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SURVIVAL AND FLIGHT CHARACTERISTICS OF CAPTIVE-REARED AND WILD NORTHERN BOBWHITE IN SOUTHERN TEXAS

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Abstract

Introductions of captive-reared northern bobwhite (*Colinus virginianus*) to bolster native populations have been largely unsuccessful. We compared the survival and flight characteristics of game-farm (n = 46), first-generation (F_1) (n = 48), wild translocated (n = 45), and wild native (n = 50) northern bobwhites. In November 1993, all birds were radio-collared, leg banded, sexed, and aged. Birds were then released on a study area in Brooks County, Texas in groups of about 15, 1 bird at a time. Upon release, the direction of departure, speed, and time required to reach cover were recorded. The mean flight speed and distance flown for wild bobwhites was significantly greater ($P < 0.01$) than captive-reared bobwhites. Wild native, wild translocated, and F_1 groups were non-randomly distributed in direction of departure at release site ($P < 0.01$). Survival of wild groups was significantly higher than captive-raised groups ($P < 0.05$). The major cause of mortality in all groups was mammalian depredation. Fifteen F_1 quail and 1 game-farm quail integrated into wild coveys. Our results re-confirm the inability of game-farm and first-generation northern bobwhites to survive in the wild, and we offer flight speed as one potential causal factor.

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Key words: *Colinus virginianus*, direction of departure, first generation, flight speed, northern bobwhite, south Texas, survival

INTRODUCTION

Since the early 1900s, captive-reared upland gamebirds have been used in numerous stocking attempts in North America. Unfortunately, these birds typically failed to survive in the wild (Buechner 1950, Robertson and Rosenburg 1988, Kennamer et al 1992). Although there has been some limited success using first-generation birds bred from wild stock or crosses between wild and captive-reared birds, survival was substantially lower than that of released wild birds (Johnsgard 1973, Prince 1988, Robertson and Rosenburg 1988). As a result, large numbers of birds must be released over time. For example, a population of ring necked pheasants (*Phasianus colchicus*) was established in the upper Gulf Coast of Texas using approximately 17,000 hybrid pheasants (wild-trapped × pen-reared) released from 1968 through 1980 (Mabie 1980). However, Backs (1982) and Roseberry et al. (1987) found that first-generation, captive-reared northern bobwhite (hereafter bobwhite), released into the wild were unable to survive and reproduce. We found no reports of successful stocking attempts which resulted in a viable population using first generation bobwhites.

Long term breeding of captive animals can lead to loss of vigor, reduced viability, growth rate, and fertility (Seal 1977). Some biologists hypothesize that stockings of captive-reared birds fail more often than those using wild birds because of genetic differences (Nestler and Studholme 1945). Hatchery propagation led to decreased genetic fitness in Hawaiian geese (Berger 1977) and has been cited as a potential reason for the failure of stocking attempts of many species (Griffith et al. 1989). However, Ellsworth et al. (1988) were unable to detect genetic differences between game-farm, wild, and first-generation bobwhites. At any rate, genetic differences are not the only factors influencing survival of stocked birds.

The breeding, rearing, transport, and release of captive-reared birds are multi-variate processes, and failure at any step could result in decreased survival of released birds (Dees 1994). Commonly observed reasons for such failures include lack of predator avoidance behavior, inability to recognize natural foods, and imprinting on humans (Waggerman 1968, Klimstra and Scott 1973, Berger 1977, Welty and Baptista 1988). Additionally, decreased flight speed, poor

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utilization of escape cover, and social hierarchy differences could decrease survival. Kassinis and Guthery (1996) examined flight behavior of wild bobwhites and reported flights averaging 31 km/hr and 47 m. These values reflect optimum adaptations to habitat structure via natural selection pressure. Because it is difficult to determine whether certain behavioral traits are learned or innate, developing husbandry techniques to increase survival is difficult.

To address this problem, we tested the following hypotheses: (1) flight speed, distance, and direction of departure at time of release for captive-reared groups of bobwhite are slower, shorter, and more varied than wild coveys; (2) survival of first generation bobwhites reared under special husbandry conditions is greater than survival of game-farm bobwhites; and (3) wild translocated and wild resident bobwhites have higher survival than both first-generation and game-farm bobwhites.

STUDY AREA

Bobwhites were released on a 202-ha pasture on a private cattle ranch located in Brooks County in the Rio Grande Plains ecological region of Texas (Gould 1975). The area was actively grazed and burned in a rotational system. Soils were moderately well drained loamy fine sand with $<1\%$ slope. Annual mean maximum and minimum temperatures for the area were 28.9° and 15.6° C, respectively and mean annual precipitation was 65.4 cm (United States Department of Agriculture 1993). The major vegetative association on the study site was a mesquite-granjeno parks (McMahan et al. 1984). Percent brush coverage varied from 5 to 10%. Predominant brush species were mesquite (*Prosopis glandulosa*), granjeno (*Celtis pallida*), and prickly pear (*Opuntia* spp), with some huisache (*Acacia farnesianna*). Surrounding pastures had 60–80% brush coverage. At the time of release, there was abundant winter bobwhite forage, including partridge pea (*Cassia fasciculata*), giant croton (*Croton* sp.), ragweed (*Ambrosia* spp.), and other forbs.

METHODS AND MATERIALS

Husbandry

We collected ninety pairs of wild bobwhite using baited funnel traps (Stoddard 1931:442) in Brooks County, Texas, during September and October 1992. All birds were individually marked with aluminum leg bands and taken to the Southwest Texas State University hatchery in Hays County, Texas. These birds were then acclimated by over-wintering, allowed to breed, and eggs were collected, stored, and incubated using standard husbandry techniques (Dees 1994). However, from the time of hatch to release, human contact was kept to a minimum to avoid imprinting. Hatchery personnel wearing a dark coat moved chicks from the incubator to brood rooms under low blue light conditions. Food and water were provided automatically. At 8-weeks of age, chicks were allowed access to $3.6 \times 2.4 \times 28.3$ m flight pens, which were protected from disturbance by a visual barrier. From this point until release, birds interacted with humans once every few days when water and food supplies were replenished (Dees 1993).

Data Collection and Analysis

We used northern bobwhite in 4 groups of 50 as follows: (1) captive-reared first generation birds (F_1) produced from wild parents, (2) captive-reared birds (GF) from a commercial game-bird farm, (3) resident wild birds (WR) trapped on the study area, and (4) translocated wild birds trapped approximately 35 km from the study site (WT). The age and sex of each bird was determined. All birds were then fitted with uniquely numbered aluminum leg bands and 6 g necklace radio transmitters (Holohil Systems Ltd., model RI-2B). First-generation birds were collected from the flight pens before sunrise on 9 November 1993, placed in groups of 15 in standard cardboard quail shipping cartons, immediately transported to the study area, and released. Game-farm birds were delivered from a game bird breeder in Henderson, Texas, transported to the study area, and released on the same date. Resident wild birds were trapped and released at the trap site on 8 November 1993. Translocated birds were trapped from 10–12 November 1993 on a ranch located about 35 km from the study site. All birds were released on the study area in groups of about 15, 1 bird at a time. Birds within groups were kept out of visual, but not auditory, contact with the bird being released. Flight speed, time required to reach cover, and direction of departure were determined for each bird.

Flight speed was recorded with a Doppler radar gun. Time of flight was recorded with a stopwatch. Speed and time were used to estimate distance flown. Differences in speed and distance flown, by age, sex, and group were determined using ANOVA (SAS 1989). Direction was recorded as clockface vectors. The first bird released from each unit was assigned the direction of 90° and subsequent birds were recorded in 30° sectors (91–120°, 121–150°, etc.). To determine whether the departure direction was significantly nonrandom, we analyzed the data with a circular distribution statistic or *V test* at the $P < 0.01$ level (Zar 1984) as follows:

$$V = R \cos(\bar{a} - u_0)$$

Where R = mean vector length, $\bar{a}$ = mean angle, and u_0 = predicted mean angle. Length (R) is a measure of concentration and varies from 0 (data are too dispersed to describe a mean direction) to 1.0 (data are all concentrated in the same direction).

Telonics receivers (model TR-2) and scanners (model TS-1) were used to locate each bird daily for the first 15 weeks of the study. Thereafter, birds were located twice weekly. Whenever possible, the cause of death was determined by field signs left at the kill site, bird remains, and post-mortem transmitter condition (DeVos and Speake 1995). Monitoring ended after 21 weeks (3 April 1994). A chi-squared goodness of fit

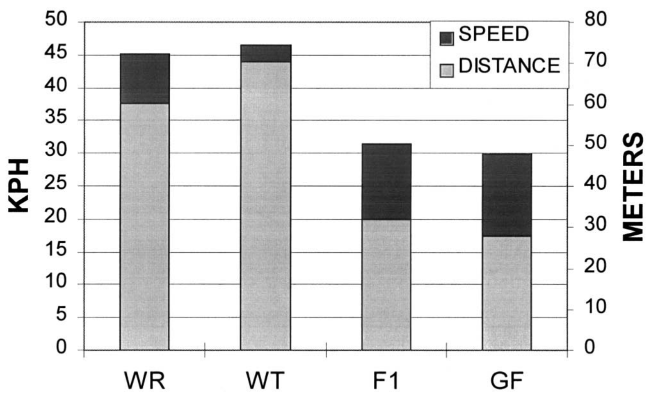

Fig. 1. Mean flight speeds and mean distances flown for wild resident (WR), wild translocated (WT), first-generation (F_1), and game-farm (GF) groups of northern bobwhite released in Brooks County, Texas, 1993.

Table 1. Frequency of direction of departure relative to the first bird released from coveys of wild resident (WR), wild translocated (WT), first-generation F(1), and game-farm (GF) northern bobwhite quail in Brooks County, Texas, 1993.

	WR		WT		F1		GF	
a_i (deg)[a]	f_i[b]	Relative f_i	f_i	Relative f_i	f_i	Relative f_i	f_i	Relative f_i
0–30	1	0.02	0	0.00	6	0.14	3	0.14
31–60	4	0.09	11	0.23	6	0.14	3	0.14
61–90	29	0.67	12	0.25	12	0.29	5	0.24
91–120	2	0.05	7	0.15	3	0.07	1	0.05
121–150	2	0.05	3	0.06	1	0.02	2	0.10
151–180	0	0.00	6	0.13	1	0.02	0	0.00
181–210	0	0.00	6	0.13	6	0.14	1	0.05
211–240	2	0.05	0	0.00	1	0.02	1	0.05
241–270	0	0.00	2	0.04	0	0.00	2	0.10
271–300	0	0.00	1	0.02	3	0.07	0	0.00
301–330	3	0.07	0	0.00	1	0.02	1	0.05
331–360	0	0.00	0	0.00	2	0.05	2	0.10
n	43		48		42		21	

[a] Angle.
[b] Observed frequency of a_i.

test (Zar 1984) was used to compare avian and mammalian mortality among groups. The LIFETEST procedure in SAS (1989) was used to analyze survival among groups at the $P < 0.01$ level. Birds with transmitter failure or birds harvested by hunters were included in the analysis as right-censored data (SAS 1989). Differences between groups were tested using log-rank tests. The ranked data were used to create 2 by 2 contingency tables, which were compared using an approximate Chi-square test statistic (Zar 1984, Pollock et al. 1989). The comparison-wise error rate was set at 0.008 so that the experiment wise error rate would be 0.05.

RESULTS

Flight Characteristics

We found differences in flight speed ($F = 33.28$, 3 df, $P = 0.0001$) and distance flown ($F = 22.90$, 3 df, $P = 0.0001$) by group, but no differences by age or sex. The mean flight speeds (km/hr) for WR (45.2 ± 0.8) and WT (46.5 ± 0.8) groups were significantly greater ($P = 0.0001$) than flight speeds of F_1 (31.4 ± 0.9) and GF (29.9 ± 1.2) groups (Fig. 1). The mean distances flown (m) by WR (60.3 ± 4.2) and WT (70.4 ± 4.2) were significantly farther ($P = 0.0001$) than distances flown by F_1 (31.8 ± 4.6) and GF (27.8 ± 5.8) groups (Fig. 1). There were no differences in flight speed or distance flown between F_1 and GF groups or between WR and WT groups. Wild resident ($u_{0.01,\ 43} = 6.704$, $P < 0.0005$), WT ($u_{0.01,\ 48} = 4.745$, $P < 0.0005$), and F_1 ($u_{0.01,\ 42} = 3.714$, $P < 0.0005$) groups were non-randomly distributed in direction of departure, while GF birds were randomly distributed ($u_{0.01,\ 21} = 2.197$, $P > 0.01$). Resident bobwhite flew in the expected mean direction more frequently than all other groups (Table 1), and had the greatest mean vector length ($r = 0.741$) when compared to WT ($r = 0.534$), F_1 ($r = 0.360$), and GF ($r = 0.374$) groups (Fig. 2).

Survival

Game-farm and F_1 quail reached 50% mortality in 9 and 10 days, respectively. Wild resident and WT birds reached a 50% loss in 72 and 47 days, respectively (Fig. 3). Survival at 12 weeks was similar between WR ($\hat{S} = 0.305$) and WT ($\hat{S} = 0.242$) groups, and was also similar between F_1 ($\hat{S} = 0.054$) and GF ($\hat{S} = 0.000$) groups. At the end of the monitoring period there were no surviving birds ($\hat{S} = 0.000$). We documented significant differences in survival among

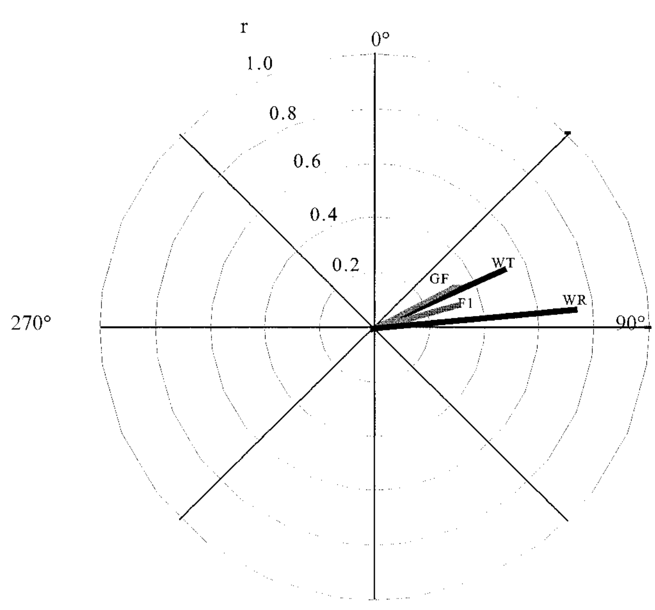

Fig. 2. Diagram of the mean direction (deg) of departure for wild resident (WR), wild translocated (WT), first-generation (F_1), and game-farm (GF) groups of northern bobwhite released in Brooks County, Texas, 1993. Length (r) is a measure of concentration and varies from 0 (data are too dispersed to describe a mean direction) to 1.0 (data are all concentrated in the same direction).

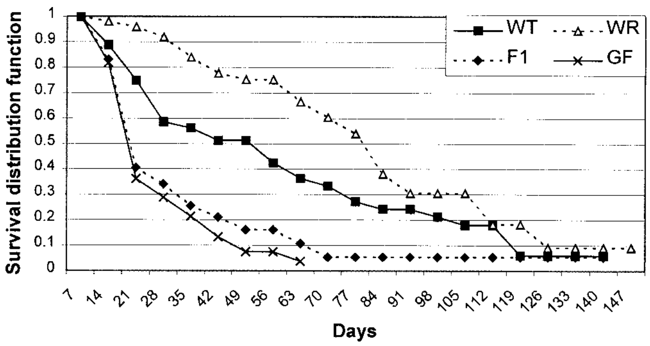

Fig. 3. Plot of the estimated survival distribution function vs. in days for wild resident (WR), wild translocated (WT), first-generation (F_1), and game-farm (GF) groups of northern bobwhite released in Brooks County, Texas, 1993.

groups (x^2 = 64.118, 3 df, P = 0.0001) (Fig. 3). Game-farm and F_1 birds had a significantly lower survival than wild groups at (x^2 = 15.079, 1 df, $P < 0.001$) and (x^2 = 7.085, 1 df, $P < 0.008$) respectively. There was no significant difference in survival between WR and WT (x^2 = 5.038, 1 df, $P > 0.03$) or F_1 and GF groups (x^2 = 0.639, 1 df, $P > 0.25$). However, cause of death was dependent on type of bobwhite group (x^2 = 11.61, 3 df, P = 0.008). Mammalian depredation was the leading cause of death in all groups. Game-farm birds experienced more avian depredation (26.1%) than WR (16%), WT (9%), and F_1 (4.3%) groups. Hunters harvested 28.9% of the resident birds and 16% of the translocated birds (Table 2). Most harvest took place after captive-reared groups had reached 50% mortality.

Table 2. Causes of mortality (%) for wild resident (WR), wild translocated (WT), first-generation (F_1), and game-farm (GF) northern bobwhite released in Brooks County, Texas, 1993.

Source	WR	WT	F_1	GF
Avian	17	9	4.3	26.3
Mammalian	39.6	60.4	74	61.9
Starvation/Dehydration	0	0	6.5	0
Collar came off	10.4	4.6	6.5	2.3
Unknown	4	10	8.7	9.5
Shot	29	16	0	0
Total	100	100	100	100

DISCUSSION

The mean flight speeds we recorded for WR (45 km/hr) and WT (46 km/hr) groups of northern bobwhite were consistent with the findings of Sooter (45 km/hr, 1947), but inconsistent with mean speed (31 km/hr) reported by Kassinis and Guthery (1996). The flight speeds of captive-reared GF and F_1 groups were significantly slower than wild groups in support of our initial hypothesis. Although game-farm and F_1 birds had similar mean flight speed, there were observable differences in flight characteristics. Twenty-nine percent of the game-farm birds walked away from the point of release, while only 8.5% of F_1 birds walked away. One F_1 quail was pursued by a great horned owl (*Bubo virginianus*) immediately after its release. This individual bird flew as fast (48.3 km/hr) as wild bobwhite before it escaped into heavy cover.

Upon initial release WT, WR and F_1 units were non-randomly distributed in their direction of departure while GF groups were randomly distributed. These results are inconsistent with our hypothesis that both captive-reared groups would be non-randomly distributed. However, it is important to note that at a $P < 0.05$ level GF birds would also be non-randomly distributed. Additionally, F_1 and GF birds had mean vector lengths (R) 50% less concentrated in direction than WR birds and 30–33% less concentrated than WT birds. Although not statistically significant, WT birds did not fly as consistently in the same direction as WR birds. Translocated birds were released in groups composed of birds caught at separate trap sites. These units were not natural coveys and this could be one possible explanation for differences in direction of departure between wild groups. Our results suggest that native coveys used auditory cues to fly in similar directions and distances at time of release.

Despite efforts to reduce the effects of imprinting, our hypothesis that F_1 birds would have greater survival than GF birds was not supported. There was no difference in survival between F_1 and GF groups. However, WR and WT birds had greater survival than both captive-reared groups, consistent with our third hypothesis and with the results of Roseberry et al. (1987) in Illinois.

Other observational information includes behavioral traits of captive-reared birds and integration of these birds into wild coveys. Game-farm birds showed little fear of humans, rarely flushing or not flushing very far. Avian predators took more GF birds (28%) than any other group. They were frequently found at the same daily location, usually under a mature mesquite, which may have improved avian predator efficiency. First-generation birds were consumed just as quickly, but changed their location more frequently and did not have as much avian depredation (4.3%). Fifteen F_1 birds and 1 game-farm bird integrated into wild coveys. Integrated F_1 birds flushed easily, and flew as fast as wild birds, while the game-farm bird did not fly, but instead ran in the direction of the flush. Integrated birds survived longer than groups containing no wild birds. Wild resident bobwhites remained in their release groups; wild translocated quail dispersed and then integrated into wild coveys resident to the site.

The breeding, rearing, transport, and release of captive-reared birds are multi-variate processes in which a multitude of factors influence the development of behavior. From the moment an egg is placed in a hatchery it is subject to different conditions than those in the wild. Temperature, humidity and other environmental stimuli are regulated artificially in breeding facilities and are certainly not identical to natural incubation. Some researchers have found evidence that differing levels of prenatal auditory (hen contentment calls) and visual stimulation (light patterns) interfered with the emergence of species typical patterns of postnatal development of incubator-reared bobwhite (Lickliter 1994, Sleigh and Lickliter 1996). It is unknown if prenatal stimuli at breeding facilities affect captive-reared birds any differently than the stimuli wild birds experience. We suspect that, once hatched, chicks in brood rooms and flight pens imprint on each other instead of a cock or hen, and their surroundings do not simulate native habitats. Klimstra and Scott (1973) found substantial differences between the diets of released captive-reared and wild bobwhite. They suspected that captive-reared birds might fail to recognize natural food items after their initial release. Bobwhites are highly social birds that communicate through numerous vocalizations and body language. These mechanisms have been developed over time as adaptations to the natural environment. Bobwhite depend on these vocalizations to facilitate breeding, predator avoidance and social hierarchy (Guthery 2000:5). It is unlikely that these mechanisms can be fully developed in flight pens. Although F_1 birds were subject to depredation by snakes, raccoons, and dogs, and harassment by birds of prey, their ability to avoid predators in the wild was not better than game-farm birds. Our findings reconfirm the inability of captive-reared first-generation northern bobwhite to survive in the wild and we offer flight speed as one potential causal factor.

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