-necked pheasant populations were established in Missouri through release programs that began in 1930 with the most recent releases made in 1980 (Christisen 1951, Chambers 1970, Cary 1981). Prime pheasant range in the state is centered on agricultural lands in the 20 most northern counties. Pheasant densities vary considerably within their range. A study of the limiting factors of habitat, as determined by land use and vegetative cover, was needed to explain the regional differences in pheasant populations and provide important clues for future management. Traditional field inventories are costly and time consuming, especially over large areas. Landsat satellite data have proved an effective tool for wildlife habitat studies involving regional analysis and monitoring (Katibah and Graves 1978, Aldrich 1979, Anderson et al. 1980, and Craighead 1980).

The objectives of our study were to (1) use Landsat data to classify general land use (row crop, small grains, pasture and hay, and linear brushy cover) for a portion of ring-necked pheasant range, (2) interpret pheasant habitat components from the Landsat classification for comparison with pheasant population data for the study area, and (3) perform detailed map accuracy and cost assessments of the Landsat analysis.

We thank the staff of the Geographic Resources Center, University of Missouri, for their assistance with the Landsat data analysis. We also thank S.L. Sheriff for statistical advice and P.S. Haverland for assistance with data analysis.

STUDY AREA

Land cover was evaluated and pheasant populations were estimated in 4 northwestern Missouri counties (633,980 ha) within the state's prime pheasant range (Fig. 1). The study area comprises a portion of the Deep Loess Hills and Heavy Till Plain Land Resource Areas, as classified by the Soil Conservation Service (Austin 1972). Nearly 75% of the area's presettlement vegetation was prairie (Schroeder 1981), while soybean and corn production and pastureland are the dominant land uses today.

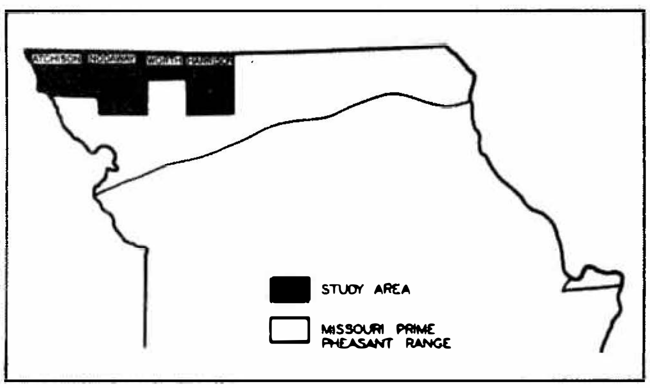

FIGURE 1. The 4-county study area in northwestern Missouri.

Topography varies from an extensive Missouri River alluvial floodplain on the western border to an intricately-dissected upland, with ridgetop to valley relief of up to 61 m. The region's land use trends over the past decade have shown rapid transition from permanent vegetation (grassland and forests) to cultivated cropland on the highly erodible loess and glacial till soils. Pheasant densities range from the state's highest to moderately low within the 4 counties.

METHODS

Digital Landsat data collected 5 June 1980 were analyzed with computer techniques to provide land cover information for the study area. The selected data set was the most recent high-quality, cloud-free, late spring image available at the time of purchase. The spring date simplified the separation of cropland (bare soil) from grassland and forest in our predominantly agricultural study area. Based on improved software capabilities the following year, a multi-temporal analysis technique (6 April and 17 June 1981) was used for Harrison County. Knowledge of crop and vegetative phenology in the study area was used for selection of these 2 dates. Each of the 4 counties was evaluated independently to minimize the influence of topographic and land use differences. Also, by selecting county-sized areas for processing, the amount of data handled at one time was reduced.

Prior to classification, the Landsat data were geographically referenced to the Universal Transverse Mercator (UTM) coordinate system using ground control points. Meyer (1978) defined the technique as a site-specific analyses. Control points were land features such as farm ponds and road intersections, that could be accurately located in the Landsat data and on maps registered with the UTM grid. To facilitate the selection of control points, the raw Landsat data were displayed on a black and white monitor. The displayed area was located on U.S. Geological Survey (USGS) 7.5 minute quadrangle maps. As control points were identified, the element and line (row and column) number of the Landsat pixel (0.45 ha) and its corresponding UTM coordinates were recorded. One or 2 points per quad map were selected. The coordinate values of the control points were used to calculate coefficients based on the method of linear approximation that mathematically defined the relationship of the UTM and element-line coordinates. These coefficients allowed for each Landsat pixel of the study area to be registered to the UTM grid within 50 m accuracy.

After geometric correction, the digital spectral data were processed into land cover information using an unsupervised technique called SEARCH (National Aeronautics and Space Administration 1972) implemented on a PDP 11/50 computer system. The SEARCH algorithm employs statistical parameters for homogeneity set by the user, then identifies statistically-separable clusters (spectral classes) by sampling the spectral response values of the Landsat data. Each Landsat pixel was assigned to a spectral class using a modified maximum likelihood algorithm based on the decision rule generated by SEARCH. In the 2-date analysis, the decision rule considered spectral data from both dates.

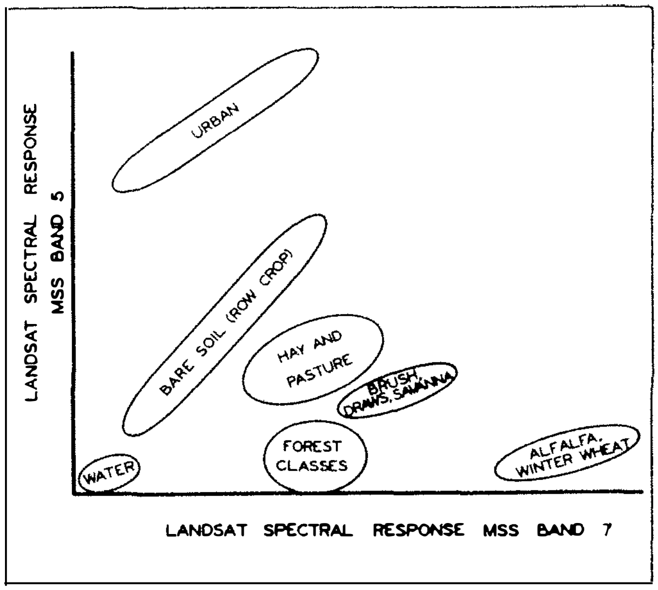

FIGURE 2. Theoretical model showing relative graphic positions of individual classes (land cover categories) in spectral bands 5 and 7.

Spectral classes were systematically reviewed for identification as vegetative or land cover categories. Two-dimensional plots showing the average response of each class in spectral bands 5 and 7 (Fig. 2) were used to predict which spectrally similar clusters might represent the same resource class. The data were also displayed on a color monitor and compared with known locations of land cover types gathered from aerial photography, aerial reconnaissance, and field visits. With these techniques the spectral classes were grouped and assigned land cover category names that appropriately described the ground conditions represented by each. A deliberate attempt was made to avoid highly discrete category names that mask inherent spectral overlap.

The accuracy assessment procedure used to evaluate the land cover classification in 2 of the counties was based on acceptance sampling and the binomial probability density function (Ginevan 1979). A computer algorithm was written to randomly generate a sample of points, stratified by land cover category from the Landsat classification file. Ninety-three sample points, each 1 Landsat pixel (0.45 ha) in size, were selected for each class. Sample point locations were machine plotted at 1:24,000 scale and registered to the appropriate USGS orthophoto quad map. The land cover classification at each point was judged correct or incorrect using medium altitude 35mm aerial color slides. A maximum of 8 misclassifications per stratum was tolerable for the class to be 85% correct, with a 0.05 probability of accepting an inaccurate class or rejecting a class mapped at greater than 95% accuracy.

Pheasant population indexes in the study area were determined in the spring using a 16-km crowing cock survey and in the late summer using a 48-km roadside survey. Spring audio indexes were calculated for each county and summer visual indexes were calculated for each quad and county for 1979-81. Pearson Product Moment and Spearman Rank Order correlation coefficients were generated for several combinations of pheasant indexes and the land cover statistics (Snedecor and Cochran 1978).

RESULTS

The land cover classifications for the 4-county study area were based on stratified processing by county of spectral signatures generated from a single-date Landsat data set for Atchison, Nodaway, and Worth counties and a 2-date data set for Harrison County. Using the unsupervised SEARCH clustering procedure, 35 to 45 spectral classes were discriminated per county. Following the interactive grouping procedure, 9 land use categories were identified in Atchison County, 7 in Nodaway County, and 8 in Worth County (Table 1). Twelve land cover categories were identified in Harrison County (Table 2). The land cover categories mapped for each county were similar. The largest variation appeared in Atchison County where an extensive floodplain of the Missouri River resulted in 2 categories, classes 8 and 9, not present in the other counties. The differences in permanent grassy vegetation were more accurately discernable in Harrison County using the 2-date analysis (Classes 3, 4, and 6). Corn, soybeans, and winter wheat were separated into unique classes (Classes 1, 2, and 8, respectively).

Output products from the Landsat classification file included tabular data and line printer and drum plotter maps. Area tabulations were made for each land cover class by county and 7.5 minute quad. Line printer maps scaled at 1:24,000 and 1:63,360 were generated to assist in grouping the spectral classes and to display the final classification. High resolution, color CALCOMP drum plotter

Table 1. Landsat classification of land cover in 3 counties in northwestern Missouri, 5 June 1980.

Land cover class (No./description)	Atchison County Ha	Atchison County % of total	Nodaway County Ha	Nodaway County % of total	Worth County Ha	Worth County % of total
1. Row crop, bare soil	101,638	69.5	117,203	51.2	22,204	31.9
2. Grazed pasture, cut hayland, short grasses	16,245	11.1	31,845	13.9	32,394	46.5
3. Grasses w/scattered trees, field/forest edges, old fields	9,410	6.5	25,355	11.1	5,686	8.2
4. Tall grasses, weeds in edges, drainages, pastures	7,291	5.0	15,982	7.0	4,855	7.0
5. Alfalfa, clover, wheat, tall grasses/weeds	4,167	2.9	27,304	11.9	370[a]	0.5[a]
6. Forest, densely stocked	2,268	1.6	5,838	2.6	2,016	2.9
7. Forest, medium stocked	2,244	1.5	5,279	2.3	1,006	1.4
8. Saturated bare soil, shallow standing water	2,837	1.9	b	b	b	b
9. Water	19		b	b	b	b
10. Wheat, mixed trees/grasses	b	b	b	b	1,122	1.6
Total	146,128	100	228,806	100	69,653	100

[a] Wheat not included in class for this county.

[b] No such class in this county.

Table 2. Landsat classification of land cover in Harrison County, northwestern Missouri, 6 April and 17 June 1981.

Land cover class (No./description)	Ha	% of total
1. Soybeans	33,965	17.9
2. Corn	15,433	8.1
3. Grazed pasture, cut hayland, short grasses	85,943	45.4
4. Alfalfa-alfalfa/brome hayland	141	0.1
5. Forest, densely stocked	10,572	5.6
6. Savanna pasture, grazed woodlot, forest, lightly stocked	22,444	11.9
7. Tall grasses, weeds in edges, drainages, draws	8,559	4.5
8. Winter wheat	10,205	5.4
9. Wetland	0	0.0
10. Water	172	0.1
11. Urban	1,495	0.8
12. Strip mines, quarries, barren lands	451	0.2
Total	189,380	100.0

maps were produced at the same scales using a FORTRAN IV algorithm written specifically for the study. The plotting procedure accepted data for any sub-section of the Landsat file and plotted at any scale within the physical limits of the plotting surface.

Accuracy assessment of the classification were completed for Atchison and Nodaway counties only (Table 3). The stratified sampling technique allowed for evaluation of individual class as well as overall map accuracies. Out of the 15 strata tested, 5 failed to meet 85% accuracy. These classes accounted for 8% of the total mapped area for Atchison County and 20.4% for Nodaway. Overall map accuracies were calculated from:

$$P_o = \sum_{i=1}^{h} W_i \frac{Y_i}{n} \qquad (1)$$

where

P_o = overall proportion correct,
W_i = proportion cover type i is of the total,
Y_i = number correct for sample of cover type i,
n = sample size, and
h = number of strata.

Table 3. Assessment of Landsat classification accuracy, Atchison and Nodaway counties, Missouri (N=93/class).

County	Class no.	N wrong	Proportion correct of N	95% CI	Overall accuracy (weighted strata mean)
Atchison	1	5	0.946	0.9924-0.8996	
	2	6	0.935	0.9854-0.8846	
	3	17 [a]	0.817	0.8962-0.7378	
	4	8	0.914	0.9712-0.8568	
	5	3	0.968	1.0000-0.9319	93.6%
	6	1	0.989	1.0000-0.9674	
	7	20 [a]	0.785	0.8691-0.7009	
	8	2	0.978	1.0000-0.9482	
	9	b	b	b	
Nodaway	1	3	0.968	1.0000-0.9320	
	2	2	0.978	1.0000-0.9480	
	3	9 [a]	0.903	0.9630-0.8430	
	4	22 [a]	0.763	0.8500-0.6760	94.4%
	5	1	0.989	1.0000-0.9670	
	6	2	0.978	1.0000-0.9480	
	7	27 [a]	0.710	0.7390-0.6810	

[a] Class failed 85% accuracy test as individual stratum.

[b] Not tested.

Each class was weighted by its percent of the total area classified. Overall accuracies of 93.6% and 94.4% ($P < 0.05$) were achieved for Atchison and Nodaway counties, respectively. These results far exceed the range of 80-90% reported for generalized land use mapping (Anderson et al. 1976, Aldrich 1979, Cannon et al. 1982).

Land cover categories were interpreted as components of pheasant habitat. For Atchison, Nodaway, and Worth counties, percentage row crop (Class 1) was positively correlated ($P<0.05$) with spring crowing cock indexes within the 7.5 minute quads where the census routes operated (Table 4). The proportion of each county in grazed pasture or hayland showed a negative relationship to bird indexes but did not correlate significantly ($P>0.05$).

Pheasant indexes were also compared with available cover as interpreted from the classification scheme. Pheasant winter and nesting cover were evaluated from the land cover classes by individual county. The tall grasses and forbs in field/forest edges, draws, and waterways class best represented winter cover for pheasants in these northern Missouri counties. The percentage of winter cover (Class 4 in Atchison, Nodaway, and Worth counties and Class 7 in Harrison County) was positively correlated ($P < 0.05$) with total pheasants observed by 7.5 quad for all counties (Table 5).

The second pheasant habitat component analyzed was nesting cover. The conglomerate class named alfalfa wheat and vigorous tall grasses (Class 5) best represented pheasant nesting

Table 4. Comparison of percent row crop to male pheasant audio indexes by quadrangle in 3 northwestern Missouri counties, 1980 (Spearman r = 0.82, N = 6, P < 0.05).

County	7.5 minute quadrangle	Percent row crop	Audio index[a]
Atchison	Langdon	84.5	19.7
	Skidmore SW	53.4	17.5
Nodaway	Parnell NW/Bedford SW	42.4	4.2
	Skidmore NE	67.6	2.9
Worth	Blockton SE	29.9	1.8
	Grant City NE/Bethany NW	18.6	0.7

[a] Calls/2 minute stop.

Table 5. Comparison of percent winter cover to total pheasants observed by quadrangle in 4 northwestern Missouri counties, August 1979-81 (N=16).

County	7.5 minute quadrangle	Winter cover (%)	Pheasants/mi 1979[a]	Pheasants/mi 3-year mean[b]
Atchison	Farragut SE	5.3	0.50	0.43
	Coin SW	11.1	2.92	1.63
	Skidmore NW	7.4	2.00	1.20
	Tarkio NE	5.4	0.48	0.53
	Skidmore SW	8.9	0.00	0.53
Harrison	Blythedale SW	5.7	0.20	0.20
	Bethany NW	3.5	0.40	0.30
	Lamoni SW	3.3	0.80	1.00
Nodaway	Skidmore SE	1.4	0.00	0.03
	Skidmore NE	2.6	0.00	0.07
	Coin SE	7.0	0.50	0.92
Worth	Bethany NW	6.3	0.00	0.00
	Grant City NE	8.2	0.00	0.00
	Blockton SE	7.4	0.45	0.51
	Blockton SW	6.4	0.13	0.84
	Bedford SE	6.3	0.25	1.25

[a] Pearson r = 0.48, N = 16, P < 0.05; N pheasants and % winter cover.

[b] Pearson r = 0.49, N = 16, P < 0.05; N pheasants and % winter cover.

Table 6. Comparison of percent nesting cover to total pheasants observed by quadrangle in Harrison County, August 1979-81 (Pearson $r = 0.99$, $N = 3$, $P < 0.05$).

7.5 minute quadrangle	Nesting cover (%)	Pheasants/mi (3-year mean)
Blythedale NW	0.1	0.2
Bethany NW	0.1	0.3
Lamoni SW	6.2	1.0

cover in Atchison, Nodaway, and Worth counties. In Harrison County, a distinct alfalfa-alfalfa/brome type (Class 4) was identified and assumed used as nesting cover by birds in that county. No significant correlations ($P > 0.05$) were found between available nesting cover and pheasant abundance in Atchison, Nodaway or Worth counties. However, a significant positive correlation ($P < 0.05$) was found between nesting cover and the 3-year mean of total pheasants in Harrison County (Table 6).

DISCUSSION

The inherent limitations of a single-date Landsat analysis were evident in the classification schemes achieved for Atchison, Nodaway, and Worth counties. Seasonal spectral overlap among land cover types prohibited complete discrimination of key pheasant habitat components. Key pheasant nesting cover (undisturbed grassy vegetation) was confused with the spectral signature of other vegetation types. For example, in the 5 June 1980 data, immature winter wheat was spectrally inseparable from grasses, weeds, and pasture legumes, creating the mixed categories of Classes 5 and 10. Nondiscrete class labels were used to acknowledge this spectral overlap while maintaining acceptable map accuracy.

Many of the difficulties in distinguishing discrete land cover classes were overcome in Harrison County by using a 2-date analysis. For example, the change of winter wheat from green to mature over the 6 April to 17 June period allowed it to be spectrally separated from pasture and other grassy vegetation which remained relatively static over the same time period. Two distinct row crop classes were identified because of variations in planting and growth cycles of these crops.

Transition classes, e.g., Classes 3, 4, and 7 were also characteristic of Landsat land cover mapping. These occurred because the spectral values of a given 0.45 ha pixel were influenced by more than one vegetative type. Analysts lumped these mixed classes to create the larger, more homogenous cover types. In this study, these mapped edge classes provided important information on available winter cover for pheasants such as uncultivated field borders and waterways.

Correlations between ring-necked pheasant indexes and the Landsat land cover classes further substantiated the relationships reported in other Midwest studies. The importance of small grain or cash grain production to pheasant numbers has been documented in Wisconsin (Wagner et al.

1965), and Iowa (Farris et al. 1977). The Landsat-generated classification scheme used in this study showed percent row crop by county and by quadrangle to be significantly correlated to pheasant abundance in Missouri. Our results also indicated the importance of weedy draws, waterways, and other non-grazed, idle grassy areas as winter refuges for Missouri pheasants. In Illinois, Labisky et al. (1964) reported that idle lands were not vital to pheasants; whereas, Kimball et al. (1956) mentioned waste or idle land as key habitat for ring-necks in the plains states.

MacMullen (1961) believed that a shortage of nesting cover was the principal limiting factor throughout most of the pheasant range. Information from this study concerning nesting cover was not conclusive because spectral overlap prevented the mapping of critical nesting cover types (alfalfa, wheat, and native grasses) as discrete classes in 3 of the 4 counties. Analysis of the 2-date Landsat data set did allow for enhanced discrimination between non-forested vegetation. The amount of alfalfa-alfalfa/brome cover was significantly correlated with pheasant abundance, perhaps reflecting its importance as nesting cover. Results of this study showed that the analysis of a single-date Landsat data set was a uniform, rapid, and cost-effective method to classify vegetative cover classes important to ring-necked pheasants in Missouri. However, the 2-date analysis is recommended over the single-date approach and is being used in a follow-up pheasant habitat mapping project in northeastern Missouri.

Project costs, including data purchase, computer processing, field verification, tabular and graphic output, and accuracy assessment, were estimated at 0.82 cents/ha.

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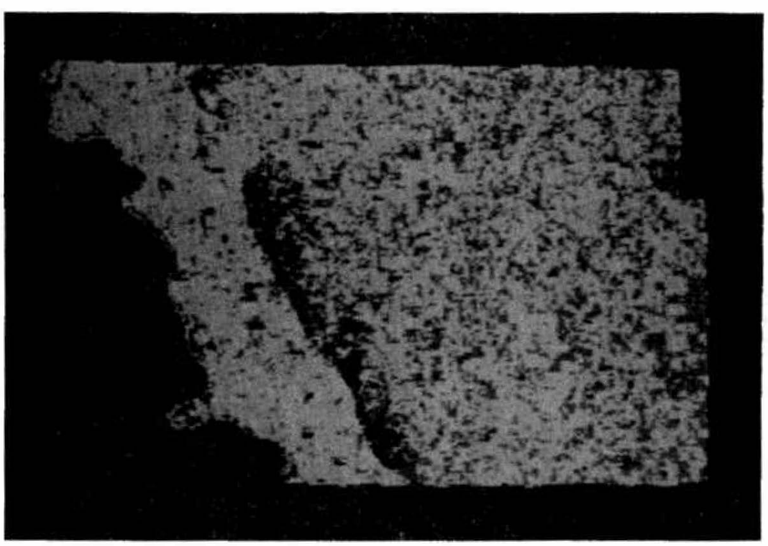

A Landsat classification of Atchison County, Missouri, aggregated to Level I land cover types: white is bare soil; black is forest; gray is hay and pasture land.

PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop
28-30 March 1983, Campbellsport, Wisconsin

INTENSIVE PHEASANT MANAGEMENT ON THE HARLAN COUNTY RESERVOIR: A SYNOPSIS

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Habitat development on public land plays an important role in Nebraska's Wildlife Habitat Development Program which is funded by the $7.50 Habitat Stamp required for all hunting. Harlan County Reservoir in southcentral Nebraska is a large block of public land being intensively developed under this program. The Reservoir is a 30,000 acre flood control, irrigation, and recreation project on the Republican River. The project consists of a 13,000 acre lake and 17,000 acres of uplands. Wildlife management and general recreation are the designated uses on slightly more than 14,000 acres.

The Corps of Engineers, Game and Parks Commission, and Nebraska Forest Service at the University of Nebraska, Lincoln entered into a 3 party cooperative agreement during the fall of 1977 to develop and improve wildlife habitat on the Reservoir. The Corps is the land management agency and assumes title to and responsibility for future maintenance of all developments. The Game and Parks Commission provides technical assistance in developing and implementing the program and funding for improvements from Habitat Stamp revenues. State Forest Service personnel are responsible for development design and the implementation phase of the program.

Project lands at Harlan County are characterized by a diverse animal community which includes the ring-necked pheasant, (Phasianus colchicus), bobwhite quail (Colinus virginianus), wild turkey (Meleagris gallopavo), mule (Odocoileus hemionus) and white-tailed deer (Odocoileus virginianus), mourning dove (Zenaida macroura), raccoon (Procyon lotor), plus, squirrels (Sciurus sp.), rabbits (Sylvilagus sp.), waterfowl, raptors, and songbirds. The area is of minor importance as a waterfowl production area, but it is an important wintering and harvest area for both mallards (Anas platyrhynchos) and Canada geese (Branta canadensis). The area is also one of the most important bald eagle (Haliaeetus leucocephalus) wintering areas in the state. The contribution of Harlan County Reservoir to harvest oriented and non-consumptive wildlife recreation far exceeds what would be expected from an area this size.

During the planning phase of the program, it was decided that all of the species should and would receive management consideration. However, emphasis would be placed on managing a major portion of the area for pheasants and bobwhite quail.

To measurably affect populations of pheasants and other wildlife on the area, it was necessary to extensively alter the habitat on this area. Previous research had revealed a positive and statistically significant relationship between an index to interspersion of cover types and pheasant and quail densities (Baxter and Wolfe, Life history and ecology of the ring-necked pheasant in Nebraska, Nebr. Game and Parks Comm., Lincoln, 1973; Taylor et al., Wildl. Soc. Bull. 6:226-230, 1978). Therefore, it was decided to increase plant diversity and the interspersion of cover types on project lands.

Developments installed to increase plant diversity and habitat interspersion included:

(1) Installation of 100 ft wide grass-legume strips to break up the large blocks of cropland which occurred on the area. Approximately 700 acres or 58 miles of grass and legume cover was established in this configuration in cultivated areas on the project.

(2) Transition zone plantings of grass, legumes, and shrubs were established between riparian timber and cropland. Transition zone plantings varied in width from 60 to 150 ft. More than 300 acres of land were devoted to this linear cover type.

(3) Boundary line plantings consisting of trees, shrubs, grasses, and legumes were established in 75 to 150 ft wide strips around the perimeter of the area. Forty-seven miles of these plantings were installed as wildlife habitat and a permanent boundary delineation for public hunting. The diversity provided by these linear developments also favorably impacts wildlife on adjacent private lands.

(4) Cluster Units are small (1/4 to 5 acres) enclosures established in areas subject to grazing. With a drainage, 2 to 5 of these units were established as a group. Each unit within a cluster was within 200 yards of another unit or development such as a boundary line planting. Trees or shrubs were planted in some units while others were just fenced to protect existing or invading woody species.

(5) Four small wetlands (1/8 to 8 acres) with drawdown capabilities were constructed and several more are in the planning or design stages of development. These areas are drained or partially drained in July and seeded with Japanese millet. Heavy use by pheasants, quail, and waterfowl was observed.

(6) Aerial seeding of Japanese millet on mudflats, inlets, and bays on the reservoir proper was accomplished when proper conditions prevailed. Millet seeded as late as 10 August matured and produced seed. These seeded flats were used extensively by pheasants in the fall. Primary waterfowl usage occurred during spring migration when the areas were reflooded.

Coincident with the habitat development program the Corps has been implementing major land use changes on the Harlan County Reservoir. These changes have had a positive impact on populations of pheasants and other wildlife. The 2 programs are complimentary.

Large agricultural crop fields were divided into 10 to 20 acre units separated by 100 ft wide grass strips which were installed under the habitat program. Mandatory crop rotations were implemented on all units and soil and water conserving practices such as minimum till or ecofallow were encouraged. The combination of smaller fields and mandatory rotations, which included small grains as well as row crops, resulted in a mosaic pattern of diverse cover on the area. Fall plowing, harvest of ensilage, and gleaning with livestock were eliminated as allowable practices.

Grazing was a particular problem on several thousand acres of rangeland on the Harlan County Reservoir. Most of the area was dominated by buffalo grass (Buchloe sp.) and blue grama (Bouteloua gracilis) due to persistent overgrazing. Therefore, grazing was terminated on project lands for an indefinite period. Vegetative response to the exclusion of grazing was rapid and dramatic. In one season mid to tall native grasses and legumes replaced the short grasses on all but the shallowest soils. Future grazing will be based on management needs, and be short term in nature. Controlled burning and hay production will be used as the primary vegetation management tools on these areas.

The harvest of tame hay was delayed after 1 July to provide secure nesting cover during the peak pheasant hatching period. Harvest of native hay occurred in late July or early August and was implemented on a rotational and strip-harvest pattern.

To increase diversity and interspersion on rangelands, suitable sites were converted to crop production.

Five percent of all agricultural row crops were left standing until 1 March of the following year to provide a readily available supply of high energy food during severe winter weather.

The Cooperative Habitat Development project was initiated without provision for formal evaluation of the impact upon wildlife populations. This is a management project and it was decided that we had sufficient data on the habitat needs of pheasants and other species to proceed with the project.

Although we lack quantitative data on the impact of these programs on pheasant numbers, we do have detailed information on land use and habitat changes, as well as good indicators of hunter use and success on the area. These factors suggest a larger pheasant population now than prior to development.

The Cooperative Habitat Development Program and the land use modifications implemented by the Corps of Engineers has resulted in a dramatic change in the face of the landscape, a tremendous increase in plant diversity and habitat interspersion, and a substantial increase in pheasant and other wildlife populations.

PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop
28-30 March 1983, Campbellsport, Wisconsin

OHIO'S WILDLIFE HABITAT RESTORATION PROGRAM: A SYNOPSIS

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The earliest documented release of ring-necked pheasants (Phasianus colchicus) in Ohio occurred in 1893 near the City of Celina in Mercer County (Hicks 1936). A second release also near Celina was made in 1896. By 1900 pheasant releases were considered common, an by 1903 the species was reported well established in 10 Ohio counties (Allen, Ashtabula, Crawford, Erie, Hamilton, Hardin, Madison, Morgan, Scioto, and Summit) (Dawson 1903). During the next 11 years, through a combination of natural reproduction, range expansion, and statewide stocking, pheasants were distributed throughout the state.

An intense systematic stocking program was initiated by state personnel in 1919 that continued well into the 1960's. From 1932 through 1967 more than 1.7 million pheasants were released by wildlife officials. Releases were principally limited to Ohio's 64 glaciated counties, after realization in the early 1930's that pheasants were incapable of surviving in the state's unglaciated regions. Pheasant harvest by the mid 1930's ranged from 500,000 to 700,000 birds, compared to annual release quotas which rarely exceeded 30,000 birds.

POPULATION STATUS

Pheasant numbers peaked in Ohio in the late 1930's (Acton et al. 1961), yet interest in the pheasant as a major game bird continued to increase over the next 20 years until an annual harvest of approximately 1,000,000 cocks was reached in the late 1940's (Dustman 1951). Similar harvests were also recorded in the early 1950's (Moore 1952, Moore and McCreadie 1953).

Pheasant densities remained relatively high for a 30-year period from 1931 through 1961, with spring densities of 80+ hens/section common in northwest and west central Ohio counties (Fig. 1). Wood and Hancock counties in northwestern Ohio supported fall pheasant densities of 240 to 300+ birds/section. During the next 7 years, researchers witnessed a steady decline in pheasant numbers in these key pheasant counties and an equally steady increase in pheasant numbers in northeastern counties (Fig. 2) (Bachant et al. 1971). Pheasant numbers have declined steadily throughout their range since 1968 (Fig. 3).

An examination of population trend information in the form of visual reports by rural mail carriers in selected northwestern counties, graphically illustrates the magnitude of Ohio's pheasant decline (Table 1). Pheasant numbers in northwestern Ohio dropped from 168+ birds/100 km in 1940, to 81+ birds/100 km in 1960, for a mean annual decline of 2.6% (51.8% total loss). During the next 22 years pheasant observations continued to decline until in 1982 mail carriers reported only 0.34 birds/100 km, for a mean annual loss of 4.5% (99.6% total loss).

Observed shifts in centers of high pheasant density, as well as the continued decline of Ohio's pheasant population, are directly attributed to intense agricultural change. The magnitude of this change is evident in the decline of pastures, hay, woodland, and grass-legume crops grown for seed or left undisturbed in Ohio's pheasant range from 1959 through 1978 (Table 2). Quality nesting habitat

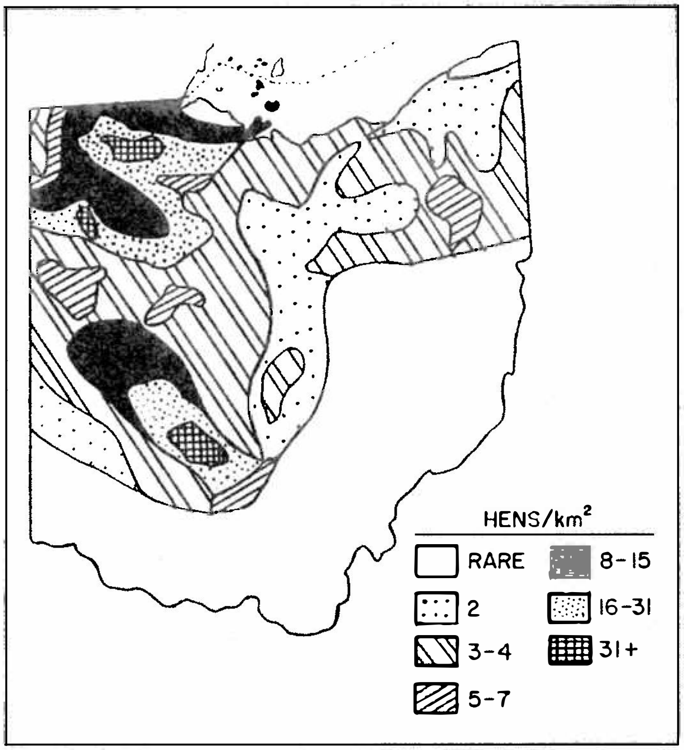

FIGURE 1. Hen pheasant densities, spring 1961.

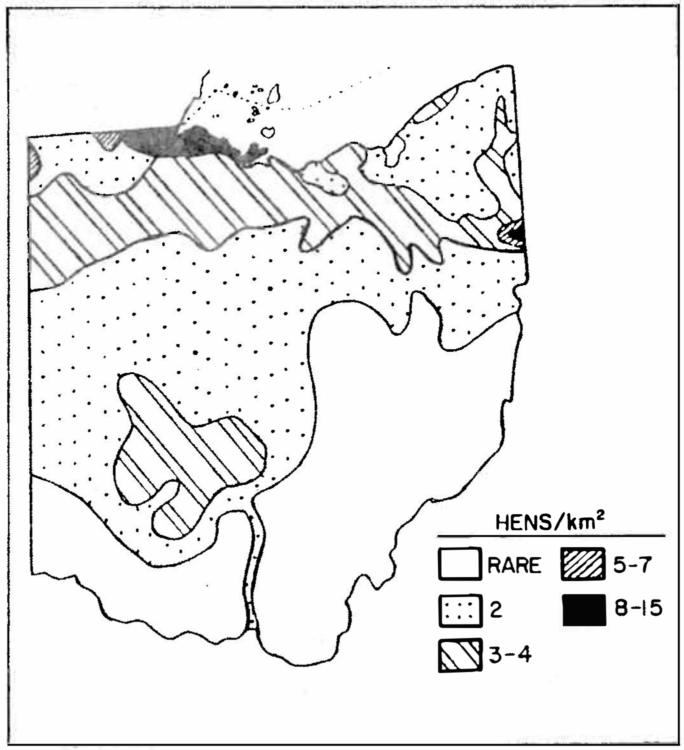

FIGURE 3. Hen pheasant densities, spring 1971.

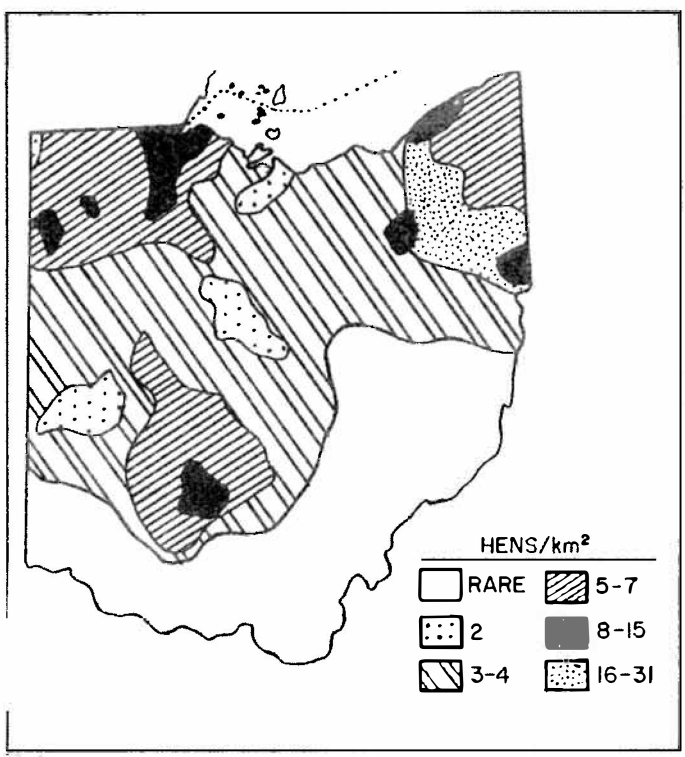

FIGURE 2. Hen pheasant densities, spring 1968.

provided by grass-legume cover grown for seed or in undisturbed acreage has declined by more than 89% in the past 19 years. For the pheasant hunter, this meant that by the mid to late 1960's, the stage was set for the decline of the ringneck as a major game species in Ohio. The loss of safe nesting cover is the principle causative factor (Fig. 4).

HABITAT RESTORATION

The Ohio Department of Natural Resources, Division of Wildlife, initiated a statewide habitat restoration program in 1978 to address this issue of observed population declines in grassland nesting wildlife. The goal of the 25-year program is to effect a 5- to 10-fold increase in populations of grassland nesting species of birds by establishing 10 ha of grass-legume nesting cover per km^2 in 202 townships.

Table 1. Ring-necked pheasants observed in northwestern Ohio by rural mail carriers.

Area	Pheasants/100 km		
	1940	1960	1982
Northwest Region	168+	81+	0.34
Wood County	311+	149+	0.09
Henry Co.	218+	218+	0.84
Hancock Co.	435+	112+	0.0

Table 2. Land use in 64 counties in the glaciated region of Ohio, 1959-78.

Land Use	Area (1000's ha)					% Change
	1959	1964	1969	1974	1978	1959 to 1978
Pasture	1172	979	698	602	509	-56.6
Hay	630	602	355	289	376	-40.3
Woodland	617	535	412	409	411	-33.4
Grass-legume cover grown for seed	107	71	15	16	6	-94.4
Grass-legume cover undisturbed		454	248	45	50	-89.0[a]

[a] Percent change 1964 to 1978 since no data were available for 1959.

The bulk of the restoration effort is planned for northwest and west central counties; a pattern that mirrors peak pheasant range in the early 1960's (Fig. 5). Of 364 ha of grass-legume nesting cover planned for each township, 202 ha will be established through a combination of 3 methods: 1/3 from outright purchase, 1/3 through promotion of switchgrass rest rotation pastures, and 1/3 from cooperative agreement with the Ohio Department of Transportation and county and township trustees to improve roadsides through seeding and delayed mowing. An additional 162 ha of nesting cover per township will be established through participation in Federal Crop Diversion Programs when available, and through a policy of trading ring-necked pheasants for habitat.

Hence, 72,874 ha of prime grass-legume cover will be established to provide pheasants and other grassland nesting wildlife with safe undisturbed nesting habitat.

Preliminary Experience

Initial habitat work began in November of 1979 in 4 study townships, 1 in each of the following counties: Pickaway, Wayne, Hardin, and Mercer (Fig. 6). Townships were chosen that were deficient in safe nesting cover. In addition to existing cover,

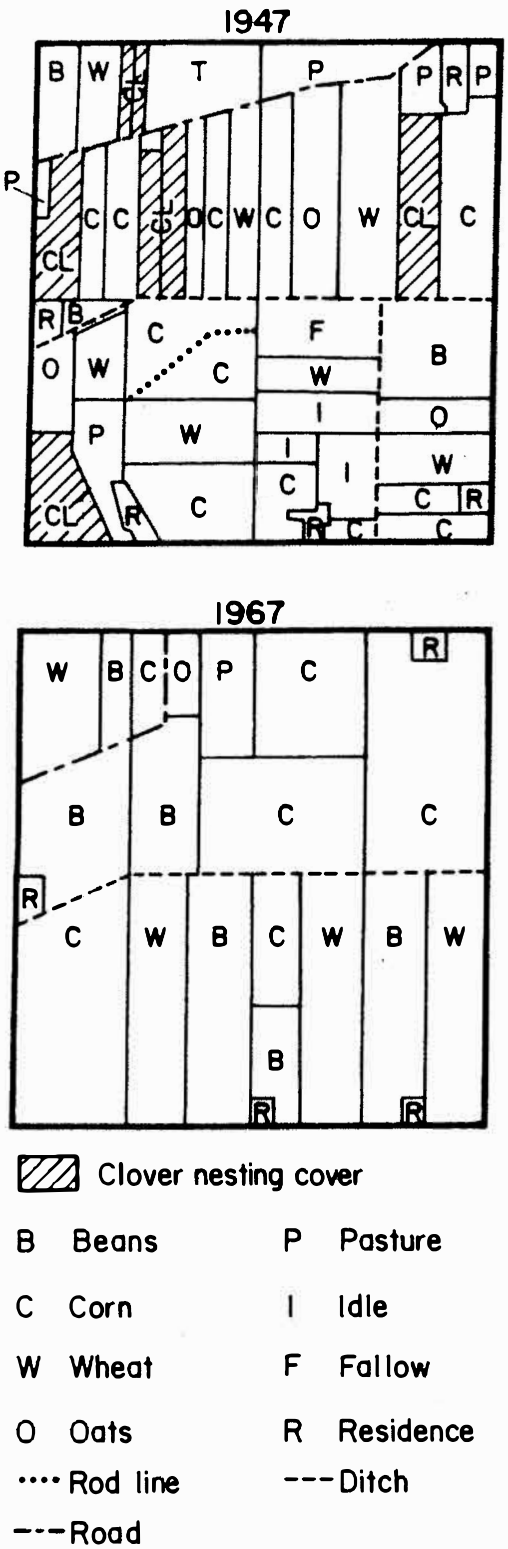

FIGURE 4. Crop patterns in Section 29, Liberty Township, Wood County, Ohio, 1947 and 1967.

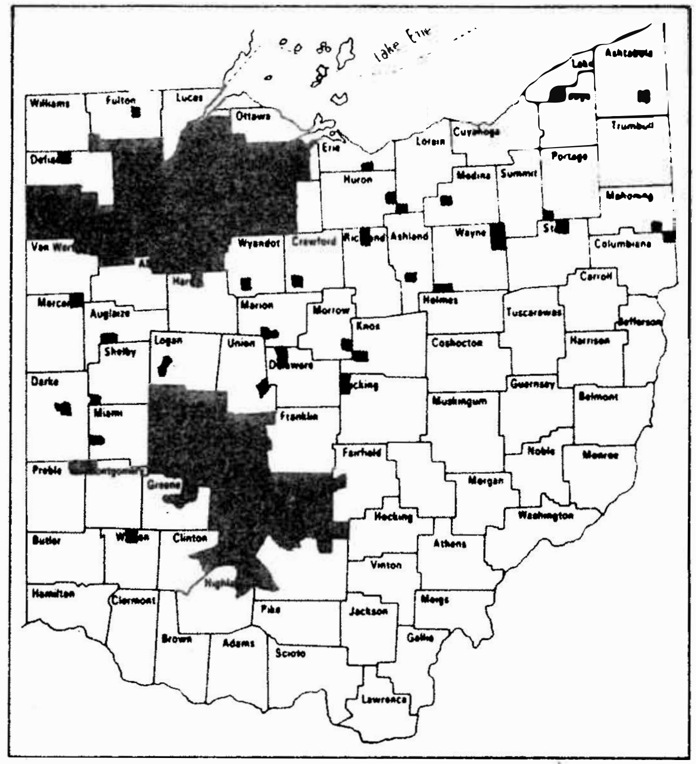

FIGURE 5. Townships selected for habitat restoration efforts.

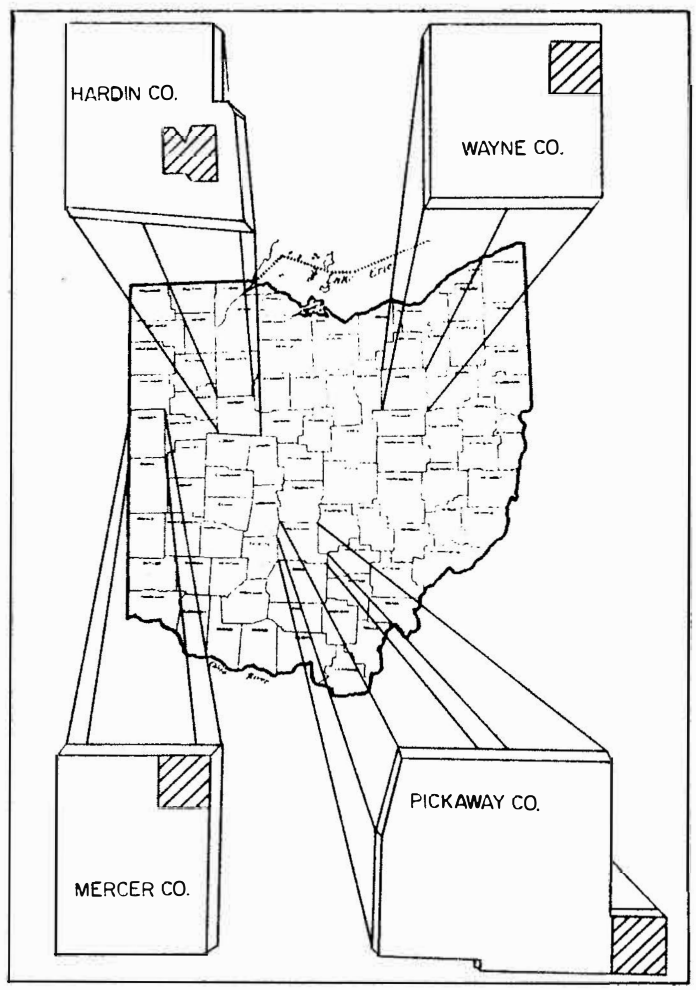

FIGURE 6. Location of pheasant study townships.

Table 3. Cost of establishing 202 ha of grass-legume cover through land lease agreements in Pickaway and Mercer study townships, November 1979 - August 1981.

Expenses	Pickaway Amount ($1,000's)	Pickaway %	Mercer Amount ($1,000's)	Mercer %
Equipment	20.0	26.6	7.8	13.2
Purchase	19.5	(97.5)[a]	7.8	(100.0)
Maintenance	0.2	(1.2)	0.0	(0.0)
Operating	0.3	(1.3)	0.0	(0.0)
Land lease	31.9	42.3	33.8	57.2
Habitat stock	2.3	3.0	2.7	4.6
Seeds	2.3	(100.0)	0.9	(33.8)
Plants	0.0	(0.0)	1.8	(66.2)
Contacts	2.1	2.8	11.7	19.7
Sportsmen	0.1	(7.2)	0.2	(1.7)
Landowners	1.7	(84.0)	11.1	(95.0)
Professional	0.2	(8.8)	0.4	(3.3)
Habitat improvements	6.0	7.9	2.4	4.0
Office work	5.2	(88.0)	1.5	(63.0)
Field work	0.7	(12.0)	0.9	(37.0)
Herbicide, lime & fertilizer	12.4	16.4	0.0	0
Travel expense	0.7	1.0	0.8	1.3
Total expense	75.4		59.2	

[a] Percent of total in each major category in parenthesis.

Table 4. Audio-visual survey data for pheasants from study townships, May 1979-82.[a]

County	Pheasants/Stop 1979	1980	1981	1982	Calls/Stop 1979	1980	1981	1982
Pickaway	0.74	0.89	0.84	0.74	0.87	1.50	1.0	1.0
Wayne	0.01	0.10	0.21	0.06	0.01	0.14	0.27	0.08
Mercer	0.0	0.04	0.01	0.03	0.0	0.04	0.01	0.04
Hardin	0.03	0.06	0.04	0.03	0.03	0.12	0.04	0.03

[a] _N_ = 4 surveys/township, except in 1981 when 1 survey was deleted due to bad weather.

Table 5. Brood survey observations in pheasant study townships, August 1980-1982[a].

County	Observations/route														
	Pheasants			Broods			Juveniles			Hens w/ young			Hens w/o young		
	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982
Pickaway	6.8	5.0	5.3	1.2	1.0	0.7	5.8	5.7	4.7	0.5	0.7	0.7	0.0	0.0	0.0
Wayne	0.5	0.5	1.5	0.2	0.2	0.5	0.2	0.5	1.3	0.0	0.0	0.0	0.0	0.0	0.2
Hardin	1.2	5.3	6.0	0.3	0.8	1.0	1.0	4.2	4.2	0.2	0.0	0.8	0.0	0.7	0.3
Mercer	0.0	1.2	0.0	0.0	0.2	0.0	0.0	1.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0

[a] $\underline{N}$ = 6 replicates/year.

Table 6. Crowing cock locations relative to grass-legume cover in the Pickaway study township.

Year	$\bar{X}$ Distance from cover (m)
1979	1239.7
1980	946.7*[a]
1981	908.8**
1982	992.0**

[a] $\underline{t}$ test, 1979 vs. 1980, 1981, 1982.
* $\underline{P}$ <0.01.
** $\underline{P}$ <0.005.

202 ha of undisturbed grass-legume cover were established in each township to provide the minimal amount of habitat required for anticipated population increases. Acreage was contracted though lease agreements to expedite habitat restoration. The ring-necked pheasant was chosen as an appropriate indicator species and surveys were designed and standardized to permit annual evaluation of land-use change and pheasant population response. Total expenses incurred in restoration efforts also were documented to permit an evaluation of cost effectiveness (Table 3). The study objectives are to monitor implementation of habitat improvements annually within 4 study townships and to evaluate ring-necked pheasant response to wildlife habitat improvements within each of 4 study townships.

Results of surveys conducted since 1979 indicate an increase in the number of calling cocks and broods observed, but these trends were not significant (P $\geq$0.05) (Tables 4 and 5). Distance of crowing cock locations from the nearest project grass-legume cover was examined for the Pickaway County township as an index to possible local impact. Mean distance from fields where grass-legume cover was established was calculated for 3 years following habitat restoration work and compared to mean distance from the same fields without grass-legume cover 1 year prior to restoration efforts using the t test (Steele and Torrie 1960:73). Crowing cock locations were significantly nearer ($\underline{P}$ $\leq$ 0.01) project grass-legume fields in years following habitat restoration work (Table 6). These findings support the premise that wild ring-necked pheasants are concentrating near restoration sites. Increased effort is planned to further delineate local response by ringnecks to habitat restoration efforts; population surveys will continue for an additional 3 years.

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IMPACTS OF NO-TILL FARMING ON UPLAND WILDLIFE

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Abstract: No-till (NT) and conventional tillage (CT) cropfields were examined in southwest Iowa in 1982 to evaluate use by nesting birds and compare small mammal populations. Nest searching was carried out twice per season in 3 fields each of NT corn in corn residue and in sod, NT soybeans in corn residue, and CT corn. Vegetative parameters for each cropfield and nest site were recorded. Insect populations were monitored in late June. Small mammals were assessed in 2 fields each of NT corn in corn residue and in sod, and CT corn. A 10 x 10 m grid of 100 live traps was placed on the edge and in the middle of each field. Traps were set for 4 periods of 6 consecutive days. Snap trapping was conducted in May to determine small mammal food habits during crop emergence. Ten 50 m transects were established in each field to assess insect damage. Nest establishment was higher in NT (37/100 ha) than in CT (2/100 ha) cropfields. Nearly 30% of pheasant nests were in NT fields. Small mammal abundance was not significantly different among treatments nor grid locations. Overall plant mortality caused by rodents was minimal (1%).

THE ART OF RESIDUAL COVER MANAGEMENT IN THE MIDWEST: A COMMENTARY

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This dissertation on residual nesting cover management is presented from a management perspective based on personal experience in applying research findings from Midwest states and on informal discussions with research and management personnel from the Midwest. The principal benefactors of management practices described herein are pheasants, mallard ducks and prairie-chickens.

Residual nest cover is defined as cover resulting from the previous year's growth. The basic strategy of residual cover management is to attract nesting hens away from vulnerable crops or vulnerable sites thereby minimizing nest destruction from predation or farming activities. As a fringe benefit, most non-crop, residual cover also remains attractive for nesting through early summer and provides pheasant brood cover rich in invertebrate foods. Pheasants also use residual cover to night roost and as a result provide some fall early morning and late afternoon hunting opportunities.

To be effective, residual cover must first be attractive enough to be used by a disproportionate share of the breeding population. Once this goal is achieved, the successful manager cannot tolerate excessive losses of nests or nesting hens to predators. High rates of nest abandonment and relocation into new growth cover on vulnerable sites also reduces the effectiveness of residual cover. The theoretical fringe benefits of successful first nest attempts in residual cover are: (1) larger clutches and therefore presumably broods, (2) smaller risks of predation or hay mower mortality on hens due to minimal time spent laying, incubating, and hatching only a single clutch of eggs, (3) minimal physiological energy and nutrient drains on nesting hens laying only one clutch, (4) lower loss of early hatched broods to hay mowing as indicated by Gates and Hale (1975).

There are 3 basic strategies for providing grassy-herbaceous residual cover. These strategies differ primarily in the period of years that the cover type remains undisturbed. The first strategy, and the one most commonly employed on public lands, is to establish or improve stands of grassy-herbaceous, perennial vegetation and then protect them indefinitely from any man-induced disturbance such as harvest, clipping, burning, spraying and recreational vehicles.

The second strategy is to enhance or establish suitable stands of vegetation as above and then "rejuvenate" the stand every few years by burning, mowing, light discing, or even plowing and replanting.

The third strategy is to harvest a crop or graze the stand every year, after the normal nesting season. The annual disturbance strategy requires that adequate residual stubble remain and that late summer or fall growth be encouraged and enhanced. While the annual disturbance strategy often allows some economic return to reduce nest cover management costs, the quality of residual cover is usually only fair because most leafy, upright fruiting stems of grasses cut once will not grow again until the following year. Diverted cornfields where picked but uncut corn stalks and weeds serve as residual cover may be utilized for nesting. Corn, milo, or soybean stubble fields where combines cut and spread weeds and crop-residues on the ground do not normally qualify residual as nesting cover.

There are a number of factors that appear to influence either the attractiveness of the residual cover or the proportion of nests in that cover which ultimately hatch.

Grassy-herbaceous stands that are at least 8-10 inches high in spring preferably more than 12-14 inches high are attractive for nesting by pheasants, mallards, or prairie-chickens. It should be basically upright, offer partial overhead concealment and have high stem densities in parts of the field, with some dead plant material on the ground surface. The primary factors affecting attractiveness appear to be: (1) the plant materials selected, (2) the plant density and plant distribution provided by establishment techniques, (3) soil fertility, (4) soil moisture, (5) physical factors which cause flattening such as snow and vehicles, and (6) ecological patterning, i.e., location in relation to other important habitat types.

Preferred plant materials for undisturbed or rotationally disturbed perennial vegetation in various parts of the Midwest include switchgrass, tall mesic warm season grass mixtures, alfalfa-brome or alfalfa-brome-timothy, and various wheat grasses. Nebraska uses a combination of 10-inch cut stubble and sweet clover in a 2-year rotational system as one of their private lands habitat improvement practices. The presence of some horizontal component of cover, usually supplied by herbaceous species, appears to enhance attractiveness. Other states are promoting warm season grass pastures. At least 8 inches of small grain stubble with assorted weeds and crop residues is reported to be functional residual cover in the high plains area.

Severe flattening of residual cover by snow is a major negative factor in many northern states. Switchgrass appears to be more resistant to flattening than any other plant materials tried to date. Switchgrass and other warm season grasses take longer to establish while cool season plant materials tend to peak early and then decline in quality after about 3-4 years. Overseeding is less desirable than slight underseeding in residual cover management because plantings with lower initial densities stand well and improve in density over time.

Ecological patterning is probably far more important than most of us realize for both attracting nesting birds and improving nest success rates. Placement of nesting fields near wintering sites, spring feeding sites, or at the interfaces between cock territories could help to attract pheasant hens to the residual cover. Planting residual nesting cover near predator dens, active raptor nests, or raptor hunting perches would not seem to be prudent. Residual nesting cover fields in a setting that is predominantly cropland are probably less likely to be subjected to searching by mammalian predators than those that are near wetlands, woodlots or other cover types commonly hunted or utilized by predators.

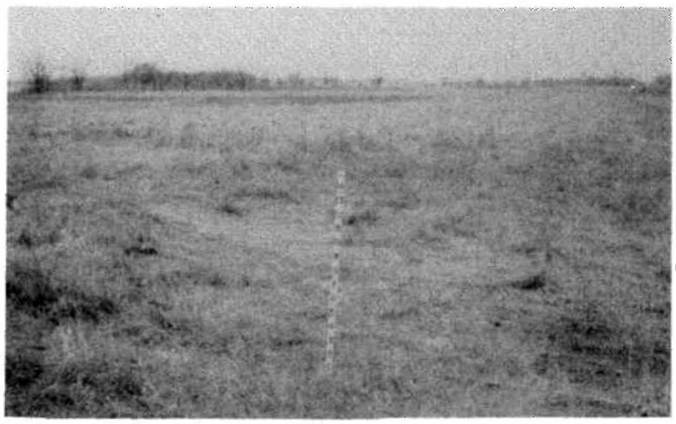
Residual cover fields that are recently established on crop fields, as opposed to those that have been completely undisturbed for at least 5 years, are more likely to have higher rates of nest success. Over time, undisturbed residual cover fields can be expected to build an increased prey base in the form of small mammals, amphibians, reptiles and invertebrates. Personal observation indicates that these areas often become dens sites for various mammals as well.

Mark A. Martin

Switch grass

Mark A. Martin

Warm season mixed grasses



LeRoy R. Petersen

Smooth bromegrass (1)

LeRoy R. Petersen

Smooth bromegrass (2)

Post-winter (April) residual nest cover in Wisconsin. (First three photos taken after heavy winter snows had melted. For comparison, smooth bromegrass (2) was taken after an open winter with little snow.)

A final comment regarding ecological patterning: small stands of attractive residual cover may concentrate nesting activity, thus making a significant proportion of the nesting population vulnerable to predation. Crop modifications such as no till planting in wheat stubble or even encouraging early nesting in green wheat, offers the prospect of scattering nests in more and larger fields rather than concentrating them in isolated, small tracts of undisturbed residual cover.

Field size and configuration has always been an important variable in residual nesting cover management. The principle guideline in pheasant management has been to provide fields at least 20 acres in size and as "blocky" as possible. While this still seems to be a reasonable guideline, one 20-30 acre tract per section constitutes only 3-5% of the total management area. That's putting a lot of your "eggs" in a very small basket and thus setting the stage for major losses to nest predators. If that's all the attractive nest cover one can afford to protect from disturbance by agricultural activities, it may be necessary to intercede directly by gamekeeping. "Game keepers" could employ selective predator control, aversive conditioning, chemical birth control for mammals and/or electric fencing to exclude mammals during the nesting season.

The last residual cover management topic to be considered is cost/benefit. Pheasants (and most other upland game birds and waterfowl) are a thin crop; with a rooster per acre of residual nest cover annually, being about all that can reasonably be expected, without predator control. If farm owners can obtain $50 - 150/acre annually in cash rent, are they more likely to produce one wild rooster per acre or to rent out the land and buy 6-18 pheasants from a game farm? On public lands, wildlife professionals too often think in terms of maximizing critical habitat types. A common result is costly wildlife areas that are predominantly undisturbed, grassy-herbaceous cover with large predator and non-game populations but few pheasants. A paper entitled, "Estimating Costs of Pheasant Production in Columbia Basin Irrigated Agriculture" (Bagwell et al. 1979), is well worth reading in regard to cost/benefit considerations. While pheasant responses in the paper cited above were hypothesized estimates, the implication was strong that the cost per pheasant produced rose rapidly when habitat enhancement practices reduced farm profits appreciably.

The state of the art in residual nest cover management for pheasants, mallards and prairie-chickens still calls for some attractive carryover cover placed in a cropland setting as abundantly as we can afford to provide it. Ecological patterning is something that should continue to improve. The use of shortened rotations of residual cover sites or at least maintenance disturbance of fixed sites to improve attractiveness and nest success rates should also be used. Additional research should focus on how to achieve better productivity from spring breeding populations at a reasonable cost in land use control, cover management, and/or predator management.

Changing USDA price support and cropland diversion programs to once again permit multi-year cropland diversion in locations where it will do the most good for soil, water and wildlife conservation has to be one of our highest priorities. We also need more innovative private lands wildlife management programs like Water Bank and the various state habitat development programs to complement an enlightened ASCS multi-year diversion program.

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Associated Workshop Activities

Roger C. Reif

Questionnaire Survey Results
PIK Evaluation
Registrants

QUESTIONNAIRE SURVEY RESULTS

Population Status, Harvest, Management, and Game Farm Programs for Gray Partridge and Ring-necked Pheasants in North America

A questionnaire requesting information on population status, harvest, major habitat management programs, and game farm activities was distributed to all states and provinces with gray partridge (Perdix perdix) and/or ring-necked pheasant (Phasianus colchicus) populations (Appendix 1) in February 1983. A second mailing in August 1983 resulted in an overall response rate of 96% (49 of 51 states and provinces; note Appendix 2 for list of colleagues responding). Preliminary results of the questionnaire were presented at Perdix III: Gray Partridge/Ring-Necked Pheasant Workshop held 28-30 March 1983. Complete results are included here for reference.

POPULATION STATUS

North American range of the gray partridge has been divided into 4 distinct regions: Pacific Northwest, Plains and Prairie, Great Lakes, and Northeast (Appendix 1 and Fig. 1). Partridge range has expanded in the eastern part of the Plains and Prairie region, remained stable in the western part of the Plains and Prairie region and the Northwest region, and contracted in the Great Lakes and Northeast regions since 1973 (Johnsgard 1973:478). Wild populations are no longer reported for Ohio and New Brunswick, and greatly reduced populations are reported for Ontario. "Primary" range is centrally located through the Plains and Prairie region and in Idaho.

North American pheasant range extends across the northern U.S., expanding in the central states northward into Canada and southward into New Mexico and Texas (Appendix 1 and Fig. 2). Scattered pockets of "primary" range exist throughout the distribution. Population distribution appears to be stable, exhibiting only minor changes since 1955 (Aldrich and Duvall 1955). Ring-necked pheasants have recently been introduced in southern Texas, northwestern Louisiana, and southern Mississippi.

HARVEST

In the 24 states/provinces reporting hunting seasons for partridge (Table 1), estimated mean annual harvest for 1977-82 approached 966,500 with the Plains and Prairie region contributing the largest component (659,600), as expected for this center of "primary" range. For pheasants, 42 states/provinces reported seasons with an estimated mean annual harvest for 1977-82 totaling over 9.5 million (Table 2). Contributing to this annual harvest were approximately 1.1 million stocked pheasants (Table 5). The largest harvests occurred in the central states -- Iowa, Kansas, and South Dakota. Pheasant harvest cannot be directly related to the range map due to various stocking programs of states and provinces (Table 5). Both states with estimated harvests over 1 million birds incorporate no stocking activities.

HABITAT MANAGEMENT

Major habitat development programs for farmland wildlife, primarily partridge and pheasant, were reported by 15 states with annual budgets ranging from $100,000 - $5,000,000 (Table 3). The primary emphasis of most programs was establishment and/or improvement of nesting and wintering cover. Other objectives included general habitat improvement, creation/improvement of travel lanes, establishment of winter food plots, and promotion of sound agricultural practices and utilization of existing agricultural programs on private lands to benefit wildlife. Programs in 7 of the 13 states attempted to impact agricultural practices by influencing agricultural programs, policies, and/or legislation.

The future of many wildlife species in providing huntable populations depends on wildlife management on private lands. Each of the habitat development programs implements 1 or more of the 7 strategies listed for Issue 1 (Intensifying human use of land and water in the agricultural sector of North America is causing a serious reduction in the carrying capacity of this ecotype for wildlife) of the Gray Partridge Management/Research Plan for North America (Dumke et al. 1980), and all 7 strategies are addressed (Table 4).

GAME FARM PROGRAMS

Stocking activities were reported by 27 of the 49 respondents (55%) with activities in all states/provinces except Alberta pertaining only to pheasants (Table 5). Currently, Alberta is experimenting with a small gray partridge production program for implementing future projects. Purposes of releases would include all listed in Table 5 except for augmenting breeding populations. Approximately 1.1 million pheasants are stocked annually by these 27 states and provinces, and 3 states (Pennsylvania, Michigan, and Wisconsin) stock over 100,000 annually. The primary purpose for stocking (28 of 37 programs) is to augment hunting opportunity. Other objectives include increasing breeding populations, providing incentives for habitat improvement on private land, extending the range, and promoting better public relations.

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Johnsgard, P.A. 1973. Grouse and quails of North America. Univ. Nebr. Press, Lincoln. 553 pp.

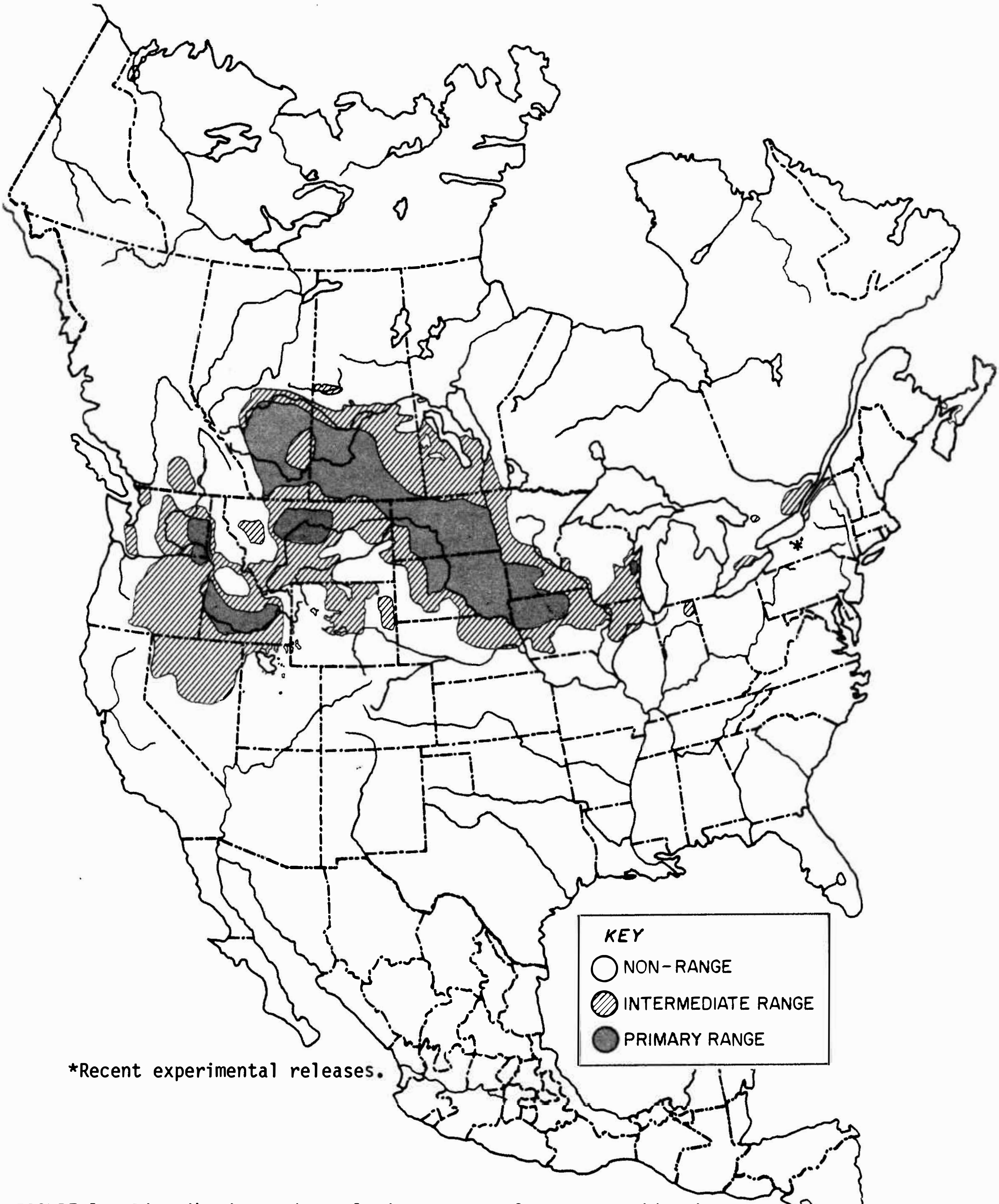


FIGURE 1. Distribution and population status of gray partridge in North America. Results of a survey conducted for PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop, 28-30 March 1983, Campbellsport, WI.

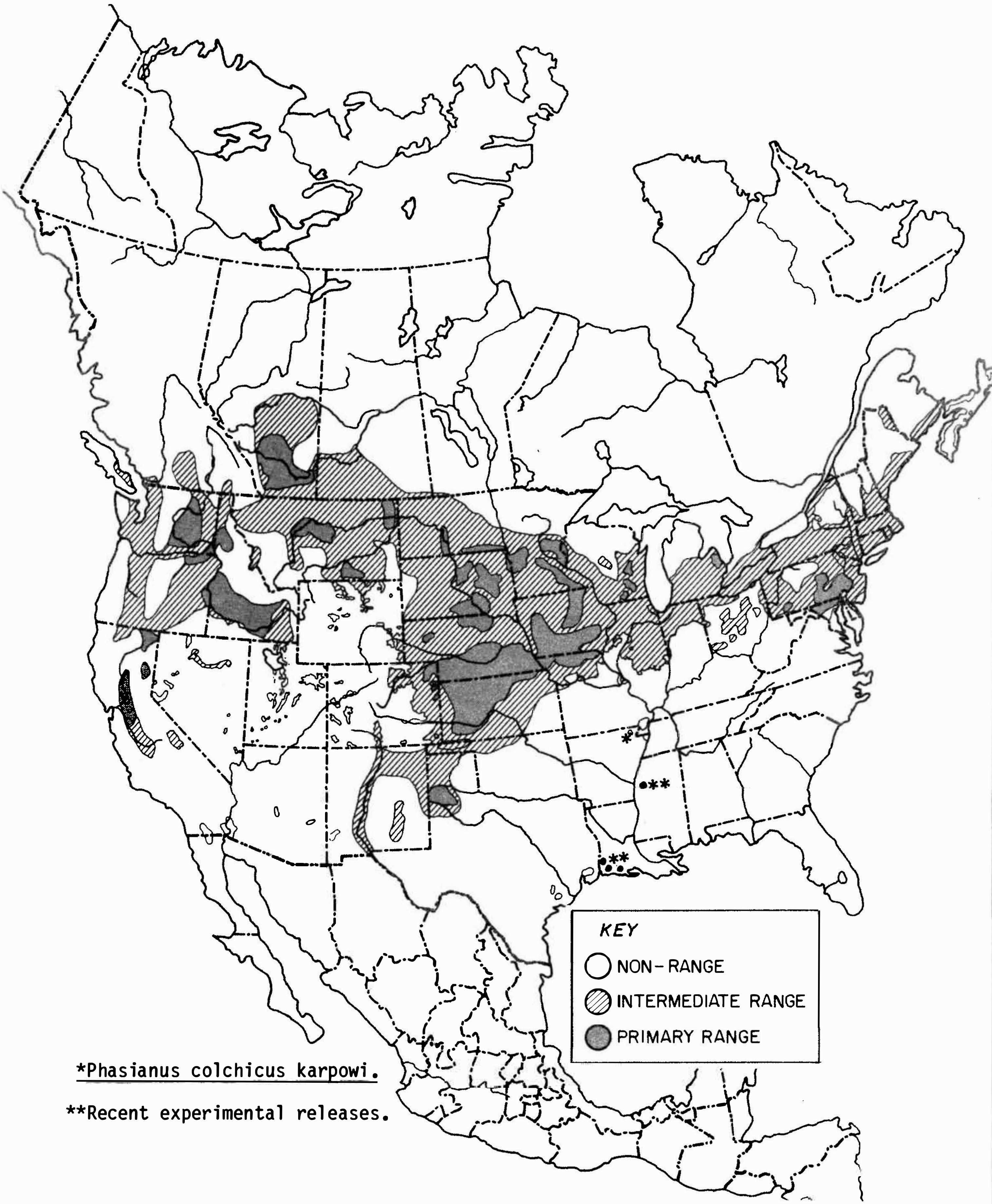


FIGURE 2. Distribution and population status of ring-necked pheasant in North America. Results of a survey conducted for PERDIX III: Gray Partridge/Ring-necked Pheasant Workshop, 28-30 March 1983, Campbellsport, WI.

Table 1. Gray partridge harvest in North America, 1977-82.[a]

State/Province	Harvest[b] $\bar{x}$	Range	Years
State			
Idaho	128.8[c]	107.4-174.0	78-82
Ill.	5.5	3.1-9.3	77-81
Ind.		Unknown[d]	
Iowa	70.6	49.0-108.0	77-81
Minn.	102.8[e]	63.0-132.0	78-82
Mont.	67.1	29.9-103.9	78-82
Nebr.	3.3	3.0-3.6	81-82
Nev.	4.1[c]	2.2-8.7	78-82
N. Y.		Unknown[d,f]	80-82
N. D.	143.5[c]	129.0-151.6	78-82
Oreg.	48.5[g]	12.0-98.0	78-82
Pa.		No season[h]	
S. D.	113.8	69.2-135.8	78-81
Utah	9.0[i]	6.0-12.0	78-82
Wash.	29.3	22.1-38.6	77-81
Wis.	48.6[i]	29.0-64.5	78-82
Wyo.	1.8	0.7-4.3	78-82
Province			
Alberta	100.0		78
B. C.		Unknown[f]	
Manit.	11.0	6.0-14.0	78-82
N. S.	1.5	1.0-2.0	78-82
Ont.	17.3[i]	14.3-19.4	78-80
Que.		Unknown[f]	
Sask.	60.0[c]	42.0-69.0	78-82
Total	966.5		

[a] Results of a survey conducted for Perdix III; Gray Partridge/Ring-Necked Pheasant Workshop, 28-30 March 1983, Campbellsport, WI. No populations present in Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Hampshire, New Jersey, Ohio, Oklahoma, Rhode Island, Texas, Vermont, Virginia, West Virginia, and New Brunswick. No response to questionnaire from Kentucky and New Mexico.

[b] Harvest in 1,000's.

[c] Hunter survey/questionnaire.

[d] Low population levels.

[e] Harvest estimate possibly inflated by 10-15% due to hunters reporting ruffed grouse as partridge.

[f] No harvest surveys.

[g] Projected harvest for 1982 included.

[h] Recently introduced.

[i] Mail survey.

Table 2. Ring-necked Pheasant Harvest in North America, 1977-82.[a]

State/Province	Harvest[b] $\bar{x}$	Range	Years
State			
Ariz.	c		78-82
Ark.		No Season[d]	
Calif.	500.0[e]	350.0-750.0	78-82
Colo.	119.0[f]	73.0-175.0	78-82
Conn.	40.0[gh]		78-82
Del.	2.0	1.5-2.6	78-82
Idaho	414.1[e]	310.4-502.5	78-82
Ill.	320.5	216.7-455.6	77-81
Ind.	15.8	8.4-18.4	77-80
Iowa	1,373.0	1,201.0-1,448.0	77-81
Kans.	1,130.2	916.0-1,260.0	78-81
La.		No season[i]	
Maine		Unknown[j]	
Md.	38.0[k]	37.1-42.5	78-82
Mass.	72.0[lm]		81-82
Mich.	305.0	215.0-396.0	78-82
Minn.	430.8	319.0-573.0	78-82
Miss.		No Season[i]	
Mo.	29.7	15.0-47.8	78-82
Mont.	102.0	98.9-106.5	78-82
Nebr.	922.4	868.9-1,007.0	78-82
Nev.	4.3[e]	3.1-6.7	78-82
N. H.	4.0	3.0-5.0	78-82
N. J.	300.0	200.0-400.0	78-82
N. Y.	182.0[l]	182.0	81
N. D.	85.0[e]	60.1-122.0	78-82
Ohio	35.2[n]	27.4-44.5	78-80
Okla.	40.0	15.0-65.0	78-82
Oreg.	245.0[f]	180.0-329.0	78-82
Pa.	858.0	765.0-917.5	78-81
R. I.	2.0[g]		78-82
S. D.	993.3	558.0-1,320.0	78-81
Tex.	33.5[o]	26.1-38.7	78-82
Utah	220.0[k]	216.0-234.0	78-82
Vt.		Unknown[d]	
Va.	0.1[p]	0.1-0.2	76-80
Wash.	101.4	90.4-109.5	77-81
W. Va.		Unknown[j]	
Wis.	390.8[k]	273.4-647.4	78-82
Wyo.	41.2	37.0-46.4	78-82

Table 2. Continued.

State/Province	Harvest[b] $\bar{x}$	Range	Years
Province			
Alberta	59.0	43.0-75.0	78-82
B. C.	9.8[q]	7.1-12.1	78-82
Manit.		No season[d]	
N. B.		No season[d]	
N. S.	10.0	9.0-13.0	78-82
Ont.	87.9[kq]	80.2-92.1	78-80
Sask.	10.0[e]	7.0-13.0	78-82
Total	9,527.0		

[a] Results of a survey conducted for Perdix III; Gray Partridge/Ring-Necked Pheasant Workshop, March 28-30, 1983, Campbellsport, WI. Newfoundland and Quebec indicated no populations present. No response to questionnaire from Kentucky and New Mexico.

[b] Harvest in 1,000's.

[c] Archery or falconry only, harvest of 0-30.

[d] Low population levels.

[e] Hunter survey/questionnaire.

[f] Projected harvest for 1982 included.

[g] Primarily game farm releases; very small natural population.

[h] Harvest estimate calculated from a 60% return rate for approximately 70,000 released pheasants. Hunting preserve harvest excluded.

[i] Recently introduced.

[j] No harvest surveys.

[k] Mail survey.

[l] Phone survey.

[m] Median harvest.

[n] Hunter questionnaire adjusted for game farm releases.

[o] Hunter interview; hunter pressure transects.

[p] Primarily game farm releases; game farm activities discontinued in 1980.

[q] Harvest from hunting preserves included.

Table 3. Habitat development programs for farmland wildlife (with budgets approaching or exceeding $100,000 annually), principally partridge and pheasants.[a]

State	Title	Annual budget[b]	General habitat	Nesting cover	Wintering cover	Travel lanes	Winter food	Agric. practices
		Primary Emphasis						
Colo.	Pheasant Habitat Project	100-140		X	X			
Idaho	Pheasant Stamp[c]	300		X	X			
Ill.	Roadside and Farmland Habitat Management Project	220		X	X			
Ind.	Pheasant Land Lease Project	150		X	X			
Iowa	Switchgrass Cost-Sharing Program	100		X	X			X
Kans.	Wildlife Habitat Improvement Program		X	X	X			X
Mich.	Pheasant Management Program[c]	200		X	X		X	X
Minn.	Pheasant Habitat Stamp[c]	500-600		X	X		X	X
Mo.	Expanded Private Land Program	450	X					X
Nebr.	Private Lands Development	1,000		X	X			
	Habitat Development on Federal Lands	190	X					
	Roadside Habitat Management	100		X	X			
N. Y.	Pilot Habitat Project[d]							
N. D.	Habitat Stamp Program	250		X				
	Herbaceous Habitat Program	125		X				
Ohio	Wildlife Habitat	2,500+	X	X		X		X
	Wildlife Habitat Planting Stock	90			X	X	X	
S. D.	Pheasant Restoration Plan	1,000		X	X	X		X
Wis.	Public Lands Acquisition and Management Program	2,000-5,000		X	X		X	

[a] Results of a survey conducted for Perdix III; Gray Partridge/Ring-Necked Pheasant Workshop, 28-30 March 1983, Campbellsport, WI. No programs in place or in development for Arizona, Arkansas, California, Connecticut, Delaware, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Montana, Nevada, New Hampshire, New Jersey, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wyoming, Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Quebec, and Saskatchewan. No response to questionnaire from Kentucky and New Mexico.

[b] Budget in $1,000's.

[c] Legislation pending.

[d] Anticipated for 1984-89.

Table 4. Specific features of habitat development programs for farmland wildlife.

State	Title	Specific Features
Colo.	Pheasant Habitat Project	Establish grass-legume nesting cover and shrub thickets to increase harvest and wintering cover on roadsides and small, leased tracts of private land or wasteland.
Idaho	Pheasant Stamp	Improve habitat on private lands.
Ill.	Roadside and Farmland Habitat Management Project	Plant 1,500 acres of grass-legume nesting cover and 50 acres of switchgrass cover for nesting and wintering on private lands and roadsides annually.
Ind.	Pheasant Land Lease Project	Establish preferred nesting and wintering cover on 1,000 acres of leased cropland in 10-20 acre tracts.
Iowa	Switchgrass Cost-Sharing Program	Assist SCS in establishment of warm season pasture on private lands for the mutual benefit of cattlemen and wildlife.
Kans.	Wildlife Habitat Improvement Program	1) Establish woody vegetation and native grasses; and 2) promote grazing and agricultural practices beneficial to wildlife on private lands.
Mich.	Pheasant Management Program	Establish permanent cover (primarily switchgrass) and corn food plots on private land by cost-sharing under the PIK program in cooperation with ASCS.
Minn.	Pheasant Habitat Stamp	1) Expand the Wildlife Habitat Improvement program to cost-share establishment of wintering cover, food plots, permanent nesting cover, and small wetland restoration; 2) implement a public relations campaign for habitat improvement aimed at landowners and sportsmen; 3) manage habitat on roadsides by delayed mowing and rejuvenation of existing cover; and 4) fund a position to influence agricultural practices and programs.
Mo.	Expanded Private Land Program	1) Expand technical assistance programs to advise landowners on agricultural practices beneficial to wildlife; 2) fund several positions to encourage communication between and provide assistance to extension and agricultural agencies; 3) establish 2 Demonstration Farms on public land to exhibit economically feasible farming operations that incorporate sound soil, water, and wildlife conservation; and 4) evaluate warm season grass planting program.
Nebr.	Private Lands Development	Establish permanent cover, planting sweet clover and oats, and protecting existing cover on private lands.
	Habitat Development on Federal Lands	Develop wildlife habitat on Corps of Engineers, U.S. Forest Service, and U.S. Fish and Wildlife Service lands.
	Roadside Habitat Management	Develop nesting and wintering cover by providing seed and seedlings for roadside seeding and living snow fence in cooperation with county and state road departments.
N. Y.	Pilot Habitat Project	Anticipated for 1984-89.

Table 4. Continued.

State	Title	Specific Features
N. D.	Habitat Stamp Program	Lease private lands and establish dense nesting cover under a federal-state cost-sharing program.
	Herbaceous Habitat Program	Plant dense nesting cover on private croplands under a federal-state cost-sharing program.
Ohio	Wildlife Habitat	Establish 180,000 acres of grass/legume cover through 1) land acquisition; 2) rest rotation pastures of warm season grasses on private lands; 3) roadside improvement; and 4) wildlife management practices employed on land in federal acreage reduction programs.
	Wildlife Habitat Planting Stock	Provide planting stock at no cost to improve and establish wintering cover, travel lanes, and winter foods.
S. D.	Pheasant Restoration Plan	1) Establish dense nesting cover on private cropland and along roadsides; and (2) improve and manage shelterbelts through federal-state cost- sharing programs.
Wis.	Public Lands Acquisition and Management Program	1) Protect key habitat components through land acquisition; and 2) enhance habitat for wildlife production and hunting opportunity by managing and planting permanent nesting cover, food plots, and winter cover.

Table 5. Ring-necked Pheasant Stocking Activities in North America.[a]

State/ Province	No. Stocked Annually[b]	Sex Ratio (M:F)	Purpose: Augment Hunting PA[c]	Augment Hunting PG[d]	Augment Breeding PA	Augment Breeding PG	Improve Habitat[e]	Extend Range[c]	Public Relations
State									
Calif.	6.0-8.0	(100:0)		X					
Conn.	70.0	(50:50)	X	X					
Idaho(1)	14.0	(50:50)	X						
(2)	10.0+						X		
Ill. (1)	66.0		X						
(2)	25.7			X					
Ind.	20.0	(50:50)	X						
Maine	3.9[k]		X[g]						
Mass.	55.0	(100:0)	X						
Mich.	110.0-120.0	(50:50)	X[f]						
Miss.	0.4[l]							X	
Nebr.	14.0	(50:50)	X		X		X		
N. H.	5.7		X[g]						
N. J.	55.0		X						
N. Y.(1)	30.0	(60:40)	X						
(2)	32.0			X					
N. D.(1)	1.8	(20:80)			X				
(2)	1.5	(100:0)	X						
(3)	0.5-1.0	(75:25)		X					X[d]
(4)	0.3	(15:85)				X[h]			X[h]
(5)	10.0	(45:55)		X[h]					X[h]
Ohio (1)	21.3	(50:50)		X			X		
(2)	12.1	(12:88)					X		
Okla.				X					X[c]
Ore.	22.0	(64:36)	X						
Pa.	225.0	(75:25)	X						
R. I.	3.0	(60:40)	X						
S. D.	22.5	(35:65)							X[h]
Tex.	16.0							X	
Wash.		(50:50)	X					X	
Wis. (1)	39.0[i]	(100:0)	X						
(2)	67.3[i]	(90:10)		X					
Wyo. (1)	16.0-17.0		X		X				
(2)									
Province									
Alberta(1)	51.5	(67:33)	X				X		X[j]
(2)	45.0	(33:67)			X				
N.S.									X[d]
Ont.			X						
Total	1,079.3								

[a] Results of a survey conducted for Perdix III: Gray Partridge/Ring-Necked Pheasant Workshop, 28-30 March 1983, Campbellsport, WI. No propagation or stocking activities employed by Arizona, Arkansas, Colorado, Delaware, Iowa, Kansas, Louisiana, Maryland, Minnesota, Missouri, Montana, Nevada, Utah, Vermont, Virginia, West Virginia, British Columbia, Manitoba, New Brunswick, Newfoundland, Quebec, and Saskatchewan. No response to questionnaire from Kentucky and New Mexico.

[b] 1,000's.

[c] Pheasants reared and released by public agencies.

[d] Pheasant chicks and/or eggs provided to private groups or individuals for rearing and release.

[e] Pheasants provided to private groups or individuals in return for habitat improvement/establishment.

[f] Program being phased out in 1983.

[g] Pheasants purchased with stamp monies.

[h] Payment to private groups or individuals for pheasant rearing and release.

[i] $\bar{x}$ for 1977-82.

[j] Augment public viewing opportunities.

[k] Varies annually; projected release for 1983.

[l] $\bar{x}$ for 1980-82; pheasants from Texas.

APPENDIX 1. Partridge/pheasant questionnaire.

The results of this questionnaire will be presented at the Partridge/Pheasant Workshop, 28-30 March 1983, Campbellsport, Wisconsin. Summary tables will appear in the published proceedings and will also be distributed to agencies cooperating in the survey. Since this questionnaire is being sent to state and provincial agencies thought to have partridges (huns) and/or pheasants, we ask that you simply ignore inappropriate questions. Please return the completed questionnaire by March 11, 1983.

Population Status and Harvest

Please review the range maps provided for pheasants and partridge and

1. Update the distribution map for your state or province.

2. Identify non, intermediate and primary range according to the key provided.

Please indicate the following harvest estimates for the previous 5 years (1978-82):

	Average	Range			Qualifications
Partridge	______	______	to	______	______________________________
Pheasants	______	______	to	______	______________________________

Habitat Management

Please describe habitat improvement projects or programs underway or awaiting funding that feature pheasants and/or partridge as a primary objective. Report only on major endeavors -- those with an annual budget approaching or exceeding $100,000. Include management activities undertaken on public or private lands. Indicate project title, objective(s), habitat components treated (winter cover, winter food, nesting cover, travel lanes, covey headquarters, etc.), annual budget, project duration, cooperating agencies, whether on public and/or private lands, current status, and any other features of interest:

Propagation and Stocking Activities

Does your agency employ game farm reared pheasants or partridge directly in any of your management programs? YES_____ NO_____

If yes, please indicate the purpose(s) for utilizing game farm stock -- range extension, augment hunting opportunity, incentive for habitat improvement on private lands, etc. -- plus sex and age composition and numbers of birds distributed annually:

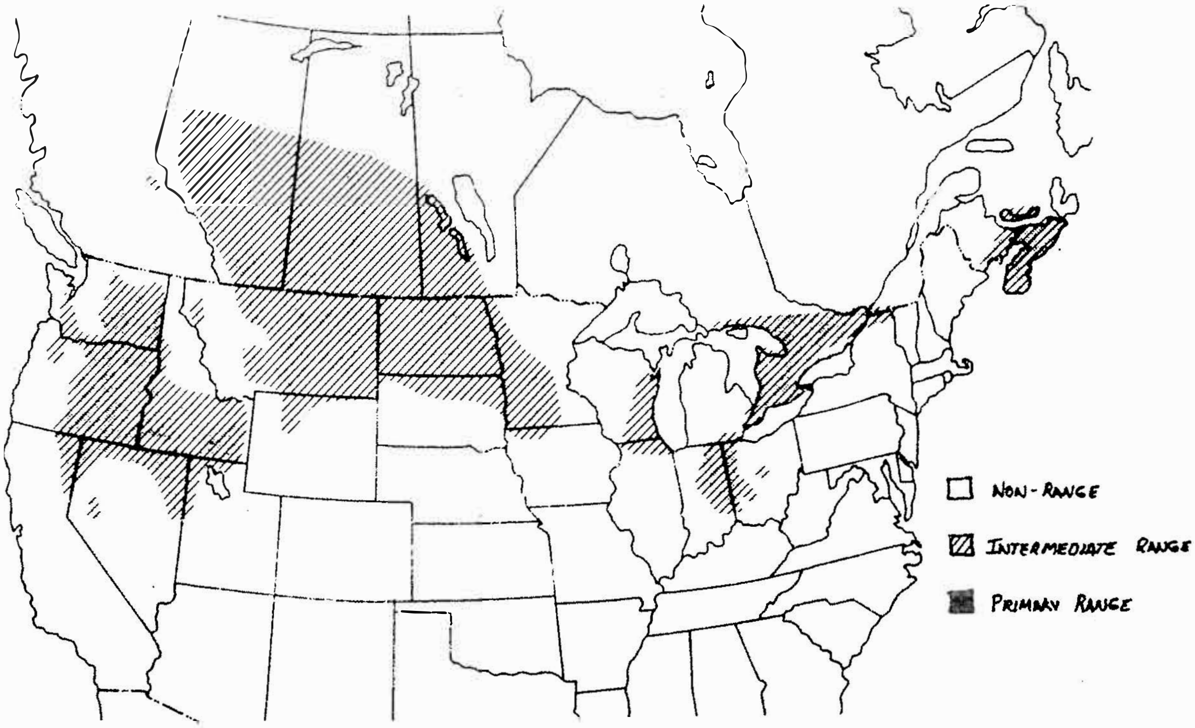
Send completed questionnaires to Robert T. Dumke, Chief, Wildlife Research Section, DNR, 3911 Fish Hatchery Road, Madison, WI 53711 or Richard B. Stiehl, College of Environmental Science, University of Wisconsin-Green Bay, Green Bay, WI 54302. Respond by March 11, 1983.

____

Name of Agency

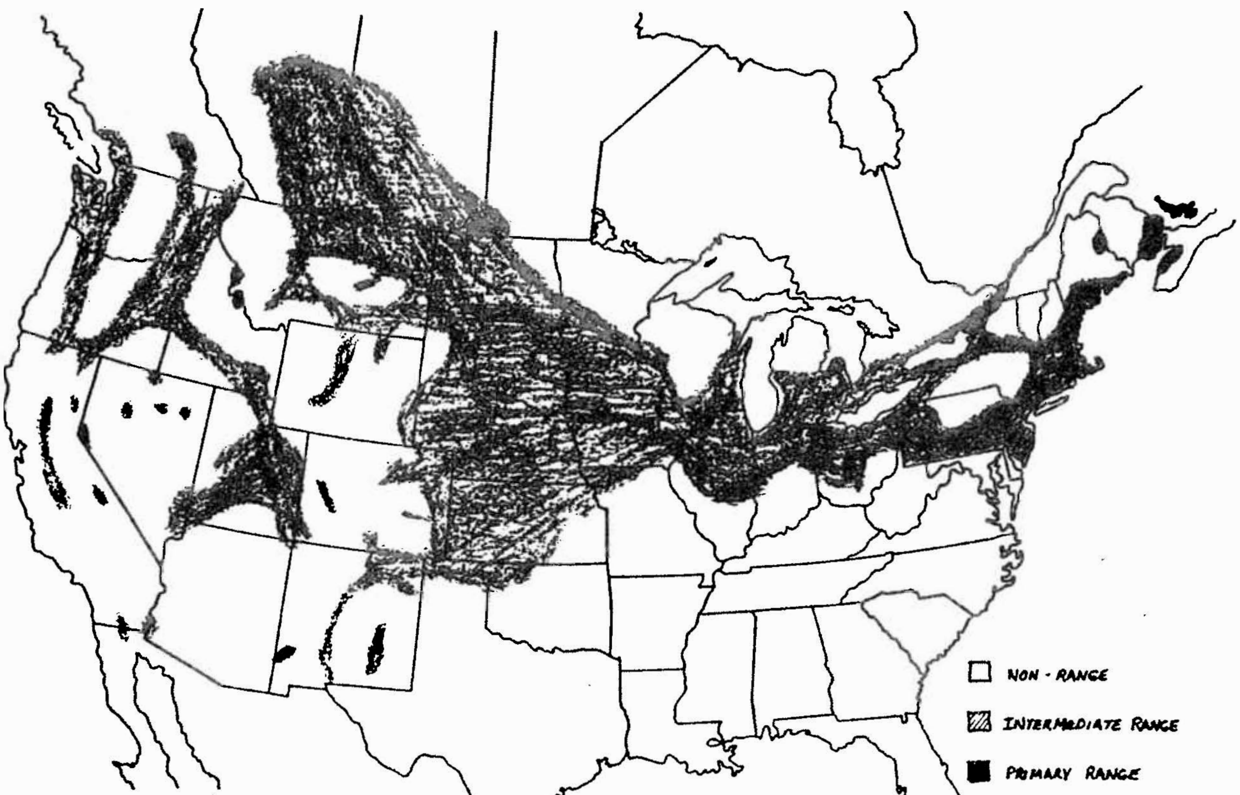
____

Name of Person Completing Questionnaire



NOTE INSTRUCTIONS ON PHEASANT RANGE MAP (OVER).
THIS FIRST ATTEMPT AT MAPPING RELATIVE ABUNDANCE FOR PARTRIDGE WILL BE CRUDE. TRY YOUR BEST! THANKS!!

GRAY PARTRIDGE RANGE MAP

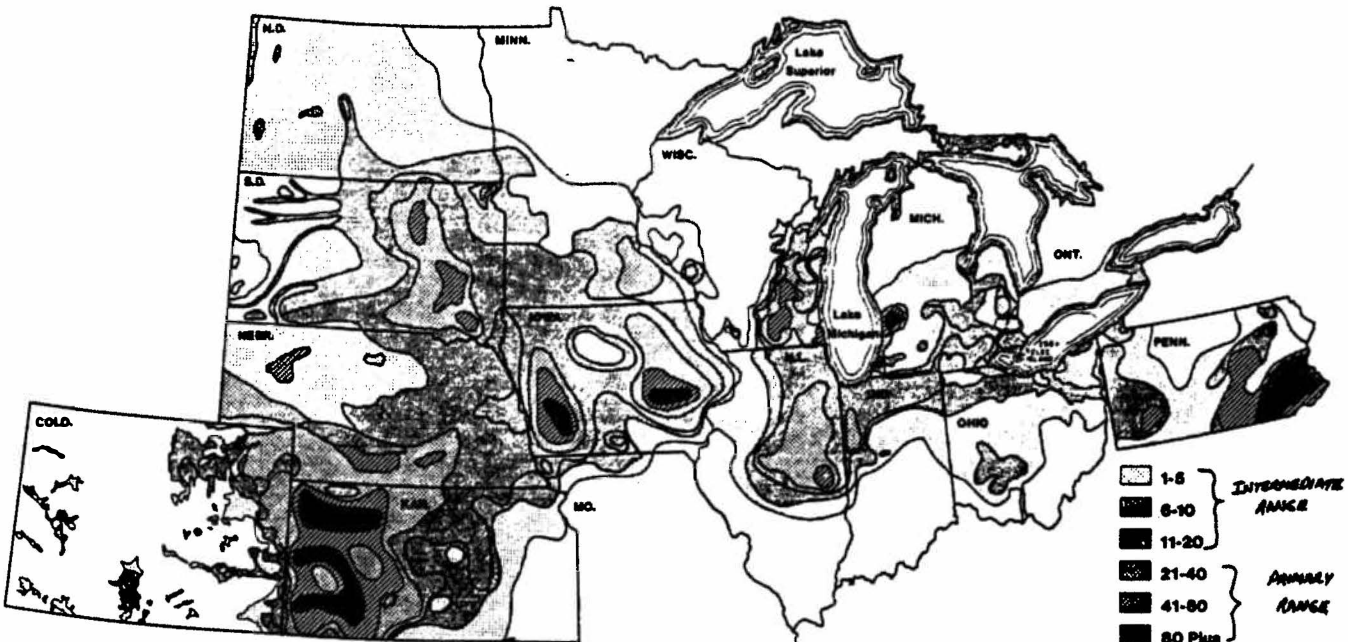


ENTER DISTRIBUTION AND RELATIVE ABUNDANCE INFORMATION ON THIS MAP OR SUBMIT A LARGER SCALE MAP OF YOUR STATE, PROVINCE, OR REGION (NOTE WISCONSIN RANGE MAP). MIDWEST BIOLOGISTS SHOULD CONSULT THE 1971 RANGE MAP IN THIS PACKET. WE WILL ATTEMPT TO RECONCILE BOUNDARY DIFFERENCES; YOU MAY BE CONTACTED FOR FURTHER INPUT. THE COMPOSITE MAP WILL BE APPROXIMATE, YET SATISFACTORY FOR DISCUSSION PURPOSES AT THE WORKSHOP.

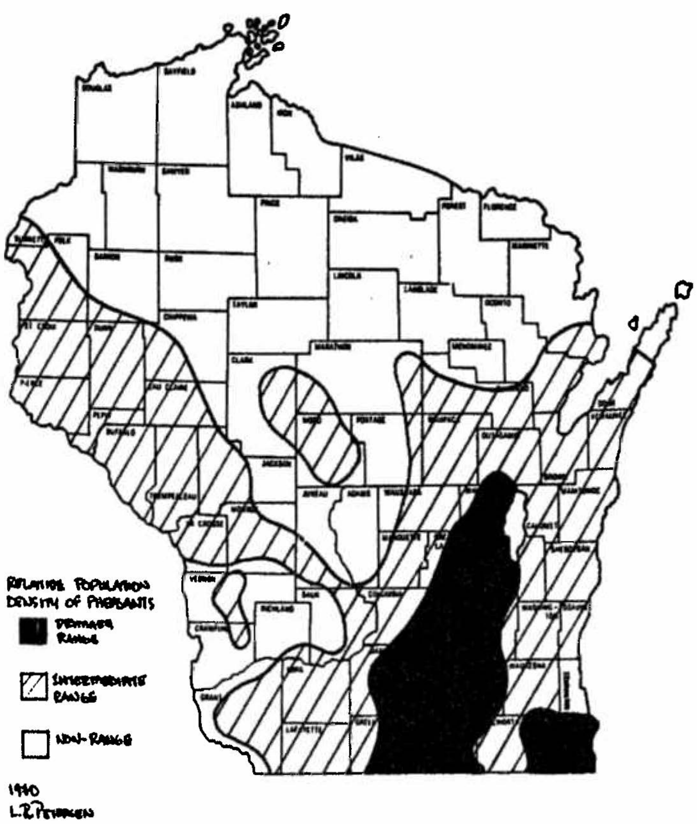
PHEASANT RANGE MAP

MIDWEST BIOLOGISTS MAY MODIFY THIS RANGE MAP
IF COMPARABLE DATA ARE AVAILABLE.

MIDWEST PHEASANT POPULATION - SPRING 1971
HENS PER SQUARE MILE



A REPORT OF THE MIDWEST PHEASANT COUNCIL of the---
ASSOCIATION OF MIDWEST FISH AND GAME COMMISSIONERS
Prepared by the COLORADO DIVISION of GAME, FISH and PARKS



APPENDIX 2. Colleagues responding to the partridge/pheasant questionnaire.

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PIK EVALUATION

COMMITTEE REPORT ON THE 1983 SET-ASIDE PROGRAM[1]

ALFRED BERNER[2], Minnesota Department of Natural Resources, Madelia, MN 56062

Wildlife biologists in 12 Midwest states surveyed 2,451 fields retired in the 1983 set-aside and PIK programs on 829 randomly selected farms. This sample represented 86,738 acres which was 0.2% of the 43,331,319 acres retired in the 12 states (Tables 1 and 2).

The survey involved 2 field checks. During mid to late June the species, height and density of the cover crop (if any) on the retired acres was noted. In late July, the same fields were checked again to note any changes in the field conditions.

Vegetation density, height, and disturbance date were used to determine the fields' value as wildlife nesting cover. Unseeded fields with volunteer annuals, and newly seeded fields which had fair, good, or excellent stand density, and were 20", 14", and 10" in height, respectively, during the first check, were classified as good to excellent nesting cover if the cover remained undisturbed until at least 15 July. The same criteria was used to evaluate established cover except the cover had to remain undisturbed only until 1 July.

[1]Modified from a letter (A. Berner to Midwest States Cooperating in the 1983 Survey of Set-aside and PIK Acres; 21 September 1983) describing final survey results.

[2]Survey coordinator.

Despite past efforts, the 1983 survey results indicated that, overall, we lost ground in trying to provide wildlife habitat on land retired under the Federal Farm Programs. Most disturbing, was the continued decline in the percent of retired acres in established cover (Table 3). The 1983 results revealed 62% less established cover than in 1978, 83% less than in 1973, and 75% less than in 1972. This general pattern was present in all states surveyed. Also, less than 65% of the approximately 2.7 million acres of the established cover was classified as good to excellent nesting cover (Table 4).

In 1983, the percent of unseeded fields was the highest of the 4 years surveyed (Table 3). Although not statistically significant, the fact that over 1/2 of the acres were unseeded is depressing, while the 30% decline in the proportion of acres classified as fallow (no cover on both checks) was encouraging (Table 5). Even with this decline in the proportion of fallow acres, over 9 million acres were without cover for 7 months or more in 1983.

The decrease in the percent of fallow acres was more than offset by an increase in the amount of stubble. The more than 17.5 million acres in stubble provided little nesting cover (only 10.9% was classified as good to excellent, Table 6). Also, farmers were more prone to destroy these fields, particularly when good volunteer cover developed.

Table 1. Number of farms and acres surveyed by biologists in 12 Midwest states, June-July 1983.

State	N farms surveyed	Acres surveyed	Acres/ farm	Acres/ field
Colorado	81	27,360	337.8	83.9
Illinois	88	6,048	68.7	24.8
Indiana	55	4,927	89.6	36.5
Iowa	93	6,804	73.2	26.8
Michigan	64	3,728	58.2	23.0
Minnesota	94	8,302	88.3	35.0
Missouri	65	3,379	52.0	18.4
Nebraska	66	5,166	78.3	28.9
North Dakota	55	4,881	88.7	39.7
Ohio	50	2,871	57.4	15.8
South Dakota	46	9,132	198.5	60.9
Wisconsin	72	4,141	57.5	15.1
Total	829	86,738	104.6	35.4

Even though 32% of the fields surveyed had been seeded by late June 1983, only 16% of these fields had good to excellent cover (Table 4). Most of these cover crops were planted too late and destroyed too early to be of value to wildlife.

Overall, only 17.5% of the fields were classified as good to excellent nesting cover in 1983 (Table 7).

In conclusion, under the 1983 set-aside the PIK programs in the 12 states surveyed, about 18 million unseeded acres (42%) had little or no wildlife cover (fallow or poor stubble), 6.8 million unseeded acres and 12.5 million seeded acres (44%) had some cover but were unsafe for nesting wildlife, and less than 6 million acres (14%) could be considered valuable wildlife cover.

Table 2. Number of acres taken out of production under the 1983 set-aside and PIK programs in 12 Midwest states.

State	Acres retired
Colorado	1,885,003
Illinois	4,872,909
Indiana	2,768,725
Iowa	6,393,842
Michigan	614,797
Minnesota	4,929,719
Missouri	2,432,520
Nebraska	5,394,192
North Dakota	6,423,891
Ohio	1,966,958
South Dakota	4,199,763
Wisconsin	1,449,000
Total	43,331,319

Table 3. Mean percent of set-aside acres unseeded (fallow or stubble), newly seeded (small grains or row crops), or in established cover (grasses, legumes, or grass-legumes) for each of 4 years a survey of retired acres was conducted in 11 Midwest states.[a]

Year	N fields surveyed	Unseeded	Newly Seeded	Established
1972	5,052[b]	48.4 (±7.8)[c]	20.8 (±5.9)	30.6 (±4.4)
1973	2,987	45.8 (±9.1)	9.5 (±2.9)	44.7 (±7.6)
1978	876[d]	47.7 (±9.1)	33.7 (±8.5)	20.6 (±6.9)
1983	2,267	57.6 (±7.0)	34.6 (±8.4)	7.8 (±2.9)

[a] Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

[b] Number of fields surveyed was not indicated for North Dakota.

[c] SE in parentheses.

[d] Number of fields surveyed was not indicated for Colorado.

Table 4. Percent of set-aside acres found to be in newly seeded and established seedings during the 1983 field surveyed in 12 Midwest states.

	Newly seeded[a]			Established cover[b]		
		Quality rating[c]			Quality rating	
	%	P-F	G-E	%	P-F	G-E
Colorado	13.8	69.0	31.0	0.4	50.0	50.0
Illinois	65.0	85.6	14.4	5.2	12.8	87.2
Indiana	44.5	63.2	36.8	29.6	54.3	45.7
Iowa	63.4	84.2	15.8	9.9	26.7	73.3
Michigan	7.9	83.8	17.2	12.3	54.1	45.9
Minnesota	24.6	95.5	4.5	1.4	38.2	61.8
Missouri	7.6	48.6	51.4	3.8	20.0	80.0
Nebraska	12.2	89.5	10.5	5.3	61.6	38.4
North Dakota	4.0	100.0	0.0	0.0	0.0	0.0
Ohio	83.9	68.0	32.0	3.1	69.2	30.8
South Dakota	11.0	94.6	5.4	4.0	14.0	86.0
Wisconsin	49.8	96.4	6.3	14.6	16.3	83.7
Mean[d]	32.1	83.6	16.4	6.2	35.6	64.4

[a] Seedings planted in fall of 1982 or spring of 1983.

[b] Perennial seedings planted in spring 1982 or before.

[c] Percent in poor to fair (P-F), and good to excellent (G-E).

[d] Weighted mean using acreages from Table 2.

Table 5. Mean percent of set-aside acres in the 4 general cover categories for the 11 states surveyed all 4 years.[a]

Year	Fallow	Stubble or volunteer annuals	Newly seeded	Established seedings
1972	41.2	7.2	20.8	30.6
1973	41.4	4.4	9.5	44.7
1978	27.0	20.7	33.7	20.6
1983	19.0	38.6	34.6	7.8

[a] The means are unweighted; the states were Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

Table 6. Percent of set-aside acres found to be in fallow and stubble during the 1983 field survey in 12 Midwest states.

	Fallow[a]	Stubble and/or volunteer plants[b]		
			Quality rating[c]	
	%	%	P-F	G-E
Colorado	48.9	36.8	89.2	10.8
Illinois	9.3	20.5	59.8	40.2
Indiana	0.4	25.4	81.0	10.0
Iowa	1.3	25.4	86.2	13.8
Michigan	12.0	67.8	69.5	32.1
Minnesota	37.6	36.4	93.5	6.5
Missouri	5.4	83.2	43.4	56.4
Nebraska	4.7	77.8	99.2	0.8
North Dakota	71.4	24.6	100.0	0.0
Ohio	5.2	7.8	85.2	14.8
South Dakota	17.8	67.2	90.8	9.2
Wisconsin	0.2	35.4	88.4	11.6
Mean[d]	21.3	40.4	86.7	10.9

[a] Fields classified as fallow were those without cover on both the June and July field checks.

[b] These fields were those with any undisturbed stubble or previously worked-up field with volunteer annuals.

[c] Percent in poor to fair (P-F), and good to excellent (G-D).

[d] Weighted mean using acreage from Table 3.

Table 7. Mean percent of fields providing none to fair or good to excellent nesting cover for each of 4 years a set-aside survey was conducted by 11 Midwest states.[a]

Year	None-fair	Good-excellent
1972	71.4 (±5.2)[b]	28.8 (±5.2)
1973	68.0 (±6.0)	32.7 (±6.0)
1978	74.1 (±5.9)	26.0 (±5.9)
1983	82.5 (±11.2)	17.5 (±3.4)

[a] Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

[b] SE in parentheses.

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MEASUREMENT CONVERSIONS

Measure	English	Metric
Linear	1 inch (inch)	2.54 centimeters (cm)
	1 foot (ft)	0.3048 meters (m)
	3.281 feet (ft)	1 meter (m)
	1 rod (rd)	5.029 meters (m)
	1 mile (mi)	1.6093 kilometer (km)
	0.621 mile (mi)	1 kilometer (km)
Area	1 acre (acre)	0.4047 hectares (ha)
	2.471 acres (acres)	1 hectare (ha)
Volume	1 $mile^2$ (mi^2)	2.59 $kilometers^2$ (km^2)
	1 $inch^3$ ($inch^3$)	16.387 $centimeters^3$ (cm^3)
	1 $foot^3$ (ft^3)	0.283 $meters^3$ (m^3)
	35.316 $feet^3$ (ft^3)	1 $meter^3$ (m^3)
Dry	1 bushel (bu)	35.238 liters (l)
Mass	1 short ton (2000 lb)	0.907 metric tons
	2.2 pound (lb)	1 kilogram (kg)