FALL AND WINTER FOOD HABITS OF THE BOBWHITE QUAIL IN THE SANDHILLS OF NORTH CAROLINA

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ABSTRACT

The contents of 4,157 quail crops from the Sandhills Wildlife Management Area were examined. The crops were collected from hunter harvested quail during the open hunting season (mid-November through late February) for seven years, 1961 through 1967.

Items of primary importance were the seeds of longleaf pine, red bay, shrub lespedeza, rye and beggarweed. A temporal examination of the data indicates that red bay was important as a source of food in late winter and during periods of pine mast scarcity.

INTRODUCTION

A review of the published literature on the bobwhite quail reveals the extensiveness and intensiveness with which this species has been investigated. At the same time it becomes apparent that based on local edaphic factors a considerable number of different plant communities interact to produce quality habitat over a large geographic area. Successful management programs require the identification of and an understanding of the role of these different plant communities.

This paper presents an insight into the value of several plant communities and their role in the production of fall and winter foods utilized by quail.

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DESCRIPTION OF AREA

The 57,000 acre Sandhills Wildlife Management Area is located in Scotland, Moore and Richmond counties in south central North Carolina. The topography of the area is gently undulating to rolling. Average annual rainfall approximates 1.27 meters. Soils of the Gilead-Lakeland series dominate the uplands and broad ridge tops. Typical vegetation is the longleaf pine-scrub oak-wire grass type. This particular soil association is characterized as being low in natural fertility and droughty. Elevations range from 76 to 150 meters above sea level.

Numerous drainways intersect the broad ridges with intermittant and perennial streams. The Bibb soil series, characterized as low in natural fertility and poorly drained, is common to the heads of these drainage-ways, while alluvial material dominates a majority of the area in the larger drainage-ways (Horton, 1967). The dense vegetation of these drainage-ways is characterized by such associates as pond pine *(Pinus serotina)*, sweetgum *(Liquidambar styraciflua)*, black gum *(Nyssa sylvatica)*, water oak *(Quercus nigra)*, willow oak *(Quercus phellos)*, sweet bay *(Magnolia virginiana)*, red maple *(Acer rubrum)*, red bay *(Persea borbonia)*, loblolly pine *(Pinus taeda)*, and yellow poplar *(Liriodendron tulipifera)*.

A more detailed description of the vegetation and edaphic factors can be found in Horton, *(ibid.)*, Wells and Shunk, (1931) and Wells (1932).

METHODS

The crops of hunter harvested quail were collected by checking station attendants during each day of the quail hunting season. These collections were initiated with the 1961-62 hunting season and continued through the winter of 1967-68.

Collections paralleled hunting seasons except during 1962-63 when they were made during the period December 15, 1962 through January 23, 1963.

The number of crops collected and the opening and closing dates for the quail season during the study varied as follows:

Year	Opening Date	Closing Date	Number of Crops Collected
1961-62	12-4-61	1-31-62	159
1962-63	12-5-62	2-13-63	57
1963-64	11-27-63	2-15-64	906
1964-65	11-21-64	2-13-65	539
1965-66	11-20-65	2-12-66	868
1966-67	11-19-66	2-18-67	737
1967-68	11-18-67	2-17-68	891
		TOTAL	4,157

In order to facilitate comparisons of the temporal importance and/or utilization of plant food items during a period of poor pine mast with a period of abundant pine mast, collection dates were arranged into approximately bi-weekly periods (Tables 3 and 4). The contents of the crops were processed in a manner suggested by Martin (1960). Plant food items having a frequency of occurrence and/or percent of volume of less than three percent are reported as a trace (tr.). The frequency of occurrence and the percent of the volume of each species was calculated by totaling the number of items and volume of each species for all crops prior to converting them to a percentage.

Identification of plant food items was made through the use of a seed reference collection at the Zoology Department, North Carolina State University and a seed reference collection assembled by project personnel during the course of the study.

FINDINGS AND DISCUSSION

During the course of this study 4,157 quail crops were examined. Plant food items are presented in Table 1.

Table 1. A List of Plant Food Items Found in Quail Crops on the Sandhills Wildlife Management Area.

Scientific Name	Common Name
Ambrosia artemisiifolia	Common Ragweed
Acer floridanum (barbatum)	Southern Sugar Maple
Aster pilosus	Field Aster
Cassia nictitans	Wild Sensitive Bean
Cassia fasciculata	Partridge Pea
Centrosema virginana	Spurred Butterfly-pea
Crotolaria rotundifolia	Rattle-box
Daucus carota	Wild Carrot
Desmodium spp.	Beggarweed
Digitaria sanguinalis	Crabgrass
Diodia teres	Buttonweed
Fragaria urens	Strawberry
Fraxinus sp.	Ash
Fragus grandiflora	Beech
Galactia volubilis	Milk Pea
Glycine spp.	Soybean
Ilex glabra	Inkberry
Ilex opaca	American Holly
Impatiens biflora (capensis)	Spotted Touch-me-not
Lespedeza bicolor	Shrub Lespedeza
Lespedeza capitata	Wild Lespedeza
Lespedeza hirta	Wild Lespedeza
Lespedeza stipulacea	Korean Lespedeza
Lespedeza striata	Common Lespedeza

Table 1. Continued.

Scientific Name	*Common Name*
Lespedeza spp.	Wild Lespedeza
Liquidambar styraciflua	Sweetgum
Ligustrum spp.	Privet
Lithospermum arvense	Gromwell
Lupinus diffusus	Sandhills Lupine
Lupine perennis	Wild Lupine
Lonicera japonica	Japanese Honeysuckle
Panicum fasciculata	Browntop Millet
Panicum spp.	Panic Grasses
Paspalum laeve	Smooth Paspalum
Paspalum spp.	Paspalum
Pinus taeda	Loblolly Pine
Pinus palustrus	Longleaf Pine
Persea borbonia	Red Bay
Phytolacca americana	Pokeweed
Prunus serotina	Black Cherry
Phaseolus spp.	Wild Bean
Rosa spp.	Rose
Rhynchosia erecta	Wild Bean
Rhus copallina	Winged Sumac
Rhus glabra	Smooth Sumac
Quercus phellos	Willow Oak
Quercus nigra	Water Oak
Quercus spp.	Acorn Fragments
Scleria ciliata	Nutrush
Scleria reticularis	Nutrush
Secale cereale	Rye
Setaria glauca	Foxtail
Smilax laurifolia	Laurel-leaf Smilax
Sesbania exalta	Sesbania
Sorghum vulgare	Sorghum
Toxicondendron radicans	Poison Ivy
Tragia ureas	Spurge
Vicia angustifolia	Hairy Vetch
Vicia grandiflora	Vetch
Vaccinium spp.	Blueberry
Vigna senensis	Cowpeas
Zea mays	Corn
Robinia psuedo-acacia	Black Locust

Table 2 presents the frequency of occurrence (expressed as a percentage) and the percent of the volume of the respective food items. An inspection of this table indicates that the fall and winter food habits of quail on this area are composed of a relatively small number of consistently important food items. The seeds of longleaf pine *(Pinus palustrus)*, red bay *(Persea borbonia)*, shrub lespedeza *(Lespedeza bicolor)*, rye *(Secale cereale)*, and beggarweed *(Desmodium* spp.*)* appear to be of primary importance.

The effect of availability on utilization of particular food items can not be minimized or overlooked. This is demonstrated by longleaf pine. Variable mast crops produced during this study had a strong effect upon the utilization of longleaf pine mast. Ocular observations indicate that bumper mast crops were present during the fall of 1961 and 1967, mediocre or average mast crops were present during the fall of 1964, 1965 and 1966. A general mast failure occurred during the fall of 1962 and 1963. The frequency of occurrence and percent of the volume of longleaf pine in Table 2 follows this general pattern.

The importance and utilization of red bay seeds as a food item is rather unexpected. This species is not rated very highly by other workers such as Martin (1935), Martin et al. (1951) and Rosene (1969), however, it is a common component of the small, thickly vegetated drainage-ways that bisect and parallel the longleaf pine-wiregrass-turkey oak uplands. With the exception of the winter of 1965-66 red bay seed demonstrates consistency in both frequency of occurrence and percent of the volume.

Beggarweed seed, occurring on the same upland sites as longleaf pine, shows considerable variation in utilization between years. It would appear from these data that beggarweed is more intensively utilized during periods when longleaf pine mast is unavailable. The highest values recorded for both the frequency of occurrence and the percent of the volume of beggarweed occurred during the years in which pine mast crop failures occurred (1962-63 and 1963-64).

Shrub lespedeza and rye, two plant species utilized in a program of habitat improvement on the area, indicate a striking dichotomy in patterns of utilization. Rye, fall-planted primarily on fire lanes, trails and newly established fields, makes a substantial contribution to the total volume of food items. Rye seeds made up 31.48 percent of the total volume of food items during the fall and winter of 1964-65. However, in spite of and in comparison to its substantial contribution to the volume of food items eaten by quail, the frequency of occurrence is low. These data suggest that during the period represented by this study (mid-November to late February) rather large quantities of rye seed were consumed by a relatively small number of quail. It should be recognized that the period of collection of quail crops for this study was at a time of decreasing availability of rye seed (e.g., rye planting is usually accomplished by early September and depending upon soil moisture, among other factors, germination is well advanced by mid-November).

Shrub lespedeza seed was utilized heavily during the period of this study. Approximately 43 percent of the quail crops examined during the fall and winter of 1966-67 contained shrub lespedeza seed and it accounted for approximately 32 percent of the volume of food items eaten by quail during this same period.

The data in Tables 3 and 4 presents an insight into the temporal importance and utilization of food items during a fall and winter when the longleaf pine mast crop failed (1963-64) and a fall and winter when a bumper longleaf pine mast crop was available (1967-68).

The seasonal analysis (Table 2) masks the short term utilization of some food items observed in Table 3. During a fall and winter preceded by a pine mast failure, red bay, shrub lespedeza and beggarweed seeds were utilized regularly and consistently. The utilization of seeds of other species was sporadic and inconsistent. Poison ivy *(Toxicodendron radicans)* received rather heavy utilization during the first two-week period. However, utilization during succeeding periods was very irregular. Although the seeds of several other species such as the sumacs *(Rhus glabra)* and *(Rhus copallina)*, milk pea *(Galactia volubilis)*, partridge pea *(Cassia fasciculata)* and wild sensitive bean *(Cassia nictitans)* were utilized with respectable frequencies of occurrence they did not contribute substantially to the volume.

Table 4 presents an example of the interaction between and utilization of two different and distinct plant communities by quail. This was represented by the communities of which longleaf pine (uplands) and red bay (thickly vegetated drainage-ways) are members. Compared to red bay, the utilization of longleaf pine began at a high level (approximately 53 and 82 percent frequency of occurrence and percent of the total volume respectively) and dropped consistently throughout the season to a frequency of occurrence of approximately seven percent and to a trace of the volume (less than three percent). This utilization closely parallels the availability of longleaf pine seed. During the same period red bay utilization was initially low. The frequency of occurrence and percent of the volume were both less than three percent. However, as winter progressed and the availability of longleaf pine decreased, red bay continued to increase in importance.

CONCLUSION

The change or shift in utilization documented here connotes a change in the distribution of quail from the uplands to the more densely vegetated drainage-ways during late winter. This does not imply that quail no longer frequent the uplands as demonstrated by their continued utilization of beggarweed and shrub lespedeza. This does, however, demonstrate that these drainage-ways, long valued primarily as a source of cover, are also an important source of food. Since the primary producers of food in these drainage-ways are woody species, fire used to regenerate quail foods on the uplands could have a harmful effect on food production and should be excluded from the drainage-ways.

Table 2. Fall and Winter food habits of bobwhite quail on the Sandhills Wildlife Management Area 1961-68.

Common Name	Scientific Name	1961-62		1962-63		1963-64		1964-65		1965-66		1966-67		1967-68	
		% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume
Longleaf pine	*Pinus palustrus*	57.86	41.17	15.79	Tr.	—	—	25.23	13.02	13.94	8.41	16.96	10.81	42.40	38.07
Red Bay	*Persea pubescens*	10.06	11.51	5.26	Tr.	21.63	17.19	39.33	28.95	6.80	3.70	26.19	19.96	17.17	15.39
Shrub Lespedeza	*Lespedeza bicolor*	18.24	5.79	36.84	8.60	20.09	5.84	28.76	9.81	36.18	16.47	42.80	31.89	20.76	8.92
Milk pea	*Galactia volubilis*	28.93	3.66	36.84	3.25	18.48	3.40	16.88	Tr.	Tr.	Tr.	3.80	Tr.	6.62	Tr.
Rye	*Secale cereale*	7.55	10.52	15.79	30.38	8.76	3.20	5.19	14.67	9.33	31.48	8.82	27.56	4.04	14.93
Wild lespedeza	*Lespedeza capitata*	6.92	Tr.	14.04	7.77	18.65	3.47	10.20	Tr.	Tr.	Tr.	Tr.	Tr.	3.48	Tr.
Beggarweed	*Desmodium* spp.	23.27	3.66	45.61	20.64	40.51	18.05	31.91	12.67	26.04	9.83	16.69	5.53	16.84	11.29
Greenbriar	*Smilax* spp.	15.09	Tr.	—	—	—	—	—	—	—	—	—	—	—	—
Wild Sensitive Bean	*Cassia nictitans*	18.24	Tr.	26.32	Tr.	8.83	Tr.	19.85	Tr.	21.66	3.40	10.18	Tr.	5.50	Tr.
Loblolly pine	*Pinus taeda*	7.55	Tr.	7.02	Tr.	3.86	Tr.	6.68	Tr.	4.49	Tr.	11.53	Tr.	7.63	Tr.
Lupine	*Lupinus diffisus*	14.47	Tr.	12.28	3.16	11.86	3.45	4.27	Tr.	4.26	Tr.	10.45	Tr.	Tr.	Tr.
Scurf pea	*Psoralea lupinellus*	Tr.	3.35	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	4.38	Tr.	Tr.	Tr.	Tr.	Tr.
Common lespedeza	*Lespedeza striata*	Tr.	Tr.	8.77	Tr.	12.25	Tr.	3.53	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
Willow oak	*Quercus phellos*	—	—	7.02	Tr.	Tr.	Tr.	Tr.	Tr.	9.33	Tr.	Tr.	Tr.	—	—
Korean lespedeza	*Lespedeza stipulace*	Tr.	Tr.	7.02	Tr.	22.44	5.98	12.24	Tr.	Tr.	Tr.	4.34	Tr.	Tr.	Tr.
Browntop millet	*Panicum fasciculatum*	—	—	—	—	6.41	10.87	Tr.	Tr.	3.34	Tr.	Tr.	Tr.	Tr.	Tr.
Partridge pea	*Cassia fasciculata*	Tr.	Tr.	—	—	5.19	Tr.	Tr.	Tr.	4.26	Tr.	Tr.	Tr.	Tr.	Tr.
Sorghum	*Sorghum vulgare*	—	—	—	—	6.62	Tr.	—	—	4.38	Tr.	Tr.	Tr.	Tr.	Tr.
Butterfly pea	*Centrosema* sp.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	16.01	4.01	Tr.	Tr.	Tr.	Tr.
Poison Ivy	*Toxicondendron radicans*	16.98	4.69	14.04	Tr.	6.40	11.04	3.15	Tr.	14.63	4.37	3.93	Tr.	Tr.	Tr.
Winged sumac	*Rhus copallina*	Tr.	Tr.	—	—	5.41	Tr.	4.45	Tr.	7.26	Tr.	Tr.	Tr.	Tr.	Tr.
Smooth sumac	*Rhus glabra*	—	—	—	—	15.78	Tr.	Tr.	Tr.	Tr.	Tr.	—	—	3.03	5.17
Inkberry	*Ilex glabra*	—	—	—	—	8.28	Tr.	Tr.	Tr.	Tr.	Tr.	—	—	—	—
Acorn fragments	*Quercus* spp.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	9.33	Tr.	4.07	Tr.	3.93	Tr.
Soybeans	*Glycine max*	—	—	—	—	8.83	19.05	—	—	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
Number of Crops Examined		159		57		906		539		868		737		891	

Table 3. Bi-weekly food habits of quail during the winter of 1963-64.

Common Name	Scientific Name	Period I		Period II		Period III		Period IV		Period V		Period VI	
		% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume
Red Bay	*Persea pubescens*	16.10	11.49	27.27	21.30	25.53	22.95	23.53	14.24	30.56	36.31	11.76	8.82
Beggarweed	*Desmodium* spp.	25.85	6.06	46.06	20.11	48.94	23.16	39.04	23.80	30.56	7.03	54.41	26.25
Shrub Lespedeza	*Lespedeza bicolor*	26.34	5.43	18.79	5.07	21.28	4.15	13.37	4.74	22.22	14.00	19.12	7.92
Korean Lespedeza	*Lespedeza stipulacea*	17.07	Tr.	25.45	6.01	25.53	8.36	22.99	4.64	16.67	Tr.	31.62	7.73
Wild Lespedeza	*Lespedeza capitata*	10.73	Tr.	20.00	Tr.	30.50	Tr.	20.32	6.96	13.89	5.36	16.91	Tr.
Common Lespedeza	*Lespedeza striata*	7.32	Tr.	19.39	Tr.	10.64	Tr.	14.44	Tr.	12.50	Tr.	9.56	Tr.
	Lespedeza spp.	7.32	Tr.	6.06	Tr.	—	—	—	—	—	—	—	—
Smooth Sumac	*Rhus glabra*	10.24	Tr.	18.79	Tr.	19.86	Tr.	17.11	Tr.	11.11	Tr.	16.91	Tr.
Poison Ivy	*Toxicodendron Radicans*	14.15	30.56	6.06	4.91	9.22	Tr.	—	—	4.17	8.51	Tr.	7.66
Inkberry	*Ilex glabra*	6.83	Tr.	4.85	Tr.	—	—	12.83	Tr.	5.56	Tr.	15.44	8.83
Partridge pea	*Cassia fasciculata*	8.29	Tr.	—	—	7.09	Tr.	—	—	—	—	6.62	Tr.
Wild sensitive bean	*Cassia nictitans*	4.39	Tr.	9.09	Tr.	14.89	Tr.	9.09	Tr.	8.33	Tr.	8.82	Tr.
Loblolly pine	*Pinus taeda*	4.39	Tr.	—	—	—	—	4.81	—	8.33	Tr.	—	—
Milk pea	*Galactia volubilis*	4.88	Tr.	7.27	Tr.	—	—	—	—	8.33	Tr.	6.62	Tr.
Soybean	*Glycine max*	14.15	29.15	13.94	25.92	Tr.	18.75	5.35	11.27	5.56	10.21	6.62	7.57
Rye	*Secale cereale*	6.34	Tr.	12.12	4.86	20.57	Tr.	12.83	Tr.	6.94	Tr.	11.76	5.28
Winged sumac	*Rhus copallina*	—	—	—	—	—	—	7.49	Tr.	—	—	6.62	Tr.
Number of Crops Examined		205		165		141		187		72		136	

Table 4. Bi-weekly food habits of quail during the winter of 1967-68.

Common Name	Scientific Name	Period I		Period II		Period III		Period IV		Period V		Period VI	
		%Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume	% Freq.	% Volume
Longleaf pine	*Pinus palustrus*	52.12	81.94	61.07	52.24	52.00	51.13	60.47	38.97	29.73	8.17	7.45	Tr.
Loblolly pine	*Pinus taeda*	16.36	7.32	—	—	11.11	Tr.	4.65	Tr.	4.73	Tr.	3.73	Tr.
Shrub lespedeza	*Lespedeza bicolor*	10.91	Tr.	10.07	Tr.	20.00	7.68	27.91	Tr.	39.86	20.59	22.36	13.44
Acorn fragments	*Quercus* spp.	4.24	Tr.	—	—	4.44	Tr.	2.33	Tr.	7.43	Tr.	3.11	Tr.
Rye	*Secale cereale*	1.82	Tr.	6.71	27.43	4.00	6.55	6.98	19.77	Tr.	23.21	Tr.	9.16
Red Bay	*Persea pubescens*	2.42	Tr.	14.77	9.38	20.00	17.73	27.91	11.79	22.30	18.47	22.98	32.92
Beggarweed	*Desmodium* spp.	3.64	Tr.	16.78	4.75	14.22	8.52	30.23	14.04	26.35	19.49	21.74	20.22
Milk pea	*Galactia volubilis*	—	—	—	—	4.00	Tr.	13.95	Tr.	15.54	Tr.	13.67	Tr.
Black Cherry	*Prunus serotina*	—	—	—	—	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	—	—
Wild lespedeza	*Lespedeza capitata*	—	—	—	—	Tr.	Tr.	6.98	Tr.	—	—	11.80	4.98
Wild sensitive bean	*Cassia nictitans*	—	—	Tr.	Tr.	3.11	Tr.	9.30	Tr.	8.11	Tr.	14.91	3.41
Spurred butterfly pea	*Centrosema virginiana*	—	—	Tr.	Tr.	—	—	Tr.	Tr.	3.38	Tr.	4.97	4.95
Number of Crops Examined		165		149		225		43		148		161	

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EFFECTS OF INTENSIVE GRAY FOX CONTROL ON POPULATION DYNAMICS OF RODENTS AND SYMPATRIC CARNIVORES

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ABSTRACT

The impact of continuously removing gray foxes *(Urocyon cinereoargenteus)* from upland Virginia poultry farms was studied over a 25-month period. Primary study areas were two sets of farm woodlots. Foxes were left undisturbed on one farm, and were intensively controlled for a 14-month period on the other. Demographic analysis of rodent populations and enumeration of sympatric carnivores were performed on both farms before, during, and after the period of fox control. During fox control, weasels *(Mustela frenata)* irrupted to significant ($P < 0.05$) levels; numbers of skunks, opossums, and raccoons remained unchanged. Weasels disappeared upon the reestablishment of foxes during postcontrol. Rodent trapping yielded 631 small mammals, including 331 woodmice *(Peromyscus leucopus)*, in 9,042 trapnights. Analysis of woodmouse population dynamics indicated that fox removal (and the resulting weasel irruption) did not affect overall density; however, all other parameters studied showed significant ($P < 0.05$) alteration. On the Reduction Area turnover rate increased, mean longevity fell from 3.10 to 1.68 months, sex ratios shifted toward more females, age structure shifted toward more subadults, and fecundity increased through continuous rather than seasonal breeding. The enlarged weasel population apparently exerted more predatory stress upon woodmice than did the original fox population. This study shows that a sympatric predator can assume the predatory role of a removed species. Implications are that predator removal studies may be invalid where sympatric predators are ignored, or where simple prey density is the only parameter used in assessing predator management.

INTRODUCTION

Predator control has long been a part of wildlife management and agricultural practice. In recent years it has become subject to increasing social and political controversy. Inherent in the phenomenon of predation are cryptic biological complexities which, if understood, might influence management decisions. Therefore, research is needed to identify not only the effects predators have upon prey populations, but also the potential adverse or favorable effects of predator management.

In some Virginia counties foxes have been managed, to a greater or lesser extent, for about 20 years. Control has been practiced in order to circumvent rabies epidemics (Marx and Swink 1963) and to protect livestock, especially poultry. In Rockingham County, Virginia, a professional trapper is employed to remove foxes upon demand by poultrymen or local citizenry. This county supports high populations of both gray foxes *(Urocyon cinereoargenteus)* and red foxes *(Vulpes vulpes)*, not only because of prime habitat but also because the area has one of the largest concentrations of domestic turkeys in the world. For about 9 months per year poultrymen keep flocks of turkeys on unprotected open range. In extreme cases there may be more than five flocks of over 5000 birds each, all within an

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