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Pheasants: Symptoms of Wildlife Problems on Agricultural Lands: Proceedings of a Symposium Held at the 49th Midwest Fish and Wildlife Conference (Milwaukee, Wisconsin: December 8, 1987)

Diana L. Hallett
Missouri Department of Conservation

William R. Edwards
Illinois Natural History Survey

George V. Burger
Max McGraw Wildlife Foundation

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PHEASANTS:

Symptoms of Wildlife Problems on Agricultural Lands.

Edited by

D. L. Hallett ***W. R. Edwards*** ***G. V. Burger***


TDavid Besenger

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PREFACE

As a point of background to this Symposium, the Midwest Pheasant Council—for 20 years the mechanism bringing pheasant research biologists and managers together to share ideas and new information—was disbanded in 1979 by the Midwest Association of Fish and Game Commissioners. Attendees at the final meeting of the Council unanimously voiced strong interest in continuing communication. This interest resulted, in part, in inclusion of pheasant papers in a multi-species workshop at the 1983 Perdix III Symposium. The same needs and interest were expressed at the 1985 annual business meeting of the North Central Section (NCS) of The Wildlife Society. This Symposium is the latest product of the ongoing need to share new information on the ring-neck.

Although pheasant research has been much reduced in recent years, there are important new ideas to report. As George Burger points out, while much research has been undertaken, no significant book on wild pheasants in America has been published in over 30 years. Pheasant life history, artificial propagation, and population regulation were reviewed at a 1973 NCS Symposium. This (1987) Symposium was not designed to update information from 1973; instead we stress perspectives from new pheasant research basic to management under changing midwestern agricultural landscapes.

The basic objective of the Symposium was to: concisely review, summarize, and present current information about the wild ring-necked pheasant, especially in relation to its habitat. Pheasants were used as an example of an upland game bird in the Midwest for presenting management innovations for the 1990's.

The initial papers of this Proceedings set the scene: the midwestern landscape, its change to intensive agricultural land use, and how the altered habitats impact ring-necked pheasants. Two papers deal with fluctuations in pheasant abundance coincident with changes in agricultural landscapes. The 3 papers that follow address policies influencing pheasant habitat: multi-year cropland diversions, annual set-aside acreages, and transitions from livestock-based agriculture to intensive row-cropping. Ensuing papers describe innovative approaches to management: genetic applications to population management; population modeling, stressing survival as a limiting factor; the role of predation; resource demands and how to meet them; and interspecific interactions between pheasants and other upland game birds. The final papers use historical lessons to better predict further directions in pheasant research and management.

I express appreciation to members of the NCS of The Wildlife Society for sponsoring this Symposium, and especially to R. T. Dumke, C. M. Pils, and W. R. Porath. Financial support for publication was provided by the NCS, Pheasants Forever, and Max McGraw Wildlife Foundation. In addition to the editors, the Steering Committee included L. R. Petersen and R. E. Warner. D. L. Hallett served as Symposium coordinator and guided final manuscript preparation, printing, and publishing arrangements for the Proceedings. S. Clark assisted with redactory editing and preparation for printing. Symposium session moderators were T. S. Baskett, A. L. Farris, G. B. Joselyn, and R. A. McCabe. C. D. Besadny made the opening remarks at the Symposium. G. V. Burger, W. R. Edwards, and D. L. Hallett served as editors. I also gratefully acknowledge the efforts of reviewers of Symposium manuscripts.

Diana L. Hallett

Diana L. Hallett
Coordinator

The pen and ink drawing used in the Symposium program, its stationery, and as the Frontispiece for this publication was drawn by David Besenger, Missouri Department of Conservation. The pen and ink drawings used at the beginning and end of some of the chapters were provided by D. Besenger and Charles W. Schwartz, formerly with the Missouri Department of Conservation. Both artists donated the use of their artwork, and we thank them for their contributions.

INTRODUCTION

The theme of the Symposium—pheasants as symptoms of wildlife problems on agricultural lands—was appropriate. To paraphrase a comment made by C. D. Besadny during the plenary session of the 49th Midwest Fish and Wildlife Conference, preceding the Symposium, the pheasant is the "miner's canary" that tests for us the quality of habitat for wildlife on agricultural lands. Clearly, wildlife diversity and general abundance have been much reduced (often drastically) on most agricultural lands. Problems of wildlife relate to the nature and intensity of agriculture, and to a technological revolution. Rapid changes in land use create problems shared by most if not all native grassland wildlife.

The origins of agriculture have been traced to the valleys and plains of Persia and to the loess plains of central China, areas that were the endemic ranges of black-necked (*Phasianus colchicus colchicus*) and gray-rumped (*P. c. torquatus*) pheasants, respectively. Thus, pheasants and agriculture share a co-evolution of some 10,000 years; eons longer when considering the numerous genera of wild plants that became the basis of modern agriculture, such as wheat (*Triticum*), oats (*Avena*), barley (*Hordeum*), alfalfa (*Medicago*), rice (*Oryza*), millet (*Panicum*), and soybeans (*Glycine*). Pheasants are also an appropriate choice because several long-term research projects as in Illinois and Wisconsin relate pheasant ecology to changes in agriculture.

In reading the papers that follow, the reader should be alert to recent changes in ecological thinking. One such change is recognition of the pervasive instability of pheasant abundance; another is that dispersal contributes importantly to pheasant abundance at local scale. New ideas on dispersal require rethinking the assumption of discrete (closed) populations, and the concept of carrying capacity when applied to small, local areas. Equally important is the recognition that abundance is primarily survival-dependent, and that predation is a primary cause of pheasant mortality. While conceptual details remain hazy, recent progress is toward a unified temporal and spatial perspective on the dynamics of establishment, abundance, and ecology of pheasants in North America.

Although pheasants were extensively established by the late 1920's, there were many early failures, and notable regional differences in dates of establishment. From today's perspective, we can clearly see that establishment was the result of pheasant releases made when and where land use was favorable. Because of the heterogeneous mix of racial types and the great numbers of birds released, genetics of released stocks probably were far less important in local establishment than were habitat and predation.

We now know that the booming pheasant populations of the 1930's were related to the economic depression of that era. When markets for farm products are depressed, land lies idle and weeds and pheasants prosper. The conversion from horse to tractor as the primary source of power on American farms allowed farming on a far larger scale and, thus, was a major contributing factor to over-production and to the depressed commodity prices that followed. Although not recognized at the time, a major factor affecting land use and pheasants in the late 1930's was cropland diversion under the Agricultural Conservation Program (ACP) of the U.S. Department of Agriculture. We know that the pheasant "bubble" broke during World War II when ACP ended and farmers returned to full production, with extensive dependence on cash grains. The Soil Bank and Feed Grain eras of cropland diversions in the late 1950's and early 1960's again saw a "boom" in pheasant abundance, followed by a "bust" accompanying a return to fencerow-to-fencerow agricultural policies.

Within this general pattern of boom and bust can be found a secondary pattern in the decades in which pheasants became regionally most abundant. Close inspection reveals in the early centers of pheasant abundance conversions from dairying and livestock-based farming to predominantly grain farming. Regional reductions in intensive haying and grazing that preceded these transitions, periods of about 10 years of less intensive land use, were associated with periods of increase in pheasant numbers. Simply stated, for the past 100 years, the pheasant in North America has been a bird of good land and of hard times.

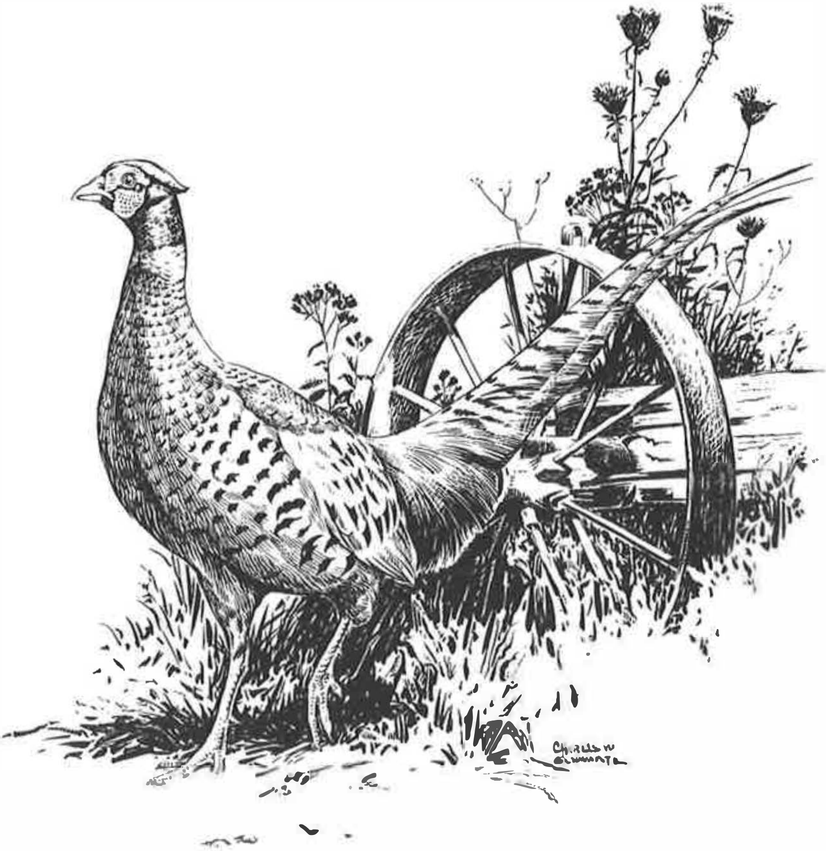
We now have reasonable rationales to explain most of the old enigmas of regional successes and failures of establishment, and of increases and decreases in pheasant abundance. These rationales relate to economic cycles, land use, weather, predation, and—perhaps—to wildlife cycles (the latter very possibly a function of predation). These rationales also provide a better understanding of pheasant biology, a new perspective on ecology, and a much clearer understanding of what determines the abundance of pheasants than was true in the past. New appreciation of innate dispersal provides an explanation for our inability to manage successfully for high, local pheasant abundance where and when pheasants are not regionally abundant. And readers are offered ideas of what constitutes harvestable surplus.

Thus in the last 3 decades, much of significance has been learned of the biology and ecology of pheasants in North America, and is to be found in these Proceedings.

William R. Edwards
Technical Editor

CONTENTS

1



100 Years of Ringnecks: An Historical Perspective on Pheasants in North America

GEORGE V. BURGER, Max McGraw Wildlife Foundation, Dundee, IL 60118

Abstract: This paper presents a chronological review of problems and accomplishments in pheasant research and management in North America over the past 100 years. Pheasants epitomize the term "farm game." They thrive best on fertile soils in areas of mixed farming managed at moderate intensity. Today, over much of their range, pheasants are greatly reduced in numbers compared with 50, 30, or even 10 years ago. They stand as symptoms of wildlife problems on agricultural lands. The roots of current problems of pheasants and other wildlife on agricultural lands are seen to lie in socioeconomics, agricultural technology, and intensive land use. The problem is thus an agricultural problem and demands an agricultural solution. The solution thus must go well beyond the bounds of traditional wildlife management. Of prime concern is the design of federal agriculture programs as they affect land use and, thus, habitat, and the local implementation of such programs, particularly cropland diversions. The solution is in wildlife professionals acting in partnership with an informed and growing citizen constituency.

Key Words: historical, management, perspective, research, ring-necked pheasant

As Madson (1962:7) pointed out, the pheasant (*Phasianus colchicus*) has become a typical American citizen, a blend of Old World races and origins alloyed in the New World's melting pot and tempered for survival in a new environment. As such, this pheasant may be more uniquely American than any native game bird. Dale (1956:1), summing up the newcomer's contribution to hunting and game management, stated that the advent of the pheasant "helped continue the sport of shooting for vast numbers of farmers and city workers...," at a time when "wing shooting for the average hunter appeared doomed on northern farms." The pheasant also demonstrated that fertile land could produce good game crops as well as good farm crops.

After many abortive attempts, the first successful pheasant population in North America was established from a release of Chinese ring-necked pheasants in 1881 in the Willamette Valley of Oregon (Prince et al. these Proceedings). Progress during the next 40-50 years was by fits and starts. But, by the late 1930's, the pheasant was established on most of the range that it occupies today and had climbed into the national limelight as a game bird. The past 5 decades have witnessed major changes in the patterns of pheasant abundance in North America. The most obvious and dramatic illustration of this, as Robert Dahlgren (these Proceedings) points out, is the fact that the continental harvest of pheasants today barely exceeds the kill of pheasants reported from North and South Dakota in 1945.

Many of the major changes in pheasant abundance and distribution from the mid-1930's through the mid-1980's have been closely related to federal cropland retirement programs and to world markets for U.S. grain crops (Edwards 1984 and these Proceedings, Berner these Proceedings). We have also begun to appreciate that surging pheasant populations negatively impacted those of prairie chickens (*Tympanuchus cupido pinnatus*) (Westemeier 1983), and probably other game birds as well (Kimmel these Proceedings).

Behind the drama of the ups and downs of pheasant abundance, 3 generations of wildlife biologists have tried to determine which conditions afford the ecological stage setting on which the pheasant will perform productively. A review of the accomplishments of these people, and a sense of the mood of the times, can be found in 2 publications: *The Ring-necked Pheasant and Its Management in North America*, edited by W. L. McAtee (1945), and *Pheasants in North America*, edited by Durward L. Allen (1956).

WHAT HAVE WE LEARNED?

Beginnings

The Pittman-Robertson and the Cooperative Wildlife Research Unit programs—revolutionary innovations of the 1930's that galvanized wildlife research—were responsible for much that McAtee's authors reported in 1945. The decade of the 1930's was a time of fact gathering. For sheer numbers, the data presented from Ohio by Leedy and Hicks (1945) on nearly every aspect of pheasant biology are still impressive. Life history studies and generalized range analyses by Leopold (1931), Randall (1940), Buss (1946), and others established the ties between farmland and pheasants. Basic food-habits research by Severin (1933), English and Bennett (1940), Fried (1940), and Wright (1941) confirmed these ties. Errington (1937) explored relative uses and values of emergency winter foods for pheasants in the northern USA. McCann (1939) shed light upon Leopold's (1931) thesis of the positive relationship between pheasant distribution and recently glaciated soils (Wisconsinian age). Studies of Errington and Hamerstrom (1937) and Baskett (1941) emanating from Iowa indicated, among other fundamental aspects of pheasant ecology, the importance of renesting.

In management, predator control was considered unnecessary—at least on a major scale—but refuges were rated as highly important in pheasant management, particularly in the eastern parts of the range. Aimed primarily at protecting—supposedly from the dangers of overhunting—"seed stocks" of pheasants to ensure adequate breeding numbers, small refuges were managed also to provide a better seasonal distribution of the harvest.

Mass releases of artificially propagated pheasants—to increase established populations or to extend existing range—were generally discounted by McAtee's authors. Yet stocking was still an important management tool in many regions. In the Northeast, Pearce (1945:52) reported pheasant releases were "something of a necessary evil—justified in view of the enormous recreational demand for pheasant shooting in areas where it can be provided only by stocking." Bennett (1945:30) believed that stocking had some merit in areas of heavy hunting pressure where the pheasant was a "relish species, not the main meal." To the present day the continuation of stocking on marginal range in many states follows in large part the reasoning of these authors—no writers since have produced more lucid arguments for continued stocking.

A second purpose of stocking in the early 1940's was the release of cocks in spring to compensate for hunting losses, and thereby reestablish suitable sex ratios for breeding (Bennett 1945). Even in the pheasant-bountiful Plains and Prairie states, stocking was then considered to have merit "if done following drastic overshooting...or to offset some catastrophe" (Errington 1945:202). Stocking to maintain proper sex ratios was subsequently found to be unnecessary (Allen 1947, Shick 1947).

Large scale use of wild-trapped birds for stocking was apparently first advocated in Ohio. "Trap and transplant" techniques were initially developed to reduce crop damage caused by an abundance of pheasants (Leedy and Hicks 1945). In Ohio, wild-trapped birds were used to restock tracts that were thought to have either had their brood stock overly reduced by hunting, or were unable to consistently support an abundance of pheasants. These early applications of pheasant "trap and transplant" later revolutionized wild turkey management.

McAtee's authors advocated winter feeding throughout most pheasant range. Also, an infant habitat-management program had been born, replete with recommendations for standing corn strips, food patches, conifer and shrub plantings, and roadside and hedgerow cover maintenance and improvement (Dalke 1945).

Optimism pervades the chapters of *The Ring-necked Pheasant,* as evidenced by statements oddly haunting in the context of today's problems. Errington (1945:199), for example, stated: "in the northern prairies... pheasants have a way of thriving, to a large extent irrespective of the attention man may, or may not, pay them;" and (p.201): "Given the essentials of good range, established pheasant populations in the north-central region seem to take in stride so many of the variables associated with land use that it is uncertain how responsive they may be to environmental manipulations." These statements seemed justified. Agriculture was then the "friend" of the pheasant and there was little reason not to have confidence in the farmer and in his use of the land. The "environmental manipulations" that agriculture would achieve in the not-too-distant future were undreamed of as yet.

In addition to buoyant optimism, a second striking feature in *The Ring-necked Pheasant* is the near-total lack of statistical analysis. To the best of my knowledge, the word "statistics" does not appear. Absent also is any discussion of Canadian pheasant populations—even Ontario's famous Pelee Island failed to make the grade. Too, page after page reads refreshingly free of "suggest" and "indicate" qualifiers, and resounds with subjectively based evaluations and recommendations. These men made mistakes, but they spoke in forthright fashion from years of field experience.

Despite optimism and subjectivity, McAtee's book contains remarkable insights. Pearce (1945:44, 45) stated: "If not the average hunter, at least a surprising proportion of the license holders will pay additional fees for the privilege of shooting over lands on which better-than-average sport can be expected..." and "It is questionable whether any state can handle enough (public management areas)...to satisfy the shooting public." In Iowa, Errington (1945:201) might have been voicing an opinion on "Set-aside Acres": "It is imperative that our soils be conserved and even modest incidental gains (for game management) should be wholly acceptable." In Michigan, Dalke (1945:160) sounded a minor alarm note: "Lacking fencerows, a farm will almost inevitably be without pheasants." Dalke (1945:185) reiterated an hypothesis—later verified by researchers in Wisconsin—that "The pheasant population is frequently proportional to the area of marsh and smaller areas of lowland, such as kettle holes."

There were other portents. In Ohio, in 1930, the Plain Church Protective Association of Wood County posted this proclamation as a defense against trespass abuse during the hunting season (Leedy and Hicks 1945:122): "As the hunting season approaches, the anxiety of landowners increases. It is a deplorable and well-known fact that many who are otherwise law-abiding citizens become outlaws when out hunting. They kill our quail, hen pheasants, poultry, and sometimes our livestock, destroy our fences, and utterly disregard the game laws by trespassing upon our land without permission. Since these laws are so flagrantly violated by so many unscrupulous hunters, therefore, we, as farmers have met and organized ourselves into an association."

Off and Running

Pheasants in North America, which appeared in 1956 only 11 years after publication of *The Ring-necked Pheasant*, revealed the flowering of widely diversified research no longer limited to a few states. Biologists attempted to identify the factors responsible for the "booms and busts" in pheasant numbers and, of course, to prepare for future eventualities. To do this they needed techniques with which to dig deeply into pheasant biology and population dynamics. And develop techniques they did. Determining numbers was essential. Kimball (1949) refined the crowing count; numerous other methods for estimating and indexing abundance were also evaluated (Kimball et al. 1956).

The principles of productivity and population turnover were recognized, but their practical application required reliable knowledge of age structure. Research disclosed the usefulness of spur length and the depth of the bursa of Fabricius for distinguishing between adult and subadult pheasants (Linduska 1943, 1945), and of primary molt patterns for aging juvenile birds (Trautman 1950) in autumn. Application of these techniques to the large samples of pheasants shot during autumn by hunters provided data on the relationships between age ratios, productivity, and pheasant abundance (Dale 1956, Kimball et al. 1956).

Sex ratios were explored as a means of determining the impact of hunting regulations on harvests and populations (Allen 1956, Kimball et al. 1956). Sex ratios were also employed to investigate the timing and extent of hen losses (Buss 1946). A major "spinoff" from sex-ratio studies was the research on egg fertility (Shick 1947, Twining et al. 1948), which relieved previous fears of cock "shortages" during breeding season—thereby removing any justification for stocking cocks in spring and simultaneously pulling a cornerstone from under the "seed stock" refuge concept. Techniques for estimating pheasant abundance, aging birds, and evaluating age structure, together with such other tools as the counting of ovulated follicles to determine the magnitude of egg production (Kabat et al. 1948, Buss et al. 1951), had pheasant biology humming.

Studies summarized by Dale (1956) explored egg laying, egg hatchability, and nesting ecology. Seubert (1952), working with confined birds, added to our knowledge of renesting. Stokes' (1954) study of pheasants on Pelee Island produced a truly impressive volume of data on the mechanics of a fall population that approached 400 pheasants per 100 acres (10 per ha). These investigations, and others, provided vital clues for management. They identified "preferred" habitats for nesting, the importance of nonfarmed lands, strip-cover, and marshes to pheasant production, and losses of hens and clutches to the hay mower. In a related context, Arnold's (1951) research in Michigan reinforced the view that predators, particularly the red fox (*Vulpes fulva*), offered no serious threat to pheasant abundance.

Food-habits studies flourished in the late 1940's and early 1950's. They revealed that although chicks consumed large quantities of invertebrates, the pheasant's main foods were cereal grains (Ferrell et al. 1949, Trautman 1952). Although pheasants exposed to prolonged and heavy snows sometimes appeared to be victims of starvation (Nelson and Janson 1949), controlled research indicated that pheasants could withstand adverse winter weather and meager rations for surprisingly long periods of time (Latham 1947, Throckmorton 1952). The latter finding raised skepticism as to the advisability of winter feeding. Allen (1956) echoed the earlier words of Bach (1945:5) when he concluded that we simply cannot feed our pheasants economically or practically in winter.

The drastic declines in pheasant abundance in prime range during the late 1940's prompted a strong look at weather as the possible culprit (reviewed by Labisky et al. 1964). Some workers, including Allen (1947), Ginn (1948), Erickson et al. (1951), and Buss et al. (1952) were of the view that production of young was depressed by unusually cool, wet spring seasons. Kozicky et al. (1955:141), however, presented evidence indicating that above-normal rainfall coupled with normal temperatures did not adversely affect production. Kimball (1948) hinted that hot, dry weather might be as detrimental to production as cold, wet weather. Findings on the relationship of weather to pheasant abundance were anything but clearcut. Kabat et al. (1950), however, suggested that weather that would cause a delay in the timing of the reproductive cycle might place a stress on pheasant hens and thereby increase mortality. And so there was progress.

Research to learn why pheasants were not where they were not also became popular. The work of Dale (1954, 1955) on the pheasant's need for dietary calcium shed light on the potential importance of this mineral to pheasant distribution. Albrecht (1944) and Crawford (1950) pointed out links between soil fertility and wildlife. Yeatter's (1950) work on the tolerance of eggs to high preincubation temperatures opened new vistas for research designed to extend the pheasant's southern limits of distribution. Studies by Allen (1947) and Shick (1952), in Michigan, constituted a breakthrough in understanding the effects of hunting on pheasant abundance. Their work led to the realization that it is virtually impossible to over-harvest cock pheasants because, as numbers of available cocks became reduced as the season progressed and hunters realized diminished returns, hunting became self-limiting. This principle has been verified repeatedly throughout the pheasant range in the past 3 decades (Edwards these Proceedings).

Closely linked to this "law of diminishing returns" was the finding by Leopold et al. (1943) that, on average, about 81% of the pheasants alive each fall on an unhunted Wisconsin refuge succumbed to one or another mortality factor during the next year; Shick (1952) calculated a nearly identical average annual mortality of 84% on Michigan's Prairie Farm. These and similar findings elsewhere led to more liberal seasons for pheasants (and other resident game), and greatly increased recreational opportunities for hunters. The last foundations had now been pulled from beneath old concepts of the need for refuges and spring releases of cocks for short hunting seasons, and for closed seasons in years of low populations. In some states, Minnesota for example, this last concept continued to prove difficult to sell to laymen, however.

Allen's (1956:456) statement that "At present, a realistic handling of the hunting season is perhaps the most constructive management that can be applied to the pheasant" sums up the management thrust of the late 1940's and early 1950's. But there was also full recognition of the value of habitat management, which "promises to be the most effective implement in the game managers' tool chest" (Kimball et al. 1956:258). In the Dakotas and other Plains and Prairie pheasant states, planting woody cover to provide winter habitat was judged the most important management step for pheasants. In the Northeast, results of intensive habitat developments for pheasants on state-owned lands proved disappointing (Studholme and Benson 1956). Costs were high and pheasants did not always respond. Pennsylvania and neighboring states initiated large-scale cooperative arrangements with landowners—a concept that remains an outstanding feature of game management on private farmland in the eastern U.S. In the Lake States, cover plantings also proved disappointing, particularly in light of widespread losses of natural cover to drainage, clean farming, and chemical spraying or debrushing of roadsides. McCabe et al. (1956:281) pointed out: "Habitat management notwithstanding, it appears now that the first concern is not so much a matter of creating cover as of preventing its destruction." Prophetic words!

Despite near-unanimous disclaimers of its biological or management validity, stocking of pen-reared pheasants remained widespread. Research had established that there was no need to stock cocks in spring to "correct" sex ratios, and documented the futility of releasing hens to increase production on occupied ranges. Further, banding studies—with some exceptions, e.g., Kabat et al. (1955)—generally revealed that survival of young pheasants released in summer was low, and that their recovery by hunters was inversely proportional to the interval of time between release and hunting (Pushee 1948, Skiff 1948). But the public demand for hunting—amplified by the pheasant decline of the 1940's—generated continued demand for stocking in many states. This was not the case in the Dakotas (Kimball 1948, Wandell 1949), however, where pheasants remained abundant until the early 1950's.

The practice of stocking pheasants to increase harvest was objected to by wildlife managers, who considered the costs exorbitant, and who believed that newly stocked birds furnished low-quality sport. Numerous experimental efforts—including the development of "gentle release" techniques (Kozlik 1948), improvement of the quality of game-farm pheasants (Stanz 1953), and the feasibility of implementing "day-old-chick" stocking programs (Besadny and Wagner 1963)—were undertaken to resolve these objections. This work centered in Wisconsin, Washington, and Oregon (Lauckhart and McKean 1956, McCabe et al. 1956).

"No Hunting" signs had increased since Ohio's Plain Church Association posted its 1930 proclamation against hunting trespass. Cooperative farmer-sportsman groups were in vogue in the Lake States. Their objectives were to control trespass while still allowing hunting on private lands, to encourage interest in habitat management and preservation, and—in Plain Township, Ohio—to pay the mortgage on a new church. Similar cooperatives, with state game agencies playing an important role, had become a feature of management in the Northeast and in California (Harper et al. 1950).

By the early 1950's, state-owned public hunting grounds had become commonplace in the Lake States. Those located near metropolitan centers absorbed heavy hunting pressure and, consequently, were often heavily stocked with artificially propagated pheasants. Also in the 1950's, privately owned shooting preserves, which had been in the background since 1910, began to increase. Nilo Farms was prominent as a model shooting preserve (Allen 1956) and the Sportsmen's Service Bureau of the Sporting Arms and Ammunition Manufacturers' Institute featured a field staff that specialized in providing technical advice to the growing shooting preserve industry.

Perhaps the most recurring observation of the early 1950's was widespread recognition of the ultimate dependence of pheasant abundance upon agriculture—not upon biologists. McCabe et al. (1956:296) wrote that the farmer "has become the custodian of most of our Lake States pheasants." Unfortunately, signs were becoming abundant that the "custodian"—influenced by economic trends and abetted by new technology—was paying little attention to the pheasants and other wildlife in his "custody." The heraldists spoke. In the Northwest: "General habitat deterioration is due to more intensive farm management..." (Lauckhart and McKean 1956:86); from the Plains and Prairies: "Intensified agricultural use, wise and foolish, is destroying pheasant habitat" (Kimball et al. 1956:263); and from Pelee Island (the pheasant "Mecca" of the time): "If not halted...(habitat destruction) could mean the end of what makes Pelee Island America's number-one pheasant range" (Stokes 1956:386). Similar warnings were sounding from the Lake States and the Southwest. Only from the Northeast came no such alarm, possibly because pheasant hunting there had long been based largely on annual stocking.

There were inklings in the early 1950's of another problem that would soon become a focal point for concern and research. Herbicides were coming into vogue and destroying vegetative cover (McCabe et al. 1956), and pesticides with soon all-too-familiar labels—DDT, Chlordane, Parathion, and others—were being viewed as a menace in the Northwest, where they were replacing older, more environmentally benign insecticides to control orchard pests (Lauckhart and McKean 1956). And herbicides, like 2,4-D and 2,4,5-T, were coming into general agricultural use to kill weeds and even trees—chemicals that helped to set the stage for today's clean farming. However, the tone of *Pheasants in North America* reflected confidence, if not the buoyant optimism of its predecessor, *The Ring-necked Pheasant.* To illustrate, Lauckhart and McKean (1956:89) wrote: "The greatest hope lies in the fact that conservation practices which must be adopted to preserve for future generations the soil and water resources of the land also should be of benefit to the pheasant"—a hope shared by most biologists then and now.

Thus, the decade of the late 1940's and early 1950's spanned by *Pheasants in North America* represented more than just another chronological segment of pheasant research. It marked the coming-of-age of professional wildlife management. Never before had a game species received more widespread attention than did the pheasant. Even so, Allen (1956) advocated an expansion of basic research on the ringneck.

On To the Present

Developments in pheasant research and management since publication of *Pheasants of North America* in 1956 constitute the final leg of the journey to the present. Highlights of the past 3 decades typify the continued thrust of research. The development of new and improved tools continued apace. They included night-lighting (Labisky 1968a), "helinets" (Brown 1981), and drugs (Fredrickson and Trautman 1978) to capture pheasants. McCabe and LePage (1958) experimented with radio-isotope tagging; radiotelemetry (Cochran and Lord 1963) came into practical use in, for example, studies of mortality and reproduction in Wisconsin (Dumke and Pils 1973), Illinois (Warner and Etter 1983), Colorado (Snyder 1985), and Missouri (Balkenbach and Hallett 1987), and in movements and behavior of released birds (Spiers 1972). There were, however, warnings that too-heavy transmitters could reduce survival of tagged birds (Johnson and Berner 1980, Warner and Etter 1983). Techniques for sexing (Linder et al. 1971) and aging (Greenberg et al. 1972) were further explored.

In the mid-1950's several important long-term studies of pheasant ecology were initiated, with those in Illinois (Labisky 1968b, 1975a; Warner 1981), Wisconsin (Gates and Hale 1974, 1975), Nebraska (Baxter and Wolfe 1973), South Dakota (Trautman 1982), Ohio (Bachant et al. 1971), Montana (Weigand and Janson 1976), and Iowa Farris 1973) leading the way. These studies repeatedly demonstrated that weed-free, intensified farming was an ominous sign of the times. Hay and small grains, once the major nesting habitats, gave way to corn, soybeans, and sorghum—and pheasant numbers declined. Renesting among wild pheasants was amply documented (Gates 1966, Dumke and Pils 1979), relationships between nesting ecology and habitat were thoroughly studied (Snyder 1984, Haensly et al. 1987), and factors that affected abundance received "deep-digging" consideration (Wagner et al. 1965, Wagner and Stokes 1968).

Research in Wisconsin (Wagner and Stokes 1968, Dumke and Pils 1973, Gates and Hale 1974) underscored the value of wetlands to pheasants in that state for nesting, brood production, and winter cover. Previously, Kabat et al. (1950) in Wisconsin and Edwards et al. (1964) in Ohio, had implicated reproductive success and possibly survival on the physical condition of hens in spring, and in turn on winter weather. Warner and David (1978, 1982), reporting on blizzard-related mortality during the extremely severe Illinois winters of 1976-77 and 1977-78, found no relationship with the availability of woody cover. In the Southwest, Whiteside and Guthery (1983) documented the importance of playas to ringnecks in Texas.

Further research on habitat relationships included reference to the old anathema—to nesting pheasants—of hay-mowing (Gates and Hale 1975, Fisher and Hartman 1983). Kirsch et al. (1978) pointed out that, while "undisturbed" grassy vegetation provides excellent nesting cover for pheasants and other prairie birds, grasslands cannot remain undisturbed for more than a few years without losing much of their value. They recommended periodic burning and light grazing as management tools, but noted that haying and heavy grazing were undesirable.

Researchers at the Illinois Natural History Survey worked on relationships of pheasant broods to cover types available on an intensively farmed area in east-central Illinois. Warner (1979, 1984) described the dependence of pheasant broods on oat fields and the greater movements of broods in corn-soybean monocultures than where small grains were present. Warner postulated that the trend to row-crop monocultures, and away from diversified farming, has led to increased chick mortality as a result of reduced insect and weed-seed foods. Whitmore et al. (1986) also looked closely at insects as foods of pheasant chicks. All of these studies had distinct management implications on state and regional scales.

Several excellent field studies on the impacts of predators on pheasants have emerged in recent years. Chesness et al. (1968) concluded that control of predators to enhance pheasant nesting success in Minnesota was economically infeasible. Gates (1972) pointed to the red-tailed hawk (*Buteo jamaicensis*) as a surprisingly effective predator on adult pheasants in Wisconsin. Dumke and Pils (1973) labeled predation as the most likely limiting factor of pheasant numbers on Wisconsin's well-studied Waterloo Area. Trautman (1972) and Trautman et al. (1974) conducted a classic study on the effect of mammalian predators on pheasants in South Dakota during the 1960's, and concluded that a multispecies predator-control program could be a highly effective way to increase pheasants and—to a lesser extent—jackrabbits and cottontails.

Much research was directed at defining possible barriers limiting the southward extension of pheasant range in the Midwest. One major finding was that pheasants failed to become established when released south of their contiguous range in Illinois because of inadequate survival, particularly during fall and winter (Ellis and Anderson 1963, Anderson 1965). The pheasant's ability to select calcium-rich grit from noncalcareous or calcium-poor grit (Sadler 1961, Harper and Labisky 1964, Korschgen et al. 1964) raised doubts as to whether a deficiency of calcium could limit the pheasant's southern distribution. However, studies of mineral physiology led Anderson and Stewart (1973) to hypothesize that an excess of barium might prevent establishment in some areas.

Throughout the late 1950's and early 1960's, research emphasis was also directed toward finding as yet untried races of pheasants that might "take hold" in unoccupied range (Bohl and Bump 1970). Except for as yet rather limited successes in Missouri, Oklahoma, New Mexico, and Nevada, recent liberation of newly acquired races has not resulted in self-maintaining population (Prince et al. these Proceedings).

Efforts to increase ringnecks where their numbers are low, or in areas that appear to offer promise but hold no pheasants, have ranged from mass releases of game-farm birds (Hartman and Shope 1981) to releases of live-trapped wild pheasants (Hartman 1971). Bright spots in the struggle to increase the pheasant's geographical range, however, are to be found in southern Iowa and northwestern Missouri, where pheasants have become established in recent years in areas that historically held few or no ringnecks (Wollard et al. 1977, Prince et al. these Proceedings). It is as yet uncertain whether these new populations result from changing land use, from releasing new genotypes, from natural selection among birds in or at the margins of their range, or from a combination of these factors (Farris 1973).

Michigan's current experiment with the Sichuan pheasant (*P. c. strauchi*) (Prince et al. these Proceedings) is the most recent attempt to establish a new race of pheasants in North America. Releases of Sichuan pheasants are aimed at marginal farmland habitats (Squibb 1985). Results from the first releases, in May 1987, have led to cautious optimism (Squibb 1987). Pennsylvania is scheduled to give Sichuans a trial in 1988 (Game Bird Bulletin 1987).

Pheasant physiology has also received considerable research attention. Physiological base-lines were established for wild hens (Anderson 1972) and for confined hens on restricted rations (Breitenbach et al. 1963). Kabat et al. (1956) found that breeding hens were in their poorest physiological condition in July and August. Increased interest in artificial propagation (for range extension or put-and-take hunting) led to a series of studies of egg production, artificial insemination, and flying performance in pen-reared pheasants (Flegal et al. 1977, Wing et al. 1977a, 1977b; Carpenter and Flegal 1981).

Food-habits studies gave way to nutritional research. Korschgen (1964) cataloged the chemical composition of foods of North American pheasants. Investigations of the pheasant's nutritional responses to corn, his primary food, led to the conclusion that wild pheasants must supplement corn-laden diets with more nutritiously balanced foods (Labisky and Anderson 1973, Anderson and Labisky 1974). These findings led to additional work on nutrition of pen-reared birds by Wollard et al. (1977), and Fuentes and Flegal (1981).

Extensive declines of pheasants in the late 1960's and 1970's resulted in numerous investigations of the possible role of pesticides. Effects of Aldrin (Hall et al. 1971), "Counter" (Labisky 1975a, b), Dieldrin (Dahlgren et al. 1972, Dahlgren and Linder 1974), DDE (Haseltine et al. 1974), and other pesticides (Greenberg and Edwards 1970, Messick et al. 1974) were studied. Even possible impacts of chemical fertilizers got a "look-see" (Fredrickson et al. 1978). Results were inconclusive. Despite evidence that pesticides used in seed-treatment adversely affect pheasant reproduction (Stromborg 1977, 1979), it was found that ringnecks can detect and will avoid pesticide-treated foods (Bennett and Prince 1981). Further, herbicides—whose use exploded in the 1960's—by eliminating insect habitat as well as cover may have a more important effect on pheasant production than insecticides (Warner 1984).

Diseases also received their share of attention in the 1970's. Research into marble spleen disease (Domermuth et al. 1975, Iltis et al. 1975) and encephalomyelitis (Proctor and Pearson 1975) brought attention, although diseases were seemingly unimportant in regulating ringneck abundance.

Thus, the past 20 years have witnessed some excellent research efforts focused on the ringneck. Yet, to a great extent, those efforts were devoted to picking up "loose ends" and testing hypotheses on what caused pheasant declines. Overall, there is no question that the amount of research steadily diminished in almost perfect parallel with the decline in pheasant numbers and, hence, with the importance of pheasants in state-agency management strategies.

What About Management?

In the recent past, progress in pheasant management seemingly has fared even less well than pheasant research. Experience led to increasing confidence in the concept—established in the 1940's—that legal hunting of cocks has little influence on pheasant abundance. The result was a cautious trend toward more liberal pheasant hunting regulations. Public opinion, however, was not always well aligned with the concept of more liberal hunting of pheasants. Consequently, hunting seasons were still closed in Minnesota and North Dakota, for example, following pheasant declines during the 1960's. Not surprisingly, George et al. (1980), noted no significant difference in trends in pheasant numbers between contiguous counties in Iowa and Minnesota, despite considerably longer hunting seasons in Iowa.

Results from habitat management for pheasants have typically been good when and where pheasants were regionally abundant, and poor where they were not. This suggests that responses on individual farms often relate more to dispersal and distribution than to enhanced production (Warner these Proceedings, Edwards these Proceedings). This happened even where game managers have had free rein to implement intensive habitat-management programs for pheasants on state-owned lands—such as on Wisconsin's Waterloo Wildlife Area (Frank and Woehler 1969)—where results have generally been disappointing, at least if success is measured by cocks in the hunters' bag. Development of habitat on private lands has involved acreages miniscule in comparison to those lost to cultivation, drainage, and urbanization. Even where relatively large-scale habitat development programs were initiated on private lands, numbers of contiguous farms, lack of care, changes in ownership, and other factors have severely reduced the usefulness of the plantings to pheasants and other wildlife (Burger and Teer 1981). Habitat programs have no doubt failed in part because the total acreages involved were relatively small. We must remember that wildlife is at best a "thin crop" (National Academy of Sciences 1970:133).

One bright spot in pheasant management in the past decade has been the manipulation of roadside cover for nesting pheasants. In Illinois, for example, production of young pheasants from experimentally managed roadsides was double that from unmanaged roadsides, and equal to that from fields of unharvested tame hay (Joselyn et al. 1968). The manipulation of cover along road rights-of-way in prime pheasant range offers a potential management program that has economic and biologic practicability (Snyder 1974, Warner and Joselyn 1986, Warner et al. 1987). A second potentially bright spot is the use of warm-season grasses that can provide both pasturage for cattle and nesting cover for pheasants (George et al. 1979)—if farmers can be sold on the concept.

Habitat, as predicted by earlier wildlifers, remains the key to pheasant abundance. Intensive land use—dictated by economics and abetted by modern technology—has, particularly since the mid-1950's, resulted in accelerated deterioration of wildlife habitat on farmlands (Burger 1978). A partial compensation for habitat losses is attainable through government subsidized cropland-retirement programs on private agricultural land (Erickson and Wiebe 1973, Harmon and Nelson 1973, Edwards 1984, Miranowski and Bender 1984, Warner and Etter 1985). Retirement programs such as those in the late 1930's, and again in the late 1950's, which called for idling of farmlands under multi-year contracts (e.g., ACP and Soil Bank) proved a boon to the pheasant and other farm wildlife (Burger 1978, Jarvis and Simpson 1978, Edwards 1984, Berner these Proceedings). Since the end of the Soil Bank program in the early 1960's, cropland retirement programs have become predominantly annual affairs, and habitat benefits for wildlife correspondingly have dwindled to little or nothing. One recent agricultural trend—minimum or conservation tillage—may have some benefits for pheasants on prime farmlands. However, Nicholson and Richmond (1985) suggested the probability of detrimental effects from increased pesticide applications on minimum-tilled acres and, in Iowa, the availability of arthropods was not found to be higher in no-till fields (Basore et al. 1987).

Stocking to provide pheasants to hunt has remained an accepted management tool in many states. For example, in the early 1980's, Wisconsin modernized and almost totally revamped its game farm facility, and launched an expanded and revised put-and-take pheasant stocking program on selected state lands. Such stocking is done either to augment numbers of wild pheasants in areas subjected to heavy hunting pressure, as in Pennsylvania (Hartman et al. 1974) and Oregon (Haensly et al. 1985), or to provide put-and-take shooting on public hunting areas. Hunters using stocked public-hunting grounds may be charged a special daily fee in addition to their regular hunting license, as in Illinois and Indiana, or be allowed to hunt under the provisions of their regular hunting license, as in Wisconsin.

Michigan—long a classic "holdout" against stocking and game farms—announced the initiation of a large-scale pheasant stocking program for state-owned lands in 1973 (Janson 1977). Some 80,000 Michigan hunters participated in 1973 and again in 1974. When a daily fee of $10 was charged in 1975, less than 16,000 hunters took part. Despite (probably because of) the $10 fee, income was not sufficient to support a self-sustaining program, and the program was phased out in the mid-1980's (Mullin 1983).

Despite the Michigan experience, put-and-take pheasant stocking is in some states still considered a viable tool to supplement sagging harvests of wild pheasants. Public (if not agency) support for stocking is evidenced by recent major investments for state game farms in Wisconsin, and by a record year in 1986 for the number of hunters paying to shoot pheasants on put-and-take state public hunting areas in Illinois (Illinois Department of Conservation 1987).

Where Are We Now?

Despite some bright spots in the domain of the pheasant, there seem few grounds for optimism. The basic reasons are no great secret. The pheasant in North America, in his greatest numbers, traditionally found his niche on our most fertile soils. He prospered where and when man had altered the original vegetation—removing forests here, plowing up prairie grasses there, and irrigating in arid lands—so that man could farm the land. In so doing, man introduced crops that provided food and, at times, ideal escape and nest cover. Research has documented the ability of the pheasant to "tough out" severe winters by resisting cold and by surviving foodless periods. The pheasants' need for winter cover is not great. Given a reasonable pattern of fencerows, swales, odd corners, ungrazed woodlots, shelter-belts, or the like, they can survive quite well. Likewise, pheasants will produce good annual crops of progeny if provided with even halfway decent nesting cover.

But that which man provided, man can take away—as he has done too often in recent years. Agriculture has increasingly become the enemy, not the friend, of the pheasant. The "custodian" has become the executioner. A complex of socioeconomic forces has made it impossible for many farmers to survive economically on small holdings. The net result is an accelerating trend toward large agribusiness holdings devoted to monotypic cropping. Cattle are handled most efficiently in feedlots. Chemical fertilizers have permitted the continuous culture of rowcrops. So, the small farm that coupled diversified livestock farming with grain production is vanishing. Once-prevalent fencerows, odd-shaped field corners, hedgerows, woodlots, ditchbanks, wetlands—and even soil-conserving terraces, grass waterways, and strip-cropping—have become grist for the crop-production mill (Grant 1972). On range where soils, climate, and terrain are best suited for pheasants, as well as for farming, events have run the full course, from native cover unsuitable for pheasants to man-induced interspersions of a diversity of cover types ideal for pheasants and, now, to no cover at all.

The loss of farmers from the land has other, more subtle influences. If no one lives in the farmhouse, there is no longer any need for the windbreak, the shade trees, the little orchard—or even for the house. Thus, one more bit of diversity disappears from the landscape—there is one less place for a hen to escape predators or the cold north wind, or to nest.

There is some movement of people back to the land in the Lake States' pheasant range, but the impact on the pheasant of these new residents is often negative. This is a "migration" of well-to-do urbanites who buy attractive—in many cases the last available—wooded building sites. True, they usually plant ornamental trees and shrubs, but most are a tidy lot, riding large lawnmowers. What was "habitat" becomes neatly mowed, clipped, and trimmed.

These proceedings bespeak our knowledge of the pheasant and his needs. Why then don't we have a recipe for successful pheasant management? We have the recipe; we simply can't put it into use. The lands on which the pheasant prospers produce grain abundantly, earn high income, are expensive to buy, and are heavily taxed. The pheasant, despite his recreational attributes, simply cannot compete economically. The problem is exacerbated when times are good and farm-commodity markets high.

Ironically, while the vast majority of what we recognize as "pheasant range" is in private ownership, the reality is that cropping is in a very real sense controlled by the "public" in terms of tax-supported, federally subsidized, cropland diversion programs of the U.S. Department of Agriculture (Berner these Proceedings). These programs have the financial resources and scope necessary to produce major changes in numbers of pheasants and other upland wildlife. Past programs have run the gamut from mostly favorable effects of the ACP and Soil Bank programs of the late 1930's and 1950's (Edwards 1984), to the less favorable effects of the federal Feed Grain program of cropland diversion of the late 1960's and early 1970's (Joselyn and Warnock 1964), and to the generally unfavorable effects of the recent Set-aside Acres Program (Berner these Proceedings).

At first glance, it appears that there has been and is today (1987) great opportunity to put our pheasant expertise to work on private farmland where it is most needed, and on a scale impossible by other means. Yet, to date, input of wildlife professionals on federal agriculture programs has been virtually nil. Until very recently we rarely acted, only reacted—gratefully accepting accidental benefits when they came, soulfully wringing our hands over losses and missed opportunities. The failure of wildlife professionals and administrators to battle, by every means available, to influence the course of federal cropland retirement programs must be viewed as one of conservation's greatest failures.

We are not alone in our failure. In the wake of the Dust Bowl years, early conservationists sought to alleviate the erosive scars on the landscape and to ensure that such destruction would not be repeated. Consequently, in the 1940's and 1950's, the work of the U.S. Soil Conservation Service—strip-cropping and terraces, contoured fields and grass waterways, planted hedges and windbreaks, and "tied down" gullies and streambanks—became conspicuous. This effort was the work of dedicated men determined "not to let it happen again."

Today few of the contours, terraces, strip-cropping practices, and even the windbreaks remain. In their place are eroding channelized stream beds, hoof-trampled mudholes, and fall-plowed fields (Grant 1972, Burger 1978). The emphasis by top-level federal administrators has clearly shifted from "Conservation" to short-term economic return. However, federal agriculture and conservation programs still have the unique potential to alter land use on private farmlands on a scale broad enough to have significant impacts on pheasants and other farmland wildlife (Brady and Hamilton these Proceedings).

Public land-management agencies—and particularly their individual administrators—must be held responsible for reversing the thrust of current conservation programs from positive and environmentally constructive to negative and environmentally destructive. Agency administrators bear an even heavier share of blame for wildlife's continuing and worsening present plight than do wildlifers.

Thus, we find North America's prime pheasant range threatened by a combination of land-use changes induced by socioeconomic factors aided and abetted by federal programs and agencies concerned primarily, if not exclusively, with a short-term economic return to landowners. In addition to the direct destruction of habitat, modern farming practices have detrimental side effects that stem from biocides and chemical fertilizers, with the threat of acid rain clouds growing on the horizon. And, as cover for nesting, winter survival, and escape decreases, the impacts of predation increase. It can be no surprise that recent population studies point to predation as a major factor influencing nesting success.

Problems facing pheasants and pheasant biologists are by no means limited to trends in land use. Public attitudes also change. Anti-hunting sentiment continues to gnaw away at public confidence and at support for wildlife management. Anti-hunting sentiments stem from man's weakening ties with the land. Increasingly, people live in cities and suburbs. Fewer of them have interest in, or an understanding of hunting, wildlife, or ecological principles. At present, both hunters and anti-hunters are minorities, albeit often highly vocal; non-hunters are for now the majority. While largely apathetic, non-hunters have the capacity to shift the balance of public sentiment in either direction, suddenly and overwhelmingly.

Recently increased public interest in pheasants and other upland wildlife is by no means neutral or negative. Sportsmen and others are becoming more involved as they learn the dependence of wild species on how private land is, can, and should be managed. A prime example is the relatively recent development of the citizen constituency movement exemplified by "Pheasants Forever" and "Quail Unlimited." The goals of these and similar organizations are to improve habitat for pheasants, quail, and other wildlife on private farmlands, to lobby effectively for environmentally sound federal programs, to promote conservation education, and to perpetuate the ideals of sport hunting and fair chase. Some 200 chapters in 20 states, with over 42,000 members of Pheasants Forever (David 1987, Wooley et al. these Proceedings) testify to the current strong interest and increased participation in ringneck management by the private sector.

The slowing of pheasant research and management efforts since the 1960's can be traced in part to growing appreciation of the fact that—in the long run—pheasant abundance depends on what happens on the land. It is thus apparent, as so many at this Symposium and before have recognized, that the most productive point of input of professionals interested in the ring-necked pheasant lies in efforts directed toward the implementation of federal agriculture programs that recognize wildlife as a desirable product of wise land use. It is toward a conservation-oriented federal land management policy—a true "land ethic"—that we as wildlife professionals must continually strive. Perhaps our greatest function as professionals is to serve as the conscience of that land ethic. The ringneck thus stands both as a symptom of the problems and as a measure of success in our stewardship of agricultural land.

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2

Distribution and Abundance of the Ring-Necked Pheasant in North America

ROBERT B. DAHLGREN, Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames, IA 50011[1]

Abstract: Pheasants (*Phasianus colchicus*) became established in North America in most of the present range by 1920. Peak abundance occurred from the late 1930's to the mid-1960's. However, since the late 1940's, pheasants have prospered more in the southern than in more northern parts of their range, and most notably in southern Iowa, Missouri, and parts of Texas in recent years. After 1971, pheasant populations entered a general decline that approximated 33% for the Midwest and 67% for the rest of the continent by 1986. Little change can be seen in pheasant distribution since 1941. The estimated continental pheasant population averaged about 31-33 million birds over the past decade, and probably is no larger (if as large) today as that of the Dakotas in the early 1940's.

Key words: abundance, distribution, population, ring-necked pheasant, stocking

In rural towns in the north-central United States and southern Canada, from the early 1940's to about 1960, 1 day each fall was special—the opening day of the pheasant hunting season. Shops closed, or operated with reduced staffs, truancy in high schools reached its peak for the year, and townspeople sought out the countryside and farm friends. Not only rural towns were affected. Metropolitan areas contributed their share to the traffic, and so did far-away states and provinces.

For some, opening day meant plucking and skinning piles of pheasants late into the night, for pay, while others plucked their own birds. To the game warden, the opening meant a hard day's work—checking, counting, and driving. To pheasant biologists, it meant hours spent interviewing hunters, probing bursae, checking spurs, measuring wing feathers, and recording weights. Church and civic groups served meals to

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[1] Present address: U.S. Fish and Wildlife Service, Upper Mississippi River Refuge Complex, PO Box 2484, LaCrosse, WI 54602.

hunters, and many dances, school plays, and night spots were the merrier, or richer, because of the presence of hunters. Nearly everyone was affected in an economic sense—sporting-goods stores, service stations, cafes, restaurants, hotels and motels, gift shops, and (in the form of revenue and taxes) all taxpayers—the public.

Today, the crowds are much smaller. In most pheasant states, habitat has been greatly reduced, and both hunters and pheasants concentrate in whatever cover remains. Hunting parties are smaller and hunters are more dependent on friendships with farmers for places to hunt. Although pheasants are fewer in many areas, they have increased in others—Iowa and neighboring Missouri, for example. Wherever pheasants are still abundant, the opening of pheasant season each fall is a big and important day. With its friendship, fun, and celebratory nature, opening day of pheasant hunting long ago became a Midwestern, if not a national, tradition.

METHODS

Pheasant abundance in North America has fluctuated dramatically over the past 60 years and centers of abundance have shifted southward. One objective of this Symposium is to define and present a time- and space-transgressive perspective of the patterns of abundance and distribution of wild pheasants in North America. A second objective is to estimate, insofar as possible, the abundance of wild pheasants in North America in 1986. I approached these objectives by using a combination of published and unpublished maps, and by development of a current (1986) map.

Maps used include an adaptation from Leopold (1931) for 1928-1929, another from Walcott (1945) for 1941, and maps for 1961, 1966, and 1971 prepared by members of the Midwest Pheasant Council (MPC). Council maps emphasized pheasant range in the Midwest. In the 1960's and early 1970's, biologists under the aegis of the MPC communicated regularly, strove to standardize survey procedures, shared data, and worked to prepare standardized maps of pheasant density. Abundance no doubt was overestimated in some areas and underestimated in others. Discrepancies in densities sometimes arose at state lines. "Border disputes" were resolved by pheasant biologists from the respective states, usually on the basis of local differences in soil type, topography, and land use.

The map of pheasant distribution for 1971 was prepared with the help of V. S. Janson and C. G. Trautman. This map was based on responses to a questionnaire which asked pheasant biologists in the various states and provinces when and where pheasants were introduced, past and current stocking programs, and relative pheasant abundance by decades. The current (1986) map was based on results from a similar questionnaire mailed in 1987. No attempt was made to resolve border disputes in developing the 1986 map. In several instances, however, biologists were supplied information on estimated densities in adjoining states and, in a few instances, biologists were given prehunt density estimates computed by using preseason and postseason sex ratios and reported cock harvest data (Dahlgren 1963). Prehunt estimates were reduced by the estimated hunting kill to obtain postseason estimates, and further reduced by ⅓ to allow for winter mortality. Resulting spring estimates of pheasant abundance were then adjusted for sex ratio to obtain statewide estimates of hens in spring.

Density zones on the respective maps allow estimates of pheasant abundance. Using a planimeter to determine the area in each zone, each area was multiplied by its mean density (or, for the 41 + density zone, 60 hens). Estimated numbers for all zones were summed to obtain an estimate of abundance for each state, and state estimates were summed to give total estimates of the continental population for the years represented by the different maps. In a few instances, estimates computed using the planimetry method appear unreasonable when compared with other estimates; maps seemed less accurate than other data.

Finally, the average annual harvest estimate of Kahl and Dumke (1984) for 1977-1982 was used to calculate an estimate of average prehunt pheasant abundance (Dahlgren 1963:284) in North America for that period. This required several assumptions: (1) a preseason cock:hen ratio of 85:100, (2) a posthunt ratio of 25:100, (3) 15% crippling loss for cocks, and (4) a hunting-related hen mortality of 25% that of cocks.

THE CHANGING PATTERN OF PHEASANT DISTRIBUTION AND ABUNDANCE

When Aldo Leopold made his game survey of the north-central states in 1928-29 (Leopold 1931), pheasants had not yet fully colonized some states where they eventually established thriving populations (Fig. 1). For example, while well established in northern Iowa by 1929, and despite repeated releases, pheasants did not reach peak densities in southern Iowa until the 1970's. Similarly, pheasants became relatively plentiful in parts of Missouri only in the past decade. Early distribution of pheasants in Indiana, Michigan, Minnesota, Ohio, and Wisconsin seems to be generally similar to recent distributions (Figs. 2 and 3), although some filling in and contractions of range have occurred. Maps of

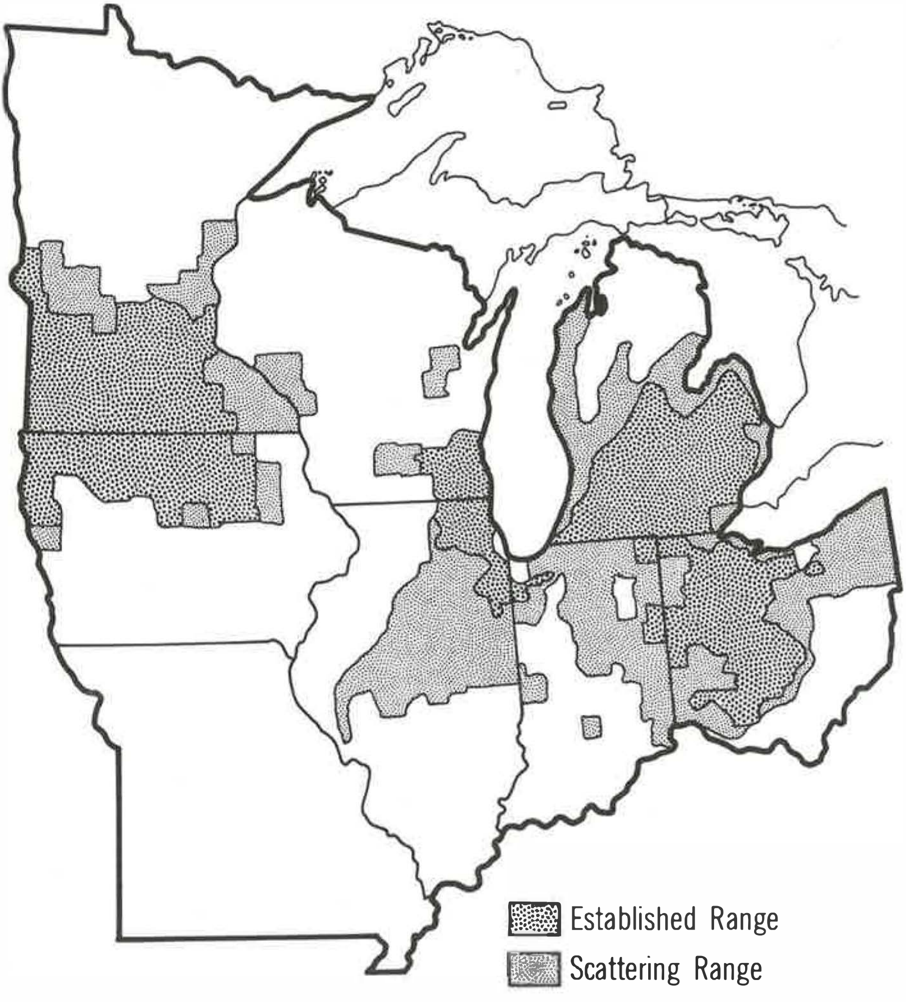

Fig. 1. Pheasant distribution in 1928-29 (adapted from Leopold 1931).

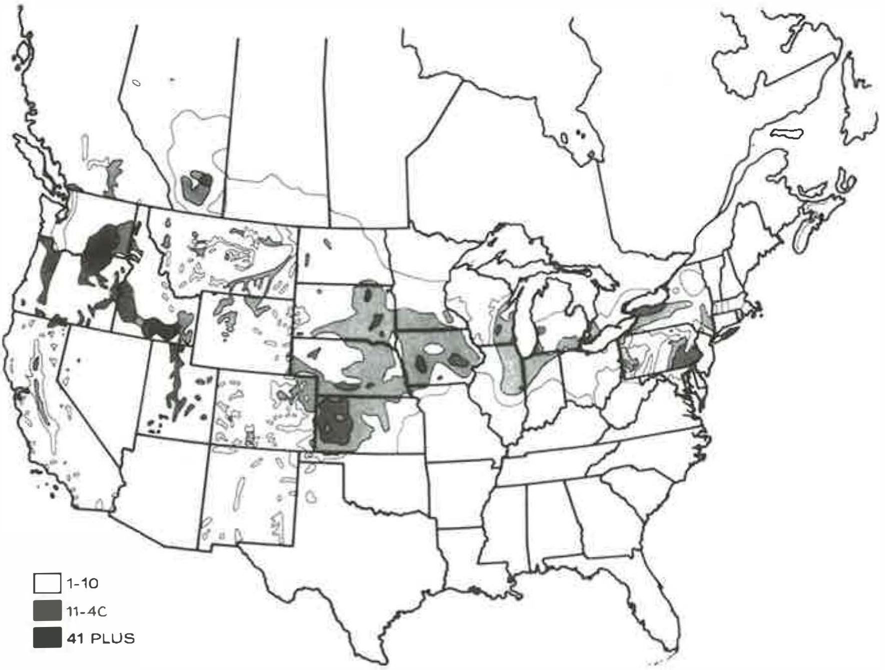

Fig. 2. Pheasant distribution and abundance as hens per mile^2 for North America in spring 1971.

pheasant distribution in 1971 (Fig. 2) and in 1986 (Fig. 3) closely resemble the map compiled by Walcott (1945) for 1941 (Fig. 4).

A number of states and provinces (23 of 43) reported pheasants established prior to 1910 (Table 1). Pheasants peaked prior to 1910 in Oregon and during the 1910's in Washington. Only Missouri and Texas claim to have more pheasants in the 1980's than in prior years, although Arizona, Kansas, Utah, and Nova Scotia report present (1986) abundance to be near previous highs. In the last 30 years, attempts have been made by numerous states to extend their pheasant range. Only a few efforts appear to have hard-earned rewards (Prince et al. these Proceedings). Louisiana and Texas currently stock pheasants, but possible range extensions have not been mapped because success is not yet clear.

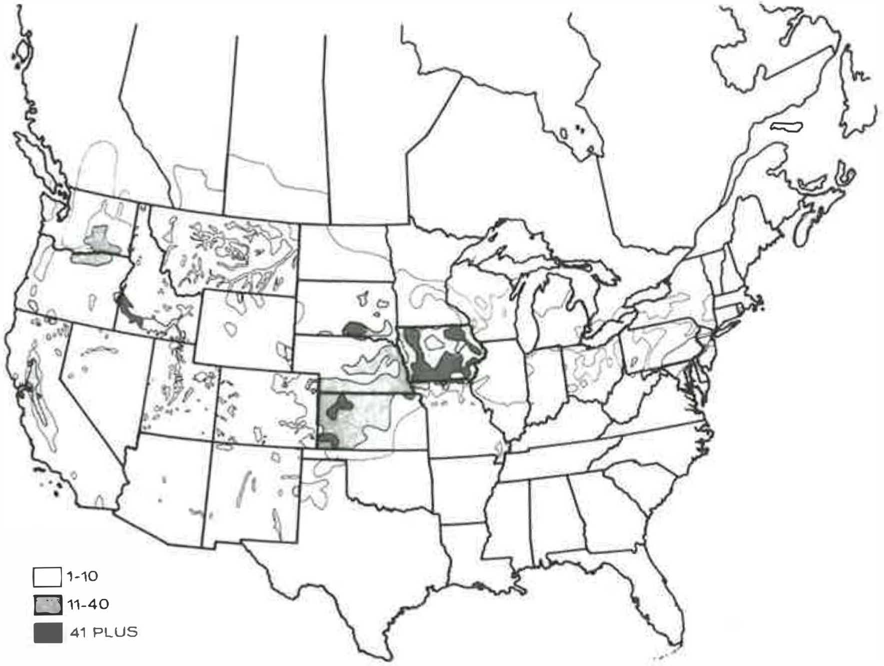

Fig. 3. Pheasant distribution and abundance as hens per mile^2 for North America in spring 1986.

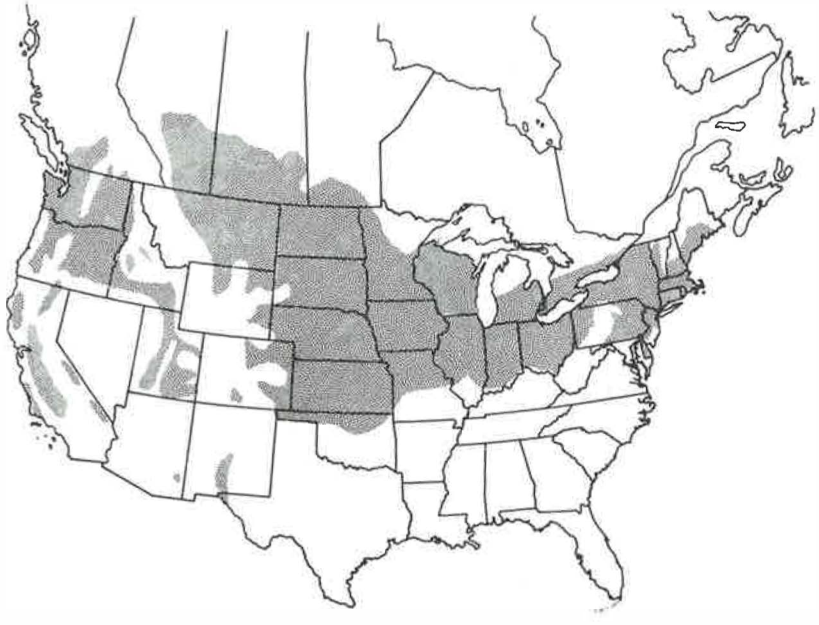

Fig. 4. Pheasant distribution for North America in 1941 (adapted from Walcott 1945).

Table 1. Period when pheasant populations were considered established by states and provinces. Numbers under each decade(s) represent relative pheasant density for the period of time with 1 representing the highest density. Spring hens in 1,000's were determined from maps of spring hen density.

	Decade(s) of establishment									**Spring hens (1,000's)**	
State or province	**<1910's**	**10's**	**20's**	**30's**	**40's**	**50's**	**60's**	**70's**	**80's**	**1971**	**1986**
AZ							3	1	2	-	6.3
CA	9	8	7	6	5	2	1	3	4	385.6	442.2
CO	9	8	7	6	1	2	3	4	5	420.3	156.5
CT			1	2	3	4				-	-
DE										5.0	7.4
ID	8	6	5	4	1	2	3	4	5	1,311.2	452.8
IL	9	8	6	3	4	1	2	5	7	475.4	20.4
IN	9	8	7	5	3	4	2	1	6	226.0	141.8
IA	9	8	7	6	5	3	1	2	4	1,443.3	2,063.3
KS	5	4	3	2	1	1	3	3	2	2,454.2	1,512.7
MD						3	1	2	4	31.9	15.7
MA	8	7	6	2	1	5	4	3	7	26.1	-
MI	9	8	6	4	1	2	3	5	7	419.3	145.4
MN	9	8	7	3	1	2	4	6	5	501.6	167.9
MO			7	6	5	4	3	2	1	48.7	260.9
MT	8	7	5	4	1	2	3	6	6	1,129.0	220.3
NE	9	8	7	2	1	3	4	5	6	1,576.7	1,016.2
NV				5	3	2	1	4	6	53.6	28.3
NJ	5	4	3	2	1	2	1	3	4	-	37.3
NM	9	8	7	6	2	1	3	4	5	274.2	64.7
NY		7	3	1	6	5	2	4	8	639.3	87.1
NC				6	5	4	3	1	2	-	-
ND	9	8	6	2	1	3	5	7	4	448.6	279.7
OH	9	8	4	1	2	3	5	6	7	199.4	82.3
OK										82.7	72.6
OR	1	2	5	4	3	7	6	9	8	2,161.3	240.4
PA	9	8	7	5	4	3	1	2	6	950.9	330.8
RI		7	6	1	2	3	4	5	5	6.7	1.1
SD	9	8	7	3	1	2	4	6	5	1,360.9	733.8
TN						2	1			-	-
TX					4	4	3	2	1	30.1	57.5
UT	6	5	4	3	1	2	3	3	2	263.8	90.5
VT		2	1	3	4	6	5	7	8	-	-
VA							1	2	3	-	-

Table 1 (continued).

	Decade(s) of establishment									Spring hens (1,000's)	
State or province	<1910's	10's	20's	30's	40's	50's	60's	70's	80's	1971	1986
WA	2	1	9	8	7	5	3	4	6	789.2	217.6
WV										20.3	4.7
WI		8	7	5	1	2	4	3	6	351.3	156.8
WY				3	1	2	4	6	5	231.4	95.2
Alberta	9	8	7	6	3	1	2	4	5	675.8	171.0
BC			4	1	2	3	5	6	7	334.7	139.4
Manitoba				2	1					31.2	
Nova Scotia					3	1	5	4	2	43.8	30.1
Ontario	4	3	2	1	6	5	7	8	9	112.4	27.3
Saskatchewan				6	5	3	1	2	4	305.2	392.8
Total										19,821.1	9,970.8

TRENDS IN PHEASANT ABUNDANCE

Personnel responding to the 1987 questionnaire indicated relative densities of pheasants in the decade of establishment and in each decade thereafter (Table 1). These estimates give a long-term perspective of changes in continental abundance. In most states and provinces (23 of 43), pheasant numbers peaked from the 1930's to the 1950's; in 13 states, populations peaked in the 1940's. In California, Indiana, Iowa, Missouri, Pennsylvania, and Saskatchewan, pheasant "highs" did not occur until or after the 1960's. That is not to say that all local pheasant concentrations in individual states peaked at the same times. They did not.

Changes in pheasant numbers in the Midwest, 1961-1986, can be seen by comparing Figs. 2 and 3 with maps prepared by the MPC (Figs. 5 and 6). By 1971, a slight expansion of the high-density zone as compared to 1966 can be seen; however, the high-density zone was again severely contracted in 1986. In 1986 the highest-density zone was found only in parts of Iowa, Kansas, Missouri, and South Dakota.

Estimations based on planimetry indicated that the prairie and plains states and provinces carried about 12,584,000 hens in spring 1961, 8,535,000 in spring 1966, 10,038,000 in spring 1971, and 6,765,000 in spring 1986. Although hen numbers in North America increased by an estimated 18% from 1966 to 1971, over the longer 25-year term of 1961-86 they declined by an estimated 46%. The pheasant decrease in the Midwest during 1971-1986 was estimated to be 33%.

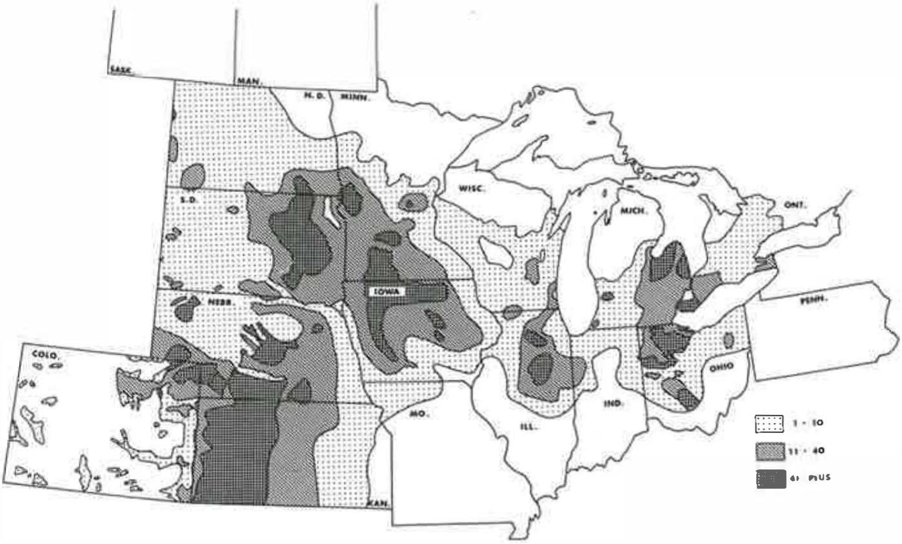

Fig. 5. Pheasant distribution and abundance as hens per mile^2 for the Midwest in spring 1961.

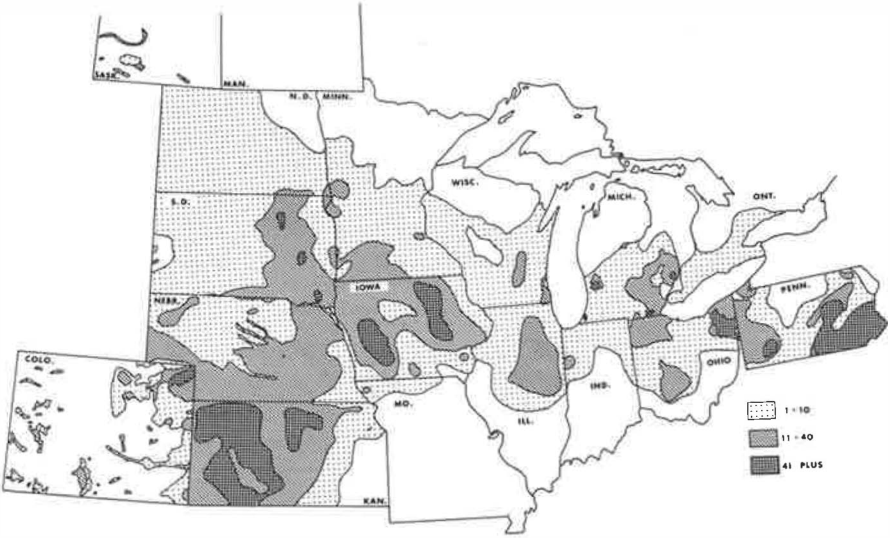

Fig. 6. Pheasant distribution and abundance as hens per mile^2 for the Midwest in spring 1966.

Considering all states and provinces reporting in both 1971 and 1986 (Table 2), there were an estimated 19,763,800 hens in spring 1971 as compared to 9,927,200 hens in spring 1986—an estimated decrease of 50% in the continental pheasant population during that 15-year period. The decline in the Midwest was 33% during those years, but other parts of North America apparently experienced an even greater decline. States exclusive of the Midwest showed a decline from an estimated 9,725,000 hens in spring 1971 to only 3,162,000 hens in spring 1986, an estimated decrease of 67%.

Rankings of relative abundance made by pheasant biologists provide yet another way to view changes in pheasant abundance (Table 1). I used a subset of 20 states that have clearly been "mainstream" pheasant states to obtain an average rank value for each decade. Pheasants were established in these 20 states by the 1910's, and all of the states reported peak populations between the late 1930's and 1950's. The relative change in pheasant abundance in these 20 states did not differ from that of a subset of 13 states and 1 province from the Midwest that met the same criteria (Fig. 7). Percentage changes from the previous decade for the subset of 20 states were +29% for the 1920's, +75% for the 1930's, +16% for the 1940's, -6% for the 1950's, -13% for the 1960's, -12% for the 1970's, and -21% for the 1980's. The curve in Fig. 7 was "smoothed" by combining relative density estimates for the 20 states.

Working back from the 9,970,800 hen pheasants reported for North America for spring 1986 (Table 1), with adjustments for sex ratio, winter losses, and hunting-related mortality resulted in an estimated total of 32,992,000 wild pheasants in North America in fall 1985. Alternatively, based on the Kahl and Dumke (1984) estimated average annual harvest of 9,527,000 for the years 1977-1982, prehunt populations would have averaged 31,604,000 pheasants in North America during those years. This prehunt estimate is in reasonably close agreement with the 32,992,000 figure obtained by working back from estimates obtained via planimetry in 1986.

While an estimated 31+ million wild pheasants for North America in the 1980's may seem to be a great many birds, we should keep in mind that 1 state alone (South Dakota) had an estimated 16-30 million pheasants in the mid-1940's (Trautman 1982). If we include North Dakota, which also had an abundance of pheasants in the 1940's, it is doubtful that the continental population of the 1980's exceeds that of the Dakotas 40 years ago. While we can be grateful for the pheasants we have today, they are a mere shadow of the past over much of the northern prairies and plains.

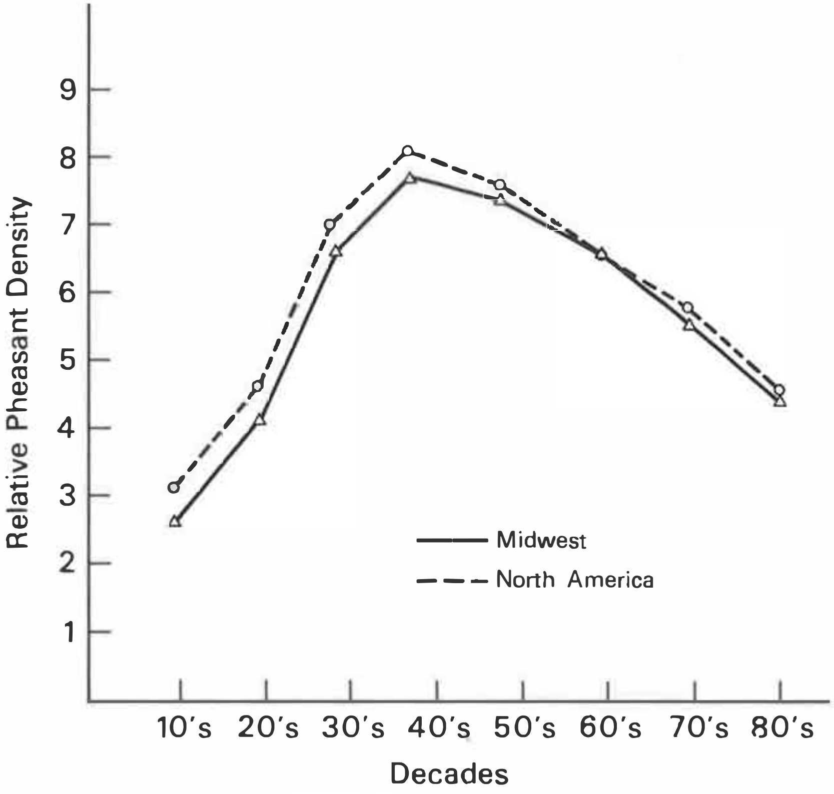

Fig. 7. Relative pheasant density estimates by decade for 20 states or provinces with populations established by the 1910's whose populations peaked from the decade of the 30's to 50's compared with estimates for 13 states and 1 province in the Midwest that met the same criteria (from Table 2).

DISCUSSION

Over time, pheasant numbers have fluctuated, and regional centers of abundance have shifted. While short-term fluctuations, particularly abrupt declines, have often been weather related, long-term trends in pheasant abundance have been associated with changes in land use. Among others, Kimball (1948) and Wandell (1949) discussed weather, more intensive farming, hay mowing, heavier hunting pressure, predation, and unknown phenomena as factors causing pheasant declines in the mid-1940's. More recent researchers have discussed weather (Klonglan 1971) and habitat loss. Buckman (1967:9), for example, concluded "safe nesting cover is rapidly disappearing and this poses the most serious threat to our pheasant future."

The importance of safe nesting cover was demonstrated during the Conservation Reserve Program (CRP). In 1961 CRP was at its peak, and pheasants were abundant (Schrader 1960, Dahlgren 1967, Trautman 1968, Erickson and Wiebe 1973, Farris et al. 1977). By 1966 much land was out of CRP, and pheasant numbers had dropped considerably (-32%, Table 2) in much of the Midwest. About 83% of the safe nesting cover occurring as wetland basins in Nebraska was destroyed by the early 1970's (Baxter and Wolfe 1973).

Mohlis (1974) documented changes in habitat corresponding with the decline in pheasant numbers in north-central Iowa, and Farris et al. (1977) reported a decrease in pheasants in northern Iowa, coinciding with an increase in southeastern counties, that resulted in an increase in total pheasant numbers statewide in the 1960's. Loss of winter and nesting cover in northern Iowa coincided with the pheasant decline in that intensively farmed region, whereas changes in farming related to chang-

Table 2. Hen pheasants per state or province (shown as 1,000's) in the spring of 1961, 1966, 1971, and 1986 as determined from spring hen density maps.

Midwest state or province	1961	1966	1971	1986
Colorado	485.1	338.3	420.3	156.5
Illinois	595.1	455.0	475.4	20.4
Indiana	97.6	211.7	226.0	141.8
Iowa	1,512.8	1,094.1	1,443.3	2,063.3
Kansas	2,642.7	1,792.1	2,454.2	1,512.7
Michigan	713.6	332.9	419.3	145.4
Minnesota	1,165.6	434.5	501.6	167.9
Missouri	51.0	64.3	48.7	260.9
Nebraska	2,035.8	1,675.9	1,576.7	1,016.2
North Dakota	630.9	369.6	448.6	279.7
Ohio	568.2	147.8	199.4	82.3
Ontario	232.4	35.9	112.4	27.3
South Dakota	1,627.7	1,225.8	1,360.9	733.8
Wisconsin	226.0	356.1	351.3	156.8
Total	12,584.5	8,535.0	10,038.1	6,765.0
% change		-32	+18	-33

es in livestock production apparently favored pheasants in southeastern Iowa.

Small grains and hay, in which many pheasants hatched in years past, are today greatly reduced, and the acreage of poorer nesting cover has increased (Table 3). Extensive fall plowing has greatly reduced the availability of winter food and cover. Use of insecticides and herbicides has meant weed-free fields and, again, significant losses of food and cover. Winter storms in the early 1960's and late 1970's killed large numbers of pheasants—in part a function of poor winter cover; recovery was limited by lack of nesting habitat.

Table 3. Acreages (in 1,000's) of non-alfalfa hay, oats, wheat, and barley (good nesting cover), and of corn, grain sorghum, soybeans, potatoes, and alfalfa hay or alfalfa mixtures (poor nesting cover) in 1940 and 1986 for selected states having pheasant populations. Acreages represent corn planted and all other crops harvested. Statistics were taken from U.S. Department of Agriculture (1942: 11, 55, 71, 82, 93, 197, 300, 333-336; 1986: A-17, 20, 22, 24, 26, 37, 43, 45, 50).

	Good nesting cover		Poor nesting cover	
State	**1940**	**1986**	**1940**	**1986**
CA	4,051	1,720	1,089	1,655
CO	3,189	3,985	1,998	1,182
ID	2,645	2,750	954	1,537
IL	9,535	1,490	11,198	19,953
IN	5,795	1,170	5,817	10,504
IA	12,290	1,490	11,467	22,652
KS	12,824	12,290	5,425	8,260
MI	6,142	1,375	3,248	5,192
MN	13,094	5,564	6,091	13,226
MO	8,078	3,650	5,208	7,070
MT	6,416	7,980	786	1,388
NE	8,654	4,495	7,571	11,259
NY	7,813	1,665	1,285	2,291
ND	14,127	15,080	1,324	3,140
OH	7,274	1,940	4,799	8,660
OR	2,533	2,120	395	582
PA	6,087	1,715	1,845	2,802
SD	8,788	7,945	3,418	7,657
UT	975	577	471	556
WA	3,548	3,703	389	778
WI	9,077	1,613	3,860	7,828
Total	152,935	84,317	78,638	138,172

In the late 1950's and early 1960's, biologists often disagreed about effects of rainfall on pheasant populations. That is until they realized that, in the Dakotas where rainfall normally is low, a dry year resulted in poor pheasant production, whereas—to the east—in Michigan and Ohio where rainfall is considerably higher, a relatively dry year usually meant good production. The range of wild pheasants in North America evidences a precipitation gradient that increases from west to east, and a temperature gradient that decreases from south to north. Drought thus is periodically more detrimental to pheasants in the Great Plains, from Alberta and Saskatchewan to Oklahoma, than is the case farther east. Similarly, blizzard conditions and deep snow cover are more often adverse factors in northern parts of the pheasant range.

Pheasant population changes are symptoms of wildlife problems on agricultural land, and the prognosis for the future is not good. The problem lies not with the pheasant, but with habitat—with how the land is used and with our ability to conserve and otherwise provide cover that pheasants require. As agriculture has changed, the types, quantity, and distribution patterns of cover have changed and, in response to those changes, the type, abundance, and distribution of wildlife has changed on agricultural lands.

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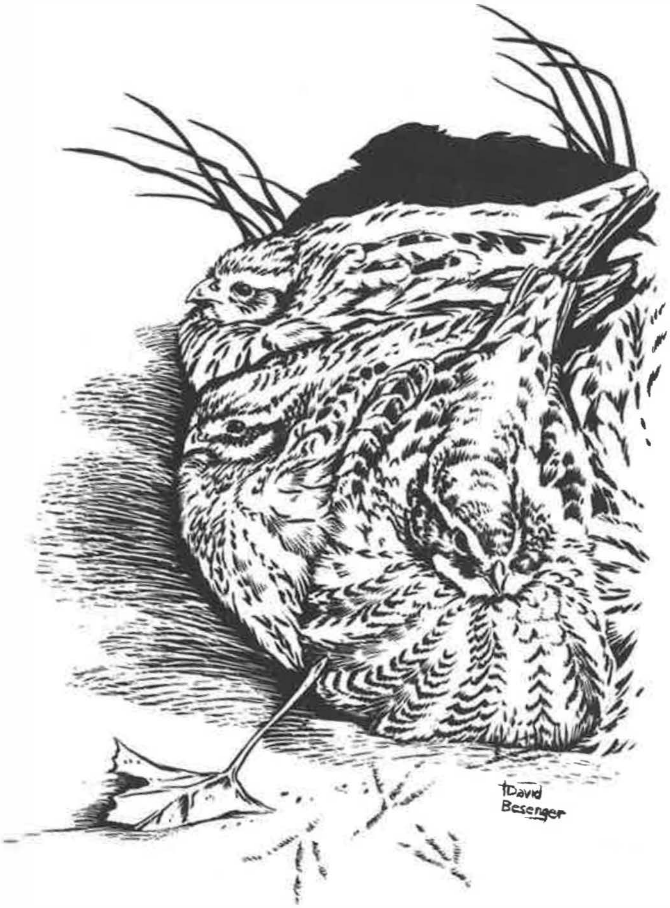

Federal Pheasants—Impact of Federal Agricultural Programs on Pheasant Habitat, 1934-1985

ALFRED H. BERNER, Minnesota Department of Natural Resources, Madelia, MN 56062

Abstract: Federal agricultural programs designed to assist farmers economically (e.g., cropland diversion and crop deficiency payment programs), and to increase production and establish conservation practices (e.g., cost-share programs, small watershed [P.L. 83-566] projects) have significantly impacted the amount and quality of pheasant habitat over the last half century. The bulk of these programs have caused destruction of existing habitats (e.g., cost-shared drainage) and creation of large amounts of unsafe wildlife habitat (e.g., annual commodity programs). Wildlife species highly dependent on grassland and wetland habitats, such as the pheasant, have been most negatively affected. Pheasants have responded positively to multi-year cropland diversion programs (e.g., Soil Bank), but negatively to annual cropland set-aside programs that allow poor cover management and require periodic disturbance (e.g., 1986 and 1987 Feed Grain and Wheat Programs).

Key Words: agricultural programs, pheasant abundance, pheasant habitat

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Federal agricultural policies and programs have been affecting the quantity and quality of ring-necked pheasant (*Phasianus colchicus*) habitat for over a half century. Impacts of these programs on pheasants in the Midwest have varied from negative to highly beneficial. Overall, pheasants in much of the Midwest are being affected negatively by various federal programs that encourage destruction of habitat and development of unsafe reproductive cover. However, pheasants have the ability to respond positively to the recently initiated Conservation Reserve Program (CRP).

LAND RETIREMENT PROGRAMS

In the Beginning

Programs designed to retire large amounts of land from crop production have had pronounced effects on the quantity and quality of pheasant habitat. Such programs began over 50 years ago with passage of the Cropland Adjustment Act (CAA) of 1934.

The total 37.4 million acres (15.1 million ha) of cropland retired under CAA in 1934 and 1935 required no cover crop. Almost 80% of this acreage was in 12 midwestern states (Table 1) (Edwards 1984). Unfortunately, biologists in the then-new field of wildlife management did not document the impact on pheasants or their habitat on this program, nor that of the Agriculture Conservation Program (ACP), which followed. The latter program annually retired an average 21.9 million acres (8.8 million ha) in 12 midwestern states between 1936 and 1942, and required planting a grass and/or legume cover crop.

Table 1. Amount of cropland retired in the U.S. under various USDA farm programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986[b]).

	Acreages in millions (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	12.2(4.9)	1.4(0.6)				13.6(5.5)
1957	21.4(8.7)	6.4(2.6)				27.8(11.3)
1958	17.2(7.0)	9.9(4.0)				27.1(11.0)
1959		22.5(9.1)				22.5(9.1)
1960		28.7(11.6)				28.7(11.6)
1961		28.5(11.5)	25.2(10.2)			53.7(21.7)
1962		25.8(10.4)	28.2(11.4)	10.7(4.3)		64.7(26.1)
1963		24.3(9.8)	24.5(9.9)	7.2(2.9)		56.0(22.6)
1964		17.4(7.1)	32.5(13.2)	5.1(2.1)		55.0(22.4)
1965		14.0(5.7)	34.7(14.0)	7.2(2.9)		55.9(22.6)
1966		13.3(5.4)	34.7(14.0)	8.2(3.3)	2.0(0.8)	58.2(23.5)
1967		11.0(4.4)	20.3(8.2)		4.0(1.6)	35.3(14.2)
1968		9.2(3.7)	32.4(13.1)		4.0(1.6)	45.6(18.4)
1969		3.4(1.4)	39.1(15.8)	11.1(4.5)	3.9(1.6)	57.5(23.3)
1970		0.1(<0.1)	37.4(15.1)	15.7(6.4)	3.8(1.5)	57.0(23.0)
1971		<0.1(<0.1)	18.2(7.4)	13.5(5.5)	3.4(1.4)	35.1(14.3)
1972		<0.1(<0.1)	36.6(14.8)	20.1(8.1)	2.8(1.1)	59.5(24.0)
1973			9.4(3.8)	7.4(3.0)	2.8(1.1)	19.6(7.9)
1974					2.7(1.1)	2.7(1.1)
1975					2.4(1.0)	2.4(1.0)

Table 1 (continued).

	Acreages in millions (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1976					2.1(0.8)	2.1(0.8)
1977					1.0(0.4)	1.0(0.4)
1978			8.3(3.4)	9.6(3.9)		17.9(7.3)
1979			4.8(1.9)	8.2(3.3)		13.0(5.2)
1980						0.0
1981						0.0
1982			3.3(1.3)	5.8(2.3)		9.1(3.6)
1983			39.3(15.9)	30.0(12.1)		69.3(28.0)
1984			5.1(2.1)	18.6(7.5)		23.7(9.6)
1985			7.1(2.9)	18.8(7.6)		25.9(10.5)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100,000's; conversions to ha were made from the original data before rounding.

In retrospect, Edwards (1984) demonstrated a strong relationship between pheasant harvests in several midwestern states and the number of acres retired and seeded to grasses and/or legumes under ACP. The data also showed a corresponding rapid decline with termination of this program in 1944. These population fluctuations strongly suggest that the 15-25 million acres (6-10 million ha) retired annually and seeded to grasses and/or legumes under ACP were instrumental in producing the high pheasant populations observed in the Midwest in the early 1940's (Schrader 1960, Edwards 1984). In addition to diverted croplands brought back into production during World War II, poor reproduction and recruitment—due to unfavorable weather conditions and loss of other nesting habitats (e.g., tractors didn't need pastures)—were considered by most biologists of the time to be primary factors for the pheasant decline (Allen 1956). Some biologists suggested that the impacts of these environmental changes on pheasant abundance were accentuated by a cyclic phenomenon (Kimball 1948).

After reaching lows through the Midwest in 1947, pheasant harvests held at moderate levels during the early and mid-1950's (Fig. 1; Schrader 1960). From 1943 to 1955, no lands were retired under federal farm programs, but subsidies were given to some midwestern farmers to plant and harvest from <0.3 to 6.4 million acres (<0.1 to 2.6 million ha) of grasses and legumes for seed.

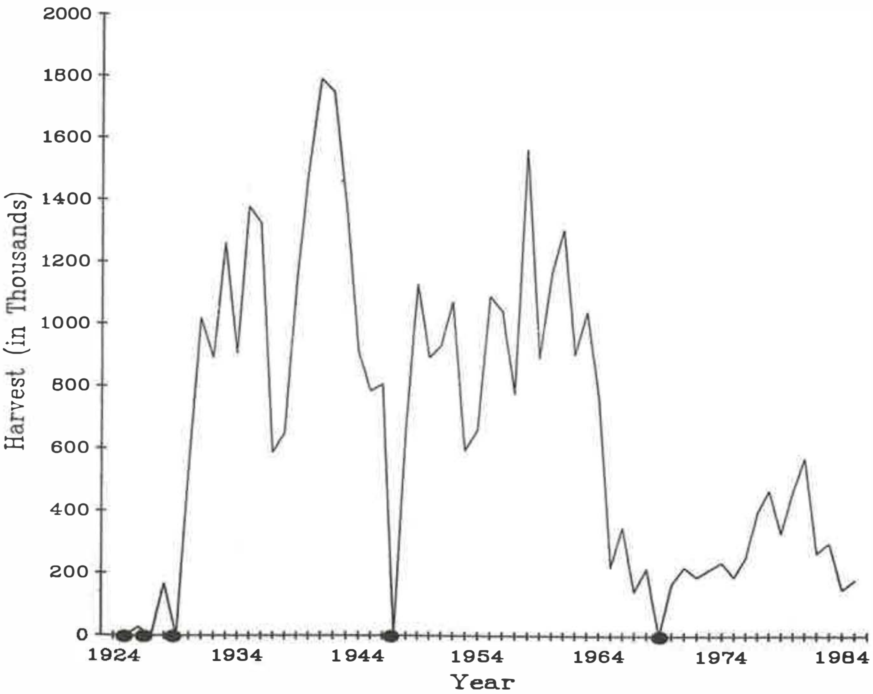

Fig. 1. Estimated pheasant harvest in Minnesota, 1924-85. Solid dots note years with closed seasons. A hen in the daily bag was allowed in 1930, 1933, 1935-37, and 1941-43. (Pheasant harvest was estimated from voluntary hunter report cards during 1924-75. Randomized hunter postcard survey was used during 1976-85.)

The Next Chapter

Beginning again in 1956, however, wild pheasants had the opportunity to respond to another federal cropland diversion program. As it had in 1934, the U.S. Department of Agriculture (USDA) began in 1956 with an annual land retirement program having no provision for seeding perennial cover. Fortunately for pheasants, the Acreage Reserve (AR) portion of the Soil Bank was short-lived (1956-58; Edwards 1984). Although an available option in 1956, the Conservation Reserve portion (CR) of the Soil Bank did not retire significant amounts of land until 1958, when almost 10 million acres (4 million ha) were enrolled—36% in 12 midwestern states. By 1960, more than 28 million acres (11 million ha) had been enrolled in CR, with over 13 million acres (5 million ha) in 12 midwestern states (Tables 1, 2).

Table 2. Amount of cropland retired in 12 midwestern states[a] under various USDA farm programs[b], 1956-85 (USDA 1970, 1973, 1976, 1986[b]).

	Acreages in thousands (ha)					
	Soil Bank					
Year	**AR**	**CR**[c]	**FGP**	**WHP**	**CAP**	**Total**
1956	7699.2(3115.8)	111.0(44.9)				7810.2(3160.7)
1957	12074.6(4886.4)	2164.7(876.0)				14239.3(5762.4)
1958	8278.7(3350.3)	3668.3(1484.5)				11947.0(4834.8)
1959		9885.5(4000.5)				9885.5(4000.5)
1960		13223.1(5351.2)				13223.1(5351.2)
1961		13146.8(5320.3)	17806.4(7206.0)			30953.2(12526.3)
1962		12018.4(4863.7)	18479.8(7478.5)	5695.7(2305.0)		36193.9(14647.2)
1963		11230.2(4544.7)	15471.3(6261.0)	3901.5(1578.9)		30603.0(12384.6)
1964		7323.0(2963.5)	21053.7(8520.2)	2836.5(1147.9)		31213.2(12631.6)
1965		5285.7(2139.0)	22081.0(8935.9)	3991.8(1615.4)		31358.5(12690.3)
1966		5196.8(2103.1)	21665.4(8767.7)	4286.5(1734.7)	959.2(388.2)	32107.9(12993.7)
1967		4494.1(1818.7)	12674.7(5129.3)		2008.4(812.8)	19177.2(7760.8)
1968		3948.8(1598.0)	21505.6(8703.0)		2005.6(811.6)	27460.0(11112.6)
1969		1584.2(641.1)	25210.3(10202.3)	5790.2(2343.2)	1985.6(803.5)	34570.3(13990.1)
1970		19.2(7.8)	23520.7(9518.5)	8557.1(3462.9)	1884.7(762.7)	33981.7(13751.9)
1971		2.2(0.9)	12931.8(5233.3)	7845.2(3174.9)	1710.0(692.0)	22489.2(9101.1)
1972		0.5(0.2)	24831.5(10049.0)	11497.5(4652.9)	1266.0(512.3)	37595.5(15214.4)
1973			6290.5(2545.7)	4028.2(1630.2)	1242.1(502.7)	11560.8(4678.6)
1974					1177.3(476.4)	1177.3(476.4)
1975					989.3(400.4)	989.3(400.4)
1976					866.1(350.5)	866.1(350.5)
1977					417.0(168.8)	417.0(168.8)

Table 2 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1978			6347.1(2568.6)	4968.5(2010.7)		11315.6(4579.3)
1979			3326.2(1346.1)	4106.5(1661.8)		7432.7(3007.9)
1980						0.0
1981						0.0
1982			2484.7(1005.5)	3022.6(1223.2)		5507.3(2228.7)
1983			31217.0(12633.1)	15487.2(6267.5)		46704.2(18900.6)
1984			4277.6(1731.1)	9497.2(3843.4)		13774.8(5574.5)
1985			5868.3(2374.8)	10029.0(4058.6)		15897.3(6433.4)

[a] Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

[b] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[c] Conservation Reserve acreages were rounded after summing original data and therefore may not equal the totals of Tables 9-20. Conversions to ha were made from acreage totals before rounding.

Field studies in Michigan, Utah, and South Dakota measured the impact of CR on pheasants. Between 1958 and 1962, Trautman (1982) found that almost 20% of pheasant production came from CR lands, although CR lands comprised less than 7% of the available nesting cover in his South Dakota study areas. In Michigan, Fouch (1963) observed an average of 2.4 times more crowing cocks and 2.7 times more pheasant broods on 55 farms with CR than on 55 farms without it. In 1964 and 1965, Bartman (1969) found that 85% of pheasant production on his Utah study area came from CR lands which then comprised about 50% of potential nesting cover.

These and other studies repeatedly showed that pheasants were significantly influenced by the amount of CR available. During the late 1950's and early 1960's, in the block of states that included Iowa, Minnesota, Nebraska, and both Dakotas, pheasants in counties with more than 5% of cropland idled under CR had a higher rate of increase than did those counties with less than 5% cropland idled (Schrader 1960). South Dakota data yielded a significant ($p = 0.05$) positive correlation between pheasant abundance and CR acreages of the previous year (Erickson and Wiebe 1973). In Minnesota, comparison of August roadside-count data between an area with many CR acres and 1 with very few (Figs. 2 and 3) indicated that, on the average, pheasant abundance in the west-central 13 counties with much CR was at least 100% higher than expected without CR. Pheasant abundance in those 13 counties was significantly correlated with the amount of CR present ($p = 0.0007$); about 47% of the variability in pheasant abundance was related to CR. Also, the trend of pheasant abundance in south-central Minnesota counties (Fig. 3) suggested that, without CR, pheasant numbers in west-central Minnesota would quite likely have begun to decline in the late 1950's instead of in the mid-1960's.

In their economic analysis, Erickson and Wiebe (1973) found that numbers of nonresident pheasant hunters were directly correlated to abundance of South Dakota's pheasants. Higher pheasant numbers in the late 1950's and early 1960's, due to improved habitat provided by CR, resulted in an annual influx of about 50,000 additional non-resident hunters during those years. Conservatively, these additional hunters contributed over $10 million each year to South Dakota's economy. These increased revenues totaled more than 55% of the amount spent annually for CR by the federal government in South Dakota (USDA 1970).

Advent of the Annual Shuffle

In 1961, Congress passed and USDA implemented the Emergency Feed Grain Program (FGP). The FGP's express purpose was to increase

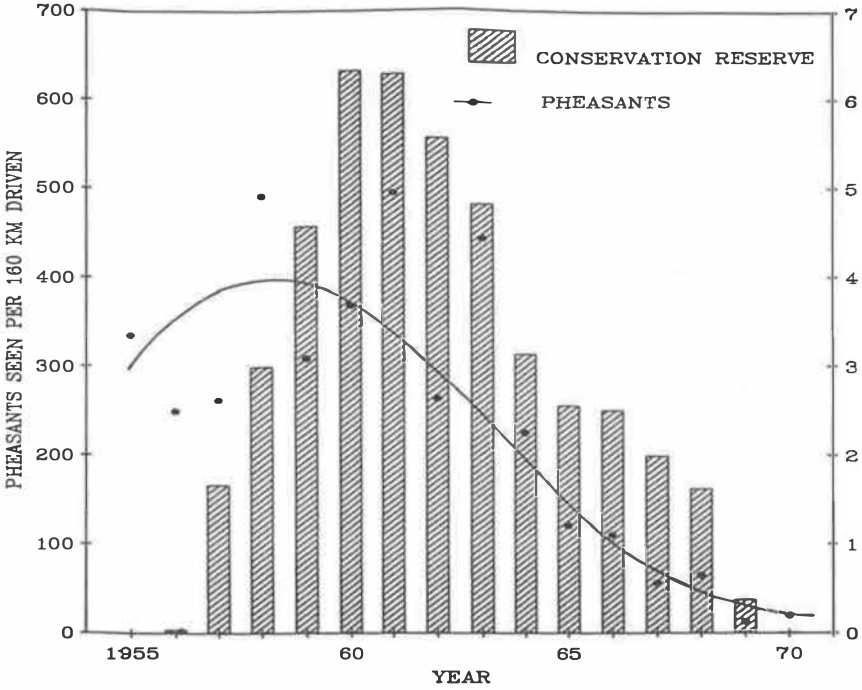

Fig. 2. Relationship of pheasant abundance to availability of all Conservation Reserve acres in 13 west-central counties of Minnesota, 1955-70.

farm income by controlling production of feed grains through an annual, paid diversion or set-aside (SA) of cropland normally seeded to corn, oats, sorghum, and barley. The next year, a similar program was implemented to include wheat production (WHP). The FGP and WHP began a new era in pheasant habitat destruction.

In the first year of the FGP, farmers in 12 midwestern states enrolled 4.6 million acres (1.9 million ha) more than at the peak of CR. In 1962, with the addition of WHP lands, this difference rose to almost 11 million acres (4.4 million ha) more than the CR maximum (Table 2; USDA 1973).

This tremendous increase in SA lands was a mixed blessing to pheasants and other wildlife. These annual programs provided new habitat in some states, while reducing quantity and quality of habitat in others. Researchers in Illinois (Joselyn and Warnock 1964), Minnesota (Nelson and Chesness 1964), and Wisconsin (Gates and Ostrom 1966) indicated that FGP and WHP had significant potential for producing sizeable amounts of habitat in portions of prime pheasant range not previously affected by CR. Warner and Etter (1985) concluded that, in fact, lands retired under FGP and WHP had a positive effect on pheasant

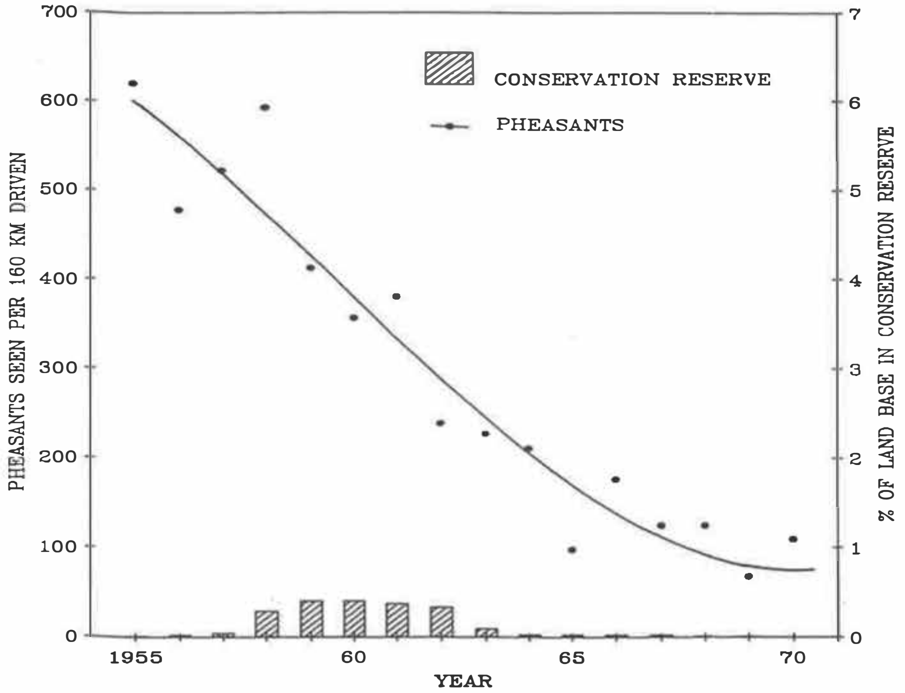

Fig. 3. Relationship of pheasant abundance to availability of all Conservation Reserve acres in 11 south-central counties of Minnesota, 1955-70.

populations in Illinois until 1973. In Indiana, Castrale (1984) found that SA was used by a variety of songbirds and mammals, but that untimely disturbance greatly reduced SA's value as safe nesting and brood-rearing habitat. In south-central Minnesota, pheasant population data indicate that the presence of SA lands has a pronounced negative effect on pheasant production (Berner 1984b). Also, an index to production from non-SA nesting cover in 11 south-central Minnesota counties was negatively correlated with the percent of potential nesting cover in SA (Fig. 4).

Positive effects observed by researchers in Illinois and Wisconsin, and also indicated in Indiana, Iowa, and Ohio were possible because a majority of the SA in those states was seeded to small grains or grasses and/or legumes and a high proportion left undisturbed through the nesting season (Tables 3-4; Berner 1973). In the remainder of the Midwest, however, this was not the case. The majority of SA fields were unseeded (e.g., summer fallowed) which, in turn, reduced availability of small grains normally grown as a crop in years when there was no SA (Harmon 1968), or lightly seeded (<1.5 bu/a or <51 kg/ha of oats) to small grain around 1 June and then destroyed by 15 July (Nelson and Chesness

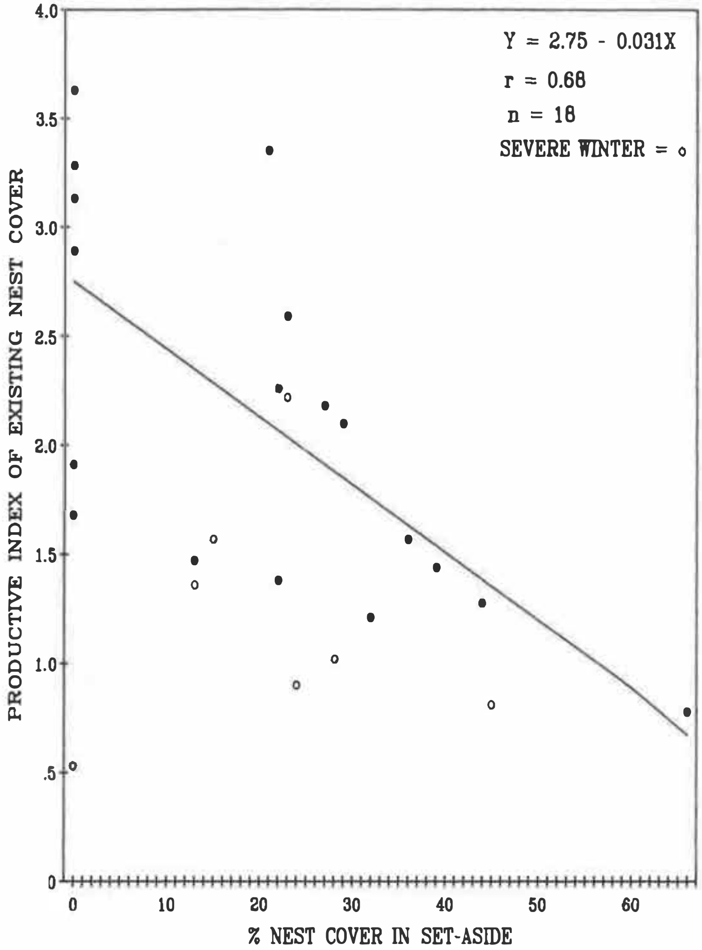

Fig. 4. Correlation between the pheasant production index for non-set-aside nest cover and the percent of all potential nest cover retired under the annual Federal set-aside (FGP and WHP) in south-central counties of Minnesota, 1960-83. Data from years with severe winters were not included in the analysis.

Notes for Fig. 4:

Pheasant production index for non-set-aside nest cover =

$$\frac{\text{chicks/160 km}}{\text{ha of non-set-aside nest cover/km}^2}$$

Non-set-aside nest cover is those acres in hay, small grains, roadsides, pastures, Conservation Reserve and odd areas, and not set-aside under an annual Federal commodity program.

% potential nest cover in set-aside =

$$\frac{\text{ha set-aside/km}^2}{\text{ha set-aside + ha non-set-aside nest cover/km}^2} \times 100$$

FGP = Emergency Feed Grain Program, WHP = Wheat Program.

Table 3. Percent of Federal set-aside (FGP and WHP)^{a} acres and number of fields (in parentheses) found to be unseeded (fallow or stubble), newly seeded (small grains or row crops), or in established cover (grasses, legumes, or grass-legumes) for 1972, 1973, 1978, and 1983 in 12 midwestern states, plus Colorado and Pennsylvania.

	Unseeded				**Newly Seeded**				**Established**			
	1972	**1973**	**1978**	**1983**	**1972**	**1973**	**1978**	**1983**	**1972**	**1973**	**1978**	**1983**
CO	66.0	86.2	94.9	85.7	9.8	1.3	5.1	13.8	24.2	12.5	0.0	0.5
	(31)	(120)	—$^{-b}$	(263)	(14)	(8)	—	(61)	(25)	(22)	—	(2)
IL	18.8	9.7	42.9	29.8	42.8	16.2	57.1	65.0	38.4	74.1	0.0	5.2
	(200)	(12)	(8)	(75)	(491)	(19)	(10)	(146)	(512)	(108)	(0)	(23)
IN	30.9	15.1	41.9	25.8	28.8	10.1	48.5	44.6	40.3	74.8	9.6	29.6
	(92)	(23)	(20)	(38)	(63)	(20)	(22)	(51)	(145)	(156)	(4)	(46)
IA	4.2	10.2	14.7	26.7	66.9	31.9	72.3	63.4	28.9	57.9	13.0	9.9
	(29)	(25)	(41)	(67)	(402)	(101)	(221)	(146)	(235)	(189)	(49)	(41)
KS	78.9	77.5	92.6	NS	7.2	0.9	7.4	NS	13.9	21.6	0.0	NS
	(361)	(108)	(19)		(66)	(5)	(2)		(135)	(55)	(0)	
MI	54.0	60.2	59.4	79.8	4.6	1.3	9.0	7.9	41.4	38.5	31.6	12.3
	(159)	(109)	(27)	(120)	(15)	(4)	(5)	(18)	(130)	(103)	(14)	(24)
MN	54.5	54.1	13.0	74.0	27.0	19.0	58.6	24.6	18.5	26.9	28.4	1.4
	(348)	(141)	(3)	(160)	(191)	(50)	(27)	(69)	(199)	(116)	(13)	(8)
MO	NS	NS	49.6	88.6	NS	NS	34.9	7.6	NS	NS	15.5	3.8
			(33)	(110)			(22)	(39)			(18)	(35)
NE	74.0	60.2	83.7	82.5	8.2	3.0	12.7	12.2	17.8	36.8	3.6	5.3
	(386)	(106)	(74)	(137)	(60)	(7)	(23)	(29)	(148)	(58)	(5)	(13)
ND	95.5	97.0	94.9	96.0	1.2	0.1	4.8	4.0	3.3	2.9	0.3	0.0
	—	(654)	(69)	(112)	—	(2)	(10)	(11)	—	(24)	(2)	(0)
OH	39.1	28.8	55.5	13.0	17.0	5.5	27.0	83.9	43.9	65.7	17.5	3.1
	(175)	(102)	(54)	(72)	(96)	(25)	(29)	(84)	(248)	(272)	(29)	(26)

Table 3 (continued).

	Unseeded				Newly Seeded				Established			
	1972	1973	1978	1983	1972	1973	1978	1983	1972	1973	1978	1983
PA	9.6	1.5	NS	NS	3.2	0.0	NS	NS	87.2	98.5	NS	NS
	(43)	(3)			(47)	(0)			(294)	(185)		
SD	57.9	57.8	16.2	85.0	15.6	10.6	69.3	11.0	26.5	31.6	14.5	4.0
	(127)	(78)	(11)	(99)	(47)	(28)	(40)	(36)	(83)	(66)	(5)	(14)
WI	38.8	24.2	29.1	35.6	7.4	6.0	24.4	49.8	53.8	69.8	46.5	14.6
	(133)	(46)	(9)	(112)	(36)	(19)	(22)	(114)	(232)	(164)	(31)	(49)
Mean[c]	53.5	61.0	41.9	60.4	22.7	8.5	45.2	33.2	23.8	30.5	12.9	6.4

[a] FGP = Emergency Feed Grain Program; WHP = Wheat Program.

[b] The number of fields surveyed was not indicated.

[c] The weighted mean is for the 11 states which conducted surveys all 4 years.

Table 4. Percent of Federal set-aside (FGP and WHP)[a] fields classified as zero to fair or good to excellent nesting cover for 1972, 1973, 1978, and 1983 for 12 midwestern states, plus Colorado and Pennsylvania.

	Zero-fair				Good-excellent			
	1972	1973	1978	1983	1972	1973	1978	1983
Colorado	96.8	97.7	100.0	90.5	3.2	2.3	0.0	9.5
Illinois	51.4	58.4	94.4	74.2	48.6	41.6	5.6	25.8
Indiana	46.6	44.7	63.0	65.9	53.4	55.3	37.0	34.1
Iowa	61.4	61.8	72.0	76.0	38.6	38.2	28.0	24.0
Kansas	86.8	81.6	100.0	NS	13.2	18.4	0.0	NS
Michigan	65.3	63.2	51.1	69.8	34.7	36.8	48.9	30.2
Minnesota	75.6	82.8	55.8	94.1	24.4	17.2	44.2	5.9
Missouri	NS	NS	76.5	46.2	NS	NS	23.5	53.8
Nebraska	85.0	71.5	84.3	94.4	15.0	28.5	15.7	5.6
North Dakota	99.2	98.6	99.7	100.0	0.8	1.5	0.3	0.0
Ohio	67.6	47.9	61.3	76.9	32.4	52.1	38.7	23.1
Pennsylvania	42.6	39.2	NS	NS	57.4	60.8	NS	NS
South Dakota	76.1	77.8	85.7	86.7	23.9	22.2	14.3	13.3
Wisconsin	59.9	52.1	46.8	78.9	40.1	47.9	53.2	21.1
Mean[b]	75.8	79.4	78.7	85.0	24.2	20.6	21.3	15.0

[a] FGP = Emergency Feed Grain Program; WHP = Wheat Program.

[b] The weighted mean is for the 11 states which conducted surveys all 4 years.

1964, Baxter and Wolfe 1973, Berner 1973, Montag 1974, Trautman 1982, Berner 1984a). In turn, undisturbed nesting cover declined, while disturbed nesting and brood cover increased. Therefore, because annual contracts permitted summer fallow and late-seeded cover crops, and further required early destruction dates of seeded small grain cover crops, SA acres at best had no overall effect on the Midwest pheasant; i.e., positive effects observed in some states were balanced by negative effects in others.

To determine the value of SA acres as pheasant habitat, wildlife personnel in 12 midwestern states, plus Colorado and Pennsylvania, surveyed lands enrolled in FGP and WHP for 1972, 1973, 1978, and 1983 (Berner 1973, Montag 1974, Berner 1984a). In the 11 states surveyed for all 4 years, the majority of SA was left unseeded except in 1978 (Table 3). From 20 to 56% of the lands were tilled (fallowed) during entire summers (Table 5). Established grasses (and/or legumes) constituted only 6-30% of SA. In 1972 and 1973, 33% or more of SA in Illinois, Indiana, Iowa, Michigan, Ohio, and Wisconsin constituted established perennial grassland cover; in the remaining 5 states less than 30% was established cover

Table 5. Weighted mean % of Federal set-aside (FGP and WHP)[a] acres in 4 general cover categories for 11 midwestern states[b] for 1972, 1973, 1978, and 1983.

Year	Fallow	Stubble or volunteer annuals	Newly seeded	Established seedings
1972	45.6	7.9	22.7	23.8
1973	55.5	5.5	8.5	30.5
1978	29.4	12.5	45.2	12.9
1983	19.8	40.6	33.2	6.4

[a] FGP = Emergency Feed Grain Program; WHP = Wheat Program.

[b] Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

(Table 3). In 1978 and 1983 this distinction could no longer be made.

In surveying of SA as pheasant habitat, vegetation density, height, and disturbance data (time and type) were used to rate the value of SA as nesting cover. Unseeded fields with volunteer annuals and newly seeded fields which had fair, good, or excellent stand density and were 20 in. (50.8 cm), 15 in. (38.1 cm), and 10 in. (25.4 cm) high, respectively, during the mid-June field check, were classified as good to excellent nesting cover—if undisturbed until 15 July. The same criteria were used to evaluate established cover, except that stands had to remain undisturbed only until 1 July.

For all 4 surveys of SA, nesting cover was rated absent, poor, or fair on about 80% and good or excellent on about 20% (Table 4). In 1972, FGP and WHP acres were surveyed in mid-November, as well as mid-June and July, to determine amounts of hunting and winter cover. Over 85% of SA had zero or poor hunting cover, 4.4% was fair, 7.4% good, and 2.8% excellent; ratings and percentages for winter cover were about the same as for hunting cover (Berner 1973).

In the late 1960's and early 1970's, Minnesota and Iowa independently conducted studies to determine the response of pheasants to improved cover management on SA. On the Iowa study area the number of successful pheasant nests increased from 20 to 101 in 3 years (1968-70). This increase was accomplished when about 66% of SA (53 a/mi^2 in a 5-mi^2 area or 8.3 ha/km^2 in a 12.8 km^2 area) was seeded to grasses and/or legumes and left undisturbed, and the remainder (29 a/mi^2 or 4.6 ha/km^2) seeded early (prior to May 1) to small grains and left undisturbed until August 1. Between 68 and 91% of the annual pheasant production came from managed SA which comprised 37-56% of available nesting cover (Nomsen 1972).

In south-central Minnesota (1970-75) spring hen pheasant numbers in 4, 36-mi^2 (93-km^2) treatment areas increased an average of 83% from 1971 to 1973 over the changes observed in 2, 36-mi^2 (93-km^2) control areas. An average of 12 acres (1.9 ha) of undisturbed grass and/or legume cover and 12 acres (1.9 ha) of undisturbed small grains/mi^2 (/km^2) were established on SA in the 4 treatment areas (Berner 1984b).

Klonglan (1973) indicated that Iowa's fall pheasant abundance could be increased from 5 million to over 9 million birds by the proper management of SA lands. A population model designed by Berner, based on pheasant responses to past changes in available nesting cover in Minnesota, suggests that ideal cover management of SA acreage (e.g., Nomsen 1972) could readily produce annual fall populations of over 4 million pheasants in Minnesota.

A Good Idea for a Little While

In 1966, USDA implemented the Cropland Adjustment Program (CAP). The CAP had all the beneficial features of CR, plus an optional payment for hunter access. Unfortunately, because FGP and WHP had more financial appeal to farmers, a maximum of only 2.0 million CAP acres (0.8 million ha) was enrolled in 12 midwestern states (Table 2).

In Indiana, both pheasants and hunters responded to CAP (Machan and Feldt 1972). The CAP farms received 3 times more hunting pressure (hours/ha) and produced 3 times the pheasant harvest/ha than non-CAP farms. Nebraska pheasant hunters responded similarly to the greater pheasant availability and improved public access to some CAP farms (Nason 1971).

COST-SHARING FOR CONSERVATION?

Congress, in the 1936 Soil Conservation and Domestic Allotment Act, established federal authority to cost-share conservation-production practices on private lands. Over the years, federal cost-share programs have had various titles: Agricultural Conservation Program (this ACP differs from the 1936-42 land retirement ACP), Rural Environmental Assistance Program, Rural Environmental Conservation Program, and now, again, ACP.

In the years 1936-1983, USDA expended over $18 billion on various approved conservation practices (USGAO 1983). During 1936-70, almost $7 billion was spent on these practices (USDA 1971), with over $2.5 billion spent in 12 midwestern states—$6.1 million/state/year. Approved practices included liming, field windbreaks, open drainage ditches, and grass waterways, to name only a few (for a complete listing of practices refer to USDA 1971).

Positive and negative effects of individual practices on pheasant habitat and abundance are difficult to assess. I was unable to find any formal attempt at such an assessment. Most wildlife biologists from state, federal, and private organizations, however, indicated that cost-share practices have in general had negative impacts on pheasant habitat (Weigand and Janson 1976). Examples cited were ponds and mowed grass waterways that replaced brush-grassy draws; dugouts in Type III marshes; backsloped terraces to allow cropping areas that would have otherwise remained in hay or pasture; concreting of irrigation ditches; and—most damaging of all—drainage. Even as late as 1973, about $31 of ACP funds were being spent for liming, irrigation, and drainage for every $1 spent on wildlife habitat (Harmon 1974a).

Pheasant habitat has been provided by some cost-share practices. Irrigation has produced quality pheasant cover in some arid areas, while grassland establishment to reduce erosion has provided nesting cover. Most cost-share practices, however, have been of limited value to wildlife. Intensive pasturing and haying have degraded some cost-shared grasslands while other grasslands lacked permanence; many cost-shared grassland areas have long since given way to grain production. Woody cover, although of greater permanency, is often of marginal value to pheasants because of the minimal length, width, and species composition of the plantings. Woody cover plantings of the size and composition adequate to protect wildlife from severe winter storms are usually established only when states insist on strong specifications and/or provide additional cost-share money.

Since 1980, the more obvious crop production-oriented practices have been removed from the cost-share eligibility list. However, long-term impacts of cost-shared practices on pheasants (30 years of drainage, for example) are still being felt throughout the Midwest. USDA (1971) reported that, from 1940 through 1970, cost-share funds aided in effectively draining over 52 million acres (21 million ha) nationwide to permit "conservation" farming! Almost half this work was carried out in 12 midwestern states (Table 6)—i.e., in good pheasant range. Note that, between 1956 and 1985, an average of 18 million acres (7.3 million ha)—equal to 71% of the acreage drained—was retired annually under federal programs in the same states!

The importance of wetlands and associated grassland to pheasants has been noted repeatedly (Gates 1970, Elliot and Linder 1972, Gates and Hale 1974, 1975, Schitoskey and Linder 1978). One can only conclude, considering the importance of wetlands to pheasant populations, that

Table 6. Total acres (ha) drained using Federal cost-share[a] funds in 12 midwestern states and in the U.S., 1940-70 (USDA 1971).

State	Affected by permanent open ditches	Affected by all drainage
Illinois	994,817(402,590)	1,341,422(542,856)
Indiana	918,885(371,861)	2,200,564(890,540)
Iowa	834,060(337,533)	2,489,235(1,007,362)
Kansas	549,229(222,266)	556,214(225,093)
Michigan	2,689,870(1,088,556)	3,901,878(1,579,040)
Minnesota	3,739,531(1,513,341)	4,709,872(1,906,025)
Missouri	2,741,021(1,109,256)	2,951,173(1,194,302)
Nebraska	700,586(283,518)	738,206(298,743)
North Dakota	1,653,225(669,039)	1,670,412(675,995)
Ohio	699,125(282,927)	2,302,098(931,630)
South Dakota	772,734(312,716)	777,181(314,515)
Wisconsin	1,593,324(644,798)	1,897,669(767,963)
Totals:		
Midwest	17,886,407(7,238,401)	25,535,924(10,334,064)
National	41,186,346(16,667,591)	52,285,419(21,159,245)

[a] Funds spent under the following programs: Agricultural Conservation Program, Rural Environmental Assistance Program, Rural Environmental Conservation Program.

cost-shared wetland conversions have negatively affected significant amounts of pheasant habitat. Unlike many establishment practices (e.g., field windbreaks), drainage is seldom reversed and usually intensifies. Drainage cost-shared under ACP will continue to depress pheasant populations into the foreseeable future.

WATERSHED DRAINAGE UNDER P.L. 566

In 1954, the Eighty-third Congress passed the Watershed Protection and Flood Prevention Act, better known as P.L. 566. This law authorized "the Secretary of Agriculture to cooperate with States and local agencies in the planning and carrying out of works of improvement for soil conservation and for other purposes."

Since P.L. 566's inception, the federal government has cost-shared on 1,382 projects nationwide (USDA 1986a). In 12 midwestern states, 361 projects have affected over 23 million acres (9.3 million ha) of watershed. Flood control was considered to be a derived benefit in 95% of these 361 projects, with drainage benefits in 20%, and wildlife benefits in only 8% (Table 7).

Table 7. Number of projects and acres (ha) impacted by Public Law 83-566 projects in 12 midwestern states and the U.S., 1956-85. Also shown is the % of projects with flood control, drainage, and fish and wildlife benefits (USDA 1986a).

			% of projects		
State	**No. of projects**	**Acres (ha) affected**	**Flood control**	**Drainage**	**Fish and wildlife**
Illinois	26	1,311,250(530,646)	81	23	0
Indiana	37	2,292,432(927,718)	97	46	8
Iowa	49	1,001,921(405,465)	96	8	2
Kansas	55	5,362,046(2,169,952)	100	0	0
Michigan	21	994,320(402,389)	95	86	9
Minnesota	18	1,499,319(606,755)	100	86	50
Missouri	24	1,233,837(499,318)	96	4	0
Nebraska	50	3,161,359(1,279,362)	92	0	4
N. Dakota	18	2,304,806(932,726)	94	56	28
Ohio	20	1,668,816(675,349)	95	35	15
S. Dakota	15	758,801(307,077)	100	7	7
Wisconsin	28	1,468,999(594,485)	93	0	14
Midwest Totals	361	23,057,906(9,331,242)	95	20	8
National Totals	1,382	88,202,566(35,694,458)	92	22	7

Several studies have documented effects of P.L. 566 projects on wetland habitat. In Minnesota, Bonnema and Zschomler (1974) found that, on completion, the 66,713-acre (27,009 ha) Crane Creek watershed had experienced a net loss of 3,360 acres (1,360 ha) of Types II, III, and VI wetlands. Since 1973, drainage in that watershed has continued along the 286,877 feet (87,440 m) of main and lateral channels, and 47,477 feet (14,471 m) of field ditches constructed during the P.L. 566 project. Although the Crane Creek work plan included provisions for mitigation, this mitigation was neither adequate nor fully implemented (Bonnema and Zschomler 1974). In Missouri, Graham (1984) documented a lack of commitment to implementation of planned mitigation on the Bear Creek/Clarence Cannon P.L. 566 project.

In a joint P.L. 566 project in North and South Dakota, drainage rates were 2.6 and 5.3 times higher in the channeled than in the unchanneled area during planning and following construction, respectively (Erickson et al. 1979). By 1972, 77% of the wetlands in the channelized portion of this joint project had been drained, compared to only 22% of the wetlands drained in the unchannelized portion. On this project, drainage was accomplished even though drainage benefits were stated to be limited to watershed protection and flood control. Both the Minnesota and Dakota projects illustrate the extensive losses of wetland habitats promoted by federal projects funded under P.L. 566. Obviously, flood control and drainage, although not outwardly promoted, have been strongly emphasized through cost-sharing under P.L. 566, as discussed by Harmon (1974b).

The primary reason for draining wetlands in the Midwest has been to allow cultivation of feed grains and wheat. Despite the fact that, in most years since 1956, acreage has been retired to reduce crop surpluses (USDA 1973, 1976, 1986b; Table 1), drainage continues to be justified on the basis of need by local farmers. Drainage especially impacts pheasant habitat in 2 ways. First, elimination of wetlands removes preferred cattail and/or shrubby winter habitat (escape cover) and permits the plowing of adjacent grasslands, reducing nesting and brood habitat. Second, crops planted in the drained wetland seldom, if ever, provide nesting or winter cover equal to that lost.

WATER IN THE BANK—P.L. 91-559

In 1970, Congress passed the Water Bank Act (P.L. 91-559) in an attempt "to preserve and improve the major wetlands as habitat for migratory waterfowl and other wildlife; conserve surface waters; reduce runoff, soil, and wind erosion; contribute to flood control; improve water quality; improve subsurface moisture; and enhance the natural beauty of the landscape" (USDA 1986c). To achieve these numerous public benefits nationwide, Congress provided an annual appropriation of a mere $10 million. Because of limited funding, since 1972 only 13 states have been eligible to participate under P.L. 91-559.

Despite the limited scope of the Water Bank, 6 midwestern states have participated. Although only 6 of the 13 participating states are in the Midwest, they encompass 83.5% of all contracts written nationwide. Midwestern states have annually enrolled an average of 335,459 acres (135,756 ha); the maximum of 508,066 acres (205,608 ha) was enrolled in 1982 (Table 8).

Water Bank was designed to protect wetlands and to provide adjacent upland nesting habitat. Enrollees are required to provide at least 1 acre of undisturbed upland grassland cover for each acre of wetland placed under contract. Of the total acreage enrolled to date, 28% has been wetland and 72% upland grass-legume cover. The latter provides prime habitat for nesting waterfowl, pheasants, and other wildlife (USDA 1986c). A 4-year study evaluating wildlife use of Water Bank sites in

Table 8. Accumulative Water Bank (P.L. 91-559) contracts and acres (ha) affected by agreements in 12 midwestern states[a] and the U.S. 1972-85 (USDA 1986c).

	Midwestern states		Nationwide	
Year	**Contracts**	**Area**	**Contracts**	**Area**
1972	406	21,172(8,568)	516	35,817(14,495)
1973	794	62,706(25,376)	933	82,213(33,271)
1974	1,590	130,440(52,787)	1,850	174,194(70,494)
1975	2,155	189,844(76,827)	2,535	248,125(100,413)
1976	2,568	238,860(96,664)	3,061	309,514(125,256)
1977	3,228	328,410(132,903)	3,781	416,613(168,598)
1978	3,710	382,797(154,913)	4,351	487,900(197,447)
1979	4,303	445,411(180,252)	5,060	566,438(229,230)
1980	4,741	488,585(197,724)	5,617	628,100(254,184)
1981	4,927	502,165(203,220)	5,896	654,841(265,006)
1982	4,921	508,066(205,608)	5,901	663,889(268,667)
1983	4,924	496,522(200,936)	5,999	667,623(270,179)
1984	4,526	460,396(186,316)	5,602	629,016(254,555)
1985	4,380	441,058(178,491)	5,405	605,649(245,098)

[a] Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

east-central South Dakota found an average of 2.6 times more adult pheasants and chicks on 10 Water Bank sites than on 10 non-Water Bank sites of similar size and composition. In addition, pheasant broods on Water Bank areas averaged 6.8 chicks, as compared to 4.8 chicks on non-Water Bank sites (USDA 1985). In short, considering the benefits, this is a good but grossly underfunded program.

DISCUSSION

Since 1934, federal agricultural programs have had varying impacts on pheasants and their habitat. In general, those that have idled large blocks of cropland for 3 or more years and provided grassland cover or protected wetlands and adjacent existing grasslands (e.g., ACP, CR, CAP, and Water Bank) (Tables 9-20) have had significant beneficial effects. On the other hand, programs that retired land on an annual basis, creating little or no permanent vegetative cover (e.g., FGP and WHP), or that fostered additional wetland drainage and grassland conversion to crop production (cost-share program and P.L. 566) have—in most cases—been detrimental to pheasants and to wildlife in general. The lack of concerted involvement by state and federal wildlife agencies and sportsmen to influence federal agricultural programs is surprising, considering the effects these programs have on land use and wildlife abundance.

The first organized effort to influence federal agricultural programs was in the early 1970's with the formation of the Farm Program Committee, comprised of 16 representatives from state wildlife agencies in 12 midwestern states, plus Colorado, Pennsylvania, the Wildlife Management Institute, and the U.S. Fish and Wildlife Service (Nelson et al. 1972, Harmon and Nelson 1973). Efforts of this Committee resulted in the passage of legislation providing USDA with authority to implement multi-year SA, develop wildlife advisory councils to USDA at state and national levels, and take perpetual easements in wetlands and flood plains. This authority was contained in Title X of the 1973 Farm Act. Unfortunately, U.S. Secretaries of Agriculture since then have yet to implement any of those provisions.

The deteriorating economic and environmental conditions on our nation's farms since the late 1970's, and the costly Payment-in-Kind (PIK) land retirement program of 1983, produced a heightened public awareness of pending federal farm legislation for 1985. For only the second time in the 50-year history of U.S. farm programs, concerted efforts were made by fish, wildlife, and environmental groups to influence federal farm legislation. These efforts produced federal farm legislation with the strongest conservation provisions written since 1934. The conservation portion of the 1985 Farm Act provided for the 45 million acre (18.2 million ha) CRP, similar to CR, and placed mandatory restrictions on using recently drained wetlands or plowed highly erodible soils (since December 23, 1985) for growing commodity crops. Unfortunately, because of continued dominance of agribusiness interests, the commodity portion of the 1985 Farm Act incorporated little conservation philosophy. Thus, considerable acreage being set aside under "annual" contracts of the 1985 program continues to impact wildlife—especially pheasants—negatively in many areas.

Available data amply demonstrate that wildlife species dependent upon undisturbed grassland habitats have suffered dramatic declines in the last 25 years (Edwards et al. 1982, Graber and Graber 1983, Warner et al. 1984, Berner 1984b, Warner and Etter 1986). Considering the several-times demonstrated potential of federal agricultural programs to benefit farmland wildlife, an even greater effort must be made by public agencies and private environmental groups to bring about sorely needed changes in land retirement and wetland drainage aspects of commodity programs (e.g., see Berner 1984b for a full listing of needed changes). Also, conservation and environmental groups must remain vigilant to, and comment on—as quickly and strongly as possible—regulations as they are developed and administrated, so that the intent and effectiveness of a given law are not undermined.

Vital to the development of future, multi-purpose federal farm programs will be data relevant to the benefits of improved wildlife abundance and distribution, and associated recreational opportunities as they enhance rural economics. To develop predictions necessary for decision making, state and federal wildlife agencies must support adequately funded research that determines the effects of farm program options on the quantity and quality of habitat, wildlife abundance, and the economics of increased recreational opportunities.

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Table 9. Amount of cropland retired in Illinois under various USDA farm programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	**AR**	**CR**[b]	**FGP**	**WHP**	**CAP**	**Total**
1956	485.6(196.5)	0.5(0.2)				486.1(196.7)
1957	437.7(174.7)	11.0(4.4)				442.7(179.1)
1958	654.6(264.9)	15.8(6.4)				670.4(271.3)
1959		344.6(139.5)				344.6(139.5)
1960		440.4(178.2)				440.4(178.2)
1961		436.7(176.7)	2105.1(851.9)			2541.8(1028.6)
1962		419.7(169.9)	2041.7(826.7)	135.4(54.8)		2597.8(1051.4)
1963		408.0(165.1)	1533.7(620.7)	43.3(17.5)		1985.0(803.3)
1964		142.9(57.8)	1694.6(685.8)	61.1(24.7)		1898.6(768.3)
1965		57.4(23.2)	1713.4(693.4)	145.0(58.7)		1915.8(775.3)
1966		55.4(22.4)	1552.9(628.4)	138.8(56.2)	27.9(11.3)	1775.0(718.3)
1967		49.8(20.2)	1017.2(411.6)		86.4(35.0)	1153.4(466.8)
1968		47.3(19.1)	1917.3(775.9)		86.2(34.9)	2050.8(829.9)
1969		9.6(3.9)	2221.5(899.0)	194.7(78.8)	85.3(34.5)	2511.1(1016.2)
1970		0.4(0.2)	1962.4(794.2)	309.0(125.0)	80.5(32.6)	2352.3(952.0)
1971		0.2(0.1)	1715.0(694.0)	346.0(140.0)	73.0(29.5)	2134.2(863.6)
1972			2743.6(1110.3)	371.0(150.1)	30.0(12.1)	3144.6(1272.5)
1973			503.3(203.7)	5.5(2.2)	32.8(13.3)	541.6(219.2)
1974					29.9(12.1)	29.9(12.1)
1975					23.5(9.5)	23.5(9.5)
1976					21.2(8.6)	21.2(8.6)
1977					12.0(4.9)	12.0(4.9)
1978			547.0(221.4)	59.1(23.9)		606.1(245.3)

Table 9 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			157.3(63.7)	32.3(13.1)		189.6(76.8)
1980						0.0
1981						0.0
1982			195.8(79.2)	55.8(22.6)		251.6(101.8)
1983			4202.1(1700.5)	337.0(136.4)		4539.1(1836.9)
1984			606.0(245.2)	146.0(59.1)		752.0(304.3)
1985			851.1(344.4)	199.9(80.9)		1051.0(425.3)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 10. Amount of cropland retired in Indiana under various USDA farm programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	258.7(104.7)	1.5(0.6)				260.2(105.3)
1957	420.5(170.2)	20.1(8.1)				440.6(178.3)
1958	590.3(238.9)	28.6(11.6)				618.9(250.5)
1959		358.1(144.9)				358.1(144.9)
1960		494.3(200.1)				494.3(200.1)
1961		493.3(199.6)	1326.5(536.8)			1819.8(736.4)
1962		463.6(187.6)	1309.8(530.1)	137.8(55.8)		1911.2(773.5)
1963		450.0(182.1)	1077.0(435.8)	50.2(20.3)		1577.2(638.2)
1964		191.3(77.4)	1259.3(509.6)	46.3(18.7)		1496.9(605.7)
1965		77.1(31.2)	1347.1(545.2)	116.2(47.0)		1540.4(623.4)
1966		73.9(29.9)	1278.2(517.3)	121.6(49.2)	27.3(11.0)	1501.0(607.4)
1967		69.8(28.2)	902.4(365.2)		72.6(29.4)	1044.8(422.8)
1968		66.7(27.0)	1571.9(636.1)		71.1(28.8)	1709.7(691.9)
1969		19.6(7.9)	1721.3(696.6)	180.6(73.1)	70.4(28.5)	1991.9(806.1)
1970		0.1(0.0)	1545.2(625.3)	245.2(99.2)	68.2(27.6)	1858.7(752.1)
1971			853.7(345.5)	245.0(99.1)	61.0(24.7)	1159.7(469.3)
1972			1528.6(618.6)	270.0(109.3)	31.0(12.5)	1829.6(740.4)
1973			345.8(139.9)	7.6(3.1)	31.5(12.7)	384.9(155.7)
1974					28.9(11.7)	28.9(11.7)
1975					23.9(9.7)	23.9(9.7)
1976					20.0(8.1)	20.0(8.1)
1977					11.0(4.5)	11.0(4.5)
1978			325.4(131.7)	32.4(13.1)		357.8(144.8)

Table 10 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			98.3(39.8)	17.3(7.0)		115.6(46.8)
1980						0.0
1981						0.0
1982			100.5(40.7)	24.8(10.0)		125.3(50.7)
1983			2482.6(1004.7)	190.4(77.1)		2673.0(1081.8)
1984			269.2(108.9)	65.6(26.5)		334.8(135.4)
1985			408.6(165.4)	100.4(40.6)		509.0(206.0)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 11. Amount of cropland retired in Iowa under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	1295.1(524.1)	2.2(0.9)				1297.3(525.0)
1957	774.9(313.6)	49.7(20.1)				824.6(333.7)
1958	1030.9(417.2)	72.6(29.4)				1103.5(446.6)
1959		493.5(199.7)				493.5(199.7)
1960		663.1(268.3)				663.1(268.3)
1961		658.2(266.4)	2784.4(1126.8)			3442.6(1393.2)
1962		585.8(237.1)	3094.8(1252.4)	31.3(12.7)		3711.9(1502.3)
1963		549.1(222.2)	2399.5(971.0)	15.1(6.1)		2963.7(1199.3)
1964		202.2(81.8)	3558.4(1440.0)	6.6(2.7)		3767.1(1524.5)
1965		51.8(21.0)	3458.9(1399.8)	19.5(7.9)		3530.2(1428.7)
1966		49.8(20.2)	3329.0(1347.2)	9.8(4.0)	25.9(10.5)	3414.5(1381.9)
1967		43.7(17.7)	1959.1(792.8)		99.9(40.4)	2102.7(850.9)
1968		39.9(16.2)	3720.7(1505.7)		98.4(39.8)	3859.0(1561.7)
1969		11.2(4.6)	3887.7(1573.3)	11.1(4.5)	97.4(39.4)	4007.4(1621.8)
1970		0.2(0.1)	3859.9(1452.8)	15.6(6.3)	92.8(37.6)	3698.5(1496.8)
1971			2470.5(999.8)	20.4(8.3)	84.0(34.0)	2574.9(1042.1)
1972			4088.7(1654.6)	21.7(8.8)	36.0(14.6)	4146.4(1678.0)
1973			944.7(382.3)	0.1(0.0)	35.3(14.3)	980.1(396.6)
1974					32.0(12.9)	32.0(12.9)
1975					25.3(10.2)	25.3(10.2)
1976					22.3(9.0)	22.3(9.0)
1977					15.0(6.1)	15.0(6.1)
1978			1195.0(483.6)	3.9(1.6)		1198.9(485.2)

Table 11 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	**AR**	**CR**	**FGP**	**WHP**	**CAP**	**Total**
1979			477.8(193.4)	2.8(1.1)		480.6(194.5)
1980						0.0
1981						0.0
1982			503.0(203.6)	3.0(1.2)		506.0(204.8)
1983			6331.5(2562.3)	41.0(16.6)		6372.5(2578.9)
1984			927.1(375.2)	8.7(3.5)		935.8(378.7)
1985			1178.2(476.8)	9.0(3.6)		1187.2(480.4)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 12. Amount of cropland retired in Kansas under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	1051.3(425.4)	32.4(13.1)				1083.7(438.5)
1957	4479.0(1812.6)	212.7(86.1)				4691.7(1898.7)
1958	966.8(391.3)	436.2(176.5)				1403.0(567.8)
1959		1122.5(454.3)				1122.5(454.3)
1960		1446.6(585.4)				1446.6(585.4)
1961		1450.0(586.8)	2457.6(994.6)			3907.6(1581.4)
1962		1366.3(552.9)	1998.8(808.9)	1540.0(623.2)		4905.1(1985.0)
1963		1277.0(516.8)	1698.2(687.2)	1252.1(506.7)		4227.3(1710.7)
1964		974.0(394.1)	2480.0(1003.6)	1116.2(451.7)		4570.2(1849.4)
1965		867.0(350.9)	2626.0(1062.7)	1219.8(493.6)		4712.8(1907.2)
1966		849.2(343.7)	2483.2(1004.9)	1439.0(582.3)	36.7(14.9)	4808.1(1945.8)
1967		751.8(304.2)	1516.3(613.6)		101.9(41.2)	2370.0(959.0)
1968		638.6(258.4)	2305.4(933.0)		101.4(41.0)	3045.4(1232.4)
1969		249.1(100.8)	2573.5(1041.5)	1782.3(721.3)	100.4(40.6)	4705.3(1904.2)
1970			2369.4(958.9)	2686.1(1087.0)	96.2(38.9)	5151.7(2084.8)
1971			1432.4(579.7)	2710.2(1096.8)	86.0(34.8)	4228.6(1711.3)
1972			2554.6(1033.8)	3426.5(1386.7)	76.0(30.8)	6057.1(2451.3)
1973			824.4(333.6)	500.7(202.6)	74.3(30.1)	1399.4(566.3)
1974					71.7(29.0)	71.7(29.0)
1975					64.2(26.0)	64.2(26.0)
1976					57.8(23.4)	57.8(23.4)
1977					38.0(15.4)	38.0(15.4)
1978			608.9(246.4)	1837.1(743.5)		2446.0(989.9)

Table 12 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			538.6(218.0)	1703.4(689.3)		2242.0(907.3)
1980						0.0
1981						0.0
1982			265.3(107.4)	755.3(305.7)		1020.6(413.1)
1983			2037.2(824.4)	3641.3(1473.6)		5678.5(2298.0)
1984			261.3(105.7)	2932.9(1186.9)		3194.2(1292.6)
1985			387.5(156.8)	2920.1(1181.7)		3307.6(1338.5)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 13. *Amount of cropland retired in Michigan under various USDA programs*^{a}, 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR^{b}	FGP	WHP	CAP	Total
1956	97.6(39.5)	14.6(5.9)				112.2(45.4)
1957	310.1(125.5)	103.5(41.9)				413.6(167.4)
1958	360.4(145.8)	169.7(68.7)				530.1(214.5)
1959		516.3(208.9)				516.3(208.9)
1960		721.0(291.8)				721.0(291.8)
1961		708.1(286.5)	531.5(215.1)			1239.6(501.6)
1962		646.4(261.6)	598.3(242.1)	253.0(102.4)		1497.7(606.1)
1963		612.9(248.0)	485.6(196.5)	97.4(39.4)		1195.9(483.9)
1964		360.0(145.7)	599.4(242.6)	93.1(37.7)		1052.5(426.0)
1965		211.5(85.6)	710.7(287.6)	189.8(76.8)		1112.0(450.0)
1966		206.9(83.7)	775.7(313.9)	241.0(97.5)	145.5(58.9)	1369.1(554.0)
1967		187.7(75.9)	588.5(238.2)		246.9(99.9)	1023.1(414.0)
1968		176.2(71.3)	802.7(324.8)		242.9(98.3)	1221.8(494.4)
1969		86.9(35.2)	883.1(357.4)	367.8(148.8)	240.5(97.3)	1578.3(638.7)
1970		0.5(0.2)	849.9(343.9)	434.9(176.0)	229.1(92.7)	1514.4(612.8)
1971			350.5(141.8)	234.8(95.0)	207.0(83.8)	792.3(320.6)
1972			660.9(267.5)	256.3(103.7)	139.0(56.3)	1056.2(427.5)
1973			172.0(69.6)	94.6(38.3)	141.7(57.3)	408.3(165.2)
1974					135.2(54.7)	135.2(54.7)
1975					119.7(48.4)	119.7(48.4)
1976					105.8(42.8)	105.8(42.8)
1977					41.0(16.6)	41.0(16.6)
1978			245.9(99.5)	31.0(12.5)		276.9(112.0)

Table 13 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			125.2(50.7)	28.7(11.6)		153.9(62.3)
1980						0.0
1981						0.0
1982			81.6(33.0)	18.1(7.3)		99.7(40.3)
1983			1269.9(513.9)	183.8(74.4)		1453.7(588.3)
1984			134.8(54.6)	72.6(29.4)		207.4(84.0)
1985			196.7(79.6)	108.4(43.9)		305.1(123.5)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 14. Amount of cropland retired in Minnesota under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	310.4(125.6)	13.8(5.6)				324.2(131.2)
1957	376.9(152.5)	552.0(223.4)				928.9(375.9)
1958	544.9(220.5)	1030.6(417.1)				1575.5(637.6)
1959		1761.9(713.0)				1761.9(713.0)
1960		1944.5(786.9)				1944.5(786.9)
1961		1903.2(770.2)	1519.3(614.8)			3422.5(1385.0)
1962		1662.4(672.8)	1738.5(703.5)	241.5(97.7)		3642.4(1474.0)
1963		1448.1(586.0)	1684.8(681.8)	163.2(66.0)		3296.1(1333.8)
1964		945.9(382.8)	2167.6(877.2)	70.6(28.6)		3184.1(1288.6)
1965		792.0(320.5)	2321.3(939.4)	150.2(60.8)		3263.5(1320.7)
1966		776.2(314.1)	2488.1(1006.9)	99.1(40.1)	122.2(49.5)	3485.6(1410.6)
1967		543.9(220.1)	1334.5(540.1)		229.1(121.0)	2177.5(881.2)
1968		371.0(150.1)	2303.2(932.1)		293.6(118.8)	2697.8(1201.0)
1969		94.8(38.4)	3063.1(1239.6)	196.9(79.7)	290.7(117.6)	3645.5(1475.3)
1970		15.5(6.3)	2719.5(1100.5)	256.7(103.9)	279.0(112.9)	3270.7(1323.6)
1971		1.6(0.7)	1321.0(534.6)	240.9(97.5)	250.0(101.2)	1813.5(734.0)
1972		0.2(0.1)	2723.6(1102.2)	401.8(162.6)	205.0(83.0)	3330.6(1347.9)
1973			616.5(249.5)	209.6(84.8)	193.9(78.5)	1020.0(412.8)
1974					184.1(74.5)	184.1(74.5)
1975					138.5(56.0)	138.5(56.0)
1976					116.8(47.3)	116.8(47.3)
1977					61.0(24.7)	61.0(24.7)
1978			663.3(268.4)	340.8(137.9)		1004.1(406.3)

Table 14 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			334.7(135.4)	226.6(91.7)		561.3(227.1)
1980						0.0
1981						0.0
1982			256.4(103.8)	243.6(98.6)		500.0(202.4)
1983			3384.1(1369.5)	1690.2(684.0)		5074.3(2053.5)
1984			474.3(191.5)	736.9(298.2)		1211.2(490.1)
1985			629.2(254.6)	890.2(360.3)		1519.4(614.9)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 15. Amount of cropland retired in Michigan under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	355.3(143.8)	4.8(1.9)				360.1(145.7)
1957	683.5(276.6)	66.7(27.0)				750.2(303.6)
1958	1131.2(457.8)	134.9(54.6)				1266.1(512.4)
1959		609.8(246.8)				609.8(246.8)
1960		832.3(336.8)				832.3(336.8)
1961		828.9(335.4)	1930.5(781.2)			2759.4(1116.6)
1962		773.7(313.1)	1924.9(779.0)	584.6(236.6)		3283.2(1328.7)
1963		717.4(290.3)	1550.3(627.4)	290.2(117.4)		2557.9(1035.1)
1964		452.4(183.1)	1883.1(762.1)	103.2(41.8)		2438.7(987.0)
1965		300.3(121.5)	2078.6(841.2)	239.5(96.9)		2618.4(1059.6)
1966		293.3(118.7)	2068.1(836.9)	264.8(107.2)	81.9(33.1)	2708.1(1095.9)
1967		279.4(113.1)	1308.6(529.6)		159.5(64.5)	1747.5(707.2)
1968		256.4(107.4)	2025.0(819.5)		161.4(65.3)	2451.8(992.2)
1969		74.4(30.1)	2213.0(895.6)	347.2(140.5)	159.8(64.7)	2794.4(1130.9)
1970		0.4(0.2)	2191.4(886.8)	438.0(177.3)	150.2(60.8)	2780.0(1125.1)
1971		0.3(0.1)	930.1(376.4)	341.3(138.1)	138.0(55.8)	1409.7(570.4)
1972		0.3(0.1)	1747.9(707.4)	376.1(152.2)	95.0(38.4)	2219.3(898.1)
1973			450.5(182.3)	47.0(19.0)	97.6(39.5)	595.1(240.8)
1974					91.0(36.8)	91.0(36.8)
1975					79.5(32.2)	79.5(32.2)
1976					72.8(29.5)	72.8(29.5)
1977					38.0(15.4)	38.0(15.4)
1978			339.2(137.3)	99.8(40.4)		439.0(177.7)

Table 15 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	**AR**	**CR**	**FGP**	**WHP**	**CAP**	**Total**
1979			122.7(49.7)	74.6(30.2)		197.3(79.9)
1980						0.0
1981						0.0
1982			74.5(30.1)	85.2(34.5)		159.7(64.6)
1983			1354.7(548.2)	902.8(365.4)		2257.5(913.6)
1984			139.7(56.5)	368.5(149.1)		508.2(205.6)
1985			227.3(92.0)	395.1(159.9)		622.4(251.9)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 16. Amount of cropland retired in Nebraska under various USDA programs^a, 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR^b	FGP	WHP	CAP	Total
1956	1523.5(616.5)	6.7(2.7)				1530.2(619.2)
1957	1967.6(687.0)	108.3(43.8)				1805.9(730.8)
1958	947.4(383.4)	154.1(62.4)				1101.5(445.8)
1959		680.3(275.3)				680.3(275.3)
1960		880.3(356.2)				880.3(356.2)
1961		876.1(354.6)	2312.6(935.9)			3188.7(1290.5)
1962		813.2(329.1)	2305.9(933.2)	484.6(196.1)		3603.7(1458.4)
1963		784.3(317.4)	1871.4(757.3)	294.7(119.3)		2950.4(1194.0)
1964		459.8(186.1)	2999.8(1214.0)	297.0(120.3)		3756.6(1520.3)
1965		330.9(133.9)	2983.2(1207.3)	418.3(169.3)		3732.4(1510.5)
1966		326.0(131.9)	2875.1(1163.5)	443.9(179.6)	85.0(34.4)	3730.0(1509.4)
1967		306.1(123.9)	1593.2(644.7)		177.8(72.0)	2077.1(840.6)
1968		289.8(117.3)	2842.1(1150.2)		177.1(71.7)	3309.0(1339.2)
1969		80.6(32.6)	2894.3(1171.3)	475.3(192.3)	175.3(70.9)	3625.5(1467.1)
1970			2715.0(1098.7)	778.9(315.2)	171.1(69.2)	3665.0(1483.1)
1971			1738.8(703.7)	792.1(320.6)	151.0(61.1)	2681.9(1085.4)
1972			3037.7(1229.3)	1040.9(421.2)	116.0(46.9)	4194.6(1697.4)
1973			870.6(352.3)	267.1(108.1)	115.0(46.5)	1252.7(506.9)
1974					109.4(44.3)	109.4(44.3)
1975					97.3(39.4)	97.3(39.4)
1976					90.4(36.6)	90.4(36.6)
1977					46.0(18.6)	46.0(18.6)
1978			1151.8(466.1)	400.7(162.2)		1552.5(628.3)

Table 16 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			681.9(276.0)	337.2(136.5)		1019.1(412.5)
1980						0.0
1981						0.0
1982			543.9(220.1)	167.5(67.8)		711.4(287.9)
1983			4306.6(1742.8)	822.3(332.8)		5128.9(2075.6)
1984			636.9(257.7)	634.0(256.6)		1270.9(514.3)
1985			814.8(329.7)	625.6(253.2)		1440.4(582.9)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 17. Amount of cropland retired in North Dakota under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	974.0(394.2)	1.6(0.7)				975.6(394.9)
1957	1344.5(540.1)	476.1(192.7)				1810.6(732.9)
1958	702.7(284.4)	800.0(323.8)				1502.7(608.2)
1959		1829.7(740.5)				1829.7(740.5)
1960		2704.8(1094.6)				2704.8(1094.6)
1961		2704.8(1094.6)	406.6(164.5)			3111.3(1259.1)
1962		2496.1(1010.1)	1104.8(447.1)	1411.8(571.3)		5012.7(2028.5)
1963		2349.1(950.6)	987.0(399.4)	1057.3(427.9)		4393.4(1777.9)
1964		1854.6(750.5)	1647.9(666.9)	696.0(281.7)		4198.5(1699.1)
1965		1452.2(587.7)	1623.6(657.1)	850.6(344.2)		3926.4(1589.0)
1966		1437.0(581.5)	1592.2(644.3)	945.1(382.5)	131.3(53.1)	4105.6(1661.4)
1967		1229.9(497.7)	421.0(170.4)		237.8(96.2)	1888.7(764.3)
1968		1090.7(441.4)	648.8(262.6)		242.1(98.0)	1981.6(802.0)
1969		541.7(219.2)	2024.8(819.4)	1334.2(539.9)	239.7(97.0)	4140.4(1675.5)
1970			2021.1(817.9)	2091.8(846.5)	228.8(92.6)	4341.7(1757.0)
1971			298.1(120.6)	1911.9(773.7)	207.0(83.8)	2417.0(978.1)
1972			2315.4(937.0)	3824.3(1547.6)	206.0(83.4)	6345.7(2568.0)
1973			596.9(241.6)	2217.3(897.3)	193.0(78.1)	3007.2(1217.0)
1974					183.2(74.1)	183.2(74.1)
1975					149.2(60.4)	149.2(60.4)
1976					117.6(47.6)	117.6(47.6)
1977					48.0(19.4)	48.0(19.4)
1978			343.6(139.1)	140.6(56.9)		484.2(196.0)

Table 17 (continued).

Year	Acreages in thousands (ha)					
	Soil Bank					
	AR	CR	FGP	WHP	CAP	Total
1979			227.4(92.0)	1249.6(505.7)		1477.0(597.7)
1980						0.0
1981						0.0
1982			173.6(70.3)	1252.3(506.8)		1425.9(577.1)
1983			828.7(335.4)	5432.0(2198.3)		6260.7(2533.7)
1984			257.8(104.3)	3415.7(1382.3)		3673.5(1486.6)
1985			351.0(142.0)	3502.7(1417.5)		3853.7(1559.5)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 18. *Amount of cropland retired in Ohio under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).*

	Acreages in thousands (ha)					
	Soil Bank					
Year	**AR**	**CR[b]**	**FGP**	**WHP**	**CAP**	**Total**
1956	179.4(72.6)	2.7(1.1)				182.1(73.7)
1957	440.9(178.4)	36.5(14.8)				477.4(193.2)
1958	519.3(210.2)	51.5(20.8)				570.8(231.0)
1959		344.6(139.5)				344.6(139.5)
1960		524.8(212.4)				524.8(212.4)
1961		516.6(209.1)	995.4(402.8)			1512.0(611.9)
1962		482.1(195.1)	870.4(352.2)	203.3(82.3)		1555.8(629.6)
1963		460.8(186.5)	673.2(272.4)	82.8(33.5)		1216.8(492.4)
1964		225.4(91.2)	788.4(319.1)	80.3(32.5)		1094.1(442.8)
1965		93.2(37.7)	951.4(385.0)	170.8(69.1)		1215.4(491.8)
1966		90.8(36.8)	977.8(395.7)	200.4(81.1)	64.4(26.1)	1333.4(539.7)
1967		86.1(34.8)	711.8(288.1)		130.9(53.0)	928.8(375.9)
1968		83.0(33.6)	1100.4(445.3)		135.1(54.7)	1318.5(533.6)
1969		40.3(16.3)	1179.8(477.5)	276.2(111.8)	133.7(54.1)	1630.0(659.7)
1970		<0.1(0.0)	1081.9(437.8)	364.1(147.3)	120.9(48.9)	1567.0(634.0)
1971			534.7(216.4)	294.1(119.0)	115.0(46.5)	943.8(381.9)
1972			911.3(368.8)	321.0(129.9)	55.0(22.3)	1287.3(521.0)
1973			277.9(92.2)	27.4(11.1)	59.4(24.0)	314.7(127.3)
1974					55.1(22.3)	55.1(22.3)
1975					46.6(18.0)	46.6(18.0)
1976					36.1(14.6)	36.1(14.6)
1977					15.0(6.1)	15.0(6.1)
1978			120.4(48.7)	34.8(14.1)		155.2(62.8)

Table 18 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			45.9(18.6)	10.1(4.1)		56.0(22.7)
1980						0.0
1981						0.0
1982			47.0(19.0)	41.0(16.6)		88.0(35.6)
1983			1619.0(655.2)	269.8(109.2)		1888.8(764.4)
1984			162.8(65.9)	102.3(41.4)		265.1(107.3)
1985			238.7(96.6)	139.4(56.4)		378.1(153.0)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 19. Amount of cropland retired in South Dakota under various USDA programs[a], 1956-85 (USDA 1970, 1973, 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	1095.7(443.4)	17.5(7.1)				1113.2(450.5)
1957	969.7(392.4)	411.0(166.3)				1380.7(558.7)
1958	626.7(253.6)	612.5(247.9)				1239.2(501.5)
1959		1286.7(520.7)				1286.7(520.7)
1960		1807.5(731.5)				1807.5(731.5)
1961		1822.1(737.4)	887.8(359.3)			2709.9(1096.7)
1962		1635.0(661.7)	868.7(351.6)	657.4(266.0)		3161.1(1279.3)
1963		1536.5(621.8)	835.9(338.3)	546.7(221.2)		2919.1(1181.3)
1964		1156.0(467.8)	1190.0(481.6)	263.0(106.4)		2609.0(1055.8)
1965		842.0(340.7)	1432.9(579.9)	464.1(187.8)		2739.0(1108.4)
1966		833.9(337.5)	1414.3(572.3)	375.6(152.0)	98.6(39.9)	2722.4(1101.7)
1967		762.0(308.4)	759.8(307.5)		183.1(74.1)	1704.9(690.0)
1968		709.9(287.3)	1483.2(600.2)		191.6(77.5)	2384.7(965.0)
1969		297.0(120.2)	1688.4(683.3)	612.6(247.9)	189.7(76.8)	2787.7(1128.2)
1970			1632.9(660.8)	922.6(373.4)	174.9(70.8)	2730.4(1105.0)
1971			898.0(363.4)	700.0(283.3)	163.0(66.0)	1761.0(712.7)
1972			1797.5(727.4)	1177.9(476.7)	131.0(53.0)	3106.4(1257.1)
1973			526.9(213.2)	648.9(262.6)	128.9(52.2)	1304.7(528.0)
1974					124.2(50.3)	124.2(50.3)
1975					113.4(45.9)	113.4(45.9)
1976					108.3(43.8)	108.3(43.8)
1977					51.0(20.6)	51.0(20.6)
1978			474.0(191.8)	1985.0(803.3)		2459.0(995.1)

Table 19 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			324.1(131.2)	421.5(170.6)		745.6(301.8)
1980						0.0
1981						0.0
1982			143.1(57.9)	372.7(150.8)		515.8(208.7)
1983			1915.2(775.1)	1951.7(789.8)		3866.9(1564.9)
1984			264.8(107.2)	1005.6(407.0)		1270.4(514.2)
1985			374.6(151.6)	1125.1(455.3)		1499.7(606.9)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP), Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

Table 20. Amount of cropland retired in Wisconsin under various USDA programs^{a}, 1956-85 (USDA 1970. 1973. 1976, 1986b).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR[b]	FGP	WHP	CAP	Total
1956	72.6(29.4)	12.8(5.2)				85.4(34.6)
1957	155.3(62.8)	117.1(47.4)				272.4(110.2)
1958	203.5(82.4)	161.8(65.5)				365.3(147.9)
1959		537.4(217.5)				537.4(217.5)
1960		763.5(309.0)				763.5(309.0)
1961		748.9(303.1)	549.1(222.2)			1298.0(525.3)
1962		674.0(272.7)	622.2(251.8)	15.0(6.1)		1311.2(530.6)
1963		637.0(257.8)	674.7(273.0)	8.5(3.4)		1320.2(534.2)
1964		358.7(145.2)	785.2(317.8)	3.1(1.3)		1147.0(464.3)
1965		210.1(85.0)	833.9(337.5)	8.0(3.2)		1052.0(425.7)
1966		204.4(82.7)	830.8(336.2)	7.4(3.0)	112.5(45.5)	1155.1(467.4)
1967		184.0(74.5)	562.3(227.6)		212.5(86.0)	958.8(388.1)
1968		170.3(68.9)	784.9(317.6)		204.7(82.8)	1159.9(469.3)
1969		78.8(31.9)	859.8(348.0)	11.3(4.6)	202.7(82.0)	1152.6(466.5)
1970		2.0(0.8)	842.1(340.8)	14.2(5.7)	193.0(78.1)	1051.3(425.4)
1971		0.2(0.1)	389.0(157.4)	8.5(3.4)	175.0(70.8)	572.7(231.7)
1972		<0.1(<0.1)	721.7(292.1)	10.0(4.0)	146.0(59.1)	877.7(355.2)
1973			211.0(85.4)	2.4(1.0)	138.7(56.1)	352.1(142.5)
1974					132.6(53.7)	132.6(53.7)
1975					110.2(44.6)	110.2(44.6)
1976					97.0(39.3)	97.0(39.3)
1977					41.0(16.6)	41.0(16.6)
1978			332.6(134.6)	3.3(1.3)		335.9(135.9)

Table 20 (continued).

	Acreages in thousands (ha)					
	Soil Bank					
Year	AR	CR	FGP	WHP	CAP	Total
1979			192.3(77.8)	2.4(1.0)		194.7(78.8)
1980						0.0
1981						0.0
1982			100.0(40.5)	3.3(1.3)		103.3(41.8)
1983			1485.4(601.1)	24.9(10.1)		1510.3(611.2)
1984			142.9(57.8)	8.4(3.4)		151.3(61.2)
1985			210.6(85.2)	13.1(5.3)		223.7(90.5)

[a] Acreage Reserve (AR), Conservation Reserve (CR), Emergency Feed Grain Program (FGP), Wheat Program (WHP). Cropland Adjustment Program (CAP).

[b] CR acreages were rounded to the nearest 100's; conversions to ha were made from the original data before rounding.

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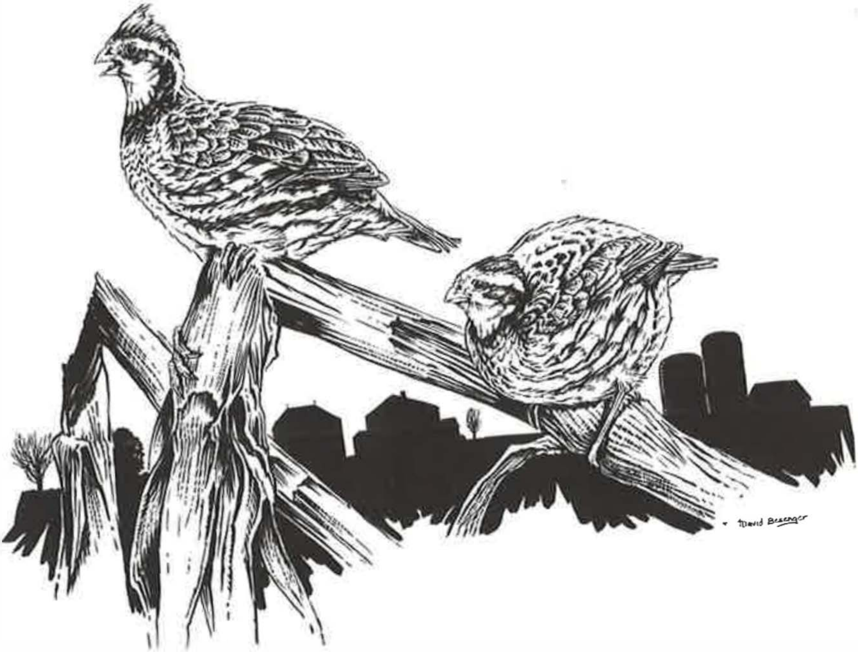

Wildlife Opportunities Within Federal Agricultural Programs

STEPHEN J. BRADY, U.S. Department of Agriculture, Soil Conservation Service, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect, Fort Collins, CO 80526-2098

REX HAMILTON, U.S. Department of Agriculture, Soil Conservation Service, Room 345, Federal Building, 100 Centennial Mall North, Lincoln, NE 68508-3866

Abstract: Impacts on wildlife habitat in agricultural regions occur as secondary effects from land-use decisions, influenced largely by federal agricultural programs. Those programs are shaped by many powerful constituencies, all having vested economic interests in the outcome of enabling legislation. Although those constituencies all nominally support provisions for wildlife, only a few receive direct economic benefits from wildlife. Here we recognize that vested wildlife interests represent a small fraction of those seeking to influence federal agricultural policy, and then identify several "windows of opportunity" where we can work within existing federal programs to achieve some of the goals of wildlife management in agricultural regions.

Key words: agricultural, federal, Food Security Act of 1985, management, wildlife

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The range of the ring-necked pheasant (*Phasianus colchicus*) in the Midwest is strongly associated with agricultural land, as recognized, for example, by Labisky et al. (1964), Edwards (1984), Warner (1984), Warner and Etter (1985, 1986), and Warner et al. (1984), and in these proceedings. Although there remain unanswered questions about pheasant behavior and ecology, there is general agreement that the primary factors determining the range within which the abundance of pheasants has fluctuated are clearly land- and land use-related. Features of agricultural land use linked to pheasant abundance include the proportion of land in rowcrops, proportion of farms classified as cash-grain farms, and the proportion of cropland in hay and small grains. Agricultural land use is influenced largely by the infrastructure that supports agribusiness—

including markets, input supplies, technology, traditions, financing, and, of course, United States Department of Agriculture (USDA) programs. Farris (1987:2), concluded "...farm legislation has a greater impact on wildlife habitat than any other human-related factor in this country, including all of our combined wildlife management efforts."

Federal farm programs impact wildlife habitat in 2 principal ways. Some programs create direct changes in land use (i.e., kinds of vegetation), while other programs result in changes in management practices and thus indirectly affect land use. Policies that involve direct changes in land use can have greater effects on habitat quality than do changes in management practices (Miranowski and Bender 1982). This is illustrated by data from Illinois (Table 1) where, during a 15-year period, there was a reported 46% decline in the harvest of farmland game attendant to a 48% increase in "cropland adequately treated" (for soil erosion control). However, the proportion of cropland used for rowcrops increased from 70% to 85% during this time. The declining harvests of rabbits, quail, and pheasants in Illinois during the period 1956 through 1982 were each significantly ($P < 0.001$) correlated with the increased planting of rowcrops (Brady 1985).

Table 1. Important cropland uses, acres (ha) of cropland adequately treated[1,2] and farmland game harvested[3] during 1967 and 1982 in Illinois.

	1967		1982		% change
Cropland	24,100,455	(9,753,320)	24,727,400	(10,007,041)	+3
Rowcrops	16,836,000	(6,813,436)	20,934,000	(8,471,874)	+24
Soybeans	6,009,000	(2,431,809)	9,270,000	(3,751,518)	+54
Hay and small grains	4,243,000	(1,717,118)	2,843,000	(1,150,546)	-33
Cropland adequately treated	8,127,295	(3,289,071)	12,020,500	(4,864,630)	+48
Farmland game harvested (summed rabbits, quail and pheasants)	4,625,000		2,475,750		-46

[1] USDA 1984.

[2] Illinois Conservation Needs Committee 1970.

[3] Ellis 1984.

Federal farm programs fall into the general categories of commodity control and income stabilization, education, conservation, and financial assistance. These programs are authorized and funded by Congress and, within legislative bounds, are managed at the discretion of the Administration via the Secretary of Agriculture. Such programs are shaped by many powerful constituencies, most of whom have vested economic interests.

While benefits for wildlife are numerous and substantial, and while most agriculture-related interests nominally support provisions for wildlife, only a few receive economic benefits from wildlife. The inability of private farm operators to capture material benefits associated with wildlife has led to implementation of agricultural practices without significant regard to program effects on wildlife (Miranowski and Bender 1982), and which Langner (1985) describes as a classic case of market failure.

Technologies are available to private landowners to maintain wildlife and fish habitat in conjunction with agricultural operations. Prior to the 1985 Farm bill, the Office of Technology Assessment (1985) concluded that a fundamental constraint to the adoption of technologies supportive of fish and wildlife on a large scale is the lack of federal commitment to assist in managing resources on private land for sustained private and public benefits. The 1985 Food Security Act (FSA) (PL 99-198), however, took resource benefits into consideration and, after passage, quickly gained the reputation of offering farms the conservation opportunity of a century. While true, not many of the opportunities within FSA for benefiting wildlife are implicitly obvious, nor do many of those responsible for administration of farm programs fully understand how those programs can be used to benefit wildlife, or what public benefits might thus be derived. Wildlife managers and other natural resource professionals need to understand federal farm programs and the politics of conservation as well as they understand the principles of ecology.

FEDERAL FARM PROGRAM PROVISIONS

The Feed Grain Program

Cropland set-asides for such commodities as wheat, corn, oats, sorghum, and barley have—since 1961—been used by USDA to influence supplies of these commodities, and to provide higher income to those who produce them. The Agricultural Stabilization and Conservation Service (ASCS) administers the Feed Grain program. Farmers can sign up for price supports if they agree to limit planting of feed grains to levels prescribed by ASCS. These levels have typically been 85-90% of full production. In 1987, farmers had the option to choose either a 20 or 35% reduction in planted feed-grain acres, with government subsidies then reflecting the amount of reduction taken. In most cases farmers had to agree to seed a vegetative cover of their choice before a deadline date. Farmer-elected county and state committees advise ASCS on local planting dates, acceptable vegetative covers, etc. In Illinois, the 1987 deadline date was June 20, and the most commonly planted cover crops were oats, timothy, or annual or biennial clovers.

Berner (1984, these Proceedings) concluded that land set aside under annual programs has a negative impact upon wildlife in general, and upon pheasants in particular. The problem is that annual programs are primarily designed for the short-term economic benefit of agribusiness interests, and fail to consider the interests of conservation and natural resources. Be that as it may, opportunities exist within the Feed Grain Program that can and should be captured for the benefit of wildlife.

The first place to start looking for wildlife opportunities in federal agricultural programs is to study program rules and to discuss with ASCS personnel and county committees what potential opportunities exist for greater benefits for wildlife. Program areas allowing potential "windows" of management opportunity include:

(1) Seeding dates.—In Illinois, for example, participating farmers can plant a cover type in Feed Grain acres as late as June 20th. This is much too late to provide nesting cover benefits.

(2) Cover type.—Farmers normally plant a cover type of their choice. The most economical and, therefore, the most popular covers are oats (*Avena sativa*), timothy (*Phleum pratense*), or clovers (*Trifolium* sp.). A mixture of oats, clover, and/or alfalfa (*Medicago sativa*) (with or without a grass) is most desirable for pheasants. Grass is important for erosion control. Oats used in conjunction with forage legumes and grasses provide quick cover, good brood habitat, and—if seeded early enough—fair nesting cover.

(3) Mowing dates.—When oats are used, they must be mowed before they reach the hard-dough stage—poor timing for wildlife. However, if the farmer is willing to pay $15 to cover the cost of an inspection, he can let the oats stand. The purpose is to prohibit harvesting commodities from land placed in the program. Non-program crops, such as clover and perennial grasses, do not necessarily have to be mowed, but weeds have to be controlled. In Illinois, the recommendation of the ASCS state committee is to mow after August 1, or set the mower sufficiently high to miss ground-nesting wildlife. However, some county committees advise farmers to mow often because unkept or weedy fields reflect poorly on the program. Decisions on mowing are left to the discretion of the farmer.

(4) Multi-year set-aside.—Under the Feed Grain Program, ASCS cannot make commitments for more than 1 year, because the program is authorized by Congress on an annual basis. However, in most recent years, there has been a feed grain set-aside. Also, it has been possible to use the same acres in consecutive years if they meet the cropping history requirement of being planted to eligible crops 2 out of the last 3 years before their enrollment in the set-aside program. Data from leading agricultural forecasters indicate that surpluses of feed grains and wheat will probably be with us into the next century (Sampson 1981). It is to the farmer's financial advantage to plan for multi-year set-asides and plant biennial or perennial vegetation, rather than seeding new acres every year.

(5) Wildlife food plots.—Food plots are permitted on set-aside acres if previously approved by the ASCS county committee. The general procedure is for a local state conservation department representative to recommend the location, crop, and size of wildlife food plots. Plots cannot be mowed, grazed, or harvested except by wildlife. In Illinois, they must remain undisturbed until March 1 of the next year. ASCS is required to spot-check each plot twice for program compliance.

Conservation Planning and Application

Soil Conservation Service (SCS) provides technical assistance in planning and application of conservation systems to conserve the resource base (soil, water, and related plant and animal resources). Assistance has been one of the mainstays of the SCS program for nearly 50 years. The objective is to apply sound resource management systems (RMS) to the land. A RMS is a combination of conservation and management practices that is compatible with site specific soil capability designations and is appropriate for the primary use of the land—practices that will protect the resource base by limiting soil losses to acceptable levels, maintaining acceptable water quality, and maintaining acceptable ecological and management levels for the selected resource use. Wildlife and fish are recognized by SCS policy as integral components of all primary land and water use systems (USDA 1983). However, the landowner must first request SCS assistance, and participation is voluntary. The landowner is the decision maker in this planning process, and it is he who decides which RMS alternatives to apply—a complete RMS, or only a single conservation practice.

While technical assistance has been available for nearly 50 years, and while great progress has been made in treating eroding cropland (Table 1), today an estimated 48% (about half) of the cropland in the Midwest still needs erosion-control treatment (Table 2). As soil-conserving measures increase, upland-wildlife habitat quality also improves (Lines and Perry 1978, Miranowski and Bender 1982). Offsite benefits from the

Table 2. Cropland Acres (ha) in 1982 in Midwestern states (USDA 1984).

State	Total cropland[1]	Needs erosion control[2]	CRP eligible[3]
	x 1000		
Illinois	24,727.4 (10,007.6)	10,617.6 (4,296.9)	3,644 (1,474.7)
Indiana	13,781.3 (5,577.2)	5,871.0 (2,376.0)	1,910 (773.0)
Iowa	26,440.7 (10,700.4)	18,170.4 (7,353.5)	7,121 (2,881.8)
Kansas	29,118.3 (11,784.0)	14,820.4 (5,997.7)	6,508 (2,633.8)
Michigan	9,443.1 (3,821.6)	3,448.0 (1,395.4)	411 (166.3)
Minnesota	23,024.1 (9,317.7)	12,125.1 (4,907.0)	1,208 (488.9)
Missouri	14,998.4 (6,069.8)	7,750.9 (3,136.7)	4,988 (2,018.6)
Nebraska	20,276.7 (8,205.9)	6,854.3 (2,773.9)	4,395 (1,778.6)
N. Dakota	27,039.2 (10,942.6)	13,581.6 (5,496.4)	1,571 (635.8)
Ohio	12,447.1 (5,037.3)	4,218.7 (1,707.3)	1,408 (569.8)
S. Dakota	16,947.2 (6,858.4)	6,846.2 (2,770.6)	1,304 (527.7)
Wisconsin	11,456.8 (4,636.5)	5,259.1 (2,128.3)	2,295 (928.8)
Total	229,700.3 (92,958.4)	109,563.3 (44,339.7)	36,763 (14,877.8)

[1] Area of all cropland (whether cultivated or not in 1982).

[2] Cropland where the soil erosion rate from wind and/or water exceeds the tolerable soil loss rate (T).

[3] Cropland that would qualify as eligible for the Conservation Reserve program.

reduction of sediment loading to aquatic habitats are also very important. While positive impacts of soil conservation practices on wildlife habitat are largely secondary (Langner 1985), it should be recognized that, if farmers are aware of the opportunities that exist in federal agricultural programs, many will implement conservation practices for the dual purposes of controlling erosion and providing wildlife habitat. As an example of multi-species wildlife benefits from good soil conservation, in Iowa 35 species of vertebrates were found using grassed backslope terraces where pheasant nesting success was 22.5%, with 1 successful nest per 12.5 acres (5 ha) of grassy cover (Beck 1982).

During the past 6 years, the Illinois Department of Conservation (IDOC) has offered free seed to farmers in the northern 60% of the state (primary pheasant range) to establish grassy vegetation on narrow-based terraces designed by SCS. Narrow-based grassy-ridge terraces are about 15 feet (4.6 m) wide, 2 feet (0.6 m) high, and are constructed across the contour on a slope of about 0.3%. The entire width is seeded to herbaceous vegetation to protect the terrace from erosion and, sometimes secondarily, to provide wildlife habitat. The increased interspersion of strips of grassy cover into rowcrop fields has other benefits which are assumed to be operable, but have not been quantitatively defined (i.e., protected access to corn stubble and waste grain). If farmers agree to manage their terraces for wildlife (delay mowing until August 1 and protect them from herbicides) the IDOC provides free seed and, in designated counties, does the planting. Are farmers interested? Definitely! Since 1981, over 600 miles of grass-ridged terraces have been planted to wildlife cover in intensively farmed Illinois pheasant range (L. M. David 1987, personal communication).

THE 1985 FARM BILL

In response to growing concerns about soil erosion, agricultural impacts on other natural resources, and surplus production of agricultural commodities, Congress included strong conservation provisions in the 1985 FSA (Title XII of PL 99-198). The FSA of 1985 did not take away the American farmer's independence, or his right to make his own decisions, but, for the first time in USDA history, a farm act required those who wished to receive program benefits to achieve minimum levels of conservation on the land from which they produced agricultural commodities. Robinson (1987) concluded that the conservation provisions in the 1985 Farm Bill could potentially do more for wildlife in agricultural America than earlier conservation programs combined were able to accomplish over the previous 30 years.

The Conservation Reserve Program (CRP)

This phase of the 1985 Farm Bill permits farmers to: (1) convert highly erodible cropland, or cropland with a history of high rates of erosion, to permanent vegetative cover; (2) receive 50% cost-sharing for establishing such cover; and (3) also receive annual rental payments for 10 years (Table 2). The national goal was to enroll 40-45 million acres (16.2-18.2 million ha) in the CRP. Of the 1985 FSA conservation provisions, CRP best facilitates conversion of cropland to permanent vegetative cover—particularly to forage grasses and legumes of great value to wildlife. Although the national goal was to plant 12.5% of the CRP land to trees, that goal is not nearly as likely to be reached in the Midwest as it is in the Southeast. Of major significance are the possible benefits of CRP to avian species identified by Graber and Graber (1983) as suffering catastrophic losses in northern and central Illinois since 1957—at least partially as a result of the loss of grassland nesting cover. These species include the upland sandpiper (*Bartramia longicauda*), bobolink (*Dolichonyx oryzivorus*), meadowlark (*Sturnella magna*), and dickcissel (*Spiza ameri-*

cana), as well as grasshopper (*Ammodramus savannarum*), savannah (*Passerculus sandwichensis*), and Henslow's sparrows (*A. henslowii*).

Highly Erodible Land (HEL)

This conservation provision of the FSA has 2 parts that have received the nicknames of "Sodbuster" and "Conservation Compliance." Both refer to lands defined as highly erodible. Factors from the universal soil loss equation (Wischmeier and Smith 1978) are used to calculate an erosion index for identifying HEL. If the HEL was in permanent vegetative cover during the 1981-1985 crop years, it is subject to "sodbuster" rules. In order to maintain eligibility for USDA program benefits under HEL, a farmer must have an approved conservation plan applied to sodbusted land before he uses that land to produce an agricultural commodity. The SCS and local soil and water conservation districts (SWCD) have approval authority for conservation plans for HEL. The distribution of HEL in the Midwest having the potential to be sodbusted is summarized in Table 3.

Conservation compliance regulations apply to HEL that produced an

Table 3. Acres (ha) of land in the Midwest with potential to be subject to Conservation Compliance, Sodbuster, and Swampbuster (USDA 1984).

State	HEL cropland[1]	HEL with sodbusting potential[2]	Wetlands with potential for conversion[3]
	x 1000		
Illinois	4,108.8 (1,662.8)	2,229.3 (902.2)	103.4 (41.8)
Indiana	2,203.2 (891.6)	1,836.3 (743.1)	45.0 (18.2)
Iowa	8,214.8 (3,324.5)	2,704.3 (1,094.4)	27.3 (11.0)
Kansas	10,594.6 (4,287.6)	5,665.2 (2,292.7)	1.2 (0.5)
Michigan	617.8 (250.0)	1,902.4 (769.9)	224.6 (90.9)
Minnesota	1,636.1 (662.1)	1,721.7 (698.8)	393.9 (159.4)
Missouri	6,298.9 (2,549.1)	8,161.9 (3,303.1)	27.3 (11.0)
Nebraska	6,632.2 (2,684.0)	12,853.5 (5,201.7)	156.3 (63.2)
N. Dakota	2,271.5 (919.3)	3,317.5 (1,342.6)	298.2 (120.7)
Ohio	2,347.7 (950.1)	3,064.8 (1,240.3)	169.3 (68.5)
S. Dakota	1,703.4 (689.4)	6,383.1 (2,583.2)	98.0 (39.7)
Wisconsin	3,421.8 (1,384.8)	3,179.0 (1,286.5)	122.6 (49.6)
Total	50,050.8 (20,255.3)	53,019.0 (21,456.5)	1,667.1 (674.7)

[1] Highly erodible cropland that is subject to conservation compliance.
[2] Highly erodible agricultural land with potential for conversion to cropland.
[3] Wetlands with medium or high potential for conversion to cropland.

agricultural commodity anytime during the 1981-1985 crop years. In such cases, a farmer must have an approved conservation plan before 1990, must be actively applying that plan, and the plan must be completely applied by 1995. If the farmer should fail to meet that schedule he is in jeopardy of losing USDA farm program benefits. Table 3 summarizes the distribution of highly erodible cropland in each of the midwestern states. Although 48% of Midwest cropland needs treatment for erosion control, only 22% of the cropland is defined as HEL. Thus, conservation compliance will potentially impact only lands having the worst erosion hazards. However, it has been estimated that nearly half of the soil erosion on cropland comes from only 10% of the land (USDA 1984); thus, HEL is potentially significant for wildlife.

Wetlands Conservation

"Swampbuster"—the wetlands conservation portion of the FSA—operates to protect wetlands by denying USDA farm program benefits to anyone who produces agricultural commodities on wetlands converted to cropland after December 23, 1985. Table 3 summarizes the area of wetlands vulnerable to drainage. Swampbuster will protect wetlands as long as farmers remain enrolled in USDA programs.

Relation to Pheasants

What do the conservation provisions of the FSA mean to pheasants and other farm-related wildlife? In total, the FSA has been projected to reduce the U.S. grain area by roughly 1/7th by 1990 (Brown 1987). Land retired to permanent cover with nonintensive uses (such as CRP) has the potential to provide great dividends for wildlife. However, if the HEL is devoted to uses such as hay production or managed pasture, little benefit to wildlife will accrue. Robinson (1987) expressed concern about SCS completing all of the additional work generated by the FSA, but with a possible reduction in the quality of conservation work accomplished.

More than at any other time in recent years, SCS field offices can use the assistance of other natural resource professionals, and especially that of wildlife biologists from related conservation agencies. Help is much needed to assist in applying ecologically sound conservation treatment to the land. McConnell (1981) pointed out that integrated natural resource programs are more successful, and outlined a coordinated program for integrated systems management on privately owned land. It is time for all conservationists to work cooperatively to conserve the total resource base.

PROGRAM INTEGRATION

Karr (1981) voiced the general view that attainment of the Clean Water Act and soil conservation objectives will automatically help improve the status of fish and wildlife and their habitats on private lands. The 1985 FSA provides a vehicle for attaining conservation-oriented objectives—provided that both governmental agencies and private organizations are sufficiently interested in fish and wildlife conservation to capitalize on this opportunity and make fish and wildlife a real concern in FSA programs.

The spirit of cooperation in wildlife conservation has never appeared stronger than it does today. Faced with seemingly insurmountable problems that have for so long adversely affected wildlife on agricultural lands, state fish and wildlife departments are starting to turn to other public agencies and to private organizations who have money, expertise, or access to landowners. Concern for dwindling wildlife resources has also brought about a proliferation of private organizations, typified by Pheasants Forever and Quail Unlimited, both of which mobilize sportsmen at local, state, and national levels to devote their money, time, and influence to the welfare and management of wildlife. Both emphasize habitat, conservation education, and agency cooperation and both are staffed by trained wildlife managers experienced in working with governmental agencies. Citizen consttuency groups are willing (anxious in fact) to combine their efforts with those of government agencies. Although young, Pheasants Forever is now assuming an active role in providing pheasant habitat throughout the Midwest (Wooley et al. these Proceedings). Cooperation among agencies and with citizen constituency groups has resulted in a number of innovative program integrations designed to capitalize on the "windows of opportunity": (1) names of potential cooperators (private land-users), as indicated by requests for technical assistance, are shared by appropriate referrals; (2) standards and specifications for conservation practices are prepared jointly; (3) technology and training are shared; and (4) public information and education activities are made complementary and, thus, mutually beneficial.

Some states have made more progress than others in the development of joint program activities. Missouri, Illinois, and Wisconsin are noteworthy in this respect. Probably the most fully coordinated statewide program has evolved in Missouri. Both the Missouri Department of Conservation (MDC) and the Soil Conservation Service (SCS) believe that erosion control and wildlife habitat improvement can successfully be integrated. Consequently, MDC has embarked upon a series of cooperative activities designed to accomplish these dual objectives. As a consequence, an agricultural liaison position was staffed, and 2 demonstration farms were established. The Missouri Private Lands Program of habitat development was restructured and expanded, and MDC biologists were placed in each SCS area office on a permanent basis, with increased interagency cooperation the result.

Activities favorable to wildlife in Missouri have been facilitated by development of the Wildlife Habitat Appraisal Guide (WHAG) which uses habitat suitability models to index local habitat quality for selected wildlife species. The WHAG was developed jointly by MDC and SCS (Urich et al. 1984). It has been used to appraise habitat conditions in day-to-day planning activities on private land, to monitor the extent of erosion control systems on wildlife habitat quality in targeted areas, to prepare area and statewide management plans, and to evaluate the effectiveness of MDC's private lands program.

Recent cooperative accomplishments by MDC and SCS have led to better utilization throughout Missouri of wildlife opportunities that previously existed in USDA programs. Increased conservation planning has resulted from the sodbuster and conservation compliance provisions of the FSA, and MDC biologists are now in a better position to ensure that habitat needs are considered. Training and assistance for wildlife management are given to SCS field personnel, and slide sets that explain wildlife habitat needs are available for use in planning sessions with landowners. The MDC has also arranged with ASCS to provide, through SWCD's, additional cost-share money to encourage establishment of warm-season (prairie) grasses, to plant trees, and to institute wildlife management on CRP lands.

Another example of effective integration of programs by state and federal agencies is the Dodge County, Wisconsin, Interagency Project to Enhance Wildlife Habitat on Farm Lands (Frank 1985). Cooperating agencies in this project are the Wisconsin Department of Natural Resources, SCS, ASCS, University of Wisconsin Extension, USDI, Fish and Wildlife Service, and the Wisconsin Department of Agriculture. The objectives are to reduce costs of agricultural production, and to use cost-sharing and incentive payments to achieve multiple natural resource conservation objectives that include improving wildlife habitat and reducing runoff and soil erosion. Few significant opportunities to benefit Wisconsin wildlife have been overlooked. Incentive payments are offered to landowners for establishing no-till winter wheat and warm-season grass pastures, leaving unharvested corn strips, delaying the mowing of grassed waterways, and converting poorly drained and erodible cropland to perennial cover. Cost-sharing is available to establish conservation practices. Participation in the Water Bank Program is encouraged. Finally, a $1 per acre payment is made to farmers who provide hunters access to their land. In Wisconsin, interagency coordination and persistence yield multiple resource benefits.

Illinois, too, is effectively integrating wildlife with agricultural programs. In 1986, the Private Lands Wildlife Habitat Management Program was initiated. A coordinator, 12 Private Lands Biologists, and 2 technicians were hired to work specifically with private landowners in planning and applying habitat management practices, many of which must complement USDA farm programs. Interagency agreement was obtained in developing specifications for CRP that provided 28 choices of seed mixtures, but eliminated forages—fescue, for example—considered to provide poor wildlife habitat. Much effort is being spent to determine ways to complement local farm programs, such as supplying farmers with seed specific to the development of pheasant habitats on their set-aside acres, planting food plots on set-aside acres, and working with ASCS county committees to identify additional opportunities to provide wildlife habitat.

RECOMMENDATIONS

(1) Federal farm programs should be rewritten to be fully compatible with environmental concerns including water quality, soil erosion, sedimentation, and fish and wildlife habitat, and still recognize the very real economic concerns of both individual farmers and society at large. However, within the existing structures of federal farm programs, opportunities exist for improvement of wildlife habitat.

(2) Agricultural interest groups and agencies, such as ASCS county committees, SWCD's, county extension councils, ASCS, SCS, and the Cooperative Extension Service typically prepare annual work plans. Biologists should become acquainted with the people in these county groups, and with the factors that determine the scope of their plans. It is important to discuss with these agency people how others can support their efforts and, afterwards, what they can do to support the efforts of biologists. This is the Golden Rule, but professional wildlife managers must take the first steps.

(3) Wildlife managers should work directly with ASCS county committees to be sure that options for wildlife habitat management receive full consideration in individual county programs. Wildlife managers should also be prepared to encourage farmers to plan for multi-year set-asides, plant cover early in spring, plant perennial cover of preferred wildlife habitat value, delay mowing until after the nesting season, and seed food plots in strategic locations.

(4) When options supportive of wildlife become available, farmers

must be made aware of those options. ASCS regularly sends out information to all program participants, and ASCS offices are often willing to let the biologist assigned to a county submit written articles for local distribution. Articles should be handy, short, timely, and to the point.

(5) SCS and SWCD's have the responsibility to plan 50,000,000 acres (20,000,000 ha) of HEL before 1990. Thus, their current workloads are so great that most SWCD's will sponsor a series of group planning sessions. A 15-minute presentation with a handout describing how wildlife management and soil conservation practices can be complementary will usually be well received at such meetings. Missouri has an excellent brief presentation that features bobwhite quail and common farming practices.

(6) Supplemental cost-sharing, or providing desirable seed for CRP, helps farmers select seed mixtures that will provide multi-resource benefits. Supplemental cost-sharing must be non-federal, but money from state agency programs and organizations such as Pheasants Forever often may be available.

The above recommendations are directed largely at state or federal agency employed wildlife managers. However—and often more effective—are knowledgeable sportsmen constituents of the various farm programs—farmers themselves. Farmers, sportsmen, and organized sportsmens' groups often have deeper insight into the socio-political side of farm programs and can do and say things, and influence people beyond what public-employed professionals can do, say, or influence—especially if wildlife professionals provide the facts. The secret is cooperation.

In 1931, Aldo Leopold was the principal author of the Game Policy developed for the American Game Conference. That still appropriate policy states: "In short, make game management a partnership enterprise to which the landowner, the sportsman and the public each contribute appropriate services, and from which each derives appropriate support" (Leopold et al. [in] Meine 1987).

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5

The Dynamics of Pheasant Abundance During the Transition to Intensive Row-Cropping in Illinois

STANLEY L. ETTER[1], Illinois Natural History Survey, Champaign IL 61820

RICHARD E. WARNER, Illinois Natural History Survey, Champaign IL 61820

G. BLAIR JOSELYN, Minnesota Department of Natural Resources, St. Paul, MN 55100

JOHN E. WARNOCK, Western Illinois University, Macomb, IL 61455

Abstract: Survival of wild ring-necked pheasants *(Phasianus colchicus)* in east-central Illinois was studied during 1962-1972 —a period of abrupt change in agriculture and declining pheasant abundance. During the phase-out of the Federal Feed Grain Program of the 1960's, increasing farm disturbances and reduced interspersion of prime cover types rendered the fall-winter landscape less hospitable for pheasants. In general, pheasants were found to have variable year-to-year patterns of survival and reproduction, reflecting complex interactions of weather, characteristics of cover, farming practices, and pheasant movements. Dispersal was similar between age classes. However, fall-to-early winter survival of juvenile hens was typically only one-half to two-thirds that of adult hens. Differential survival between juvenile and adult hens was confined to fall and early winter. For a juvenile hen, the later the date of hatch, the lower its probability of survival from autumn into winter. Likelihood of survival was not a simple function of physiological condition as expressed by body weight, but apparently related to how pheasants responded to changing weather and farming disturbances in fall, with older, relatively experienced birds more likely to cope with these changes. Had juvenile hens survived as well as adults, numbers of pheasants in winter would have been nearly one-third higher.

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[1] Present address: Illinois Department of Conservation, Gibson City, IL 60936.

Key words: abundance, ecology, land use, mortality, pheasant, population, regulation, ring-necked, survival

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Following World War II, the combination of new agricultural technologies and public policies converged to foster more intense land use. By the mid-1980's, these forces had drastically reduced pheasant population levels over much of the traditional prime range in the Midwest. Some of these changes (for example, emerging row-cropping technologies) were gradual, and took several years before their effects were clear (Warner and Etter 1986). Other changes, in programs of cropland diversion, for example, precipitated quite rapid changes in pheasant distribution and abundance (Edwards 1984, Dahlgren these Proceedings).

The Sibley Study Area (SSA) in east-central Illinois has provided a background for pheasant research for 4 decades. Farmers on the area have been early adopters of emerging agricultural technologies. However, changing farm practices have not always appeared negative in the short term. For example, during 1955-60, row-crop plantings expanded to include an additional 20% of the farmland on the SSA, as oats and rotation hay diminished. Pheasant numbers in late winter increased from 62/section in 1957 to 89 in 1960 (minimal counts from a fixed-wing aircraft) (Labisky 1968a).

Numbers of pheasants on the SSA peaked during 1961-63, in association with set-aside and conserving acres portions of the Federal Feed Grain Program (Fig. 1). Because of relatively high corn bases and intensive cultivation on the area by the late 1950's, responses by pheasants to farm programs that diverted land from production of row crops—and into small grains, grasses, and legumes—may have been more pronounced in the SSA than for much of the mid-continental pheasant range. As the Feed Grain Program faded on the SSA in the mid 1960's, a new era emerged, with more intensive row-cropping that supplanted "diverted acres" and much of the remaining livestock and rotation farming. These changes set the stage for patterns of pheasant abundance that have extended well into the 1980's (Warner and Etter 1986). In hindsight, pheasants clearly benefited from the "safe" nesting cover present during this era.

Work in Illinois and elsewhere in the late 1950's and early 1960's emphasized nesting and the significance of year-to-year variations in reproduction and survival during the nesting season (Joselyn and Warnock 1964, Gates and Ostrom 1966, Edwards 1984, Warner and Etter 1986). The obvious conclusion was that establishing undisturbed nesting cover should be a management priority (Joselyn et al. 1968).

Impacts of diminished availability of cover provided by hay and oats

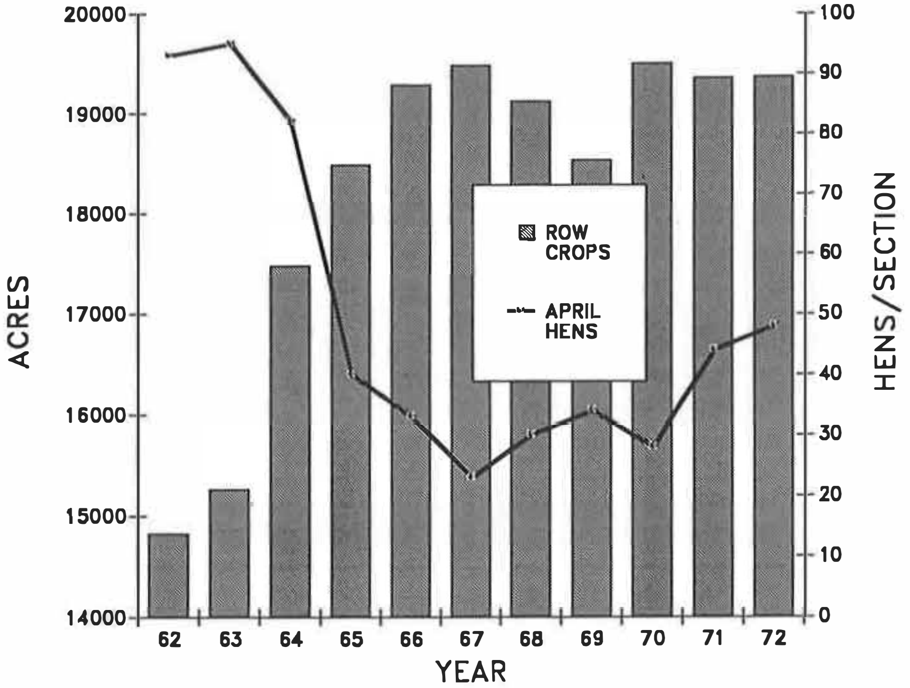

Fig. 1. Trends in row crop plantings and hen pheasant abundance on the Sibley Study Area, 1962-1972 (after Warner et al. 1987).

were not limited to the nesting season. For example, as prime brood foraging habitats disappeared in the decades following World War II, chick survival from hatch to early autumn declined significantly (Warner et al. 1984). Further, as set-aside fields were planted to crops in the mid-and late-1960's, nest densities in roadsides were consistently high, whereas nest densities in remaining hay fields declined abruptly (Warner et al. 1987).

Thus, we need to look beyond the effects of changing land use on pheasant reproduction. Our objective is to portray the complex nature of interactions between pheasants and their environment during a transition to what has become "conventional" row-crop farming in the Corn Belt. In this vein, we infer how the gradual dismantling of key habitat components on fall and winter landscapes has affected pheasant survival. Using original data from over 3,500 wild pheasants captured, marked, and observed on the SSA in the 1960's and early 1970's, we present trends in survival from fall through spring. Emphasis is on relative survival among sex and age classes. Dispersal was important during fall and winter. However, rates of dispersal on the SSA were found to be essentially the same for juvenile and older hens; further, except for 1 year, there is no reason to conclude that egress exceeded ingress (Etter unpublished data).

METHODS

The Study Area

Studies of wild pheasants reported here were conducted from 1962 through 1972 on the 23,200-acre (9,393-ha) SSA in Ford and McLean counties in east-central Illinois. The area has deep, dark, nearly flat prairie soils developed in loess over calcarious Wisconsinian glacial till. The mean annual temperature is about 51°F (11°C), with annual precipitation of 34 in. (86 cm) (Joselyn et al. 1968, Labisky 1968a, Warner et al. 1987). Land use was monitored seasonally. Aerial photographs were used to record field boundaries, cropping patterns, and field disturbances. For purposes of capturing and marking birds the area was subdivided into 3 sectors. These included the central 4 General Land Office sections (259 ha/section), the intermediate 12 sections surrounding the central portion, and the perimeter 20 sections surrounding the intermediate area.

Capture Sequences and Observations

Pheasants were captured by night-lighting (Labisky 1968b) during fall (18 September-14 November, 1962-1970) and winter (6 January-22 February, 1962-1966). Captured birds were leg-banded, and those >7 weeks of age or >454 g were also marked with back tags for individual identification (Labisky and Mann 1962). Age classes were determined by bursa depth, using a criterion of ≤ 8 mm for adults. Dates of hatch for juveniles were estimated to the nearest week by measuring the most recently molted primary (Etter et al. 1970).

Under conditions of complete snow cover, pheasants were counted by helicopter at 7-25 m altitudes on 27-28 February 1963, and 5 March 1965. Findings from aerial counts were substantiated by ground-based reconnaissance preceding aerial work—totaling 95 + hours in 1963 and 160+ hours in 1965—and by counts from vehicles conducted concurrently with helicopter censuses. Post-hunt counts for sex ratios were obtained by ground surveys when there was snow cover; sex ratios were based on cumulative counts of 5,742, 4,369, 7,925, and 617 pheasants observed in late winters, 1963-66, respectively, and were corrected for illegal hen kill from fluoroscopy data for ratios of live cocks:hens carrying shot (Edwards 1962).

Analyses of Survival

Fall and winter survival rates were based upon marked pheasants known alive at 1 January each year; i.e., we used observation rates to infer survival rates. Classifications of birds known dead or alive for a given period were established from (1) live birds viewed using binoculars and spotting scopes from vehicles in winter and spring and (2) documented mortalities (for example, hen carcasses encountered during nest searches, road-killed specimens, and birds examined during systematic surveys of hunters).

Regression models of covariance (ANOVA and MANOVA; Nie et al. 1975) were employed to analyze survival within age classes. Main effects in the models were capture site (central, intermediate, or perimeter) and year. Covariates included, for juveniles, weight and age at capture, as well as date of hatch; and, for adults, weight and molt stage at capture, and date of molt initiation.

FINDINGS

Land Use and Pheasant Abundance

Table 1 reflects the rapid transition to intensive row-crop farming that occurred on the SSA during the early 1960's. Land planted in hay and small grains declined about 60% from 1962 to 1965. By 1965, nearly 80% of the SSA was planted to corn or soybeans. By the mid-1960's, prime cover types, such as hay and small grains, had become greatly reduced, but the decline in grassy cover was not uniform over the area. Some farms moved exclusively into row-crops, while others continued to produce both cash grains and forage crops. The interspersion of critical cover types for pheasants was nonetheless dramatically reduced as plantings of corn and soybeans expanded (Fig. 2). From 1962 to 1965, the number of quarter-sections with at least 1 hay and 1 small-grain field declined from 75 to 28.

Fall and Winter Landscapes

Crop harvest constituted a dramatic change in the fall landscape. From 1962 through 1965, 80, 85, 85, and 66%, respectively, of the corn

Table 1. Land use on the Sibley Study Area, 1962-1965.

Cover type	Percent of land area			
	1962	1963	1964	1965
Growing Season				
Permanent[a]	8.1	8.1	7.9	7.8
Corn	41.8	45.4	54.7	54.5
Soybeans	22.1	20.5	20.7	25.3
Small grains (SG)	14.9	13.9	8.4	6.4
Hay[b]	12.1	11.4	7.1	5.3
Hog pasture	1.0	0.7	1.1	0.7
Miscellaneous[c]	0	0	<0.1	<0.1
Subsequent fall-winter				
Plowing	51.5	56.1	62.6	55.3
Crop stubble				
Corn	19.7	19.0	17.6	25.9
Hay and SG	14.4	12.5	8.7	6.4
Soybeans	6.3	4.3	3.2	4.6

[a] Includes road and railroad rights-of-way, drainage ditch banks, and miscellaneous ungrazed grasses and forbs.

[b] Forage crops including hay and rotation hay pasture.

[c] Primarily sudan grass.

crop was harvested in Ford and surrounding counties during the 7-week period from 6 October to 10 November (Illinois Department of Agriculture). Harvests progressed even more rapidly over more localized areas (Etter unpublished data). Over the period 1962-72, about 1/3 of the SSA typically provided winter cover considered to be of at least some value to pheasants, although <2% of the area was in permanent cover. However, the amount of hay and small-grain stubble (with emergent legumes) present during winter declined progressively over the early 1960's (Table 1, Figs. 1 and 2). Due to expanding row-crop production, corn stubble actually increased moderately in the mid-1960's. Fall plowing typically occurred on 50-60% of the area.

Numbers of pheasants on the SSA declined sharply after 1963 (Fig. 1). This decline occurred in consort with the phase-out of cropland diversion, reduction of livestock numbers, and increased production of row crops. Approximately 3,400 pheasant hens were present on the area in late winter of 1963, by late winter, 1965, the number of hens on the area had declined to about 1,100. Thus, the phase-out of diverted acres and reductions in small grain stubble and other grasslands were primary forms of environmental change on the SSA in the mid-1960's. The question, however, is how did these changes affect mortality, natality, and dispersal of local pheasants?

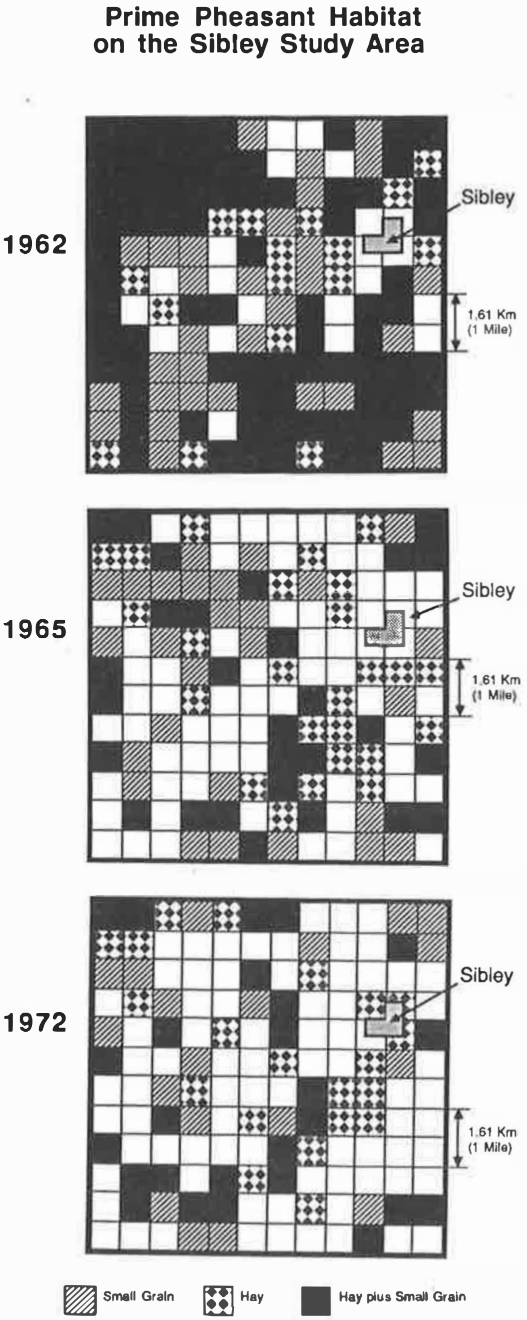

Fig. 2. The dispersion of rotation hay and small grain fields throughout quarter-sections on the Sibley Study Area during the growing seasons of 1962 and 1965.

Hen Age Ratios and Relative Survival Rates

The ratio of juvenile to adult hens among captured pheasants was higher in fall than in the following winter each year 1962-65. A higher ($P<0.05$) rate of survival of adults compared to juveniles was indicated from capture data (Table 2) and subsequent tag observations (Table 3). The survival of juvenile hens relative to adults averaged 51%, based on capture data, and 64% from tag observations. Trends in year-to-year differences in relative survival were similar for the 2 estimates (Tables 2 and 3).

The lower relative survival rate of juvenile hens during fall was not evident after early winter (Table 3). For example, age ratios of hens observed alive each spring, 1962-66, were unchanged ($P>0.05$) from those observed during the previous winter (Table 4). Known winter-to-winter survival rates for both age classes averaged 24% during 1963-64 and 1964-65 (Table 5). Although rates of winter-to-spring and winter-to-winter survival rates were similar for the 2 hen age-classes, body weights were different; mean weights of adult hens captured in January and February, 1962-66, were heavier (1,012 + -91g [$\bar{x}$ + -SE], $N = 454$) than for juveniles (964 + -80g, $N = 464$) ($P<0.05$).

Table 2. Numbers of juvenile hens/adult hen for wild pheasants captured in fall and winter, Sibley Study Area, 1962-63 through 1965-66.

	Juveniles:adult			
Year	**Fall**	**Winter**	***z*-score**[a]	**Relative survival**[b]
1962[c]	2.58 (1,074)[d]	1.33 (350)	5.71*	52%
1963	1.72 (598)	0.97 (134)	2.98*	56%
1964	1.51 (301)	0.63 (132)	4.13*	42%
1965	1.61 (245)	0.91 (84)	2.24	57%
Mean	2.02	1.04		51%
Juveniles % ± SE	67.1 ± 1	51.0 ± 2		

*$P < 0.05$.

[a] *z*-scores for the proportion of the population juvenile in the fall and winter (Glass and Stanley 1970).

[b] Relative survival, fall-to-winter, juvenile hens as compared with adult hens.

[c] Refers to the calendar year at the beginning of fall trapping; winter captures extended into the following calendar year.

[d] Sample sizes, n = total hens of both age classes.

Table 3. Numbers of fall-tagged juvenile hens/adult hen for wild pheasants observed alive the following winter, Sibley Study Area, 1962-63 through 1965-66.

	Juveniles:adult			
Year	**Fall**	**Winter**	***z*-score**[a]	**Relative survival**[b]
1962[c]	2.58 (1,052)[d]	1.60 (343)	3.67*	62%
1963	1.71 (590)	1.12 (194)	2.95	66%
1964	1.53 (291)	0.89 (85)	2.20*	58%
1965	1.57 (229)	1.12 (68)	1.21	71%
Mean	2.02	1.30		64%
Juveniles				
% ± SE	67.3 ± 1	56.9 ± 2		

*$P < 0.05$.

[a] *z*-scores for the proportion of the population juvenile in the fall and winter (Glass and Stanley 1970).

[b] Relative survival, fall-to-winter, juvenile hens as compared with adult hens.

[c] Refers to the calendar year at the beginning of fall trapping; winter captures extended into the following calendar year.

[d] Sample sizes, n = total hens of both age classes.

Table 4. Numbers of juvenile hens/adult hen for wild pheasants observed alive in winter (January-March) and the following spring (April-June), Sibley Study Area, 1962-66.

		Juveniles:adult	
Year Winter	**Spring**	**z-score**[a]	
1962	1.42 (121)[b]	1.26 (86)	0.42
1963	1.80 (230)	1.75 (283)	0.19
1964	1.09 (192)	1.04 (110)	0.20
1965	0.57 (138)	0.50 (30)	0.30
1966	0.75 (49)	0.78 (64)	0.10
Mean	1.15	1.28	
Juveniles			
% ± SE	53.0 ± 2	56.2 ± 2	

[a] z-scores for the proportion of the population juvenile in fall and winter (Glass and Stanley 1970).

[b] Sample sizes (n = totally individually identified hens); an individual hen may be reported in both seasons, but only once/season.

Table 5. Known winter-to-winter survival of adult (A) and juvenile (J) hen pheasants, Sibley Study Area, 1963-64 through 1964-65.

		Hens known alive		
Year	**Age**	**1st winter**	**2nd winter**	**Survival (%)**
1963-64	A	209	55	26
1964-65	A	243	53	22
	Total	452	108	24
1963-64	J	290	57	20
1964-65	J	152	47	31
	Total	442	104	24

Factors Related to Hen Survival

From the analysis of covariance model (Table 6), we infer that survival of juvenile hens was not related to weight, but was negatively related (P<0.05) to age at capture and date of hatch, i.e., earlier-hatched hens had higher rates of survival, with date of hatch the more important

Table 6. Analysis of covariance for factors related to observation rates of juvenile hen pheasants captured on the Sibley Study Area during fall, 1962-65[a].

Source of variation	df	SS	MS	F-value
Covariates	3	4.011	1.337	6.991**
Age at capture	1	0.790	0.790	4.133*
Date of hatch	1	2.347	2.347	12.270**
Weight at capture	1	0.048	0.048	0.249
Main effects	5	2.943	0.589	3.078**
Capture sector[b]	2	1.779	0.889	4.650**
Year	3	0.221	0.074	0.387
Interactions	6	1.386	0.231	1.208
Area *x* year	6	1.386	0.231	1.208
Explained	14	11.051	0.789	4.128*
Residual	1,428	273.084	0.191	
Total	1,442	284.134	0.197	

*$P < 0.05$, and ** for $P < 0.01$.

[a] Hens were captured and back-tagged from 1 October-11 November annually, n = 1,443 for total captured and tagged.

[b] Birds were categorized as having been captured either in the central 4 general land office sections, the intermediate 12 sections surrounding the central portion, or the perimeter 20 sections surrounding the intermediate portion.

covariate. In addition, pheasants captured in closer proximity to the border of the study area had a lower probability ($P<0.01$) of subsequent observation than that for birds captured and marked closer to the center of the area—a difference attributed to dispersal off the study area.

Hens hatching late in the nesting season exhibited lower survival rates during fall. A multiple regression analysis of the rates at which various hatch classes were observed after 1 January indicated that the observation rate declined about 3% for each week of progression of the nesting season, i.e., on average, 3% fewer of the hens hatched the fourth week of June and known alive in October were subsequently observed in winter, as compared to hens hatched the third week of June. Thus, young-of-the-year hens hatching in early spring approached the estimated 80% fall-to-winter survival rate calculated for adult hens, whereas those hatched in July had far lower rates of survival.

Analysis of covariance of fall-to-winter observation data for adult hens indicated that weight, date of molt initiation, and molt stage when captured had no significant effect on survival. Sites of capture were, however, also important ($P<0.05$) for adults, with highest rates of observation for hens captured in the interior, and lowest rates near the perimeter of the area. Observation rates were not different among years for either age class.

Factors Related to Cock Survival

Analysis of covariance of observation rates for juvenile cocks that survived hunting (of fall-tagged cocks after allowance for those known shot), also suggested a higher probability of survival for those hatched earlier ($0.05<P<0.10$). However, analysis of observation rates of those juvenile cocks known to be alive at the onset of hunting (1962-64)—typically only 4 weeks after capture—did not implicate any of the variables listed in Table 6 as affecting survival.

After correction for incidental killing of hens, and crippling loss, sex-ratio data for 1962-64 indicated that an estimated 64% of the adult and 74% of the juvenile cocks were shot; thus, on average, juvenile cocks were roughly 16% more vulnerable to hunting than adult cocks. Hunter-returned tags ($N=1{,}267$) during these same years indicated an approximately 13% higher rate of kill of juveniles compared to adults. During 1965-70, when pheasants were less abundant and there were fewer hunters, tag returns ($N=670$) were 8% higher for juvenile than for adult cocks.

Thus, given the smaller sample sizes, and with allowances made for hunting-related losses, differential mortality of young vs. adult cocks during fall and early winter appeared similar to that observed for juvenile vs. adult hens. A mean fall ratio of 7.7 juveniles/adult cock was estimated by correcting the data for rates of hunter kill. Comparing this figure with the observed winter age-ratio of 4.0 juveniles/adult cock suggested a 52% rate of relative fall-to-winter survival for juvenile cocks, compared to the 51% relative survival rates calculated from capture data for juvenile hens.

DISCUSSION

Long-Term Patterns of Pheasant Survival and Land Use

The late 1950's and early 1960's were characterized by substantial increases in abundance that led to peak numbers of pheasants documented during this long-term study (Fig. 1). Relative survival rates were high during the late 1950's and early 1960's, as were winter age-ratios (Labisky 1962, unpublished Job Completion Report W-66-R-2, Labisky and Jackson 1969:720). Conditions favorable to high rates of survival occurred during an era when only about 30% of the area was moldboard-plowed in the fall (Labisky 1968a) and nesting and roosting cover on the area were well dispersed (Fig. 2). By the mid-1960's, fall plowing disturbed twice as much of the autumn landscape on the SSA as it had earlier (Table 1), and nesting and roosting cover had become poorly dispersed.

After their precipitous decline of the early 1960's, pheasant numbers on the SSA exhibited less pronounced fluctuations from 1966 through 1971, and a trend toward modest increases (Fig. 1, Warner et al. 1987). Observations of 88 of 601 hens of both ages tagged over the period 1967-68 through 1970-71, however, again indicated a 52% relative survival rate from fall to winter—no different (P>0.05, Table 2) than that for 1962-65.

In general, the lower relative survival of juvenile females during fall (Table 3) had an important bearing on the demography of pheasants on the SSA. We estimate that there would have been nearly ⅓ more hens on the area each winter had juveniles survived at the same rate as adults. This estimate assumes that 80% of the adult hens survived to winter (based on seasonal apportionment of a 36% winter-to-winter survival rate as indicated by 1963 and 1965 helicopter counts and winter age ratios), and a relative survival rate of 64% for juvenile hens (Table 3).

Relative survival rates for juveniles from the late 1950's through early 1970's, taken together, suggest that negative environmental conditions in fall and winter depress the survival of pheasants of all age classes, with young-of-the-year being particularly vulnerable. As the juvenile cohort comprises the major fraction of the fall population, we conclude that numerical upswings must, in part, be the result of environmental conditions favoring above-average survival, especially for young-of-the-year, during fall and winter.

A Scenario for the Decline in Pheasant Numbers During the Period of Agricultural Transition of the 1960's

The interplay of weather, land use, and responses by pheasants to their environment was complex on the SSA during the transition period of the early to mid-1960's. The reproductive season of 1962 was unusually favorable, and included a relatively late median mowing date for hay (25 June); favorable nesting conditions led to a high juvenile-to-adult ratio in fall (Table 2). The rate of fall-to-winter survival of hens during 1962-63, however, was probably lower than average, and at least in part reflective of the large juvenile cohort.

The effect of the large numbers of juvenile hens produced in 1962 could also be seen during the 1963 breeding season—the beginning of a major numerical decline. Mortality of hens from hay mowing in 1963 was high (median mowing date of 18 June), and the percentage of surviving hens with broods was low, in part a consequence of the relatively shorter time span during which younger pheasants nest (unpublished data). Fall and winter of 1963-64 were uneventful. Numbers of pheasants present in spring 1964, to some extent reflected the poor nesting season in 1963.

The spring and summer of 1964, however, led to some of the most intriguing events that comprised the pheasant decline of the 1960's. During that era, about 44% of the SSA—the Sibley Estate—was operated under the direction of a single farm manager (Labisky 1968a). All of the estate-owned land went out of the Feed Grain Program in 1964, with many fields of prime nest habitat provided on program-diverted acres plowed and planted to crops in April and May of that spring. It appears that an unusually large number of hens present on the area in fall and winter subsequently nested off the area that spring. Dispersal from the area in spring 1964 was apparently high due to destruction or lack of available nesting cover.

Further, a drought in the spring of 1964 persisted well into the summer and resulted in poor-quality nesting cover, low nest success (Warner et al. 1987), and considerable late nesting and late (August)-hatched young. Mowing of hay (median date of 10 June) was early, and regrowth slow. In 1964, nest densities in small grains were at a record high, and there was presumably more-than-average late nesting in row crops (Joselyn and Warnock 1964). As a consequence, low nest success, small brood size, and poor fall-winter survival all contributed to a crash in pheasant numbers in 1964 (Fig. 1).

In late February of 1965, a snow storm brought the worst winter-related mortality of the decade. Although weather conditions were relatively uneventful for the rest of 1965 and 1966, nest densities in hay declined both years (Warner et al. 1987). Diminished quality of habitat, including increasing fragmentation of prime roosting and nesting cover, was evident through the mid-1960's and prolonged the era of declining numbers of pheasants (Fig. 2).

Responses by Pheasants to Environmental Disturbances

For hens, the negative relationship between juvenile survival and date of hatch noted here and in previous works (Stokes 1954, Mallette and Harper 1964, Gates 1971, Greenberg et al. 1972), indicates that older birds are more able to cope with environmental changes that occur from autumn to early winter. Pheasant survival during fall is not necessarily a simple function of physiological condition, but may relate strongly to age-specific relative vulnerability to predation, and how juvenile and adult pheasants respond to seasonally changing weather, vegetation, and farm-related disturbances (Table 6).

Labisky and Anderson (1973) speculated that an abrupt change in diet in fall may cause nutritional stress. Corn, the principal food during fall and winter, is limited in nutrients. Further, the morphology and physiology of the gut adjust slowly to major changes in diet—thus affecting the uptake of nutrients (Thomas 1986). Radical loss of habitat, as a result of harvest and fall plowing operations that result in disorientation, and physiological stress on birds not yet fully mature, quite possibly underlie the high rates of juvenile mortality in the fall—especially as the differential in survival between age classes is clearly tied to this season. Predation was no doubt important. However, there could be many factors contributing to high fall mortality.

It is plausible that the intensively disturbed midwestern autumn landscapes of the 1980's may be even less hospitable for pheasant survival than conditions that were considered relatively negative in the mid-1960's. In addition, diminished survival of chicks in recent decades (Warner et al. 1984), underscores the significance of birds recruited into the autumn population being afforded relatively positive conditions for survival. Thus, a better understanding of the dynamics of fall survival under current (more intensive) farming practices is merited.

Finally, apart from mortality, egress appeared to be a substantial factor influencing observation rates of birds marked on the SSA. This suggests that habitat initiatives designed to enhance pheasant survival are best implemented on regional scales (minimally a township in size or larger)—such that movements do not become a primary factor limiting responses by pheasants to habitat-development projects.

Because of the differentially low survival of juveniles in fall and early winter, the traditional practice of attributing pre- and posthunt differences in sex ratios entirely to hunting yields overestimates of the proportion of cocks taken by hunters—a statistic of major importance to the management of hunting. The juvenile:adult sex ratio can be expected to decline during fall independent of hunting, and high rates of fall mortality denote the need for an early opening date for the annual pheasant hunting season. Further, curtailment of legal shooting of wild hens has certainly been warranted. Fluoroscopy data indicated that shooting of hens on the SSA removed about 8-10% of the prehunt hen population—probably a relatively low rate of hen kill for the region, because biologists were highly visible and personally contacted many hunters.

CONCLUSIONS

Our findings indicate that (1) average fall survival of juvenile hens was substantially lower than for adult hens; (2) the higher relative mortality of juvenile hens occurred during late fall and early winter; (3) a substantial portion of the total annual mortality occurred during this critical fall period; (4) changing farming practices in recent years may well have produced environmental conditions less suitable for fall survival; and (5), in total, pheasant declines during the early-to-mid-1960's were caused by a complex interaction of factors affecting nesting, survival, and local movements as a result of unfavorable land use changes and adverse weather.

On the SSA, strong numerical upswings have apparently been accompanied by high rates of survival in autumn and winter, reflective of improved habitat as a function of altered land use. In the almost 20 years since the time of this work, fall farming-related disturbances have become even more pronounced. Winter cover has been both qualitatively and quantitatively reduced—including a decreased interspersion of grassland (Fig. 2, Warner and Etter 1986). During the era of the Feed Grain Program, the best nesting, brooding, and roosting habitats were the same fields that sustained high pheasant survival over winter. While pheasant managers may think in terms of "safe" nest cover, brood habitat, fall-winter food patches, etc., pheasants, of course, do not. Traditionally, good pheasant range has been characterized by preferred cover types relatively numerous and well dispersed across the landscape and thus readily available during critical periods.

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6

Habitat Management: How Well Do We Recognize the Pheasant Facts of Life?

RICHARD E. WARNER, Illinois Natural History Survey, Champaign, IL 61820

Abstract: Research on wild ring-necked pheasants (*Phasianus colchicus*) in North America has lagged in recent decades, thus hampering development of effective management strategies for pheasants on contemporary agricultural landscapes. This paper explores demographics that appear to be common for pheasants in the Midwest and describes general guidelines for management interventions and their evaluation. Future efforts in pheasant research and management should be directed to (1) potentials and constraints posed by rapidly changing, and thus unstable, agricultural environments; (2) limitations of small-scale habitat initiatives; (3) innate dispersal; and (4) survival as the primary mechanism limiting pheasant abundance.

Key Words: abundance, ecology, management, *Phasianus colchicus*, population, ring-necked pheasant, regulation

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The first century of ring-necked pheasants in North America provides a panoramic view of the art of wildlife management—its birth, proliferation, successes and failures, and future challenges. Perhaps more than any other species, the pheasant has been part-and-parcel of wildlife management concepts forged for agricultural environments. Upland game research was at its zenith when pheasants were thriving. In the wake of declining pheasant numbers—and of research dollars as well—the study of factors determining pheasant abundance has for the most part atrophied to a skeletal framework of monitoring trends in abundance and harvest.

Habitat initiatives have often succeeded in attracting pheasants to targeted locations, but rarely have they enhanced abundance on a sustained basis. There are varied reasons for these limited successes, including political and extrinsic factors that have pervasive effects on habitat over broad regions of the pheasant range. However, limited successes in part also relate to inadequacies in our understanding of pheasant ecology—inadequacies which have hampered development and delivery of management designs applicable to contemporary agricultural landscapes.

Indeed, pheasant research has lagged in 2 fundamentally important ways. First, with a limited comprehension of how pheasants have responded to fluctuations in land use and changing agricultural technology, we can only portray future pheasant trends with broad strokes. Second, for much of the current pheasant range in North America we have neither a satisfactory conceptual framework for explaining the dynamics of pheasant demography nor a good understanding of how these dynamics might be enhanced through management. The purposes of this paper are (1) to explore basic tenets concerning pheasant dynamics that appear to hold over space and time in North America and (2) to consider what these tenets imply about the potential future scope and directions of pheasant management and research.

ELEMENTS OF DYNAMIC PHEASANT RANGE

Habitat

A given portion of range supports a temporally and spatially unique aggregation of individual pheasants. Pheasant abundance on a regional scale is variable (unstable) and reflects time-dynamic patterns of reproduction and morbidity, plus egress and ingress, summed over numerous local settings. The term habitat provides an abstract framework for describing key components that influence pheasant abundance during a specified period over some unit of range.

There are pervasive factors associated with land use (Edwards 1984) and other variables (e.g., weather) that interact to variably limit range occupation and abundance (McAtee 1945). With respect to the flow of energy and disturbance regimes, environments inhabited by pheasants are clearly not stable either spatially or temporally. Local conditions of habitat and environment are variable and often unpredictable relative to their effects on patterns of local recruitment (natality and ingress) and mortality (mortality and egress). As regions and time frames are expanded, explanations for patterns of range occupation and abundance become more obvious and more predictable—local stochastic perturbations ("noise") and effects of dispersal tend to average out.

Dispersal

In view of the unstable nature of environments, movements have an important bearing on abundance and even persistence of pheasants. In fact, the potential ecological significance of dispersal has largely been overlooked. Published reports tend to indicate that most marked pheasants move no farther than 1-2 miles (1.5-3 km) during seasonal shifts (Leopold et al. 1938, Leedy and Hicks 1945, MacMullen 1952, Selleck and Hart 1957, Mallette and Bechtel 1959, Lyon 1965, Gates and Hale 1974, Dumke and Pils 1979). Conversely, those same findings also imply that (1) significant seasonal changes in range occupation are the norm and (2) the relatively small numbers of birds that move 2-10+ miles (3-16 km) are potentially significant for gene flow, range extension, and recolonization of formerly occupied range at large scale, and local habitats at small scale. Further, much dispersal is innate and occurs over a wide spectrum of environmental conditions and densities (Howard 1960, Krebs et al. 1973, Brown 1978, Edwards et al. 1981, Etter et al. these Proceedings).

Movements of individuals help ensure that some pheasants find, and thus may respond to, the occurrence of positive environmental conditions where and when such conditions exist (Warner and Etter 1985). For example, during the late 1930's in Ohio, for every 100 nests in hayfields approximately 30 hens were killed or maimed by hay mowing (Leedy and Hicks 1945). This regional statistic does not describe variability within and among farms in reproductive success resulting from specific haying and grazing programs or weather, for example. Therefore, small-scale shifts in activity centers during the breeding season, and longer movements during dispersal, can in effect buffer local differences in survival within a region.

The importance of dispersal (or less-pronounced movements) to persistence and abundance of pheasants at localized settings, however, does not mean that the probability of survival increases with degree of movement. Just the opposite effect was found for pheasant broods in Illinois (Warner et al. 1984). Additionally, Edwards (1963) recognized the propensity for disturbed and dispersing pheasants to concentrate on refuges (Bachant et al. 1971), but found no evidence that regional survival and abundance were enhanced by refuges—at least at the scale suggested by Leedy and Hicks (1945).

DESIGNING MANAGEMENT INTERVENTIONS

Considerations of Time and Space

Temporal and spatial parameters are integral to blueprints for habitat management for pheasants. Time relates to identification of the critical periods for which survival, reproduction, and dispersal by pheasants potentially can be enhanced by management. Where management practices are designed to enhance survival, there are 2 periods in the annual cycle that merit particular consideration. The first occurs in spring and summer, corresponding with reproduction and brood-rearing (Warner and Etter 1985). The second occurs in autumn or early winter, or both, when pheasants, especially juveniles, move extensively and have been shown to experience relatively high mortality across a spectrum of environments and habitats in North America (Etter et al. these Proceedings). Periods of differentially high juvenile mortality are typically accompanied by abrupt and often extreme changes in weather, land use, and depreciating habitat conditions unfamiliar to dispersing—or recently dispersed—young-of-the-year pheasants (Gates 1971, Etter et al. these Proceedings).

Spatial scales are important in defining both the size and area targeted for habitat initiatives and in designing cover configurations. Both "diluted" and "intensive" habitat management schemes have been common in the Midwest. They differ primarily in spatial scales. Diluted efforts are typically habitat programs that receive little local promotion and are available to interested landholders over a large region. Diluted efforts usually have low rates of participation and do not comprehensively address habitat needs (Burger and Teer 1981). For example, a small winter food plot may attract pheasants and thus provide immediately visible results. It does not necessarily follow, however, that small and highly dispersed plots offering limited seasonal benefits can significantly impact pheasant abundance at regional or local scales.

Alternatively, intensive management efforts produce specified habitat components that recur in close proximity over some unit of pheasant range (perhaps a township or county) wherein consideration is given to cover arrangements—at field, farm, and larger resolutions of scale—to ensure that habitat interventions positively impact pheasant numbers over the defined management area (Warner and Etter 1985). Because of egress and ingress related to both dispersal and to more or less routine movements of adults, intensive management schemes cannot easily be demonstrated or evaluated on only a few farms or sections of land. For example, on the township-size Sibley Study Area (SSA) in Illinois in the 1960's, a large fraction of pheasants captured in fall dispersed beyond the borders of the unit in subsequent months (S. L. Etter and R. E. Warner, unpublished data). Warner and Joselyn (1986) considered 20 contiguous sections to approximate the minimal area for demonstrating the effects of block roadside management.

Interactions at Landscape Scales

Insular Habitats and Changing Agriculture.—Wildlife managers are faced with mitigating habitat deterioration and resulting fragmentation, a problem common to most species today. Attention of ecologists and conservationists in recent years has been directed to concepts of island biogeography, including the insularization of terrestrial habitats. Indeed, as grasslands and small grains have diminished in the Midwest, attractive nest and brood cover has become increasingly insular over much of the pheasant range.

Good pheasant range is comprised of cover types that do not require pheasants to move often and extensively in order to survive and reproduce. Attractive types and configurations of pheasant habitat are typically byproducts of cropping practices enhanced by federally funded programs that have diverted land from crop production (Edwards 1984, Berner these Proceedings, Etter et al. these Proceedings). As a part of rotations and mixed farming systems, relatively diverse and attractive grassy cover types formerly tended to contribute importantly to regional landscapes at all seasons, and thereby accommodated winter roosting, nesting, brood-rearing, and foraging by pheasants (Warner and Etter 1986). Further, small farm and field sizes ensured that key elements of cover recurred over relatively restricted spatial units—and thus minimized movements and facilitated survival of large numbers of pheasants. Trends toward larger field sizes and increased mechanical and chemical disturbances have rendered the limited remaining grassland cover more spatially disjunct and isolated, and less diverse (Warner et al. 1984). The implication is that pheasant habitat has become insular—both spatially and in terms of the ecological separation of essential life-sustaining component elements—a form of insularization that has as yet received little research attention.

Fields of corn (*Zea mays*) stubble, traditionally the principal source of food and cover for wintering pheasants (McAtee 1945), exemplify how agricultural technology has, in effect, constrained habitat values associated with individual cover types. In recent decades, waste corn has remained plentiful at harvest, especially with the vast acreage now in corn production (Warner et al. 1987). However, use of new and shorter hybrid corn varieties, and replacement of old-style corn pickers by modern combines have reduced corn stubble, as have trends toward more fall tillage (Warner and Etter 1986). In addition to diminished stubble, adoption of 2,4-D in the 1950's, and chemical control of weedy forbs and grasses in the early 1960's, has eliminated much of the understory vegetation in cornfields after harvest. Thus, for rowcrops—especially corn—the net effect for pheasants of changing agricultural technology has been loss of potential benefits of such fields for protection from weather, for concealment, and as sources of a diverse, available food base (grain, weed seeds, insects, sprouting vegetation, etc.) over much of the year.

Configurations of Key Cover Types.—Compared to the era of less intensive farming, cover types today individually contribute more narrowly to the pheasant's life-sustaining requirements. Pheasants must now range over greater areas and suffer greater exposure to elements and predators, with the result that fewer survive. Management endeavors that minimize essential movements by pheasants should be emphasized.

Improving survival, particularly of hens and young, remains a top priority for habitat initiatives (Gates and Hale 1974, Jarvis and Simpson 1978, Warner and Etter 1985). Structure of the available vegetation affects the selection of nesting sites by hens, and also their vulnerability to farm disturbances and predation (Dumke and Pils 1973, 1979, Lachlan and Bray 1976, Warner and Etter 1983, Warner et al. 1987). It is critical that timing and extent of disturbances in key nesting habitats be minimized where vegetative structure is attractive to nesting hens. For example, hay mowing has traditionally been a plague over the midwestern pheasant range, often destroying a large fraction of nesting hens (Errington and Hamerstrom 1937, Leopold et al. 1943, Leedy and Hicks 1945, Baskett 1947, Stokes 1954, Allen 1956, Kimball et al. 1956, Wagner et al. 1965, Warner 1981, Snyder 1984). Recent attempts to abate mechanical disturbances in hayfields (Hartman 1984), and development of roadside vegetation as an alternative nest cover (Warner and Joselyn 1986), have enhanced survival and, thus, local numbers of pheasants.

Interactions between predators and pheasants, and how these interactions are affected by structure, juxtaposition, and disturbances of vegetation, are dynamic and not easy to anticipate in planning a management scheme (Trautman 1982). This is evident in the case of managed roadsides developed in relatively large contiguous blocks (20 + sections) in Illinois, where treatment of large tracts has helped buffer effects of both dispersal and year-to-year changes in availability of other prime nesting habitats. Higher percentages of hens nested on managed roadsides in years when other grassy habitats were reduced (Warner et al. 1987).

The extent of mammalian nest predation on roadsides has reflected the effective breeding densities of pheasants on a regional basis, with more grass available/hen resulting in lower rates of mammalian nest predation (Warner and Joselyn 1986, Warner et al. 1987). Jarvis and Simpson (1978) in Oregon found that nest success and chick survival where higher after numbers of breeding pheasants had precipitously declined, apparently because predation had relaxed. In Illinois, small-grain fields are generally not attractive for initial nest attempts (Labisky 1968). However, fields such as oats appear to attract potential predators beginning in early spring, thereby diverting some of the predator activity away from prime nest sites (Warner et al. 1987).

Careful recognition should be given to factors of time and space that affect the value of habitats managed as nest cover. Contrary to conventional wisdom, when cover is managed for nesting pheasants for a period of years, narrow linear strips (along roadsides, for example) do not necessarily have higher rates of nest predation compared to field situations (Warner and Joselyn 1986, Warner et al. 1987). Managed hayfields, however, typically produce community structures that, after several years, result in a convergence of predators and thus low nesting success (Warner et al. 1987). This phenomenon has also been observed on sanctuaries managed for the greater prairie-chicken (*Tympanuchus cupido pinnatus*) in Illinois, where fields of grasses have persisted much beyond 3-5 years (R. L. Westemeier unpublished data). Moreover, plans to maximize numbers of small fields and interspersions of edge, conventionally recommended for upland game, may not always be appropriate. There may be situations in which small field size allows relative ease of access to nests by predators and, thus, offers easier access to active nests than is the case with larger tracts.

Hunting of Isolated Habitats.—Hunting pressure is responsive to changes in abundance, and typically relaxes in conjunction with a decline in pheasants (Leedy and Hicks 1945, Baxter and Wolfe 1973, George et al. 1980, Warner and Joselyn 1986, Edwards these Proceedings). Even where hunting effort has declined along with pheasant abundance, potential vulnerability of hens remains an important consideration. Total hunting effort may relax regionally, yet substantial pressure may remain directed to locally isolated and concentrated groups of pheasants. Where concentrated hunting pressure occurs, coincidental shooting of hens can be counter-productive to habitat management (Whiteside and Guthery 1983).

The extent to which hunting—especially incidental killing of hens—threatens pheasants in relatively isolated settings depends at least in part on how shooting is temporally distributed relative to the timing of fall dispersal and attendant high natural mortality. Compensation of natural mortality by hunting should not be assumed. Since the early 1960's, incidental killing of hens has ranged from 6 to 10% of pheasants present in late fall on the SSA (Etter et al. these Proceedings). Hunting pressure has tracked pheasant abundance; thus hen kill has been highest in years when pheasants and, therefore, hunters were most abundant. A simulation model based on demographics of pheasants near SSA (Warner and Etter 1985) suggests that if the numbers of hens killed during hunting were double (ranging 12-20%—with half of the kill occurring late in the hunting season—this level of additional exploitation would ultimately depress abundance.

EVALUATING MANAGEMENT INTERVENTIONS

Population Analysis

Management strategies for ring-necked pheasants ultimately rely upon some form of what is commonly referred to as "population analysis." It is important in such analyses that demographic parameters provide sufficient and reliable information. By definition, "population" refers to individuals exchanging genetic material, i.e., to species or racial populations. As used here, however, reference is to dynamic local aggregations of pheasants where time and space parameters have been defined. Such local aggregations are, with rare exception, "open" to emigration and immigration.

Demographic statistics for pheasants reflect patterns of recruitment, survival, movements (including dispersal), and combinations of these, within and among local aggregations of pheasants. When averaged over large regions, such information does not necessarily identify specific phenomena affecting local abundance. For example, statistics collected for broad regions do not portray site-related annual variations in dispersal, reproductive success, and survival. It follows that increased insularization of local aggregations signals range deterioration, even if regional indices of abundance (e.g., incidental hunting success) show little change. Moreover, in regions of low density, colonization and persistence of pheasants in new areas must precede significant numerical increases in abundance.

Pheasant Demography

Most conceptual population models are based on the premise that abundance is "regulated," and consider demographic phenomena within the context of equilibrium—i.e., stable age structures would eventually occur under relatively constant environmental conditions (Krebs 1972, May 1986).

Although such abstract assumptions can often provide useful benchmark comparisons (Eberhardt 1985), a precursory consideration of the North American pheasant range (Dahlgren these Proceedings) underscores the practical limitations of assuming environmental stability. Conceptual models can be similarly flawed by assumptions of closure, both in terms of dispersal and genetic stability.

Conventional population models have also tended to assume that density-dependent cues are always operant and drive the population toward stability (Lotka 1925, Bernadelli 1941, Ricker 1954). Such assumptions should not be made without good reason. Abundance may be dynamic in a number of different ways—chaotic, expanding, declining, or oscillating—at more or less the same time, with or without density-related feedbacks (Chesson and Case 1985, May 1986). Inversity should, therefore, not be assumed to be universal and, where evident, may be a function (result, not a cause) of extrinsic or intrinsic factors, or both.

Intrinsic factors may, or may not, have pronounced effects on abundance at extreme densities, whereas extrinsic factors related to land use and predation may be more consistently associated with regional abundance. W. R. Edwards (personal communication), for example, holds the view that local abundance is not regulated, but merely reflects over time combined effects of dispersal, reproduction, escape, and survival of individuals in variable, periodically hostile, environments.

Given the above, past emphasis on carrying capacity in pheasant management has been naive, if not daft. In evaluating the results of management programs on pheasant abundance, biologists should not assume that observed demographic phenomena for wild populations will conform to models based on assumptions of closure, equilibrium, and strict density dependency, particularly on a local scale where environmental conditions are unstable and heterogeneous. Accordingly, few (none come to mind) management plans designed and promoted as providing predictable, stable annual crops of pheasants have produced such results.

Measurement and Validity

The techniques, areas, and scales of time and space needed to adequately evaluate responses by pheasants to management are critical. Specifically, techniques need to be accurate and reliable, and to encompass a time frame appropriate for the management strategy. Past evaluations have often come up short in both the amount of time taken, and the size of area under consideration. Areas must be of sufficient size to account for routine movements and dispersal.

States and provinces annually survey the relative abundance of pheasants (Midwest Pheasant Council 1974). In the absence of bias, these surveys reasonably portray changes in pheasant numbers and range, although few such surveys provide reliable inferences about regional or year-to-year differences at finer resolutions (Kozicky et al. 1952, Midwest Pheasant Council 1974). Sample designs constrain conclusions that can be drawn from survey data. Information on relative abundance has often been used as a surrogate basis for drawing inferences about population phenomena when, in fact, such information may not be suitable or sufficiently sensitive for such purposes. For example, a numerically small (<10%) shift in a demographic parameter can, over a very few years, invoke a major change in abundance (Warner and Etter 1985). Further, delineation of parameters affecting demographic change is unlikely without research focusing on different spatial and temporal resolutions to account for numerical extremes and variations in several key statistics (May 1973).

Most demographic analyses make use of age and sex ratios. Such ratios are highly subject to methods of observation and, thus, data must be carefully obtained and applied in deciphering demographic trends. Either high or low ratios can accompany a wide spectrum of numerical states and changes in abundance (Buss et al. 1955, Wagner 1957, Gates 1971, Caughley 1974, Etter et al. these Proceedings). Although age ratios can be indicators of net productivity (reproductive success plus juvenile survival) prior to hunting, they rarely stand alone as indicators of fall-to-spring or fall-to-fall survival. Age and sex classes often have different vulnerabilities to capture and observation (Gates 1971), and to the gun (Eberhardt and Blouch 1955, Selleck and Hart 1957). Ratios are often biased if samples do not accurately represent pheasants in all various available habitats.

Composites of several types of information generated from different surveys are often employed to evaluate demographic responses. For example, a common practice has been to evaluate statewide trends in seasonal mortality of pheasants using a spring hen index (from cock-call counts), a fall population index (estimates of the cock kill), and winter sex ratios. Yet, as Wagner and Stokes (1968) imply, such approaches to population analysis are no stronger than the weakest link—least accurate or precise, or biased. When indices describing reproductive and survival phenomena are not independently derived, there is no basis for detecting autocorrelation and other biases that may affect the validity of conclusions.

Even when only relatively favorable counting conditions are selected, weather and other factors can often affect variability of survey and census data. Therefore, sample sizes are a primary concern (Kozicky et al. 1952, Midwest Pheasant Council 1974). One approach to reducing error terms and confidence intervals is to repeat a census or survey numerous times and base the index of abundance on some lesser number of "high" counts. This approach has improved precision and accuracy of estimates of cock call counts, for example, in Illinois (Warner and David 1982). The following illustrate real-world challenges regarding integration of appropriate research and evaluation procedures with management planning.

The Ford County Management Unit (FCMU).—The FCMU, established in 1967, represents a pilot project designed to evaluate the potential of roadside management for pheasants on a contiguous block of 20 sections of farmland in east-central Illinois (Warner and Joselyn 1986). Data for pheasants on the FCMU since 1967 illustrate the strengths and liabilities of some common approaches to population analysis.

Let us assume that a late-summer roadside census (broods counted/100 miles [161 kms] during 8-16 mornings in July-August) was the primary criterion used to evaluate responses by pheasants to roadside management. Further, beginning in 1974, surveys of hunters on the FCMU made during opening weekend of the upland game season were available as a secondary criterion of relative abundance. Brood surveys indicated a sharp decline in pheasants beginning in 1970, the year in which vegetation seeded on FCMU roadsides had become fully established (Fig. 1). Brood counts for the area were not correlated with numbers of cocks killed/hunter on the opening weekend ($P>0.05$, $r=0.50$). Taken alone, brood data lead to a conclusion of "no effect" for the habitat initiative. Hunter-kill data, when considered with the brood data, could be interpreted either as "inconclusive" or as pointing to "no effect." However, when data from other sources are considered, results of the management effort become clearer. For example, densities of breeding hens (from spring censuses and winter helicopter counts) and numbers of chicks hatched (from nest studies), peaked in the early 1970's, after roadside cover had

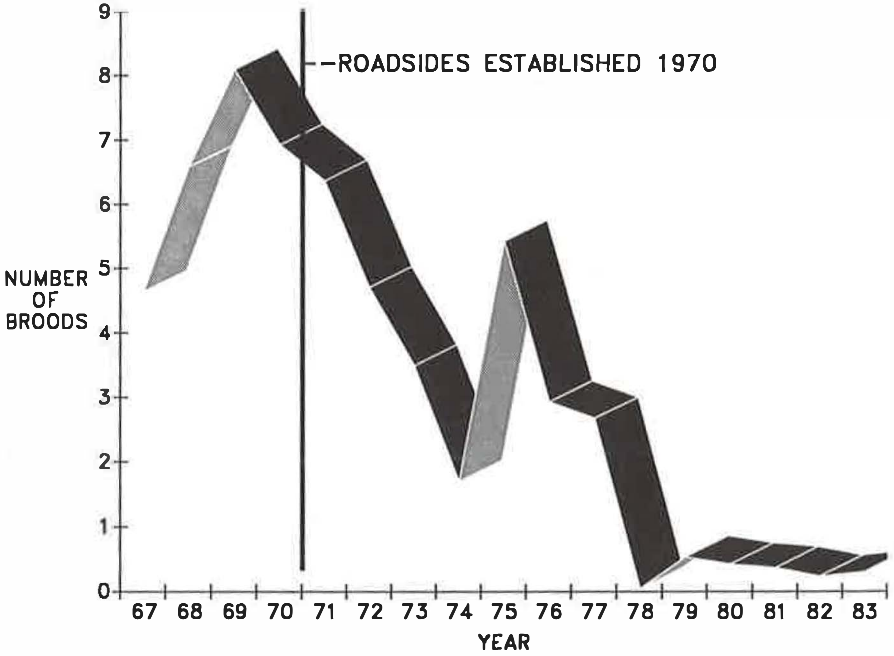

Fig. 1. Numbers of broods counted/100 miles (161 km) on the Ford County Management Unit, 1967-83, using standardized July-August roadside censuses.

become established. Over much of the 1970's these trends were contrary to brood counts (Fig. 2).

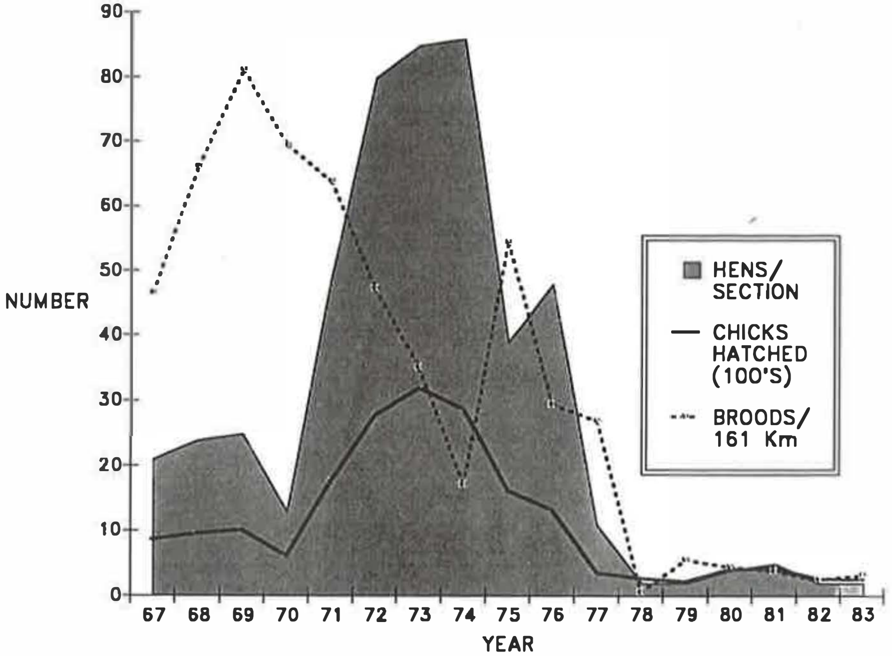

Fig. 2. Independent measures of pheasant abundance on the Ford County Management Unit, 1967-83. Hens/section were estimated using late winter/early spring censuses. Chicks hatched (x 10^2) were estimated from nest studies. The census methodologies are described by Warner and Joselyn (1986).

Table 1 lends additional perspective to similarities and differences among evaluation techniques used in the FCMU study. Abundance of hens in spring explained 92% of the variation in nests hatched on roadsides ($r = 0.96$, Table 1), and 97% of the variation in chicks hatched on the area (Fig. 2). Thus, at least for the FCMU, late summer and early fall indices did not provide reliable means for evaluating responses by pheasants to management.

Demographic data for the FCMU, therefore, indicate that even subtly different approaches to demographic analysis—including those from techniques widely used by biologists—can lead to quite different inferences about responses by pheasants to management (Fig. 1, Table 1). Also, if the roadside program had been evaluated for only a few years—for example 1969-72 (Fig. 1)—the potential of roadside management could have been overstated in light of subsequent changes in land use. It is

Table 1. Relationships between demographic statistics for pheasants on the Ford County Management Unit in Illinois, 1967-1983. Warner and Joselyn (1986) describe methods used in generating the statistics.[a]

	Simple correlation coefficients[a]		
	Brood counts[e]	Roadside nests	Spring hens
Roadside nests[b]	0.35 ($N=9$)		
Spring hens[c]	0.33 ($N=17$)	0.96 ($N=9$)	
Hunter kill[d]	0.50 ($N=10$)	0.87 ($N=8$)	0.89 ($N=10$)

[a] Underlined r-values are significant, $P < 0.05$.
[b] Numbers of nests hatched on roadsides, 1973-1981.
[c] Numbers of hens per section in April, 1967-1983.
[d] Cocks killed per hunter during opening weekend, 1974-1983.
[e] Broods observed per 161 km averaged for 8+ late summer counts, 1967-1983.

incumbent on researchers, therefore, to provide for as many pieces of the puzzle as possible, and for as long as feasible. The value of comprehensive, long-term data bases is obvious.

The Ohio Experience.—In the fall of 1979, the Ohio Department of Natural Resources (DNR) began habitat restoration efforts for pheasants in 4 townships in portions of what had been prime pheasant range 2 decades before (Bachant et al. 1971). The stated goals were to provide an additional 500 acres of relatively undisturbed nest cover in each township and to evaluate subsequent numerical responses by pheasants. Surveys were implemented to annually monitor changes in land use and pheasant abundance (Henry 1986). By 1985, however, there had been no detectable response. Some of the reasons given for the lack of response included adverse weather, failure to address all habitat needs of pheasants in those townships, lag time in establishing quality nest cover, and unstable land leases (Henry 1986).

The Ohio endeavor provides a contemporary illustration of: (1) problems of making significant changes in pheasant habitat on intensively farmed landscapes; (2) the perpetual challenge of preventing agricultural disturbances from being a major detriment to nesting—even with land leases; (3) the fact that no evaluation can be better than available demographic data; (4) given the lag time in developing attractive habitat and instability of farmland environments, an accurate evaluation requires long-term efforts—perhaps 10 years or more—especially where pheasants are sparse; (5) management interventions which are expensive and difficult to sustain where results are not immediately forthcoming; and (6) the need for large-scale programs to elicit meaningful numerical responses.

CONCLUSIONS

Management (and evaluation) strategies for ring-necked pheasants should recognize that environmental conditions constantly change temporally and spatially. Management should thus accommodate: (1) appreciation of temporal and spatial scales as factors affecting responses of pheasants to management; (2) the highly unstable nature of agricultural ecosystems, and variability inherent in other elements of the physical environment; (3) the continuing need for in-depth analyses of mechanisms affecting demographic patterns based on contemporary habitats; and (4) innate dispersal.

Trends in the dynamic nature of the abundance of ring-necked pheasants on America's prime agricultural lands are reminders that the white man came relatively late to mid-continental North America—with his plants, animals, and machines—and, from a geologic time frame, in the wink of an eye, changed the face of a continent. The current weak pulse of pheasants across their acquired range in North America reflects development of the most capital-intensive agricultural enterprise in the history of the world. As a result of this agriculture, more topsoil by weight is annually eroded from many fields than grain is produced. Farm enterprises and the quality of rural life today are generally in extreme duress. Whatever means are adopted to "manage" the farm economy will affect pheasants.

Viewing wild ring-necked pheasants as a predictable, sustainable crop for hunters to harvest has side-tracked wildlife agencies from planning for, or even understanding, the demographics of abundance that determine potentially achievable harvests. Pheasants will generally persist in relative, albeit unstable, abundance where agriculture is diverse and conducive to their survival and reproduction. In this context, management can have a bright future provided that production of farm commodities is in keeping with real costs and demands, that soil losses are reduced to tolerable levels, and that reasonable steps are taken to provide for the welfare of the pheasant. The conclusion that quality pheasant range is in large degree a by-product of a diverse and sustainable agricultural economy is inescapable.

Further, recent annual expenditures of tens of millions of dollars by hunters in pursuit of pheasants in the Midwest (Warner and Etter 1986) provide ample evidence that investments in research and management make economic as well as ecologic sense. What other than a government corporation would allow a multi-million dollar enterprise to dwindle with only a whimper? However, wild pheasants are not produced with a profit motive. At present we have only crude means of appraising the economic and aesthetic values of wildlife species as recreational commodities. As a result, the loss of the pheasant enterprise has not been widely appreciated by the public.

With the largely self-inflicted economic blow that agriculture has incurred, future land-use directions are not clear. Whatever patterns develop, the crow of the pheasant (or its absence) will continue to reflect the quality of life on the "Grand Prairie," and the successes, failures, and challenges of wildlife management as well.

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7

A Population Model as an Aid to Pheasant Management

DAVID A. HILL, The Game Conservancy, Fordingbridge, Hampshire, U.K.[1]

PETER A. ROBERTSON, The Game Conservancy, Fordingbridge, Hampshire, U.K.[1]

Abstract: A preliminary statistical-dynamic model of pheasant (*Phasianus colchicus*) abundance was used to predict the effects of nest success, chick survival, density-dependent overwinter loss of females, and release of hand-reared pheasants on the dynamics of theoretical populations. In simulations using the model, pheasant numbers increased with higher nest success and chick survival, and annual releases of hand-reared birds reduced productivity of wild populations. Breeding success had little influence on subsequent breeding populations because of density-dependent overwinter loss in females and density-dependent non-territoriality in males. Maximum sustainable yield was obtained with 20% harvest. Findings are discussed in light of current pressures on wild pheasants in Britain.

Key words: population model, density dependence, ring-necked pheasant, management, harvest

Ecological models are useful when designing studies of complex systems. They can reveal weaknesses in our current knowledge, so that future research may be planned (Jorgensen 1986). Models have also been used to test scientific hypotheses by simulating an experiment and predicting the results—a certain number of individuals, for example—which can then be compared with observation data. Habitat management programs can be designed and tested using ecological models. This approach, combined with later field observations, is often more efficient than field studies alone.

Most game bird models have concentrated on the effects of certain factors on the numbers of birds that can be taken by hunters (Hill and

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[1] Present address: The Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, U.K.

Carter unpublished data). Here we concentrate primarily on possible effects of several manipulative management practices on the availability of pheasants for shooting. These practices are: (1) controlling predators mainly to improve nest success, (2) providing areas rich in insects to increase chick survival, (3) improving woodland shrub cover for females in winter, and (4) releasing hand-reared pheasants.

The pheasant is of commercial importance in Britain, representing over 80% of all quarry (game birds, wildfowl, and mammals) taken by hunters. Approximately 15 million pheasants are released annually in the UK for shooting purposes. Traditional management of woodland habitat and control of predators have declined as a consequence of increased dependence on hand-reared birds and the relative ease with which they can be raised. Pheasants are shot on driven shoots in which birds are "pushed" over a line of 8-9 "guns" by up to 20 beaters. Sexes are shot indiscriminantly, although selection for cocks occurs toward the end of the season. A typical British shoot would meet every 2 weeks from November through January.

STUDY AREAS

Pheasant populations were studied at 2 locations. Damerham, Hampshire, in southern England, is a 525-acre (210-ha) lowland arable farm, approximately 15% woodland. The North Farm estate, Sussex, also in southern England, is a 15,500-acre (6,200-ha) lowland arable farm with about 9% woodland. Field sizes average 60-65 acres (25 ha) on both areas; woodlands are mixed deciduous, mainly *Fagus sylvatica* and *Betula pendula*, and plantations of conifers. Land use is dominated by winter cereal grains grown on 75-78% of both areas, and both are generally typical of estates in the south and mid-counties of England.

METHODS AND MODEL CONSTRUCTION

The model (Fig. 1) is based on findings from studies of pheasants at Damerham, augmented by data on insects from North Farm, where chick survival has been monitored for the past 14 years (Hill 1985).

Nest Success

Nest success was initially kept constant at 46% because, as yet, we have no data that indicate it to be density dependent. Because pheasants

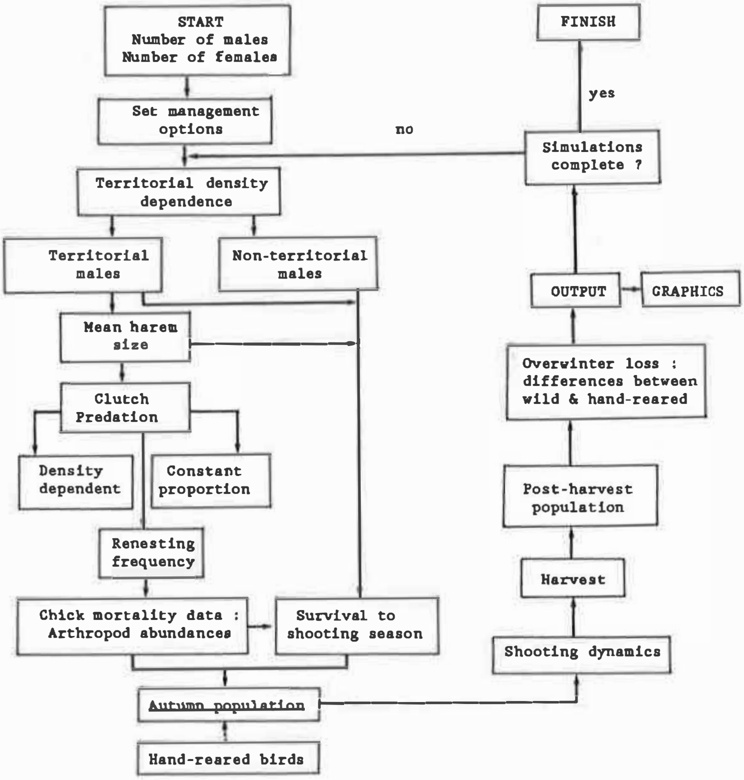

Fig. 1. Schematic representation of the pheasant population model—a statistical-dynamic model.

routinely renest after the loss of early nests (Stokes 1954, Hill and Robertson 1988a), renesting was included in the model. However, using extremes of nest success and nest density observed in studies at Damerham, it was also possible to simulate nest success under the assumption that success was density-dependent. There is evidence that nesting success of grey partridge [*Perdix* p. *perdix*], for example, is density dependent (Potts 1986).

Extremes of 30% loss of nests at low density, and 85% loss at high density, were incorporated into the model as:

$$Pn/1 + e^{(3.75-(0.0445\ F))}$$

where Pn = the percent of nests lost and F = female density. Constant and density-dependent nest success were compared with respect to sustained harvest.

The extremes of nest success used in the model have been documented from the Game Conservancy's Pheasant Nest Recording Scheme. Rates of nest success in excess of 65% have been achieved on a sustained basis through intensive predator control (Hill and Robertson 1988b).

Chick Survival

Pheasant chicks depend on insects for survival during the first 2 or 3 weeks of life (Hill 1985). Where insects are few, chicks range over large areas and suffer higher rates of mortality than where insects are more abundant. Multiple regression analysis, based on 14 years of data from the North Farm on densities of *Carabidae, Chrysomelidae,* and *Lepidoptera,* plus sawfly larvae, treated as independent variables (Potts 1986) explained 58% of the between-year variance in rate of chick survival (Hill 1985); data for all arthropods combined increased the explained variance to 95% (Table 1). The effect of arthropod availability was included in the model, using a stochastic term that provided a distribution for chick survival with a mean of 37.3 ± 2.9%, i.e., chick survival similar to that observed for North Farm.

Table 1. Multiple regression analysis of chick survival rate, insect abundance and mean May temperature during 1970-1983 on the Sussex study area (*p<0.1; ** p<0.01; NS Not Significant) (from Hill 1985).

Insect Group	Partial regression coefficients
Carabidae	13.27**
Chrysomelidae	5.74**
Lepidoptera and sawfly larvae	2.79*
Heteroptera	-0.52 NS
Jassidae and Delphacidae	-0.02 NS
Curculionidae	-5.08 NS
Aphididae	-0.01 NS
Mean May temperature (°C)	-2.32 NS
Constant	35.9
Total explained variance	0.95
df	13

Summer Survival

Survival over the summer was assumed to differ both between sexes and between adults and immatures. Survival rates used were territorial adult males = 0.9, non-territorial adult males = 0.7, adult females = 0.6, immatures (<1 year), both sexes = 0.9. These rates were based largely on unpublished material from Game Conservancy records and from studies at Damerham.

Survival of Hand-reared Birds

On many British estates, 6-week-old, incubator-reared pheasant poults are released in July and August into large open-topped wire pens. As the poults mature they begin to leave the pens, often returning at night until they reach about 12 weeks of age, after which they seldom return. Numbers of pheasants reared and released on shooting estates in Britain have almost trebled over the past 25 years; however, total numbers shot (wild and hand-reared) have not increased as rapidly (Fig. 2).

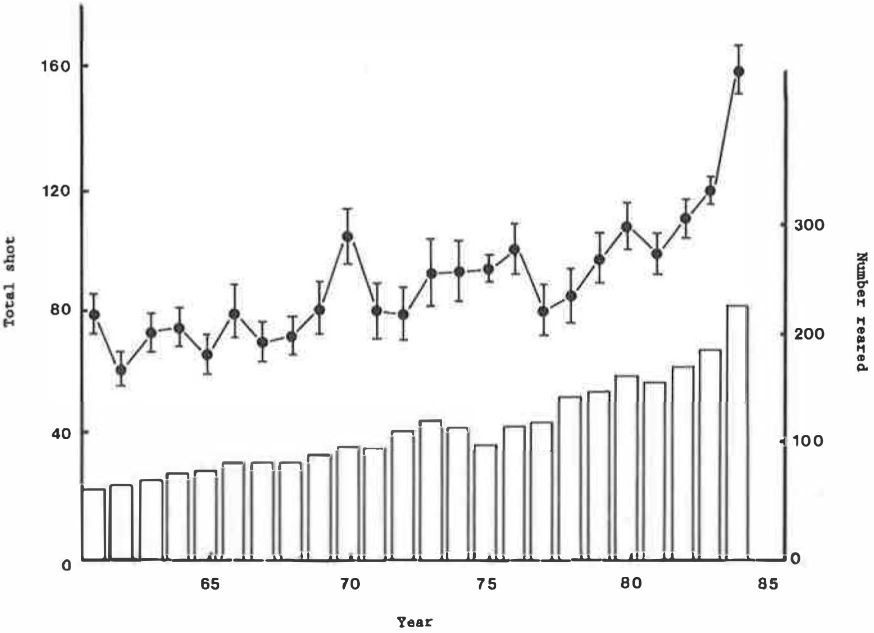

Fig. 2. The increase in the mean (± SE) number of pheasants shot (circles) and the number of hand-reared pheasants released (histograms) per km^2 on shooting estates in Britain as determined from the Game Conservancy's National Game Census.

Hand-reared birds often sustain high mortality immediately after release (Robertson 1986). Survival of released hand-reared birds from September to the following January is only 52% that of their wild-reared counterparts (Hill and Robertson 1987, Hill and Robertson 1988b).

Furthermore, radiotelemetry studies revealed that hand-reared hens surviving the fall and winter suffer much higher rates of mortality during the following summer than do wild-reared pheasant hens (Hill and Robertson 1986). This high mortality of adult hand-reared hens occurs either while the females are off the nest during incubation or during the first few days of brooding. There appears to be no difference in risk between wild and hand-reared hens when incubating. Consequently, the number of fledged young produced per female is higher for wild than for hand-reared hens.

The loss of hand-reared hens during winter was estimated using the formula:

$$Py = K/(0.52\ x) + y$$

where Py = the proportion of hand-reared birds that suffer mortality during the winter, K = logarithmic value for overwinter loss converted to a proportional loss (i.e., 1-10K-K), x = the post-shooting wild-bred population, and y = the post-shooting hand-reared population. Breeding success of hand-reared hens was assumed as 0.261 relative to wild-reared hens.

Male Overwinter Loss

Numbers of territorial males each spring remain relatively constant between years (Lachlan and Bray 1976). At Damerham, locations of marked pheasants were mapped daily, based on observations made at dawn and dusk from 15 April-15 May for 5 years. These observations showed the proportion of spring males remaining non-territorial to be positively correlated with the number of poults released the previous summer (Table 2). Overwinter loss (km) of the males—in terms of the increase in non-territoriality with an increase in male density (M)—takes the form of a standard k-factor analysis (Varley and Gradwell 1968):

$$km = -1.545 + (1.048(\log 10M))$$

the slope of $b = 1.048$, which was tested and supported by a k-mortality density-dependence plot and reversed regression analysis (Varley and Gradwell 1968) infers slight over-compensation. However, it is based on only 5 years' data. For the purposes of this exercise, survival was constrained not to fall below 10%.

The model allows for immigration and emigration. In a previous study at a site with similar habitat 8km from Damerham, less than 1% of the wing-tagged pheasants recovered were taken beyond 1.5 km from their points of release (Bray unpublished data). This suggests that dispersal of hand-reared pheasants in arable lowlands does occur, but distances

Table 2. Spring territoriality and non-territoriality of male pheasants at Damerham in relation to the release of 6-week-old poults the previous summer.

	1983	1984	1985	1986	1987
Poults released previous summer	600	800	0	1000	950
Territorial male density (no./100 ha)	14.5	11.2	15.1	15.1	14.0
Non-territorial male density (no./100 ha)	15.6	26.8	5.3	42.9	19.0
Mean (± SE) harem size	2.19 ± 0.25	3.33 ± 0.46	3.26 ± 0.32	3.04 ± 0.35	3.21 ± 0.28
Harem density (no./100 ha)	10.2	7.3	9.3	13.7	6.8
Territorial males with females (%)	70	65	61	90	48

moved are small. Further, recoveries on an adjacent estate of wing-tagged, hand-reared birds from Damerham showed that females tended to move farther than males (Hill and Robertson 1986). While the k-factor equations for overwinter loss cope with immigration and emigration (net immigration being equated with negative values of k), we constrained natural survival of Damerham males not to fall below 10%.

Female Overwinter Loss

Females also exhibit density-dependent losses, with dispersal a contributory factor (Hill and Ridley 1987). Overwinter loss of marked females was calculated as:

$$kf = -1.464 + (0.762(\log 10F))$$

where kf = female overwinter loss and F = abundance of females in autumn. The slope of +0.762 infers under-compensation but, here again the relationship is based on only 5 years of data. For the purpose of investigating effects of harvest, natural survival is constrained not to fall below 20% (results from wing tagging indicate survival of hens to be higher than that of males).

RESULTS

The Influence of Nest Success on Fall Abundance

Nest success was simulated to increase and decrease by 50% (Table 3). A 50% "improvement" in nest success—equivalent to survival of 69% of clutches—led to an increase in autumn numbers. Therefore, where predation is a problem, a reduction of nest predators should result in significantly more pheasants being present in the autumn.

Table 3. Model estimates ($\bar{X}$ ± SE) of equilibrium densities of pheasants in autumn, in response to different levels of nest success and chick survival.

	No./200 ha
Observed	261 ± 16
Nest success	
50% increase	440 ± 32
50% decrease	199 ± 11
Chick survival	
60% increase in arthropods	355 ± 17
60% decrease in arthropods	144 ± 16

The Influence of Arthropods on Chick Survival

Simulated chick survival was found to be increased by 51.6 ± 2.9%, and decreased 23.0 ± 2.9% following increases and decreases, respectively, of 60% in the density of total arthropods (Table 3). This in turn resulted in respective increases and decreases in autumn pheasant numbers of 36 and 45%. These results indicate that improvements in chick survival due to a better food supply should significantly increase numbers of pheasants prior to shooting.

The relative merits of improving nest success or chick survival are difficult to determine, although it would seem a less worthwhile exercise to improve the numbers of broods produced (i.e., by improving nest success) if there are limited brood-rearing areas or insufficient food. On the other hand, the lack of any known density dependence operating on chick survival for pheasants or other galliformes suggests that improving nest success should not result in reduced chick survival.

Importance of Overwinter Density-Dependent Loss of Females

Relatively small changes in density-related parameters led to large changes in both numbers of females surviving the winter and in abundance of females in autumn (Table 4). This finding suggests that further research of factors affecting density-dependent overwinter loss of hens could be rewarding.

Table 4. Effects of changes in the parameters of female density dependence on numbers of females surviving the winter and on equilibrium densities in the fall. (This exercise simulates the effect of changes in the amount of breeding habitat.)

	No. surviving winter	Autumn population size
Observed	129 ± 8	261 ± 16
Decrease intercept[a] by 30%	467 ± 28	943 ± 53
Decrease strength of density-dependence from 0.762 to 0.6	460 ± 30	930 ± 60
Increase strength of density dependence from 0.762 to 1.0 (full compensation)	44 ± 2	88 ± 5

[a] The intercept of the density dependent relationship between the number of females in the autumn and the proportion surviving to breed the following spring.

Sustainable Yield

The model was used to estimate maximum sustainable yield (MSY) by manipulating the percent of the population shot. Results indicated that, if nest success is held constant, MSY would be achieved by shooting approximately 20% of the autumn population. At that level of harvest, the breeding population would be reduced to 70 females, or 71% of that without shooting (Fig. 3). Optimum sustainable yield would be achieved by harvesting at a slightly lower rate than 20%. In Fig. 4, MSY was approximately 45% of the autumn population when dictating the variable of nest success as density-dependent. This would correspond to a breeding population of approximately 75 hens, or 74% of the number that would have been present in the absence of shooting.

The Influence of Hand-reared Birds

The model was used to simulate—for a 20-year period—the effects of releases of hand-reared pheasants on: (1) productivity (expressed as the

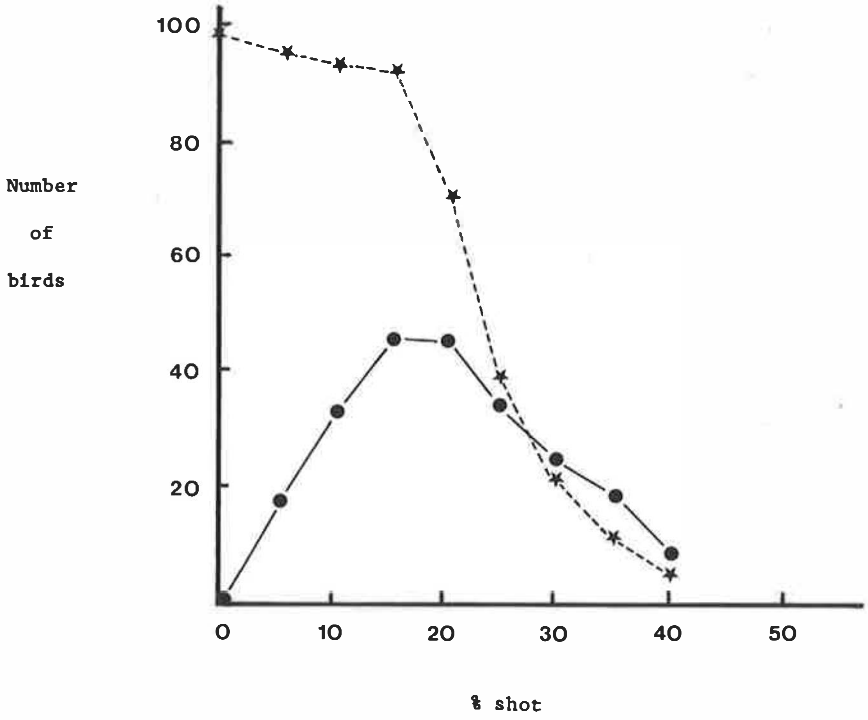

Fig. 3. Determination of maximum sustainable yield for the pheasant population based on model predictions assuming constant nest success. Solid line - yield; dotted line - breeding female population.

number of young produced to fledgling age by 100 hens) and (2) the percentage of the breeding female population consisting of hand-reared birds.

The percent of the breeding population consisting of hand-reared females increased as more pheasants were released, but reached a plateau at about 57% of the breeding population. The model reasonably predicted the proportion of hand-reared birds in the Damerham breeding female population as evidenced from records of pheasants trapped during late winter. The model predicted that, as annual releases are increased (to over 8,000), the productivity of the breeding population would decline and ultimately stabilize at a low rate. A decline in productivity was similarly predicted for a 50-year simulation where 800 pheasants were released annually. The latter number corresponds to the average number

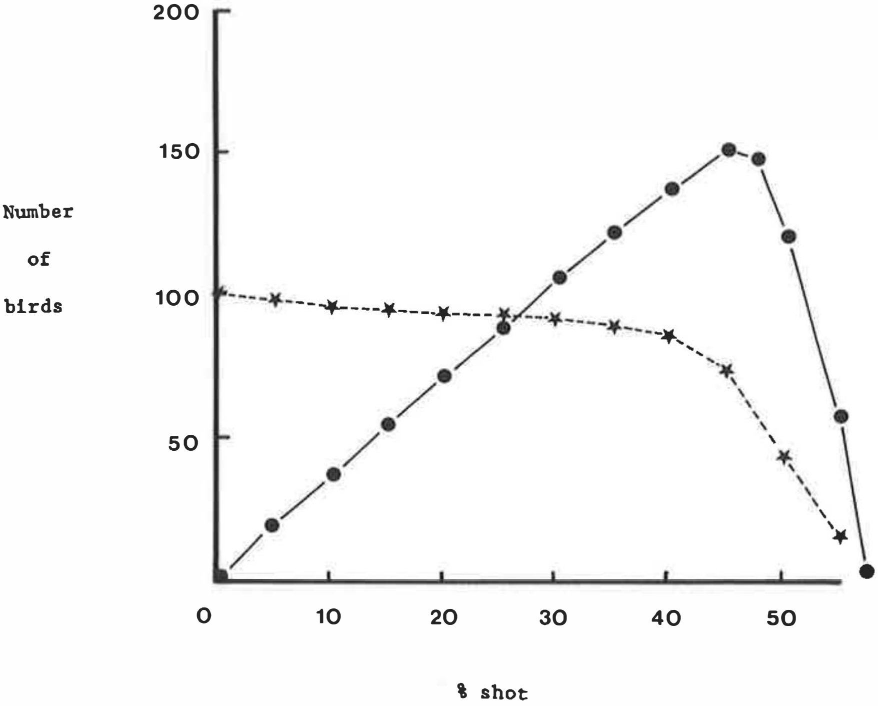

Fig. 4. Determination of maximum sustainable yield for the pheasant population based on model predictions assuming density dependent nest success. Solid line - yield; dotted line - breeding female population.

of hand-reared pheasants released on British estates in recent years. Declines in productivity were predicted for both an unshot population, and one where 30% was harvested.

Simulations, based on annual releases of 600 poults, further suggested that as the percent of the autumn population shot increases, there is an increase in hand-reared birds in the breeding population. The result is reduced net productivity because of differences in reproductive success between hand-reared and wild pheasants (Fig. 5).

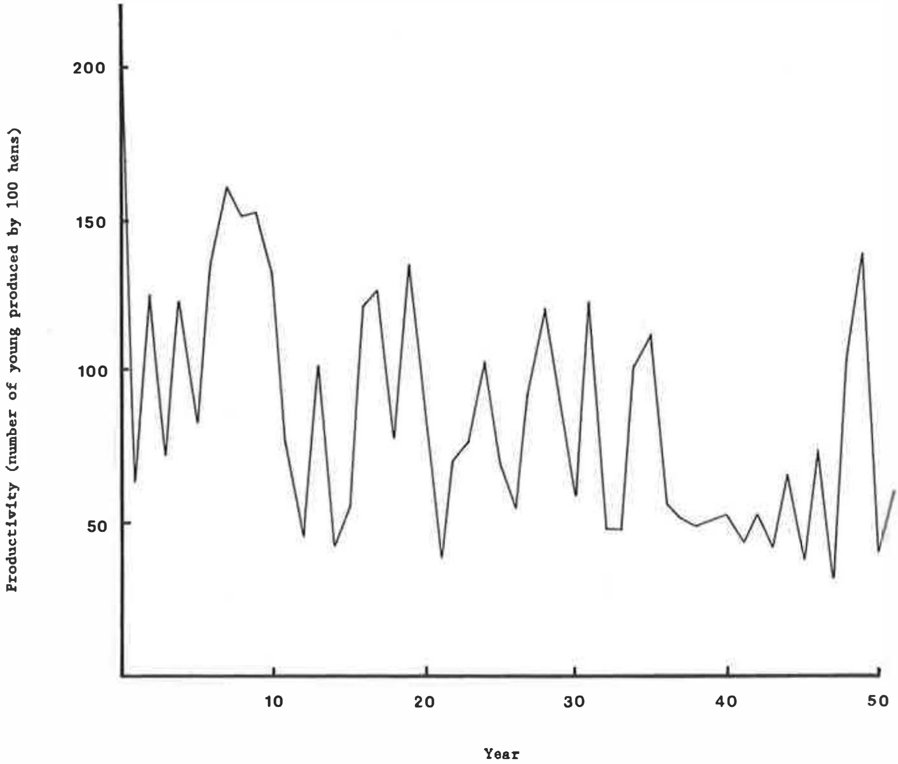

Fig. 5. Simulated trends in net productivity on the Damerham study area if 800 pheasants are released annually in the absence of hunting.

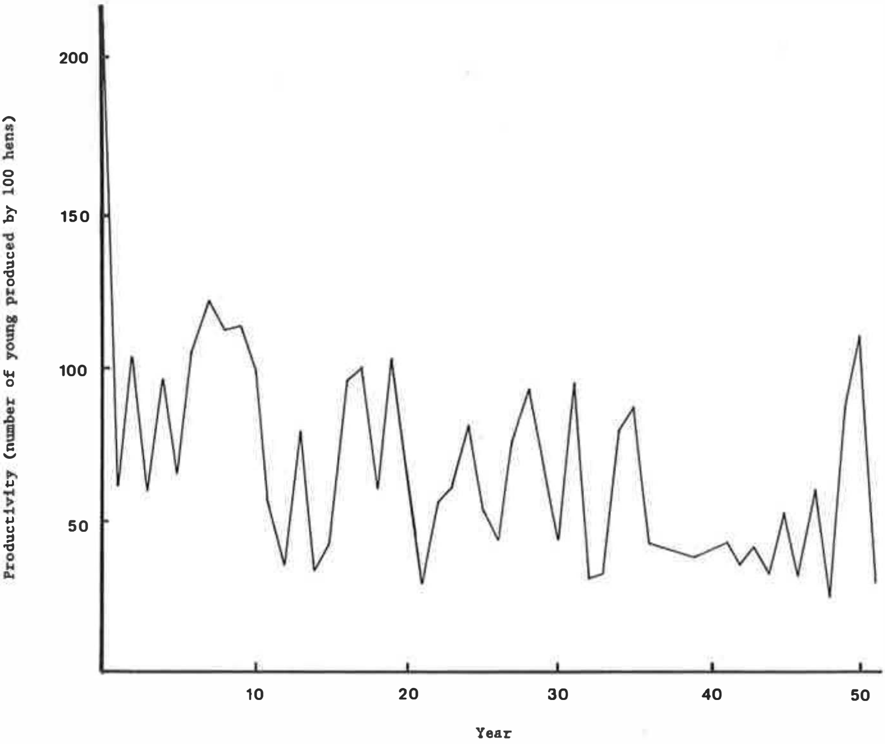

Fig. 6. Simulated trends in net productivity on the Damerham study area if 800 pheasants are released annually with 30% of the autumn population taken annually by hunters.

DISCUSSION

The model demonstrated that managing field boundaries to encourage invertebrate prey of pheasant chicks could increase and consequently improve shooting. Recent work has shown that brood sizes increased dramatically where pesticide-free field margins were maintained (Sotherton and Rands 1987). Broods appear to concentrate their feeding within such borders and benefit from the arthropods which inhabit borders.

Once they are well-fledged, pheasants spend less time in open field habitats and more in shrubby woodlands, which appear to benefit survival of females more than males. The model showed the potential value of implementing habitat management on seasonally used woodlands to increase numbers of breeding females. While the importance of woodlands to pheasants is not universally recognized, in southern England much coppice woodland is retained for the benefit it provides

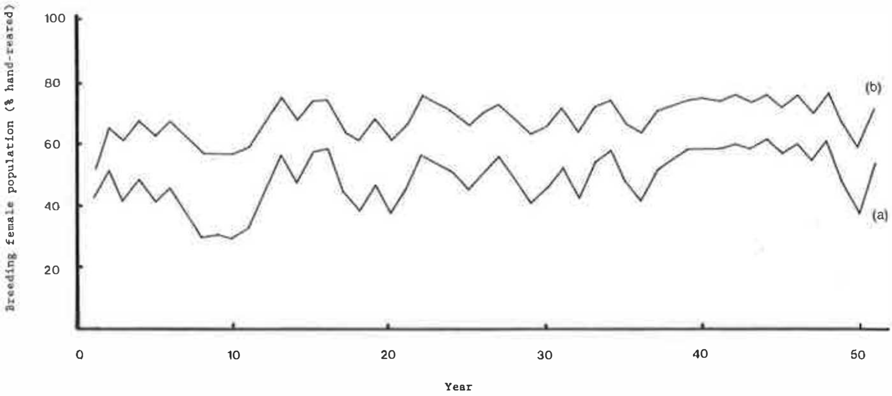

Fig. 7. Simulated trend in the percent of the female breeding population composed of hand-reared birds when 800 pheasants are released annually, (a) with no hunting and (b) with annual fall harvest of 30%.

pheasants as "holding" and winter cover (Hill and Edwards 1986). Small woodlands (<1.5 ha), particularly those with an abundance of shrubs, are most beneficial to pheasants (Hill 1986 unpublished data).

An activity which is likely to cause increased concern in future years is the release of hand-reared pheasants. While many "shoots" exist purely because of hand-rearing, the move back to more traditional management may not be far away. Our findings imply that productivity of wild populations could be reduced over time by even medium-sized annual releases. It is hoped that this information will lead game keepers and owners to take a more sympathetic view toward managing for wild-reared pheasants as an alternative to competing forms of land use, particularly farming and forestry.

The model used in this exercise is available, and can be modified to incorporate different hypotheses and other findings. The next step using the model will be to improve the efficiency and cost-effectiveness of our management practices.

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8

Pheasant Survival and the Role of Predation

LEROY R. PETERSEN, Wisconsin Department of Natural Resources, 3911 Fish Hatchery Road, Madison, WI 53711

ROBERT T. DUMKE, Wisconsin Department of Natural Resources, 3911 Fish Hatchery Road, Madison, WI 53711

JOHN M. GATES, Deceased

Abstract: Fluctuations in pheasant abundance are caused primarily by variable rates of mortality, with reproductive performance playing a subsidiary role. This paper examines seasonal and annual (fall-to-fall) survival with emphasis on predation. Mean annual survival of hens of 30-35% appears normal. Wisconsin pheasant studies suggest a long-term decline in survival and abundance, and an increase in productivity. Low survival has resulted from habitat loss, and operates through increased predation. Important predators of adult pheasants are the red fox, red-tailed hawk, and great horned owl. Predator numbers vary spatially and temporally. High numbers of red foxes have persisted since the 1940's in nearly all midwestern states. In addition, the red fox expanded westward into the prairie states in the 1950's to early 1960's. Red-tailed hawk and great horned owl numbers were relatively stable in the 1950's and 1960's but generally increased 1965-85 in the plains and prairie states, the Great Lakes states, and those parts of New England that support pheasants. Predation rates are related to snow depth in winter. Unfavorable weather combined with poor habitat occasionally results in excessive predation in spring. Predator-prey ratios are likely higher in Wisconsin than in the more intensively cultivated and highly simplified agricultural habitats of the plains and prairie states. Predation is, at best, imperfectly density dependent. It appears that severe winters lead to loss of body condition and increased mortality due to predation. Attainment of weights favorable for reproduction depends on the time of winter break-up, and on favorable prenesting temperatures. Reproduction success relates in part to the physiological condition of hens at the start of reproduction as well as weather and spring cover conditions as they influence predation.

Key Words: great horned owl, hen survival, predation, red fox, red-tailed hawk, ring-necked pheasant

Long-term population fluctuations in pheasants appear to be regulated principally by mortality, with reproductive performance having a more subsidiary role. In North Dakota, fall population trends observed by Martinson and Grondahl (1966) suggested a greater correlation with annual indices of survival than with indices of reproductive success. Similarly, in South Dakota, Dahlgren (1963) described a pattern of yearly survival variation closely linked with population trends. Ellis and Anderson (1963) and Anderson (1964) concluded that factors affecting reproduction were less critical than factors affecting survival in range expansion near the southern limits of pheasant distribution in Illinois. From Pelee Island, Ontario, Stokes (1954:104) concluded that "The steady rise in the fall population between 1946 and 1949 was due to high annual survival and good reproduction, and the leveling off in 1950 was the result of lower survival rather than poorer reproduction." In Oregon, Jarvis and Simpson (1978) showed that long-term population fluctuations in spring pheasant indices resulted primarily because of changes in survival of adult hens during winter and summer, and not from changes in recruitment.

This paper examines seasonal and annual survival of hen pheasants with an emphasis on predation. The abundance of predators and their relative impact on pheasants were explored. Emphasis centers on survival of hens from the time of brood dissolution, approximately September 1, until the following fall.

The paper suffers from 3 limitations. First, there are few thorough studies of hen pheasant mortality. Since 1940, only 7 states or provinces have pursued studies designed to measure annual mortality, and only 3 have made a serious effort to identify and evaluate causes of death on a year-round basis. Second, the few investigations that have been reported are uneven in their geographic distribution; accordingly, any attempt to synthesize a set of generalizations may rest on a shaky foundation. Pheasants inhabit a highly dynamic agricultural community, subject to ever-changing land-use patterns that alter the entire ecosystem and place our interpretations at risk. Finally, we are mindful that conclusions reached by any review are bound to be colored by personal experience. Our experience has been principally with Wisconsin pheasants and, although we recognize this as a possible shortcoming, we also note that over the years a larger body of survival and predation mortality information exists from Wisconsin pheasant range than from any other area. Further, our findings are consistent with similar findings by other workers.

ANNUAL SURVIVAL

Historical Perspective

The earliest measures of annual survival for North American pheasants were provided by studies begun in 1937 at the University of Wisconsin Arboretum (Leopold et al. 1943, McCabe 1949) and the nearby Fish Hatchery Marsh (FHM) (Buss 1946). These were long-term trapping and banding operations, and the findings allowed inferences on survival from recapture data. Aside from the early Wisconsin studies, only 3 attempts at estimating annual survival were found in the literature of the 1940's. In Pennsylvania, Randall (1940) determined population gains and losses for 1938-39 and calculated annual survival. Hypothetical population models were developed for Ohio and Minnesota pheasants by Leedy and Hicks (1945) and Schrader (1944), respectively. The data used in both models were a synthesis of previous research, the details of which were never fully explained.

A second set of reliable survival estimates for pheasants did not exist until the Pelee Island, Ontario, investigation by Stokes (1954). Stokes used fall population estimates and age ratios to calculate the number of surviving birds from the previous year's population total. Stokes was first to calculate sex-specific rates of mortality.

The California studies of pheasant survival, originally reported by Harper (1960) and definitively analyzed by Mallette and Harper (1964), represent the most intensive banding effort yet carried out on a North American galliform. Nearly 20,000 pheasants were banded in the Sutter Basin over a 7-year period (1952-58); survival rates were calculated by life-table methods (Hickey 1952).

More recently, Gates (1971) obtained life-table estimates of age- and sex-specific mortality, and used a combination of methods to calculate time-specific mortality in Wisconsin. On another study area in Wisconsin, Dumke and Pils (1973) calculated annual survival from population estimates and age ratios, and from a cohort of 218 radio-equipped hens studied over a 4-year period. Survival information we have to draw upon comes down to estimates from only 18 studies in 13 states or provinces (Table 1).

Annual Survival of Hens

Mean annual survival of hens, considering adults and juveniles combined, has been estimated at 53% on Pelee Island, 29 and 40% on 2 different areas in California, 30% in New York, 26 and 27% in Wisconsin,

Table 1. Comparison of mean annual survival rates for pheasants in different sectors of North America.

State or province and study area (or county)	Years	Starting date for survival estimation	Percentage annual survival									Authority
			Hens			Cocks			Sexes combined			
			J[a]	A	B	J	A	B	J	A	B	
WI												
U.W. Arboretum	1937-47	Midwinter	—	—	—	—	—	—	21	46	30	McCabe 1949
Fish Hatchery	1940-43	Midwinter	—	—	—	—	—	—	19	35	22	Buss 1946
Waupun	1960-66	October 1	26	31	27	7	5	7	—	—	—	Gates 1971
Waupun	1960-65	April 1	30	33	30	13	15	13	—	—	—	Gates 1971
Waterloo	1968-71	October 1	—	—	26	—	—	—	—	—	—	Dumke & Pils 1973
Waterloo	1968-71[b]	October 1	18	33	20	—	—	—	—	—	—	Dumke & Pils 1973
NY												
Albany	1938-53	Fall	—	—	45	—	—	—	—	—	—	Benson & Mason 1953
Avon	1979-82	October 1	—	—	30	—	—	—	—	—	—	Penrod et al. 1986
Avon	1979-82[b]	October 1	25	45	31	—	—	—	—	—	—	Penrod et al. 1986
IA												
Lucas & Wayne cos.	1977-80[b]	October 1	24	16	22	—	—	—	—	—	—	Wooley & Rybarczyk 1981
CO												
Sedgwick	1981-82[b]	March 1	—	—	52	—	—	—	—	—	—	Snyder 1985
Ontario												
Pelee Isl.	1946-50	Fall	—	—	53	—	—	9	—	—	—	Stokes 1954
Pelee Isl.	1949-50	Fall	39	37	—	—	—	—	—	—	—	Stokes 1954
CA												
Sutter Basin	1952-58	Fall	35	42	40	16	22	19	—	—	27	Mallette & Harper 1964
Honey Lake	1955-57	Fall	29	28	29	—	—	—	—	—	—	Mallette & Harper 1964
Honey Lake	1955-61	Fall	—	—	—	14	24	19	—	—	—	Mallette & Harper 1964

Table 1 (continued).

State or province and study area (or county)	Years	Starting date for survival estimation	Percentage annual survival									Authority
			Hens			Cocks			Sexes combined			
			J	A	B	J	A	B	J	A	B	
PA												
Lehigh Co.	1938-39	Fall	—	—	54[c]	—	—	—	—	—	—	Randall 1940
NE												
Valentine Refuge	1941-44	Midwinter	—	—	—	—	—	12[c]	—	—	—	Mohler 1959
OH	Hypothetical year		—	—	37	—	—	—	—	—	—	Leedy & Hicks 1945
IL												
Kendall Co.	1946-48	Fall	—	—	22	—	—	15	—	—	—	Robertson 1958
Neoga	1961-62	Fall	—	—	11[c]	—	—	—	—	—	—	Anderson 1964
MN												
Martin Co.	Hypothetical year		—	—	38[c]	—	—	34[c]	—	—	—	Schrader 1944
	1957-60		—	—	30-35	—	—	—	—	—	—	Chesness & Nelson 1964
Nova Scotia												Nostrand 1963
Kings Co.	1958-62	Fall	—	—	25[c]	—	—	—	—	—	—	(unpublished report)
UT												
Benson Unit	1960-65	Fall	—	—	24[c]	—	—	16[c]	—	—	—	Stokes 1968

[a] J = juvenile, A = adult, B = both.

[b] Radio-tagged cohort.

[c] Calculated from author's original data.

and 22% in Illinois and Iowa (Table 1). Survival rates reported from Wisconsin (1960-71), Iowa (1977-80), and New York (1979-82) apparently occurred during years of relatively stable or slightly declining abundance. Hen survival given for California's Sutter Basin (1952-58) was from a population believed to be stable during the 7-year study period (Mallette and Harper 1964); the high, indicated hen survival on Pelee Island (1946-50) was from a rapidly growing population (Stokes 1954).

Differences in survival rates between reported stabilized populations, illustrated by the California and Wisconsin examples, may signify differences in productivity, or measurement error. Wisconsin pheasants, in contrast with California birds, suffered higher rates of death but were able to maintain their numbers by virtue of better reproductive success. In Wisconsin, Gates (1971) reported a fall hen age-ratio of 3.0 juveniles/adult for the Waupun Area, whereas Harper (1960) found a fall ratio of 1.8 juveniles/adult for hens in California's Sutter Basin.

Anderson (1964) reported on the reproductive success and survival of pheasants south of established pheasant range in Illinois. From the data Anderson presented, we calculate an annual 2-year mean hen-survival rate of 11%. We considered this rate inadequate for population maintenance, although reproduction was comparable to self-maintaining populations (Anderson 1964). Robertson (1958) reported age characteristics for pheasants on an area in northern Illinois (Kendall County) during 1946-48 which indicated a 22% annual survival of hens during a period of regional declines.

Published estimates on annual hen survival from the plains and prairie states are given for the late 1950's by Chesness and Nelson (1964), Wooley and Rybarczyk (1981) for 1977-80, and Snyder (1985). However, findings from Colorado (Snyder 1985) were only for 1981-82 and are not representative estimates of survival because of an unusually mild winter (W. Snyder 1987 personal communication). Chesness and Nelson (1964) refer to unpublished findings for south-central Minnesota which indicate annual rates of hen survival of 30-35% for the years 1957-60. In South Dakota, Kimball (1948) reported an average of 55% juveniles among hens shot by hunters in 1945 and 1946; because South Dakota pheasants were declining at that time (Kimball 1948), survival of hens must have been substantially less than 55%.

We conclude that, although survival statistics available for comparison are limited, they suggest average annual hen survival of 30-35% is typical of self-maintaining populations in which reproduction is keeping pace with mortality. Even short-term annual survival of 20% or less is apparently insufficient for population maintenance as a general rule, and rates appreciably higher than 40% are restricted to rapidly increasing populations in highly favorable environments. Also, survival may be lower as one approaches the limits of pheasant distribution; however, much additional study is needed before geographic patterns of survival variation can be clarified.

Annual Survival of Cocks

Reported estimates of annual survival of cock pheasants range from 7% in Wisconsin to 34% in Minnesota (Table 1). Hunting appears to be the principal mortality factor and chief determinant of annual variability in cock survival. Cock harvests ranging from an estimated 49% of the prehunt population in Michigan (Allen 1947) to 93% of the prehunt population on Pelee Island (Stokes 1954) were reported in the literature (Table 2). A posthunt ratio of about 10 cocks/100 hens is not detrimental to reproduction (*vide* Shick 1947, Wagner et al. 1965). Harvests of 90% are alluded to as a management goal (Allen 1956, Madson 1962). With allowance for mortality outside the hunting season, annual cock mortality of up to 95% appears within the biological capabilities of the species. Estimated cock mortality in most midwestern states is presently well below this level, except perhaps in localized areas of unusually heavy shooting pressure.

Table 2. Examples of estimated harvests of cock pheasants from North America on public wildlife properties and/or leased private lands managed as public shooting areas.

Location	Years	Type of hunting[a]	% of prehunt cock populations shot by hunters	Reference
East-central MI	1937-42	A	75-90	Shick 1952
South-central MI	1939-45	A	49-76	Allen 1947
Central CA	1947-49	B	74-85	Harper et al. 1951
Central CA	1948-49	B	73-86	Harper et al. 1951
Pelee Island, Ontario	1947-50	B	78-93	Stokes 1954
North UT	1953-54 1960-65	B	76-88	Stokes 1968
East-central WI	1960-64	C	75-86	Gates 1971

[a] A = public and/or leased private lands managed as public shooting areas;
B = private lands with restricted or managed access to public hunting;
C = private lands open to hunting at landowner's discretion.

Age-specific Trends in Survival

Findings of Buss (1946) and McCabe (1949) indicated average annual survival of adult pheasants to be 16 and 25%, respectively, greater than that of juveniles (Table 1). One of the recognized biases affecting the studies of Buss and McCabe was the failure of all banded survivors to return each winter due to dispersal of juveniles. Subsequent Wisconsin research has shown that the proportion of surviving juveniles returning to winter cover is significantly lower than that of adults (Gates 1971), hence the age-related survival differences reported by Buss and McCabe may have been exaggerated. Stokes (1954, on Pelee Island 1946-50), Mallette and Harper (1964, in California 1952-61), and Gates (1971, in Wisconsin 1960-65) found only 1-7% differences in survival rates of juvenile and adult hens, while Wooley and Rybarczyk (1981) reported juvenile hens with 8% greater survival than adults during 1977-80 in Iowa. However, Dumke and Pils (1973, in Wisconsin 1968-71) and Penrod et al. (1986, in New York 1979-82) found survival of adult hens 15-20% greater than that of juvenile hens, concurring with estimates of both Buss (1946) and McCabe (1949).

In the cock segment of the population, California studies showed an 8-10% higher survival of adult than juvenile cocks (Table 1). In Wisconsin, where harvest and annual mortality were higher than in California, there appears to be little relative age-specific difference for cock pheasants.

Intrinsic Factors in Survival

The existence of intrinsic mechanisms affecting pheasant survival is a subject that has received scant attention. In Gambel's quail (*Lophortyx gambelii*) in Arizona, for example, Sowls (1960) concluded that "birds which hatch in a year of high productivity continue to have a higher survival rate, even as adults in later years, than birds hatched in a year of low productivity." Also, in California, juvenile pheasants produced in the latter stages of the nesting season suffered higher rates of mortality than those produced earlier (Mallette and Harper 1964). Among cocks banded in California at 9-11 weeks of age, first-year mortality averaged 86% for birds hatched during the first 3 months of the nesting season, but increased to 91% for those hatched in the fourth month. For the same age-groups of banded hens, mortality averaged 62, 69, 78, and 88% among those hatched April through July, respectively. A similar pattern of survival was observed in Wisconsin by Wagner et al. (1965) who postulated that the "quality" of the egg progressively declines with an increase in the number of eggs previously laid, and that egg quality in turn affects chick vigor and post-hatching survival.

In Illinois, Labisky (1968) concluded that the mortality of late-hatched pheasant chicks was no greater than that of early-hatched birds during a period of increasing pheasant abundance. Data from his Sibley Study Area showed the hatchability of eggs laid in April and May, and chick survival to be slightly greater among late-hatched broods (Labisky 1968). However, also in Illinois, Etter et al. (1987) found higher rates of mortality in juveniles hatched during the latter stages of the nesting season during a period of declining pheasant abundance. In Wisconsin, Gates (1971) estimated cohort-specific survival for fall- and winter-marked juvenile hens (fall to winter, fall to spring, and fall to summer; winter to spring, winter to summer, and winter to the succeeding winter) but, over a 6-year period, observed no relationship in mortality over timing of hatch for juvenile pheasants.

Long-term Trends in Survival of Wisconsin Pheasants

Long-term studies of Wisconsin pheasants provide the only known opportunity to examine long-term trends in survival. Survival rates reported by Buss (1946) and McCabe (1949) applied to both sex classes combined. The Arboretum pheasants studied by McCabe were subjected to light hunting pressure while outside of the area's boundaries. Winter sex ratios on the area averaged 64 cocks/100 hens during 1937-47 (McCabe 1949). The population on FHM was more heavily hunted and, during 1943 when pheasants were still very abundant, the population exhibited a posthunt ratio of 16 cocks/100 hens (Buss 1946). Sex ratio data clearly demonstrated a higher survival of hens than cocks. We suggest that annual hen survival on the Arboretum was no less than 30% and on FHM substantially higher than 22% as calculated by Buss (Table 1).

These rates of survival compare with 27% for hens on the Waupun Area in 1960-65, and 26% on the Waterloo Area in 1968-71 (Table 1). Whereas differences in survival rates between earlier and more recent studies may represent differences between areas or individual years, rather than a long-term change, the possibility exists that survival of Wisconsin pheasants has declined between the 1940's and 1970's. Because statewide abundance of pheasants in Wisconsin during these years also declined (Wagner et al. 1965), Gates (1971) postulated a long-term change in Wisconsin pheasant demography which involved a decrease in survival, a decrease in population levels, and an increase in productivity. The Wisconsin environment was viewed as having become less favorable for pheasant survival, contributing to population decline. Lower levels of abundance appear to allow higher rates of productivity by a decrease in density-dependent restraints on reproduction. As circumstantial evidence of changing productivity, McCabe (1949) reported an average winter age-ratio of 1.1 juvenile hens/adult hen in 1942-47, compared with 2.9 juveniles/adult hen observed by Gates (1971) in 1958-65. The findings of both McCabe (1949) and Gates (1971) occurred when Wisconsin pheasant abundance was declining, the latter occurring despite increases in idle croplands seeded to grass/legume cover during the Soil Bank era.

Gates (1971) speculated upon factors contributing to higher mortality rates among Wisconsin pheasants during 1958-65. Nest destruction in hayfields increased from 63% in 1936-42 (Buss 1946) to 83% in 1959-65 (Gates 1971); the rate of hen loss attributable to mowing likely changed proportionately. We suspect that hen mortality from highway traffic and illegal shooting has intensified since 1936-42. However, it is the long-term increase in predators coupled with deteriorating habitat that is believed to be the major factor in the lowering of survival rates since the 1940's.

During 1938-56, fluctuation in Wisconsin pheasant numbers from harvest-trend estimates showed no significant relationship to snow cover (Wagner et al. 1965). During 1957-76, however, trends in statewide harvest estimates demonstrate near-significant correlation with snow cover ($P = 0.06$). The latter period was no more variable in snow cover from year to year, suggesting that winter weather may presently exert greater influence on pheasant survival than was formerly the case. This relationship infers a long-term change in security of the winter environment; the outcome of winter-cover loss; reduced food availability; higher, more effective predator densities; and more likely, an interaction among these 3 factors. We believe that annual mortality of pheasants has increased over the past 2-3 decades. Although supported by circumstantial evidence, it follows that low survival has resulted from habitat loss and operates through increased predation.

SEASONAL VARIABILITY IN PHEASANT SURVIVAL

Estimates of fall-to-spring and spring-to-fall survival of hen pheasants were available from 15 investigations among 12 states (Table 3). No geographical or chronological patterns of fall-to-spring or spring-to-fall survival were readily apparent from these investigations. Fall-to-spring survival ranged from 28% (1960-62) for a non-self-sustaining pheasant population in Illinois (Anderson 1964), to 77% (1937-41) reported for a rapidly-growing population on Protection Island, Washington (Einarsen 1942). The lowest average fall-to-spring survival for a self-maintaining population was 43%, computed from population estimates provided by Shick (1952) for the Prairie Farm, Michigan (1939-42). Fall-to-spring

Table 3. Examples of estimated seasonal rates of survival for hen pheasants.

State or province and study area	Years	Reference dates	Percent survival Fall-spring	Percent survival Spring-fall	Reference
WA					
Protection Island	1937-41	Nov, Mar	77	—	Einarsen 1942
PA					
Lehigh Co.	1938-39		67	81	Randall 1940
MI					
Prairie Farm	1939-42	Prehunt, May	43[a]	—	Shick 1952
Rose Lake	1940-42	Prehunt, end winter	52[a]	—	Allen 1946
Rose Lake	1942-45	Prehunt, Apr	62[a]	—	Allen 1946
Ontario					
Pelee Island	1946-50	Prehunt, May	69[a]	76[a]	Stokes 1954
NY					
Monroe Co.	1946-49	Prehunt, Apr	53[a]	—	Robeson 1950
MN	Hypothetical year	Oct, Apr	56[a]	68[a]	Schrader 1944
OH					
Statewide	Hypothetical year	Prehunt, Apr	62	58	Leedy & Hicks 1945
IL					
Kendall Co.	1946-48	Prehunt, Apr	75	36	Robertson 1958
Neoga	1960-62	Prehunt, May	28	38	Anderson 1964
Nova Scotia					
Kings Co.	1958-62	Prehunt, May	72	43	Nostrand 1963 (unpublished report)

Table 3 (continued).

State or province and study area	Years	Reference dates	Percent survival		Reference
			Fall-spring	Spring-fall	
WI					
Waupun	1958-65	Prehunt, May	48	50	Gates 1971
Waterloo	1968-71	Prehunt, Apr	58	45	Dumke and Pils 1973
CO					
Sedgwick	1979-81	Mar, Aug	—	56	Snyder 1985
IA					
Lucas & Wayne Cos.	1977-80	Oct, Apr	54	39	Wooley & Rybarczyk 1981

[a] Calculated from the author's original data by J. M. Gates. Resulting estimates should be used with caution as Gates' procedures and notes were lost at his death and calculated survival estimates cannot be verified.

survival on the 9,000-acre area ranged between 32 and 57% during the years 1939-42.

Fall-to-spring hen survival varied between 27 and 64% ($\bar{x}$ = 48%) during 1958-65 on the Waupun Area (Gates 1971). Variations in survival during the period of days with complete snow cover annually ranged from 60 to 83%, and were the principal determinants of annual variability in fall-to-spring survival.

Spring-to-fall survival estimates of hens ranged from 36% in Kendall County, Illinois, in 1946-48 (Robertson 1958) to 81% in Lehigh County, Pennsylvania, in 1938-39 (Randall 1940) (Table 3). Spring-to-fall hen survival was also below 40% on the Noega Area (38%), Illinois (1960-62; Anderson 1964), and in Lucas and Wayne counties (39%) in southern Iowa (1977-80; Wooley and Rybarczyk 1981), but were over 70% on Pelee Island (76%), Ontario (1946-50; Stokes 1954). Investigations in Ohio (for a hypothetical year; Leedy and Hicks 1945), Nova Scotia (1958-62; Nostrand 1963, unpublished report), Colorado (1979-81; Snyder 1985), and Wisconsin (1958-65, 1968-71; Gates 1971, Dumke and Pils 1973) provided mid-range (45-58%) spring-to-fall survival estimates. Gates (1971) found that spring-to-fall survival varied between 34 and 58% during 1958-65. Nesting season (1 May-10 August) loss was the principal component of spring-to-fall (1 May-1 October) mortality (Gates 1971).

THE ROLE OF PREDATION

Primary Predators

Findings indicate that, over time, fluctuations in pheasant abundance are more closely related to hen survival in winter and in spring than to reproductive performance. Therefore, the predators of greatest concern are those that prey upon hen pheasants—nest predators or egg eaters are of secondary concern.

Pheasants seldom constitute a major fraction of an individual predator's diet; nevertheless, pheasants may be taken by a variety of predators. In Wisconsin, 11 mammals and 9 raptors are recorded as preying on pheasants (Wagner et al. 1965); however, only 3 predators (red fox, *Vulpes fulva*; great horned owl, *Bubo virginianus*; and red-tailed hawk, *Buteo jamaicensis*) appear to be individually or collectively significant to pheasant abundance in Wisconsin (Gates 1971, Dumke and Pils 1973, Pils and Martin 1978, Petersen 1979). In New York, Penrod et al. (1986) found gray fox (*Urocyon cinereoargenteus*), in addition to red fox, great horned owls, and redtails, as significant pheasant predators while, in Colorado, raptors—primarily great horned owls—were the major source of predation (Snyder 1985). Attention will focus on studies in which quantitative estimates were made of losses to predation (Table 4).

The red fox is commonly singled out as the major pheasant predator and, under certain circumstances, this reputation may be deserved. In Michigan, during the early 1950's, areas of high pheasant abundance and low fox numbers lost only 3-7% of wintering pheasants from foxes (Arnold 1956) while, on another Michigan study area, spring losses due to red fox were only 1-2% of the pheasant population (Craighead and Craighead 1956). However, on the Waupun Area in Wisconsin, an average of 12% of the winter population of hens was removed by predators other than red-tailed hawks, with red foxes being most important (Gates 1971). On the Waterloo Area, Dumke and Pils (1973) calculated that 29% of the hens present were taken by red foxes during the period October through March. A later investigation at Waterloo by Pils and Martin (1978) revealed a 9% loss to foxes during 1 April through 30 June (i.e., spring). In southern Iowa, Wooley and Rybarczyk (1981) lost 45% of their radio-tagged hen pheasants to mammalian predation, with red fox the major mammalian predator.

And, in New York during 1979-82, Penrod et al. (1986) determined a 20% average annual loss by red and gray foxes, with approximately 3/4 of all such mortalities occurring from the beginning of complete snow cover to the onset of incubation.

Great horned owls and red-tailed hawks are seemingly underrated in their importance as pheasant predators, especially during earlier studies. In southern Wisconsin, pheasants were the leading prey item in the diet of red-tailed hawks during the hawks' nesting season, and the second-leading prey identified among food remains in great horned owl nests (Orions and Kuhlmann 1956). In southern Michigan, Craighead and Craighead (1956) estimated that, in spring, 4-5% of the pheasants were taken by raptors (principally great horned owls, Cooper's hawks, and red-tailed hawks). Later, Gates (1972) estimated that redtails on average removed 7% of the hens present each winter, and 5% of those present in spring on the Waupun Area. More serious losses occurred at the Waterloo Area, where redtails removed, on an average, 2% of the winter and 23% of the spring pheasant populations, while great horned owls took 2 and 12% of the winter and spring pheasant populations, respectively (Petersen 1979). Red-tailed hawks asserted a greater influence at Waterloo because resident hawks were 60% more numerous than resident horned owls. The estimated number of pheasants consumed per raptor was nearly identical for both raptor species. At Waterloo, redtails consumed an average of 3.7 pheasants/spring, while horned owls took an estimated 3.8 pheasants. The primary predators (red fox, redtails, and horned owls) on the Waterloo Area removed an estimated 28% of the 1 December hen pheasant population by 30 June during 1972-75 (Petersen 1979).

Table 4. Examples of predation rate estimates for pheasants in North America.

				Percentage lost to predation[a]				
Predator	**State or province and area**	**Years**	**Sex**	**W[b]**	**Sp**	**Su**	**F**	**Reference**
Red fox	Southern Michigan	Not available	Both	3-7	3	1		Arnold 1956
Red fox	Southern Wisconsin	1968-71	Hens	29				Dumke & Pils 1973
Red fox	Southern Wisconsin	1972-85	Both		9			Pils & Martin 1978
Great horned owl	Southern Michigan	1942, 1948	Both		2			Craighead & Craighead 1956
Great horned owl	Southern Wisconsin	1972-75	Both	2	12			Petersen 1979
Red-tailed hawk	Southern Michigan	1932	Both			3		English 1934
Red-tailed hawk	East-central Wisc.	1959-65	Hens	7	5			Gates 1972
Red-tailed hawk	Southern Wisconsin	1972-75	Both	2	23			Petersen 1979
All raptors	Southern Michigan	1942, 1948	Both	3	4-5			Craighead & Craighead 1956
All raptors	Northeast Colorado	1979-81	Hens		33	17		Snyder 1985
All predators	Northern Iowa	1935-36	Both	0.2				Green 1938
All predators	SE Pennsylvania	1938-39	Both		3	7		Randall 1939, 1940
All predators	Pelee Island, Ont.	1949-50	Hens			3		Stokes 1954
All predators	East-central Wisc.	1959-65	Hens	19	4	6	9	Gates 1971

[a] Estimated as a % of the numbers considered alive at the start of the season.

[b] W = winter; Sp = spring; Su = summer; F = fall.

Contemporary studies elsewhere suggest continuing high pheasant predation rates. Wooley and Rybarczyk (1981) lost 32% of a radio-tagged cohort of hen pheasants to avian predators in Iowa, although specific raptors were not identified. Penrod et al. (1986), in New York, lost 42% of their tagged hen pheasants to avian predators, with horned owls and redtails identified as principally involved. And, finally, Snyder (1985) reported a 44% average mortality from avian predators on tagged hen pheasants in Colorado during spring and summer; horned owls were identified as the major predator.

On the Waupun (Gates 1971) and Waterloo (Dumke and Pils 1973) areas in Wisconsin, average annual rates of predation of hens were estimated at 38 and 62%, respectively. On the Avon Area in New York, Penrod et al. (1986) estimated an average predation rate of 65% for hen pheasants. Such high levels of exploitation were apparently not typical in the plains and prairie states until the mid-1970's. Earlier, predation was generally regarded as an insignificant cause of pheasant mortality, except perhaps as an aftermath of winter storms (Bue 1949 unpublished report, South Dakota Dep. Game, Fish and Parks; Kimball et al. 1956). In Iowa, during the severe winter of 1935-36, Green (1938) reported less than 1% of the winter pheasant population preyed upon, even though pheasants must have been extremely vulnerable to predation with the relatively small amount of available winter cover. In Illinois, neither Robertson (1958) nor Labisky et al. (1964) mentioned predation in the context of mortality factors affecting pheasant populations. Recent findings in South Dakota (Trautman et al. 1974), Iowa (Wooley and Rybarczyk 1981), and Colorado (Snyder 1985) suggest that predation plays an important role in limiting pheasant abundance in the plains and prairie states.

Trautman et al. (1974) evaluated the possible benefits from 2 different programs of carnivore reduction. They found an average of 74% more pheasants on study areas in eastern South Dakota where populations of red fox, raccoon, badger (*Taxidea taxus*), and skunk (*Mephitis mephitis* and *Spilogale interrupta*) were annually reduced by 22-46% over a 4-year period (1967-70). However, on 4 areas where red foxes were reduced 85%/year over a 5-year period (1965-69), pheasant numbers increased only 19%. Apparently, increased pheasant abundance on the predator control areas primarily reflected improved nest success after nest predators (raccoon, badger, and skunk) were reduced along with foxes. In contrast, the removal of 4 species of nest predators (striped and spotted skunks, raccoons, and crows [*Corvus brachyrhynchos*]), over a 3-year period (1960-62) in Minnesota, increased pheasant nest success and chick production, but failed to increase late-summer pheasant numbers (Chesness et al. 1968).

Long-term Changes in Predator Abundance

The abundance of pheasant predators in the Midwest has changed both temporally and spatially over the past 50 years. Unfortunately, changes in the abundance of such species as the red fox, great horned owl, and red-tailed hawk are difficult to quantify. Sargeant (1982) examined red fox population trends in midwestern North America since 1800, using fur harvest records. Although flawed by incomplete records, changes in reporting, and lack of information necessary to relate harvest to density, fur harvest provides the only long-term population indicator available over a broad geographic area. Sargeant (1982) concluded that fox numbers were quite low from 1900 to the early 1930's throughout the Midwest. Red fox was even reported absent in many northern areas, due primarily to high harvest demands. By the mid-1940's, however, foxes had increased to high levels throughout the Midwest, an increase that coincided with expansion and historic peaks in pheasant distribution and numbers.

Factors responsible for major increases in fox abundance were improved habitat conditions after settlement (but delayed until the mid- to late-1930's), a release from interspecific coyote competition because of intensive control efforts, and low harvest pressures with declining pelt prices (Sargeant 1982). No doubt the major land-use changes brought about by the depression, and by the Agricultural Conservation Program of 1936-42—responsible for diverting 5-15% of the total acres harvested in the Midwest to permanent grass-legume cover—further contributed to increased fox numbers (W. R. Edwards 1984 personal communication). Since 1946, high red fox numbers have persisted in nearly all the midwestern states, with some major range expansion occurring in the western prairie states during the late 1950's. Concurrent with high fox numbers has been the persistent decline of pheasants in the Midwest until the late 1950's.

Since 1949, Wisconsin red fox population trends have also been monitored, using an annual questionnaire survey of rural residents. The survey is free of the biases related to pelt prices. The landowner survey shows foxes increasing from the early 1950's until a peak in 1967. Subsequently, red foxes declined slightly until 1975, and have remained relatively stable (Wisconsin Dep. Nat. Resour. [DNR] unpublished data). Currently, red fox numbers in Wisconsin are similar to those reported by landowners in the late 1950's, and approximately 60% greater than those reported in 1949.

In contrast to the findings of Penrod et al. (1986) showing gray fox as an important predator of pheasants, gray foxes in Wisconsin are generally confined to rough, hilly, forested terrain where habitat for pheasants is marginal (Jackson 1961, Petersen et al. 1977). Gray foxes are not considered serious pheasant predators in Wisconsin.

Regional changes in abundance of great horned owls and red-tailed hawks are even more difficult to quantify. Both species were generally listed as "common," "regular," or "abundant" (Kumlien and Hollister 1951, Graber and Graber 1963, Gromme 1963, Green and Janssen 1975, Dinsmore et al. 1984) at the time when pheasants were greatly expanding their range and abundance during the late 1920's and early 1930's. Since 1935, Christmas Bird Counts (CBC) have usually reported wintering horned owls and redtails as commonly observed, with stable to increasing abundance (Graber and Golden 1960, James 1967, Boyajian 1968, Bock and Smith 1971, Koenig 1975, Dinsmore et al. 1984). Due to inherent flaws in CBC data, Temple and Temple (1976) used fall through spring summaries of weekly observation records in central New York to monitor 1935-72 changes in wintering birds. Their findings, however, are in agreement with CBC results showing that horned owls and redtails were common and relatively stable since 1935. Furthermore, analyses of redtail banding data from 1927 to 1967 (Henny 1972) show no significant change in mortality or recruitment rates for either species, implying population stability for redtails and horned owls over the 40-year time span throughout the contiguous U.S.

Perhaps the best available indicator of recent trends for horned owls and redtails is the Breeding Bird Survey (BBS), an annual monitoring of birds throughout North America, initiated in 1965 and jointly sponsored by the Canadian Wildlife Service and the U.S. Fish and Wildlife Service (Robbins et al. 1986). The BBS monitors trends in bird numbers by political and ecological regions. The BBS indicates that, since 1965, populations of both horned owls and redtails have been relatively stable or increasing throughout the major pheasant range. However, annual changes of pheasants and their relative abundance (i.e., the average number of pheasants observed per transect for those transects where pheasants were seen) are independent of, and therefore appear unrelated to BBS data for horned owls and redtails, suggesting no cause and effect relationship (Table 5).

Prairie states BBS data show greater relative abundance of horned owls and redtails when compared to other regions during 1965-85. Such differences could in part be due to greater ease in observing raptors in the flatter, more open terrain typical of the prairie states, but they also reflect real differences (S. Droege unpublished data). Average annual increases were substantially greater for redtails than for horned owls in the Midwest and were somewhat similar for both species in the western prairie states, while horned owls show faster gains in the eastern region (Table 5). Relative abundances by regions were averaged in 5-year

Table 5. Trends in abundance of great horned owls, red-tailed hawks, and ring-necked pheasants based on Breeding Bird Surveys (1965-85).[a]

	Mean % change/year			Relative abundance index[c]		
Region and state	**Owls**	**Redtails**	**Pheasants**	**Owls**	**Redtails**	**Pheasants**
Midwest Region						
Illinois	+2.55[b]	+3.84[b]	- 6.75[b]	0.16	0.30	11.99
Indiana	+0.21	+2.52	- 2.73[b]	0.21	0.45	4.92
Iowa	+0.93	+0.54	- 2.25[b]	0.30	0.363	4.77
Michigan	+1.90	+2.07	- 3.14	0.06	0.401	0.54
Minnesota	+2.91[b]	+6.34[b]	- 2.78[b]	0.17	0.47	5.04
Missouri	- 1.38	- 0.41	- 0.84	0.37	0.82	3.10
Ohio	+1.57[b]	+3.79[b]	- 7.84[b]	0.07	9.56	2.66
Wisconsin	- 0.01	+5.82[b]	- 2.97[b]	0.10	0.57	2.83
Region 3	+0.36	+3.23[b]	- 3.13[b]	0.17	0.46	12.06
Western Region						
Colorado	+3.66	+6.05[b]	- 0.64	0.27	0.65	19.07
Kansas	+0.63	+0.34	+3.98[b]	0.71	1.77	34.89
Montana	+2.85	+4.68[b]	- 0.25	0.23	0.73	15.92
Nebraska	+1.80	+2.03	+1.53	0.25	0.40	28.05
North Dakota	+3.10	+0.26	+3.51[b]	0.22	0.45	7.40
South Dakota	- 1.11	+2.16[b]	+0.16	0.62	0.65	20.21
Region 6	+1.09	+1.60[b]	+1.57[b]	0.32	0.75	16.43
Eastern Region						
Massachusetts	—	+0.44	- 4.94	—	0.16	2.45
New Jersey	+3.01[b]	+2.79[b]	- 8.24	0.04	0.20	2.12
New York	+1.49[b]	+0.29	- 6.46[b]	0.07	0.61	3.33
Pennsylvania	+0.87	+4.12	- 0.64	0.07	0.30	3.43
Region 5	+3.06[b]	+1.65[b]	- 2.86[b]	0.07	0.31	2.20

[a] Data source: S. Droege 1987 unpublished data, U.S. Fish Wildl. Serv., Washington, D.C.

[b] Denotes significant change.

[c] Defined as the average number of birds of a species seen/transects where that species was observed.

intervals to determine chronologies of overall increases. Horned owls appeared to show a sustained increase during 1965-85, whereas redtails were variable in abundance until a rapid increase in numbers occurred during 1980-85.

Factors responsible for increased numbers of horned owls and redtails are difficult to ascertain. Both species are generalists, utilize a wide variety of prey, and occupy a wide variety of habitats. Both raptors endured periods of persecution when shooting of predators was quite common (Graber and Golden 1960), although shooting pressure on redtails was found to be relatively small and has remained fairly constant during 1927-57 (Henny and Wight 1972). Land-use changes, coupled with a proven ability to adapt to a changing environment, perhaps play a role.

Influence of Weather on Predation

Most studies, other than those in Wisconsin, indicate that maximum predator pressure on pheasants occurs during spring (Bishop 1944, Errington et al. 1940, Latham 1950, Craighead and Craighead 1956, Petersen 1979, Wooley and Rybarczyk 1981, Snyder 1985, Penrod et al. 1986). Usually, mortality is most severe from the beginning of dispersal from winter cover through the egg-laying period (Snyder 1985, Penrod et al. 1986). Late winter storms occurring after dispersal has begun can be particularly devastating. In Colorado, Snyder (1985) consistently found the highest mortality of radio-tagged pheasants during April. In New York, Penrod et al. (1986) determined that the highest daily mortality for pheasants occurred during the pre-nesting (i.e., dispersal) period, averaging only 24 days long. However, the greatest annual mortality occurred during the longer period of complete snow cover, averaging 73 days in length in New York.

In Wisconsin, both Gates (1971) and Dumke and Pils (1973) observed that predation was greatest in winter, and of secondary importance during spring. Rates of winter predation on the Waupun Area were highly variable among years, ranging from 2 to 33% (Gates 1971). Vulnerability was governed chiefly by winter weather, particularly the depth and duration of snow cover. Studies on the Waterloo Area substantiated the influence of snow cover on pheasant predation. Predation rates averaged 50% during winters with heavy snow (Dumke and Pils 1973), whereas a period of abnormally mild winters resulted in predation rates ranging only from 2 to 5% (Petersen 1979).

The low spring predation rates on the Waterloo Area during 1968-71 (Dumke and Pils 1973) contrast with high spring rates in 1972-75 (Pils and Martin 1978, Petersen 1979). Differences were again considered to be weather related. The Waterloo Area centered on a river flood plain and, therefore, much of the early nesting cover was highly susceptible to spring flooding. Abnormally heavy spring precipitation during 1972-75 annually flooded 80% of the wetlands, flattened the residual vegetation, pushed pheasants to higher ground, and forced many hens to abandon their nests. The movement and concentration of pheasants in limited residual cover increased their vulnerability to predation, particularly from raptors (Petersen 1979). Overhead vegetative cover appears critical in protecting pheasants from raptor predation (Snyder 1985, Penrod et al. 1986). Therefore, weather-related events affecting overhead protection, particularly during periods when vegetation is at a minimum, influence losses to avian predation.

While predation may be the cause of death for many pheasants, the physical condition of the hen pheasant alters its vulnerability to predation (Craighead and Craighead 1956). While yet speculative, it appears that wet and cold weather during nesting invariably leads to prolonged renesting which, in turn, is thought to increase stress, and thus accelerate hen mortality (Buss et al. 1952, Wagner et al. 1965, Gates and Woehler 1968). Kabat et al. (1950, 1956) suggested that late nesting and renesting delay the onset of molt and the regaining of weight lost during nesting. Because molting and the regain of energy reserves requires approximately 5 months (Kabat et al. 1950, Anderson 1972), Jarvis and Simpson (1978) suggested that mortality following nesting may not occur until the following winter, when adult hens again become vulnerable to predation.

Pheasant Vulnerability to Predation

Recent studies have substantiated that predation is the leading cause of pheasant mortality, and that there has been an upward trend in hen mortality due to predation over the last 3 decades (Gates 1971, Wooley and Rybarczyk 1981, Penrod et al. 1986). Concurrently, overall hen survival appears to have declined in recent years, as well. Mean annual hen-survival determined from studies prior to 1960 was 35%, compared to an average of 25% for studies from the last 26 years (Table 1).

Wagner et al. (1965) indicated that changes in pheasant predation rates would vary with changes in predator numbers, the abundance of buffer species, or with pheasant density. As mentioned, abundance of midwestern red foxes, great horned owls, and red-tailed hawks appears to have remained relatively stable or on the increase for several decades.

In Wisconsin, the primary buffer species for all 3 predators is the cottontail rabbit (*Sylvilagus floridanus*), with mice and voles being of secondary importance (Pils and Martin 1978, Petersen 1979). Wisconsin cottontail harvest estimates show no discernible change since the early 1940's, suggesting a relatively stable statewide population (Wisconsin DNR unpublished data). Cottontail abundance in Iowa during 1963-86 also shows no discernible trends, suggesting relative statewide stability (Kinzler 1988); however, Edwards (1985) documented dramatic declines in cottontail numbers in central Illinois during 1958-78, changes believed related to substantial changes in land-use patterns. In the Midwest, pheasants have declined an average of more than 3%/year since 1985. Only in Kansas and North Dakota do pheasants show a significant increase during the last 20 years, and a positive trend is also indicated in Nebraska (S. Droege 1987 unpublished data, U.S. Fish and Wildlife Service, Washington, DC). Overall, increased pheasant predation rates observed over the past 3 decades can be explained according to Wagner et al. (1965): widespread stable to increasing predator abundance, relatively stable cottontail numbers in at least some regions, and near range-wide declining pheasant populations.

Wagner et al. (1965) discussed density-dependent predation on pheasants. Because pheasants rarely compose the major fraction of any predator's diet, it is unlikely that an increase in pheasant numbers alone is generally followed by an increase in predator density. Numerical or functional responses by predators will likely depend on the abundance and vulnerability of their primary prey. Given the possibility of annual changes in pheasant, predator, or buffer-prey numbers, all occurring partially or wholly independent of each other, and yearly differences in weather affecting prey vulnerability, it is somewhat difficult to conceptualize predation as acting as a density-dependent regulator of pheasant abundance. At best, predation might be considered imperfectly density-dependent as defined by Milne (1962). The western plains are unique in that they are the only major portion of the North American pheasant range where substantial increases in pheasant abundance can be confirmed since 1965. Such increases have occurred despite apparent high densities of red foxes, great horned owls, and red-tailed hawks.

Under more diverse landscape and habitat conditions, such as found in Wisconsin, higher predator densities could likely prevail than is true in the intensively cultivated and highly simplified agricultural habitats characteristic of the plains and prairie states. Wagner et al. (1965) postulated an inverse relationship between abundance of predators and percent of cultivated lands. While such a relationship may hold true for a collective predator community, when comparing abundance of the primary predators that relationship seems less valid (Table 5).

It is interesting to compare our concern for pheasant survival, predation, and habitat to our concern for breeding waterfowl in the prairie pothole region. Cowardin et al. (1983) indicated that the basic waterfowl management problem is low recruitment resulting from habitat destruction, operating through predation. While nest predators play a major role, an estimated 25% of nesting female ducks, and a substantial portion of the ducklings are killed annually by predators (Johnson and Sargeant 1977, Cowardin et al. 1983, Sargeant and Arnold 1984, Sargeant et al. 1984). Waterfowl predation during the breeding season has probably increased greatly since pristine times and, especially, in recent decades; changes in habitat and predator numbers appear responsible (Sargeant and Arnold 1984). Waterfowl habitat in early spring is typically present in the form of relatively small, dispersed islands in a black, cultivated desert, where breeding ducks and predators try to exist on the same range. Continuing deterioration of habitat further concentrates both predators and prey.

Pheasant vulnerability to predation does not appear to diminish with low pheasant abundance; therefore, factors in addition to density are responsible for increased pheasant predation rates. Craighead and Craighead (1956) discussed the role of prey risk-factors, which together with prey density determine the vulnerability of prey to predation. It was the combined action of both prey risk and density that determined raptor density in southern Michigan (Craighead and Craighead 1956). Risk factors are often associated with the physical condition (age, strength, speed, agility, and escape reaction) of individual prey animals. Movements, activities, and habits are other risk factors generally governed by habitat and weather. Winter behavior of pheasants in Wisconsin is greatly influenced by snow cover. During winters of heavy snow cover, pheasants gather in flocks of 15-70 birds near a reliable food source, spend a greater amount of time feeding, and are at greater risk to predation. However, with light snow cover, pheasants remain in small groups, scattered over a wide area; greater food resources are available, and risk to predation is small (Gates 1971, Petersen 1979). Only 2 of the risk factors are subject to management: availability of protective cover and food, and the associated concentration and dispersal of prey (Craighead and Craighead 1956). Management as related to these factors is defined as habitat management.

Main (1987) determined that prey vulnerability to predation decreases as habitat complexity increases, i.e., the structural complexity of preferred cover as well as habitat "quality." Habitat complexity should be viewed both at the local level and as a regional mosaic. In more northern climes, snow cover alters pheasant behavior, protects buffer species (notably mice and moles) from predation, and severely reduces the amount of secure pheasant winter habitat. Snow also destroys the structural qualities of herbaceous vegetation and, thus, impacts dispersing hens the following spring. Pheasant spring survival and nest success appear strongly related to "adequate" dispersal and nesting cover with sufficient structural qualities to conceal the hen (Gates 1971, Boyd 1981, Snyder 1985, Penrod et al. 1986). In the southern part of their U.S. range, except for an occasional winter storm of uncommon severity, pheasants are less affected by snow cover (Wood and Brotherson 1981, Warner and David 1982). However, management strategies for pheasants in the southern portion of their range parallel those of the Upper Great Lakes in that good juxtaposition of quality roosting, feeding, and mid-day loafing sites in finite amounts remain paramount (Gates 1970, 1971, Olsen 1977, Warner and David 1982, Gatti 1983).

VARIATION IN MORTALITY AND POPULATION FLUCTUATION

Information on variability in pheasant mortality and its relationship to population fluctuation stems from 2 principal sources: (1) intensive long-term studies of individual populations from which time-specific mortality rates have been measured and related to environmental influences and (2) extensive studies from which indices of mortality have been derived from regional and statewide population data. Extensive studies are more sensitive to environmental influences operating at a regional scale (e.g., land-use patterns), whereas intensive studies reflect localized influences on the behavior and survival of individual pheasant populations. Actually, the 2 types of studies are complementary. Mechanisms identified at the local level are essential to understanding responses at a regional scale and the reverse also is true. In the following discussion we consider results from both intensive and extensive studies.

Buss et al. (1952) were first to direct attention from the traditional view of winter as the most critical season of pheasant mortality. In Whitman County, Washington, good winter survival in 1949-50 resulted in a breeding population in 1950 at least as high as in 1949. In spite of good reproductive success in 1950, as gauged by the percentage of juveniles in fall, pheasant numbers in fall 1950 were 50% below 1949; adult mortality must have been higher than usual during the 1950 reproductive season. Buss et al. (1952) hypothesized that unusually wet and cold weather during the nesting season in 1950 led to prolonged renesting which, in turn, increased physical stress and thereby accelerated mortality of breeding hens.

In southwestern North Dakota, an 8-year series of regional population indices (1955-63) suggested that survival, productivity, and population trends were positively correlated with May and June precipitation (Martinson and Grondahl 1966). Under the semi-arid conditions of that region, pheasant survival was highest during and after growing seasons of above normal rainfall which, in turn, had a beneficial effect on the quality of summer, fall, and winter habitat.

In South Dakota, Dahlgren's (1963) analysis of statewide pheasant indices during 1947-62 showed a direct relationship between the level of annual mortality and the yearly change in fall populations. Winter mortality was highly variable during 1947-52, but remained generally constant thereafter. Variable rates of spring and summer mortality were principally responsible for yearly differences in adult survival after 1952. Actual causes of mortality were not identified, but fluctuating influences in the spring-to-summer environment, at least after 1952, must have been of prime importance, despite a traditionally harsh winter environment. Under the drought-prone conditions of the Dakotas, the quality of spring and summer habitat may be subject to more drastic yearly fluctuations than in states farther east, with correspondingly greater influence on pheasant survival.

In Wisconsin, Wagner (1957) and Wagner et al. (1965) concluded from statewide data that short-term population fluctuations were affected jointly by reproduction and mortality, but that the 2 were correlated through the influence of spring (prenesting) temperature. Because those workers believed that over-winter mortality was generally constant among years, some stage of the spring-to-fall interval was considered as the logical period for variation in annual survival. Based on circumstantial evidence, they isolate the late-summer period as the chief determinant of yearly hen survival trends. Wagner et al. (1965) also postulated that colder springs led to increased levels of random egg-dropping and clutch abandonment, which in turn led to poorer physiological condition of hens and higher levels of stress-related mortality after nesting.

The hypothesis regarding the phenology of pheasant mortality reached by Wagner et al. (1965) was not substantiated by subsequent intensive Wisconsin studies by Gates (1971) and Dumke and Pils (1973). Both latter investigations showed highly variable rates of winter loss, and in neither was late-summer mortality a major variable component of annual mortality. Variation in reproductive success among surviving hens played a subsidiary role in population fluctuation (Gates 1971). We therefore conclude that short-term population change in Wisconsin pheasants may be jointly dependent on winter and spring weather conditions according to the following 3-phase hypothesis:

1. Severe winter weather leads to accelerated winter mortality primarily through increased vulnerability to predation and loss of energy reserves (weight) among surviving hens.
2. Spring weight gains depend on (a) prenesting temperatures, which largely determine the rate at which energy stores can be accumulated and (b) time of winter breakup, which affects the potential period of weight gain and thus the timing for onset of egg production and possibilities for renesting.
3. Reproductive success depends on hen survival during nesting which, in turn, relates to physiological condition at the start of reproduction and to weather and cover conditions that influence predation on hens.

Kozicky et al's. (1955) analysis of weather in north-central Iowa during 1936-52 indicated that 2 successive months of below-normal temperatures between December and February precipitated a decline in pheasant abundance the subsequent autumn, as did below-normal temperatures in May and June. Severe winters were followed by population declines regardless of spring temperatures. Winter weather was thus seen by Kozicky et al. (1955) as the dominant influence on population trends, modified within certain limits by variations in spring temperatures. Their explanation for changes in population fluctuations was not greatly divergent from our hypothesis outlined above.

On Pelee Island, Stokes (1954) reported that poor survival in 1949-50, leading to a leveling-off of pheasant numbers, was associated with unusually heavy snowfall and freezing rain, which possibly took a heavy toll of wintering birds. On Michigan's Prairie Farm, hen survival between late November and early May varied from 33 to 58% during 1939-42 (Shick 1952). In the winter of heaviest loss, a mid-winter food shortage during a period of heavy snow resulted in lower hen weights than observed in winters of less snowfall (Shick 1952). In the northern prairie states, where direct loss to winter storms is paramount, mortality fluctuates from year to year (Erickson et al. 1951, Kimball 1948, Nelson and Janson 1949, Kirsch 1951, Trautman 1953, Miller 1948, Fischer 1956, Trautman 1982).

Farther south, under more benign winter conditions, the conclusion of Wagner et al. (1965), mentioned previously, may well apply. In Illinois, winter loss appears to be light in most years (Robertson 1958, Labisky et al. 1964), although population declines of 44-82% were observed to follow winter storms of unprecedented severity in east-central Illinois (Warner and David 1982). In Nebraska, a 6-year series of population data reported by Linder et al. (1960) showed that spring breeding populations of hens were a near-constant percentage of the number of chicks reared the previous summer. Such a relationship could not have prevailed unless winter mortality was not highly variable among years.

In conclusion, from this review we no longer accept the generalized hypothesis of Wagner et al. (1965:41) that "...winter loss is roughly constant, or is relatively light and variable, between most years" in the Midwest. The bulk of the evidence, at least from the northern tier of states in the Midwest, indicates to us that winter and spring losses are the major components of annual mortality, and are responsible for year-to-year changes in pheasant abundance. Under certain circumstances, winter and spring weather may also have an effect on the timing of reproduction, renesting, and survival of hen pheasants during the nesting and brooding seasons.

SUMMARY

Annual hen pheasant survival rates of 30-35% are typical of self-maintaining populations. Average annual survival of less than 30% is apparently insufficient for population maintenance, while survival higher than 40% suggests a growing pheasant population. Hen survival shows slight or non-existing age-class differences among most investigations.

Annual cock pheasant survival ranges from 7 to 34%; annual cock survival near 5% appears to be within the biological capabilities for population maintenance. Age-specific differences in survival of cocks is dependent upon hunting pressure.

Wisconsin studies suggest a long-term change in pheasant demography involving decreases in survival and abundance, and an increase in productivity—the latter insufficient to offset the decrease in survival.

Range-wide fluctuations in pheasant abundance are caused primarily by variations in hen mortality, with reproductive performance playing a subsidiary role. Hen survival has declined in recent years. Mean annual hen survival from studies prior to 1960 was 35% compared to a 25% average from studies during 1961-86.

Predation on pheasants apparently has increased substantially since the 1940's, most notably since 1960. The leading cause of hen mortality is predation, with the primary predators being red fox, great horned owl, and red-tailed hawk. Nest predators have been of secondary importance.

Predator numbers vary spatially and temporally. High numbers of red foxes have persisted since the early 1940's, while horned owls and redtails have remained relatively stable or increased in number throughout the major pheasant range since 1935. Declining pheasant numbers, along with abundant predators, have led to higher pheasant predation rates.

Low pheasant survival due to predation has resulted from habitat loss. Pheasant vulnerability does not appear to be strongly related to pheasant density, but is strongly influenced by winter snow cover and by quality and quantity of spring cover during dispersal and nesting.

Short-term population fluctuations in Wisconsin pheasants can be explained by a 3-part hypothesis: (1) severe winters lead to accelerated winter mortality and loss of body condition among surviving hens; (2) recovery to normal prenesting energy reserves depends on the timing of winter breakup and spring temperatures; and (3) reproductive success depends on the physiological condition of hens, survival during nesting, possibilities for renesting, and weather conditions that influence predation as functions of both behavior and habitat.

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CHARLES W SCHWARTZ

9

Genetic Management of North American Pheasants

RICHARD E. WARNER, Illinois Natural History Survey, Champaign, IL 61820

DAVID P. PHILIPP, Illinois Natural History Survey, Champaign, IL 61820

Abstract: Hypothetical scenarios are presented to illustrate possibilities for using genetic information to develop management strategies for wild and captive pheasants (*Phasianus colchicus*). Scenarios of genetic change consider natural and man-induced phenomena as they relate to abundance, dispersal, hunting, sex ratios, abundance and possible inbreeding depression in captive, founding, and wild populations. Objectives are outlined for a cooperative range-wide pheasant genetics investigation. Interim suggestions are offered for sustaining genetically adequate numbers of breeding pheasants on game farms and, also, for wild pheasants during periods of low abundance and in areas of limited local distribution.

Key Words: abundance, ecology, genetics, *Phasianus colchicus*, population, ring-necked pheasant

This article outlines steps leading to the integration of genetic information into programs of pheasant management. These steps address a series of questions. First, are extant concepts in genetic conservation applicable to pheasants? Second, in order to foster genetic variability and prevent its loss, what practices should be encouraged or prevented? Third, how should future research on pheasant genetics be structured? And, finally, what results can reasonably be expected from pheasant genetics investigations?

North American Pheasant Range and Stocks

Wild pheasants have now been established for 25-100 generations over most of their present range in North America. Vegetative characteristics of much of today's pheasant range only superficially resemble that into which founding populations were introduced, and certainly differ from endemic ranges in Asia. Pheasant range in North America is ecologically diverse, although races of wild *P. colchicus* over evolutionary time no doubt also inhabited diverse and dynamically changing Eurasian grasslands.

Status of Genetics Information and Research

Pheasants brought to England and central Europe by the Romans as early as the first or second century may be ancestral to stock introduced successfully in North America (Johnsgard 1986). Clearly, the history and status of pheasants on this continent and elsewhere portray unique challenges and uncertainties relative to genetic management. Little is known of how gene pools of pheasants in North America compare with those of extant endemic populations in Asia (Delacour 1977)—whatever their current status may be—or even with ancestral stocks as they exist in Europe.

In some states, more or less continual mixing of game-farm stocks of diverse origins with established wild bloodlines has been the norm, not the exception. A plethora of propagation and release programs still persist, of so-called "Sichuan" pheasants in Michigan, for example (Prince et al. these Proceedings). From the perspective of natural selection, and given the more or less continuous changes in land use, it seems unlikely that sufficient time has elapsed for a clear emergence of co-adapted gene complexes in North America. Genetic variability between and among pheasant groups on this continent would, in large part, reflect characteristics of vaguely documented founding and subsequently released racial stocks. At present, there is little basis beyond the occurrence of locally diverse phenotypes on which to postulate racial identities. Unfortunately, meristic and morphometric data are not sufficient for the task of identifying racial origins (Trautman 1982, Warner et al. 1987).

Although North American and European racial stocks have been the subject of considerable work in systematics (Schultz and Church 1972, Gutiérrez et al. 1983, Helm-Bychowski and Wilson 1986), wildlife biologists have not been quick to apply emerging genetics concepts to questions of pheasant management. While much reduced in abundance in many regions (Dahlgren these Proceedings), pheasants are in no real danger of extinction and—with the possible exception of greater prairie-chickens (*Tympanuchus cupido pinnatus*) (Westemeier these Proceedings) and gray partridge (*Perdix p. perdix*) (Kimmel these Proceedings)—are of little perceived threat to other species. Aside from a few basic studies of systematics, however, recent demands for better pheasant management have not been sufficient to direct the limited resources available to genetics research.

Definitions of Some Genetic Terms

Allele—1 of 2 or more forms of a gene; the inherited combination of alleles determines certain characteristics of individuals.

Ecotype—a genetic race that possesses distinct morphological and/or physiological characteristics and is found in a particular location or habitat.

Effective Population Size (N_e)—the size of an "ideal" (for our purposes, hypothetical) population that would have the same rate of inbreeding and decrease in genetic diversity due to genetic drift as in the population of *N* individuals being studied; N^e is usually <N because of such factors as unequal sex ratios, non-random distribution of offspring, or non-random mating.

Fitness—relative survival value and reproductive capability of a genotype in comparison with other genotypes in a population.

Fixation—the process by which some alleles are eventually lost from the population through random genetic drift (allele frequencies of 1 generation are usually not exact duplicates of those of the parental generation).

Genotype—genetic identity of an individual.

Genetic Drift—occurs where allele frequencies of any single gamete sample deviate from those of the parental generation. Some alleles are eventually lost, with greater rates of loss occurring where N^e is small.

Genetic Variability—diversity of the gene pool, including within- and among-population variability, both of which can bear upon natural selection and, ultimately, upon the persistence of a population.

Heterozygosity—the condition in which an organism possesses different alleles of the same gene at the same locus on homologous chromosomes.

Homozygosity—(opposite of heterozygosity) can lead to lower fitness of individuals, loss of additive variability in populations, and an increase in recessive deleterious alleles.

Inbreeding Depression—reduction in fitness or vigor of a population due to inbreeding of normally outbreeding organisms; inbreeding allows for increased expression of deleterious, typically recessive, alleles.

Mixing—introduction, as a result of dispersal or release, of individuals into other breeding populations having somewhat different genetic backgrounds.

Phenotype—the physical expression of a genotype, often related in part to environmental influences.

Population—refers to a group of pheasants exchanging genetic material during a given period of time.

(See Schonewald-Cox et al. 1983 and Chapman 1985 for more information pertaining to the above terms.)

CONSIDERATIONS IN GENETIC MANAGEMENT

Conventional Models of Genetic Conservation

Conventional models of heredity assume genetic equilibrium as a starting point, i.e., the Hardy-Weinberg model. Such models assume that allele frequencies for a given population of organisms do not change between generations (Chambers 1983). In reality, allele frequencies do shift because of such factors as genetic drift, fixation, mutation, selection, dispersal and changing effective population size, all of which affect the rate of inbreeding (Schonewald-Cox et al. 1983). For example, mutations are believed to occur at a rate of about 10^{-5} per gene per generation. For vertebrates, rates of that magnitude would not be rapid enough to offset the loss of variability from genetic drift, unless effective population size is quite large, i.e., >25,000 (Crow 1985).

At least theoretically, a diminution of genetic variability would be accompanied by increased homozygosity and could lead to reduced fitness, increased frequency of deleterious alleles, and even inbreeding depression (Philipp et al. 1983, Meffe 1986). Thus, genetic conservation of wild vertebrates has emphasized the prevention of decay in heterogeneity resulting from reductions ("bottlenecks") in effective breeding size (N^e) and dilution of co-adapted gene complexes by mixing stocks—something often associated with propagation and release efforts (Meffe 1986). Although inbreeding depression could be critical (Chapman 1985), its actual significance is not well documented for wild vertebrates (Templeton and Read 1983). It is also clear that: (1) many populations have at some (many) point(s) in evolutionary time survived—if not thrived—from founding numbers much smaller than what would theoretically seem optimal (Lewontin 1985), (2) highly inbred populations may quickly regain variability (Lewontin 1985), and (3) potential for rapid increase in genetic variability is recognized for domestic animals (Chapman 1985). In fact, there is now interest in cyclic inbreeding as a way of increasing and redistributing genetic variability in domesticated animals (Pirchner 1985).

Conventional models used in genetic analysis (Schonewald-Cox et al. 1983) may or may not be applicable to pheasants. For example, assumptions of stable environments, stable abundance and random breeding are mathematically convenient, but unrealistic for wild, or even confined animals (Chapman 1985). Assumptions for constant and uniform harem size for pheasants are similarly unrealistic. The variable interactions of individuals, environments and interventions by man produce responses not accounted for in simple models of genetic change (Hohenboken 1985). As more and better information becomes available, generalizations concerning the roles of natural selection, mutation, behavior, stability, closure, and historical accident will probably not hold (Lewontin 1985).

For pheasants, patterns and variations in behavior lack careful description, although their breeding system appears to be dynamic, with more-or-less frequent mixing of individuals among local mating groups. Variable mating behavior of individuals, and the long period of viability of sperm following mating, underscore the need for more facts in future considerations of hypothetical changes in N_e. However, regardless of how well the reproductive patterns for pheasants are documented in the future, the complex mating behavior of pheasants (Ridley and Hill 1987) will likely restrict the use of simple mathematical formulae for computing N_e to carefully defined situations.

Given that ring-necked pheasants hold special challenges (and opportunities) for genetic research, and that conventional models for genotypic change appear too simplistic for wide application, genetic analysis that will ultimately enlighten pheasant management has a long way to go. Nonetheless, alterations in gene frequencies do occur, and the potential for the diminution and expansion of genetic variation and fitness are real. Further, factors potentially leading to a loss of genetic variability in small isolated populations are clear, even if there are uncertainties in how to frame algorithms that describe such changes over time.

Interim Considerations

If and where the loss of genetic variability from inbreeding might occur, physical and behavioral factors would interact to determine N_e. The theoretical increase in inbreeding per generation is computed as $\frac{1}{2}N_e$ (Meffe 1986); accumulated inbreeding, F_t, over a number of generations is expressed as $F_t = \frac{1}{2}N_e + (1-\frac{1}{2}N_e)Ft\text{-}1$, where t is the breeding period (Chesser 1983). To estimate F_t, factors affecting the degree of isolation between potential mates are cast within a set of numerical probabilities, sometimes termed "neighborhood effective size equations" (Chesser 1983). For pheasants, it is also necessary to account sex ratio, N_e for each breeding interval, and the average dispersal radius (d). Effective population size with respect to sex ratio is computed as N_e =

$(4N_m N_f)/(N_m + N_f)$, where N_m is the number of males and N_f is the number of females (Meffe 1986); where there is dispersal, the effective population size (neighborhood effective size) is $N_d = 4Pi(N_e \times d^2)$ and d is again the dispersal radius (Chesser 1983).

These equations are generic, in that they represent information obtained for a variety of plants and animals (Chesser 1983, Chapman 1985, Meffe 1986). Generic assumptions include: (1) random mating or assignment of individuals to harems, (2) uniform harem sizes during and among breeding periods (t), (3) no intermingling of members from different harems, and (4) dispersal radii reflecting a normal distribution, such that the mean dispersal radius (d) has predictable variance properties. With the assumption of a normal distribution, by definition 39% of all pheasants would reproduce within the radius d, 87% within 2d and 99% within 3d (Chesser 1983). While assumptions are simplistic when applied to pheasants, the use of models nonetheless allows insight into the possible significance of variations in sex ratio, harem size, N_e and isolation of breeding pheasants. Besides, even though dispersal distances, e.g., are not normally distributed, normal distributions can often be reasonably approximated by data transformation, i.e., by working with logarithms of dispersal distances.

Model I: Importance of Dispersal

Model I considers the effect of dispersal (mixing through egress and ingress) on accumulated inbreeding in a small, semi-isolated, wild pheasant population. A total of 100 pheasants is assumed to be breeding in a given area each year for 10 generations; harem size is 4 (i.e., a sex ratio of 1 cock: 4 hens); it is assumed that ingress equals egress. In this model, the effective breeding population, $N_d = 4 \text{ Pi} \times N_e \times d^2$, $N_e = (4 N_m N_f)/(N_m + N_f)$, d is the average dispersal radius; dispersal radii were 0.5 and 1.0 mile (0.8 and 1.6 km). By construct of the formula, when d = 0.5 mile (0.8 km), 39, 87, and 99% of the birds would move no farther than 0.5, 1.0, and 1.5 miles (0.8,1.6,2.4 km), respectively, from where they were hatched to where they reproduced. In like manner, when d = 1.0 mile (1.6 km), 39, 87, and 99% of the birds would breed within 1.0, 2.0, and 3.0 miles (1.6,3.2,4.8 km), respectively, of where they were hatched. The accumulation of inbreeding is computed as $F_t = ½N_d + (1-½N_d)F_{t-1}$, where t represents a given generation.

Implications from Model I (Fig. 1) are first that within contiguous range, dispersal over 5-10 generations appears sufficient to mitigate any accumulated negative effects of inbreeding in groups of pheasants having a small N_e, and second, a significant loss of genetic variability is difficult to envision over relatively contiguous pheasant range given the innate dispersal of wild pheasants (Warner these Proceedings). For a founding

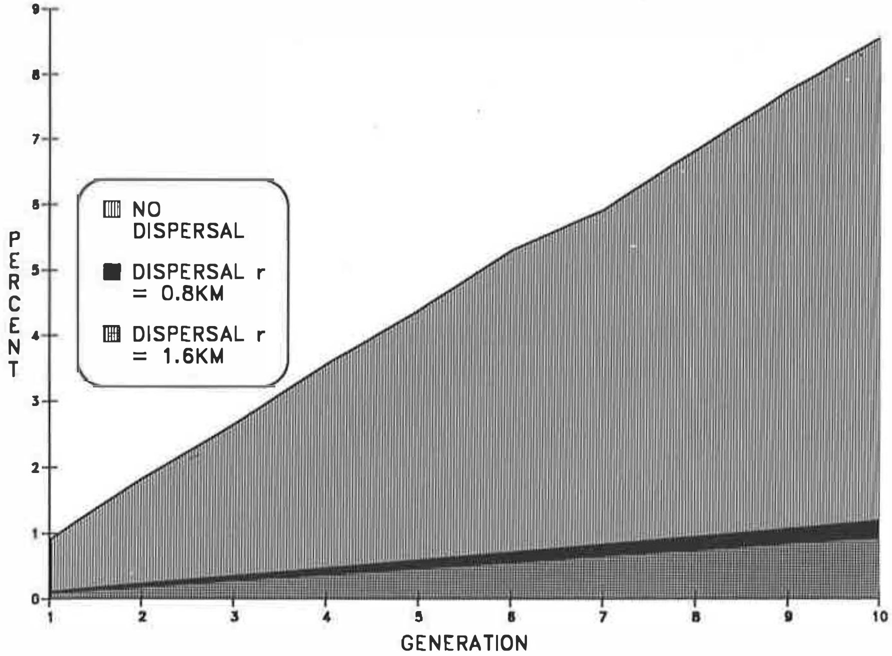


Fig. 1. Model I—effects of dispersal on accumulated inbreeding in a small population; $N = 100$ annually, with a harem size of 4. With average dispersal radii of 0.5 and 1 mile (0.8 and 1.6 km), 87% of the birds breed within 1 and 2 miles (1.6 and 3.2 km), respectively, of the location of hatch.

group of pheasants that remains small and isolated over several generations, however, accumulated inbreeding might possibly reduce genetic heterogeneity (Fig. 1). Historically, it seems that founding populations of pheasants have either rapidly expanded both numbers and range—thus gaining heterogeneity within a few years—or dwindled into extinction; this scenario is consistent with results predicted by Model I. In effect, genetic heterogeneity tends to increase or decrease with abundance.

Model II: Sex Ratios and Abundance

Model II explores the effect of harem size on accumulated inbreeding for a small, declining, semi-isolated wild population. Initially, $N = 100$, with a reduction of 10 breeding individuals per year. Random breeding was assumed for constant harem sizes of 2 and 10; N_e and N_d were computed as in Model I, with an assumed $d = 0.6$ mile (1.0 km). By construct, 87% of the birds would produce young within 0.9 mile (1.7 km) of where they had hatched.

The results of Model II suggest that, with a harem size of 2 (reasonable for a small group of pheasants), accumulated inbreeding would be <2% in 10 years (Fig. 2). However, if harem size averaged 10, the effects of accumulated inbreeding could have a negative impact on a small semi-isolated population. Thus, ramifications of high sex ratios are a matter of obvious concern in managing reproduction in small captive flocks. Granted, there would be very few (if any) small, semi-isolated groups of wild pheasants that would experience a sufficiently high percentage of cocks being taken by hunters to result in a harem size of 10. However, if observed, low cock:hen ratios could signify a potential loss of genetic heterogeneity.

Together, these hypothetical models suggest that managers should consider the possible loss of genetic heterogeneity when dealing with small, reproductively isolated groups of pheasants—wild or captive. The possibility of loss of genetic heterogeneity is compounded where 2 or more of the following conditions exist: (1) highly distorted sex ratios, (2) small numbers of birds, and (3) isolation from genetic mixing—especially for small captive flocks maintained for several generations without introducing new bloodlines.

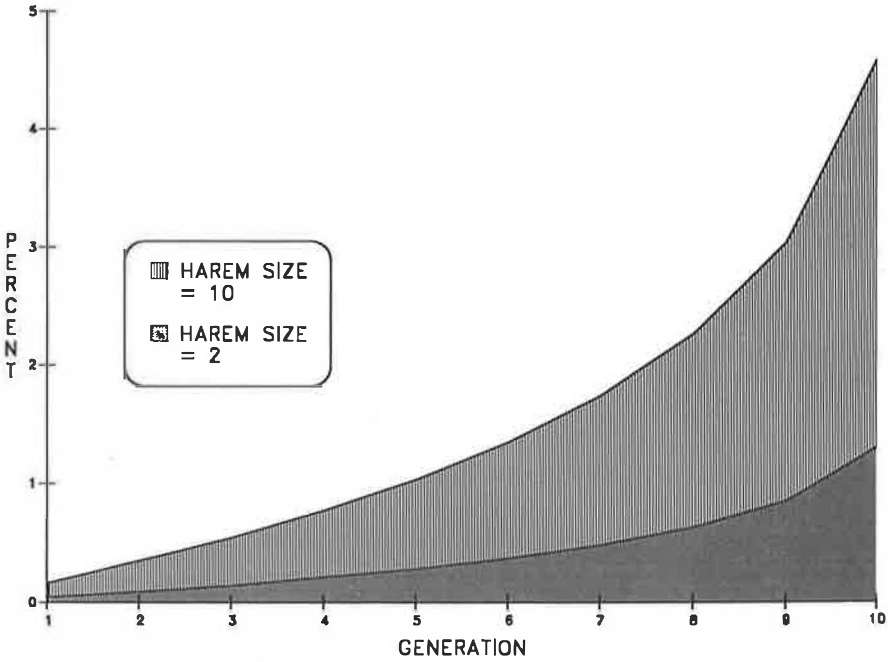


Fig. 2. Model II—effects of sex ratios and a declining small population; $N = 100$ in year 1 and declines by 10 individuals annually. The average dispersal radius is 0.6 mile (1.0 km), and 87% of the birds breed within 0.9 mile (1.7 km) of the location of hatch.

Pending more detailed genetic analyses of pheasant stock, we suggest the following for genetic management of game-farm and wild pheasants.

Short-term Management Strategies

1. **Pheasants on Game Farms.**—Although 1 male can maintain fertility of eggs from numerous females, N_e will become reduced as harem size increases (Fig. 2). Therefore, for maintenance of genetic diversity in breeding flocks of <100 females, wild or captive, managers should avoid high cock:hen ratios. In addition to maximizing N_e, managers should plan for regular out-crossings of confined birds (Templeton and Read 1983, Meffe 1986), and the addition of stock from wild genotypes should also be considered (Schonewald-Cox et al. 1983). Further, where propagation is for the eventual release of game-farm stock, selection of breeders should not necessarily proceed on the basis of characteristics such as body size, plumage, clutch size or catchability—characteristics that may not at all relate to fitness in the wild (Meffe 1986).

2. **Wild Pheasants.**—Maladaptive gene complexes can persist as recessives over many generations (Meffe 1986). Mixing of genotypes may produce robust F1 stock, but subsequent generations might well show a reduction in fitness and the loss of desirable co-adapted gene complexes. Pending more information, pheasants that would potentially cause dilution of co-adapted gene complexes should definitely not be introduced into reasonably secure wild flocks. Also, in order to help maximize N_e in small, semi-isolated flocks of wild pheasants, intensive hunting of cocks should be prevented—at least pending better information. Given the harem-like breeding behavior of pheasants, breeding sex ratios of 50:50 would not be expected even in the absence of hunting, thus limited hunting of cocks would normally be permissible.

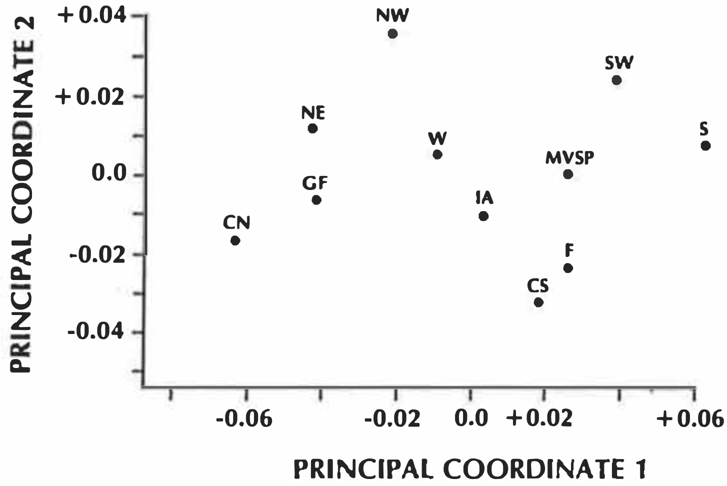
Long-term Goals of Pheasant Management

Because of their diverse racial origins and unique history, management of pheasants in North America could well benefit from a comprehensive effort to determine the extent of genetic variation within breeding populations and the occurrence of regionally or locally distinct genotypes. Range characteristics and performances of populations that show potential genetic differences should be characterized. Delineations of regional genotypes would be a basis for criteria for identifying where the future mixing of various stocks may, or may not be appropriate. Improved techniques for protein electrophoresis and restriction endonuclease-fragment analysis of mitochondrial DNA (mtDNA) offer new possibilities for detailed genetic analyses of pheasant stocks. With recent techniques in mind, we offer the following recommendations.

1. Techniques for Analysis of Pheasant Genetics.—The first step is to identify laboratory procedures that best detect genetic differences. Warner et al. (1987) recently used starch-gel electrophoretic procedures to quantify allelic variation at 41 enzyme loci among samples of wild and game-farm pheasants from Illinois and Iowa. Findings indicated that protein electrophoresis has promise for delineation of genetic differences both within and among groups (Fig. 3). Techniques for assessing more subtle changes in DNA sequences, such as mtDNA, appear particularly promising for evaluating genetic divergence and well-suited for comparing present North American pheasant genotypes with endemic races in Asia (Schultz and Church 1972, Helm-Bychowski and Wilson 1986, Mack et al. 1986).

2. Inventory of Wild and Game-farm Pheasant Genotypes.—Effective management of any species requires knowledge of the degree and structure of genetic variation within and among subgroups of organisms. States should work cooperatively to evaluate the potential for a comprehensive inventory of the genotypes of wild and game-farm pheasants in North America.

3. Inventory of Historic Stocks.—An estimate of the total genetic variation of *P. colchicus* necessarily includes consideration of both historic European stocks and extant endemic Asian stocks. Only through genetic evaluation of possible founding stocks can the genetic structure of North American pheasant populations be put in proper taxonomic and,



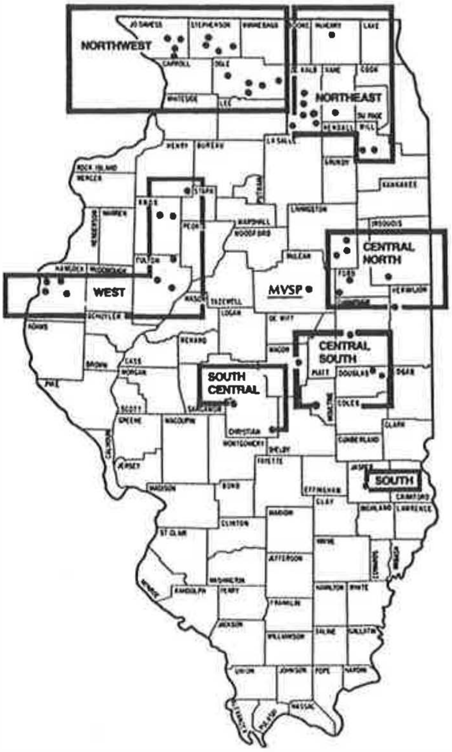


Fig. 3. A principal coordinates analysis of relative genetic distances for pheasant populations in Illinois and for 1 in Iowa, based on analysis of phenotypes of 41 enzyme loci (after Warner et al. 1987). Locations of samples are noted on the map. MVSP is Moraine View State Park; IA is Wayne County, Iowa; NW is northwest; NE is northeast; CN is central-north; CS is central-south; S is south; W is west; SW is southwest; GF is game-farm stock; and F is a first filial cross of the game-farm x wild pheasants from the southwest region.

thus, ecological perspective. Although wildlife managers may be tempted to justify such an endeavor simply on the potential value of introducing new, or reintroducing recently extirpated stocks, such justification may, or may not, ultimately prove appropriate. Documentation of where endemic Asian genotypes have persisted and how they have responded to environmental change is per se justification for genetic evaluation.

4. Genetic Analysis of Sympatric Species.—Because of the meager historical documentation of racial types that resulted in range establishment, probable racial mixing and the relatively recent exposure of pheasants to rapidly changing land use, interpretation of genetic differences among wild populations must be made with caution. A genetic analysis of 1 or more sympatric endemic species—the bobwhite quail (*Colinus Virginianus*), for example—would enhance comprehension of how pheasants, and wild vertebrates in general, vary genetically and respond to changing land use and other environmental conditions.

5. Breeding Ecology and Population Genetics.—Models describing changes in genetic variability over time are currently based on assumptions regarding: (1) stability, (2) closure, (3) behavior, (4) dispersal, (5) aspects of population ecology, and (6) management programs. The validity of such assumptions is critical and, for now at least, too often unknown. In order to construct viable genetic models, the behavioral ecology of pheasants must be defined more clearly, particularly as it relates to innate dispersal and harem/territory formation.

CONCLUSIONS

New concepts pertaining to the genetic management of wild vertebrates are emerging. It is clear that there have been situations where species have survived drastic reductions in numbers or colonized at low densities without apparently suffering the effects of inbreeding depression predicted by conventional genetic models (Meffe 1986). Recent research findings in agriculture and animal husbandry indicate that genotypes can change dramatically in small, isolated populations over only a few generations (Pirchner 1985). The stability (or lack thereof) of breeding systems, genome organization, and breeding mode all influence genetic variability (Lewontin 1985).

What can reasonably be expected from pheasant genetic research? First, emerging techniques, such as mtDNA analysis, should afford useful insights into how pheasant genotypes in the U.S. currently compare with probable ancestral types in Europe and in Asia. Second, parallel studies (if possible) of how endemic races of pheasants in Asia exist relative to current land use have implications for fitness of those and similar genotypes in North America. Third, work in fisheries (Philipp et al. 1983, Meffe 1986, Ryman and Utter 1987) suggests that identifiable locally adapted pheasant ecotypes may now be present or eventually occur in North America, and should be protected from potentially negative effects of mixing with other stocks. Fourth, studies integrating reproductive behavior and genetics (e.g., Gibson and Bradbury 1985) may give insights into what genes affect fitness characteristics of wild North American pheasants, and may, therefore, lead to better management strategies. Perhaps most important, these steps would foster an approach to pheasant management in which genetic considerations would be an integral part.

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10

Dimensions of Quality Pheasant Hunting

THOMAS A. HEBERLEIN, Center for Resource Policy Studies and Programs, Department of Rural Sociology, University of Wisconsin, Madison, WI 53704

Abstract: A sample of 287 Wisconsin pheasant hunters was presented 6 scenarios that described different hunts. Lists of elements which enhanced or detracted from hunts were generated from nominal group sessions, and showed that human elements (e.g., relations with members of their own or other hunting parties, landowners, and conservation officials) were considered to most enhance or detract from hunt quality. Respondents showed substantial agreement about elements constituting a high- vs. low-quality hunt, indicating that it is possible, via questionnaire surveys, to determine what factors hunters consider constitute hunting quality. While most hunters rated losing cripples as a serious detractor, wildlife-related dimensions, including bagging game, were rated as desirable but not necessary for a quality hunt.

Key Words: hunting, pheasant, quality

When managing game species, wildlife managers are implicitly managing recreational experiences for human predators. The question of hunting "quality" is central to recreational concerns. But what is hunting quality? Can it be defined and can it be managed? The answers to such questions are elusive. This paper reports findings from a survey of a random sample of persons who reported hunting pheasants in Wisconsin in 1980, focusing on the question of hunting quality from the hunter's viewpoint.

The production orientation of game management has typically assumed that more wildlife produces better hunts in a relatively linear fashion. Leopold (1949:130) noted the fallacy of such thinking when, in *Thinking Like a Mountain*, he commented: "I thought that because fewer wolves meant more deer that no wolves would mean hunters paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view." Just as ecological relationships represent complex interactions, so, too, do recreational experiences. One way to explore complex questions is to use opinion surveys. Hunters can be queried systematically to reduce sampling bias. Asking exactly the same questions of each hunter gives a data base that allows more systematic testing of hypotheses.

Most studies of hunters from a psychological orientation have focused on differences among individual hunters, and on the multiple satisfactions of hunting (Hendee 1974, Potter et al. 1973). Unfortunately, a focus on individual differences masks characteristics shared by various segments of the hunter population. The goal of the work reported here was simply to see if pheasant hunters have shared definitions of hunt quality, and to what degree various elements contribute to hunt quality.

METHODS

The Sample Frame

A 2-step process was used to obtain a sample of Wisconsin pheasant hunters. In 1980, there were 437,540 hunters with a license valid to hunt pheasants; "small game" licenses were held by 184,861 persons, while 252,679 more held "sportsman" licenses, both of which allowed hunters to hunt small game, including pheasants. Not all small game or sportsmen's license holders hunted pheasants, however, so a screening procedure was used to identify a sub-sample of those persons hunting pheasants in Wisconsin in 1981.

Initially, the Wisconsin Department of Natural Resources (DNR) used random sampling procedures to draw a primary sample of 10,033 names from the population of 437,540 potential pheasant hunters. License holders in 25 counties were arbitrarily eliminated from this primary sample because of a low level of participation in pheasant hunting by persons living in those counties. This reduced the sampling frame to 8,026, which included 3,730 small-game license-holders and 4,926 sportsman's license holders; 800 names and addresses were then drawn at random from the pool of 8,026 in a fashion that assured geographical representation. The sub-sample of 763 license holders was sent a screening post card on November 25, 1981, and asked to indicate the types of game they hunted in 1981; of these, 459 (60%) responded; 288 (62%) of the respondents indicated that they had hunted pheasants in 1981. These 288 individuals thus became the sample for the pheasant-hunter questionnaire survey.

The survey consisted of an advanced letter mailed the first week of December, a questionnaire mailed on December 15, a reminder post card mailed to arrive 3-5 days after the questionnaire, a follow-up letter mailed 10 days later to non-respondents and, finally, a second copy of the questionnaire sent by certified mail to those who had not responded by January 15. Using these 5 mailings, 242 (84% of 287 questionnaires; 1 was undeliverable) were returned completed; all returns were used in the analysis.

Scenarios

As part of the questionnaire, hunters were given 6 different scenarios (Table 1) which briefly described pheasant hunts, and were asked to rate the quality of each on a 5-point scale. They were also asked to indicate elements that added to or detracted from the quality of the hunt described by a given scenario.

Table 1. Summary of 6 hypothetical pheasant hunting scenarios evaluated by Wisconsin pheasant hunters.

Pheasants Bagged:

Scenario 1.—You hunted on your own land, or on a friend's land, with an old friend, using a good, well-trained dog. There were lots of pheasants, your friend killed 2 cocks—one with exceptionally long tail feathers—you made a difficult double, and the dog made a difficult retrieve; no birds were crippled and lost.

Scenario 2.—Farmers near the public area that you were hunting on had been picking corn and a lot of birds had moved onto the area, which you had all to yourself. In an hour you located 6 pheasants, half of them roosters. You killed 1 on the rise, missed 1, and bagged a second with 2 shots. Your dog worked well.

Scenario 3.—You hunted with your dog on a public area, saw 2 cocks and a hen, you missed the first cock and bag the second, and your dog did OK and got birdy several more times, which is the normal thing for him. Other hunters were nearby, but created no problems.

Pheasants Not Bagged:

Scenario 4.—You hunted a familiar public area with your dog. There were numerous other hunters, but by being careful you avoided problems. You took a tough shot in heavy brush but missed. The dog was birdy a couple more times, but got a deep cut on a toe, and you came home.

Scenario 5.—You and your dog hunted hard on a public area but found no birds. Other hunters were nearby and at least once were in the spot that you wanted to hunt. The dog seemed confused by the other hunters. You left the area and on the way home stopped to hunt on private land, but before you saw any pheasants, the landowner made you leave.

Scenario 6.—You and your dog went to a nearby public area. The area was fairly crowded when you began hunting. There were soon more hunters than you ever saw there before. One group tried to beat you to all the good looking cover and you had words with them. Your dog disappeared and you found him in a pasture chasing cows. You went home without seeing any pheasants.

Quality Attributes

To gain a better perspective of what attributes might constitute a quality hunt, a list of 31 attributes which could enhance hunting quality, and 27 others which might detract from hunting quality, were included on the questionnaire. These attributes had been generated from 6 nominal group discussions by wildlife managers of the Wisconsin DNR; those managers were also hunters. These attributes reflected 4 domains: (1) wildlife, (2) nature, (3) human, and (4) equipment. For each attribute that potentially enhanced hunt quality ("enhancers"), respondents were asked to indicate whether it was necessary, important, helped, or made no difference in hunt quality. For each "detractor" attribute, respondents were asked whether it definitely detracted, tended to detract, may detract, or made no difference to hunt quality.

Findings reported here were generated from judgments offered in response to hypothetical situations described in a questionnaire. Both the method used and conclusions drawn point to general procedures which may hold well across a range of samples. It is desirable that the method used be replicated and tested further on a larger sample of hunters.

FINDINGS

Responses to the Scenarios

Respondents agreed on which scenarios characterized high and low quality hunts. Almost 90% rated Scenario 1 as a very high-, and Scenario 6 as a very low-quality hunt (Table 2). In Scenario 1, good dog work, hunting with an old friend, the double, and hunting on one's own land enhanced quality for at least 40% of the respondents, while getting a limit was rated as an enhancer by 17% (Table 3). Bagging (42% in

Table 2. Respondent ratings of quality of scenarios of 6 hypothetical pheasant hunts.

	Very high	High	Average	Low	Very low	$\bar{x}$
Scenario 1	89	8	3	0	0	4.9
Scenario 2	52	32	13	3	0	4.3
Scenario 3	10	39	40	4	1	3.6
Scenario 4	0	6	35	43	18	2.3
Scenario 5	0	0	10	35	55	1.6
Scenario 6	0	0	3	9	88	1.2

Scenario 2) was viewed as less important than seeing pheasants (58% in Scenario 1). In Scenario 2, seeing many pheasants was rated as an enhancer by 58% of the respondents, whereas bagging a limit was listed as an enhancer by only 25%. By far the most frequently indicated detractor (by 76% of these responding) was missing a shot, while 40% said that hunting on public land detracted from quality (Table 3). In Scenario 3, which offered few details, few elements appeared to particularly detract or enhance. Of the elements considered in Scenario 3, the most frequently indicated detractors were missing a shot and the presence of other hunters.

In Scenario 4, where the hunter did not bag a bird, seeing pheasants added to quality as did getting a shot (Table 3). Missing, rated as a detractor by 72% in Scenario 3, was only rated as a detractor by 27% in Scenario 4. In the latter scenario, the presence of numerous other hunters and dog problems reduced the quality of the hunt. Not bagging a bird was rated as a detractor by only 175 of the hunters in Scenario 4.

Table 3. Elements that respondents indicated to add to, or detract from, the quality of pheasant hunts.

Element	**Add %**	**Detract %**
Scenario 1		
Good dog work	47	3
Hunt with old friend	45	9
Shoot a double	42	13
Own the land	40	9
Hunt wild pheasants	33	16
Hunt improved cover	29	8
Bag a trophy bird	27	18
Bag a limit	17	15
Hunt over your own dog	16	6
Partner shoots a limit	15	21
The pheasants are "tricky"	13	39
Scenario 2		
Lots of pheasants	58	5
Good dog work	42	4
Shoot at pheasants	39	3
Hunt over your own dog	29	5
Bag a limit	25	7
No other hunters	23	25
Hunt on a public area	11	40
Miss a shot	0	76
Scenario 3		
See pheasants	55	1

Table 3 (continued).

Element	Add %	Detract %
Bag a pheasant	42	2
Shoot at pheasants	38	1
Hunt over your own dog	35	1
Dog work "OK"	30	4
Hunt on public area	8	21
Other hunters nearby	2	49
Miss a shot	2	72
Fail to get a limit	1	37
Scenario 4		
See 2 pheasants	82	3
Take a shot	60	4
Hunt over your own dog	34	6
Hunt on public area	11	15
Have a dog problem	4	61
Hunt on a crowded area	4	73
Miss a pheasant	3	27
Fail to bag a pheasant	2	17
Scenario 5		
Hunt over your own dog	56	2
Hunt hard	49	6
Hunt alone	39	6
Hunt on public area	25	7
Other hunters nearby	5	36
Interference from other hunters	4	50
Your dog distracted by others	3	24
No pheasants seen	3	34
Told to leave private land	3	50
Scenario 6		
Hunt on a public area	61	5
Hunt over your own dog	58	9
See no pheasants	7	22
Problem with your dog	6	41
Crowded hunting area	6	56
Fail to bag a pheasant	5	5
Problems with other hunters	5	80

In addition to seeing no birds and having a problem dog, the quality of the hunt in Scenario 5 was lowered by interference with other hunters, and by the hunters being ordered off private land. Dogs, however, added to the quality of a hunt, as did hunting alone and hunting hard (Table 3). In Scenario 5, hunting on public land was seen as an enhancer rather than as a detractor, as in Scenario 2. In Scenario 5, seeing no birds was considered a detractor by 34% of the respondents, while interference by other hunters was treated as a detractor by 50%, as was being "kicked off" private land.

The worst-rated hunt, Scenario 6, was made so by problems with other hunters, crowding, and dog problems. Hunting on a public area and being accompanied by a dog were the only positive attributes in what 9 out of 10 respondents rated as a very low-quality hunt (Table 3). Seeing no birds (Scenario 6) was rated as a detractor by 22% of the respondents.

Enhancer Elements

Seven elements were rated as necessary for a good hunt, 4 of which fell in the area of human conditions (Table 4). The 4 elements indicated as being necessary for a high-quality hunt were (1) safe hunting practiced

Table 4. Respondent ratings of elements that potentially enhance pheasant hunts.

		Percent of respondents			
Element	**Domain**	**Nec.[a]**	**Imp.**	**Helps**	**No diff.**
1. Necessary for a high quality hunt					
Safe practices	Human	71	24	4	1
Permission to hunt	Human	60	26	13	1
Equipment (function)	Equipment	58	37	5	0
Good companions	Human	50	41	8	1
No cripples	Wildlife	46	40	10	4
Equipment (type)	Equipment	46	39	14	1
Arrest	Human	46	39	19	8
2. Important to quality of hunt					
Beauty in nature	Nature	32	38	24	6
Good health	Equipment	30	46	23	2
Place to hunt	Human	33	41	23	3
Escape to field	Nature	32	38	24	6
Sportsmanship	Wildlife	26	38	22	13
Good dog	Equipment	26	35	30	10
Birdy cover	Nature	22	39	36	3
Outdoor exercise	Nature	22	44	27	8
3. Help improve hunt quality					
Getting a shot	Wildlife	21	35	39	4
Outsmart a pheasant	Wildlife	17	37	39	8
Knowing the area	Nature	17	33	40	10
Crisp autumn day	Nature	16	36	38	10

Table 4 (continued).

Element	Domain	Percent of respondents			
		Nec.[a]	Imp.	Helps	No diff.
Know local people	Human	9	39	43	10
Being comfortable	Equipment	12	30	45	13
Bag a pheasant	Wildlife	12	20	60	8
Make excellent shot	Wildlife	11	29	43	17
See other wildlife	Wildlife	11	25	46	19
Hunt with a group	Human	11	23	41	26
Moderate temperature	Nature	8	23	50	20
No other hunters	Human	5	19	46	31
Trophy pheasant	Wildlife	3	12	48	37
Shoot limit	Wildlife	11	25	46	19
4. Make no difference to hunt quality					
Empty parking lot	Human	0	8	34	59
Outshooting partner	Human	0	2	13	34

[a] Nec. = necessary, Imp. = important, diff. = difference.

by others, (2) having permission when hunting on private land, (3) knowing and trusting one's hunting companions, and (4) no worries about violation of hunting regulations. Good equipment in proper working condition was also an enhancer. The top wildlife enhancer was not losing cripples.

Nature-related elements comprised 4 of 8 elements rated as important by hunters (Table 4). Beauty in nature, escape to the field, fresh air and exercise, and birdy cover were rated as important by a plurality of the respondents. Having a good place to hunt, good health, stamina, and a good dog were also important. Giving birds a fair chance was the only clearly wildlife-related element listed as important. Of 14 wildlife-related elements, 7 fell into the category of "helps add quality" to a hunt. Most important among the wildlife elements were getting to shoot at pheasants and outsmarting them. Ranked twenty-second out of the 31 enhancer elements was bagging a pheasant. Only 12% of the respondents indicated that bagging a pheasant was necessary for a high-quality hunt, 20% said that it was important, and 60% simply said that bagging a pheasant helps. Much further down the list of enhancers were getting a limit and bagging a trophy bird, ranked twenty-seventh and twenty-eighth among the 31 enhancers, respectively. Seeing other wildlife and making a good shot also helped to add quality. Leaving from an empty parking lot or doing better than one's partner apparently made no difference to the respondents. Thus, the respondents appeared to show greater agreement about the things that could go wrong than in those things that would seemingly increase the quality of a hunt.

Detractor Elements

Of 27 detractor elements included in the 6 scenarios, a majority of the respondents rated 14 as lowering the quality of a hunt (Table 5). Of these 14, 6 were in the human domain and all 4 equipment elements were included. Two wildlife items were listed among detractor elements. At the top of the list of elements that could ruin a hunt were gunshot accidents, being arrested, and bad manners of other hunters. Most hunters agreed that bad manners, getting kicked off private land, unfriendly non-hunters, and equipment failure reduced the quality of a hunt. Having poor health, losing key equipment, having a gun that did not work, or a dog problem, similarly reduced quality; nature elements had little to do with decreasing quality. More than 2/3 of the respondents indicated that losing cripples reduced quality, and more than 1/2 said that seeing no pheasants reduced quality. Failure to see other wildlife was also a detractor.

Table 5. Respondent ratings of elements that potentially detract from pheasant hunts.

		Percent of respondents			
Element	**Domain**	**Def.[a]**	**Tends**	**May**	**No diff.**
1. Definitely detract from hunt quality					
Gunshot accident	Human	98	0	1	0
Arrest for violation	Human	82	9	6	3
Loss of cripples	Wildlife	69	24	7	0
Manners of companions	Human	67	26	5	1
Poor health	Equipt.	56	31	11	2
Manners, other htrs.	Human	53	33	11	2
See no pheasants	Wildlife	52	28	16	5
Told to leave land	Human	51	28	14	7
Unfriendly nonhunters	Human	49	32	16	4
Lack key equipment	Equipt.	47	38	14	1
Dog problems	Equipt.	44	39	15	3
Equipment failure	Equipt.	39	37	23	2
See no other wildlife	Wildlife	39	28	18	16
Bad weather	Nature	30	29	26	16
2. Tend to detract from hunt quality					
Poor habitat	Wildlife	32	48	19	2

Table 5 (continued).

Element	Domain	Percent of respondents			
		Def.	Tends	May	No diff.
Other hunters close	Human	20	40	38	3
Not knowing area	Nature	30	39	24	6
No shots at pheasants	Wildlife	26	35	27	12
Miss shots at pheasants	Wildlife	30	33	25	12
Difficult terrain	Nature	11	33	32	25
3. May detract from hunt quality					
Hunt with strangers	Human	7	28	47	11
Unattractive area	Nature	18	35	38	9
Bagging no pheasants	Wildlife	8	30	37	26
Too cold or wet	Nature	13	34	37	17
Unfamiliar with area	Nature	11	32	37	20
"Civilization"	Nature	19	31	32	19
4. Make no difference to hunt quality					
See other hunters	Human	2	13	41	44

[a] Def. = Definitely detracts from hunt quality, Tends = Tends to detract, May = May detract, No diff. = Makes no difference.

Wildlife elements had a greater role in the category "tends to reduce" quality. Poor habitat, not knowing where to hunt, getting no shots, and missing shots tended to lower quality; however, those elements lowered quality for no more than 1/3 of the respondents. Crowding also reduced quality, but was not as important as the other detractors. Not bagging a pheasant was ranked twenty-third among the 27 detractors listed. Only 85 of the respondents indicated that not bagging a pheasant would definitely detract from the quality of a hunting trip, over 25% of the respondents said that bagging a pheasant made no difference, and 37% indicated that failure to bag may reduce quality. More respondents felt that an unattractive hunting area reduced quality of a hunt more than not bagging a pheasant. Seeing other hunters was not indicated to be a detractor by most respondents.

DISCUSSION

Reactions to the scenarios indicated that hunters largely agree on what elements constitute quality hunting. Responses also indicated that seeing, shooting, and bagging all play a role in determining quality. This finding was consistent with results of studies of actual hunts of white-tailed deer (*Odocoileus virginianus*) (Heberlein et al. 1982).

The scenarios also demonstrated the relative importance of a variety of elements within the total context of a hunt. Respondents more consistently rated seeing birds as an enhancer than they did bagging birds or getting a limit. Thus it seems probable that many hunters would consider hunts high quality if they see pheasants and other wildlife even if they came home empty-handed on occasion. Crowding and negative human interactions decreased hunt quality.

While respondents generally agreed about hunting quality, the scenarios showed the complex nature of hunting experiences. While quality might not be perceived very differently by 2 hunters, it can differ markedly between hunts. Quality hunts occur when there is a preponderance of enhancers and an absence or near absence of detractors. Unfortunately, a single detractor can ruin what had been a high-quality hunt.

Nature-related variables assume secondary importance. A spectacular day, or sunset, or a particularly nice place add to the quality of the hunt. Other secondary factors were that pheasants were present in the area, and that the hunter knew where to find them; getting shots; and not missing. Variables at the third level of importance are neither necessary nor even terribly important to a quality hunt. Elements that "help" make a quality hunt include bagging a pheasant, getting a limit, outsmarting birds, making an excellent shot, seeing no other hunters, and knowing the area.

The survey indicated a pyramid—or hierarchical—organization of several factors that collectively determine the quality of a hunt. This idea is consistent with Maslow's (1954) notion of a hierarchical order of human needs. At the bottom of the pyramid are elements which must be present for a quality hunt. At the next level are the nature-related elements, including seeing and shooting at birds. At the top of the pyramid are elements that help, but are not as necessary or as important as the other elements.

Findings indicate that it is a mistake to focus too strongly on numbers of pheasants bagged. Birds bagged do not represent the foundations of quality hunting. Rather, birds bagged represent the top of the hunting recreation pyramid. The primary concerns in the management of pheasant hunters, as indicated by this study, are the presence of birds, a good place to hunt, and reasonable numbers of other hunters in the immediate vicinity.

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11

South Dakota Fee Hunting: More Headaches or More Pheasants

KENNETH E. SOLOMON, South Dakota Game, Fish and Parks, Box 915, Huron, SD 57350

Abstract: Fee hunting is promoted as an alternative source of income and as a draw for tourism. In South Dakota, fee hunting—with emphasis on released pheasants—is growing rapidly and has recently become a subject of controversy. Hunters see it as landowners taking undue advantage of the pheasant resource, and some fear for the pheasant's welfare. The basic problem, however, is the current low level of pheasant abundance that directly or indirectly affects landowners and businessmen as well as hunters. Common problems require common solutions. In November 1987, representatives of South Dakota's citizen groups, private shooting preserves, hunter organizations, landowners, and state wildlife managers met and talked about South Dakota ringnecks. Cooperation is essential and all have important roles to play. Suggestions are offered as to the nature of those roles.

Key Words: habitat, hunting, management, ring-necked pheasant

"Fee hunting"—dirty words to South Dakota hunters. They represent dollar signs to South Dakota landowners and businessmen, however.

In recent years, numbers of landowners who apply for private shooting preserve status, or simply charge a daily fee for hunting, have increased rapidly. South Dakota averaged only 3 registered pheasant shooting preserves 1965-82. By 1987, the number of shooting preserves had jumped to 66, but represented only 0.2% of South Dakota farms. However, landowners whose farms were not registered as pheasant shooting preserves, but who charged a daily fee to hunters, constituted 5% of all landowners. The recent rapid growth in fee hunting has alarmed many hunters, and the issue has become highly controversial. Battle lines are drawn with landowners on one side, hunters on the other—and wildlife managers caught in the middle.

Agriculturalists and others see fee hunting as a tool to help rescue the family farm financially, to increase recreational opportunities for sportsmen, and to increase the abundance of pheasants. Many hunters see it as landowners taking unfair advantage of wild pheasants, with abundance of wild pheasants being decreased as a result. They also fear loss of the American traditions of public ownership of wild game and free hunting. Wildlife managers understand these views, and some see fee hunting as landowners investing little to harvest much. There is, however, a "common ground" on which these diverse interests can stand—it is their common concern for the current low density of pheasants.

In the mid-1940's, South Dakota had estimated fall populations of about 18 million pheasants, but only about 6 million in the early 1950's (Trautman 1982). By the late 1950's, pheasants had boomed back to near 11 million, but then fell to less than 2 million in 1977. Another, even lower, peak of about 4 million occurred in 1981; numbers then fell again, to less than 2 million in 1986. When pheasants numbered above 10 million, there were complaints that they destroyed newly sprouted corn, and farmers gladly said yes to hunters seeking places to hunt. Smiling hunters were everywhere. Small-town merchants well remember what high pheasant numbers and eager hunters meant to their cash registers. With recent busts overshadowing earlier booms, South Dakotans are aware that they might be losing their state bird and the economic and recreational benefits it has provided.

While hunters and others may scorn landowners for considering fee hunting, all need to understand that efforts to increase pheasant abundance, to some greater or lesser degree, have helped foster the idea of fee hunting. Also, with state and federal agencies now suggesting it as an alternative income source, more and more landowners are considering fee hunting. The idea of fee hunting has become firmly planted in the minds of landowners—and the recently poor farm economy has proven to be good fertilizer.

INVOLVEMENT OF CITIZEN CONSTITUENCY GROUPS

In 1977, when pheasants numbered only about 1.5 million, South Dakota wildlife managers, with strong public support, initiated a statewide program of pheasant restoration. The program required small-game hunters to purchase a $5 stamp, the proceeds of which were to fund contracts with landowners for habitat, predator control, and restocking (80, 10, and 10% of revenues, respectively). During the program's first 5 years, pheasants increased to about 4 million by 1981. Mild winters and improved survival, not the new program, largely were responsible. Although effective locally around contracted habitat—26,000 acres (10,000+ ha) total—the program's annual budget of $900,000 was inadequate to impact statewide pheasant abundance materially. The public assumed that it should.

With the return of "normal" winters in 1982-86, pheasant numbers in South Dakota again fell to 1.5 million. Concerned citizens, seeing the state's program as a failure and afraid of losing their pheasants, increasingly began to organize as local groups to address local pheasant problems. Today (fall 1987), there are in South Dakota 28 different citizen groups whose basic objective is to improve pheasant hunting. They include, to name a few, Pheasant Country LTD (PCLTD), Pheasants Limited, Pro Pheasants, Pheasants Awareness, Pheasants for South Dakota (PFSD), Pheasant Restoration Association (PRA), Pheasants Forever (PF), and the James River Pheasant Association. Numerous sportsmen's clubs, chambers of commerce, and service clubs also started local projects to bring back "their" ringnecks. To differing degrees, each local constituency group is composed of landowners, hunters, and businessmen. These 28 citizen groups fall under 1 of 3 management philosophies: (1) restocking, (2) habitat management, and (3) restocking + habitat management.

Groups Interested Only in Stocking

Fully 20 of the 28 organizations (70%) have chosen the "quick-fix" approach—pheasant stocking. These 20 groups are composed largely of hunters and businessmen who hope to provide more birds for hunters, better relations with landowners, and increased local business by drawing hunters to their communities.

From only 12,000 pheasants released in 1977, efforts have increased to the point where over 200,000 were released in 1987. Whether soliciting contributions in piggy banks placed near cash registers, or via organized fund-raising events, money for stocking has been raised readily. Even in sparsely populated counties, $5-20,000 for local pheasant releases has been raised annually with little difficulty. With these funds, sponsoring groups provide cooperating landowners or youth groups with free day-old chicks, feed, pen materials, or all of these.

While members of groups that stock may dislike fee hunting, they nonetheless encourage stocking with every pheasant they purchase. When a landowner is "given" chicks to raise, or young birds to release, the sponsoring group transfers ownership to that landowner. The idea of private ownership is "sealed" when a group pays the purchase price to a pheasant raiser. For landowners, ownership is implicit with the expenses and labor incurred in accepting the birds. As has been said, "I might argue about whether pheasants raised by Mother Nature on my land belong to the public or to me, but there is no argument about who owns the birds I raised in my pen." In the "owner's" eyes, he has the right to "sell" what he has raised, be it corn, hogs, or pheasants.

Because only 6-10% of released pheasants survive winters in South Dakota, some groups are now considering spring releases of adult hens. The $10-12 cost per adult hen in spring has landowners in a quandary. They wonder if eggs should be gathered and sold before the hens are released, or how they might charge hunters to harvest the cocks they hope spring-released hens will produce. Few realize that 1 cock bagged for each hen released would be about the best they should hope for—and probably less than ½ that from game-farm hens.

Private raisers feel that results of stocking evaluations such as Morse (1951) and Kabat et al. (1955), for example, do not apply to South Dakota. South Dakotans have a unique attitude toward pheasants that stands as a legacy from the high abundance of pheasants in the 1940's and 1960's. They fail to realize that a wild ringneck is a wild ringneck, regardless of where it is found; they do not readily accept results of research in other states. Contrary to what researchers elsewhere have repeatedly determined, most pheasant raisers expect all released pheasants to survive, stay where released, and hatch full clutches—with all chicks surviving to hunting season.

Groups Favoring Only Habitat Development

Just 6 citizen groups in South Dakota stress only habitat development; of these, 4 are chapters of PF, 1 is the PRA, and 1 is PFSD. All 6 are composed mainly of hunters interested in educating landowners about the need for wildlife habitat, and in creating better relations with landowners. The $10-20,000 raised annually by each group provides a solid start toward better local pheasant-habitat management. Such funds are used primarily to provide landowners with trees, chemicals, and grass seed, and to pay for food plots planted near good winter cover.

Unfortunately, even $20,000 is not sufficient to do much to increase pheasant numbers in an entire county. With an average of 600 farms per county, each farm would receive only $33—less than the current average cash rent for 1 cropland acre. Habitat groups can afford to do little more than educate local landowners and, perhaps, instill in them the desire to provide and preserve more habitat. If a landowner were willing to establish more habitat than the sponsoring group can afford, who else might pay the landowner's costs?

Groups Favoring a Combination of Habitat + Stocking

The 2 groups that represent the restocking + habitat development philosophy are South Dakota's largest and best-organized constituency groups. Both are chapters of PCLTD, and both actively encourage landowners to seek compensation for their efforts. Members are mainly businessmen and landowners who work to put landowners in contact with paying, nonresident hunters. For annual fees of $15-400, landowners, businessmen, and nonresident hunters can become PCLTD members. Each cooperating landowner receives 100 free pheasants and is paid to set aside 10 acres of habitat. Hunter-members receive a list of landowners who are willing to accommodate paying hunters. Businessmen hope to create better public relations with landowners and to hear their cash registers ring. Landowners may set up their own hunting operations and fee structures, with no obligations to PCLTD.

THE ROLE OF STATE WILDLIFE MANAGERS

"Unfortunately, it is the collective opinion of the wildlife agencies that lease hunting, for the most part, has not encouraged habitat management nor improved the hunting opportunities on private lands for the average sportsman" (Wiggers and Rootes 1987). Although many wildlife managers oppose fee hunting, they nevertheless often promote it indirectly and unknowingly through state pheasant management programs.

Active since 1977, South Dakota's state-sponsored pheasant restoration program provides incentives for pheasant stocking. The program pays up to $1 per bird for pheasants raised, and released at 7 weeks of age. Initially, the stated goal was to educate raisers as to the cost and poor survival of pen-raised birds. Raisers were educated, but not necessarily in the way anticipated. Program data, showing poor winter survival of stocked birds, effectively altered the emphasis of many constituency groups from striving for better winter survival and higher rates of reproduction to the immediate benefits of hunting released pheasants. Few groups today ask what habitat is needed to increase survival and nesting. More ask, "How do I get maximum return this fall, before my released birds die?" Maximizing return from released pheasants requires the added expense of holding birds until they can be released just prior to the hunt. The current (1987) average cost to raise a bird to 16 weeks is about $5.60. Cost per released pheasant bagged often reaches $14-20. Few landowners will make such an investment without compensation.

Wildlife managers may also encourage the idea of fee hunting through management of state public hunting areas. As asked by one landowner: "Why do game wardens disagree with my charging hunters so I can afford to establish more habitat, feed pheasants through the winter, pay property taxes, repair fences, and put shoes on my kids' feet? After all, you wardens own land and require license fees so you can establish more habitat, feed pheasants through the winter, pay property taxes, repair fences, and put shoes on your kids' feet."

South Dakota's Pheasant Restoration Program and Wildlife Habitat Improvement Program provide landowners with 25-50% cost sharing for establishment and leasing of pheasant habitat on private land. In the past 10 years, $4.4 million has been spent on these 2 programs to establish cover and lease habitat on 18,000 acres (7,200 ha). As landowners learned that habitat could produce more wildlife, they also learned that the state cannot afford, on a statewide scale, to establish more habitat. Few landowners can keep much land out of production without someone paying rent. The pattern is clear; when the state's habitat contracts end after 6 years, less than 5% of the rented acres remain in wildlife habitat.

Negative attitudes of South Dakota wildlife managers toward fee hunting are based on their concern for the pheasant resource. While conservation attitudes are desirable, managers must at the same time continue to work with landowners who, in effect, act as stewards of the public's pheasants. Managers must understand that their efforts should be directed toward showing landowners what pheasants need, and that landowners will expect compensation for their efforts to increase pheasants.

THE ROLE OF GOVERNMENTAL AGENCIES

For over 30 years, state wildlife agencies and organized sportsmen have encouraged federal programs that would provide long-term cropland diversions. The objective has been to provide additional high-quality wildlife habitat at no additional cost to the state or to hunters. The CRP, Sodbuster, Swampbuster, and Conservation Easement provisions of the Food Security Act of 1985 (FSA) gave visions of better days to come. South Dakotans well remember the abundance of pheasants during the Soil Bank era of the late 1950's and early 1960's, and a few even remember the abundance of the late 1930's and early 1940's. The 1985 program, however, specifically mentioned fee hunting—something "new."

In their efforts to help farmers during the current farm crisis, both state and federal agencies suggested fee hunting as offering an alternative source of farm income. Through pamphlets, posters, newsletters, and other program literature, the U.S. Department of Agriculture (USDA) has reinforced the FSA's mention of fee hunting. The Kansas Extension Service's manual titled Guidelines for Increasing Wildlife on Farms and Ranches—with ideas for supplemental income sources for rural families (Henderson 1984), for example, answers many landowner questions concerning fee hunting.

The U.S. Fish and Wildlife Service and Wildlife Management Institute also suggest fee hunting. Their literature on, and support of, agricultural extension service publications, further justifies fee hunting in the landowners' eyes. A consequence of federal emphasis on fee hunting is that hunters not only pay taxes to take land out of crop production (to raise commodity prices, to raise farm income, and to help save family farms) but may also be asked to pay to hunt on those same acres. To most South Dakota hunters, this seems unfair.

In South Dakota, fee hunting has been suggested at the Governor's Agricultural Conferences and at other state-sponsored forums. Conferences sponsored by the state departments of Agriculture and Tourism attempt to educate landowners on how to charge for hunting. In promoting fee hunting, South Dakota hopes that its number 2 industry, tourism, will benefit. State officials are well aware that, when pheasants were abundant, hunters added millions of dollars annually to the state's economy. In 1963, 204,200 resident and nonresident sportsmen hunted South Dakota's 10 million pheasants, and spent an estimated $42.9 million in the process ($210/hunter). In 1976, only 97,325 hunters hunted the state's 1.4 million pheasants, and spent just $4.4 million. Lower numbers of pheasants, followed by lower numbers of hunters, represented a $38.5 million annual drop in gross income for South Dakota—and that drop did not account for "ripple" effects as "hunter money" passed through local economies.

Governmental agencies must not encourage fee hunting without encouraging landowners to invest in pheasant habitat. Supplemental income from honey bees, potato chips, Christmas trees, or catfish farming requires capital investment by landowners. Fee hunting potentially can offer immediate profit, with no capital investment. Landowners may simply charge for the few pheasants occupying their less-than-adequate shelterbelts or swales. But, by encouraging landowners to invest in habitat, state government could help ensure pheasant abundance, hunting opportunities, and an economic return on such investments.

CONCLUSIONS

The current "pheasant issue" in South Dakota is fee hunting. There are at least 2 problems basic to this issue. First is the current relative low abundance of wild pheasants for persons who like to hunt ringnecks in a state once renowned for its pheasant hunting. The more basic problem, however, is economic, as farmers, ranchers, and business people struggle to survive another agricultural depression. Similar depressions occurred in the 1930's and late 1950's—not incidentally, the same decades when pheasants prospered best. Fee hunting is part of a complex solution to a difficult economic problem, a solution new to South Dakota and, therefore, controversial.

The problem of pheasant abundance in South Dakota is the common problem of wildlife on agricultural land—a symptom of land use and the economics of our time. It is a problem of small farmers trying to save financially stricken small farms. It is a problem of owners struggling to keep small businesses solvent. It is a problem for hunters who want pheasants to hunt and places to hunt them—hunters who have never before been asked to pay for their hunting recreation. In short, it is a problem shared by most South Dakotans. Common problems require common solutions.

Although the views of landowners, businessmen, hunters, and wildlife managers on fee hunting differ, they share a common concern (albeit for quite different reasons) for the abundance of pheasants in South Dakota. In order to achieve even a minimum solution, landowners, hunters, businessmen, and state wildlife managers all need to realize first that they share this concern for pheasant abundance, and second that all have contributed to the controversy over fee hunting, a controversy that detracts from progress toward the common goal of more pheasants and better hunting in South Dakota. To accomplish that goal, they must think in terms of providing nesting and winter cover on perhaps 20% of the farmland in the state. No state or federal agency, or citizen group alone can pay the full bill.

On 7 November 1987, South Dakotans took the first step toward finding a common solution to the problem of low pheasant abundance; a step in which 80 representatives of citizen groups, shooting preserves, hunter organizations, landowners, and state wildlife managers met and talked about South Dakota ringnecks. Hopefully, the ultimate outcome will be a cooperative effort to improve pheasant abundance.

Pheasant management in South Dakota, or in any other state, can be successful only if wildlife managers, businessmen, landowners, and hunters all have a basic understanding of pheasant ecology and biology, and are willing to recognize the efforts needed by themselves as individuals or as groups. Each constituency, and each public agency, has its role to play—a cooperative role. No single program can suffice.

WHAT SHOULD BE DONE?

The state wildlife agency should:

1. Emphasize development of "permanent" nesting and winter habitat, while de-emphasizing habitat leasing and stocking.

2. Cooperate with local constituency groups in their habitat programs, and seek to educate their members in principles of pheasant ecology and management.
3. Maximize use of current revenue sources, and seek new revenues from those who benefit from the pheasant resource, to support habitat development.
4. Recognize that some constituencies may accept the cost of stocking (a local, "quick-fix" solution) as an alternative to the slower, larger-scale, habitat solution.
5. Not spend its limited funds on "quick-fix" programs.

Businesses and landowners, as individuals and as constituencies, should:

1. Recognize that they share a common financial interest in the pheasant resource, and should thus expect to participate financially in pheasant management (i.e., be willing to support, financially, both state and local constituency programs that include habitat development).
2. Recognize that state wildlife managers are knowledgeable in pheasant ecology and management, and appreciate the efforts needed to increase pheasant abundance.
3. Understand that the state might wish to charge for a permit that would allow daily fee hunting, with such funds designated only for habitat.
4. Actively lobby for state and federal programs to benefit pheasants and other wildlife.

Hunters, individually and as constituencies, should:

1. Contribute to locally-funded programs that include habitat development.
2. Support programs of habitat development funded by state pheasant habitat stamps and other means.
3. Actively lobby for state and federal programs that benefit pheasants and other wildlife.

All of these "partners in pheasant conservation" should recognize that:

1. Pheasant abundance is dependent on survival—eggs in nests, young, and adults—and that habitat is the key to abundance; further, within the framework imposed by habitat and weather, pheasants may also be cyclic (Kimball 1948, Edwards these Proceedings).
2. Wild pheasants have consistently been abundant only where and when undisturbed grasslands have been well distributed across agricultural landscapes—in effect, good nesting cover is critical.
3. Winter cover is important in sustaining pheasants through severe winter storms.

4. Logistics of scale and cost make it impossible for state programs alone to manage for high pheasant densities on private lands.
5. The only realistic basis for pheasant management on private lands is partners in pheasant conservation, the basis for which currently exists in South Dakota.

There is clearly much work to be done to restore pheasants in South Dakota to levels even near those of 20 years ago, to say nothing of 40 years ago. While agencies and constituency groups each have major roles they need to play, in the end actual work must be done by people—individuals. Restoration of pheasant abundance can only be done by working on private farmland and by affecting land use. Restoration will require the active involvement of many people and many farms, and through much cooperation by partners in pheasant conservation.

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12

Pheasants Forever, Quail Unlimited: The Role of Species Constituency Groups in Upland Wildlife Management

JAMES B. WOOLEY JR., Pheasants Forever, Inc., Route 1, Chariton, IA 50049

ROGER WELLS, Quail Unlimited, PO Box 26, Americus, KS 66835

WILLIAM R. EDWARDS, Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820

Abstract: Cooperative partnerships between public agencies and citizen constituent groups provide a significant opportunity to manage upland wildlife in agricultural regions. Pheasants Forever and Quail Unlimited are independent conservation organizations that, although focused on different upland species, share common goals. Both are very young conservation organizations. However, their membership, success in fund raising, legislative influence, and beneficial impacts on wildlife habitat are growing rapidly. Both are staffed by professional wildlife managers, focus on the need to develop habitat and provide conservation education, and target a wide range of game and nongame species. Both provide controlled voices of dissent against unsound wildlife programs, advocate legislation beneficial to wildlife, and generally function as effective interfaces between private individuals and government agencies.

Key Words: bobwhite quail, habitat development, ring-necked pheasant, wildlife management

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The pervasive, long-term impacts of habitat losses on farmland wildlife have been well documented. Our purpose is to discuss the rapidly expanding role of species constituency groups in upland wildlife management. The groups considered are Pheasants Forever, Inc. (PF), and Quail Unlimited, Inc. (QU).

The involvement of citizen constituencies is, of course, not new. Today there is a plethora of citizen's groups concerned with wildlife and natural resources issues at local, state, national, and international levels. PF and QU, however, are unique in their combination of focus on resident upland wildlife, fund raising for local projects to develop and preserve habitat, and direct involvement of local chapters in those projects. These organizations provide active programs of conservation education; legislative involvement at local, state, and national levels; direct cooperation with state wildlife departments; and strong advocacy for wildlife management with local agricultural constituencies. Prior to the advent of PF and QU, there had never been a large-scale, directed effort to organize the upland wildlife constituency as a positive element in the conservation movement.

THE CONSTITUENCY

The 1980 National Survey of Fishing, Hunting, and Wildlife-associated Recreation (U.S. Dep. Interior, Fish Wildl. Serv., Govt. Print. Off., Washington, DC, 1982) indicated that of 12.4 million small-game hunters in the United States, some 4.2 and 3.7 million pursued pheasants and quail, respectively. Among upland-game hunters, only numbers of rabbit and squirrel hunters (7.6 and 6.5 million, respectively) exceeded those of pheasant and quail hunters. Pheasant hunters were estimated to spend 35 million days per year afield.

The upland wildlife constituency is both large and relatively affluent. The 1980 Survey indicated that small-game hunters spent about $135 each per year to pursue their quarry of choice. The impact of expenditures by small-game hunters is impressive, contributing an estimated $1.7 billion to the nation's economy in 1980. However, that number fails to account for the effects of dollars flowing through a series of hands in local economies. It also ignores money spent by those who enjoy wildlife, but do not buy hunting licenses—a constituency which far surpasses that of numbers of hunters.

THE GROUPS

PF and QU are independent conservation organizations that, although focused on different species, share common goals. Independent efforts to establish both groups began only about 6 years ago. Both organizations have grown rapidly in fund-raising ability, and in their capacity to enhance wildlife habitat. Both are operated under supervision of boards of directors and are staffed by experienced wildlife biologists.

Both focus primarily on the need to develop and preserve habitat and to support conservation education. Both groups embrace the upland sporting and nonsporting publics, targeting a wider range of species than their names imply. Both employ fund-raising mechanisms similar to those used by other conservation organizations; however, emphasis is on local chapter control of funds expended within broad organizational guidelines. Although PF chapters are located primarily in the North (pheasant range), most QU chapters are in the South (quail range). Goals common to both organizations are to:

1. Organize their respective constituencies to effectively speak out on issues (ecological, financial, and legislative) that affect the status and management of upland wildlife.
2. Cooperate actively in partnership with government agencies, public and private organizations, and individuals that share common interests in the preservation, development, and promotion of upland wildlife.

Pheasants Forever, Inc.

Chartered in 1982, PF is a tax-exempt, nonprofit, charitable conservation organization under Section 501 C(3) of the IRS Code, and incorporated under the laws of the State of Minnesota. It was founded with the single objective of securing legislation for issuance of a stamp to be sold annually to Minnesota pheasant hunters, with proceeds earmarked for habitat restoration. That legislation, passed in 1982, has formed the cornerstone of wildlife habitat management programs for private lands in Minnesota. Many of the business professionals who helped found PF still guide it today. Goals identified in the bylaws of PF are:

1. Charitable and educational purposes consistent with organizations qualifying for exemption under the Internal Revenue Code.
2. To educate the public in habitat management for restoration of pheasant populations.
3. To encourage the public to cooperate with, and support, state and federal authorities in improvement of pheasant habitat and other pheasant restoration projects.

The first PF chapter was established in Minnesota in 1982. The organization grew rapidly during the next 2 years, and expanded into Iowa in 1984. Currently (August 1988), there are about 240 PF chapters in 18 states (Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Montana, Nebraska, New York, North and South Dakota, Ohio, Pennsylvania, Utah, Washington, Wisconsin, and Wyoming). All chapters hold annual fund-raising banquets. As of July 1988, membership in PF was about 37,500 and growing rapidly. In fiscal 1987, PF generated $2.75 million through the combination of membership banquets, nonmembership events, merchandise sales, and corporate donations—an approximate 4-fold increase in revenues over fiscal 1985.

There are specific policies for use of chapter funds. Locally generated PF income remains largely under control of the chapter and is spent primarily on local habitat development projects. Policy specifically prohibits any sponsorship of private of public stocking before-the-gun with PF funds and further forbids stocking in any form by PF chapters. However, monetary donations are allowed for state-agency-sanctioned releases of wild-trapped or F-1 generation ring-necked pheasants into areas of suitable habitat, or for state-sponsored research purposes.

Local PF chapters are involved in habitat development in numerous ways. Whenever possible, chapter-generated funds are matched with those from other sources—usually those of Agricultural Stabilization and Conservation Service (ASCS), Soil Conservation Service, and state or local natural resource agencies—to both enhance and extend wildlife benefits. For example, payments have been used to increase size or diversity of shelterbelts, enhance nesting cover development on land diverted from crop production under the Conservation Reserve Program (CRP), provide incentives for establishment of native grasses, and cooperatively cost-share the purchase of expensive equipment needed for habitat work (specialized seed drills, tree planters, sprayers, etc.). Chapters also fund acquisition of seed and planting stock, and pay wages of temporary help. Many chapters establish significant acreages of food and cover plots through seed donated to PF by major seed companies.

In the examples mentioned above, PF chapters that provide financial and physical support for habitat management do so in consultation with professional resource-agency personnel. Active cooperation between agency professionals and local chapters helps assure high-quality habitat at a reasonable cost, minimizes unproductive approaches, and maximizes cooperation of landholders. Chapters of PF also cost-share land acquisition with natural resource agencies. Agencies then own and manage the area for upland wildlife and associated recreation. For example, local chapters have cooperated with county conservation boards and the Iowa Department of Natural Resources (DNR) to fund acquisition of over 1,000 acres in Iowa in 1986 and 1987.

The concept of an upland wildlife stamp as a user-funded basis of support for habitat programs is strongly endorsed by PF at the national level. In Minnesota, sales of Pheasant Restoration Stamps now generate approximately $4-500,000 annually. In the past, approximately $15-20,000 per year of Minnesota Pheasant Stamp funds have been allocated to the Wildlife Management Institute to encourage passage of federal farm legislation favorable to wildlife, and for other information-related activities. Chapters of PF supported passage of similar legislation in Idaho.

Pheasants Forever is also becoming involved in other types of legislative activity. In conjunction with other groups, PF was actively involved with passage of Reinvest In Minnesota, a major land retirement/wildlife habitat bill in Minnesota in 1986 and its reauthorization in 1987. In efforts to protect nesting wildlife, PF was responsible for initiation and passage of Minnesota legislation that prohibits government agencies from mowing roadsides until after 1 August. The organization is now becoming involved in efforts aimed at preserving roadside habitat in Iowa. And it is currently pursuing efforts to incorporate further wildlife values into national farm policy, such as multiyear contracts for long-term retirement of a portion of annual set-aside acreage.

From the beginning, conservation education endeavors have also been an important feature of PF programs. In Iowa, PF and the Iowa DNR have worked together in preparation of slide/tape programs on the ring-necked pheasant and roadsides, made available to the public. Two full-color posters that offer suggestions on how to increase wildlife on agricultural land diverted from crop production have been developed for use nationwide. In Minnesota, PF and others have funded development of a school curriculum promoting wise use of roadsides and associated wildlife values. A variety of other program materials has been developed on habitat themes for use at public meetings and elsewhere.

The rapid growth of PF in Iowa provides an indication of the strong public interest in local programs of upland wildlife management. The first Iowa PF banquet was held in November 1984. In December 1987, there were 70 Iowa chapters with approximately 15,000 members. In the past 3 fiscal years, Iowa chapters generated approximately $860,000 for habitat development.

In Iowa, Minnesota, and other states, growth has facilitated the formation of state associations (e.g., the Iowa Pheasants Forever Council). These associations provide leadership, facilitate communication among chapters, and provide potential for additional fund-raising mechanisms. More importantly, state associations provide unified structures that speak effectively to legislators and agency administrators.

Quail Unlimited, Inc.

Quail Unlimited was founded as a tax-exempt, Section 501 C(3), charitable conservation organization in 1981. A board of trustees establishes policy and represents the interests of all regions where chapters exist. Trustees nominate individuals to serve on a Board of Directors which drafts budgets and hires staff. The focus of QU is directed toward habitat management on private lands, undertaken in concert with programs of state conservation departments in order to:

1. Restore and perpetuate North American wild quail.
2. Work cooperatively with private individuals, citizen groups, corporations, and natural resource agencies to establish and maintain wildlife habitat.
3. Determine solutions to diverse management problems.
4. Improve the image of the sportsman and his role in conservation.

In 1986, QU experienced a growth of 94%. As of December 1987, there were more than 150 QU chapters in 21 states (Alabama, Arkansas, California, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Mississippi, Missouri, Nebraska, North and South Carolina, Ohio, Oklahoma, Tennessee, Texas, Virginia, and West Virginia); current membership in QU is 31,000. Over $1.65 million was raised by QU in 1987. Funds are raised through annual membership banquets, sale of QU art and stamps, and corporate donations. By policy, 20% of the funds raised by QU may be granted to the wildlife agency in the state of origin, if specifically earmarked for upland game-bird management. Such donations ensure essential communication between state wildlife agencies and QU chapters.

In states with 5 or more chapters, state councils coordinate QU activities and, thus, can provide a unified voice in working with legislatures and wildlife agencies. State councils maintain contact with legislators, track bills of importance to upland game birds, testify at legislative hearings, and notify chapters of needed action. Councils also maintain contact with wildlife agencies, make presentations to agency commissions, and may retain funds for use on projects with statewide impact.

Chapters of QU become directly involved in habitat improvement projects in their immediate areas. In Kansas, chapters are cost-sharing new shelterbelts and grass seedings on CRP lands, and building guzzlers for wildlife water supplies in arid regions. Missouri chapters have sponsored workshops on grassland habitat management and use of fire to maintain openings and stimulate native seed-producing plants. Other chapters have purchased fire-control equipment and drip torches for loan to landowners. Chapters in several states make available to members and the public such specialized equipment as tree planters, native-grass drills, and root plows. The Missouri Department of Conservation recently completed a program called "Operation Bobwhite." This intensive program targeted approximately $1 million in state revenues for quail management. Missouri QU chapters gave significant impetus to this project.

Other QU projects include providing seed for establishment of wildlife food patches. Seed is made available—free of charge—through donations from major seed firms. An Indiana chapter has initiated a program called HELP (Habitat Edge Lease Program) in which landowners are paid to leave 20-ft strips along field edges for nesting, brood cover, and feeding areas. Project YIELD (Youth Involvement in Educational Land Development) is a nationwide QU project that funds habitat work of groups such as Future Farmers of America, Scouts, and 4-H.

To increase local awareness of habitat problems and solutions, some QU chapters have instituted a series of timely, professionally written "Conservation Messages." These are prepared primarily for publication in rural newspapers, where they have strong local appeal and impact. Manning information booths at county and state fairs, farm equipment shows, and other places where farmers and landowners gather is almost universal among QU chapters.

CONSTRUCTIVE INVOLVEMENT OF THE UPLAND WILDLIFE CONSTITUENCY

The Midwest consists primarily of privately-owned farmland. In Illinois, for example, only about 5% of the state is in some form of public ownership, with something less than 1% currently subject to management by the Illinois Department of Conservation. Of that 1%, only a fraction is managed as habitat for upland wildlife. The problem of extremely limited state control of upland wildlife habitat is little different in other agricultural states. Habitat-related problems of pheasants and quail cannot be solved by state wildlife agencies working only on public lands. At the same time, major logistical problems exist in implementing extensive programs of habitat development on private lands.

However, state wildlife agencies must effectively influence habitat availability (land use) on private lands to fulfill their publicly perceived mandates. To accomplish their mission, state agencies need to interact directly with large numbers of private landholders; with various branches of federal, state, and local governments; and with varying agricultural interests. We believe these efforts can be enhanced materially by a cooperative relationship between wildlife agencies, and strong, well-informed citizen constituencies represented by upland wildlife conservation organizations. Such efforts can best be accomplished when chapters serve as an interface among interested individuals, landholders, and agencies to provide wildlife habitat.

Results obtained to date by PF and QU indicate that potential problems of a cooperative constituency approach are far outweighed by the benefits. Trained agency biologists can provide a source of local expertise to chapters on planning, programs, guidelines for habitat management, planting materials, equipment, and techniques (e.g., prescribed burning, seeding, fertilization, and noxious-weed control). In that relationship, agencies can guide and exercise a degree of quality control while greatly extending their effectiveness in the preservation and development of wildlife habitat.

Constituency groups have the ability to aid the resource directly, and to facilitate the work of agency professionals responsible for wildlife management (e.g., legislative and monetary support). "Grass roots" participation in program and policy formation can significantly enhance local response to government-sponsored programs. At the same time, through successful cooperative ventures with agencies, the constituency group creates a resume of results that builds membership and strength for future joint efforts.

THE FUTURE OUTLOOK

Current public interest in both upland wildlife and representative constituency groups is expanding. Both PF and QU are providing organized representation and focus to those interested in the welfare and management of upland wildlife. And in the short run, both organizations may benefit from the wildlife abundance that current CRP cropland diversions generate. We believe, therefore, that the upland wildlife constituency movement will continue its rapid expansion. That expansion can be enhanced by wildlife agencies working in close partnership with conservation organizations at chapter, state, and national levels.

The worth of groups such as PF and QU will ultimately be measured by their success in organizing their clientele to work toward development and preservation of habitat. That work should include:

1. Development of private funding to support or cost-share cooperative programs of habitat development, conservation education, land acquisition, and research where other sponsorship does not currently exist or is inadequate to meet needs.
2. Support of sound programs of wildlife management being undertaken by a variety of government agencies.
3. Serving as an interface, facilitating the relationship between landowners and federal, state, and local agencies in habitat management programs.
4. Advocacy of changes in legislation, programs, and policies that will benefit wildlife.

5. Provision of dissent against unsound wildlife practices, programs, and policies.

Long-range progress of upland wildlife conservation organizations will depend on demonstration of positive short-range accomplishments. Those accomplishments will include continued chapter expansion, proper utilization of funds, and involvement in critical conservation issues at state and national levels (e.g., farm policy legislation and private lands habitat programs), plus local input (e.g., working to limit roadside mowing and various activities of county ASCS committees and drainage districts).

In the future, greater consideration of citizen constituencies should be directed to involvement of businesses and corporations in habitat development. Corporations potentially can provide financial support, professional services, specialized equipment, and materials, and are often major landowners. As already noted, major seed producers have participated in habitat development by donation of seed to both PF and QU for establishment of cover and food. Although the potential value of corporate involvement to wildlife conservation is obvious, public relations and tax benefits for the donors can also be significant. The expanding area of corporate involvement in wildlife management represents an as-yet largely undeveloped resource for all wildlife constituency groups.

The potential for species-oriented conservation organizations to offer important leadership and support in the development of wildlife habitat extends far beyond current funding achievements. Resistance to involvement of outside interests in what heretofore has been the singular responsibility of agencies is sometimes strong in today's highly organized government and agricultural bureaucracy. A large proportion of PF and QU membership, however, is comprised of individuals active in community sectors served by county boards and supervisors, ASCS committees, soil and water conservation districts, and others. This overlap provides opportunity to address public concerns related to land-use impacts on upland wildlife.

CONCLUSIONS

The current good fortune of recent "long-term" federal cropland retirement programs has given both wildlife agencies and species constituency groups a short-term opportunity to become better organized and more effective at incorporating wildlife values in shaping agricultural policy. There is little hope that this current reprieve from intensive land use will last long.

In agricultural regions, state wildlife departments control only a small fraction of the land. There is increasingly severe competition for recreational uses of that limited land base, and for the limited state funds available for its management. Alone, wildlife agencies are not able to manage wildlife on extensive acreages of potential upland habitat—i.e., on private farmland. Unfortunately, programs of upland wildlife management in most states succeed or fail based on the productivity and harvest of wildlife on private farmland.

We believe that future preservation and management of upland wildlife lies in developing a cooperative relationship between organized constituency groups and the local, state, and national agencies whose collective endeavors impact habitat in agricultural regions. Cooperation must extend beyond simply raising funds; it must extend to the land, to individual farmers and landowners, and to state and federal legislators. Broadly based cooperation is essential for securing needed type and scale of changes in agricultural and wildlife programs, and for funding necessary to benefit wildlife significantly on a meaningful scale. Without such cooperatively directed mutual efforts, we find little reason for optimism about the future preservation of upland wildlife in intensively-cropped agricultural regions.

13

Potential Impacts of Ring-Necked Pheasants on Other Game Birds

RICHARD O. KIMMEL, Farmland Wildlife Populations and Research Group, Minnesota Department of Natural Resources, Madelia, MN 56062

Abstract: Evidence, often circumstantial, indicates that ring-necked pheasants (*Phasianus colchicus*) may adversely impact the abundance of gray partridge (*Perdix perdix*), greater prairie-chickens (*Tympanuchus cupido pinnatus*), and possibly other species via nest parasitism, competition for habitat, transmission of disease, and aggressive behavior. I postulated that pheasants raised by another species as a result of nest parasitism imprint to the host species, increasing the possibility of interspecific interactions. Potential negative impacts should be considered in management decisions and planning introductions.

Key Words: gray partridge, interspecific interactions, nest parasitism, prairie-chicken, ring-necked pheasant

Wildlife managers have expressed concern about negative impacts of ring-necked pheasants on the abundance of other prairie and farmland species, such as gray partridge, greater prairie-chickens, and prairie-nesting ducks. While much of the evidence is contained in brief reports, and is often circumstantial, information that exists warrants consideration in decisions regarding pheasant introductions.

Herein, I review reports of pheasant interactions with other species and explore costs to the species involved. Because most reports on negative interactions between pheasants and other North American species involve nest parasitism, I will examine it in detail. I will also explore competition for habitat, disease, and aggressive interactions, concluding with discussions of population relationships between pheasants and other species, and management strategies.

NEST PARASITISM

The tendency of pheasants to lay eggs haphazardly (Erickson et al. 1951) and in nests of other birds (Carlson and Rollings 1941a, Baskett

1947), the overlapping nesting requirements of pheasants with other prairie upland birds and waterfowl, and the tendency of pheasants to nest near other birds (Carlson and Rollings 1941b) are behaviors leading to interspecific nest parasitism by pheasants. This nest parasitism has been thought to negatively impact gray partridge, prairie-chickens, and possibly other species.

Species Involved

There are numerous reports of gray partridge nests containing pheasant eggs (Tegetmeier 1904, Yeatter 1934, Hamerstrom 1936, Errington and Hamerstrom 1938, North Dakota Game and Fish Department 1942, Yocum 1943, Schrader 1944, Erickson et al. 1951, Edminster 1954). In many cases the incidence of parasitized nests is relatively low. Reported proportions of gray partridge nests containing pheasant eggs are 1.3-7.1% (Carlson and Rollings 1942b, Knott et al. 1943, McCabe and Hawkins 1946). Errington and Hamerstrom (1938) and Carlson and Rollings (1941b) indicated a much higher incidence (>25%) of pheasant parasitism. Parasitized partridge nests have contained 1-20 pheasant eggs (Carlson and Rollings 1941a, b, Carlson 1943, McCabe and Hawkins 1946).

Pheasant eggs have been reported in prairie-chicken nests (Carlson and Rollings 1941a, Vance and Westemeier 1979). Carlson and Rollings (1941a) reported that 2 of 12 prairie-chicken nests in Minnesota each contained 1 pheasant egg. Vance and Westemeier (1979) found that 17 of 197 (3%) prairie-chicken nests in Illinois contained pheasant eggs.

Instances of nest parasitism by pheasants occur for northern pintail (*Anas acuta*) (Carlson and Rollings 1941a, Rollings 1941, Erickson et al. 1951), blue-winged teal (*A. discors*) (Hamerstrom 1936, Carlson and Rollings 1941a, b, Rollings 1941, Erickson et al. 1951, Glover 1956, Nickell 1966, Evans and Wolfe 1967, Baxter and Wolfe 1973), northern shoveler (*A. clypeata*) (Bennett 1936, Baxter and Wolfe 1973), and mallard (*A. platyrhynchos*) (Bennett 1938, Carlson and Rollings 1941a, b, Miller and Collins 1954, Baxter and Wolfe 1973). The proportion of waterfowl nests containing pheasant eggs has been reported as 3.7-6.8% (Bennett 1936, Girard 1939, Glover 1956, Baxter and Wolfe 1973). Parasitized waterfowl nests have contained 1-11 pheasant eggs (Bennett 1936, Sharp and McClure 1945, Baxter and Wolfe 1973).

Pheasants parasitize nests of other species, including northern bobwhite (*Colinus virginianus*) (Hamerstrom 1936), king rail (*Rallus elegans*) (Hamerstrom 1936), Virginia rail (*R. limicola*) (Bennett 1936), American woodcock (*Scolopax minor*) (Leedy and Hicks 1945), blue grouse (*Dendragapus obscurus*) (Leedy and Hicks 1945), ruffed grouse (*Bonasa *umbellus*) (Bump et al. 1947, Kenaga et al. 1955, Klebbe 1958), turkey (*Meleagris gallopavo*) (Carlson 1943), and domestic chicken (*Gallus gallus*) (Carlson and Rollings 1941b). Tegetmeier (1904) provides records of pheasant eggs in "wood pigeon" and "squirrel" nests in trees. Bump et al. (1947) reported finding pheasant eggs in 11 of 2,016 (0.5%) ruffed-grouse nests in New York in areas where woodlands and farms overlapped.

Consequences of Nest Parasitism

When a nest is parasitized, outcomes vary. Carlson and Rollings (1941a, b) reported abandonment of gray partridge nests due to the presence of many pheasant eggs. Westemeier (1983) noted that nest parasitism by pheasants resulted in both lower hatching success and in parasitic broods in prairie-chickens. Pheasant eggs deposited in waterfowl nests may reduce the number of eggs deposited by the host (Bennett 1938).

Vance and Westemeier (1979) suggested that increased predation could be related to nest parasitism; of 17 parasitized nests, 4 hatched successfully, 2 were abandoned, and 11 were depredated. Visits or uncovering the nest by a pheasant may increase vulnerability to predation. A nest parasitized by pheasant eggs can result in hatching the young of the host species, the parasitizing species, or both with outcome related to differences in incubation periods of the species involved and the behavior of the incubating hen.

Dumke (1980) reported the incubation period for partridge to be 24-25 days and Knott et al. (1943) reported the incubation period for pheasants to be 23.5 days. If pheasant eggs are deposited in a partridge nest prior to incubation, pheasant chicks could hatch before the partridge eggs pip. A partridge hen may leave the nest with pheasant chicks and abandon her own clutch. Partridge adults accompanied by a pheasant chick were reported by McCabe and Hawkins (1946), Jenkins (1961), and Wishart (in Kobriger 1977:31). In Minnesota I have received reports of partridge pairs with chicks of both species.

Of 12 blue-winged teal nests parasitized by pheasants, pheasant eggs hatched along with teal eggs in 2, 7 nests did not hatch, and 3 hatched teal only (Bennett 1938). The incubation period for blue-winged teal is 24.2 days (Bellrose 1976), about 1 day longer than for pheasants. Hamerstrom (1936) and Carlson and Rollings (1941b) reported finding parasitized teal nests where eggs of both pheasants and teal had hatched. Nickell (1966) reported pheasants hatching before ducklings in teal nests and an observation of pheasant chicks on the back of a teal.

For waterfowl, "A few of these mixed clutches are sometimes successfully incubated, but how the pheasant chicks get along with their foster brothers and parents is not known" (Erickson et al. 1951:24). With mixed broods, the situation should be resolved the first time the brood takes to water.

Bump et al. (1947:289) reported the incubation period of ruffed grouse to be 24 days, and that pheasant eggs hatch first, "sealing the doom of her own clutch." Kenaga et al. (1955) observed a ruffed grouse in Michigan leaving a nest with 4 pheasant chicks, abandoning viable ruffed grouse eggs that were close to hatching.

Observations of Parasitized Nests of Captive Gray Partridge

In an attempt to determine the effects of pheasant nest parasitism on gray partridge, I studied captive gray partridge incubating clutches containing both partridge and pheasant eggs. Two pheasant eggs were placed in each of 32 partridge nests after the twelfth partridge egg was laid; 14 nests contained only partridge eggs. After hatching, behavior of adults and chicks was recorded.

During 1984-88, partridge incubated 17 clutches artificially parasitized with pheasant eggs. Of 9 parasitized clutches that hatched, 6 produced broods containing both partridge and pheasant chicks, 2 contained only partridge chicks, and 1 clutch hatched only pheasant chicks.

Imprinting Considerations

Imprinting determines perception of species and, therefore, the object to which an individual directs social behaviors as an adult (Lorenz 1937). Such behaviors include mating, defense of territory, and flocking. Interspecific imprinting may explain examples of mixed-species coveys involving pheasants (e.g., Nelson 1964) and mixed-species/pheasant hybrids (e.g., Lincoln 1950, Reichholf 1982).

Schein (1963) hypothesized that an individual imprinted to another species will preferentially attempt to mate with the other species, even if conspecifics are available, as demonstrated for Coturnix quail (*Coturnix coturnix haponica*) imprinted to northern bobwhite (Kimmel and Schein 1971). Imprinting potentially explains situations where a pheasant disrupts prairie-chicken mating activity. Follen (1966) reported a male pheasant chasing a booming prairie-chicken and then displaying like a pheasant. Vance and Westemeier (1979) reported a pheasant disrupting the breeding behavior of a male prairie-chicken and then courting a female prairie-chicken. In theory, social behaviors for pheasant cocks hatched from a parasitized prairie-chicken nest would be directed at prairie-chickens. However, such behaviors would be innately controlled and characteristic of pheasants.

Prairie-chickens gather at leks to display and breed. Male chickens establish small displaying territories in close proximity on booming grounds (Johnsgard 1973). Cock pheasants establish large territories and do not tolerate other males (Trautman 1982). Thus, in theory, a pheasant imprinted to prairie-chickens would be expected to be attracted to a booming ground, attempt to defend a territory the size of which is characteristic of pheasants, and display to prairie-chicken hens. A pheasant in such a case would attempt to defend an entire booming ground and totally disrupt prairie-chicken mating activities on that ground (e.g., Sharp 1957, Vance and Westemeier 1979).

Mating by conspecifics imprinted to other species has been demonstrated in the laboratory (e.g., Kimmel and Schein 1971). Schein (1963) hypothesized earlier that an individual imprinted to another species would mate with members of its own species in the absence of the imprint species. A hen pheasant imprinted as a result of a parasitized nest to prairie-chickens could be mated by a male pheasant and lay fertile eggs. An underlying question: is a hen pheasant imprinted to prairie-chickens as a result of a parasitized nest more likely to parasitize nests of the imprint species?

Population Density/Nesting Cover Relationships

Errington and Hamerstrom (1938) noted a relationship between the incidence of nest parasitism of gray partridge and pheasant density. In 1934, drought resulted in limited nesting cover, and 5 of 11 nests were parasitized; in 1933 and 1935, 2 of 15 nests were parasitized. Errington and Hamerstrom (1938) concluded that shortage of acceptable nesting sites resulted in increased interspecific competition. Similarly, Bennett (1936, 1938) noted a relationship between the degree of parasitism of waterfowl nests and pheasant density in Iowa. During 1933-35, when he recorded pheasant densities of 1 hen per 4-5 acres, many parasitized duck nests were found. In 1936, after a severe winter had greatly reduced the pheasant population, he found no parasitized duck nests.

Carlson and Rollings (1941b) felt that pheasant nest-parasitism in northwestern Minnesota was not significant for prairie-chickens because of large amounts of available nesting cover, but speculated that pheasant parasitism was a serious limiting factor where intensive agriculture concentrated pheasants into limited nesting cover. While there are reported differences in types of cover used for nesting by pheasants, and other species that nest in grasslands, reduced amounts of available cover tend to concentrate these species, thus increasing nest parasitism (e.g., Evans and Wolfe 1967).

Significance of Nest Parasitism

There are differences in opinion on the significance of pheasants parasitizing nests of gray partridge. Leedy and Hicks (1945) felt nest parasitism by pheasants in Ohio was so infrequent as to be unimportant. However, W. R. Edwards (personal communication) found a view, widespread among Ohio game wardens in 1951, that pheasants were responsible for partridge declines in northwestern Ohio in the 1930's and early 1940's. In 1951-53, Edwards found no partridge in parts of Ohio inhabited by pheasants. R. Potts (personal communication) believed that pheasant parasitism of partridge nests on game-keepered estates in England was not a significant factor affecting partridge numbers. Weigand and Janson (1976) felt that few pheasant eggs laid in nests of other birds hatch.

Well over 40 years ago, Carlson and Rollings (1941b) believed that pheasant nest parasitism was a factor limiting the increase of gray partridge in southern Minnesota. They noted that 3 of 6 parasitized partridge nests were abandoned. Failure of parasitized partridge nests was noted in Wisconsin by McCabe and Hawkins (1946).

OTHER MECHANISMS

Competition for Habitat

Niche overlap between pheasants and other species occupying similar habitats can result in competition for limited resources. Introduced species, such as the pheasant, can result in reduced populations of native species through competition for habitat (Leedy and Hicks 1945)—-areas in Ohio with high concentrations of pheasants had fewer bobwhites, although habitat was good for bobwhites. Errington (1945) reported competition between pheasants and bobwhites for winter cover, finding that bobwhite densities in Wisconsin were lower in winter cover when pheasants were present.

Westerskov (1964) indicated possible competition for roosting, feeding, and nesting habitat between gray partridge and pheasants. Potts (1970) noted possible competition for insects, an important food source for young of both partridge and pheasants. Mettler (1977) noted competition between pheasants and partridge where habitat was limited in intensive agricultural areas in Minnesota.

The potential for competition for habitat between prairie grouse and pheasants is not clear. Sharp and McClure (1945) reported pheasant competition for food with sharp-tailed grouse in Nebraska. Edminster (1954) noted that pheasants and prairie-chickens rely on the same foods, but suggested that this was not a significant factor limiting prairie-chicken populations. Westemeier (1983) indicated potential competition between pheasants and prairie-chickens for habitat for mating, nesting, and roosting.

Reichholf (1982:18) described a "retreat" of black grouse (*Tetrao tetrix*) in central Europe as a result of possible competition with pheasants for habitat. A habitat shift from lowlands to boreal and alpine habitats by black grouse was suggested as an example of character displacement as a mechanism for coexistence with pheasants (e.g., McNaughton and Wolf 1970).

Disease

Lund and Chute (1972) found that pheasants were able to tolerate infections of blackhead (*Histomonas meleagridis*), and suggested that pheasants could disseminate blackhead to other gallinaceous birds, concluding (1972:6) "...species of birds highly susceptible to histomoniasis cannot thrive for long if they must share their territory with the pheasant." Species highly susceptible to blackhead include ruffed grouse and chukar (*Alectoris graeca*). Pheasants may introduce blackhead to gray partridge (Bishop et al. 1977, Wright et al. 1980).

Losses of wild turkey poults in Pennsylvania followed a severe winter when pheasants and wild turkeys shared feeding stations (Lund and Chute 1972).

Aggressive Interactions

Wildlife literature contains reports of pheasants impacting other species through aggressive interactions. Pheasant aggression on prairie-chicken booming grounds has been well documented (Harger 1956, Anderson 1969). There are accounts of pheasants killing prairie-chickens (Leopold 1933, Mohler 1952, Vance and Westemeier 1979), gray partridge (Bent 1932), and bobwhites (Leopold 1931). Vance and Westemeier (1979) noted that, in 78% of pheasant x prairie-chicken encounters, pheasants dominated prairie-chickens. Svedarsky et al. (1982) noted several instances of male pheasants harassing feeding prairie-chickens.

POPULATION RELATIONSHIPS

Bent (1932) alluded to a negative relationship between pheasants and gray partridge. Under "Enemies," Bent (1932:7) wrote, "The ring-necked pheasant may have to be reckoned with, as an enemy of the partridge." There have been reports of relationships between pheasant and partridge abundance from Minnesota (Mettler 1977), Iowa (Spiker 1929, Schwartz 1975, Wright et al. 1980, McCrow 1982), Indiana (Wright 1966), Denmark (Westerskov 1964), and England (Potts 1970).

Carlson and Rollings (1942a, b) felt that Minnesota partridge populations were negatively impacted by pheasant nest parasitism during periods of high pheasant densities and limited nesting cover. Carlson (1943) reported a pheasant density 6 times that of partridge, and a high incidence of nest parasitism. In Minnesota, partridge decreased during periods of high pheasant densities in the 1950's and early 1960's (Mettler 1977). Conversely, decreasing pheasant densities through the 1970's and early 1980's have accompanied the highest recorded partridge densities (Joselyn and Lake 1986). In Iowa, a decrease in pheasant numbers (following the March 1965 blizzard) coincided with a rise in partridge numbers (Bishop et al. 1977).

In northeastern Illinois, Leopold (1931:55) noted that prairie-chickens, gray partridge, and pheasants occurred together without "visible signs of interference." However, in 1941 the Committee on Bird Protection, of which Leopold was a member, noted that pheasant introductions may eliminate some native game birds (Westemeier and Edwards 1987), suggesting a shift in his views.

Westemeier (1980) reported that prairie-chickens in Illinois were negatively impacted by pheasants through nest parasitism and harassment. He felt that similar problems have existed in South Dakota, Indiana, and Michigan. Westemeier and Edwards (1987) suggested that the decline of prairie-chickens in the Midwest cannot be explained on the basis of land-use changes alone. While federal cropland-diversion programs should have benefited prairie-chickens, they knew of no areas where chickens and pheasants benefited simultaneously.

MANAGEMENT STRATEGIES

Over 50 years ago, Leopold (1931) voiced concern about pheasants introduced into areas in Wisconsin holding prairie-chickens, and suggested controlling pheasant numbers through hunting seasons. Vance and Westemeier (1979) suggested a policy for not releasing pheasants near critical areas holding prairie-chickens. Westemeier (1986:2) noted, "Interactions between pheasants and prairie-chickens have been identified as currently posing the greatest single threat to the survival of the prairie-chicken in Illinois. In the absence of interventions to control numbers of pheasants on the sanctuaries, the survival of our remnant prairie boomers appears unlikely." Westemeier (1983) listed possible management strategies for pheasant control; mowing grass to 30 cm to reduce its attractiveness as escape cover for pheasants; burning in fall, instead of winter or spring, to reduce pheasant-roosting habitat; live-trapping and moving pheasants; controlled pheasant hunting/shooting on sanctuaries holding prairie-chickens; and managing for pheasant habitat in desired areas to pull pheasants away from critical prairie-chicken areas.

In Minnesota, biologists have discussed management strategies to limit pheasant densities in southwestern counties holding highest densities of gray partridge. To favor partridge, a wildlife plan suggests planting rows of low shrubs, preferred by partridge, instead of blocks of woody cover utilized by pheasants in winter, and maintaining low nesting cover preferred by partridge instead of thick, high nesting cover preferred by pheasants.

CONCLUSIONS

Leopold (1931) and Edminster (1954) voiced concern for possible effects of introduced exotics on native species. Unfortunately, planning can be overshadowed by public-relations aspects when considering introductions. Game department personnel are public employees, responding to introductions requested by the public. While state personnel can, and hopefully will, voice sound ecological concern when reason exists, the final administrative decision may be politically motivated. Judgments by professional game managers are often abandoned in lieu of public relations.

The popularity of ring-necked pheasants with sportsmen has overshadowed concerns for negative impacts on other wildlife. Although evidence is largely circumstantial, the voluminous number of accounts of prairie-chickens and gray partridge being impacted by pheasants is cause for concern. Prairie-chickens are generally less popular with sportsmen because of the limited hunting opportunity "chickens" offer. Gray partridge are not as popular, because they are difficult to hunt and not as familiar to sportsmen (Kimmel and Erpelding 1987). Thus, public pressure could be expected to favor management for pheasants.

Careful planning is imperative when introducing or managing pheasants. Wildlife programs may intentionally manage against pheasants in areas holding remnant flocks of prairie-chickens. Attempts to reestablish prairie-chickens, or introduce gray partridge into areas holding even moderate pheasant densities, may be futile. While evidence is not as abundant for other species, concern for pheasant impacts on bobwhite, ruffed grouse, wild turkey, sharp-tailed grouse (*Tympanuchus phasianellus*), and—possibly—waterfowl is warranted.

Current attempts to introduce Sichuan pheasants (*Phasianus colchicus strauchi*) into Michigan and other states may impose a new threat. The Sichuan pheasant apparently differs from the ringneck in habitat use (Squibb 1985). The Sichuan pheasant potentially could impact a different array of species, including bobwhite, ruffed grouse, sharp-tailed grouse, and wild turkey. Regarding introductions of Sichuan pheasants into Pennsylvania: "although the Chinese birds prefer forest type covers, they should not compete with ruffed grouse for nesting habitat" (Pennsylvania Game Commission 1987). Question: is "should not compete" good enough?

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14

An Evaluation of Methods for Controlling Pheasants on Illinois Prairie-Chicken Sanctuaries

RONALD L. WESTEMEIER, Illinois Natural History Survey, 304 Poplar Drive, Effingham, IL 62401

Abstract: Pheasants (*Phasianus colchicus*) pose a serious threat to the preservation of the last 2 populations of prairie-chickens (*Tympanuchus cupido pinnatus*) on their native range east of the Mississippi River. Methods of pheasant control evaluated included opportunistic shooting of both sexes; shooting of cocks from blinds on leks and on crowing territories; use of funnel traps baited with game-farm pheasants; use of artificial nests, plus intensive nest searching to collect pheasant eggs and hens, and cover manipulations to concentrate pheasants, primarily during fall and winter. Of these, cover manipulation in conjunction with opportunistic shooting was most efficient. By spring 1987, crowing cock pheasants on the overall study area and density of pheasant nests on sanctuaries had been reduced by 62 and 58%, respectively. However, parasitism of prairie-chicken nests continued high at 38% in 1987, presumably owing in part to private releases of hen pheasants in the vicinity of the sanctuaries.

Key Words: competition, control, interspecific, management, nest parasitism, *Phasianus colchicus,* prairie-chicken, ring-necked pheasant, *Tympanuchus cupido pinnatus*

Two isolated local populations of prairie-chickens supported by sanctuaries in south-central Illinois constitute the last remnants of once-legendary abundance (Westemeier 1985) on native range east of the Mississippi River. In Jasper County, 14 scattered sanctuaries were acquired, beginning in 1962 (Fig. 1). In Marion County, the first of 8 sanctuaries was acquired in 1969. All sanctuaries were seeded to grasses and have been intensively managed to provide nest cover. Prairie-chickens responded well to all sanctuaries in both counties (Sanderson et al. 1973, Westemeier 1973); however, their numbers declined in Jasper County during 1973-86. Pheasants became established on the sanctuar-

Prairie-Chicken Sanctuaries, Jasper County

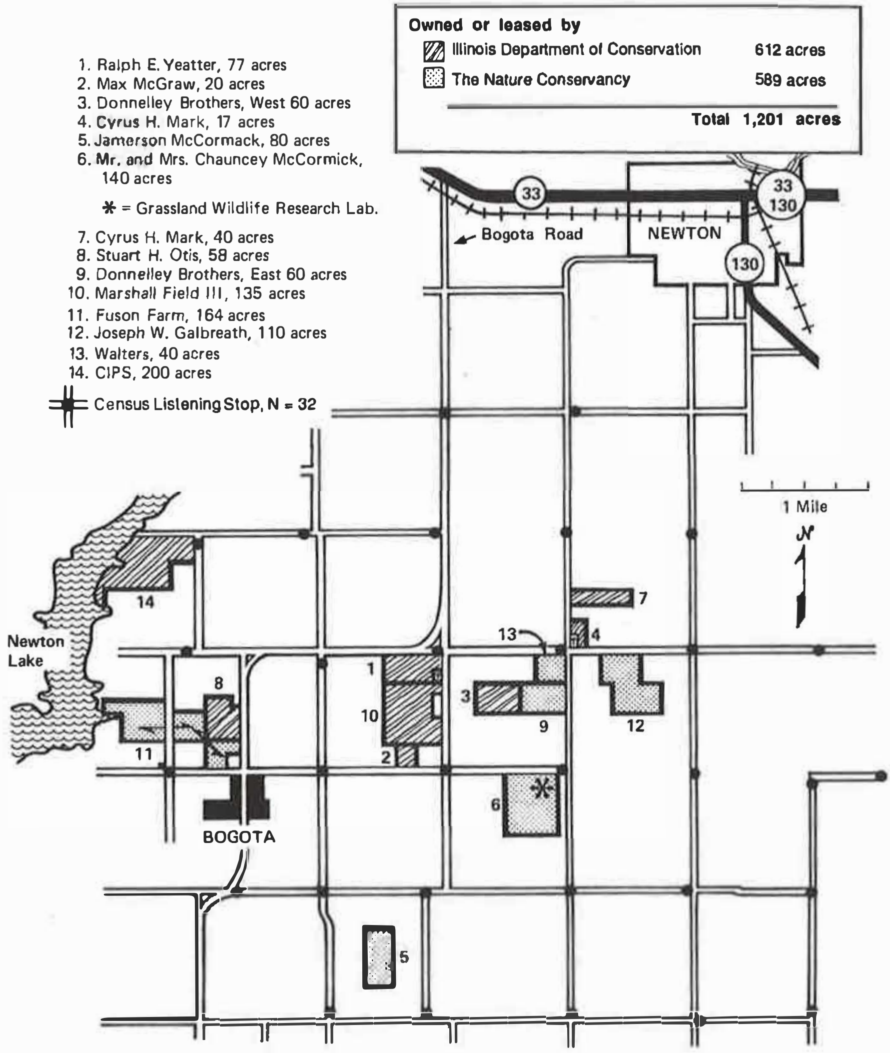


Fig. 1. Distribution of prairie-chicken sanctuaries and roads, and listening stops used to locate booming grounds and to census pheasants on the Bogota Study Area, Jasper County, IL.

ies in Jasper County about 1970, but their densities were relatively low until the 1980's (Westemeier 1984a) (Figs. 2 and 3). By 1981, pheasants were widely dispersed on or near the sanctuaries, and at least as numerous as prairie-chickens which, by then, tended to be limited to 3 central sanctuaries. Over the same period, and in the absence of pheasants, prairie-chickens supported by Marion County sanctuaries continued to show favorable densities and distributions. Agricultural landscapes in

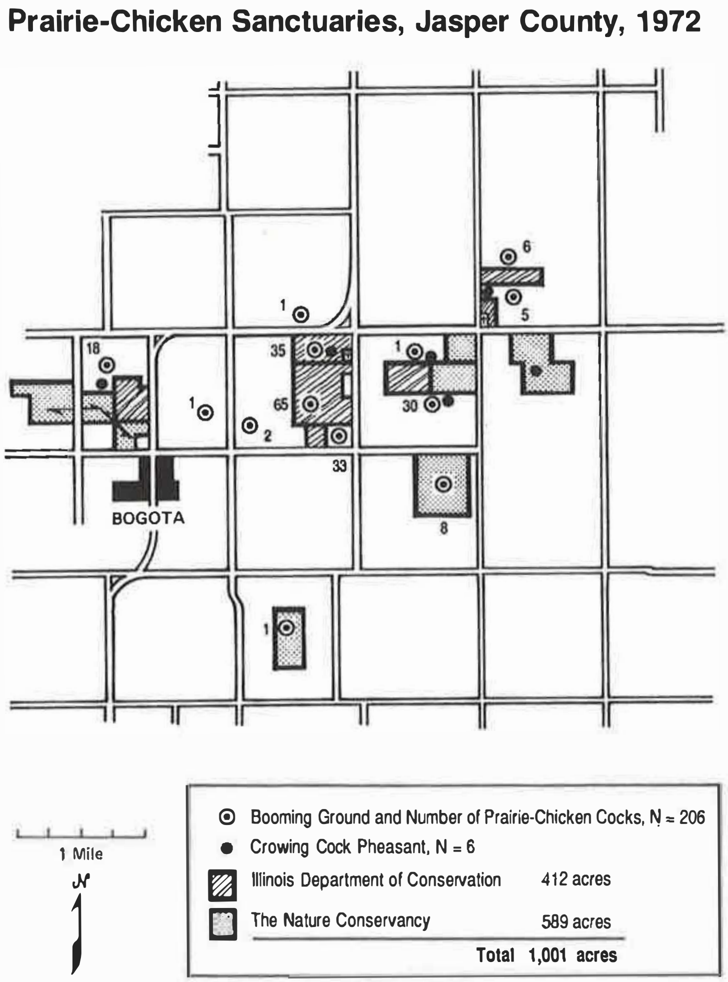
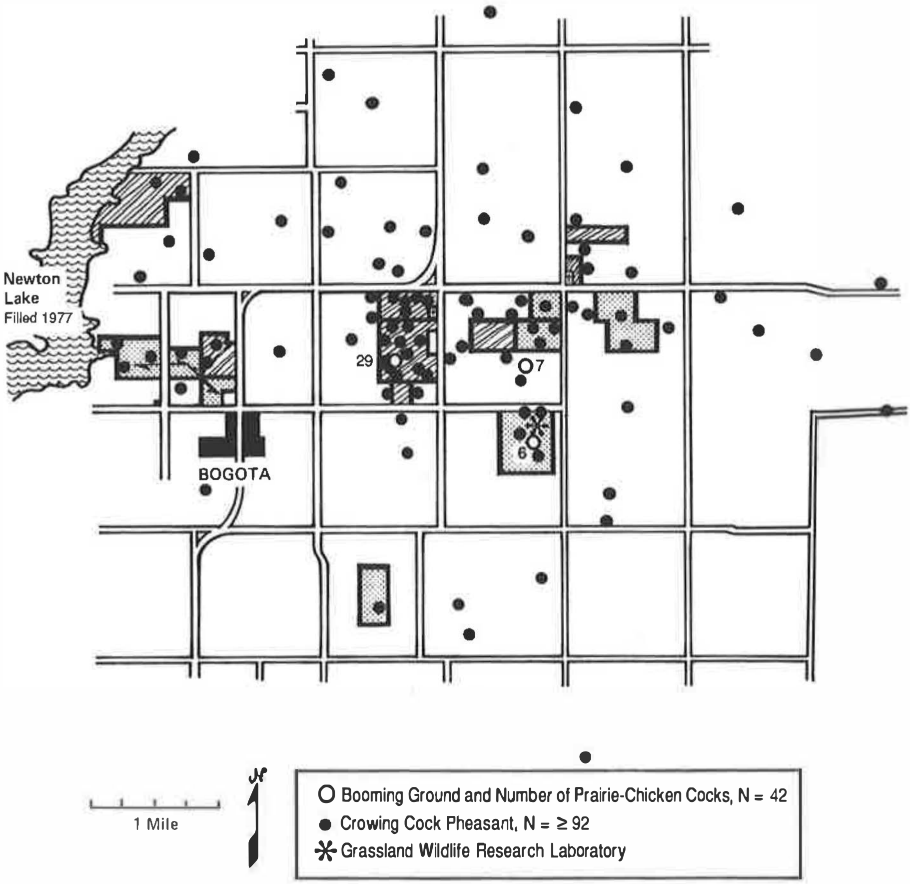


Fig. 2. Distribution of booming grounds, prairie-chicken cocks, and crowing pheasant cocks on the Bogota Study Area, Jasper County, IL, spring 1972.



Prairie-Chicken Sanctuaries, Jasper County, 1986

Fig. 3. Distribution of booming grounds, prairie-chicken cocks, and crowing pheasant cocks on the Bogota Study Area, Jasper County, IL, spring 1986.

both counties and management programs on both sanctuary systems were similar, except that restored stands of tall, dense native grasses were more limited in Marion County.

Extirpation of prairie-chickens, concomitant with range expansion by pheasants, has been reported at regional scales (Cahalane et al. 1942, Sharp 1957) and also locally (Westemeier 1984a, Westemeier and Edwards 1987). Antagonistic interactions between the 2 species include harassment and dominance by pheasants on prairie-chicken leks (Harger

1956, Sharp 1957, Anderson 1969, Vance and Westemeier 1979), dominance by pheasants over prairie-chickens at winter feeding stations (Sharp 1957), parasitism and depressed success of prairie-chicken nests (Vance and Westemeier 1979, Westemeier 1984a), and reduced hatch rate of prairie-chicken eggs (Westemeier et al. unpublished data).

Extirpation of prairie-chickens on the sanctuaries in Jasper County is quite possible unless pheasants on these sanctuaries are controlled (Vance and Westemeier 1979, Westemeier 1984a, Westemeier and Edwards 1987, Westemeier et al. unpublished data). Both species are popular with local residents, but for very different reasons. The colorful exotic ring-neck is in demand by hunters, yet—ironically—the sanctuaries must be closed to hunting because of their limited area and the danger of shooting prairie-chickens although pheasant control is desperately needed.

In this paper, recent numbers and distributions of the 2 species are first discussed to update the problem. Information about the local setting is basic to pheasant researchers and managers should they wish to use techniques herein described. My objective was to evaluate, in terms of person-hours of effort, various methods to control pheasants on prairie-chicken sanctuaries in Illinois. Parameters of reproduction by prairie-chickens, limited primarily to nest and egg success in 1986 and 1987, were examined for possible improvements as a consequence of the removal of pheasants and their eggs. Appropriate management strategies for pheasant control are considered.

STUDY AREAS AND METHODS

Study areas in Jasper County include 14 sanctuaries, ranging in size from 17 to 232 acres (7-94 ha; Fig. 1), and distributed over an intensively farmed landscape dominated primarily by soybeans (*Glycine max*), corn (*Zea mays*), and fall-seeded wheat (*Triticum aestivum*) (Sanderson et al. 1973, Westemeier and Buhnerkempe 1983, Westemeier 1984a, Buhnerkempe et al. 1984). The 8 sanctuaries in Marion County are ecologically similar, but more widely separated. Management of both sanctuary systems is an ongoing cooperative effort of The Nature Conservancy, the Illinois Department of Conservation (IDOC), and the Illinois Natural History Survey (INHS).

Censuses

Block-shaped areas of 32-36 mi^2 (83-94 km^2) encompassing the 2 sanctuary systems have been censused systematically (Grange 1948, Westemeier 1971, Hamerstrom and Hamerstrom 1973, Sanderson et al. 1973) each spring since 1963 for prairie-chickens and since 1981 for pheasants. During 1963-80, the relative abundance of pheasants had been derived incidental to standardized censuses of prairie-chickens. Standard listening stops (32 in Jasper County, Fig. 1) were limited to about 1 minute during the peak of hen visitation in late March-early April to locate booming grounds; these were repeated (4-minute listening times) during late April-early May to record crowing pheasants. Listening-stop routines were run only once for each species each spring; however, prairie-chicken cocks on leks were frequently censused, and often supplemented by observations by observers in blinds and by sightings during the conduct of other research and management activities that occurred almost daily (Vance and Westemeier 1979).

Control Methods

Most meadows on the sanctuaries are routinely either combined for seed or rotary mowed to create a stubble height of 12-16 inches (30-40 cm) favored by prairie-chickens (Westemeier 1973, Buhnerkempe et al. 1984). However, 15 patches of 5-10 acres (2-4 ha), and 5 strips up to 10 yards x 0.25 mile (9 m wide x 0.4 km long) of tall, dense native prairie grasses (*Panicum virgatum, Sorghastrum nutans*, and *Andropogon gerardi*) were left undisturbed, mostly on the perimeters of sanctuaries at least 0.25 mile (0.4 km) from booming grounds. These patches and strips of tall, heavy, herbaceous cover concentrated pheasants (Westemeier 1984a), thus facilitating pheasant control efforts by project personnel and making cocks more readily available to hunters on adjacent private lands.

Efforts were made on 20 occasions between 17 March and 23 April 1986 to reduce the number of pheasant cocks, primarily on the Yeatter-Field-McGraw (YFM) Sanctuary Unit (Fig. 1), by discreet (i.e., not highly visible or audible to local residents) shooting from portable blinds. The YFM unit contained the largest prairie-chicken booming ground (29 cocks; 69% of the total) in spring 1986, as had been the case annually over the past 23 years at Bogota. Blinds for shooters using .22 caliber rifles were placed near prairie-chicken leks where cock pheasants were frequently observed, and in pheasant territories; calls were generally used to try to attract pheasants into range; tape recordings of pheasant chicks were tried on 6 occasions and, on occasion, caged game-farm pheasants were placed on top of blinds as live decoys.

Following a pilot effort in June 1985, livetrapping of pheasants with funnel traps, using game-farm pheasants as "bait," was tried on 26 days between 20 March-26 June 1986 (Table 1). Trapping periods were usually from 0800 to 1700 hours, with traps checked at 1200 and 1700 hours.

Table 1. Summary of efforts to control pheasants on prairie-chicken sanctuaries, Bogota Study Area, 1986 and 1987.

				Pheasants & eggs collected				
							Per person-hour	
Control method	**Period**	**Trap-hours**	**Person-hours**	**Cocks**	**Hens**	**Eggs**	**Birds**	**Eggs**
Shooting:								
Opportunistic (1986)	Jan.-May		4	5	7		3.00	
From blinds (1986)	17 Mar.-23 Apr.		41	9	0		0.22	
Controlled (1987)	14-16 Jan.		196	22	27		0.25	
Opportunistic (1987)	Jan.-May		38	19	20		1.03	
Livetrapping:								
Funnel traps								
Males as bait (1986)	20 Mar.-26 Jun.	555	51	5	0		0.10	
Females as bait (1986)	31 Mar.-26 Jun.	297	27	4	0		0.15	
Noose carpets (1986)	20 Mar.-22 Apr.	141	9	0	0		0.00	
Bow net (1987)	14 Apr.- 2 May	216	2	0	0		0.00	
Nest studies:								
Artificial nests (1986)	1 Apr.-15 May		56	0	3	⩾ 61	0.05	1.09
Artificial nests (1987)	1 Apr.-15 May		40	0	0	13	0.00	0.33
On-foot searches (1986)	29 Apr.-30 Jun.		445					
Pheasant[a]				0	17	322	0.04	0.72
Prairie-chicken[b]				0	0	19		0.04
On-foot searches (1987)	2 May-30 Jun.		618					
Pheasant[a]				0	7	140	0.01	0.23
Prairie-chicken[b]				0	0	28		0.05
Cable-chain drag (1986)	20-21 May		64	0	0	0	0.00	0.00
Total or Mean	1986	993	697	23	27	402	0.07	0.71
Total or Mean	1987	216	894	40	54	181	0.11	0.28

[a] Pheasant nests terminated during nest searches.

[b] Prairie-chicken nests from which pheasant eggs were removed.

Bait-birds were also used in conjunction with 25-30 monofilament snares (Berger and Hamerstrom 1962). Criteria used in the selection of trap sites included: (1) frequent observation of cock pheasants on a specific site; (2) good visibility, such as that provided by field lanes, firelanes, or bare ground; (3) ready access for project vehicles; and (4) concealment from the general public. Windy or rainy days were avoided for trapping.

In April 1985 an attempt was made to attract parasitic egg deposition by pheasants to artificial nests that contained 2-3 white, domestic chicken (*Gallus gallus*) eggs; 3 of the 16 artificial (decoy) nests were parasitized (i.e., were later found to contain 1-2 eggs of wild pheasants). These results prompted an expanded study. On 1 April 1986, 29 artificial nests were created on the 3 central sanctuaries, using marked pheasant eggs; the number of artificial nests was gradually increased to a maximum of 79 on 18 April. Clutch size was also regularly increased by adding 1 egg twice a week to each artificial nest, whether or not it had been parasitized. Destroyed or missing clutches were replaced with the number of eggs that would have been present had predation not occurred. Densities of artificial nests ranged from about 20 to 30/25 acres (10 ha) in fields where parasitism had been documented during 1970-85, and 1-4 nests/25 acres in other fields. The 60-acre (24-ha) West Donnelley Sanctuary (Fig. 1) served as a "control" (i.e., received no artificial nests).

So that artificial nests would be visible to hen pheasants, nests were placed within 20 inches (0.5 m) of field edges and sharp breaks in cover such as field lanes, firelanes, and bare fields. A depression was made in grassy vegetation, a mat of grassy duff was added, and "entries" were oriented east, northeast, or north to help protect eggs from spoilage and bleaching. Blaze-orange plastic flagging was tied to vegetation 10 yards (9 m) north of each artificial nest to mark nest location.

In 1987, artificial nests consisted of 20 sets of 2 white plastic eggs (2.5 x 1.8 inches (63 x 45 mm) each about 10 yards (9 m) from a similar artificial nest that contained 2 golf balls. My primary intent in offering these 40 artificial nests—which were limited to the YFM unit—was to learn: (1) if simulated eggs could be a satisfactory substitute for real eggs and (2) whether parasitic hen pheasants might be attracted to artificial nests and then live-trapped. A bow-net trap (Salyer 1962) with an automatic trigger was tried at 2 artificial nests in which parasitism had already begun.

Systematic nest searches (Westemeier 1973, Westemeier and Buhnerkempe 1983), conducted in 1986 and 1987, involved single, total coverage on foot of about 350 acres (142 ha) of grasslands each year on the central sanctuaries (Fig. 1). The searches were initiated earlier (about 1 May) in 1986 and 1987 than in the past 23 years, in order to remove pheasant eggs from more of the active prairie-chicken nests and to remove more pheasant eggs and hens from active pheasant nests. Cable-chain dragging (Higgins et al. 1977) was also tried in 16 fields totaling 103 acres (42 ha) in an attempt to find active pheasant nests on peripheral sanctuaries where prairie-chickens had not been found during the censuses.

RESULTS AND DISCUSSION

Local Abundance and Distributions

The twenty-fourth consecutive census of greater prairie-chickens in Illinois, conducted in spring 1986, revealed 116 cocks. These included 42 cocks on the main study area at Bogota (1,201 acres [486 ha] in sanctuaries) in Jasper County (Fig. 3), and 70 cocks near Kinmundy (760 acres [308 ha] in sanctuaries) in Marion County. In spring 1987, respective counts of prairie-chicken cocks were 36 and 60.

Prairie-chicken abundance at Bogota reached its zenith in spring 1972, with about 206 cocks (Fig. 2) dispersed over essentially all sanctuaries—a high density for such limited habitat (Westemeier 1973, Kirsch 1974). In spring 1972, only 6 pheasant cocks were known to be in the Bogota census area. However, by spring 1986, at least 92 pheasant cocks were present in the census area (Table 2), about 60 of which were in close proximity to leks being used by the 42 remaining prairie-chicken cocks which, by then, were limited to the 3 central sanctuaries (Fig. 3). Thus, between 1972 and 1986, pheasants increased 1500% and prairie-chickens declined 80%. In spring 1987, the count of pheasant cocks at Bogota was down to 35 (-62%), apparently as a result of control efforts during the previous year. In 1986, at Bogota, there were 31.2 pheasant cocks/mi^2 (12.2/km^2) on or near the sanctuaries, as compared with 1.0 cock/mi^2 (0.4/km^2) on private land surrounding the sanctuaries. Preno and Labisky (1971) estimated a mean density of 8.5 cocks/mi^2 (3.3/km^2) in spring for prime Illinois pheasant range for 1955-69. Thus, in 1986, pheasant numbers on sanctuary grasslands at Bogota were high, and clearly responsive to sanctuary habitat. Conversely, pheasant densities on surrounding intensively cropped farmland were much lower.

Since about 1980, short-term, local colonizations by prairie-chickens have frequently occurred near sanctuaries in Marion County (Westemeier 1984b). However, local colonizations by prairie-chickens have not occurred in Jasper County since 1980. Thus, in recent years, trends in abundance, distribution, and dispersal behavior of prairie-chickens at Kinmundy (the control area) were favorable, compared with unfavorable trends at Bogota. As mentioned, pheasants have been abundant on and near the Jasper County sanctuaries. Except for 3 crowing cocks in spring 1987, no pheasants have been heard in Marion County during standard pheasant

Table 2. Numbers of crowing cock pheasants and pheasant nests, and numbers of pheasants, pheasant nests, and pheasant eggs removed from prairie-chicken sanctuaries in Illinois; Bogota Study Area, 1969-1987.

Year	Spring count of crowing cocks	Pheasant nests found	Pheasants removed from sanctuaries			
			Cocks	Hens	Nests	Eggs
1969	4	1				
1970	6	7				
1971	8	10				
1972	6	4				
1973	8	9				
1974	14	4	2	1	0	0
1975	22	6	6	4	0	0
1976	18	5	3	3	0	0
1977	23	5	2	2	0	0
1978	26	13	6	13	7	84
1979	22	10	3	3	2	20
1980	25	12	1	2	0	0
1981	48	21	3	1	1	14
1982	46	19	0	1	1	10
1983	29	11	6	3	4	62[a]
1984	24	29	0	5	6	74
1985	40	28	3	5	8	95[a]
1986	92	54	23	27	24	402[a]
1987	35	23	40	54	9	181[a]

[a] Includes pheasant eggs laid in artificial nests and some eggs removed from prairie-chicken nests.

censuses in recent springs. However, a few pheasants were seen on the Marion County sanctuaries in 1986 and 1987—pheasants may well become a problem on these sanctuaries in the near future.

Control Techniques

Cover Management/Shooting.—Cover management to concentrate pheasants, followed by opportunistic shooting by on-site staff, was the most efficient (3 birds/person/hour) method of control (Table 1). Pheasants were removed primarily by shooting during inclement weather conditions (fog, snow, ice, and high wind) when they were likely to be using the shelter of heavy cover on sanctuaries. Groups ranging from 5 to 46 pheasants were observed to be closely associated with patches of tall, dense, prairie grasses on the sanctuaries that had been left undisturbed adjacent to corn stubble on private land during the winters of 1985-86 and 1986-87.

During the controlled shoot, conducted by IDOC personnel in mid-January 1987, 77 pheasants were flushed, 51 were considered "in range" and 49 were "dropped," using 152 rounds of steel shot. The flushing rate in undisturbed prairie grass was 2.63 pheasants/acre (0.17 pheasants/ha) vs. 0.05/acre (0.02/ha) in redtop bentgrass (*Agrostis alba*), timothy (*Phleum pratense*), and smooth brome (*Bromus inermis*), most of which had been combined for seed or mowed to a height of 10-16 inches (30-40 cm). Thus, the flushing rate was 8-9 times greater in tall, undisturbed, prairie grass than in short vegetation (Westemeier 1984a). Subsequent opportunistic shooting by project personnel through May 1987 accounted for 39 additional pheasants removed from the sanctuaries in Jasper County, about 1/hour/person (Table 1).

Shooting from Blinds.—Use of small portable blinds near prairie-chicken leks and on pheasant crowing territories in 1986 was moderately successful (0.22 birds/person/hour) for removing individual cock pheasants (Table 1). The 9 cocks taken by this approach were on the YFM unit; most of which were <0.25 mi (<0.4 km) from the main booming ground. In 1 instance, a commercial pheasant call (Mallardtone) appeared effective in coaxing a wild cock from about 330 yards (300 m) to within 50 yards (45 m) of a blind. Tape recordings of "lost" calls by pheasant chicks appeared ineffective in attracting pheasants on 6 occasions (about 6 person-hours) during May-July.

Live-trapping.—During 5-26 June 1985, 4 cock pheasants were captured in funnel traps in 152 traps-hours (2.6/100 trap-hours). This suggested that cock numbers might be effectively reduced in local areas if trapping took place throughout the breeding season. However, in 852 trap-hours from late March to late June 1986 only 9 cock pheasants (1.1/100 trap-hours) were taken, despite more than double the number of cocks being present in 1986 (Tables 1 and 2). Dates of captures in 1986 were 21 and 22 May, and 13, 16, 19, 23, and 25 June—the period when most hens would be incubating or rearing broods. One of the 4 captures in 1985, and 4 of the 9 captures in 1986, were made using game-farm hen pheasants as bait. Of the 4 pheasant cocks taken in 1985, and the 9 captured in 1986, 2 and 8, respectively, were captured before noon. Thus, it may be possible to improve efficiency somewhat by limiting live-trapping to the period of about 15 May-30 June, using caged hen pheasants as bait, and trapping between 0800 and 1200 hours. Noose carpets near caged pheasant hens were ineffective in capturing pheasants.

Artificial Nests.—In 1986, pheasants laid at least 61 eggs in a minimum of 19 of 79 artificial nests placed in sanctuary meadows between 1 and 18 April (Tables 1 and 3). Approximately 1 hour of effort

Table 3. Results of artificial nest placement to attract parasitic egg laying by pheasants on prairie chicken sanctuaries, Bogota Study Area, 1986.

	Artificial nests placed and results						Prairie-chicken nests found		
				Parasitic eggs deposited					
Sanctuary	N	Nests/ 10 ha	Nests parasitized	N	N/10 ha	Grassland searched for nests (ha)	Total	Para-sitized	% Para-sitized
YFM[a]	18	19.3	4	12	12.9	9.3	9	6	67
YFM	26	4.4	6	24	4.0	60.0	6	3	50
E. Don[b]	6	29.7	3	11	54.4	2.0	0	—	—
E. Don	9	5.9	2	4	2.7	15.0	1	0	0
C. McC[c]	20	4.9	4	10	2.4	41.3	9	2	22
W. Don[d]	0	—	—	—	—	16.6	6	1	17
Total or Mean	79	5.4	19	61	4.2	144.1	31	12	39

[a] Yeatter-Field-McGraw unit.

[b] East Donnelley unit.

[c] C. McCormick unit.

[d] West Donnelley unit (control).

was spent working on artificial nests/parasitic egg laid in such nests in 1986 (Table 1). Pheasants first laid eggs in the artificial nests between 7 and 11 April; parasitism rose rapidly thereafter until 18 April (Fig. 4). By mid-April, during intervals between inspections of only 3 days, predators—primarily crows (*Corvus brachyrhynchos*)—had removed about 90% of the eggs in artificial nests on the C. McCormick and East Donnelley sanctuaries. All nests considered to be pilfered by crows were empty, with no egg shells in the vicinity of the nest sites; evidently, eggs were carried away (Montevecchi 1976). Flagging, placed 10 yards (9 m) from each artificial nest, may have provided a visual cue that aided crows in finding artificial-nest sites (Picozzi 1975, Yahner and Wright 1985).

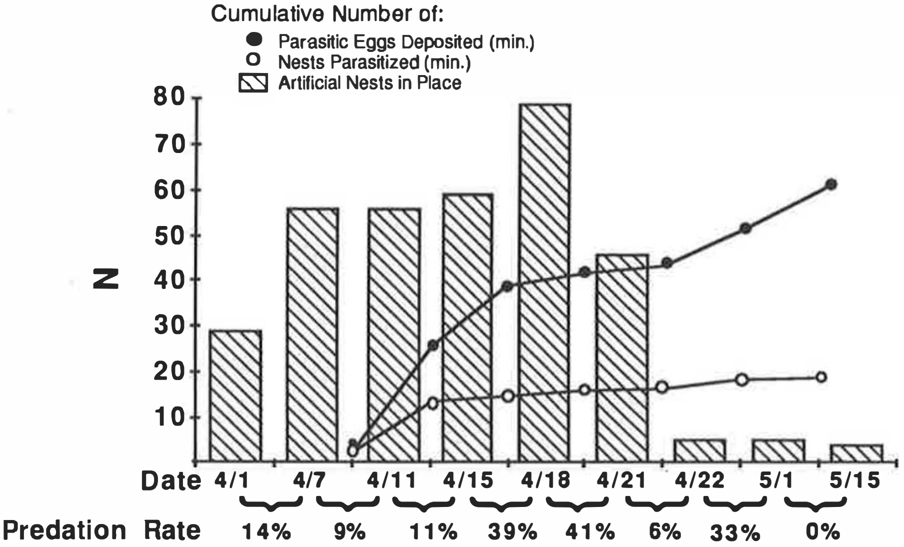


Fig. 4. Egg deposition by pheasants in artificial nests on prairie-chicken sanctuaries, Bogota Study Area, Jasper County, IL, 1 April-15 May 1986.

On 21 April, 2 crows were seen carrying eggs from artificial nests within 10 minutes after eggs in empty, previously depredated nests had been replaced. Because of the high rate of predation by crows and the probable increased risk to nearby prairie-chicken nests (Sugden and Beyersbergen 1986), work with artificial nests was mostly terminated by 22 April 1986. Six artificial nests that remained intact and well-concealed from crows were checked until 15 May; 5 of these 6 nests were parasitized by pheasants. It is likely that the number of parasitic eggs deposited by pheasants in artificial nests was considerably above 61 eggs, and that more decoy nests left in the field for a longer time would have received greater numbers of parasitic pheasant eggs.

In 1986, 12 (39%) of 31 prairie-chicken nests at Bogota were parasitized by pheasants (Table 3). That rate compares favorably with rates of nest parasitism in 1983 and 1985 when pheasants were only 32 and 43%, respectively, as abundant as in 1986. Numbers of parasitized prairie-chicken nests from 1969 to 1985 correlated with abundance of pheasants ($P<0.05$) and with numbers and densities of pheasant nests ($P<0.01$) (Westemeier et al. unpublished data). The rate of parasitism, based on regression analysis for the previous 15 years of data, suggests that parasitism would have been about 60% instead of the observed 39% had no artificial nests been present. However, for individual sanctuaries, the incidence of parasitism of prairie-chicken nests was not closely correlated with the rate of parasitism on artificial nests ($P>0.10$), or with the density of artificial nests placed in fields ($P>0.10$) (Table 3). For example, on the YFM unit, where 19.3 artificial nests/25 acres (10/ha) had been placed, and 12.9 parasitic eggs/25 acres deposited, the parasitism rate among prairie-chicken nests was 6 of 9 nests (67%); on the control area, with no artificial nests, the parasitism rate was 1 of 6 nests (17%).

Use of artificial nests was continued in 1987, but at a reduced level compared with that of 1986. Plastic eggs and golf balls were used in 1987 to preclude food rewards for predators. Of 40 artificial nests evaluated in 1987, pheasants laid 1-4 eggs (12 total) in 6 of 20 artificial nests containing plastic eggs, and 1 egg in 1 of the 20 artificial nests containing golf balls.

Although predation in 1987 of artificial nests containing plastic eggs or golf balls was much reduced from 1986, when pheasant eggs were used, depredation nevertheless occurred at 5 nests with plastic eggs and at 3 nests with golf balls. None of these depredated artificial nests showed evidence of parasitism by pheasants. However, pheasants parasitized 4 other nests containing plastic eggs, and 1 containing golf balls, prior to depredation. Despite some predation, plastic eggs appear to be a suitable substitute for real eggs in artificial nests. Several attempts in 1987 to capture parasitic hens with bow-net traps over artificial nests proved futile.

Nest Searches.—The cable-chain drag was ineffective in locating pheasant nests (Table 1); however intensive (on foot) searching of 356 acres (144 ha) of sanctuary grasslands in 1986 resulted in finding 31 prairie-chicken, 54 pheasant, 13 northern bobwhite (*Colinus virginianus*), 9 mallard (*Anas platyrhynchos*), and 3 upland sandpiper (*Bartramia longicauda*) nests, plus an assortment of nests of passerine birds. Nests of the same species found in 1987 were 24, 23, 9, 3, and 5, respectively. Among these potential hosts, 12 prairie-chicken nests and 1 mallard nest contained pheasant eggs in 1986, and 9 prairie-chicken nests were parasitized in 1987.

Thus, despite intensive control efforts, a 62% reduction in the crowing-cock index, a 58% reduction in pheasant nest density, and the lowest prairie-chicken population on record, the incidence of nest parasitism by pheasants (38%) in 1987 was essentially unchanged from 1986 (39%) (Table 4). On the basis of the correlation between pheasant nest density and parasitism of prairie-chicken nests in previous years, the percentage of nest parasitism was expected to be about 24% in 1987. This comparison of parasitism incidence may be confused by the extensive use and effectiveness of artificial nests in 1986. As previously discussed, parasitism of prairie-chicken nests may have reached 60% in 1986 had there been no artificial nests. Another complication in the continued high level of parasitism was apparently the result of an early-April release of 56 hen pheasants by local individuals. Although survival of such stock is characteristically low, the released hens apparently survived long enough to parasitize prairie-chicken nests. However, the reduction in pheasant nest density at Bogota in 1987 was similar to the reduction in pheasant numbers as indicated by counts of crowing cocks.

Table 4. Changes in pheasant and prairie-chicken abundance following efforts to control pheasants on prairie-chicken sanctuaries, 1986 through spring 1987, Jasper County, Illinois.

	1986	1987	% Change
Pheasant			
Crowing cocks	92	35	-62
Nests/10 ha	3.8	1.6	-58[a]
Prairie chicken			
Cocks	42	36	-14
Nests/10 ha	2.2	1.7	-23
Nests parasitized (%)	39	38	-3[a]

[a] Release of 56 hen pheasants by local individuals reportedly occurred in early April 1987.

Nest searches were effective in finding an average of 52% of parasitized prairie-chicken nests and 44% of pheasant nests soon enough for removal of pheasant eggs prior to hatching (Table 5). Considering the later and more prolonged nesting season typical of pheasants, these respective percentages probably represent our finding a higher proportion of the total unhatched, parasitized, prairie-chicken nests, than unhatched pheasant nests.

Removal of parasitic pheasant eggs from active prairie-chicken nests seemingly offered a means of thwarting possible losses of unhatched prairie-chickens. Of 14 parasitized prairie-chicken nests found early

Table 5. Effectiveness of nest searches in finding pheasant nests and parasitized prairie-chicken nests soon enough for removal of pheasant eggs on 3 central sanctuaries (215 ha), Bogota Study Area, 1986 and 1987.

Species, year	Total nests found	Nests parasitized by pheasant	Active nests from which pheasant eggs were removed	
			N	%
Prairie-chicken				
1986	31	12	5	42[a]
1987	24	9	6	67[a]
Total/mean	55	21	11	52[a]
Pheasant				
1986	54		24	44
1987	23		10	43
Total/mean	77		34	44

[a] % of those nests parasitized.

enough to remove pheasant eggs, 12 (86%) subsequently produced young prairie-chickens (Table 6). This compares very favorably with 46% success for nests from which pheasant eggs were not removed, and 51% success for prairie-chicken nests which were not parasitized; however, sample sizes were small and these differences were not significant ($P>0.20$). Over the past 25 years, success of 850 prairie-chicken nests of known fate averaged 52% (Westemeier unpublished data). Thus, the 51% rate of success for unparasitized nests was not surprising.

Strangely, egg success (hatched eggs/total eggs) was no better for prairie-chicken nests from which parasitic pheasant eggs had been removed (71%) than for those from which pheasant eggs were not removed (75%), or for clutches that were not parasitized (78%) ($P>0.50$). The reason for this phenomenon remains an enigma. Ages of embryos at the time of their deaths, in clutches from which pheasant eggs were removed ruled out the possibility that embryo mortality might have been due to researchers flushing incubating prairie-chicken hens. These embryos had died either before the nests were found or shortly before hatching time, supporting the conclusion (Westemeier et al. unpublished data) that pheasant interactions with incubating prairie-chickens can result in mortality of prairie-chicken embryos even when the parasitic eggs do not hatch—and possibly even when prairie-chicken nests are not parasitized. Disrupted incubation by prairie-chicken hens, relating in some way to the presence of pheasants, is a possible cause of embryonic mortality of prairie-chickens.

Table 6. Summary of (a) rate of hatch of prairie-chicken eggs and (b) success (i.e. ≥ 1 prairie-chicken egg hatched) in nests where parasitic pheasant eggs were (Column 1), or were not (Column 2) removed, and for unparasitized nests (Column 3).

	Parasitized nests		
Category	Pheasant eggs removed (1)	Pheasant eggs not removed (2)	Unparasitized nests (3)
[a]Eggs hatched	113/159 (71%)	85/113 (75%)	237/302 (78%)
[b]Successful nests	12/ 14 (86%)	11/ 24 (46%)	32/ 63 (51%)

[a] $\chi^2_2 = 0.760$ ns ($P > 0.50$).
[b] $\chi^2_2 = 2.995$ ns ($P > 0.20$).

Consistent with the abundance of pheasants at Bogota in 1986, density of pheasant nests found during intensive searches (3.9 nests/25 acres (10 ha) was about double that found in 1985 (2.0 nests/25 acres). In 1986, 17 incubating pheasant hens and 322 pheasant eggs were collected from 24 (44%) of the 54 pheasant nests found on sanctuaries (Tables 1, 2, 4, and 7). Predation and abandonment terminated 25 (46%) of the pheasant nests, and only 5 (9%) nests were known to have been successful. Thus, far more incubating pheasant hens and eggs were collected in 1986 than in past years, thereby greatly reducing the success of those nests. The degree to which these efforts constitute "control," however, presents several questions. How many pheasant hens were present at Bogota in spring 1986; how many were successful in rearing young; how many young were reared; how many survived the 1986 hunting season; how many pheasants moved to and away from the sanctuaries during fall 1986 and winter 1986-87? There are no answers to these questions.

Conclusions Regarding Pheasant Control

Efforts implemented to control pheasants on the 3 central sanctuaries occupied by prairie-chickens at Bogota in winter-spring 1986 resulted in removal of an estimated 53% of the pheasant cocks. Among nests that were either still active or already successful when found during nest searches, terminations included 80% of known pheasant nests, and 68% removal of parasitic pheasant eggs in all known prairie-chicken nests. For the entire Bogota Study Area in spring 1986, removals of pheasants and their eggs probably involved no more than 23% of the cocks and 14% of the hens and nests present—not particularly high levels of removal.

Table 7. Maximum counts of pheasants in winter 1985-86 followed by spring 1986 count of crowing cocks and pheasant nests found on and near prairie-chicken sanctuaries, Bogota Study Area, Jasper County, Illinois.

Sanctuary and vicinity	Maximum winter count[a]			Spring counts of cocks[b]	Pheasant nests found				
	Total	Cocks	Hens		T[c]	D	C	A	S
Yeatter, Field, McGraw	73	19	43	25	27	10	13	1	3
Donnelley-Walters	17	6	11	11	17	7	9	0	1
Marks	8	2	6	3	0	0	0	0	0
Galbreath	5	2	3	5					
C. McCormick	7	3	4	4	10	6	2	1	1
J. McCormack	[d]	[d]	[d]	1					
Otis-Fuson	15	[d]	[d]	7	0	0	0	0	0
CIPS	12	[d]	[d]	4	–[e]	–	–	–	–
Private land	[d]	[d]	[d]	32	–	–	–	–	–
Total	137	32	67	92	54	23	24	2	5

[a] Total may be larger than number of cocks and hens because sexing was not always possible.

[b] Pheasant cocks <0.4 km from sanctuaries were considered on sanctuary.

[c] T = total, D = depredated (some probably abandoned first), C = eggs collected from active nests, A = abandoned, S = successful. All nests were on sanctuaries.

[d] No data.

[e] = No nest searches on either CIPS or private lands.

However, the controlled shoot in January 1987, plus follow-up opportunistic shooting, apparently resulted in a significant reduction in pheasant abundance and nest densities on the sanctuaries in Jasper County in spring 1987. Both the special shoot and subsequent opportunistic shooting demonstrated that, in bad weather, pheasants concentrate in specific types of cover—particularly in undisturbed prairie grass—where they can be removed with minimal risk to prairie-chickens. Importantly, the IDOC-managed shoot demonstrated to the local community the positive resolve and official character of efforts to control pheasants on sanctuaries. Subsequent opportunistic shooting by project personnel proceeded with little fanfare among local residents. Still, the probable release of pheasants by private local interests in spring 1987, followed by a 38% rate of parasitism of prairie-chicken nests, strongly suggests a need for modification of local sentiments toward the 2 species.

Benefits to prairie-chickens achieved by control efforts should be considered as temporary. Reproduction by survivors, possible private releases, and potential for ingress of pheasants from adjacent private land, would eventually repopulate pheasants on the sanctuaries. No single method is likely to provide a satisfactory, cost effective, long-term solution to pheasant control on the prairie-chicken sanctuaries. An ongoing, integrated approach to pheasant control will be necessary.

MANAGEMENT CONSIDERATIONS

Habitat Manipulation

Because of the utilization of similar cover types for nesting by prairie-chickens and pheasants (Buhnerkempe 1979, Westemeier et al. unpublished data), altering management of nest habitat will not significantly reduce either parasitism or the possibility of interspecific competition. However, selection of tall, dense cover by pheasants—but not by prairie-chickens—for roosting (nocturnal and diurnal) and for escape cover, suggests that habitat management should aim at reducing availability of cover types preferred by pheasants in winter (Westemeier 1984a). Practices recommended for managing prairie-chicken sanctuaries include: (1) combine grasses for seed, mow, or possibly graze most grasslands to a height of 12-16 inches (30-40 cm) in late summer or fall; (2) conduct prescribed burns of prairie grass in late fall, instead of late winter or early spring; and (3) plow old sods (non-native sods that are scheduled for renovation) in fall instead of in spring. These practices should apply to >90%, while patches and strips of tall, dense cover should comprise <10% of sanctuary areas.

Pheasants in winter have shown a preference for undisturbed stands of prairie grass—particularly switchgrass—and other tall, heavy, herbaceous cover in close proximity to corn stubble suitable for feeding. Pheasant distribution can be manipulated by providing such cover/food interfaces. In order to facilitate legal hunting by local sportsmen on private land near sanctuaries without causing major trespass problems on the sanctuaries, stands of tall, dense cover should be 2-10 acres (1-4 ha) in size, developed adjacent to private land, and well away from leks and homesites. Participation by hunters in pheasant control on prairie-chicken sanctuaries could possibly result in favorable public and political relations; however, such participation could generate more problems than benefits.

Nest Studies

The long-term study—since 1962—of nesting ecology at Bogota constitutes the heart of prairie-chicken management in Illinois. This study has provided a wealth of knowledge on other resident and migrant grassland birds. It is important that such research continue, although obtaining sustained funding for long-term research is becoming increasingly difficult. Intensive, on-foot nest searches should begin in late April, in conjunction with habitat manipulations and shooting, in order to facilitate pheasant control and to evaluate the efficacy of control. Although future use of artificial nests will undoubtedly not effectively control parasitism, artificial nests offer a useful "sensing system" to detect whether or not parasitism continues to be a problem.

Public Relations

Local public reaction to pheasant control has presented problems. Some local area residents wholeheartedly support efforts made to control pheasants, some are indifferent, and others are highly adamant in their opposition. As Kimmel (in this Symposium) noted: "The popularity of the ring-necked pheasant with sportsmen may have overshadowed concern for negative impacts with other wildlife." Thus, the uniqueness of Illinois' remnant prairie-chickens, and their aesthetic, educational, heritage, and scientific values, must be emphasized at every opportunity—especially locally. By contrast, the legal aspects of the release of pheasants by individuals in a sanctuary area for prairie-chickens should be appropriately modified. Similarly, the illegality of releasing exotic species on dedicated nature preserves designed for preservation of state endangered species should be enforced and publicized. Finally, a recovery in prairie-chicken abundance at Bogota, if associated with a substantial reduction of pheasants, would demonstrate the importance of considering interactions among species when developing management plans for other wildlife.

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15

SICHUANS, PHEASANTS OF THE FUTURE?—LEARNING FROM PAST RELEASE PROGRAMS

HAROLD H. PRINCE, Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824
PETE SQUIBB, Wildlife Division, Michigan Department of Natural Resources, Lansing, MI 48909
GLENN Y. BELYEA, Wildlife Division, Michigan Department of Natural Resources, Lansing, MI 48909

Abstract: We review the history of pheasant introductions (*Phasianus colchicus*) in North America. Although pheasant range in North America was well defined by the late 1930's, many state game departments continued to release pheasants. Recent release programs have resulted in range expansions in southern Iowa, northern Missouri, and Texas; similar releases in areas where wild pheasants were declining have had little effect. Recent acquisition of wild *P. c. strauchi* from Sichuan Province, China, provides a new alternative for restocking and possible range expansion. In China, Sichuan pheasants occupy conifer and early second-growth habitats adjacent to agriculture. These pheasants are currently being released in unoccupied habitats in Michigan. Success will depend largely on the ability of Sichuan pheasants to escape high levels of predation.

Key Words: establishment, introduction, *Phasianus colchicus,* propagation, releases, ring-necked pheasant

Delacour (1977) concluded that pheasants were culturally important in southeast Asia over 3,000 years ago. Pheasants were known to ancient Greeks living along the River Phasis, now known as the Rion, in the country of Colchis. Greeks and Romans procured numerous species of pheasants (MacPherson 1896). There are records of pheasants in England following the Norman conquest in 1066 (Sprake 1936). In addition to Europe and North America, pheasants were successfully established in Australia, Hawaii, Japan, and New Zealand (Johnsgard 1986). Conditions allowing a rapid increase in pheasants in North America—in

Oregon in the 1880's, for example—may never be fully understood. Our purpose is to review briefly the taxonomy of the genus *Phasianus* as it pertains to release and establishment of ring-necked pheasants in North America. Factors that appear to have affected establishment are considered a basis for future releases.

A BRIEF REVIEW OF PHEASANT TAXONOMY

Delacour (1977) recognized 16 genera, including 49 species and 122 races of pheasants. Interest here revolves around the "true" pheasants belonging to the genus *Phasianus* which are—or were—distributed across Asia from the southern foothills or the Caucasus in Iran; along the Black Sea; eastward across Afghanistan, Turkistan, and Mongolia to the Pacific Ocean; and southward across China and Korea to the shores of the China Sea (Delacour 1977, Johnsgard 1986) (Fig. 1). Species of true

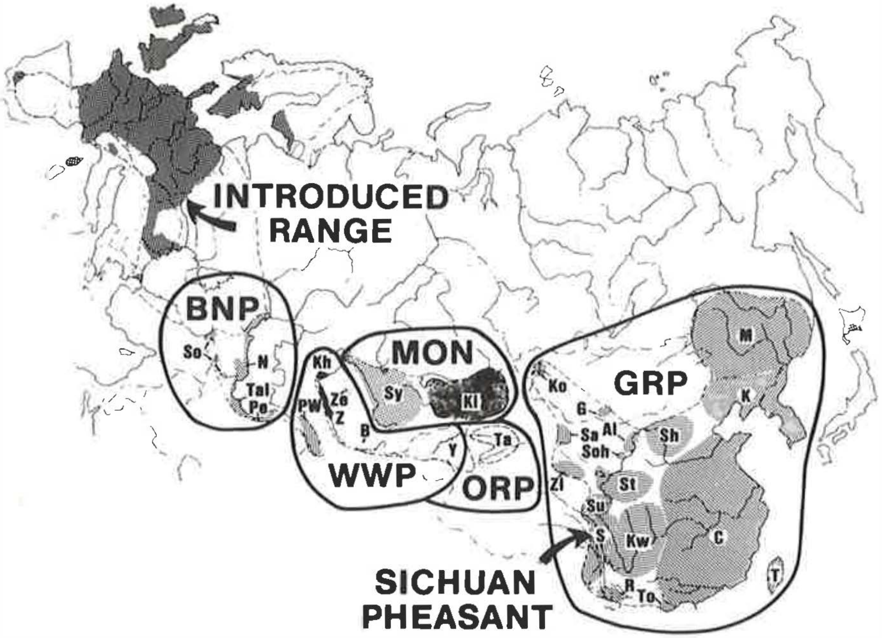

Fig. 1. Pheasant distribution: Black-necked (BNP)—northern Caucasian (N), Persian (Pe), southern Caucasian (So), Talisch Caucasian (Tal). White-winged (WWP)—Bianchi's (B), Khivan (Kh), Prince of Wales (PW), Yarkand (Y), Zarudny's (Z), and Zerafshan (Ze). Mongolian (MON)—Kirghiz (Ki), Syr Daria (Sy). Olive-rumped (ORP)—Tarim (Ta). Gray-rumped (GRP)—Alashan (Al), Chinese (C), Gobi (G), Kobdo (Ko), Korean (K), Kweichow (Kw), Manchurian (M), Rothschild's (R), Satchu (Sa), Shansi (Sh), Sohokhoto (Soh), Stone's (St), Strauch's (S), Sungpan (Su), Taiwan (T), Tonkin (To), Zaidan (Zi) (from Johnsgard 1986).

pheasants currently recognized are the "common" pheasant (*P. colchicus*) and the Japanese "green" pheasant (*P. versicolor*) (Delacour 1977, Wayre 1969, Johnsgard 1986). Geographic races of *P. colchicus* are divided into 5 groups:

1. The "black-necked" group (4 races) occupies the western end of the species' range and includes the "old English black-necked" type.
2. The "white-winged" group, from southern Russian Turkestan and northern Afghanistan, comprises 6 races.
3. The "Mongolian" group (2 subspecies) is found only in Russian and Chinese Turkestan.
4. The "Tarian" or "olive-rumped" group (2 subspecies).
5. The "Torquatus" or "grey-rumped" group (17 races).

These 31 races replace one another geographically, and constitute what could be termed a "superspecies" (Delacour 1977), as they interbreed freely in confinement, and produce fertile hybrids. Although all inhabit temperate regions, each race is found in somewhat different habitats (Delacour 1977). Unfortunately, it is easier to identify where pheasants do not occur—deep forests, high mountains, and arid steppes—than to describe any special requirements of individual races. Suitable habitats typically include grassy or reedy areas, with brushy coverts and scattered trees, at moderate altitude.

In England, the black-necked type apparently remained fairly pure until ring-necked pheasants were imported from the Orient in the eighteenth century (MacPherson 1896). By the late nineteenth century, pheasants in Europe represented a diverse mix of at least 3 or 4 races (Wayre 1969, Bohl and Bump 1970). The heterogeneous gene-pool was extensively introduced in the U.S. in the late 1800's and early 1900's. Races imported since the mid-1950's include the black-necked Kirghiz (Mongolian), Chinese ring-necked, and green pheasants (Wayre 1969). However, several races of pheasants from the interior of today's People's Republic of China apparently were never imported for propagation—for example, Strauch's pheasant, *P. c. strauchi*, from Sichuan Province.

STOCKING TO ESTABLISH PHEASANTS IN NORTH AMERICA

Although wild pheasants imported from China in 1880-81 were highly successful when released in Oregon, most pheasants released in the U.S. apparently derived from stock imported from Europe, primarily England (Phillips 1928, Delacour 1945). Details are unclear as to the first successful release of Chinese pheasants in Oregon. Phillips (1928) reported that a shipment of 70 birds from China safely reached Olympia, Washington, in 1880, but never reached Portland, Oregon. A second attempt, made a year later, resulted in the release of over 200 pheasants from China in the Willamette Valley (Phillips 1928). Leffingwell (1928), however, reported that 12 of the first 70 birds shipped survived and were released on the ranch of George Green at the mouth of the Willamette River; the year he cited was 1881, not 1880. According to Leffingwell (1928), a second shipment of 28 birds arrived from China a year later in 1882 and was released on the ranch of John Denny in the Willamette Valley. Although the number of wild pheasants from China released in Oregon could have ranged from 40 to 200 (Phillips 1928, Leffingwell 1928), there was no discrepancy in reports of their success. In 1891, only 10 years post-release, an estimated 50,000 pheasants were taken in Oregon on the first day of pheasant hunting.

English pheasants first arrived in North America when they were introduced in the state of Washington in 1883 (Phillips 1928). Wild ringnecks from Oregon were also released in Washington in the 1890's (Lauckhart and McKean 1956). Pheasants from Washington were later transplanted to British Columbia and Idaho. California received wild-trapped pheasants from Oregon between 1889 and 1898, and at least 1 early importation of pheasants from Hong Kong (Hart et al. 1956). After over a century of repeated failures, pheasants finally became established in Massachusetts, New Jersey, New York, and Pennsylvania in the 1890's (Phillips 1928, Studholme and Benson 1956). Releases of pheasants in Alabama, Delaware, Georgia, Maryland, North and South Carolina, Tennessee, Virginia, and West Virginia were unsuccessful.

The earliest releases of pheasants in the Midwest were during 1900-1910 (Leopold 1931). Most successful pheasant introductions in the Midwest resulted from efforts by state game departments, including Indiana (1907), Illinois (1910), Michigan (1918), Ohio (1919), and Wisconsin (1929) (Leopold 1931, McCabe et al. 1956). State programs also were initiated in Minnesota (1905); Iowa, Missouri and North Dakota (1910); South Dakota (1911); and Kansas (1924) (Kimball et al. 1956) (Fig. 2). Private stocking in Colorado began in 1894 with releases by the state in 1901 (Phillips 1928). Stocking in Texas apparently did not begin until 1939 (Yeager et al. 1956).

STOCKING FOLLOWING ESTABLISHMENT

Once pheasants became established, hunters wanted more pheasants. Many state pheasant-release programs were expanded in response to hunter demands. Objectives of releases were not clearly defined beyond attempts to comply with the strongly expressed wishes of hunters for

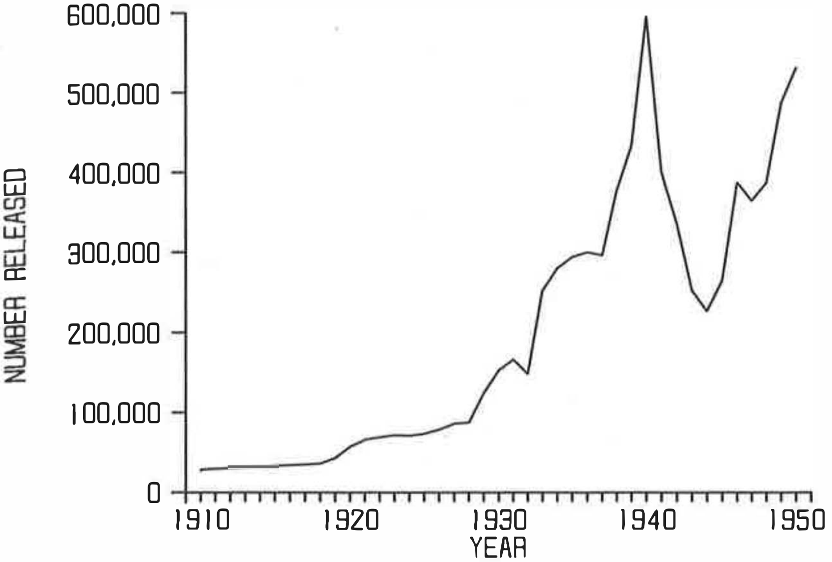

Fig. 2. Estimated numbers of pheasants released in the U.S. by state fish and game agencies (Allen 1956).

more pheasants. Stocking remained prominent in most state game programs throughout much of the pheasant range in North America well into the 1950's. Published records indicate that 30-90,000 adult pheasants were released annually into the U.S. from 1920 to 1928, with numbers increasing to 240-600,000 adult birds annually during 1933-50 (Leopold 1931, Bump 1951). Pushee (1948) reported that 32 states stocked approximately 1¼ million pheasants in 1948, not including private releases or state programs that distributed eggs or day-old chicks.

Impacts of continued stocking on pheasant numbers following establishment can never be fully understood. Evaluation of pheasant releases did not begin in earnest until the 1940's. Clark (1942) reported that 71% of the monies spent by state game departments for propagation, purchase, and distribution of game animals was spent on stocking pheasants. The rationale for pheasant stocking during the 1940's shifted to restoration and public relations as opposed to establishment and increased abundance. Clark (1942), for example, questioned the value of stocking once pheasants were established, and recommended that stocking be done only after the causes of depletion had been corrected.

Although, by 1940, the value of habitat was generally recognized, intense hunting pressure was still considered to be an important determinant of pheasant abundance (Einarsen 1942). Pheasant stocking was justified on the basis of heavy hunting pressure, until it became accepted that annual harvests were the result of pheasants produced by wild, not released, birds (Pough 1948, Skiff 1948). In the 1950's, evaluation of releases to increase hunting success were initiated. Recovery by hunters of 5-50% of pheasants released were typical (Pough 1948, Kabat et al. 1955, Lauckhart and McKean 1956, Burger 1964). Gentle, and night releases of 10-16-week old juvenile pheasants in late summer resulted in highest rates of return (Lauckhart and McLean 1956). Low return of cocks bagged by hunters, and low reproductive success of released hens, did not warrant the cost of spring releases of adult birds (Kabat et al. 1955).

Results of stocking evaluations of the mid-1950's showed that releases in areas where pheasant numbers had declined had little effect on local abundance. The rationale for stocking thereafter evolved into the concept of "put and take" hunting (McCabe et al. 1956). Each fall, large numbers of pheasants were released onto public hunting areas to accommodate heavy hunting pressure near metropolitan areas (Kozicky and Madson 1966). Unfortunately, such releases usually created far more demand than they fulfilled. Economic considerations eventually caused discontinuation of many expensive, large-scale stocking programs. Management emphasis then shifted primarily to habitat.

Introduction of exotic game birds drew renewed interest in the 1960's (Bump 1951). Allen (1950) suggested that releases in America of races of pheasants living in remote parts of Asia, and not yet released in America might be useful. Allen's views provided justification for "The Foreign Game Introduction Program" (FGIP) of the U.S. Fish and Wildlife Service begun in the mid-1950's (Bump 1963). In theory, that program was designed to limit unwise introductions, and attempted to fill vacant habitats by using trial introductions of previously unavailable races of pheasants and other game birds. The result was that 5 races of pheasants were imported from ranges in western Asia where conditions seemed similar to those in the southern and southwestern U.S. Imports included Talisch Caucasian pheasants (*P. c. talischensis*), Persian pheasants (*P. c. persicus*), Bianchi's pheasants (*P. c. bianchi*) from Afghanistan, *P. c. karpowi* from Korea, and green pheasants (*P. versicolor robustipes*) from Japan (Bohl 1964).

The FGIP was responsible for release of at least 15,000 green pheasants and over 200,000 of various races and hybrids of common pheasants in 25 states from 1962 to 1977 (Table 1). Persian pheasants, both pure strain and crossed with other common pheasant types, were released in 14 southern states as far west as Oklahoma. Talisch Caucasian pheasants were introduced into 8 southern states and Iowa. Although Talisch Caucasian pheasants initially showed some promise in Oklahoma and Virginia (Bohl and Bump 1970), there is no evidence that any Talisch Caucasian or green pheasants still exist from those releases.

Table 1. Summary of common pheasant introductions by subspecies made between 1959 and 1979 in the U.S.; data from Bohl and Bump (1970) unless otherwise specified.

Subspecies	State	Year	Time of release	Number released
Western Iranian pheasant (pure)	AL	1960-68	Fall	2,906
	KY	1962-68	Spring-summer	331
	LA	1966-68	Winter	53
	MO	1965-68	Spring	234
	OK	1962-68	Spring summer fall	2,035
	SC	1961-68	Summer fall	1,055
	TN	1964-68	Spring summer	1,369
	TX	1967-68	Summer	12
	VA	1961-68	Spring summer	1,589
			Total	9,584
Western Iranian ringneck cross	AR	1962-68	Spring fall	428
	FL	1961-68	Summer	936
	GA	1963-66	Spring fall	712
	IN	1964-68	Spring	2,072
	IA	1962	Spring	155
	KY	1961-66	Spring summer fall	3,344
	TN	1961-68	Spring summer fall	26,382
	VA	1960-68	Spring summer fall	11,943
			Total	45,972
Eastern-western Iranian ringneck cross	VA	1959-62	Fall	417
Eastern Iranian pheasant (pure)	IA	1962	Spring	42
	KY	1962-66	Spring fall	401
	OK	1963-68	Spring fall	2,420
	TN	1964	Fall	502
	VA	1961-64	Spring summer	1,930
			Total	5,295
Eastern Iranian ringneck cross	IA	1962-63	Fall	200
	KY	1961-66	Spring summer fall	2,253
	MD	1961-68	Spring	2,304
	MO	1959-61	Fall winter	1,633
	TN	1960-63	Fall	15,650
			Total	22,040
Afghan white-winged pheasant (pure)	AZ	1966-69	Winter	2,368
	CA	1965-68	Spring summer	2,425
	NV	1963-68	Spring	415
	NM	1960-68	Spring summer winter	17,201
	OK	1964-68	Summer fall	2,978
Afghan white-winged pheasant (pure) (continued)	TX	1966-68	Summer winter	1,019
	UT	1964-68	Spring fall	731
			Total	27,137

Table 1 (continued).

Subspecies	State	Year	Time of release	Number released
Afghan white-winged ringneck cross	NV	1962-65	Spring	228
	OK	1961-67	Fall	4,170
			Total	4,398
Korean pheasant	IL	1963-64	Spring	339
	IN	1964-75	Spring	11,799
	MI	1970-71	Spring	1,800
	MO	1962-68	Spring fall	7,371
	MO	1967-71	Spring	4,172[a]
	NY	1968	Spring	1,248
	PA	1962-68	Spring	5,010
	VA	1968	Fall	12
			Total	31,751
Korean-ringneck cross	PA	1963-67	Spring summer fall	41,566
Chinese ring-necked pheasant (wild or F1)	IL	1959-61	Winter	814[d]
	IA	1962-73	Spring fall	24,511[b]
	IA	1978-79	Fall	2,510[c]
	IN	1964-72	Fall	987[e]
	MO	1967-68	Fall	414[f]
	MO	1974-80	Fall	9,290[f]
	PA	1964-66	Spring	1,006[g]
	TX	1964-71	Summer fall	2,942[h]
			Total	42,474

[a] Wollard et al. 1977
[b] Farris et al. 1977
[c] Rybarczyk and Wooley 1983
[d] Anderson 1964
[e] Castrale 1982
[f] Cary 1983
[g] Myers 1970
[h] Mabie 1980

Afghan white-winged pheasants, both pure strain and crossed with ring-necked types, were introduced in 7 southwestern states, and became established in restricted habitats in New Mexico and Nevada, where they have been hunted since 1964 and 1966, respectively. In the early 1980's, areas in the Mojave Desert of Nevada still had local white-winged pheasant populations that supported harvests of about 100 wild cocks per season (Madson 1987). Lack of habitat apparently prevents expansion of local white-winged populations.

Between 1962 and 1975, over 70,000 Korean pheasants—both pure strain and ring-necked crosses—were released in 5 midwestern states and as far east as Pennsylvania and Virginia (Table 1). Wollard et al. (1977) evaluated the spring release of 4,172 Korean pheasants on an area void of wild pheasants in Missouri. Mortality was high initially, but reproduction apparently was normal. A self-sustaining but low-density population remained on this Missouri site 6 years following release.

Releases of 1,800 Korean pheasants in 1971-72 in the "thumb region" of Michigan initially resulted in increased local pheasant numbers. However, in subsequent years abundance was comparable to that on nearby areas (Heezen 1976). Between 1964 and 1975, 11,799 pen-reared Korean pheasants were released in 4 central Indiana counties. Observations made 3 years after the last release revealed low-density populations in some areas (Castrale 1982). Self-sustaining populations of Korean pheasants failed to develop in Pennsylvania (Bohl and Bump 1970). Although releases of Korean pheasants tended to be more successful than those of Persian, Talisch Caucasian, and Afghan races, no dramatic successes resulted in any of the 7 states stocking them. Low survival of locally hatched pheasants appeared to be the major limiting factor, although Wollard et al. (1977) proposed that nesting habitat limited the success of Korean pheasants in Missouri.

At least 40,000 wild-trapped or F1 progeny of wild-trapped Chinese ring-necked pheasants have been released in the U.S. since 1959 (Table 1). A huntable population developed in southeastern Iowa, following 1962-73 releases of over 24,000 F1 birds (Farris et al. 1977). Huntable populations were also established in northern Missouri from the release of 9,290 F1 black-necked x Chinese ring-necked pheasants from Iowa (Cary 1983). Another self-sustaining population became established on the Texas Gulf Coast from 967 wild-trapped ring-necked pheasants, and 1,975 pen-reared, racially-mixed pheasants (Mabie 1980). High (40-80%) mortality during the first month after release, and low average dispersal distances (134-450 m) characterized the Texas releases.

A 16-year attempt (1949-64) to reestablish pheasants near Centre Hall, Pennsylvania, using juvenile ring-necked pheasants raised on game farms, was unsuccessful (Myers 1970). Hunting and poor reproduction were believed to be the main reasons for this failure. Releases from 1964 to 1966 of wild-trapped ring-necked pheasants were successful, with the highest density on record for that site observed in 1969 (Myers 1970). However, pheasant numbers on the Centre Hall area subsequently declined to low levels (G. Storm, personal communication).

From 1980 to 1983, release of game-farm, ring-necked pheasants in Oregon's Willamette Valley failed to reverse a long-term decline of pheasants (Jarvis and Engbring 1976, Castillo et al. 1984). Attempts to establish game-farm pheasants failed at 2 different sites in Kentucky in the early 1950's (Nelson 1964), in 1957-61 on an area in southern Illinois (Anderson 1964, 1968, Ellis and Anderson 1963), and in Iowa in 1961 (Farris et al. 1977). Release programs using F1 pheasants produced on game farms were singularly unsuccessful in increasing pheasant numbers in southern Minnesota (Johnson 1972, Berner 1974). Programs in Oregon using spring releases of F1 progeny of wild pheasants were similarly ineffective (Castillo et al. 1984).

In summary, importations of new races of pheasants in the late 1950's and 1960's may have resulted in establishing new populations on the Gulf Coast of Texas (Afghan white-winged pheasant), in Nevada (*P. colchicus* x Afghan white-winged pheasant), and in Missouri (*P. c. karpowii*). Recent releases of F1 *Phasianus colchicus* (ring-necked) pheasants in southern Iowa and northern Missouri were also successful. These successes stand in contrast to numerous other unsuccessful attempts to establish pheasants in at least 23 other states. A common denominator of the recent successful F1 releases was the extended period of years over which releases were made. Releases using wild-trapped stock appeared to be the most successful.

Low survival was consistently implicated as a major factor affecting success of pheasant introductions (Anderson 1964, Hessler et al. 1970, Dumke and Pils 1973, Jarvis and Engbring 1976, Mabie 1980, Castillo et al. 1984). The first 4 weeks after release appear most critical for survival. Castillo et al. (1984) concluded that poor survival of released hens was not entirely a matter of genetic background, and that conditioning pheasants to react to predators may improve survival of released birds.

CURRENT ATTEMPTS TO ESTABLISH SICHUAN PHEASANTS IN MICHIGAN

In 1983, the Michigan Department of Natural Resources initiated introduction of pheasants (*P. c. strauchi*), obtained in Sichuan Province, Republic of China, in an attempt to bolster pheasant abundance in Michigan following a long-term pheasant decline (Squibb 1985). The "Sichuan project" is based upon release of progeny from a captive breeding flock of 24 adult pheasants obtained from China in February 1985, and 505 chicks hatched from eggs collected from wild nests in spring 1985. The breeding flock of Sichuan pheasants had the potential to introduce genetic material different from that of Michigan's remnant "wild" populations. Another consideration was that, in China, these pheasants inhabit areas vegetatively similar to parts of Michigan not considered to be typical pheasant cover, formerly supporting an abundance of pheasants.

The collection site in Guangyuan County, Sichuan Province, lies in the Tsinling Shan and Tapa Shan Mountains (Chen 1970) in central China, 105 ¾° E and 32 ½° N, at an elevation of 1,300-1,800 m. Climatic data were approximated for the collection site, based on 3 years of weather records for Chengdu, Sichuan Province, and adjusted for a 970-m difference in elevation. Mean temperatures in Lansing, Michigan (Sommers 1977), average 3.7 and 2.9 C lower in January and April, respectively, than those estimated for Guangyuan County, while respective July and October mean temperatures are similar. Although annual rainfall in both areas averages 812-864 mm, nearly 80% of the annual rainfall in Sichuan occurs from July to September; whereas, in Michigan, rainfall is distributed more uniformly. In Sichuan, wheat, corn, and potatoes are the common crops, with the remainder of the area vegetated by a mixture of conifers, mainly pines (*Pinus spp.*), and oaks (*Quercus spp.*); forested and brushy areas are grazed by cattle and the lower branches of trees are pruned for firewood. Inedible plants (thorny and woody) dominate the ground layer. The area lies about 1,000 m below the spruce (*Picea* spp.) zone.

After review of pheasant propagation and release programs in other states, we selected procedures to best ensure high genetic heterogeneity as well as desirable physiological and behavioral attributes. The current strategy is to try to establish Sichuan pheasants in habitats in Michigan, now void or nearly void of wild pheasants, and to maximize sizes of founding populations. Another part of the program is to hold breeders for as many seasons as possible in order to minimize inbreeding, selection, and genetic drift within the captive population. Progeny from at least 120 different wild females are represented in the captive breeding flock. Procedures include:

1. All individuals imported from Sichuan as eggs were pedigree-hatched according to family groups.
2. All first generation birds were retained as breeders.
3. A random mating scheme, excluding full- and half-sib crosses to minimize inbreeding.
4. A maximum number of males to maximize effective population size, and protect against inbreeding and genetic drift.
5. Maximizing generation interval to minimize selection in captivity.
6. Standard rearing techniques with modifications for space, food, and isolation.

Young Sichuan pheasants reared in Michigan are provided about 4 times the amount of rearing space normally provided pheasants on game farms (13.9-18.5 m^2/bird). Young birds are held until about 10 months old, and are released just prior to the breeding season (Hartman 1971, Castillo et al. 1984). Care has been taken in handling to avoid shock response (Burger 1964). Potential release sites are evaluated on the basis of vegetation similar to that in Sichuan Province. Groups of 50-60 pheasants have been released on alternate sections (mi^2) within selected townships, with 500-600 total pheasants released per township. Areas with higher proportions of non-agricultural cover types (old field, brush, and early successional woodlands) are considered optimal for releases. Hunting is restricted to minimize mortality and dispersal. Release evaluations will be made for at least 5 years.

CONCLUSIONS

Repeated releases over many years were necessary before pheasants established self-maintaining populations in much of what we now recognize as the range of wild pheasants in North America. While variable, the common phenotype of wild pheasants typically resembles *P. c. torquatus*. However, the gene pool represents an unknown and variably heterogeneous mixture of at least 4-5 races. Research over the past 30 years suggests that failures in establishment have related to low survival.

Sustained release programs appear to have had little or no lasting impacts on abundance, once pheasants were well established. Recent establishments in Texas and Nevada, and range extensions in Iowa and Missouri, may have resulted in part from stocking.

Recent work by Warner et al. (these Proceedings) indicate regional differences in genotype among wild pheasants. Whether these genetic differences relate to inherent differences among founding populations, selection following establishment, or both, is not presently known. Regional differences in pheasant genetics support—or at least do not refute—the hypothesis that establishment is in some part a function of genotype. On that basis, releases to establish, reestablish, or even revitalize declining pheasant populations warrant further work, such as that currently underway in Michigan, using *P. c. strauchi*. Releases of newly imported races along with selective breeding of genotypes may prove viable in future pheasant management programs.

ACKNOWLEDGMENTS

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16

Realities of "Population Regulation" and Harvest Management

WILLIAM R. EDWARDS, Illinois Natural History Survey, 607 East Peabody, Champaign, IL 61820

Abstract: Pheasant harvest is discussed within the context of time, space, and the dynamics of abundance. Both hunting effort and harvest vary from farm to farm, region to region, and day to day; both are heaviest early in the hunting season and in areas where pheasants are most abundant. Pheasant harvests tend to: (1) increase during agricultural depressions and decrease in periods of prosperity, (2) respond positively to cropland diversions that feature seeding of perennial forages, (3) increase during regional transitions from livestock to cash grain farming, and (4) increase toward the ends of decades and decrease in mid-decades (i.e., be cyclic). Pheasant abundance relates to land use and is primarily survival dependent; dispersal, however, is an important factor in local harvests. We should not assume numerically stable or definable (closed) populations, and we should be slow to assume density dependence, inversity, and regulation (as opposed to limitation) of abundance. Hunting seasons should open as early as possible because of high nonhunting mortality of pheasants in fall and early winter. Sex ratios show pheasants to be vulnerable to hunting. Hunting mortality, on average, should not exceed about 25% of hens alive when hunting begins. Illegal and accidental kill of hens often approximates 15% or more, leaving little margin for safety. Legal hen seasons appear to be warranted rarely if at all. Cocks-only seasons of 40-60 days are "reasonable." Devising a framework to increase harvest, except at high levels of abundance, would be extremely difficult.

Key Words: abundance, cycles, dispersal, harvest, hunting, population, ring-necked pheasant

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The ninety-seventh year in which wild pheasants were hunted in North America was 1987. The first pheasant hunting season opened in Oregon in 1891, just 10 years after 12 pheasants were released near the mouth of the Willamette River; a second release of 28 reportedly was made there in 1882 near fabled Peterson's Butte (Leffingwell 1928:93). The first season was spectacular, with an estimated 50,000 birds taken the first day (Walcott 1945)—perhaps the first of many examples of over-estimation of pheasant harvest.

My primary purpose is to discuss harvest of wild pheasants within the context of time and space, and the dynamics of abundance; the objective is to conceptualize a rationale for pheasant harvest management from the perspective of population ecology, using diverse findings from a variety of studies. Nevertheless, harvest estimates are of interest.

Estimates of statewide harvest for 11 traditionally important pheasant states for 1940-85 are summarized (Table 1). Perhaps the most significant trend is that total estimated harvest in 1985 was only about ¼ that of 40 years earlier. As Dahlgren (these Proceedings) notes, continental harvests in recent years have probably totaled less than those of the Dakotas in the mid-1940's. Dumke et al. (1984) estimated mean annual pheasant harvest for North America for 1977-82 as 9,527,000. Based on a 1983 questionnaire to which biologists in 35 states and 7 Canadian provinces responded, average annual releases of 1,373,000 pheasants from game farms in 24 states and 3 provinces contributed to that average harvest. Iowa and Kansas reported average annual harvests of 1,373,000 and 1,130,200, respectively; neither state reported releases of game-farm pheasants. Other states with large estimated annual harvests in recent years include South Dakota (993,300), Nebraska (922,400), and Pennsylvania (858,000). No other state reported recent average harvests >500,000. The largest average annual provincial harvest estimate for 1977-82 was 87,900 for Ontario.

Bias in Harvest Estimates

Annual estimates of pheasant harvest are typically obtained from questionnaires mailed to hunters. The procedure is inexpensive, and names of licensed hunters are readily obtainable. Where sampling procedures are consistent and samples large, questionnaire results show good precision, but tend to be quite biased; successful hunters are more likely to report than are those less successful (Sondrini 1950, Thompson 1951, Wagner et al. 1965). Robertson (1958), for example, found that respondents to second and third mailings of questionnaires reported success rates that averaged almost 20% lower than those reported by respondents to first mailings, and noted that success was 25-40% less when reported for hunting parties as opposed to individual hunters. Hjersman (1951:95) found that a correction factor of 0.40 should be applied to estimates from questionnaires from California pheasant hunters. In a 1952 Ohio study (Edwards 1959a), the "best estimate" of harvest was 55% of that reported on questionnaires.

Table 1. Estimated harvest (in thousands) of pheasants for 12 states, 1940-85.

State	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	Source of estimate
PA	459	291	353	467	482	750	1,160	1,021	918	534	Fred Hartman
MI	1,200	1,300	800	1,150	950	683	481	837	215	87	Pete Squibb
IN	220	46	41	75	110	106	–	–	31	28	Robert Feldt
IL	–	–	–	–	747	573	847	712	325	305	Jack A. Ellis
MN	1,498	784	891	1,090	1,164	220	166	188	466	179	Alfred Berner
IA	–	–	–	1,549	–	1,118	1,789	1,230	1,429	853	Alan Farris
ND	(800)	2,400	60	235	240	59	45	66	73	139	Lowell Trip
SD	3,125	7,508	507	1,608	2,577	797	901	497	1,151	802	Kenneth Solomon
NE	–	–	–	465	1,165	1,322	1,026	577	869	467	William Baxter
KS	–	–	–	–	801	473	606	564	972	645	Randy Rogers
CO	179	251	157	118	204	94	127	73	121	118	Warren Snyder
Mean	1,069	1,797	401	751	844	563	715	577	597	378	

Crippling Loss

Crippling loss is an important element in hunting-related mortality of pheasants (Table 2) but, as Stokes (1954:123) observed, "Estimates of crippling loss are probably the least accurate of all hunting season statistics." Most estimates of crippling loss are based on reports by hunters. Randall (1940) estimated that 1 cock was lost for every 2 bagged.

Table 2. Estimates of pheasant crippling loss, % of cocks bagged during hunting.

Location (area)	Years	Loss	Reference
California			
Sartain & McManus ranches	1947-48	30	Ferrel et al. (1949:320)
Illinois			
Kendall County	1947-48	4-29	Robertson (1958:99)
Michigan			
Prairie Farm	1937-42	18-27	Shick (1952:98)
Rose Lake	1940-45	11-33	Allen (1947:234)
Montana			
Cocks	1947-53	5-19	Weigand & Janson (1976:51-53)
Hens	1947-53	18-25	Weigand & Janson (1976:51-53)
Ohio			
Wood County	1937-38	18	Leedy & Hicks (1945:71)
Pennsylvania			
Lehigh County	1938	50	Randall (1940:302)
Lebanon County	1970	16-20	Hartman & Sheffer (1971:198)
Ontario			
Pelee Island	1950	20(5)[a]	Stokes (1954:234)

[a] Recovery of "lost" pheasants by other hunters reduced actual loss from 20 to 5%.

Although Leedy and Hicks (1945) concluded that crippling loss was considerably higher than reported, Allen (1942) noted that crippling loss is less where hunting pressure is heavy because cocks downed but not recovered by 1 hunter are sometimes recovered by another. Stokes (1954) estimated actual crippling loss on Pelee Island in 1950 at 5%, even though individual hunters failed to recover about 20% of the pheasants that fell before their guns. Weigand and Janson (1976) concluded that when both sexes were legally hunted in Montana, crippling loss of hens was about twice that of cocks. Although no good estimate of crippling loss appears possible, losses in the range of 15-35% seem reasonable, depending on pheasant abundance, habitat, and hunting pressure.

HUNTING PRESSURE AND HARVEST

Most published data on counts of hunters are 25 or more years old (Gerstell 1938, Leedy and Hicks 1945, Shick 1952, Preno and Labisky 1971). Estimates of hours of pheasant hunting/100 acres show a wide range (Table 3). It appears that, where pheasants were abundant, private land has been hunted in the range of 25-50 hours/100 acres. However, many public areas are hunted perhaps 4-8 times more than private land.

Table 3. Estimates of hours of pheasant hunting/100 acres (40 ha).

Locations	Years	Hours/ 100 acres	Reference
California			
Sartain Ranch	1947-49	120-295	Harper et al. (1951:147)
MacManus Ranch	1948, 1949	184-201	Harper et al. (1951:147)
Michigan			
Prairie Farm	1937-45	91-256	Allen (1947:239)
Rose Lake	1939-45	99-245	Allen (1947:239)
Ohio			
4 NW counties	1952	27- 33	Edwards (1959b)
Delaware Area	1953-56	748-934	Leite (1965:31)
Utah			
Benson Area	1953-56	35- 56	Stokes (1968:869)
Wisconsin			
Potter's Marsh	(?)	82- 94	Stokes (1956:377)
Ontario			
Pelee Island	1947-50	83-186	Stokes (1956:377)

For example, almost 10 hours of hunting/acre (0.4 ha) took place on Ohio's Delaware Wildlife Area (DWA) in the 1950's and early 1960's (Leite 1965).

Public hunting areas near metropolitan centers provide extreme examples of heavy hunting pressure. Cumulative hours of hunting for 1956-60 on the 6,000-acre (2,400-ha) DWA ranged from 748 to 934/100 acres (40 ha) (Edwards 1959b, 1962, Leite 1965, unpublished data Ohio Div. Wildl., Olentangy Wildl. Exp. Stn., Ashley). In 1962, 14,157 hunters on the DWA reported hunting 44,910 hours (748/100 acres) and taking 2,827 pheasants (554 of them wild) for an average harvest of only about 0.20 pheasants/hunter, and 0.063/hour. On opening day 1956, 3,626 hunters checked in, and DWA was hunted by an average of about 60 hunters with 190 hours of hunting/100 acres—almost 5 hours/ha.

In general, past findings indicate that hunting pressure: (1) is greater where pheasants are abundant; (2) differs greatly from area to area, along with numbers of pheasants harvested; (3) is much higher during the first few days of the season; (4) is typically heaviest on opening day and heavier on weekends and holidays; (5) is much greater on public areas than on private land; (6) is far heavier on areas where pheasants are released; and (7) remains high on areas where pheasants are released during the season. Given the increases over the years in field and farm size, differences in cropping, crop harvest, fall tillage, and the general reduction in pheasant abundance in the Midwest, the impression gained from casual observations of hunters in the field is that hunting pressure on private lands has declined considerably in recent decades. Parts of Iowa, Kansas, and Missouri, for example, stand as exceptions to that generalization.

Harvest/100 Acres (40 ha)

Stokes (1954) reported that, in fall 1950, hunters killed 14,578 cocks and 12,581 hens—a total of 27,159 pheasants—on 10,085-acre (2,300-ha) Pelee Island in Lake Erie. That kill represented 144.6 cocks, 124.7 hens, and 269.3 total pheasants killed/100 acres (40 ha); after deducting crippling losses, 136.6, 116.8, and 253.4/100 acres, respectively. It is doubtful if that level of harvest has ever been equaled, or even closely approached, elsewhere in America on similar or larger units.

For the most part, estimates represent unusual areas of concentration and periods of peak abundance; some estimates may also have been high. On contiguous units of pheasant range, perhaps 100,000 acres (40,000 ha) or more, cock harvests rarely have exceeded 20/100 acres (Randall 1940, Ferrel et al. 1949, Shick 1952, Stokes 1954). An arbitrary classification of county or larger units of pheasant range on the basis of annual harvests of wild cocks/100 acres (40 ha) today might be: poor <1, fair 1-3, good 3-6, excellent 6-10, the best >10. An average harvest of 10 cocks/100 acres would require an average fall density of roughly 15 cocks and 20 hens, or some 35 pheasants/100 acres—about 225 total pheasants/mi^2 (252 ha). Entire counties where pheasant densities average >225 pheasants/mi^2 are rare today.

Seasonal Distribution of Pheasant Harvest

In Ohio, Leedy and Hicks (1945) estimated that about 30% of the harvest occurred on opening day for the years 1937-39. In Michigan in 1955, 22% of the trips and 31% of harvest came on opening day (Blouch

1956). Opening day produced an estimated 40-60% of the annual harvest in Illinois (Robertson 1958) and 53-84% of the annual harvest in York and Lebanon counties, Pennsylvania, in 1968-69 (Hartman and Sheffer 1971).

Leedy and Hicks (1945) reported that an average of 55% of the harvest occurred during the first 3 days of Ohio's season in 1937-39. Allen (1947) estimated that 64-88% of annual harvest on Michigan's Rose Lake Area took place during the first week of the season. Shick (1952) determined that an average of 73% of the annual harvest was taken in the first week at Prairie Farm, Saginaw County, Michigan in 1937-42. In California, the first 3 days of the hunting season accounted for an estimated 50% of the annual bag on 10 public hunting areas in 1946-49 (Hart et al. 1956), and 70% of the annual bag on 2 other public areas (Harper et al. 1951). Blouch (1956) estimated that, in Michigan in 1953, about 64% of the trips, 66% of hunting hours, and 76% of the harvest occurred by the end of the first week of the season. Of 637 wild pheasants taken in 1959 during a 9-week hunting season at Ohio's DWA (Edwards 1962), 398 (63%) were taken on opening day, 512 (80%) by the end of the second week, and 602 (95%) by the end of the third week.

A consequence of heavy hunting pressure early in the season is that a high proportion of the available pheasants typically is taken quite early. On Pelee Island (an extreme example) 93% of the total cock population was killed by hunters in 4 days and 74% in only 2 days (Stokes 1954). Although the harvest on Pelee Island was unique, harvests of 30-50% of wild cocks on the first 1-2 days of hunting each fall have not been unusual elsewhere in prime pheasant range.

Seasonal Patterns of Success

Hunting success tends to be lower after the first day—often markedly so—in heavily hunted pheasant range (Table 4). Hartman and Sheffer (1971) reported an average of 2.63 pheasants bagged/hunting party on

Table 4. Comparison of numbers of wild pheasants taken/hour of hunting on opening day versus numbers taken during the remainder of the hunting season.

State	Year(s)	First day	Remainder of season	Source of data	Reference
Michigan	1938	0.151	0.071	Bag checks	Allen 1947
Ohio	1952	0.143	0.034	Bag checks	Edwards 1959b
		0.238	0.125	Questionnaires	Edwards 1959b
Illinois	1946-51	0.249	0.116	Questionnaires	Robertson 1958

opening day in Pennsylvania, and 1.11, 0.57, 0.70, 0.68, and 0.26 for the first-fifth weeks, respectively. Findings from field studies also show that after the first day hunter numbers drop sharply, although, in prime range hunters tend to hunt more days and, particularly, on weekends. Generally reduced success after the first few days of the season helps explain why so many hunters hunt only a relatively few days early in the season. Allen (1947) saw the law of diminishing returns limiting pheasant hunting pressure. The more-or-less progressive seasonal decline in hunting success would relate to a reduction in pheasants during the season as a result of hunting. In addition, not many flushes are required before most cocks are either dead or have found secure coverts in such sanctuaries as farms closed to hunting, standing crops, large plowed fields, and marshes.

The primary implication here is that extension of cocks-only pheasant seasons beyond 2 weeks—even beyond 1 week—allows additional hunting opportunity but has little effect on hunting pressure or harvest (Reynolds 1959, Edwards 1959b, 1962, Leite 1965, George et al. 1980, Whiteside and Guthery 1983).

HUNTING-RELATED MORTALITY OF PHEASANTS

Rates of hunting-related mortality are typically expressed as percentages of prehunt pheasant abundance. Of concern are (1) total hunting-related mortality and (2) the fraction actually bagged excluding crippling loss. Unfortunately, both types of estimates are sometimes referred to as "harvest." Estimates of hunting-related mortality of pheasants are usually derived on the basis of sex ratios taken before and after hunting, with allowance made for the ratio of cocks to hens killed. Harvest estimates typically are obtained by further correcting estimates of total hunting-related mortality for crippling loss.

I simulated on the assumptions of: (1) a 50:50 juvenile sex ratio, (2) an average net productivity of 4 young/hen, (3) a crippling loss that is 25% of the number of pheasants bagged, (4) postseason sex ratios ranging from 10 to 50 cocks/100 hens, (5) accidental and illegal shooting of hens ranging from 3 to 10 cocks killed/hen killed, and (6) cocks-only hunting. I performed this exercise to obtain insight into how harvest would relate to sex ratio and to hen kill. Simulated harvests ranged from 40 to 90% (Table 5); low cock/hen ratios were associated with high rates of hunting-related mortality.

Published estimates of hunting mortality of wild cocks ranged from about 45% to slightly >90% (Table 6) and, in general, tend to be somewhat higher than those from simulation, possibly because most

Table 5. Simulated estimates of % hunting-related mortality of wild cock and hen pheasants for various rates of cocks:hens killed and different posthunt sex ratios.[a]

	Sex ratio (cocks:100 hens)				
Prehunt	**70**	**73**	**77**	**80**	**83**
Posthunt	**20**	**20**	**30**	**40**	**50**
Kill ratio (cocks:hens)					
10:1	86.7	74.0	62.9	52.1	41.9
	(6.1)[a]	(5.4)	(4.8)	(4.2)	(3.5)
8:1	86.8	74.5	63.4	52.1	41.9
	(7.6)	(6.8)	(6.1)	(5.3)	(4.4)
6:1	87.2	75.0	64.3	53.6	43.4
	(10.2)	(9.1)	(8.2)	(7.1)	(6.0)
4:1	87.9	76.4	66.0	55.6	45.4
	(15.4)	(13.9)	(12.7)	(11.1)	(9.4)
3:1	88.7	77.8	67.8	57.7	47.7
	(20.7)	(18.9)	(17.4)	(15.4)	(13.2)

[a] % hunting-related mortality of wild hens.

Table 6. Published estimates of the hunting-related mortality of wild cock pheasants.

State/area	Year(s)	% mortality (CI)	Reference
California			
Sartain Ranch	1947-48	85 (84-86)	Ferrel et al. (1949)
McManus Ranch	1947-48	80 (73-86)	Ferrel et al. (1949)
Illinois			
Kendall Co.	1946-51	52 (45-60)	Robertson (1958)
Michigan			
Prairie Farm	1937-42	74 (53-90)	Shick (1952)
Rose Lake	1940-45	63 (54-76)	Allen (1947)
Ohio			
Wood Co.	1937-38	74	Leedy & Hicks (1945)
Statewide	1959-61	70	Edwards (1963a)
Pennsylvania			
Lehigh Co.	1938	68	Randall (1940)
Lebanon Co.	1970	90 (88-93)	Hartman & Sheffer (1971)
Wisconsin			
State	1950-60	73 (59-84)	Wagner et al. (1965)
Ontario			
Pelee Island	1950	93	Stokes (1954)

pheasant research has taken place where pheasants were abundant. It is also likely that some past estimates of harvest were based on the assumption of a 1:1 prehunt sex ratio, and perhaps assumed zero loss of hens as well. Those assumptions would result in harvest overestimates.

Hunting mortality of hens simulated for cocks-only regulations ranged from 4 to 20% (Table 5). Not much information is available on the illegal hunting-related mortality of wild hens. Wagner et al. (1965), using figures of Leedy and Hicks (1945), estimated hen kill in Ohio at 22% in the late 1930's. Dale (1956) believed that a hen kill 20% that of cocks would be unusually high. Chesness and Nelson (1964) estimated hunting-related hen mortality of 11% for pheasants in Minnesota 1958-60, 11% in North Dakota 1957-59, and 13% in Wisconsin 1953-56, but only 6% in South Dakota 1952 and 1959. Edwards (1963a) and Wagner et al. (1965) both estimated hen kill at about 16% in Ohio 1959-61, and in Wisconsin 1953-60, respectively. On the basis of hunting pressure, hen kill would be considerably higher on public areas where hunting pressure is often far higher than on private lands (Edwards 1959b, Leite 1965).

It appears that hunting mortality and harvest are highly variable, depending on pheasant abundance and hunting pressure. Under cocks-only regulations, total hunting-related mortality of cocks alive at the start of hunting would typically range from 55 to 75%; cocks actually bagged would range from 45 to 65%, and illegal kill of hens would be 10-15%. Thus, estimates of hunting mortality under cocks-only regulations appear well within what wild pheasants of both sexes can reasonably sustain. However, the margin of security for hens afforded by cocks-only regulations does not appear great—i.e., a margin of security possibly equivalent to 10-20% of the prehunt hen population. Overharvest of wild hens could well be a problem on public areas that sustain high levels of hunting pressure.

Results from Legal Hunting of Hens

Midwest states that have held hen seasons include Indiana, Iowa, Kansas, Minnesota, and North and South Dakota. Most legal hen seasons occurred 1941-46 and in the 1960's, tending to be held during high pheasant abundance. Disparate sex ratios suggest annual losses of up to 90% for cocks, and we must assume that hens are no less vulnerable to hunting than cocks. With an average net productivity in fall of 2 juvenile hens/adult hen, hens could not long sustain hunting-related mortality similar to that of cocks, i.e. usually >49%. However, with annual hunting mortality of hens typically in the range of 10-15% under cocks-only regulations, hens clearly sustain some level of annual loss due to hunting. Thus, the issue is not whether hens can be hunted, but the level of annual hunting mortality that wild hens can reasonably sustain without causing a reduction in abundance the following year.

Seasons when hens were hunted legally in Minnesota (Schrader 1944), Indiana (Ginn 1955), South Dakota (Kimball et al. 1956), and Wisconsin (Wagner et al. 1965) were almost always followed by declining pheasant harvests in subsequent years, usually counter to regional trends during those years. Wagner et al. (1965) concluded that killing as few as 20-25% of hens may reduce pheasant abundance in some areas.

Declines following legal hen seasons have not been universal. In Nebraska, hens were hunted 1937-41 and pheasants peaked in abundance in 1942 (Mohler 1959). In Iowa, hen shooting was allowed in both spring and fall 1943 with higher roadside counts of pheasants in 1944 than in 1943 (Kozicky et al. 1952). Harper et al. (1951) found that responses of pheasants to legal hunting of hens in California depended on the proportion of hens killed by hunters. Although minimal, the California data suggest that 30-35% may be a critical limit for legal hen kill by hunters. This fraction is roughly equivalent to 50% of the average net productivity of adult hens as indicated by prehunt juvenile:adult hen age ratios, and is also equivalent to the average percent survival of hens fall to fall.

Wagner et al. (1965:121) evaluated the relationship for percentage of hens shot (X) and percentage change in abundance the following year (Y) for pheasants on Pelee Island; the correlation coefficient, $r = -0.869$ ($P < 0.01$) suggested that about 75% of the change in annual abundance related to legal hen kill. The line of best fit for the regression intercepted the line of zero change at about 32-33% hen kill (Fig. 1), implying that hunting-related mortality of hens in excess of about 32-33% could result in reduced abundance the following year.

These findings (Harper 1960, Wagner et al. 1965) were consistent with those of Hickey (1955) who concluded that annual harvests of game birds should not exceed 50% of the average annual mortality. Because net productivity varies yearly, Hickey's concept of a critical limit for harvest probably should be revised to state that annual harvest should not exceed about 50% of the fraction of juvenile hens present on opening day.

Thus, it appears reasonable to conclude that hunting hens is possible, or illegal kill of hens under cocks-only regulations is allowable, provided that on average the annual kill of hens should not exceed about 50% of the juvenile hens present in an average year; otherwise abundance would decline. An average harvest near 33% would limit the potential for increase. Thus, in normal years under current regulations, only a narrow margin for increase exists, with no assurance that legal killing of hens could readily be limited to 15-20% beyond current illegal losses to hunting. Consequently, opportunities for legally hunting wild hen pheasants are limited to those rare situations where pheasants are so abundant

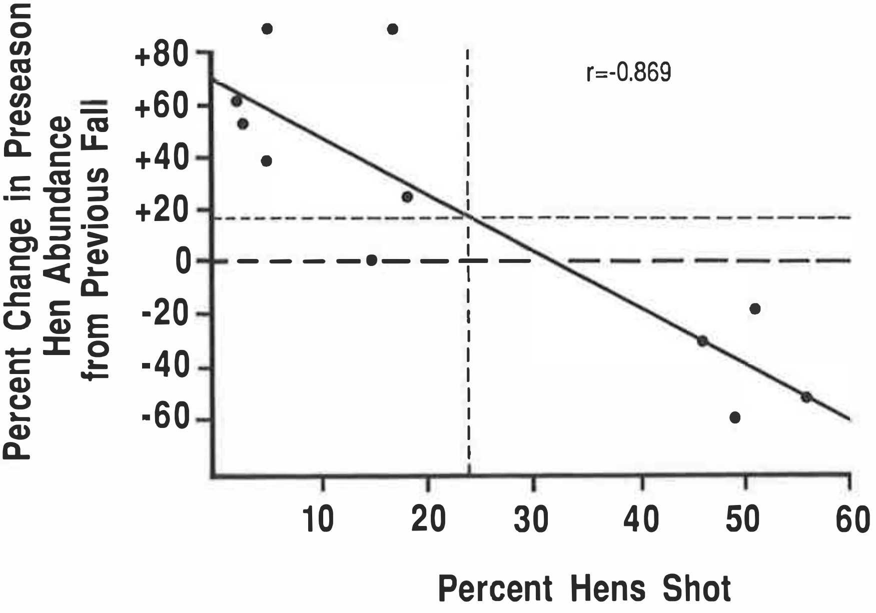

Fig. 1. The effect on Pelee Island pheasants of legal hunting of hens on abundance the following fall (from Wagner et al. 1965:121).

that they cause economic damage. In most areas, legal hunting of wild hens does not seem a practical option for harvest management.

INFERENCES FROM SEX RATIOS

Sex ratio data obtained under cocks-only hunting provide a basis for estimating proportionate hunting-related kill, allow correction of call counts in order to obtain spring indices of hen abundance, and provide factors to correct fall cock age ratios in order to obtain productivity estimates. Sex ratios tend to be biased in favor of cocks (Leedy and Hicks 1945, Buss 1946, Hickey 1955, Mohler 1959, Wagner et al. 1965). Reliable prehunt sex ratios are difficult to obtain; the best may be those derived from pheasants captured by night lighting (Labisky 1968a).

Winter vs. Fall Sex Ratios

Fall sex ratios (cocks/100 hens) for 6,306 pheasants captured prior to hunting on the Sibley Area, 1957-69, ranged from 57 to 88:100 with a mean of 70:100; the fall sex ratio of adults ranged from 12 to 47:100 with a mean of 22:100 (Table 7). The average cock:hen ratio of juveniles captured in fall at Sibley 1962-66 (Table 8) was 92:100. Snyder (1977) estimated a prehunt sex ratio of Colorado pheasants at 77, 72, and 75:100 in 1974, 1975, and 1976, respectively. Fall sex ratios of adult pheasants in Colorado (1974-76) were higher than those at Sibley Area, suggesting lower rates of cock mortality.

Table 7. Fall and winter sex ratios and estimates of winter abundance for pheasants on the Sibley Study Area, Ford County, Illinois, 1957-1969 (Illinois Natural History Survey 1981).

		Sex ratios (cocks:100 hens)		Abundance (Total/640a)
Year	N	Fall	Winter	(259 ha)
1957	212	71 (30)[a]	23	66[b]
1958	354	69 (22)	56	62
1959	183	79 (29)	30	88
1960	181	83 (16)	27	82
1961	369	65 (12)	28	110
1962	1,846	72 (19)	15	116
1963	1,001	67 (17)	18	111
1964	507	68 (22)	15	101[b]
1965	385	57 (16)	17	46
1966	346	64 (28)	33	42
1967	195	88 (32)	32	3
1968	423	68 (23)	45	38
1969	304	62 (47)	36	50
Total/mean	6,306	70 (22)	29	72

[a] Adult cocks:100 hens.

[b] These estimates are for early spring.

The mean cock:hen ratio for all pheasants captured at Sibley in the winters of 1962-66 was 19.3:100 (178:924) compared to 19.4:100 (155:801) for adults captured in fall (Table 8). Over the 5-year period, the mean sex ratio for pheasants captured in winter was consistent with that of adults captured in fall. In effect, the same relative numbers of cocks and hens survived from winter to the following fall. Thus, sex ratios of Sibley pheasants 1962-66: (1) do not suggest higher nonhunting mortality of hens than cocks, (2) do not support hypotheses for compensatory nonhunting winter mortality, and (3) do not suggest elevated summer mortality of hens as postulated by Wagner (1957). As suggested by Etter et al. (these Proceedings), disproportionate mortality, exclusive of hunting, relates

Table 8. Pheasants captured during fall (prehunt) and winter (posthunt) on the Sibley Study Area, Ford County, Illinois, 1962-66.[a]

		Cocks		Hens		
Year	Period	Adult	Juvenile	Adult	Juvenile	Total pheasants
1962	W	9	27	111	113	260
	F	56	716	300	774	1,846
1963	W	13	50	150	200	413
	F	38	365	220	378	1,001
1964	W	6	22	68	66	162
	F	27	179	120	181	507
1965	W	3	15	81	51	150
	F	15	125	94	151	385
1966	W	8	25	44	40	117
	F	19	116	67	144	346
Total	W	39	139	454	470	1,102
	F	155	1,501	801	1,628	4,085

[a] S. L. Etter (personal communication).

primarily to pheasant age, with juveniles more vulnerable than adults, particularly during fall and early winter.

Without fall pheasant sex-ratio data other than from the Sibley Area, a range of fall sex ratios was simulated based on the assumptions of: (1) an equal juvenile male:female sex ratio, (2) net productivity over the range of 0.5-4.0 juvenile hens/adult hen, and (3) prebreeding sex ratios of 10-50 cocks/100 hens. The simulated ratios suggest that prehunt sex ratios range between 65 and 80 cocks/100 hens (Table 9). Results from simulation are consistent with sex ratio data from Sibley (Tables 7 and 8), and with those from Colorado (Snyder 1977). However, the simulated fall

Table 9. Simulated prehunt pheasant sex ratios assuming various levels of net productivity and different adult sex ratios.[a]

Productivity (Juv:hen)	Adult sex ratio (cocks:100 hens)				
	10	20	30	40	50
2	55	60	65	70	75
3	64	68	72	76	80
4	70	73	77	80	83
5	74	77	80	83	86
6	78	80	83	85	88

[a] Based on the model of Stokes (1954:87); assumes equal sex ratio of juveniles.

sex ratios tended to be lower than those often mentioned for high-density pheasant range.

Winter (Posthunt) Sex Ratios

High winter sex ratios (cocks/100 hens) were typical in the late 1930's and early 1940's where pheasants were abundant and numbers of hunters were low—45-75 + cocks/100 hens in South Dakota, for example (Kimball et al. 1956). However, in Michigan, where pheasants were abundant but were heavily hunted in the early 1940's, Shick (1952) found winter sex ratios of about 10:100. Ohio and Wisconsin, areas of pheasant abundance in the early 1940's, yielded winter sex ratios in the range of 20-25:100 (Leedy and Hicks 1945, Buss 1946).

Winter sex ratios were low (<10:100) on Pelee Island, Ontario, in the late 1940's and early 1950's when pheasants were abundant and hunting pressure heavy (Stokes 1954). Winter sex ratios of pheasants on the Sibley Area 1957-70 ranged from 15 to 56:100 (Table 7). Hartman and Sheffer (1971) reported winter sex ratios of 7-14:100 in heavily hunted pheasant range in Pennsylvania, 1961-69. Ratios of 20-40:100 are rather typical in pheasant range of good-to-average density. In general, winter sex ratios have been low where pheasants are abundant and hunting pressure correspondingly heavy (Allen 1947, Ferrel et al. 1949, MacMullan 1960, Dahlgren 1963, Russell 1965, 1968, Preno and Labisky 1971, Trautman 1974, Weigand and Janson 1976).

Allen (1947) pointed out that high pheasant densities attract heavy hunting pressure, resulting in a high proportion of cocks being shot and, thus, in low sex ratios. It follows that sex ratios are inversely related to both pheasant and hunter densities. Allen (1947) also saw no threat of overharvesting wild cocks, and Shick (1952) concluded that 8-10 cocks/100 hens could sustain fertility. Because prebreeding sex ratios of 30-50 + :100 were common in the late 1940's and early 1950's, biologists recommended more liberal pheasant hunting. By 1970, seasons averaged about 40 days, about double that in 1950.

INFERENCES FROM AGE RATIOS

Juvenile:adult cock ratios reported in the literature range from a low of 1.09:1 in South Dakota in 1945 (Kimball 1948), to highs in 1948 of 23:1 and 22:1 in California (Ferrel et al. 1949) and on Pelee Island (Stokes 1954), respectively. Unless differences in adult sex ratios are taken into account, comparisons of cock age ratios have little significance. The low age ratio in South Dakota assuredly indicated low productivity since the juvenile:adult hen ratio that fall was 0.91:1.

As hens are not legally hunted in most states, net productivity usually is estimated by using winter sex ratios to correct cock age ratios. If juvenile cocks are more vulnerable to hunting than are adults, cock age ratios from bag checks would lead to overestimates of net productivity. However, of primary interest here is the tendency for age ratios of pheasants taken by hunters to decline over the course of a hunting season (Allen 1947, Kimball 1948, Ferrel et al. 1949, Buss et al. 1952, Eberhardt and Blouch 1955). Age ratio declines as the hunting season progresses suggest that juvenile cocks suffer higher rates of mortality in fall and early winter than do adults. Most workers have assumed that juvenile cocks are more vulnerable to hunting. Stokes (1954) and Hart (1954), for example, concluded that cock age ratios from heavily hunted areas more closely approximate true ratios than do cock age ratios from areas not heavily hunted. That may not be totally the case. Etter et al. (these Proceedings) present evidence that indicates that changes in age ratios in late fall relate, in part, to differentially high mortality of juveniles due to factors such as predation and dispersal. In short, it is difficult to measure accurately cock age ratios or productivity from harvest data.

The mean fall juvenile:adult ratio for 1,656 cocks captured at Sibley 1962-66 was 9.7:1 (Table 8). This mean age ratio for cocks suggests an average mortality and survival of about 91 and 9%, respectively. The mean fall juvenile:adult ratio for 2,409 hens captured at Sibley 1962-66 was 2:1. Assuming an approximate 50:50 sex ratio for juveniles prior to hunting, the 2:1 mean hen age ratio suggests an average net productivity prior to hunting of about 4 total surviving young/hen. The 2:1 fall juvenile:adult hen age ratio at Sibley suggests average fall-to-fall mortality of 67%. Significantly, mean annual fall-to-fall survival of hens (33%) was about 3 times that of cocks—9%. Thus, differences in survival between cocks and hens relate largely to hunting.

Given the mean juvenile:adult ratio of 9.7:1 for cocks at Sibley in fall (Table 8), the respective mean winter age ratio of cocks captured 1962-66 was 3.56:1. The mean fall and winter age ratios of all hens captured at Sibley was 2:1 and 1:1, respectively. Thus, fall-to-winter survival of juvenile cocks was 37% relative to that for adult cocks, and fall-to-winter survival of juvenile hens was 52% relative to that for adult hens. Although some of the higher mortality of juvenile cocks may have been due in part to age-related differences in vulnerability to hunting, the high mortality of juvenile hens under cocks-only hunting regulations suggests that factors other than hunting were responsible for high fall-to-winter mortalities of juvenile cock and hen pheasants at Sibley 1962-66. Thus, changes in cock age ratios during prolonged hunting seasons should not be interpreted simply as a function of age-related differences in vulnerability to harvest.

Fall-winter Mortality

If we assume that fall-to-winter losses of adult hens ranged from 10 to 20%, survival of a theoretical fall population at Sibley Area of 300 hens (20 juveniles:100 adults) into the following winter would have been 80-90 juveniles and 80-90 adults. These obviously rough approximations suggest a mean fall-to-winter survival of 80-90/200 (40-45%) for juvenile hens, 80-90/100 (80-90%) for adult hens, and 160-180/300 (53-60%) for all hens, with fall-to-winter mortality ranging from 55 to 60% for juvenile hens and 40-47% for all hens, respectively. Projected hen mortality would be even higher if losses of adults were above 20%. These roughly approximated rates of fall-to-winter mortality may seem high, and quite possibly were above average since pheasants declined markedly at Sibley 1964-66 (Etter et al. these Proceedings). Nevertheless, long-term fall and winter age ratios, coupled with this decline at Sibley, lead to the hypothesis that variable survival during fall-to-winter was important in fluctuations in pheasant abundance at Sibley in the 1960's. An obvious implication from high nonhunting fall mortality is that hunting should come as early in fall as possible.

The Concept of "Species-normal" Age Distribution

The concept of "normal" age distribution (Lotka 1925) proposes that population age structure varies about an average that is normal for the particular species. Further, changes in abundance derive from the combination of short-term departures of rates of productivity, survival, and dispersal from their respective long-term means. Long-term trends in abundance would derive over time from short-term fluctuations.

The series of data years (13) for Sibley is sufficiently long, and the samples sufficiently large (n = 6,306 for Table 7 and 5,187 in Table 8), that the mean fall juvenile:adult ratio should approximate the normal age ratio (Lotka 1925) for pheasants in fall. The premise is that changes in pheasant abundance likely would correlate directly with annual survival of hens above or below normal (about 33%). Similarly, increases in abundance would be more likely where net fall productivity is 2 juvenile hens/adult hen, and less likely with productivity ≤2:1. Changes in local abundance would relate additionally to differentials between immigration and emigration; at a regional scale, effects of immigration and emigration would tend to balance. Other inferences from the species-normal age ratio concept are that: (1) high age ratios are not necessarily characteristic of low density, or vice versa; and (2) above-normal net productivity usually should not be expected to compensate for above-normal mortality.

Mallette and Harper (1964) estimated fall-to-fall mortality of pheasants in the Sutter Basin of California for 1952-58 at 86% for juvenile cocks, 78% for adult cocks, 71% for juvenile hens, and 58% for adult hens. These estimates imply mean fall juvenile:adult ratios of 5.25:1 for cocks, 1.86:1 for hens, and 3.71 total young/hen. These estimates also imply that net productivity, mortality, and survival of pheasants in California are generally similar to those of pheasants at Sibley, suggesting that average fall juvenile:adult ratios at Sibley may approximate the norm for wild pheasants in fall. This deduction supports the concept of a species-normal age distribution for wild pheasants.

The species-normal age ratio concept implies reproduction largely independent of density, in contrast to Stokes (1954), Linder and Agee (1963) and Labisky (1968b), who concluded that reproductive success was higher at low density and that numbers of young produced were naturally adjusted by nest abandonment during laying and/or incubation. These workers did not consider possible effects of differences in reproductive performance between first-year and older hens. On average, older hens tend to evidence higher productivity (S. L. Etter and R. E. Warner unpublished data).

PRODUCTIVITY AND SURVIVAL AS FACTORS RESPONSIBLE FOR CHANGES IN PHEASANT ABUNDANCE

Data for pheasants on the Sibley Area (S. L. Etter personal communication) provide an opportunity to better understand the relative roles of productivity and survival in fluctuations of short-term abundance (Table 6). I used these data in an attempt to partition annual changes of abundance to changes in survival and net productivity, which first had to be estimated. The model assumed that changes in abundance were due to the combination of departures in survival and net productivity from long-term means.

I computed indices to annual hen survival as the fraction of adult to total hens examined in winter (i.e., winter-to-winter survival). A "normal" winter survival index was estimated as the mean winter survival. I computed indices for net productivity for the winters of 1962-65 as 1 minus the ratio of adult to total hens. I then expressed departures from normal in annual survival and net productivity as plus or minus percentages. Percent departures from the respective norms of annual survival and net productivity were then added to obtain estimates of "expected" percent changes in abundance for individual years; estimates of "expected" changes in abundance agreed well with "observed" (hens/640a) percent changes.

The results (Table 10) generally support the concepts that: (1) both net productivity and survival of pheasants at Sibley were variable, (2) changes in abundance related to the combined effects of departures of net productivity and survival from their long-term means, and (3) variations in annual survival were about twice as important to annual changes in abundance as were changes in net productivity. Recognize that changes in net productivity relate significantly to survival rates of embryos, chicks, and juvenile pheasants. Etter et al. (these Proceedings) conclude that pheasant abundance at Sibley 1957-69, reflects complex responses to habitat and other factors affecting survival and is consistent with earlier findings (Stokes 1952, Anderson 1964, Wagner and Stokes 1968, Gates

Table 10. Effects of annual variations in productivity and survival on changes in abundance of hen pheasants in winter on the Sibley Study Area, Ford County, Illinois, 1957-69. Changes in indices are expressed as percentages of their respective 13-year means.[a]

Year	Change in productivity index (±%)	Change in survival index (±%)	Sum & change (productivity + survival)	Change in abundance (±%)
1957	(Base Year)	—	—	—
1958	+ 6	- 4	+ 2	0
1959	- 16	+56	+40	+33
1960	- 22	+29	+ 7	+ 4
1961	- 9	+53	+44	+38
1962	+13	- 12	+ 1	- 1
1963	- 3	+ 1	- 2	- 2
1964	- 24	+ 8	- 16	- 14
1965	- 6	- 48	- 54	- 49
1966	+ 2	- 18	- 16	- 18
1967	+29	- 51	- 28	- 30
1968	+ 8	+25	+33	+30
1969	+21	- 11	+10	+13

[a] The index of net productivity was estimated as the proportion of juvenile hens to total hens each winter; the survival index was estimated as the proportion of adult hens 1 winter to total hens the previous winter.

1971, Dumke and Pils 1973, Warner et al 1984). That abundance is largely determined by survival is also consistent with the concept of density-independent limitation of animal abundance (Andrewartha and Birch 1954, Andrewartha 1961). Wagner and Stokes (1968), for example, found no strong indication of density-dependent mortality. However, one has difficulty in totally discounting variable probability for survival as it might relate to Errington's (1945) notion that the relative "security" of individuals is a function of density. Predation is probably the major factor that might be expected to be density dependent, with densities of both prey and predators important.

DISPERSAL AS A FACTOR IN LOCAL PHEASANT ABUNDANCE

Dispersal probably stands as the major unaccounted-for variable in determining local pheasant abundance and harvest. If dispersal is a factor, changes in local pheasant abundance should reflect fluctuations in abundance at a larger scale.

Public hunting areas often show high rates of harvest relative to pheasant abundance in the general vicinity. Annual harvests of wild pheasants on the DWA, Ohio, 1951-62 ranged from 500 to 800, or 8-11/100 acres (40 ha) (E. A. Leite unpublished data)—2-5 times higher than on private land even in the better Ohio range. A sharp decline in wild pheasant abundance at the DWA in the mid-1960's (Fig. 2) cannot be explained by increased hunting pressure, shooting of hens, extreme weather, or to changes in vegetation paralleling those on private land in central Ohio. The decline at the DWA apparently did relate strongly to the general decline of pheasants in Ohio and most of the Midwest that began after 1962, coinciding with the end of the Soil Bank program and a return to full-production agriculture (Edwards 1984). The coefficient of correlation of the pheasant harvest decline at the DWA with trends in pheasant abundance statewide in Ohio for 1958-71 was $r^2 = 0.924$; the coefficient of determination, $r^2 = 0.854$, indicated that about 85% of this variation was associated with statewide changes in pheasant abundance.

A reasonable conclusion is that the abundance of pheasants at DWA was closely linked with abundance statewide. The most logical linking mechanism is dispersal, i.e., pheasants at DWA existed as a dynamic local extension of the population on a larger scale, linked over space by dispersal, and over time by reproduction. This hypothesis implies that while local abundance is highly vulnerable to local habitat, abundance is also a function of habitat on a larger spatial scale—thereby helping to explain why small-scale local habitat programs are most effective where

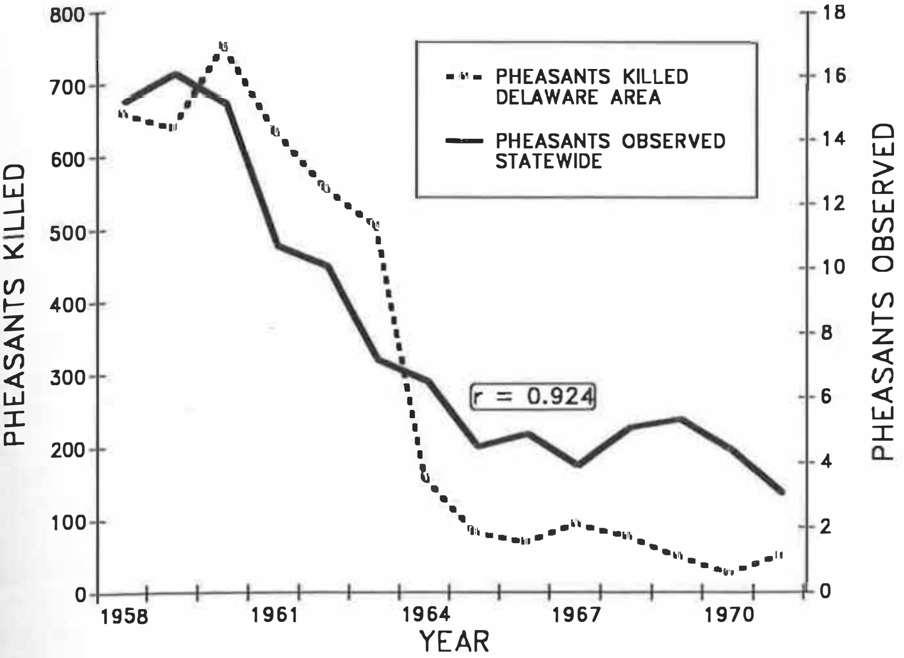

Fig. 2. Trends in numbers of pheasants observed/1,000 mi (1,600 k) driven statewide in Ohio in late summer by rural mail carriers and numbers of wild pheasants bagged by hunters on the Delaware, Ohio, Wildlife Area, 1958-1971 (E. A. Leite, personal communication 2/17/88).

and when pheasants are regionally abundant and less effective elsewhere. The strong implication is that habitat management should be at least in blocks of perhaps a township (about 9,000 ha) in size. A further implication is that much of what has been viewed in the past as local "production" has related strongly to local dispersal. Thus, management efforts should be directed to providing cover that attracts and helps hold immigrants, and discourages emigration.

Managing for dispersal offers a new dimension to the old concept of pheasant refuges (Leedy and Hicks 1945). Although evidence (Edwards 1963a, b) does not suggest that refuges promote pheasant abundance by saving significant numbers of hens from being shot by hunters, in good range pheasants often concentrate on refuges in large numbers during the hunting season and tend to remain in the general area during winter. Refuges thus serve as centers of dispersal in spring. The new dimension is that refuges could be used for concentrating dispersing pheasants in areas where favorable habitat has been developed or preserved, e.g. nesting cover.

ARE PHEASANTS CYCLIC?

For over a century, local establishment, range extensions, and increases in abundance of wild pheasants have consistently occurred in the late and early years of decades. Declines—exclusive of those directly attributable to changes in land use and weather—have repeatedly come in mid-decade. Cyclic patterns would be obscured by lack of long-term continuity in data, by variable weather conditions, and by changes in land use. Nevertheless, a case may exist for pheasant abundance conforming to the concept of a 10-year cycle (Keith 1963).

The general success of pheasants in the late 1920's, 1930's, and 1950's, with lesser or regional increases in the late 1940's, 1960's, and early 1980's have been mentioned, as have declines of the mid-1940's and weaknesses in the mid-1930's, 1950's, and 1970's.

Kimball (1948) concluded that probability of establishment was greater when releases of pheasants were made during the increase phase of wildlife species believed to be cyclic. Grange (1948) considered the pheasant cyclic. Errington (1954) cautioned against overemphasizing numerical fluctuations as the sole indicator of cycles. Several workers noted that major increases of pheasants in the late 1930's and early 1940's, and the decline that followed in the mid-1940's, coincided with the grouse (*Tetraonidae*) cycle (Allen 1953, Errington 1957, Dale 1956, McCabe et al. 1956, Keith 1963). Bailey (1968) noted regional cyclic tendencies in cottontail abundance, and Edwards et al. (1981) suggested that cottontail cycles in Illinois tend to be masked by changes in land use and weather. Roseberry and Klimstra (1984) recently concluded that bobwhites are cyclic in Illinois. It is difficult to rationalize why prairie grouse (*Tympanuchus cupido* and *T. phasianellus*), bobwhites, and cottontails would be cyclic and pheasants would not.

CONCLUSIONS

Wild pheasants have been hunted for >60 years over most of their North American range. Hunting regulations have evolved in recognition of pheasant biology, ecology, abundance, harvest, hunting pressure, changes in farming, and changing attitudes of hunters and landholders. Current cocks-only hunting regulations appear both adequately conservative and reasonably liberal. There seems little basis or need for major change. With the possible exception of heavily hunted public areas, hen kill under cocks-only regulations probably is not excessive. Seasons of 40-60 days and daily bag limits of 2-3 cocks seem reasonable. Because rates of natural mortality are high in fall and early winter, season openings should be early to allow maximum harvests. Barring season closings and shooting hens, future changes in pheasant hunting regulations largely will be cosmetic. Reduced pheasant abundance, however, may at times call for a more conservative posture. In any event, devising a framework to increase harvest, except at high levels of abundance, would be extremely difficult.

Optimum and Sustained Yield

Wagner (1969) pointed out that optimum yield theory has had little impact on wildlife management. This result is not surprising considering the complexity of factors relating to dynamics of abundance: instability of agricultural environments, massive areas of occupied range, small average size of farms, the great number of landholders, limited control of hunters, and relative ease of dispersal. Optimum yield theory would be most applicable to organisms in controlled or "closed" environments; Scott (1954) suggested managing harvests of wildlife for sustained yields.

When both sexes of a species are harvested, maximum sustained yield is normally realized with abundance of about half of what it would be if the population were unharvested (Pielou 1974). With bobwhites, for example, Roseberry (1979) concluded that maximum sustained yield occurred under annual harvests of approximately 40-45%. Given the lower reproductive rate of pheasants, maximum sustained yield would be achieved under hen harvests of 30-35%. Under cocks-only hunting, annual hunting mortality of cocks and hens combined normally approaches and may, on occasion, slightly exceed 50%, particularly in the Great Lakes states. Given the desirability of margins for safety and for increase in numbers, and the problems inherent in controlling hunting on private land, it is likely that maximum sustained yield and maximum abundance of pheasants are both currently approached under today's relatively liberal cocks-only hunting regulations.

What Is Successful Pheasant Harvest Management?

It is clear that demand for the opportunity to hunt pheasants far exceeds the ability of agricultural land to support wild pheasants. This problem was exemplified by data obtained in the 1950's and early 1960's from DWA, where harvest of wild pheasants then ranged from 8 to 11/100 acres, about 50-70/mi^2. Yet, even in 1962 when 2,877 total pheasants (wild plus released) were bagged at DWA (Leite 1965), almost 50/100 acres, success averaged only about 1 pheasant bagged/5 hunters and about 1/16 hours of hunting. These data show that unless there is a significant increase in cost, demand for pheasant hunting on public areas will increase to exceed any level of supply that can reasonably be provided.

Thus, the true measure of success in harvest management lies in maximizing recreation and harvest consistent with maintaining abundance relative to capacity of the habitat to support wild pheasants. Programs of harvest management where (1) hunters are given cocks-only seasons of 30 + days of hunting, (2) winter sex ratios are near or below 25 cocks/100 hens and illegal hen kill does not exceed 15-20% of the prehunt population of hens should be regarded as successful.

Comments on "Population Limitation"

An understanding of forces underlying changes in abundance is basic to harvest as well as to other aspects of pheasant management. This analysis presents findings that suggest a perhaps unexpected perspective on the "regulation" of pheasant abundance, relating to abundance that is more or less constantly variable across space and over time. Numbers change over time as a result of the combination of natality, mortality, and dispersal varying from the species-normal condition. Abundance increases when the combined effect of these 3 factors is positive—above normal—and decreases when their effect is negative—below normal. Reproduction, however, seemingly maximizes within the physiological capacity of individuals to reproduce. High and low densities relate to high and low numbers of individuals surviving and being produced. High—or low—rates of productivity and survival, however, are not restricted a priori to either high or low density. Stochastic environmental events (e.g., weather) are important to short-term changes in abundance. Long-term variability in abundance relates largely to dynamic changes in agriculture. Local abundance reflects local conditions and events, but also reflects events at some larger spatial scale as a result of dispersal. Individuals thus occur in open, dynamic aggregations as extensions of species populations at some larger spatial and temporal scale, linked over time by reproduction and across space by dispersal.

Changes of abundance over time at regional scale relate primarily to variable survival, with dispersal important to abundance at local scale. Abundance increases, and numbers are high, where and when large numbers of individuals survive. Long-term trends reflect short-term changes in abundance just as local areas reflect changes in numbers of individuals surviving, reproducing, and dispersing. In effect, abundance is limited rather than regulated. Although regional abundance tracks changes in land use, short-term local abundance cannot reasonably be predicted simply on the basis of land use. This model assumes nothing of stability and closure, or of inversity beyond that related to dynamic probabilities of survival.

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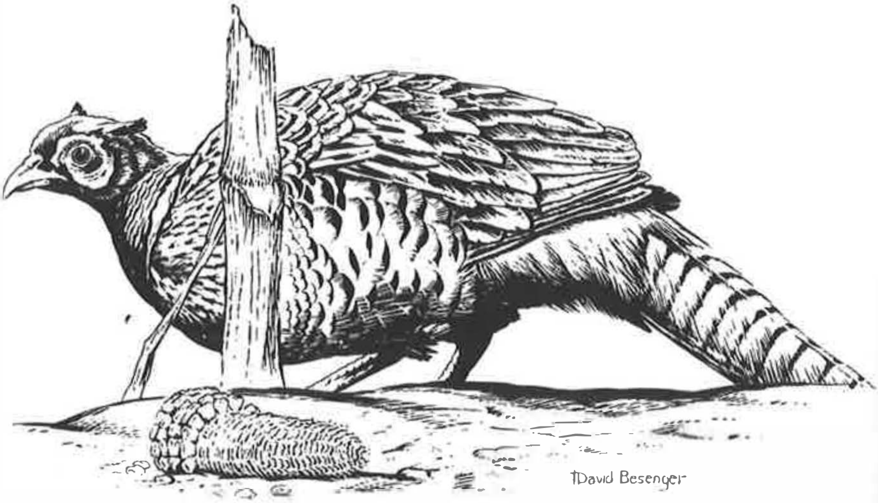

A PERSPECTIVE ON THE SYMPOSIUM AND ON PHEASANTS

WILLIAM R. EDWARDS, Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820

The Symposium went far toward meeting its objectives. New concepts and several revisions of old theories of pheasant ecology and management were presented. In ecology and wildlife management, as in all science, truth is elusive and often a matter of perspective; what is more or less right is axiomatically more of less wrong. The job of research is to question continually and to seek better approximations of truth. Ecological theory is currently undergoing rapid change, as is wildlife management. Change was evident at this Symposium. Although some will challenge the validity of new and controversial ideas, research in recent years has made significant progress, as these Proceedings document. Following is a summary of the 16 papers contained in these Proceedings.

PHEASANTS AND THE CHANGING MIDWEST LANDSCAPE

The first 5 papers consider pheasants in relation to agriculture in North America over the past 100 years. George Burger recognizes in his extensive review that problems faced by pheasants have long been symptomatic of problems faced by all wildlife on agricultural lands, and that the most important future role of wildlife professionals lies in efforts to redirect federal farm programs so that land use becomes more, rather than less, productive of pheasants and other wildlife.

Pheasants 1930-86

Robert Dahlgren depicts the abundance and distribution of wild pheasants in North America since 1930. Pheasant abundance peaked in the Lake States in the early 1940's and in the Dakotas by 1950. A second peak occurred in the early 1960's. Dahlgren estimates that, since the 1940's, centers of abundance have shifted southward with current strength greatest in southern Iowa, Kansas, and parts of Missouri; since the early 1970's, pheasants have declined by an estimated 33% in the Midwest and by 67% elsewhere. Dahlgren also estimates that over the past decade prehunt abundance in the U.S. has averaged roughly 31-33 million pheasants, and concludes that the number of wild pheasants alive in North America today is no greater than that of just 2 states—North and South Dakota—in the early 1940's.

Federal Pheasants

Since 1934, programs of the U.S. Department of Agriculture have been dominant in determining agricultural land use in the U.S. Alfred Berner points out how such federal programs have adversely affected habitat and thus abundance of pheasants and other wildlife. Programs of cost-shared drainage and subsidies for commodity production have significantly reduced wildlife habitat. Only cropland diversions of the 1930's and 1950's that specified seeding of perennial soil-conserving legumes and grasses proved highly supportive of wildlife, including pheasants.

Berner reports that the 1985 Farm Act, which reflected concerted efforts of fish, wildlife, and environmental constituency groups, had the strongest conservation provisions of any act since the 1930's. Unfortunately, the acreages of land currently (1987) set aside under annual contracts remain high; therefore, cropland diversions fail to maximize wildlife and conservation benefits. Those concerned about the future of wildlife must remain ever alert and continue to press for agricultural programs that best benefit the combination of agriculture, conservation, and wildlife.

Windows of Management Opportunity

Impacts of federal agricultural programs on wildlife habitat occur as secondary effects of land-use decisions. Stephen Brady and Rex Hamilton point out that federal programs are shaped by powerful constituencies, all having strong, vested interests. Although most agricultural groups nominally support wildlife, few receive direct economic gain from it; consequently, support of these groups is not strong. Although wildlife advocates constitute only a small fraction of those trying to influence federal agricultural policy, wildlife professionals have opportunities to work within current programs to benefit wildlife.

Potential windows of management opportunity include: (1) working with agency personnel who prepare work plans and implement conservation programs on individual farms; (2) working with county ASCS committees, farm groups, and individual farmers who establish policy at the local level; (3) supplying program participants with information on options supportive of wildlife; (4) attending meetings, making presentations, and distributing materials on how wildlife and soil conservation programs can be complementary and cost effective; (5) working to obtain supplemental cost-sharing from other agencies or sources for projects that benefit wildlife; and (6) enlisting support of citizen constituency groups at local, state, and national levels. Brady and Hamilton conclude that the future of wildlife management on private land depends on effective use of all such windows of opportunity.

Pheasant Responses to Increased Intensity of Land Use

Insights into how animals respond to changes in land use, particularly as those changes relate to federal programs of cropland diversion, are essential if we are to manage wildlife successfully on agricultural lands. The years 1962-72 mark the transition between the era of the Soil Bank and years of maximum agricultural production in the 1970's. Stanley Etter and his colleagues direct attention toward survival and dispersal as primary determinants of pheasant abundance during a decade of agricultural change. They found that pheasant abundance reflects complex interaction of prior abundance, weather, crop and cover types, and farming practices. As the Soil Bank and the Federal Feed Grain programs were phased out, and the amount and interspersion of prime pheasant habitat were reduced, pheasants declined correspondingly. Fall-winter survival of juvenile hens was typically only ½ to ⅔ that of adult hens. The later the date of hatch, the lower the probability of survival.

Young-of-the-year appear particularly vulnerable during fall and early winter. The findings of Etter and his colleagues are further significant because they recognize the role of dispersal in local abundance, and thereby recognize the need to initiate management on areas the size of a township—9,000 ha—or larger so that dispersal does not unduly limit responses of local pheasant numbers to management. The fact that local programs of habitat development tend to be successful where and when pheasants are abundant, and unsuccessful where and when they are not, relates largely to effects of dispersal.

NEW DIMENSIONS IN PHEASANT BIOLOGY

Pheasant Facts of Life

Research on pheasants has lagged in recent decades. However, some recent findings are relevant to new approaches to wildlife management on agricultural lands; Richard Warner discusses several such new dimensions.

Abundance varies with time and space. Beyond a few years (typically 2-3 at most), abundance is variable and reflects time-dynamic shifts in natality, mortality, and dispersal. Temporary shifts in biotic rates, and thus abundance, relate to fluctuations in weather and changes in land use. Shifts in rates are temporary and result in changes in abundance, which also are temporary.

As the scale of observations increases, local perturbations begin to average out, and patterns related to changes in regional land use become clearer. Abundance becomes more predictable, and the concept of carrying capacity is increasingly relevant as spatial scale increases. Unfortunately, prescription management at local scale does not (cannot) yield closely predictable results. Habitat initiatives need to be large in scale, and in reasonable proximity, to minimize potential losses to dispersal. Future management initiatives should stress survival, particularly of hens, nests, and young. In time, we will come to recognize that attracting and holding dispersers may be more significant to local abundance than is “production” of game on the same local areas.

Population Models

Simulation is used increasingly to help identify limiting factors, depict complex interactions, and predict possible responses of wildlife to alternative management strategies. David Hill and Peter Robertson demonstrate the utility of models for management of pheasants by gamekeepers on large estates in Great Britain.

The following remarks are made to note that models are useful but not infallible. The inherent weakness in theoretical models lies in the validity of assumptions on which they are founded. Care should be taken in interpretation of results from simulations based on assumptions of stability and closure. Assumption of closure eliminates dispersal as a possible mechanism of regulation and is usually not valid for local populations. However, assumption of closure is permissible for areas sufficiently large that local effects of immigration and emigration would offset one another. Another potential weakness in models is assumption of density-dependent changes in natality and mortality rates. Evidence for density-dependence is not nearly so strong as has often been supposed. Models that assume compensatory natality rarely treat age-related differences in reproduction and survival as variables.

Predators and Predation

LeRoy Petersen and Robert Dumke provide insights into survival and the role of predation as primary factors in the dynamics of pheasant abundance. They conclude that vulnerability to predation increases as habitat quality declines. They also point out that long-term studies of pheasant ecology have gone far to redefine the role of predation, and that predation is probably the most consistent cause of pheasant mortality. This is not to suggest that predator control will prove economically feasible except, possibly, at local scale. What is most important relative to predation is that we have a better appreciation today of the need for management interventions directed toward higher survival.

Pheasant Genetics

Pheasants have done well where and when habitats favored normal or above-average rates of survival, and poorly where and when they have not. Genetics considerations pose longstanding questions for pheasant biologists. An old idea was that new and better-adapted races might improve genetic diversity and, thus, extend the area of range occupied by wild pheasants.

Only recently have techniques become available for assessing subtle differences among racial stocks. Richard Warner and David Philipp suggest how genetic concepts might be integrated into pheasant management. They urge that genotypes of wild pheasants as they now exist in North America be inventoried, making feasible attempts to relate that information to similar data for parental types in Asia. Knowledge of how endemic races exist relative to current conditions in Asia could prove useful in making management decisions in North America regarding preservation of local genotypes and importation of new races. Warner and Philipp make the potentially important point that management should seriously consider preservation of locally adapted racial types and prevent potentially negative effects of mixing (i.e., with new releases).

NEW DIMENSIONS IN PHEASANT MANAGEMENT

Quality Pheasant Hunts

Thomas Heberlein uses the hunter questionnaire as a mechanism to identify elements that contribute to what hunters consider a quality pheasant hunt. Questionnaires using large sample sizes are readily attainable, but typically are biased. Nonetheless, Heberlein finds considerable agreement among hunters regarding elements that add to or detract from the quality of a pheasant hunt.

Heberlein found that hunter success and numbers of pheasants bagged do not represent the foundation of quality hunting. Rather, success in bagging game represents the frosting on the cake. The bases of a quality hunt are presence of game, an attractive place to hunt, and presence of a reasonable number of well-mannered hunters. With those elements in place, a high proportion of hunts are viewed by most pheasant hunters as quality hunts. Those 3 elements—not success—therefore should form the basis of harvest management.

Fee Hunting—Headache or Opportunity

In recent years, fee hunting of pheasants has increased rapidly in South Dakota. Kenneth Solomon points out that agricultural interests now actively promote fee hunting as a source of local income. As a result, increasing numbers of landowners and merchants in depressed rural communities see fee hunting as financially rewarding. One criticism by hunters of fee hunting on private farmland is that landowners are taking undue advantage of limited abundance of wild pheasants—pheasants that are not "owned" by landowners. The greater problem for hunters is that, as more landowners charge fees, less land is available for free hunting.

Wildlife managers in South Dakota are caught in a no man's land between agricultural interests and pheasant hunters. The bottom line for both groups is pheasant abundance. Progress toward pheasant abundance can best (quite probably only) be made by wildlife professionals working closely with both landowners and hunters.

The Upland Constituency Movement

As this Symposium theme recognizes, an ever-expanding wildlife habitat crisis exists in agricultural regions, with no end or relief in sight. Working alone, wildlife agencies are not logistically or financially able to manage wildlife effectively on private farmland. James Wooley and Roger Wells conclude that the best hope for future preservation and management of upland wildlife may well lie with wildlife constituency groups acting in partnership with state conservation departments and other governmental agencies at local, state, and national levels.

Recent development of the wildlife constituency movement, exemplified by Pheasants Forever and Quail Unlimited, bespeaks direct public involvement as a positive force in wildlife conservation. Wildlife managers and administrators need to recognize the current vigor of the constituency movement and use that energy to manage pheasants on private lands.

The Importance of Nest Parasitism

Richard Kimmel provides a useful review of the literature on the propensity of pheasant hens to lay eggs in nests of other birds. Kimmel's review suggests that nest parasitism by pheasants is common where pheasants and other game birds use the same coverts for nesting. Where pheasants are common, nest parasitism can have adverse effects on reproductive success and, thus, abundance of other species. Parasitism appears as part of the reproductive strategy of the ringneck, apparently occurring more often early in the nesting season by year-old hens. Nest parasitism is a strategy that "spreads the risk" of egg destruction. It is also a strategy consistent with high numbers of hens forced to nest in locally restricted, relatively insecure habitats, as opposed to leking as a mechanism of concentrating a species that in presettlement times was widely dispersed at low average densities.

Kimmel hypothesizes that pheasant chicks hatched and reared by another species would be imprinted reproductively on that species, a factor that could, in subsequent years, act to disrupt the mating behavior of the other species. This idea is consistent with aggressive behavior of pheasant cocks on prairie chicken leks.

Contributions from Research on Prairie Chickens

Perhaps surprisingly to some, Ronald Westemeier's research over the past 25 years on prairie chickens in Illinois provides a wealth of insights on pheasant ecology and management. For example, establishment of pheasants on prairie chicken sanctuaries near Bogota, Illinois, has been the result of recent availability of grassland habitat and relative protection from disturbance and predation afforded by the sanctuaries. There is now little reason to continue to think that factors formerly limiting southward range extension by pheasants in Illinois are related to genetics or physiology. Further, it is clear from Westemeier's work that, as pheasants became abundant, prairie chicken numbers declined. This change occurred on an area where, in the preceding decade, prairie chickens had increased substantially following development of the local system of grassland sanctuaries. The decline in prairie chickens relates to reduced nesting success associated with parasitic laying of eggs by pheasant hens in prairie chicken nests. Westemeier's work demonstrates the difficulty of controlling pheasant abundance in an area where habitat is favorable and where hen pheasants are given good escape cover and extensive protection from hunting.

Pheasants of the Future?

Harold Prince and his colleagues review the taxonomy of "true pheasants" and their introduction into North America. They also describe the recent importation of a "new" race, the "Sichuan" pheasant (*P. c. strauchi*), a race apparently not previously imported to America. Thus, the search for a new and better-adapted race of pheasant goes on at high expense, with fanfare and public support and acclaim.

The basic problems in survival of released pheasants have been—assuming adequate food—first, escape from predation including that on nests, and second, favorable weather. On the basis of land use, vegetation, and climate in its ancestral range, Prince and his colleagues are optimistic about chances for establishment of Sichuan pheasants in Michigan. Time will tell.

Realities of Population Regulation and Harvest Management

A number of perspectives emerged from my appraisal of time/space transgressive patterns in pheasant harvest. First, successes and failures, booms and busts, have inversely mirrored the strength of markets for agricultural commodities and federal programs of cropland diversion. Decades in which pheasants became most abundant regionally relate to agricultural market conditions which forced shifts out of livestock production and, later, resulted in regional farm economies based predominantly on cash-grain production. Economic conditions that increased acreages of fallow grasslands were more favorable for pheasants.

There has also existed a tendency for establishment, range extension, and abundance of pheasants to be positive in years near the turn of decades (the sequence of years ending in 8, 9, 0, 1, 2, or 3) and negative in mid-decade (years ending in 4, 5, 6, or 7). This is consistent with the belief of several early workers that pheasants are cyclic.

Pheasant harvests were found to be strongly survival dependent. No single factor regulates pheasant abundance; such factors as extreme weather and—to a lesser degree—land use, particularly at local scale, are largely unpredictable, and dispersal complicates prediction of abundance at local scale. It is clear that abundance is uneven because environments differ over time and space. It is time to stop regarding what are highly dynamic local aggregations of pheasants as discrete, stable, "organismic" populations and, particularly, as closed populations. If we fail to acknowledge instability, the necessity of innate dispersal, and the role of individuals, we may never understand pheasant ecology.

Harvestable surplus derives from what has been appropriately termed "autocatalytic production"—the production of more young than are typically necessary to replace local losses. Such "surplus" productivity "accommodates" innate dispersal, which facilitates species persistence in variable, hostile environments.

Sex ratios demonstrate vulnerability of pheasants to heavy hunting pressure. However, polygamy and the law of diminished returns as it affects hunters combine to allow liberal hunting of cocks, but not of hens. Limited evidence suggests that, if we wish to leave an adequate margin for increase, any removal of hens by hunting should not exceed about 25% of hens present before the hunting season. In most pheasant ranges, current accidental and illegal hen kills are half or more of what can reasonably be tolerated. Current game laws—liberal with respect to hunting of cocks and conservative relative to hens—are "reasonable," and major changes in current "cocks-only" hunting regulations appear to be unwarranted at this time.

Thus, we have learned much of importance regarding both pheasant ecology and management. We better appreciate what caused pheasant releases to be successful or unsuccessful and pheasants to fluctuate in abundance, and we are in a stronger position to predict how pheasants will respond as conditions change in the future. The value of long-term commitments by state agencies to pheasant research is demonstrated repeatedly in these Proceedings. Numerous workers recognize and deplore the current, greatly reduced status of research on pheasants. Because the agricultural world is so susceptible to change, it is critical that research on pheasants continue—not only for the sake of wild pheasants—but because they serve so effectively as indicators of wildlife problems on agricultural lands.