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Pheasant Production Using Wild Cocks and Penned Game-Farm Hens

Michael R. Grode

PHEASANT PRODUCTION USING WILD COCKS AND PENNED GAME-FARM HENS

By

Michael R. Grode

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PHEASANT PRODUCTION USING WILD COCKS

AND PENNED GAME-FARM HENS

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Raymond L. Linder — May 2, 1972
Thesis Advisor — Date

Donald R. Progulske — May 2, 1972
Head — Date
Department of Wildlife and
Fisheries Sciences

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PHEASANT PRODUCTION USING WILD COCKS AND PENNED GAME-FARM HENS

Abstract

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Pheasant production using free-flying wild cocks and penned game-farm hens was evaluated during 1971. Hens were placed in 0.5-acre pens to compare production at density levels of 10, 20 and 40 hens per acre. Wild cocks entered the 0.5-acre pens the day following introduction of the game-farm hens. The greatest numbers of cocks were observed in the pens with the highest density of hens. Censusing in mid-March indicated a population of 12 to 15 wild cocks in the vicinity of the study pens. A known mortality of 31 hens occurred and percentage mortality was similar at each density level. Pulling of the primary wing feathers allowed a successful hen to leave the pen with her brood soon after hatching. Eighty-six percent of all eggs laid were placed in nests. Average clutch size for all nests was 9.7 eggs and for incubated nests 10.2 eggs. Of 213 nests established, 90 percent were incubated. Hens laid an average of 17.1 eggs per hen. The average fertility of eggs was 48 percent and hatchability was 13 percent. Eleven percent of the nests established were successful and 126 young were produced, an average of 0.9 young per hen. The average cost per chick produced was $11.99. Peak hatching occurred from June 1-8; an average brood size of 5.5 chicks was produced. A higher proportion of nests was located in alfalfa than in warm-season grasses

when a choice was available. Incident light readings were lower and density of vegetation was higher in alfalfa than in warm-season grasses. Pheasants were produced by using wild cocks and penned game-farm hens; however, this method of raising pheasants is economically unsound unless a higher rate of reproduction can be attained.

INTRODUCTION

The ring-necked pheasant (*Phasianus colchicus*) is the most important species of upland game bird in Nebraska (Linder et al. 1960). The present pheasant population in the state grew from the release of about 500 pairs between 1915 and 1925 (Mohler 1960). Peak pheasant populations were reached in the early 1940's, followed by a gradual decline to the present time.

Loss of available nesting cover coupled with low nesting success in areas of intensified agriculture during the nesting season has contributed in part to this decline (Mohler 1960). Linder et al. (1960), in an analysis of pheasant nesting in south-central Nebraska, found that 37.2 percent of all nests established were destroyed by farming operations, including 22.2 percent by alfalfa mowing. Nesting losses on private lands due to agricultural operations have also been reported in many other midwestern states (Dustman 1950, Baskett 1947, Fischer 1954, Trautman 1960, Gates 1966, and Elliott 1970).

In an effort to compensate for the loss of nesting cover and low reproductive success in areas of intensified agriculture, a study involving the use of wild cocks and game-farm hens confined to 0.5-acre pens was conducted during the summer of 1971. The basic concept of raising game birds under semi-confined conditions was used in Virginia for producing turkeys (Mosby and Handley 1943). They put 15-20 hen turkeys in a 1-acre, open-top pen enclosed by wire where native wild gobblers were enticed into the enclosures for mating.

Confinement of hens in pens and utilization of native wild cocks for natural insemination offers several advantages: (1) hens are afforded protection from predation and agricultural operations during the nesting season, (2) the amount of nesting cover required to produce a given number of birds is less than in land intensively farmed, and (3) chicks produced by mating game-farm hens with wild cocks retain wild characteristics.

The objective of this study was to determine the biologic and economic feasibility of mating wild cocks with penned game-farm hens for pheasant production in areas of deficient nesting cover in south-central Nebraska.

DESCRIPTION OF THE STUDY AREA

The study was conducted in 1971 on the Cornhusker Game Management Area, Hall County, Nebraska, established in 1964 from surplus Federal lands purchased by the State of Nebraska in 1962 (Fig. 1). The area is comprised of three tracts of land totaling 815 acres.

The study area lies within the Platte River Valley. Topography is nearly level to gently undulating. Silt loams of the Hord, Hall, and Wood River series comprise the soils of the area (Yost et al. 1962). Intense farming of row crops is practiced on leveled, irrigated land surrounding the study area.

Hall County has a typical continental climate with wide seasonal variations. Summers are warm with strong south and southeasterly winds while winters are long and cold, with predominating winds from the north and northwest. Precipitation averages 24.6 inches annually, occurring mostly as thundershowers from April to September. Average annual air temperatures range from 26 F in the winter to 75 F in the summer.

Vegetation on the area consisted primarily of perennials such as alfalfa (*Medicago* sp.), little bluestem (*Andropogon scoparius*), Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). During the month of July, annuals began to appear among the perennial grasses and along the fence borders. Predominant among the annuals were sunflowers (*Helianthus* spp.), squirreltail (*Hordeum jubatum*),

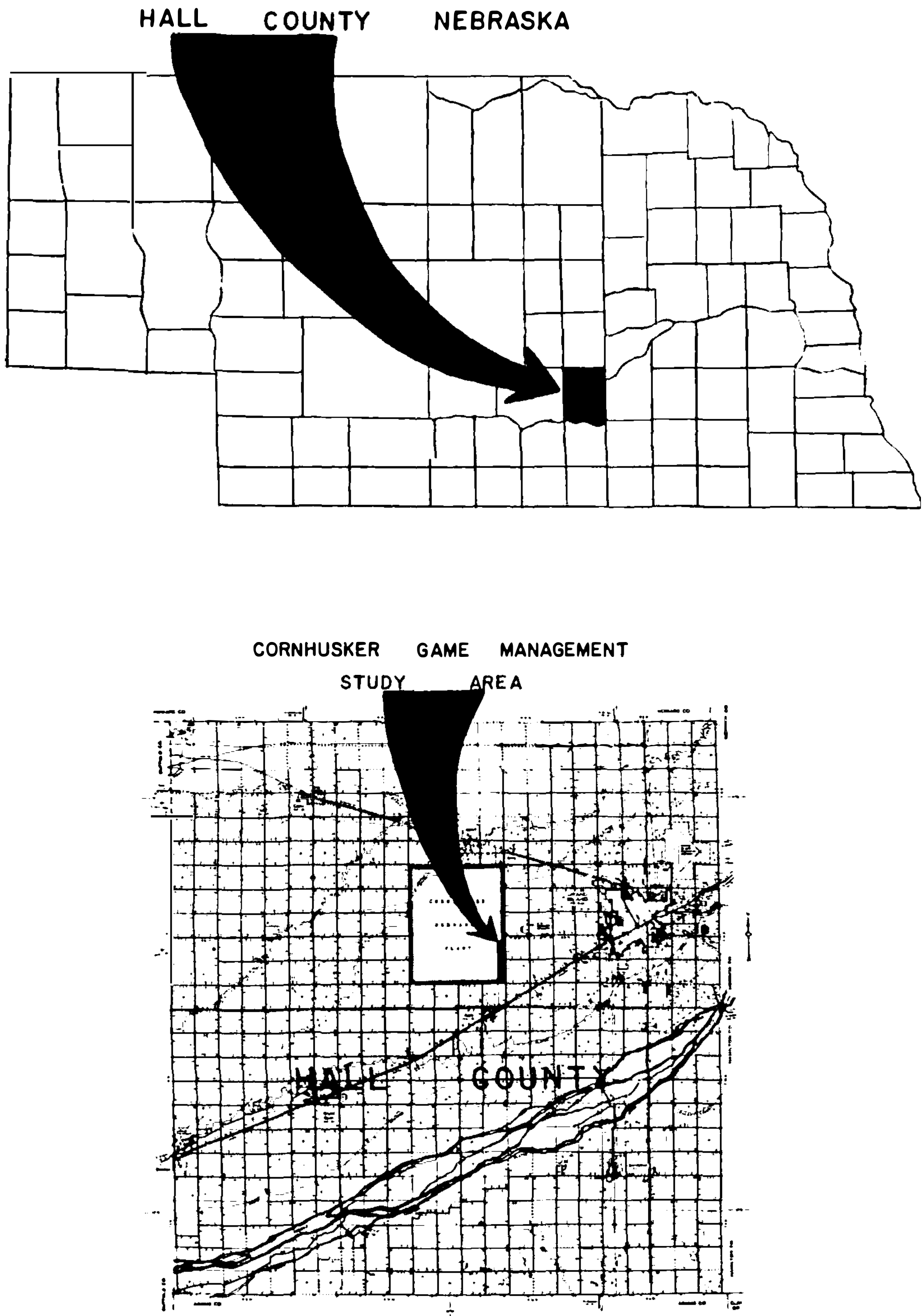


Fig. 1. Location of Cornhusker Game Management Study Area.

fireweed (*Kochia* sp.), cheatgrass (*Bromus tectorum*), perennial sow thistle (*Sonchus arvensis*), prickly lettuce (*Lactuca virosa*), and wild flax (*Coreopsis tinctoria*).

MATERIALS AND METHODS

Six 1-acre pen sites of suitable nesting cover were selected in the fall of 1970. Three pens were located on the north half of the study area and three on the south half (Fig. 2). To facilitate analysis of the experiment, each pen was divided in half, resulting in twelve 0.5-acre pens. Stocking densities were randomly assigned to each pair of 0.5-acre pens for both locations.

Pen construction was begun in the spring of 1971. Two-inch mesh poultry netting, 6 feet in height, was erected around each 1-acre plot. To discourage mammalian predators, the netting was buried 8-12 inches in trenches dug the previous fall. Similar netting, 5 feet in height, was used to divide each pen in half. Six-foot steel posts were used to support the netting. To permit ingress of wild cocks, tops of pens were left open.

One-year-old game-farm hens purchased from the Cordova Game Farm, Cordova, Nebraska, were stocked at rates of 10, 20 and 40 hens per acre on April 19 and 20. Birds were randomly assigned to pen location and density level (Fig. 2). Hens were identified by varying combinations of metal bands, plastic bands, and patagial markers (Fig. 3). The patagial markers consisted of Safflag strips $4 \frac{1}{2} \times \frac{3}{4}$ inches attached to the patagium with a metal band. To render the hens flightless for approximately 5 weeks, the primaries of the unmarked wing were removed by pulling (Fig. 4). This technique was chosen over other methods because the flightless interval allowed sufficient

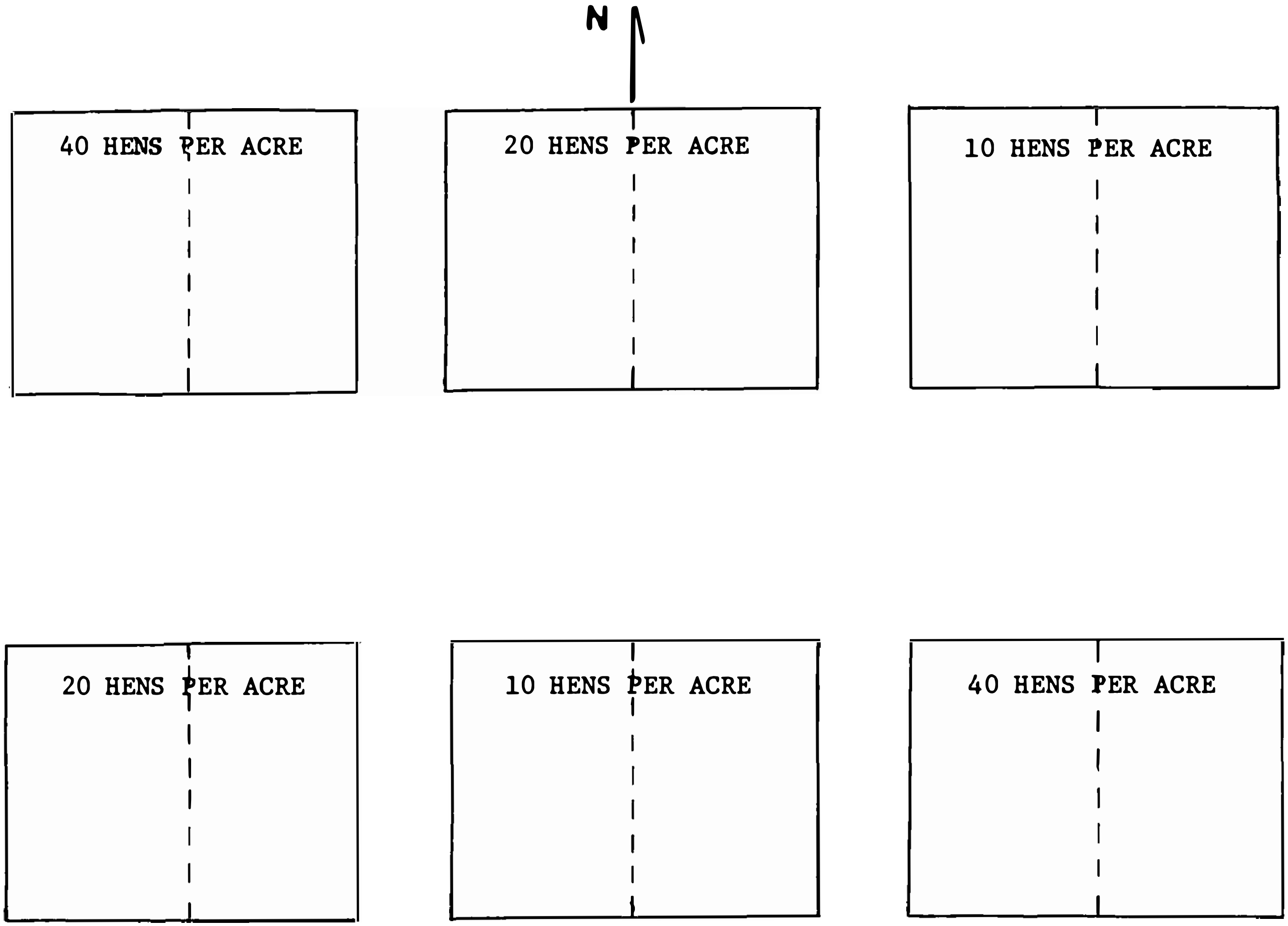


Fig. 2. Arrangement of pens showing density of hens in each pen.

time for nesting and breeding to occur. The hen was able to leave the pen with her brood immediately after hatching. It was desirable to have the hens leave the pen soon after hatching, thus circumventing potential problems common to high-density populations, such as high chick mortalities and nest abandonment due to the presence of chicks hatched by other hens. High chick mortalities due to pecking have been reported in high-density populations under pen conditions (Kessler 1953). Linder and Agee (1965) proposed that nest abandonment may occur when an incubating hen is subjected to the presence of chicks hatched by other hens.

Feeders with 200-pound capacity and 8-gallon water fonts were placed in each pen. Hens were fed and watered at weekly intervals depending upon weather conditions. During rainy periods, feed was changed daily to prevent spoilage. High-protein mash and oyster shells were used to supplement the natural food supply in the pens.

Observations to determine cock response to penned game-farm hens began immediately after introduction of the hens and continued until May 24. Observations were made for 1 day on the north pens and the next day on the south pens except on rainy days during which no observations were made. A 20X to 60X spotting scope was used to observe cock behavior during the observation period beginning 1 hour before sunrise and ending 1 to 1½ hours after sunrise. Visual observations with the scope were made from a distance of 200 to 250 yards. Sound observations were used at distances of 20 yards or less. Using both vision and sound, the number of cocks in each pen and on the outside borders was ascertained.

Fig. 3. Patagial markers were used to identify hens at each density.

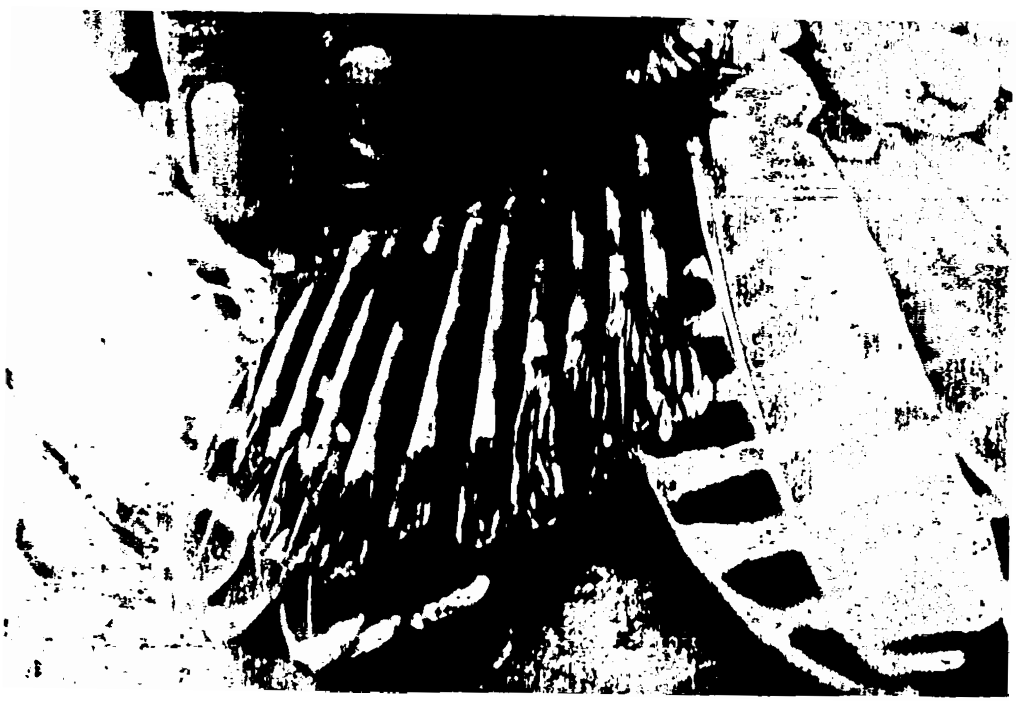


Fig. 4. Regrowth of feathers 2 weeks after primaries were pulled.

Observations of crowing cocks in mid-March indicated a population of 12-15 cocks in the vicinity of the study pens. Triangulation was used to locate each crowing cock. Crowing counts taken during late April and early May averaged 30-35 calls per 2-minute interval at the pen sites.

Brood observations were made from ½ hour before sunrise to ½ hour after sunrise by driving slowly around the perimeter of each set of three pens between May 25 and July 13. Location, size, and age of each brood observed was recorded.

To evaluate production within the pens a nest search was conducted July 13-15. Each pen was methodically searched in east-west swaths by searchers using sticks to part the dense vegetation (Fig. 5). Colored flags were used to identify successful or unsuccessful nests and dropped eggs. Dropped eggs were gathered during the first 3 weeks of the study to reduce avian predation. One or more eggs in a nest form was considered a nest (Linder et al. 1960). Eggs located within 0.5 meter of a nest were considered to be associated with that nest. The location of each nest was measured from the nearest border and plotted on graph paper. The cover type and number of hatched or unhatched eggs in each nest were recorded. Unhatched eggs were gathered, opened, and their fertility determined by visual inspection.

Nesting vegetation was analyzed using a cover-board (Sisson 1968) and a Sekonic Model S light meter (Fig. 6). The cover-board is a 1 meter x 1 meter black surface made up of 20 vertical strips of plywood 5 centimeters wide and 1 meter long joined by a tongue and

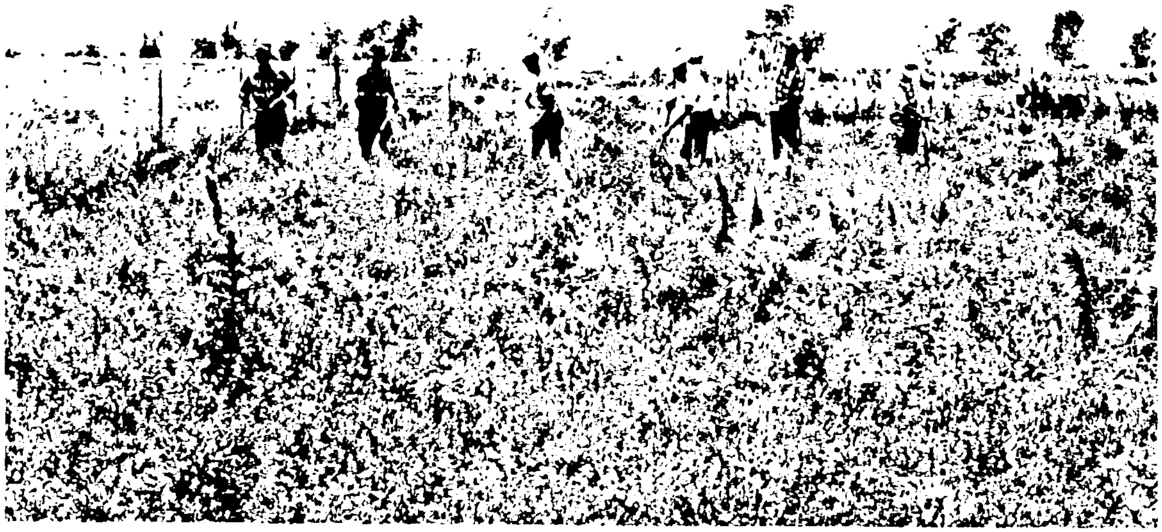


Fig. 5. Nests were located by a thorough search through the vegetation.

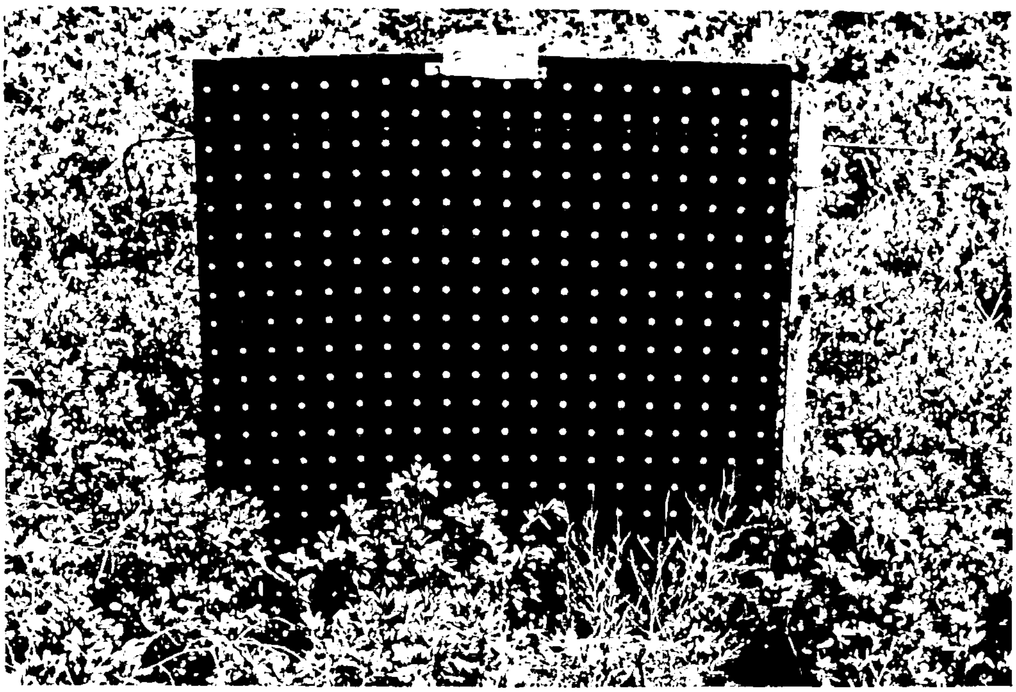


Fig. 6. Vegetation was analyzed by recording the number of dots obscured on the cover board.

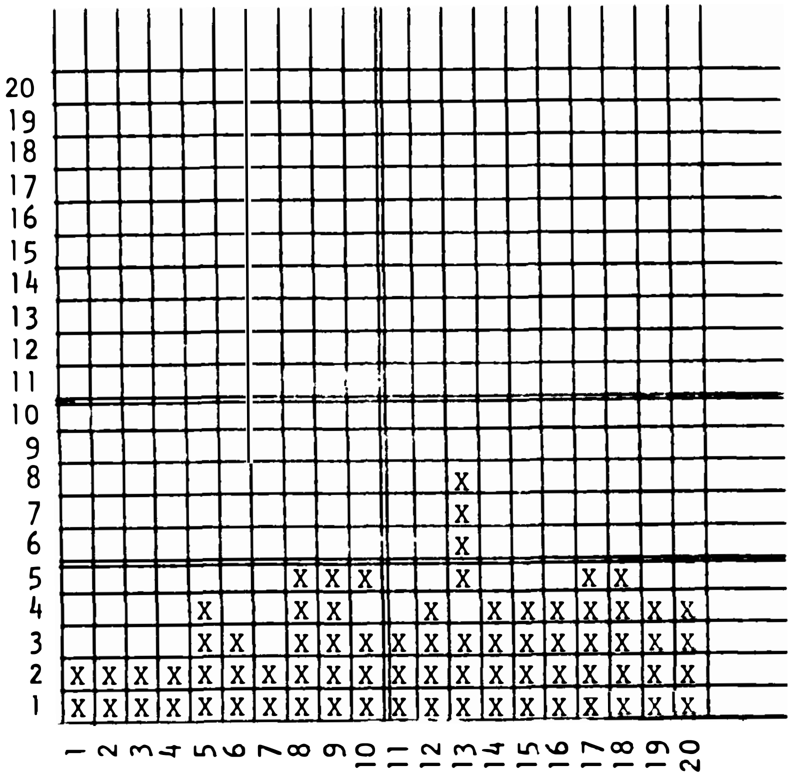
groove to allow the cover-board to conform to a slope. Reference dots (white thumbtacks) were spaced 5 centimeters apart vertically and horizontally.

North-south transects were established using four markers placed at 30-meter intervals, with the first being placed 3.2 meters east of the center fence. The vegetation was recorded by placing the cover-board near the marker and photographing the vegetation in front from a distance of 3 meters. Slides were then developed, projected on a screen, and the number of dots obscured on the bottom half of the cover-board was counted.

Dots obscured by vegetation (hits) were recorded on a grid chart simulating the cover board. To calculate a density index, a contour line was drawn following the highest vertical dots hit in each column. Average height was estimated by summing all dots (hits and non-hits) falling under this line and dividing by the number of columns with a hit. The total number of hits was then divided by the average height giving a density index (Fig. 7).

Incident light was measured at the base and top of the most dense vegetation immediately in front of the board. Readings were recorded in footcandles.

Location South
Pen Density 20
Photo Number 3



Sum of Squares 77
Number of Columns Hit 20
Average Height = $\frac{\text{Sum of Squares}}{\text{No. Cols. Hit}}$ 3.85
Total Dots Hit 75
Density Index = $\frac{\text{Total Dots Hit}}{\text{Average Height}}$ 19.48

Fig. 7. Example of density index calculation.

RESULTS AND DISCUSSION

Response of Wild Cocks to Penned Hens

Cocks responded to the penned game-farm hens by entering the pens the day following introduction of the hens. Cocks were initially attracted to the high-density pens but were observed in all pens within a week. During the 5-week observation period, the high-density pens attracted the greatest number of cocks. Observations of 59 cocks were made in the high-density pens compared to 41 observations in the medium-density and 31 observations in the low-density pens (Table 1). The number of cocks observed varied each day, but more than one cock per 0.5-acre pen was seldom observed. Few confrontations occurred between cocks. The concealment afforded by the dense vegetation and the presence of fence boundaries appeared to limit the size of a cock's territory and subsequently reduced confrontations between cocks. On several occasions cocks were seen in close proximity to one another on opposite sides of the center fence, but no confrontation was observed.

Cocks entered the pens in late evening and early morning, remaining as long as they were not disturbed. Once inside the pens, cocks began crowing and displaying. Cocks also displayed along the outside border of the pen with the hens of their harems nearby on the opposite side of the fence. Courtship activity was most predominant in open areas and areas of short vegetation. In Wisconsin, Taber (1949) reported similar results in his study on the breeding behavior of the ring-necked pheasant.

Harem formation was noted by the end of the first week. The peak of breeding activity occurred following introduction of hens

Table 1. Number of cocks responding to confined game-farm hens during a 5-week observation period.

DENSITY (hens per acre)	NORTH				SOUTH			
	Days Observed	Days Cocks Observed	Number of Cocks Observed: In Pen	Number of Cocks Observed: Outside Border	Days Observed	Days Cocks Observed	Number of Cocks Observed: In Pen	Number of Cocks Observed: Outside Border
10 east	23	11	10	1	26	9	6	3
10 west	23	4	2	2	26	7	5	2
20 east	23	8	6	2	26	11	8	3
20 west	23	6	6	0	26	15	11	5
40 east	23	11	12	0	26	24	17	8
40 west	23	9	7	4	26	14	8	3
Total	23	--	43	9	26	--	55	24

through the first week of May. Observations were terminated May 24 because breeding activity declined and visibility was reduced by vegetation.

Mortality of Game-Farm Hens

A known mortality of 31 birds occurred during the study period (Table 2). The percentage of hens lost at each of the three density levels was relatively constant with 25, 20 and 23 percent mortality in the pens with 10, 20 and 40 hens per acre, respectively. Loss of hens inside the pens was minimal; the greatest loss occurred after the hens had left the pens. Eight birds were lost within the pens; four being lost to red-tail hawks (*Buteo jamaicensis*), and four to undetermined causes. The remaining 23 birds were lost outside of the pens to mammalian predators and undetermined causes.

Brood Observations

Broods were observed to leave the pen by 1 week of age and no chick mortality was observed within the pens. From these observations, it appeared that pulling the primary wing feathers allowed the hens to leave the pens soon after the eggs hatched.

Hatching dates, calculated by backdating from the ages of broods observed, indicated an initial hatch date of May 25 and a final hatch date of July 12. The peak occurred from June 1-8, with an average of 5.5 chicks per brood observed. Using an average laying rate of 1.3 eggs per day (Buss et al. 1951), an incubation period of 23 days, and

Table 2. Mortality of game-farm hens confined to 0.5-acre pens.

DENSITY (hens per acre)	NUMBER OF BIRDS LOST			NUMBER OF BIRDS LOST BY		
	Total	In Pen	Out of Pen	Mammalian Predation	Avian Predation	Undetermined
10	5	1	4	4	1	0
20	8	2	6	2	1	5
40	18	5	13	10	2	6
Total	31	8	23	16	4	11

an average clutch size of 10 eggs, the peak period of nest initiation was determined to have occurred from May 8-16.

Egg Production

Hens produced 2,392 eggs for an average of 17.1 eggs per hen (Table 3, Appendix Table A). This figure compares closely with the average of 21 eggs per hen reported by Kabat and Thompson (1963) in their pen studies of breeding behavior in young and old hens. However, other pen studies have reported higher rates of egg laying. In Wisconsin, Buss et al. (1951) found that 11 hens confined in large pens laid an average of 34 eggs. Seubert (1952), working with penned birds, reported an average of 32.6 eggs per hen for the 1951 nesting season. The disparity in laying rates between this study and those previously mentioned is probably due to the shorter length of time hens in this study were confined to pens. An analysis of variance showed no significant difference ($P > 0.05$) in egg production per hen between density levels.

The average clutch size for all nests was 9.7 eggs (Table 3). The highest-density pens had the largest number of eggs per nest, 11.2. A higher proportion of communal nesting with fewer nests being established is probably the reason for the larger clutch size in the highest-density pens. An average of 1.3 nests per hen was established in the highest-density pens compared with 1.9 and 1.8 at other density levels. On Protection Island, Einarsen (1945) noted an increase of laying in dump nests associated with an increased

Table 3. Egg production of game-farm hens confined to 0.5-acre pens.

DENSITY (hens per acre)	NUMBER OF EGGS Total	In Nests	Per Nest	Dropped	Destroyed	Per Hen
10	345	311	8.4	27	20	17.3
20	743	614	8.2	111	18	18.6
40	1304	1136	11.2	121	34	16.3
All Densities Combined	2392	2061	9.7	259	72	17.1

population density. In Ohio, Seubert (1952) reported a lower number of nests in high-density populations due to an increase in early dump nests.

Eggs located in nests comprised 86 percent of all eggs produced (Table 4, Appendix Table B). Although a greater percentage of eggs were placed in nests by hens in the lowest-density pens in comparison with those in the other densities, the average clutch size was smaller than that of those in the highest-density pens. The greater percentage of eggs within nests is probably due to a lower total percentage of dropped eggs and destroyed eggs in the lower-density pens than in those with higher densities of hens. The 11 percent average for dropped eggs is conservative in that it includes only eggs laid singly and not associated with a nest. Crows (Corvus brachyrhynchos) destroyed a constant percentage of eggs in pens at each density level.

Of the 213 nests established, 192 (90 percent) were incubated (Table 5, Appendix Table C). The 10 percent of nests unincubated were most likely nests established early in the nesting season. Kabat et al. (1948) reported that wild hens typically lay eggs at random and desert one or two nests before laying a clutch and incubating it. Voluntary abandonment of nests early in the laying period could also account for the larger average clutch size in incubated nests compared to the average clutch size for all nests (Tables 4 and 5).

Fertility of eggs ranged from 45 to 52 percent with an average of 48 percent. In comparison to fertility in wild and captive birds

Table 4. Status of eggs found during the nesting season.

DENSITY (hens per acre)	EGGS Total	Percent In Nest	Percent Dropped	Percent Destroyed
10	345	90	8	2
20	743	83	15	2
40	1304	87	8	5
All Densities Combined	2392	86	11	3

this figure is quite low. An insufficient number of wild cocks for successful insemination of the hens could explain the low fertility. However, the number of cocks observed in the pens would indicate otherwise. A more plausible explanation is that eggs containing embryos dying in early incubation cannot be distinguished from infertile eggs (Seubert 1952). Fertile unincubated eggs are also impossible to distinguish from infertile eggs after being exposed to the weather. Lack of embryo development and decomposition within the egg make fertility determination extremely difficult. Under conditions of this study, determination of fertility by the presence of visible development within the egg gave a minimal estimate. Laying of infertile eggs by hens prior to fertilization by cocks may have also lowered the fertility estimate. Undoubtedly there were more fertile eggs than detected. No significant difference ($P > 0.05$) in fertility was found between density levels.

The average hatchability was 13 percent for fertile eggs and 5 percent for all eggs. Hatchability in both instances declined with increasing density (Table 5).

Nesting and Hatching Success

A total of 213 nests was established for an average of 1.5 nests per hen (Table 6, Appendix Table D). On a per-acre basis, this is equivalent to 35.5 nests per acre. Of the 213 nests established, 23 or 11 percent were successful. Although an 11 percent success rate is low, success rates below 30 percent are not uncommon; Baskett

Table 5. Fertility and hatchability of eggs found in nests incubated by game-farm hens.

Density (hens per acre)	NESTS Total	NESTS Number Incubated	EGGS Total	EGGS Per Nest	EGGS Percent Fertile	EGGS Percent Fertile Hatched	EGGS Percent All Eggs Hatched
10	37	33	303	9.2	45	25	10
20	75	68	589	8.7	52	14	6
40	101	91	1065	11.7	47	10	4
All Densities Combined	213	192	1957	10.2	48	13	5

(1947) 25 percent, Gates (1966) 29 percent, Hamerstrom (1936) 23 percent, and Randall (1940) 20 percent.

Sixteen percent of the hens were successful and 126 chicks were produced, an average of 0.9 young per hen (Table 6). The average brood size for successful hens was 5.5 young. Basing young per hen on the original hen population does not allow for hen mortality and those hens leaving the pens without a brood. Since hens were capable of flight 4 to 5 weeks following their introduction, it is conceivable that hens which left the pen without raising a brood may have nested and reared a brood outside of the pen. Hens which left the pens early in the nesting season were often seen with cocks on the study area. The low rate of reproduction might also be explained by the age of hens. Kabat and Thompson (1963) observed that hen pheasants in their second or later breeding season were reproductively superior to hens in their first breeding season. They found that older hens built more nests, laid more eggs in nests, and had 40 percent more successful clutches than young hens. Since the hens used in this study were 1-year-old, a low reproductive capacity and reduced fidelity to the nest may have influenced the rate of reproduction.

The lower nesting effort of 1-year-old hens appears to be conducive to nest abandonment under high densities. Stokes (1954) found that nest abandonment increased with increasing density on Pelee Island. Other workers (Gates 1971 and Linder et al. 1960) have also reported similar results. With a fertility of 48 percent, production should have exceeded 0.9 young per hen. Of 213 nests

Table 6. Nesting and chick production by game-farm hens confined to four 0.5-acre pens for each density.

DENSITY (hens per acre)	NUMBER OF NESTS			PERCENT OF HENS SUCCESSFUL	NUMBER OF CHICKS		
	Total	Per Hen	Successful		Total	Per Successful Hen	Per Hen
10	37	1.9	6	30	34	5.7	1.7
20	75	1.9	7	18	44	6.3	1.1
40	101	1.3	10	13	48	4.8	0.6
All Densities Combined	213	1.5	23	16	126	5.5	0.9

established, 192 were incubated for sufficient time to detect at least one fertile egg. However, only 23 of these nests hatched successfully. It would seem most plausible to assume that nest abandonment by the 1-year-old game-farm hens during early incubation was responsible for the low rate of reproduction.

Nesting Vegetation

Nesting cover was analyzed only in the south pens. Vegetation was comprised of 50 percent warm-season grasses and 50 percent alfalfa with the warm-season grasses located in the north half of the pen and the alfalfa in the south half. The chief warm-season grasses were little bluestem (*Andropogon scoparius*), Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). A summary of nesting cover, incident light measurements, and density indices can be found in Appendix Table E. Incident light measurements and density indices were taken from data gathered on May 8 to correspond with peak nesting. Incident light measurements were recorded on sunny days where incident light at the top of the vegetation was 7500 footcandles.

Eighty-nine nests were established in alfalfa compared to 10 in warm-season grasses (Table 7); an analysis of variance showed this to be a highly significant difference ($P < 0.01$).

Other research has shown that fencerows, roadsides, and legumes had a higher proportion of nests than other cover types (Kozicky and Hendrickson 1956, Stokes 1954, Trautman et al. 1959, and Gates and

Table 7. Characteristics of vegetation used for nesting by game-farm hens in the south 0.5-acre pens.

DENSITY (hens per acre)	NUMBER OF NESTS		INCIDENT LIGHT (footcandles)[a]		DENSITY INDEX	
	Alfalfa	Warm Season Grass	Alfalfa	Warm Season Grass	Alfalfa	Warm Season Grass
10	14	4	510	2370	17.3	12.5
20	34	1	525	5850	17.7	5.4
40	41	5	615	1875	19.7	16.8
All Densities Combined	89	10	550	3365	18.2	11.6

[a] Measured on the ground at the base of the plant.

Ostrom 1966). Within these preferred cover types, summertime maximum temperatures and saturation deficits remain lower than in other cover types (Francis 1968). Alfalfa exhibited a much lower incident light reading and higher density index than the warm-season grasses (Table 7). Alfalfa has a dense vegetative structure which allows minimum light penetration resulting in a lower temperature and saturation deficit in the nesting environment. When given a choice, pheasant hens are more prone to select nesting vegetation with a microclimate having these characteristics.

Cost of Young Produced

Total expenditures for labor, birds, and materials were used to arrive at a cost per young produced by the game-farm hens. Labor, estimated at $1.60 per hour, included time spent constructing the pens and caring for the birds. Time consumed in scientific observation and data gathering were not included. Game-farm hens were purchased at $3.50 each. The cost of pen materials was amortized over a 5-year period. The average cost per chick was $11.99 (Table 8). The highest cost per bird, $14.44, was in the highest-density level. The cost for rearing birds via this method is considerably greater than the cost incurred in most game farm operations. Workers in Ohio reported a cost of approximately $2.00 per bird, while in Illinois, McCabe et al. (1956) reported a cost range of $0.90 - $1.10 per bird. Besadny and Wagner (1963) gave a cost of $1.03 per chick released in the day-old chick program in Wisconsin. In light of the low number

Table 8. Production cost of young produced by game-farm hens confined to 0.5-acre pens.

DENSITY (hens per acre)	TOTAL COST	YOUNG PRODUCED	COST PER YOUNG PRODUCED
10	351.66	34	10.34
20	465.52	44	10.58
40	693.24	48	14.44
All Densities Combined	1510.42	126	11.99

of chicks produced and resultant high cost per chick produced, this technique appears to be economically unfeasible unless a higher rate of reproduction can be attained.

SUMMARY AND CONCLUSIONS

Wild native cocks entered the 0.5-acre enclosures the day following introduction of the game-farm hens. Although the greatest number of cocks was observed in the high-density pens, cocks were observed in all pens during the study. Confrontations between cocks were probably reduced due to concealment by the dense vegetation and fence boundaries. Peak breeding in the pens occurred from April 20 to May 10.

Mortality of hens was greatest after they had left the pens. A constant percentage of hens was lost in each of the three densities.

Regrowth of primary flight feathers that had been pulled allowed hens with broods to leave the pen within 1 week after hatching. Peak nesting occurred between May 8 and May 16; the largest number of broods hatched during the first week of June.

No significant difference ($P > 0.05$) was found in egg production per hen between density levels. Communal nesting and a large percentage of dropped eggs in the pens with 40 hens per acre resulted in a larger number of eggs per nest but a lower percentage of eggs laid in nests. The percentage of egg destruction by avian predators was similar in all densities.

Ninety percent of all clutches established had been incubated and incubated clutches contained more eggs than unincubated clutches. Egg fertility was lower than that found in the wild. Inability to detect fertility in decomposing eggs and eggs lacking sufficient embryo development to be seen caused an underestimate of the fertility rate. Rate of fertility did not vary significantly ($P > 0.05$) between density levels.

Relatively few eggs hatched. Less than one chick per hen was produced by the game-farm hens in the 0.5-acre pens. Nest abandonment by the game-farm hens during early incubation may be one cause for the low rate of reproduction.

A significantly ($P < 0.01$) higher number of nests was in alfalfa than in warm-season grasses where both cover types occurred in the pens. A more favorable microclimate for nesting created by decreased light penetration through the dense vegetative canopy may account for the larger number of nests in alfalfa.

Production costs averaged $11.99 per chick produced and were highest in the pens with a 40-hen-per-acre density. It appears that pheasant production using wild cocks and game-farm hens is possible; however, unless productivity can be increased it is not economically feasible.

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APPENDIX

Table A. Egg production of game-farm hens confined to 0.5-acre pens.

DENSITY (hens per acre)	NUMBER OF EGGS Total	In Nests	Per Nest	Dropped	Destroyed	Per Hen
NORTH PENS						
10 east	77	69	7.7	7	1	15.4
10 west	88	81	8.1	5	2	17.6
20 east	163	124	7.8	31	8	16.3
20 west	228	190	8.3	32	6	22.8
40 east	412	352	10.4	41	19	20.6
40 west	346	299	15.7	36	11	17.3
All Densities Combined	1314	1115	10.0	152	47	18.8
SOUTH PENS						
10 east	96	88	8.8	6	7	19.2
10 west	84	73	9.1	9	10	16.8
20 east	213	187	9.8	23	2	21.3
20 west	139	113	6.6	25	2	13.9
40 east	274	243	10.6	24	3	13.7
40 west	272	242	9.7	20	1	13.6
All Densities Combined	1078	946	9.3	107	25	15.4

Table B. Status of eggs found during the nesting season.

DENSITY (hens per acre)	EGGS Total	Percent In Nests	Percent Dropped	Percent Destroyed
NORTH PENS				
10 east	77	90	9	1
10 west	88	92	5	3
20 east	163	76	19	5
20 west	228	83	14	3
40 east	412	85	10	5
40 west	346	86	10	4
All Densities Combined	1314	85	12	3
SOUTH PENS				
10 east	96	92	6	2
10 west	84	87	11	2
20 east	213	88	11	1
20 west	139	81	18	1
40 east	274	89	9	2
40 west	272	89	7	4
All Densities Combined	1078	88	10	2

Table C. Fertility and hatchability of eggs found in nests incubated by game-farm hens.

DENSITY (hens per acre)	NESTS Total	NESTS Number Incubated	EGGS Total	EGGS Per Nest	EGGS Percent Fertile	EGGS Percent Fertile Eggs Hatched	EGGS Percent All Eggs Hatched
NORTH PENS							
10 east	9	9	69	7.6	35	12	4
10 west	10	10	81	8.1	64	33	21
20 east	16	15	123	8.2	61	35	21
20 west	23	22	188	8.5	52	11	6
40 east	34	33	340	10.3	58	6	4
40 west	19	19	299	15.7	44	3	1
All Densities Combined	111	108	1100	10.2	52	13	7
SOUTH PENS							
10 east	10	6	80	13.3	30	38	11
10 west	8	8	73	9.1	48	14	7
20 east	19	18	170	9.4	49	8	4
20 west	17	13	108	8.3	45	0	0
40 east	23	17	191	11.2	36	18	6
40 west	25	22	235	10.7	45	19	9
All Densities Combined	102	84	857	10.2	43	14	6

Table D. Nesting and chick production by game-farm hens confined to 0.5-acre pens.

LOCATION	Available Hens	NUMBER OF NESTS Total	NUMBER OF NESTS Per Hen	NUMBER OF NESTS Successful	PERCENT OF HENS SUCCESSFUL	NUMBER OF CHICKS Total	NUMBER OF CHICKS Per Successful Hen	NUMBER OF CHICKS Per Hen
NORTH PENS								
East	5	9	1.80	1	20	3	3.00	0.60
West	5	10	2.00	3	60	17	5.66	3.40
East	10	16	1.60	4	40	26	6.50	2.60
West	10	23	2.30	2	20	11	5.50	1.10
East	20	34	1.70	3	15	12	4.00	0.60
West	20	19	0.95	1	5	4	4.00	0.20
Totals and Averages	70	111	1.59	14	20	73	5.21	1.04
SOUTH PENS								
East	5	10	2.00	1	20	9	9.00	1.80
West	5	8	1.60	1	20	5	5.00	1.00
East	10	19	1.90	1	10	7	7.00	0.70
West	10	17	1.70	0	0	0	0.00	0.00
East	20	23	1.15	2	10	12	6.00	0.60
West	20	25	1.25	4	20	20	5.00	1.00
Totals and Averages	70	102	1.46	9	13	53	5.88	0.76

Table E. Characteristics of vegetation used for nesting by game-farm hens confined to 0.5-acre pens.

LOCATION	DENSITY (hens per acre)	NUMBER OF NESTS IN			BASE INCIDENT LIGHT (footcandles)[a]		DENSITY INDEX	
		Alfalfa	Warm Season Grasses	Both ~~Cover~~ Types	Alfalfa	Warm Season Grasses	Alfalfa	Warm Season Grasses
North	10	0	14	6	--	4810	--	12.51
South	10	14	4	0	510	2370	17.32	12.48
North	20	5	28	6	--	6450	--	14.51
South	20	34	1	1	525	5850	17.68	5.35
North	40	12	28	10	--	4650	--	8.84
South	40	41	5	2	615	1875	19.69	16.78

[a] Measured on the ground at the base of the plant.