

The Bobwhite Quail of Crane Naval Ammunition Depot, Indiana - 25 Years of Protection and Plant Succession

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THE BOBWHITE QUAIL OF CRANE NAVAL AMMUNITION DEPOT, INDIANA--25 YEARS
OF PROTECTION AND PLANT SUCCESSION

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Abstract:

A low-density bobwhite quail population was studied to determine its status after 25 years of plant succession and protection from hunting on Crane Naval Ammunition Depot. The summer breeding population on the study area was approximately one-fifth of that around the periphery of CNAD. The winter population was approximately 1 bird per 50 acres. The subadult to adult ratio was normal (83:17) but the corresponding sex ratio of 60M:40F was unbalanced. Coveys retained their identity and, with the exception of 1 covey, maintained their numbers during winter. The major habitat limitation occurred during the nesting and brooding season. The low density of bobwhites was concluded to be primarily the combined result of poor nesting cover and above-normal loss of mature females during the breeding season.

The objectives of this study were to identify the dynamics of a low-density bobwhite population and the importance to it of available cover types on an area where the major cultural land-management practice was right-of-way mowing for 25 years, excepting recent timber management practices.

Southern Indiana is near the southern boundary of the area where extended periods of cold temperatures and snow may limit bobwhite quail populations. Bobwhites are generally abundant in this area of Indiana, however, and provide a significant contribution to sport hunting. Previous studies of bobwhite quail in Indiana include Reeves' (15) state-wide investigation in which he studied in detail a population in the farm habitat of adjoining Daviess County. Madden (11) reported the fall foods of southern Indiana bobwhites.

We wish to thank the commanding officers of Crane Naval Ammunition Depot for their permission to use this area for study. Many employees of CNAD helped in collecting information or supported the study in a variety of other ways. Michael Donahue and Roy Raider were especially helpful during the summers they worked with us. Journal Paper No. 4744

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from Purdue University Agricultural Experiment Station in cooperation with the Indiana Division of Fish and Wildlife and the Crane Naval Ammunition Depot.

Study Area

Crane Naval Ammunition Depot (CNAD) occupies most of the northern 0.33 of Martin County in southwestern Indiana. The original oak-hickory forests are currently considered to be in a sensitive balance with beech-maple and western mesophytic forest types (9,14). Farms began to break up the forests during the 1800's and by 1900 most ridge-tops and flood plain terraces were tilled. Hillsides that remained forested during the agricultural era were frequently grazed. Farming declined rapidly after 1900 (13).

Since its formation in 1940, CNAD has been an effective wildlife refuge because of military security and the resultant limitation of public access to the area. During this study, 56,160 of a total 62,780 acres were in some stage of forest succession. In addition, 4,660 acres were maintained by annual mowing as roadside, ammunition magazine, and powerline openings. The remaining 2,960 acres were in roads, buildings, and other man-made structures. Land cleared for farming during the 1800's left the most obvious impression on the original wooded landscape. Since the cessation of farming at least 25 years ago, various seral stages from grass-herb to brush communities have developed. Many of the areas appear savannah-like, with shrub growth scattered throughout a dense grass-herb ground cover. Forested areas were relatively undisturbed from establishment of CNAD until about 1959 when timber management practices began (3).

Within CNAD, 4 sq miles were selected for intensive study along Boggs Creek. The main cultural practice on the study area consisted of mowing at ammunition magazines, powerlines, and roadsides; although some scattered, selective logging and timber-stand improvement was performed.

Methods

A census of whistling males was conducted at weekly intervals on the study area and along the southern and western perimeter of CNAD during the breeding seasons of 1966 and 1967. The procedure was the same used by Bennitt (4) except that stops were made at 0.5-mile intervals.

Two types of trapping techniques were used in this study. Cock-and-hen traps were effective for the April-through-August breeding season (19). Bait trapping was used during the fall-to-spring period.

Birds captured in traps were banded, sexed, aged, and released at the trap site. Back tags and colored dyes were used to mark some birds for individual recognition.

Methods employed in the quantitative vegetation sampling have been

described previously (6) except for the determination of cover types in bobwhite activity centers. A revised map of the vegetation cover types on the study area was prepared from a U. S. Forest Service map drawn in 1959 based on 1953 aerial photographs. The acreage of cover types was determined from these maps with fixed-radius plots around the activity center of 12 bobwhite quail and compared to the cover-type acreage in an equal number of randomly located plots. The 340-yard radius of the sample plots was an average of the activity radii of birds recaptured 3 or more times (5).

Findings

Habitat Studies

The forest was predominantly oak-hickory with a combined importance for all oak and hickory species of 62%. Hard maple ranked fourth and American beech ninth among all species found; combined, these species had an importance of only 14%.

The most important woody plants greater than 1 ft tall and less than 4-inches dbh are listed in Table 1. Potentially valuable fruit-producing species occurred in this vegetation layer, particularly in abandoned fields.

Woody plants, including seedlings and vines less than 1 ft tall, are listed in Table 1. Greenbriar and trumpet creeper tangles were the only species dense enough to provide shelter in some areas. Wild grape, blueberry, dewberry, and posion ivy all produced potentially valuable fruit.

Mowed openings were maintained in a predominantly grass-herb community, and grasses found there in descending importance, were bluegrass, fescue, panic grass, andropogons, cheat, sedge, red-top, tall purpletop, timothy, triple-awn grass, wild oats, and foxtail.

Nineteen woody plants occurred in mowed openings but only the vines survived the repeated mowing. A valuable fruit producer, dewberry, was the most important woody species in mowed openings. Wild rose was the only other woody plant known to produce fruit in the mowed areas.

Seeds of legumes and composites have been reported as important items in the diet of bobwhites of Indiana (15), Illinois (2,8), Kentucky (1), and Missouri (7). Korean lespedeza was the most important herbaceous plant in mowed openings on CNAD, and it has been found in a larger percent of Indiana quail crops than any other food item (Table 2). Reeves (15) ranked it third in percent volume behind corn and sassafras. Field observations made on feeding coveys in fall and winter confirmed that the abundance of Korean lespedeza in mowed openings of CNAD attracted quail during the winter.

Sweet clover produced abundant seed crops in mowed openings; however, it is a species that has been insignificant in the diet of quail in Indiana (15), Illinois (8), and Missouri (7). Tick trefoil, beggartick,

ragweeds, and trailing wild bean in CNAD abandoned fields produced seeds that were potential fall and winter food sources. Seeds of wood sorrel, tick trefoil, and trailing wild bean were common foods in woodlands.

The density of plants in the ground layer has been recognized as an important variable in the selection and use of areas by bobwhites (17,19). In general, woodlands had the least dense ground layer of woody and herbaceous plants (206 plants per m^2) on CNAD, abandoned fields had slightly more (218 plants per m^2). The density of plants in mowed openings was more than twice that in other community types (464 plants per m^2). Thirty-three % of the ground-layer plants in woodlands were woody, whereas woody plants composed 10% of the plants in abandoned fields. Mowed areas had less than 10% woody-plant composition. Plant density and the rank growth of herbaceous plants in abandoned fields may reduce the late-winter value of these areas for providing food because much of the plant material covers the ground surface, and needed food supplies are not readily available. In addition, grass is considerably more dense in abandoned fields than in woodlands.

Bobwhite Studies

A survey of whistling (calling) males was conducted weekly during May through July, 1966 and 1967, to identify the annual size of the breeding male population and to determine the peak date of calling intensity. For both years the average calling index was 0.23 during the third week of July. The calling index along the farmland perimeter of CNAD during this same period averaged 1.2 calls, indicating a considerably higher population of breeding birds. Comparison of the call index value in this study to the call index values of 2.64 and 2.05 reported by Reeves (15) for the same soil types in adjacent areas of southern Indiana indicates a relatively low density of bobwhites on the study area. Reeves (15) conducted the whistling survey during the third week of July, but recommended the last of June as the best time for Indiana.

The peak calling index on the study area occurred in the last week of June in 1966 (0.62) and the second week of June in 1967 (0.85). The highest calling index on the perimeter of CNAD occurred in the third week of June both years (3.65 in 1966 and 2.31 in 1967). A calling index was obtained each week and found to be cyclic with highest values at approximately 4-week intervals and low values at approximately the midpoint in time between high records. This suggested that nesting began uniformly and renesting attempts may have occurred at greatest frequency on successive 4-week intervals. Speake and Haugen (18) reported that bobwhite whistling activity fluctuated with nesting activity and that sharp declines in calling followed peaks of hatching. Rosene (17) considered the peak in calling to coincide with the maximum in nesting activity. Small secondary calling peaks occurred in late July and early August in Kansas (16).

The low calling index and low breeding population it represented on CNAD probably reflected 2 basic factors: low reproduction and/or high annual losses in the population. Rosene (17) considered the

whistling male census to reflect the quality of nesting cover; therefore, the low calling index on CNAD suggests that poor nesting conditions were present. It should be recognized that if losses were high during the fall and winter, the population remaining until the next breeding season could be small even though nesting cover was excellent.

The average turnover rate in a bobwhite population is reported to be 70-80% of the population each year with the highest rate in the northern ranges (17). Reeves (15) reported that 84.9% of juvenile birds were taken during the 1947-1951 hunting seasons in Indiana. The average age composition of 59 bobwhites captured on CNAD was 83% subadults and 17% adults (Table 3). Comparison of the number of individuals captured and recaptured indicates that a large proportion of the population was handled.

We consider the average age structure for the population of bobwhites on CNAD to be normal in terms of recruitment of young individuals. The year-to-year variation in our results could be expected from a low-density population in which a small variation in the number of individuals captured in either age class would cause a relatively large change in the age ratio.

A representative sex ratio of CNAD bobwhites was obtained only during the period when they were in coveys. During the breeding season, trapping was selective for males, and females were not readily observed. The sex ratio of 5 coveys (51 birds) which occupied the 4-sq-mile study area in 1965-66 and 2 coveys (19 birds) immediately adjacent to the study area within CNAD was 59M:41F. Females were never observed in greater number than males in any covey, and were equal in number in 2 coveys. The normal sex ratio in juvenile and subadult age classes is 50M:50F but the male portion will normally average 60% of the adult age class (17). Mortality of female bobwhites on CNAD was somewhat greater than would typically be expected for an age distribution which had a normal high subadult composition. Rosene (17) reported the proportion of males increased after the onset of nesting activity, which suggests a time of the year when female bobwhites on CNAD may be unusually vulnerable. In the 5 coveys on the study area between November 1965 and April 1966, the number of females declined less than the number of males in 2 coveys, both sexes remained stable in 2 coveys, and the sex ratio was not determined in 1 covey. These ratios indicate that female mortality was less than or equal to that for males within the coveys on the study area during the winter season.

Bobwhites typically have small home ranges (10,12,17). Forty-four individuals were captured during the summer trapping seasons of 1965-1967 of which 21 individuals were recaptured. Of 20 birds recaptured in the same summer that they were banded, 14 (70%) were recaptured within 0.5 mile, 19 (95%) moved less than 1 mile, and 1 bird moved more than 1 mile.

Males that move > 1 mile during the summer are unusual and presumably are not mated. An example on CNAD involved a subadult male that moved down the Boggs Creek Valley 2,530 yards in 8 days and 2,470 yards

back up the valley 7 days later. He was recaptured a third time, 15 days later, 770 yards south of the previous capture site.

Movement records for more than 1 summer season were obtained from 3 individuals. Two birds recaptured on the study area after 2 years had moved an average of 8,950 yards from the last capture site. One bird, recovered after 3 years, moved off the study area and at least 1,760 yards from the previous capture site. No birds were found to move to or from the study areas or the southern perimeter of the depot during a single summer trapping period.

The average summer activity radius determined for 12 bobwhites captured 3 or more times was approximately 340 yards (range 60 to 710 yards). Individuals that had unusually long movement records were not included in these calculations.

To evaluate the relationship of bobwhite centers of activity to vegetation cover types in the summer, we compared the cover-type vegetation acreages around the activity centers of 12 bobwhites to a random sample of the cover-type acreages present on the entire study area. The results of an analysis of variance test of the variation within the 2 types of samples indicated that mowed openings were a smaller but more consistent acreage in both samples than other vegetation cover types. Mowed openings averaged 13 acres (20%) in both types of sample areas. By comparison, abandoned fields and woodlands were larger than mowed openings, and much more variable in size. An average of 18 acres (27%, range 5-43 acres) of the 66-acre plot taken around bobwhite activity centers was in the abandoned field cover type, whereas abandoned fields averaged 15 acres (23%, range 0-50 acres) at randomly selected plots elsewhere. Woodland acreage was the most variable of the 3 cover types and averaged 35 acres (53%, range 6-60 acres) in plots around activity centers compared to 38 acres (57%, range 2-56 acres) in randomly located plots.

The dominant plant species were recorded at 118 sites used by bobwhite coveys during the winter season. This information provided a percent frequency occurrence of species at feeding, loafing, and roosting sites (Table 4) and is the basis for comparing the composition of winter habitat used by bobwhites against other available areas.

The ubiquity of goldenrod and broomsedge precluded their use as indicators of any selectivity by bobwhites. Korean lespedeza, wild carrot, tall purpletop, and bluegrass found at winter feeding sites (Table 4) were important constituents of mowed-opening vegetation (Table 2). Blackberry and common persimmon found at feeding sites are representative of the shrub borders of abandoned fields, situations where bobwhites were more often found loafing than feeding, as is indicated by the frequency of blackberry, serotia lespedeza, and sassafras at loafing sites. Bobwhite roosts were most often found in abandoned fields, and the plant species commonly found at roost sites agrees accordingly (Tables 2 and 4). The frequency of roosts found in pines increased during periods of snowy cover, indicating a need for more substantial cover during severe weather.

Conclusions

The purpose of this study was to identify the characteristics of a low-density, nonhunted bobwhite population that occupied an area that had undergone 25 years of plant succession. The whistling male index indicated that the breeding male population on the study area was less than 0.20 of that around the farmland perimeter of CNAD. The winter population on the study area was found to be 5 coveys or 51 birds (gross density approximately 1 bird/50 acres).

The sex and age characteristics of this population indicate how it has responded to the limited amount of suitable habitat and still remained viable. The age ratio indicates that the recruitment of young is similar to that normally found in populations of bobwhites at this latitude. The 60M:40F sex ratio, however, was found to be slightly unbalanced for a young population; it probably reduced the reproductive potential of this population. No evidence was obtained during this study to explain why the sex ratio favored males; however, it has been shown elsewhere that females are subject to greater mortality than males during the breeding season. The fact that fewer females than males were found in winter coveys and that the number of females was more stable than the number of males supports the conclusion that females are likely lost in greater proportion than males during the breeding season. During the remainder of the year, mortality probably is non-selective and the males and females die at a rate commensurate with their numbers in the population.

Comparison of the vegetation conditions on CNAD and those reported used by nesting bobwhites indicates that the edge of abandoned fields adjacent to mowed openings had the best potentiality. However, nesting bobwhites also prefer a low to medium density of ground vegetation and a minimum of plant litter. Since abandoned fields had dense ground vegetation (218 stems per m²) and an abundance of plant litter, nesting conditions were suboptimal. Dry upland abandoned fields were predominantly in dense old stands of broomsedge, which are also reported to be suboptimum nesting conditions (17).

There was no evidence that nonmated birds moved off the study area during the breeding season. Evidence from birds recaptured in more than a single season, however, suggests that bobwhites may move long distances at other times of the year, possibly during the fall.

The number of coveys remained stable during the fall to spring period; 4 of 5 coveys maintained a relatively stable size.

The relationship between vegetation and bobwhite coveys indicates that areas used for feeding and loafing in the edge between abandoned fields and woodlands had a limited amount of plant litter on the ground surface. Coveys fed in mowed openings and roosted in abandoned fields in the latter part of the winter when much of the plant material had lodged. In light of these results we have concluded that winter food and cover on CNAD was adequate for the population present in the winter of 1965-66 and that the major factors controlling the numbers of bobwhites

occurred during the breeding season as a result of suboptimum nesting conditions and disproportionate adult female mortality.

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Table 1. The important woody plants identified from three layers in the abandoned field and woodland communities of CNAD¹

Species	Abandoned Field			Woodland		
	0-1 ft. (%) ²	1-5 ft. (%)	> 5 ft. (%)	0-1 ft. (%)	1-5 ft. (%)	> 5 ft. (%)
Elm	--	4.0	20.9	--	--	--
Sycamore	--	3.4	17.4	--	--	--
Persimmon	--	13.5	16.2	--	--	--
Sassafras	--	--	14.0	8.0	14.5	12.0
Boxelder	--	--	11.8	--	--	--
Dwarf sumac	7.2	15.4	10.0	--	--	--
Flowering dogwood	--	10.0	5.0	--	14.3	21.8
Red maple	11.5	4.8	5.0	--	2.3	3.9
Hard maple	--	--	--	5.8	3.0	19.9
Hickory	--	--	--	--	6.6	7.1
Ironwood	--	--	--	--	7.7	6.2
Black gum	--	--	--	--	--	5.6
Oak	--	--	--	5.6	9.2	5.6
Ash	--	--	--	4.2	4.9	3.9
Tulip poplar	--	--	--	4.2	--	3.3
Trumpet creeper	7.4	18.1	--	--	--	--
Wild rose	6.5	9.6	--	--	--	--
Willow	--	8.2	--	--	--	--
Indian currant	--	3.8	--	--	--	--
Greenbriar	--	--	--	6.1	17.0	--
Blueberry	--	--	--	5.1	1.7	--
Dewberry	27.8	--	--	--	--	--
Poison ivy	24.7	--	--	8.3	--	--
Virginia creeper	10.0	--	--	12.3	--	--
Black cherry	5.1	--	--	--	--	--
Wild grape	--	--	--	5.2	--	--

¹Excludes stems over 4 inches dbh.²Importance = (relative density + relative frequency)/2 for each plant species.Table 2. The important herbaceous plants identified from three communities on CNAD¹

Species	Mowed opening (%)	Abandoned field (%)	Woodland (%)
Korean lespedeza	33.4	2.1	--
Goldenrod	7.7	18.3	5.7
Plantain	6.7	--	--
Sweet clover	6.0	--	--
Wild carrot	5.1	--	--
Cinquefoil	4.7	5.9	6.4
Ox-eye daisy	2.3	--	--
White clover	2.1	--	--
Black medic	2.0	--	--
Wood Sorrel	1.8	2.1	4.8
Tick trefoil	0.6	9.9	7.2
Yarrow	--	9.1	--
Beggar ticks	--	8.9	--
Ragweed	--	6.4	--
Violet	--	5.5	6.8
Pennyroyal mint	--	4.7	4.5
Agrimony	--	4.6	--
Trailing wild bean	--	3.0	9.6
Bedstraw	--	--	12.0
Pussy toes	--	--	10.6
<u>Eupatorium</u> spp.	--	--	3.9

¹Importance = (relative density + relative frequency)/2 for each plant species.

Table 3. Number of bobwhite quail captured and recaptured on CNAD (1965-1967). The number of previously uncaptured individuals in parentheses.

Year	Months						
Age class	Jan.	Feb.	May	June	July	August	Total
1965							
Adult	--	--	--	2(2)	5(1)	--	7(3)
Subadult	--	--	--	5(4)	19(5)	11(2)	35(11)
1966							
Adult	1(1)	2(0)	3(2)	5(1)	--	--	11(4)
Subadult	11(11)	10(3)	5(4)	8(5)	5(4)	--	39(27)
1967							
Adult	--	--	--	1(1)	3(1)	2(1)	6(3)
Subadult	--	--	--	8(7)	9(3)	5(1)	22(11)
Total							
Adult	1(1)	2(0)	3(2)	8(4)	8(2)	2(1)	24(10)
Subadult	11(11)	10(3)	5(4)	21(16)	33(12)	16(3)	96(49)

Table 4. Plant species with 10 highest percentage frequency occurrence values at winter bobwhite activity sites on CNAD.

Species	Feeding ¹ (62) (%)	Species	Loafing (25) (%)	Species	Roosting (31) (%)
Goldenrod	65	Blackberry	44	Goldenrod	77
Broomsedge	57	Broomsedge	40	Broomsedge	65
Korean lespedeza	48	Goldenrod	36	Aster	48
Tall purpletop	40	Serecia		Beggarticks	36
Bluegrass	33	lespedeza	32	Bluegrass	36
Blackberry	31	Bluegrass	24	Pine	32
Serecia		Sassafras	20		
lespedeza	24	Aster	20	Foxtail	32
Panic grass	24	Pussytoes	20	Cinquefoil	32
Wild carrot	23	Korean		Selfheal	32
		lespedeza	0		
Common persimmon	21	Fescue	16	Common persimmon	26
		Panic grass	16	Flowering dogwood	26
		Tick trefoil	16		

¹ Number of sites examined.

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ASPECTS OF BOBWHITE QUAIL MOBILITY DURING SPRING THROUGH FALL MONTHS

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Abstract:

The mobility of bobwhite quail was studied on an 1160-acre nonhunted area in southern Illinois during March through November. Seventy-eight quail (39 adult males, 29 adult females and 9 young of the year) were radio instrumented. Radio locations totaled 2,302 during 1,726 days in which quail were radio marked. Increase in average monthly range from March to April was attributed to change in habitat preference. Considerable variation in monthly ranges during the period of June through August were noted and attributed to variations in breeding status of individual birds. An increase in monthly ranges during October was associated with covey formation.

Past research on mobility of bobwhite quail has produced conflicting data. Although some studies have shown bobwhite to be quite sedentary (4,10), others have shown them to be capable of moving considerable distances (2,3,5,7,11).

In an attempt to clarify mobility during the spring-through-fall months, several authors have tried to relate movements to a particular time of the year. Loveless (7) concluded that there was no special increase in movement during the spring, but that bobwhite were highly mobile during the summer months. In contrast, Lewis (6) and Murphy and Baskett (8) in Missouri found movement in the spring to exceed that of summer. Movements in the fall are also exemplified by conflicting data. Agee (1) found that coveys often established their winter ranges within 100 yards of their hatching point. Duck (3), Lehman (5), and Loveless (7) on the other hand showed a definite shift from fall to