AN ABSTRACT OF THE THESIS OF

JOHN ENGBRING for the degree MASTER OF SCIENCE
(Name of student) (Degree)

in Fisheries and Wildlife presented on December 13, 1974
(Date)

Title: POPULATION ECOLOGY OF A PHEASANT POPULATION AUGMENTED BY RELEASE OF GAME FARM PHEASANTS

Abstract approved: Redacted for Privacy
R. L. Jarvis

Production and survival parameters of wild and introduced ring-necked pheasant (Phasianus colchicus) populations were studied at William L. Finley National Wildlife Refuge from October 1972 to September 1974.

Game farm males were released immediately prior to and during the hunting season. Of the 1,300 males released, hunter harvest averaged 64 percent for the 2 years. The remaining birds apparently succumbed to crippling loss, death due to release shock, or predation, as only a few game farm cocks survived to winter and none were found alive by the first spring following release.

Adult game farm females released each April prior to egg laying also suffered high mortality rates. Of the 148 released in 1973, one was found alive four months later. In 1974, 187 were released; four

were found alive four months later. At least four of these five game farm hens found alive during the two summers raised broods. Observations of game farm hens in 1974 indicated that a majority of this mortality occurred shortly after release.

As evidenced by sample roadside censuses and trapping data, the wild population was greatly reduced from 1973 to 1974. The census of pheasants in summer with the use of dogs indicated that the wild population had been reduced from a summer density of 26.5 birds/100 ha in 1973 to 11.3 birds/100 ha in 1974. Heavy flooding in the winter of 1973-74 was believed to be a major factor in the population reduction.

Recruitment decreased dramatically between years. In 1973 estimated survival to recruitment at 6 weeks of age was 259 chicks, while in 1974 only 113 chicks were produced. This reduction in recruitment was attributed to a reduced breeding population rather than to decreased production per hen, since chick per hen ratios were identical (4.9:1) both summers. Production per hen approximated that of areas outside of Oregon.

These data suggest that on Finley Refuge survival factors rather than variances in productivity are the probable factors influencing population fluctuations.

Population Ecology of a Pheasant Population Augmented by Release of Game Farm Pheasants

by

John Engbring

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1975

APPROVED:

Redacted for Privacy

Assistant Professor of Wildlife
in charge of major

Redacted for Privacy

Head of Department of Fisheries and Wildlife

Redacted for Privacy

Dean of Graduate School

Date thesis is presented December 13, 1974

Typed by Ilene Anderton and Lyndalu Sikes for John Engbring

ACKNOWLEDGEMENTS

Thanks is first given to my major professor, R. L. Jarvis, who initially proposed the project and assisted throughout the research and preparation of the thesis.

Cooperation of Refuge personnel was greatly appreciated, particularly the thoughtful help of R. S. Rodgers and the enthusiastic support of C. F. Zeillemaker.

F. D. Kirkpatric and J. Pesek of the Oregon State Wildlife Commission were always helpful and patient. I thank them.

I am particularly indebted to those who contributed the use of their dogs: E. C. Meslow, R. L. Jarvis, H. F. Horton, and J. E. Tabor.

The advice of W. S. Overton and the assistance of G. H. Arscott is gratefully acknowledged.

R. M. Storm offered technical advice as well as companionship, for which I will always be deeply indebted.

Finally I wish to thank those whose friendship I shared during the past years, particularly my good companions S. Furniss, M. Bunnell, M. Storm, and my brother Paul.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

POPULATION ECOLOGY OF A PHEASANT POPULATION AUGMENTED BY RELEASE OF GAME FARM PHEASANTS

INTRODUCTION

This is a report on the dynamics of wild ring-necked pheasant (Phasianus colchicus) population annually supplemented by introductions of adult game farm females in the spring and game farm males in the fall.

The Oregon Wildlife Commission (Oregon State Game Commission prior to 1974) began raising and releasing pheasants in large numbers in 1910 (Lauckhart and McKean 1956). The purpose of the release program was, and still is, to augment the wild population of pheasants and to provide hunters with more game. After attempting various release schemes, the state of Oregon settled on a program generally consisting of two phases. The first phase involves the release of adult male pheasants immediately prior to and during the fall hunting season. The second phase involves the release of excess adult females during the spring and early summer.

The majority of males released in fall are taken by hunters. In Oregon, about 60 percent of the males released were taken by hunters (Oregon State Game Commission 1951). Data from other states indicated the percent harvested ranged from 50 to 70 (Hart

et al. 1956; Burger 1964, Potter et al. 1973). Annual survival of game farm males released in fall appeared to be low as approximately 1 percent were bagged in subsequent seasons at Summer Lake (Oregon State Game Commission 1951) and in California (Harper et al. 1951).

Information concerning game farm males from the time of release to the following year is limited. In Wisconsin, Burger (1964) found that 8 percent of the males released in fall survived to the following spring, indicating that the game farm birds were contributing breeding stock to the wild population. However, other studies have not calculated an over-winter disappearance rate or determined survival to the time of spring breeding.

Survival and production of hens released in the spring just prior to egg laying is variable; March to November mortality was 95 percent at Summer Lake (Oregon State Game Commission 1951) and 37-72 percent at Eliza Island (Salter 1949, Wick 1952, Bohl 1955). On Eliza Island, approximately two young were added to the fall population (October - November) for each hen released in spring (Salter 1949; Hansen 1953). In Wisconsin, each hen released in spring contributed slightly less than one bird to the population in late October (Kabat et al. 1955, Besadny and Wagner 1963). Release of game farm pheasants in Illinois, in an area of apparently suitable habitat but south of the range of established populations, reproduced

at rates comparable to wild populations but low survival prevented the establishment of a viable population (Ellis and Anderson 1963).

It appears that there is considerable variation in the survival and production of hen game farm pheasants from area to area, and that these parameters must therefore be determined on a specific area basis.

Finally, knowledge of the fate of game farm pheasants is inconclusive unless viewed in conjunction with survival and production parameters from the local wild population.

Objectives

To study dynamics of a pheasant population in which game farm hens are introduced in the spring and game farm males are introduced prior to and during the hunting season in the fall.

Specific points considered were:

1. Determine disappearance rate of game farm cocks released in fall and their survival to the time of spring breeding;
2. Determine disappearance rate and productivity of game farm hens released in spring;
3. Compare production and survival of the wild population with the same parameters from released game farm pheasants.

Description of Study Area

Pheasants are released at several locations in the Willamette Valley by the Oregon Wildlife Commission. A release program suitable for study was practiced at William L. Finley National Wildlife Refuge. Because of the existence of a wild pheasant population along with a hunter check system that facilitated collection of data, a portion of this refuge was chosen as the study area.

Located 19.3 km south of Corvallis, the 2,155 ha Refuge was established in 1965 primarily as a waterfowl refuge. The region is characterized by a mild climate, with an average annual temperature of 53°F. (12 C) and an average annual precipitation of 37.7 in. (95.7 cm) recorded at the Oregon State University meteorological station (Environmental Data Service 1973). The bulk of precipitation occurs as rain during winter months; summers are warm and dry.

The Refuge represents a fairly diverse plant community, the eastern half being located in the Willamette Valley and the western half encompassing the foothills of the Coast Range (Franklin and Dyrness 1973). Such a variety of habitat attracts many species in addition to waterfowl. The various cover types on the Refuge (Table 1) appear to satisfy most requirements of pheasants.

Table 1. Land classification on William L. Finley National Wildlife Refuge, 1974. (Data from Refuge files.)

Cover type	Area (ha)	Percent of total area
Wetlands	125.0	5.8
Seasonally flooded basins and flats	386.2	17.9
Cereal grain fields	87.9	4.1
Grass seed production fields	655.9	30.4
Unharvested grasslands	344.1	16.0
Harvested grasslands (grazed or mowed for hay)	169.9	7.9
Forestlands	284.8	13.2
Brushlands	83.2	3.9
Administrative	17.2	0.8
Rocky outcrop	0.8	0.0
Total	2155.0	100.0

The study area chosen (1407 ha) consisted of the prime pheasant habitat on the Refuge along with a small section of land adjoining the northeast side of the Refuge (Figure 1). The coniferous region on the western edge of the Refuge and the southern portion of the Refuge, which consisted largely of extensive cultivated grass seed fields, were not included in the study area. There were approximately 19 km of drivable roads on the study area; about half of these roads could

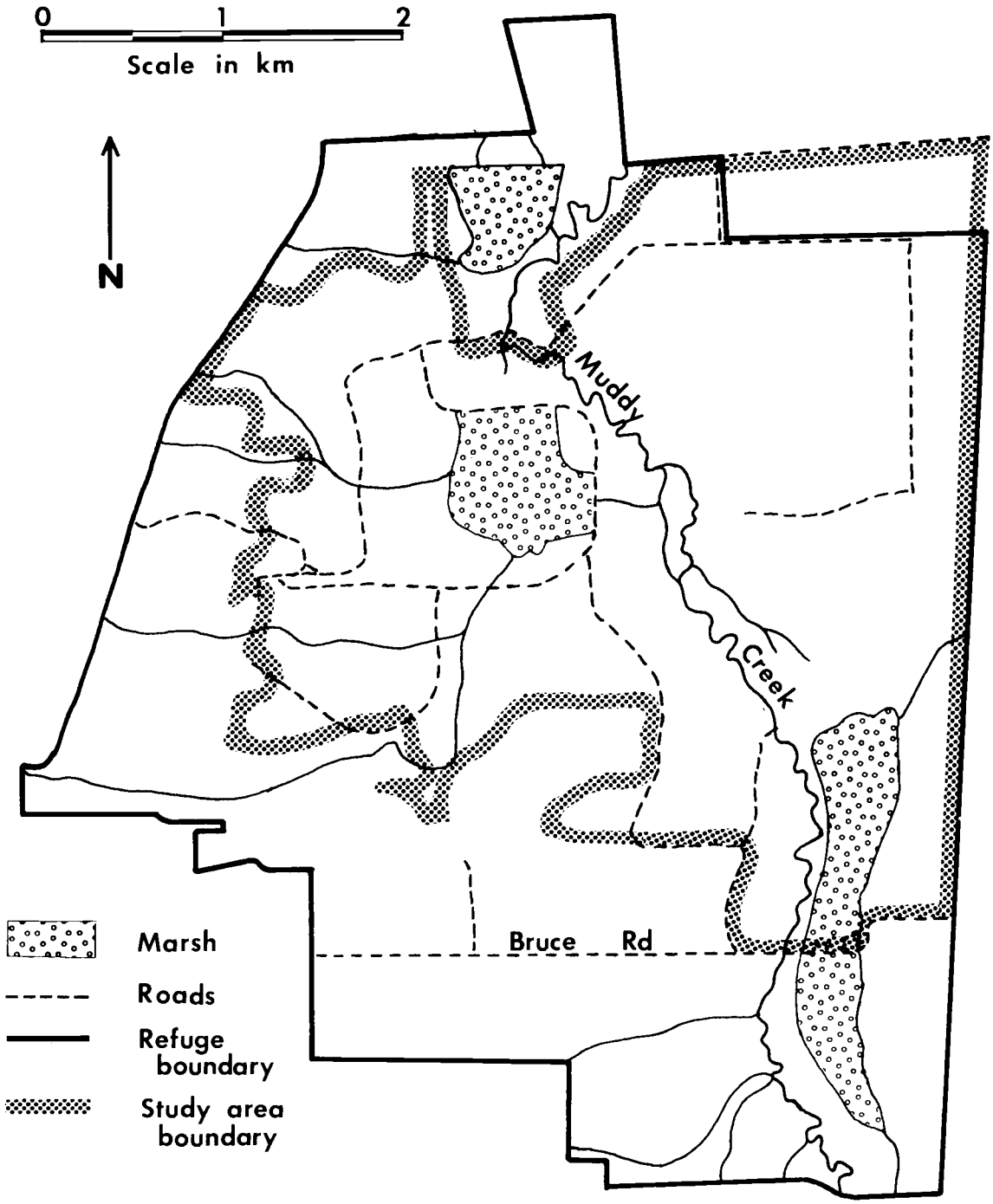

Figure 1. Study area and William L. Finley National Wildlife Refuge. Hunting area includes that portion of the Refuge east of Muddy Creek and south of Bruce Road.

not be driven during winter months or during wet periods in spring or fall. Marshes on the study area (Figure 1) were seasonal, and contained little water in summer.

Data on pheasant hunting were collected on the entire area open for pheasant hunting (Figure 1), although part of the hunting area was not included in the study area. It should be kept in mind that the population of pheasants on Finley Refuge was nearly all contained within the study area, and that the population estimates on the study area closely approximate the total number of pheasants on the Refuge.

METHODS

Marking

Game farm pheasants were marked with tags placed on the left wing of the bird. Wild birds trapped in winter were marked on the right wing. The tags measured 2.5 by 12.7 cm and consisted of a plastic impregnated nylon cloth, Saflags (Safety Flag Co. of America, Pawtucket, R.I.). Wing tags were attached by folding the tag over the leading edge of the wing and placing a nylon fastener through the tag and the patagium. Nylon fasteners were inserted by means of a Buttoneer (Dennison Manufacturing Co., Framingham, Mass.). Approximately a 2.5 by 10 cm section of the tag was visible when attached in this manner. Colors used for the different releases and for trapped wild birds included dark blue, light blue, green, white, orange, black, and magenta.

Wing tags were readily visible with a 20 X spotting scope to at least a distance of 1 kilometer, but most birds observed were much closer and could be observed without the aid of a spotting scope. Birds flushed were easily identified providing the bird flew away from, and not across, the observer's line of vision. A pair of 7 X 35 binoculars were commonly used to determine presence or absence of a tag. When one or both sides of the bird were obstructed from view

it was possible to either flush the bird or wait until the bird exposed both sides.

Method of Release

The release of game farm pheasants consisted of capturing, wing-tagging, placing the birds in crates, and immediately liberating the birds after transporting them to the release sites. Exclusive of wing-tagging, this is the normal procedure followed by the Oregon Wildlife Commission, and usually required less than 3 hours for releases made on Finley Refuge. Similar release methods have been associated with considerable shock for the relocated bird, and may be a major cause of death immediately following release (Buss 1946; Harper et al., 1951, Burger, 1964).

In the fall 200 cocks were released the day before hunting season opened and four (1972) or five (1973) releases of 100 males each were made at irregular intervals during the remainder of the season. Birds were released in small groups throughout the hunting area.

Each spring one release was made just as game farm hens began egg laying. On 2 April 1973, 205 birds were released: 148 hens and 57 cocks. On 11 April 1974, the release consisted of 187 birds, all hens. Hens were released in small groups throughout the study area.

Observations

Observations were made by driving along an established census route each day that data were collected. In 1972, roadside counts were supplemented with observations made on foot, but few birds were seen and counts made while walking were discontinued.

Counts began a half hour after sunrise and continued until the route was completed, usually 1 1/2 to 2 hours later. Exceptions were the evening observations made while trapping in winter and four evening observation periods in the spring of 1973, when the disappearance rate of game farm hens was being calculated. Roads were driven at 15 mph. Little variation in a route existed within a season, but routes differed slightly between years depending on road conditions. Certain vantage points were chosen as stopping areas from which surrounding fields were examined with binoculars. Data recorded for each observation included time, sex, location, sides of the bird seen, and the presence (color) or absence of a wing tag.

Hunting

Hunting data were collected from the 1008.5 ha hunting area on Finley National Wildlife Refuge (Figure 1). The hunting season, approximately a 3-week period, opened in mid-October and extended

into the beginning of November. Hunters were allowed two cocks per day, with four in possession.

Wing tags on game farm cocks were collected from hunters at check stations to determine hunting mortality. Collection of data was simplified by the hunter check system employed at the refuge, which required that each hunter report to a check station before entering the field and complete a two-part hunting permit, half of which was deposited at the check station before hunting and half of which was returned to the check station after the hunt. Three such check stations existed on the Refuge. Information required on the hunting permit included the number of birds killed and the number of hours spent in the field.

Two of the three check stations on the Refuge were established as hunter check points, and birds brought in by hunters were examined on days when hunting pressure was predicted to be greatest. No birds were stocked in the vicinity of the third check station and it received minimal use by hunters.

By examining birds at hunter check points, the data collected on hunting permits were confirmed as well as supplemented. It was eventually possible to determine the number of game farm birds harvested, the number of wild birds harvested, and the age ratio of the wild birds harvested.

Data collected from hunting permits were assumed to have negligible bias. As an example of hunter conscientiousness, on the opening day of the 1972 season when 144 birds were examined at the two check stations, the hunters reported on their hunting permits a total of 144 birds killed.

Wild birds were aged on the basis of bursal depth (Linduska 1943, Stokes 1954, Robertson 1958).

Trapping

Traps were constructed and operated during winter months. Once captured, wild birds were banded, wing-tagged, and released. Field observations were then used to obtain a marked to unmarked ratio. By utilizing the Lincoln Index (Overton and Davis 1969) an attempt was made to determine the total number of pheasants on the study area. Traps were modeled after Kutz's (1945) design, but were built without a predator skirt. A welded wire fabric (2 X 4 in. mesh) was used for the main body and the funnel entrance. Nylon netting enclosed the top.

Trapping procedure involved prebaiting in areas where pheasants were commonly sighted. Traps were then placed on these sites but were not opened for several days. Once opened, traps were baited and checked daily at dusk. Initially sudan grass (*Sorghum sudanense*) seed and wheat (*Triticum aestivum*) were used as bait,

but only wheat was used when it was found to be the preferred grain.

Disappearance Rate of Game Farm Hens

The disappearance rate of hens released in spring was calculated in 1974 by plotting the number of observations (for each 2-day period) against time. An identical portion of the study area was censused in an identical manner during each 2-day period. The number of observations of wild hens was used as a comparison to account for reduced observations of game farm hens due to onset of nesting and reduced visibility resulting from growth of vegetation. It was assumed that the behavior of both wild and game farm hens was similar and that mortality of wild hens was negligible.

Census of Pheasants in Summer

An estimate of population size and production was obtained on the study area by searching suitable cover with dogs. The census commenced in early July with the mowing of hay and grass seed fields. The removal of these potential cover sources reduced greatly the amount of cover to be searched. It was possible to search the study area twice before early September, at which time it became difficult to distinguish hens from chicks.

The search procedure consisted of circling the perimeter of a field and then walking parallel transects approximately 50 m apart

over the remainder of the field. Occasionally one, but most often two dogs were used in the census work.

The study area was divided into cover types (Table 2). Those cover types providing suitable pheasant habitat were searched, while unsuitable types were not. The perimeter of all cover types not searched, all roadsides (23.4 km), and all hedgerows (9.5 km) on the study area were searched each year. Most sudan grass fields, too sparse to provide cover during the first search, were searched only once in late summer.

Identification of Broods

Broods on the study area were identified on the basis of their spatial distribution, age of young, and by noting the final location of the first brood flushed in relation to the flushing position of a second brood. The total number of broods on the study area could then be determined.

Studies concerning the movement of hens and chicks indicate a limited range for young broods. In South Dakota, broods less than 3 weeks old were restricted to a 5-10 acre (2.04-4.05 ha) area around the nest (Kuck et al. 1970). Hanson and Progulske (1973) found that the major axis of the area used by broods in South Dakota of various ages rarely exceeded 0.5 mi. (0.81 km). Based on these findings, a standard of 0.8 km was used as the diameter of the home range of

Table 2. Cover types and amount of cover searched on the study area, summer, 1973 and 1974, William L. Finley National Wildlife Refuge.

	1973		1974	
	Area (ha)	Percent of total	Area (ha)	Percent of total
Cover types searched				
Unmowed hay and grass	90.3	6.4	99.2	7.0
Grassy, brushy areas	322.8	22.9	322.8	22.9
Sudan grass	106.5	7.6	117.3	8.3
Corn (*Zea mays*)	6.0	0.4	0.0	0.0
Subtotal	525.6	37.4	539.3	38.3
Cover types not searched				
Mowed hay	46.9	3.3	29.3	2.1
Pasture	141.7	10.1	159.2	11.3
Woods and swamp	321.5	22.8	321.5	22.8
Fallow	145.2	10.3	0.0	0.0
Grass seed	170.5	12.1	358.0	25.4
Small grain	55.9	4.0	0.0	0.0
Subtotal	881.7	62.7	868.0	61.7
Grand total	1407.3	100.1	1407.3	100.0

broods in this study. Observations of broods less than this distance apart were considered to be repeat observations of a single brood, while observations greater than this distance apart were designated as two broods.

An aging guide for juvenile pheasants, which pictured chicks and hen at 2-week intervals up to the age of 16 weeks (Minnesota Division of Game and Fish 1965), was used to age chicks to the nearest week. Chicks with an age difference of 10 or more days were considered as separate broods. Generally, broods separated on the basis of age were less than 6 weeks old, since younger chicks are more accurately aged than older chicks.

RESULTS AND DISCUSSION

Dispersal, Ingress, and Egress

Dispersal from release sites was thought to be minimal. Numerous studies have indicated that adult game farm pheasants when released travel short distances, generally less than 1 or 2 mi. (1.6-3.2 km) (MacNamara and Kozicky 1949, Harper et al. 1951, Kabat, et al. 1955, Robertson 1958, Burger 1964). Although a systematic search of the area surrounding the study area was not conducted, roads outside the perimeter of the study area were usually driven during daily field activities. Only four game farm birds were sighted outside the study area; all were within 0.4 km of the study area boundary.

Birds released on areas with sufficient food and cover disperse less widely than those released on poor pheasant habitat (Leopold et al. 1938, MacNamara and Kozicky 1949, Robertson 1958, Burger and Oldenburg 1972). The quality of habitat on surrounding areas was generally inferior to habitat on the study area. Dense coniferous forest occurred to the west and extensive grass seed fields occurred to the east of the study area. The only areas comparable in quality to the study area consisted of limited strips of cover to the north and south along Muddy Creek.

Because of the limited habitat on surrounding countryside and the relatively sedentary habits of wild pheasants, ingress of birds was not thought to influence the wild population to any great degree. Egress of young birds may occur during years of high production.

Retention and Effect of Wing Tags on Marked Birds

Retention of wing tags during the 1973 hunting season, when all birds were both banded and wing-tagged, was 99 percent. These retention data represent only a short period, 3 weeks at the most. However, some wing tags were retained by wild males for at least a year.

Wing-tagged birds may have suffered disproportionate predation, but the extent of such predation on marked birds is difficult to assess (Gates 1971). Logically, the size of the tag, the color of the tag, and the position of the tag on the bird would be the three most important factors influencing the detectability of a bird by predators. Small size and lateral placement of the wing tag should be advantageous over the backtag described by Labisky (1962). Also, darker, less conspicuous colors were used for most of the releases.

Sex Ratio of Wild Birds

The sex ratio (hens/cock) of wild pheasants on the study area obtained by roadside counts in winter was 0.5:1 both years, and

indicated considerably fewer hens per cock than has been found in both hunted and non-hunted populations. Sex ratios on refuges are commonly lower than sex ratios on hunted areas (Dale 1952), but rarely does the ratio drop below one hen per cock. This low sex ratio is particularly difficult to explain on the study area, since approximately half of the pheasant population is hunted. Two possible explanations exist for this unbalanced sex ratio. First, the roadside observations from which sex ratios were obtained are biased and there are in fact more hens on the study are than there appear to be. Second, the sex ratio as obtained is correct and hens are being subjected to a higher annual mortality than cocks.

Trapping data, although meager, tend to support the observed sex ratio. Over the 2-year period 11 hens and 23 cocks were captured, a ratio nearly identical to that obtained by observation. Since trapping has been shown to be biased toward hens (Leopold et al. 1938, Gates 1971), these data reinforce the theory that fewer hens than cocks are present in the winter population.

Much debate has been devoted to the validity of roadside counts as a method of obtaining sex ratios. Wagner et al. (1965) and Stokes (1954) discussed the variables involved. A marked increase in the observability of hens compared to the observability of cocks was noted when snow was present (Wagner et al. 1965). In fact, hens were observed twice as frequently when snow was present as when

snow was absent. It is probable that hens were overlooked in this study as well, since no snow was present when data on sex ratios were gathered. If the findings of Wagner et al. (1965) were applied to this study, the sex ratio on the study area would be approximately 1:1.

The census conducted in summer with the use of dogs also indicated that more hens were present than were observed in winter. During the month of August when most hens had completed incubation, the ratio of flushed birds was 58 hens and/or broods to 66 cocks in 1973, and 20 hens and/or broods to 17 cocks in 1974. Differential flushing patterns between these two groups of birds may bias the data somewhat, but this bias is not thought to be significant.

For these reasons it is believed that more hens are present per cock than winter sex ratios indicate, and that the true ratio probably approaches one hen per cock. A ratio of one hen per cock was therefore used in later calculations.

Hunting Mortality

Percent of Wild Population Hunted

Pheasants flushed in the summer census were segregated into birds observed on and off the hunting area (Table 3). By the second search in 1973 the pheasant population was equally divided between

the two areas, thus, 50 percent of the population was believed to be hunted. The second search of 1974 revealed 37 percent of the population on the hunted area.

Table 3. Numbers of pheasants flushed on hunted and unhunted portions of the study area, 1973 and 1974, William L. Finley National Wildlife Refuge.

	1973		1974	
	non-hunted area	hunted area	non-hunted area	hunted area
First search (July)	48	97	36	18
Second search (August)	70	71	51	30
Total	118	168	87	48

Hunting Mortality of Wild Cocks

The ratio of wild birds harvested per man hour in the field was regressed against time ($r = -0.86$, significant at 95 percent level in 1972; $r = -0.79$, significant at 99 percent level in 1973), and the daily harvest of wild birds was derived from these regressions on days when the take was unknown. It was then possible to calculate the total number of wild birds harvested (Table 4).

Harvest of wild birds was minimal, with less than 10 percent of the total harvest consisting of wild cocks (Table 4). The bulk of this harvest occurred early in the season, as over half the wild birds harvested were taken the first 2 days of the season.

Table 4. Summary of pheasant hunting data, 1972 and 1973, William L. Finley National Wildlife Refuge.

	1972	1973
Total birds stocked	600	700
Total birds harvested (as reported by hunters)	427	493
Calculated number of wild birds harvested	47	39
Calculated number of game farm birds harvested	380	454
Percentage of game farm birds harvested	63	65
Total birds checked at hunter check stands	228	236
Number of game farm birds checked	197	206
Number of wild cocks checked	31	30
Young:adult ratio of wild cocks	2.1:1	1.7:1

The 39 wild birds taken in 1973 represented 53 percent of the preseason cock population on the hunted portion of the Refuge, a lesser percentage than indicated by studies of a similar nature elsewhere (Table 5). This lower rate of harvest on the Refuge is most probably explained by the shape of the hunting area and its relative position to the non-hunted area. Seldom is a pheasant over 0.8 km from the non-hunted area, and birds could easily reach sanctuary on the western side of the refuge.

Table 5. A comparison of hunting pressure and percent harvest of wild cock pheasants for several different studies.

Location	Length of study	Gun hrs. per 100 acres	Percent of cocks killed	Reference
California (Sartain)	3 yrs	196	81	Harper et al. 1951
California (McManus)	2 yrs	192	80	Harper et al. 1951
Pelee Island	4 yrs	122	79	Stokes 1954
Wisconsin	13 yrs	no estimate	73	Wagner et al. 1965
Finley Refuge	2 yrs	119	53	This study

Hunting Mortality of Game Farm Cocks

The calculated number of game farm birds harvested (Table 4) was derived by subtracting the calculated number of wild birds harvested from the total birds harvested.

The percentage of game farm pheasants harvested (63 percent in 1972 and 65 percent in 1973) is similar to that found in other studies. The bulk of this harvest occurs shortly after release. In 1972 leg bands of different colors were used for each release. It was determined from a sample of 317 birds that the average length of time birds spent in the field before being taken by gunners was 1.7 days.

In addition to hunting mortality, at least three other primary sources of depletion immediately affect released cocks: crippling loss, death due to release shock, and predation. Crippling estimates are highly variable, but range from 5 to 30 percent of the total cocks in the bag (Harper et al. 1951, Stokes 1954). From a sample of 226 remains, Burger (1964) found that release shock accounted for as many deaths as shot wounds, and that predation accounted for the remaining deaths. Such losses are difficult to assess and were not monitored on the study area. However, a high percentage of birds not taken by hunters probably succumbed to one of these three causes before the end of the hunting season.

Disappearance Rate of Game Farm Cocks

The post-hunting season population of game farm cocks proved to be low, and no disappearance rate could be determined. A problem thought to be aggravating the scarcity of birds was the low observability of birds immediately following the hunting season, as noted by Fisher et al. (1947).

In the fall of 1972 approximately half of the game farm cocks in each release were wing-tagged and it was necessary to double the number of marked birds observed to obtain an adjusted number of game farm cocks on the study area. In November and December 1972, four searches, done largely by foot, were made of portions of

the study area. Eleven observations of cocks were made, four being game farm (adjusted figure). Later searches conducted from January through March 1973), resulted in 163 observations of cocks, only two which were of game farm origin (adjusted figure). It was known from trapping data collected in January and February that at least one other marked bird was present on the study area. In spring 1973, 360 observations of cocks were made. None were marked.

The following year, in an attempt to increase the sample size, an 8.5 km route was established and driven during a period immediately following the hunting season. Out of a total of 28 observations, four were of game farm origin. In the winter of 1973-74 one game farm cock was identified among 28 observations of cocks. In addition to this one surviving game farm bird, two others were trapped on the study area in January 1974. Of the 125 observations in spring 1974, none were marked.

Thus, only a few game farm cocks survived to winter and apparently none remained alive by the first spring following release.

Trapping

Trapping efforts were largely unrewarded (Table 6), and too few birds were marked to make significant conclusions about population size. In the winter of 1972-73 the success, 0.57 birds per trap

day, was encouraging and promised favorable results the following winter. Despite an increase in trap days, however, fewer birds were captured the second season, resulting in a success of 0.08 birds per trap day. A decreased population as well as a snowless winter may have accounted for the lower success. Difficulty in trapping pheasants in areas with mild winters or during snowless periods has also been noted in California (Hart et al. 1956) and in Wisconsin (Gates 1971).

Table 6. Pheasant trapping data, winter, 1972-73 and 1973-74, William L. Finley National Wildlife Refuge.

	Winter 1972-73	Winter 1973-74	Total
Trap days (number of traps x days opened)	45	85	130
Number of birds trapped	44	13	57
Number of birds retrapped	17	4	21
Wild birds marked	26	7	33
Success (Wild birds/trap day)	0.58	0.08	0.25
Game farm cocks trapped	1	2	3
Wild males trapped	16	6	23
Wild females trapped	10	1	11
Sex ratio of wild birds trapped (females/males)	0.59:1	0.17:1	0.48:1

Disappearance Rate of Game Farm Hens

On 2 April 1973, 148 marked hens, along with 57 unmarked cocks, were released on the study area. It was decided to group observations in 10-day periods. Although the same area was not covered each day, the area searched every 10 days was identical. A 19.5 km route was established and driven every other day over a 50-day period following the release. Only 22 observations of game farm hens were made, and the regression of released hens against time was not significant at the 95 percent level ($t = 1.729$, $r = -0.71$, $df = 3$). Apparently grouping of the data over 10-day periods proved to be a crude technique for detecting fluctuations in the population of game farm hens.

Over this same 50-day period, 70 observations of wild hens were made. These observations plotted against time resulted in a regression significant at the 97.5 level ($t = 4.503$, $r = -0.93$, $df = 3$). A disappearance rate of 5.5 birds every 10 days was calculated from the regression. This disappearance of wild hens is due primarily to the growth of cover and the initiation of nesting, although mortality may also be influencing the counts to some extent. Because significant data were not obtained from the released hens, disappearance rates could not be compared.

In the spring of 1974 an 18.1 km route was driven daily, there being no variation in the route from day to day. The release, made on 11 April 1974, consisted of 187 game farm hens, all marked.

Compared to the previous year, many more observations of game farm hens were made; 144 observations being made the first month after release. When observations were grouped in 2-day periods and plotted against time, a highly significant regression was obtained (Figure 2) ($t = 6.754$, $r = -0.90$, $df = 11$). The disappearance rate was 11.7 birds every 10 days, but because only eight observations of wild hens were made in the spring of 1974, the disappearance rate of game farm hens could not be compared to the disappearance rate of wild hens. If the disappearance rate of wild hens in 1973 (5.5 hens/10 days) is compared to the disappearance rate of game farm hens in 1974 (11.7 hens/10 days), the resulting difference, 6.2 birds every 10 days, should approach the mortality rate of game farm hens. This value appears to be low. A disappearance rate of 6.2 birds every 10 days would result in nearly half of the hens being alive 4 months after release. In fact few game farm hens were present 4 months after release.

Most of the hens disappeared within the first few days after release, after which a more gradual rate of decrease occurred (Figure 2). The linear regression averages losses over the

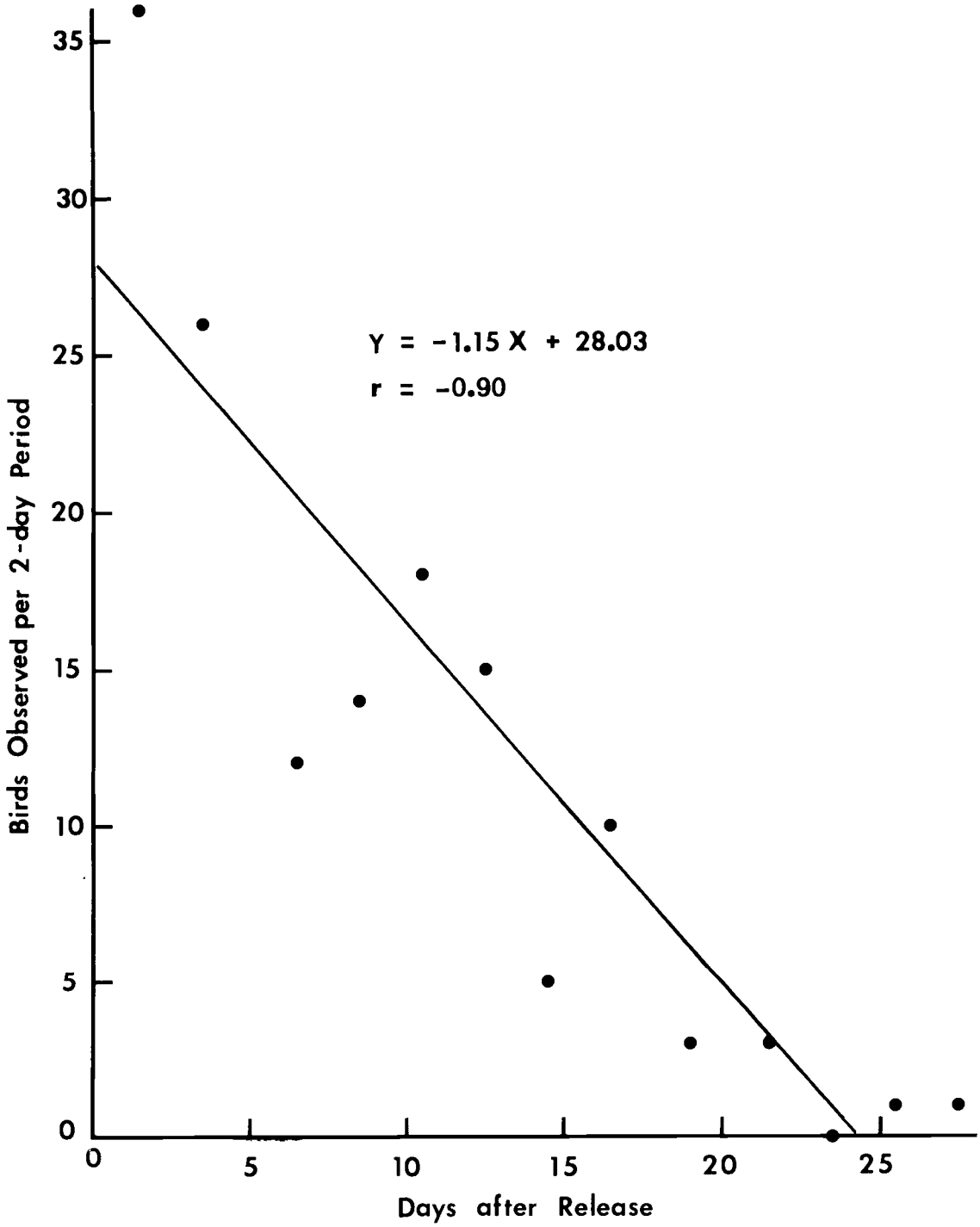

Figure 2. Relationship between the number of observations of game farm hens and days after release.

observation period and does not account for the heavy, nearly instantaneous losses suffered by game farm hens immediately after release.

Census of Pheasants in Summer

In 1974, 23 broods were found and identified on the basis of a difference in age, spatial distribution, or presence or absence of a wing tag on the hen. Of these 23 broods, three were with game farm hens, 16 were with wild hens, and four remained unidentified. It was assumed in later calculations that the four unidentified broods were of wild origin.

In 1973, when nearly twice as many hens and chicks were flushed as in 1974 (Table 7), identifying broods proved to be difficult. For this reason the 1974 brood per flushed chick ratio (0.29) was used to calculate the number of broods present in 1973. This calculation is based upon the assumption that an equal proportion of the total chicks present on the study area were flushed each year and that brood size was similar each year. The 1974 brood per chick ratio (0.29) times the number of chicks observed in 1973 (Table 7) results in an estimate of 41 broods on the study area in 1973.

Table 7. Pheasant observations with the use of dogs, summer, 1973 and 1974, William L. Finley National Wildlife Refuge.

		1973	1974
Males		84	31
Females:	wild	29	14
	game farm	0	4
Chicks:	wild	142	68
	game farm	0	13
Unidentified hens and/or chicks		26	4
Total observations		281	134

Production and survival of game farm hens proved to be minimal both years. Only one of the 148 hens released in 1973 was discovered. She had a brood of four chicks. Of the remaining 25 hens on which it was possible to determine the presence or absence of a wing tag, none had tags. In 1974, when 187 hens were released, four were found on the census. At least three of these birds raised broods. None of the other 22 hens on which it was possible to determine the presence or absence of a wing tag were marked. Depletion of the released hens was nearly complete within 4 months. It does appear, however, that the very few surviving game farm hens were just as successful as the wild hens in raising a brood.

Population Estimate in Summer

The number of wild broods on the study area (41 in 1973 and 20 in 1974) indicated that there were at least these numbers of wild hens present each summer. In addition to these successful wild hens, a portion of the hens observed were without broods, and should be included in the hen population estimate. Out of 25 observations of wild hens in 1973, six were without and 19 were with broods (a ratio of .32). Out of 22 observations of wild hens in 1974 three were without and 19 were with broods (a ratio of .16). The estimate of broodless hens on the study area would then be 13 hens (41 x .32) in 1973 and three hens (20 x .16) in 1974, resulting in a total hen population of 54 hens in 1973 (41 + 13) and 23 hens in 1974 (20 + 3). Assuming a 1:1 ratio of hens and cocks on the study area, an equal number of cocks as hens should be present on the study area each summer, yielding a total adult population of 108 and 46 in the summer of 1973 and 1974, respectively.

A method of testing the validity of the 1973 population estimate would be helpful, since it was based on a calculated number of broods rather than a discrete set of broods as in 1974. Since the 1974 population estimate is believed to be accurate, a ratio, total population to the number of birds flushed, may be established from which another 1973 population estimate can be derived. It must be assumed that an

equal proportion of the population was flushed each summer. This ratio for cocks in 1974 (0.74) times the 84 cocks flushed in 1973 (Table 7) results in an estimate of 62, 8 above the previous cock estimate. Such may well be the case, since the August sex ratio indicated slightly more cocks per hen in 1973 than in 1974, which would tend to increase the above estimate of cocks.

The ratio of the wild hen population to wild hens flushed in 1974 was 1.64. Thus, in 1973 when 29 wild hens were flushed (Table 7), the estimated hen population was 48 birds (1.64 x 29). This estimate is only 6 fewer than the original estimate of 54.

Fluctuation in Size of Population

Evidence based on roadside counts indicated a decrease in the wild pheasant population from 1973 to 1974. During 11 evening counts in the winter of 1972-73, an average of 6.36 birds were seen per trip. In the winter of 1973-74, after driving the same route 17 times, an average of only two birds were seen per trip, a reduction of 69 percent. Trapping success also indicated a decrease in population size, although the lower success in 1974 may be attributed to the snowless winter that year. In 1973, 0.58 birds were caught per trap day, while in 1974 there was an 86 percent reduction, and only 0.08 were caught per trap day.

Spring observations of wild hens were also greatly reduced in 1974. In 1973 an average of 2.3 hens were seen per trip during roadside sample censuses. This same area sampled 26 times in 1974 resulted in an average of 0.3 hens per trip, a reduction of 87 percent. Because 57 unmarked cocks were released in the spring of 1973, a comparison of cock observations between the two spring counts could not be made.

The estimates of the adult population made during each summer (108 in 1973 and 46 in 1974) indicate a reduction of 58 percent in 1974, and suggest that the other indices of population size overemphasized the decline in population

The reduction in population size was first evident during winter trapping and censuses in January, suggesting the decline had begun in fall. Heavy rainfall and flooding during the winter of 1973-74 was probably a major cause of this decline. To verify this hypothesis, the number of birds flushed during each summer was divided into those flushed east of Muddy Creek, an area nearly entirely flooded in the winter of 1973-74, and those flushed west of Muddy Creek, an area with a considerable amount of high ground. On the higher western portion of the study area, 118 birds were flushed in 1973 and 87 birds were flushed in 1974, a reduction of 26 percent. On the flooded eastern portion of the study area, 168 birds were flushed in 1973, while only 48 were flushed in 1974, a

reduction of 71 percent. The reduction in population was in fact disproportionately spread over the study area, with the greatest reduction occurring on the commonly flooded eastern side. This evidence suggests flooding negatively influenced the survival of pheasants during winter.

Recruitment

An initial summer production estimate (July - August) of wild birds was made by multiplying the wild chick to wild hen ratio by the estimated number of wild hens on the study area. The chick to hen ratio included all observations made with the use of dogs (Table 7). In 1973 the estimated production of young at 6 weeks of age was 265 chicks (4.9 x 54). Fewer than half as many were produced in 1974, when the estimated recruitment to 6 weeks of age was 113 chicks (4.9 x 23).

These estimates, including chicks and adults, yield densities of 26.5 birds/100 ha (10.8/100 acres) in 1973 and 11.3 birds/100 ha (4.6/100 acres) in 1974. Seasonally, these represent peak densities. It should be remembered that these densities pertain only to the 1407 ha study area, which consisted of higher quality pheasant habitat than surrounding countryside.

A second estimate of recruitment utilized age ratios from wild males obtained at hunter check stands and the adult preseason sex

ratio, a technique widely employed (Dale 1952, Stokes 1954, Wagner et al. 1965, Gates 1971). It is generally acknowledged that juvenile cocks are more readily shot than adults, a fact that could bias age ratios of harvested cocks (Kimball 1948, Wagner et al. 1965). However in heavily hunted areas the vulnerability of young and adult is nearly equivalent (Stokes 1954; Hart 1954) and the young:adult ratio from Finley Refuge is therefore thought to have little bias.

In 1973 the young;adult age ratio of harvested wild cocks was 1.7:1. Utilizing the 1:1 sex ratio of adult birds obtained in summer, each hen raised 1.7 young cocks or, assuming an equal number of young hens raised, 3.4 total young. Total production to late October was therefore 3.4 x 54 (estimated number of hens in summer, 1973), or 184 young. This estimate is 30 percent below the summer recruitment estimate, and may reflect mortality of chicks from the age of 6 weeks to the hunting season.

Recruitment: A Comparison with Other Areas

A commonly used index of productivity, the female age ratio, was compared from a number of studies to that obtained in this study (Table 8). The female age ratio on the study area was derived from age ratios of cocks obtained during the hunting season and the adult sex ratio. Age ratios of harvested wild cocks (young:adult) were 2.1:1 in 1972 and 1.7:1 in 1973 (Table 4). Utilizing the 1:1 adult sex

ratio, each adult hen produced 2.1 and 1.7 young cocks during each of these respective years. Assuming an equal number of young hens were produced, the female age ratio would then be 2.1:1 in 1972 and 1.7:1 in 1973, indicating that production per hen on the study area closely approximated that of other areas (Table 8).

Table 8. A comparison of wild hen age ratios from various pheasant study areas.

Area and years studied	Fall and/or winter hen age ratio (young per adult)	Reference
Pelee Is., Ont. 1946-50	2.2	Stokes 1954
California 1952-58	1.8	Harper 1960
Illinois 1947-48	2.5	Robertson 1958
South Dakota 1945-46	1.2	Kimball 1948
Utah 1953-54 and 1960-65	3.3	Stokes 1968
Wisconsin 1958-65	3.0	Gates 1971
Oregon 1972-73	1.9	This study

Although no female age ratio was calculated in the fall of 1974, when total pheasant recruitment was less than half that of 1973, chick per hen ratios were available for both 1973 and 1974. These were identical both years (4.9 chicks per hen), and indicated that production per hen remained as high in 1974 as in 1973 despite the drop in total recruitment.

The dramatic decrease in total recruitment can be attributed to a reduced breeding population rather than to decreased production per hen. Flooding appeared to strongly affect overwinter survival and was most likely the reason for this reduced breeding population. It was found in this study, as in a number of others (Stokes 1954, Ellis and Anderson 1963; Anderson 1964, Gates 1971), that in certain areas survival factors rather than variances in productivity are the probable factors influencing population fluctuations of pheasants.

LITERATURE CITED

Anderson, W. L. 1964. Survival and reproduction of pheasants released in southern Illinois. J. Wildl. Manage. 28(2):254-264.

Besadny, C. D., and F. H. Wagner. 1963. An evaluation of pheasant stocking through the day-old-chick program in Wisconsin. Wis. Conserv. Dept., Tech. Bull. No. 28. 84 pp.

Bohl, W. H. 1955. The survival of juvenile ring-necked pheasants on Eliza Island, Washington, during 1952. M.S. thesis. Oregon State Univ. 99 pp.

Burger, G. V. 1964. Survival of ring-necked pheasants released on a Wisconsin shooting preserve. J. Wildl. Manage. 28(4): 711-721.

Burger, G. V., and R. C. Oldenburg. 1972. Using pheasant band recoveries to evaluate habitat on shooting preserves. J. Wildl. Manage. 36(1):146-149.

Buss, I. O. 1946. Wisconsin pheasant populations. Wis. Conserv. Dept., Publ. 326, A-46. 184 pp.

Dale, F. H. 1952. Sex ratios in pheasant research and management. J. Wildl. Manage. 16(2):156-163.

Ellis, J. A., and W. L. Anderson. 1963. Attempts to establish pheasants in southern Illinois. J. Wildl. Manage. 27(2):225-239.

Environmental Data Service. 1973. Climatological Data. Oregon Vol. 79, No. 13. 17 pp.

Fisher, H. I., R. W. Hiatt, and W. Bergeson. 1947. The validity of the roadside census as applied to pheasants. J. Wildl. Manage. 11(3):205-226.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S. For. Serv., Pacific N.W. For. and Range Exp. Stn., Res. Pap. PNW-80. 417 pp.

Gates, J. M. 1971. The ecology of a Wisconsin pheasant population. Ph. D. Thesis. Univ. of Wisconsin. 912 pp.

Hansen, C. G. 1953. A nesting study of ring-necked pheasants with controlled predation on Eliza Island, Washington. Report submitted to Ore. Coop. Wildl. Res. Unit, Oregon State Univ. 40 pp.

Hanson, L. E., and D. R. Progulske. 1973. Movements and cover preferences of pheasants in South Dakota. J. Wildl. Manage. 37(4):454-461.

Harper, H. T. 1960. The effects of a three year limited hen season on pheasant populations in California, 1955-1957. Proc. Annu. Conf. Western Assoc. State Game and Fish Commissioners. 40:168-176.

Harper, H. T., C. M. Hart, and D. E. Shaffer. 1951. Effects of hunting pressure and game farm stocking on pheasant populations in the Sacramento Valley, California, 1946-1949. California Fish Game. 37(2):141-176.

Hart, C. M. 1954. Pheasant hunting pressures in California. Proc. Annu. Conf. Western Assoc. State Game and Fish Commissioners. 34:219-226.

Hart, C. M., B. Grading, and H. T. Harper. 1956. The pheasant in California. Pages 90-158 in D. L. Allen, ed. Pheasants in North America. The Stackpole Co., Harrisburg, Pa. 490 pp.

Kabat, C., F. M. Kozlik, D. R. Thompson, and F. H. Wagner. 1955. Evaluation of stocking breeder hen and immature cock pheasants on Wisconsin public hunting grounds. Wis. Conserv. Dept., Tech. Wildl. Bull. No. 11. 58 pp.

Kimball, J. W. 1948. Pheasant population characteristics and trends in the Dakotas. Trans. North Am. Wildl. Conf. 13:291-314.

Kuck, T. L., R. B. Dahlgren, and D. R. Progulske. 1970. Movements and behavior of hen pheasants during the nesting season. J. Wildl. Manage. 34(3):626-630.

Kutz, H. L. 1945. An improved game bird trap. J. Wildl. Manage. 9(1):35-38.

Labisky, R. F., and S. H. Mann. 1962. Backtag markers for pheasants. J. Wildl. Manage. 26(4):393-399.

Lauckhart, J. B., and J. W. McKean. 1956. Chinese pheasants in the Northwest. Pages 43-89 in D. L. Allen, ed. Pheasants in North America. The Stackpole Co., Harrisburg, Pa. 490 pp.

Leopold, A., O. S. Lee, and H. G. Anderson. 1938. Wisconsin pheasant movement study, 1936-37. J. Wildl. Manage 2(1): 3-12.

Linduska, J. P. 1943. A gross study of the bursa of Fabricius and cock spurs as age indicators in the ring-necked pheasant. Auk 60(3):426-437.

MacNamara, L. G. and E. L. Kozicky. 1949. Band returns from male ring-necked pheasants in New Jersey. J. Wildl. Manage. 13(3):286-294.

Minnesota Division of Game and Fish, Game Research Unit. 1965. Aging guide for juvenile pheasants. Madelia, Minn. Unpublished.

Oregon State Game Commission. 1951. Annual report-game division. Ore. St. Game Comm., Portland. 139 pp.

Overton, S. W., and D. E. Davis. 1969. Estimating the numbers of animals in wildlife populations. Pages 403-455 in R. H. Giles, ed. Wildlife Management Techniques, 3rd ed. The Wildl. Soc., Wash., D. C. 623 pp.

Potter, D. R., J. C. Hendee, and L. E. Evison. 1973. Hunters at regulated plant-and-shoot pheasant areas in western Washington. USDA For. Serv. Res. Pap. PNW-160. 30 pp.

Robertson, W. B., Jr. 1958. Investigations of ring-necked pheasants in Illinois. Ill. Dept. Conserv. Tech. Bull. No. 1. 137 pp.

Salter, R. L. 1949. Survival and increment of an early spring release of ring-necked pheasants on Eliza Island, Washington. M.S. Thesis. Oregon State Univ. 74 pp.

Stokes, A. W. 1954. Population studies of the ring-necked pheasants on Pelee Island, Ontario. Ont. Dept. of Lands and For., Tech. Bull. Wildl. Series No. 4. 154 pp.

Stokes, A. W. 1968. An eight-year study of a northern Utah pheasant population. J. Wildl. Manage. 32(4):867-874.

Wagner, F. H., C. D. Besadny, and C. Kabat. 1965. Population ecology and management of Wisconsin pheasants. Wis. Conserv. Dept., Tech. Wildl. Bull. No. 34. 168 pp.

Wick, W. Q. 1952. The winter mortality and movement of wild and game-farm ring-necked pheasants on Eliza Island, Washington. M.S. Thesis. Oregon State Univ. 63 pp.