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FACTORS INFLUENCING NORTHERN BOBWHITE HUNTING SUCCESS ON TWO SOUTH GEORGIA PLANTATIONS

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ABSTRACT

Success of wild northern bobwhite (*Colinus virginianus*) management programs on private lands is most often measured by the rate of coveys pointed during the hunting season. Thus, managers of these properties are keenly interested in factors that influence hunting success. We examined how coveys pointed/hour, a measure of hunting success, was influenced by time of hunting season, time of day, weather parameters, and supplemental feeding on 2 intensively-managed plantations over 4 years. There were significant annual differences in the number of coveys pointed/hour among the 4 study years, but hunting success did not vary during the hunting season. Afternoon hunts had consistently higher success rates than morning hunts; however, the effect size was variable from year to year. The selected weather model indicated an interaction between 12-hr barometric pressure change and starting air pressure; hunting success increased with a rapid pressure increase that resulted in a high pressure value at the start of the hunt. A secondary weather model documented a negative relationship between starting air temperature and hunting success. The number of days since supplemental feed was spread had no significant effect on hunting success in 5 of 6 years for the 2 plantations over 3 years. Knowledge of how these variables influence hunting success should improve hunting and provide realistic expectations of hunt success for a given set of circumstances.

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Key words: *Colinus virginianus*, coveys pointed/hour, Georgia, hunting success, northern bobwhite, season, supplemental feeding, weather

INTRODUCTION

Plantations that intensively manage for wild northern bobwhite hunting often use the number of coveys pointed during a hunt as a primary measure of success. Landowners and managers of these properties, expend extensive time and monetary effort to maintain high bobwhite population levels to maximize hunting success. Hunting success is often the only variable used to evaluate management success or to generate an index of population size (Palmer et al. 2002). Thus, there is tangible interest from plantation staff to better understand the potential factors that influence hunting success to better assess population levels and land management impacts.

Southeastern plantations support bobwhite populations that are sufficiently large to observe coveys on essentially every hunt and provide an opportunity to measure potential factors that impact hunting success (Stribling and Sisson 2009). There is often adequate variation in daily hunting success to assess the effect of independent variables at multiple time scales. Bobwhite populations do not fluctuate as dramatically annually

compared to other portions of the species range, which allows for data to be pooled among years with a reduced year effect (Brennan et al. 2000, Palmer et al. 2002). Plantations conduct hunts regardless of weather rather than picking the best days to hunt, which provide a breadth of hunting weather conditions. They also hunt based on tradition and routine, and record covey observations following specific rules, which has allowed for hunts and data collection to be relatively standardized (Rosene 1969). This level of hunting consistency and sample size allows for a more detailed analysis of some of the factors influencing hunting success. There has been limited previous research that has quantified the influence and interaction of temporal hunting variability and weather variables on hunting success. Previous analyses have been based on general observations (Rosene 1969) or from quantified observations (Sisson and Stribling 2009) with no specific attempt to document effect size.

Use of supplemental feed spread along dedicated trails consistently every 2 to 3 weeks throughout the year has become a standard practice on southeastern plantations (Stribling and Sisson 2009). Sisson et al. (2000b) documented that use of supplemental feeding initially reduced hunting success when compared to

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hunting results in areas without food supplementation. This result was also correlated with decreased winter home range size and increased over-winter survival (Sisson et al. 2000a). Presumably, high food availability associated with supplemental food areas reduced the susceptibility of bobwhites to harvest. However, it has been recognized that availability of supplemental feed decreases during the time between spreading of feed (Miller 2011). There is potential for hunting success to change as food availability changes between feedings.

Our study objectives were to: (1) quantify the changes to hunting success relative to daily and seasonal timing, (2) investigate the potential impacts of weather variables on hunting success, and (3) investigate the relationship between the days post supplemental feeding and plantation hunting success.

STUDY AREAS

We conducted this study on 2 private plantations in southern Grady County (Grady Plantation) and Baker County, Georgia (Baker Plantation). The primary management objective of these plantations is to maintain high density bobwhite populations (> 3.7 bobwhites/ha) with other game species management and timber production as secondary objectives. Grady Plantation (2,266 ha) contained upland pine (*Pinus* spp.) (70%), hardwood drainages (22%), scattered 0.8–2 ha annually-disked fields (4%), and other minor land cover types and property improvements (4%). Upland pine habitat consisted of planted loblolly pine (*P. taeda*) stands ranging from 10 to 50 years of age. All pine stands had been thinned over a 5-year period to timber densities with a range of basal areas (4.4 and 9.1 m²/ha), which resulted in open canopies that allowed growth of contiguous groundcover suitable for bobwhites. The Baker Plantation (4,490 ha) was composed of natural openly-spaced mature pine (4.4 and 9.1 m²/ha) woodlands with scattered live oaks (*Quercus virginiana*) (78% of study area). Upland timber was managed to have a low density of trees with an open canopy to promote a contiguous growth of groundcover favored by bobwhites. Scattered throughout the uplands were fields (1–2 ha) (17%), which were annually disked in January to promote annual weed growth.

Management in the uplands on both study areas included use of low intensity biennial prescribed fires, roller drum chopping, and mowing to produce groundcover conditions favorable for bobwhites. Other management activities included year-round supplemental feeding with milo and corn, and mesomammal predator trapping. Supplemental feed was scattered throughout the uplands along a dedicated trail using a tractor and feed wagon. Feed trail density varied, but averaged 2.9 km of feed trail for every 40.5 ha of upland habitat. Feed was spread on a course approximately every 14 days, but feed times ranged from 12 to 25 days. The amount of feed used on both study areas was ~ 174 to 261 L/ha/yr.

METHODS

Hunting Data

Bobwhite hunting on both plantations was conducted consistently throughout the Georgia bobwhite hunting season, mid November-late February. Hunting parties consisted of the hunt manager who coordinated all activities during the hunt, 1 or 2 scouts that kept track of the hunting dogs, a wagon driver, the hunting supply wagon, and 1 to 4 hunters. All hunts were conducted on horseback and from the hunting wagon. Hunting dogs, primarily English pointers, were used in braces with 2 to 4 braces used throughout the hunt. The amount of land covered during a hunt ranged from 81 to 162 ha, which was the typical size of a hunting course. Hunting courses were hunted between 1 and 6 times within a hunting season. The typical hunt was ~ 3 hrs in length, but ranged from 1.5 to 3.5 hrs. Hunts were classified as morning (0900 and 1200 hrs), or afternoon (1500 and 1800 hrs). Start times and length of hunting had minimal variation during the study. Records for each hunt were recorded by the hunt manager. Records included the location of the hunting course, start and end times, number of participants, general weather, days since supplemental feed was spread on the hunt course, number of coveys seen, number of coveys pointed, single bobwhites pointed, and number of bobwhites harvested. Coveys seen was the total number of coveys seen during the hunt including wild flushes and pointed coveys. Pointed coveys were those that were pointed by a steady dog and included those that were shot into and those that flew before the hunt party could arrive. Single bird flushes, both pointed and wild flushes, were recorded separately and not used in the analysis. A covey was defined as a group of ≥ 6 bobwhites.

Weather Data

We collected detailed weather information from a Georgia automated environmental monitoring network weather station at Wight Nurseries (4.3 km west of Cairo, GA, USA), 16 km northwest of Grady Plantation and 48 km south of Baker Plantation. We selected this weather station because it was between both study areas and data were collected hourly with minimal interruptions, and were archived. Hourly weather data collected from the station were air pressure (kilopascal), air temperature (°C), relative humidity (%), wind speed (m/sec), wind direction (degrees), and precipitation (mm).

Data Analysis

The analysis focus was the effect of various weather parameters on the number of coveys pointed during a hunt. The exact time that each covey was pointed was not known and only the total number of coveys pointed during the hunt was known. Thus, the rate of coveys pointed/hour (pointed/hr) and the total coveys pointed divided by length of hunt was used as the dependent variable. Weather variables were summarized for each hunt and analyzed. Hunt start times were rounded down and end times up to maximize the number of weather observations

Table 1. Annual hunting success differences (mean $\pm$ CI) by time of day and time of season for 2 plantations in southern Georgia, 2006-07 to 2009-10.

	Hunting season	<i>n</i>	Pointed coveys/ hour	Time of day		Time of season	
				AM	PM	Early	Late
Grady Plantation	2006-07	40	3.10 $\pm$ 0.28	3.08 $\pm$ 0.44	3.03 $\pm$ 0.36	2.91 $\pm$ 0.41	3.16 $\pm$ 0.37
	2007-08	41	2.80 $\pm$ 0.28	2.28 $\pm$ 0.44	2.94 $\pm$ 0.37	2.89 $\pm$ 0.51	2.75 $\pm$ 0.34
	2008-09	44	3.23 $\pm$ 0.33	2.54 $\pm$ 0.32	3.76 $\pm$ 0.42	3.37 $\pm$ 0.58	3.12 $\pm$ 0.38
	2009-10	50	4.22 $\pm$ 0.22	4.12 $\pm$ 0.32	4.37 $\pm$ 0.28	4.37 $\pm$ 0.36	4.13 $\pm$ 0.27
Baker Plantation	2006-07	127	4.70 $\pm$ 0.32	4.62 $\pm$ 0.49	4.78 $\pm$ 0.41	4.60 $\pm$ 0.43	4.80 $\pm$ 0.48
	2007-08	100	4.10 $\pm$ 0.30	3.59 $\pm$ 0.40	4.63 $\pm$ 0.41	4.39 $\pm$ 0.61	3.97 $\pm$ 0.34
	2008-09	105	4.98 $\pm$ 0.30	4.59 $\pm$ 0.40	5.40 $\pm$ 0.43	4.77 $\pm$ 0.5	5.08 $\pm$ 0.38
	2009-10	100	5.26 $\pm$ 0.30	4.70 $\pm$ 0.39	5.72 $\pm$ 0.41	5.69 $\pm$ 0.59	5.09 $\pm$ 0.35

for each hunt. Each hunt had between 3 to 5 weather observations for analysis. Correlation matrixes were analyzed to assess multicollinearity among the data, which could decrease the precision of individual estimated coefficients by inflating variance (Burnham and Anderson 1998). A pairwise comparison of weather variable regression coefficients was used and correlated variables of $r < -0.40$ or $r > 0.40$ were considered similar and only one was selected for further analysis. It resulted in a truncated list of weather variables to use as independent variables in the model analysis. Variables included in the model were air pressure at the start of the hunt (AIRPRES), the 12-hr change in air pressure prior to the start of the hunt (PRESCHANGE), average air temperature during the hunt (TEMP), average relative humidity during the hunt (RH), average wind speed during the hunt (WIND), average wind direction during the hunt (WINDDIR), and the amount of precipitation 3 days before the hunt (PRECIP). The categorized variables time of day and time of season were used as independent variables. Time of day was categorized as morning (0900–1200 hrs) or afternoon (1300–1800 hrs) and time of season was classified as early (Nov–Dec) and late (Jan–Feb).

We used an Akaike Information Criterion (AIC) modeling approach for data analysis and inference related to weather parameters. A list of 23 biologically plausible models was generated using a combination of weather variables, time of day variables, and relevant 2-way interactions prior to analysis. The global model included all variables including all possible 2-way interactions and was preliminarily analyzed to test for model convergence and significance. We generated AIC for small sample sizes (AIC_c) for each model and estimated variable parameters using generalized linear modeling (GLM) procedures for both fixed and random variables (PROC MIXED; SAS Institute Inc. 2008). Hunt year was not included in any of the model statements in the weather analysis due to model over parameterization.

GLM procedures were used (PROC GLM; SAS Institute Inc. 2008) for analysis of the supplemental feeding data. Hunting records for each study site were analyzed separately. Hunting success data were blocked on year and days since feeding was treated as a covariate and the interaction between these variables was analyzed.

RESULTS

We reviewed 175 hunting records on Grady Plantation that were collected during 4 hunting seasons (2006-07 to 2009-10). Number of hunts per year ranged from 40 to 50 and the average number of coveys pointed/hr was 3.4 ± 0.16 (95% CI) (Table 1). Hunting success varied among hunting seasons with 2007-08 having below average coveys pointed/hr and the 2009-10 hunting season having above average coveys pointed/hr (Table 1). We observed minimal differences in coveys pointed/hour between the early (mean = 3.44 ± 0.27 , $n = 71$) and late hunting seasons (mean = 3.33 ± 0.20 , $n = 104$) with this pattern being similar across years (Table 1). Coveys pointed/hr were slightly higher for afternoon hunts (mean = 3.51 ± 0.21 , $n = 94$) compared to morning hunts (mean = 3.21 ± 0.24 , $n = 81$). Higher afternoon hunting success was documented for 3 of 4 years with the 2008-09 hunting season having significantly more coveys pointed/hr in the afternoon (Table 1).

Grady Plantation hunting records were also used in the weather variable analysis. The selected best model ($AIC_c = 465.8$; $\Delta AIC_c = 0.0$; $w_i = 0.73$) from the 23 models included the explanatory variables time of day, AIRPRES, PRESCHANGE, and AIRPRES $\times$ PRESCHANGE interaction. Variable parameter estimates ($\pm$ 95% CI) for the selected best model were 7.03 ± 39.5 for intercept, -0.6221 ± 0.280 for time of day (AM), -0.033 ± 0.240 for AIRPRES, -127.44 ± 75.8 for PRESCHANGE, and 1.256 ± 0.744 for the AIRPRES $\times$ PRESCHANGE interaction. Variable parameter estimates where the 95% CI did not incorporate zero included time of day (AM), PRESCHANGE, and AIRPRES $\times$ PRESCHANGE. There were significant differences in the predicted slopes of PRESCHANGE between low and high starting AIRPRES (Fig. 1). We observed model convergence with good model fit and a significant predicted slope for all but 1 explanatory variable, but the overall coefficient of determination was low ($R^2 = 0.12$). The second best model ($AIC_c = 468.0$; $\Delta AIC_c = 2.2$; $w_i = 0.24$) was the same as the selected best model with the addition of TEMP (-0.0368 ± 0.0358). This indicated a decrease in coveys pointed/hr as the temperature increased.

There were 135 observations on Grady Plantation from 3 hunting seasons, 2007-08, 2008-09, and 2009-10, used for analysis on the impacts of days since supple-

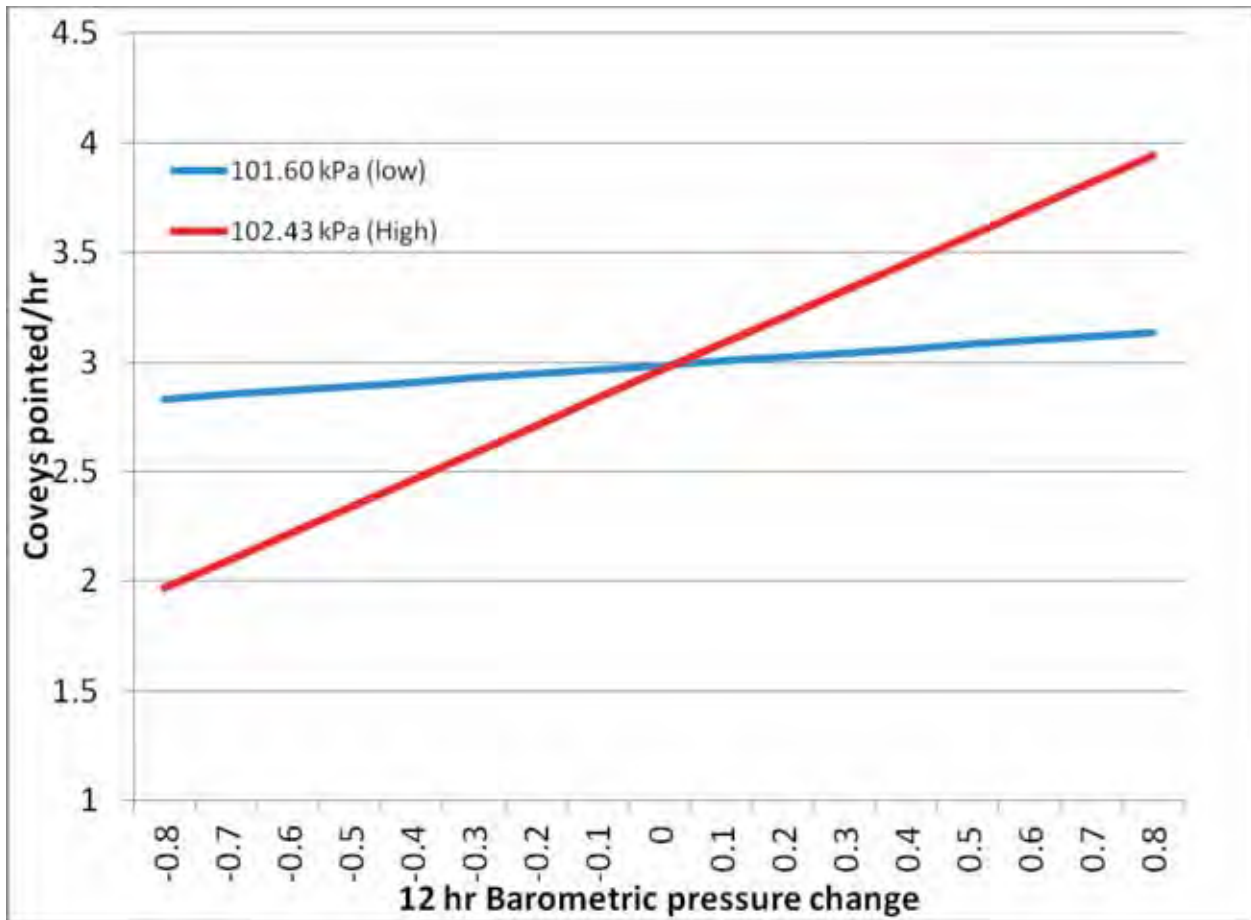


Fig. 1. Predicted bobwhite coveys pointed/hr from the selected best model for Grady Plantation, 2006-07 to 2009-10. Prediction lines include a low (101.60 kPa) and a high (102.43 kPa) barometric pressure value in relation to the 12-hr barometric pressure change prior to the hunt. All other model variables were fixed using data means.

mental feeding on coveys pointed/hr. Supplemental feeding data were not collected during the 2006-07 hunting season. Multiple regression revealed a significant year effect ($F_{2,129} = 14.5$, $P = 0.0001$), a significant effect of days since supplemental feeding ($F_{1,129} = 6.17$, $P = 0.01$), and a significant effect of the interaction between these variables ($F_{2,129} = 6.19$, $P = 0.002$) (Fig 2A). Days since supplemental feeding had an overall inverse relationship ($\beta = -0.1152 \pm 0.0565$) to coveys pointed/hr, but that negative trend was only observed in 1 of 3 years (Fig 2A).

We reviewed 432 hunting records from Baker Plantation during the same 4 hunting seasons (2006-07 to 2009-10); the number of hunts for each season ranged from 100 to 127 and the number of coveys pointed/hr averaged 4.76 ± 0.16 . Hunting success, similar to Grady Plantation, varied among hunting seasons with the 2007-08 season having below average coveys pointed/hr and the 2009-10 season having above average coveys pointed/hr (Table 1). Minimal differences were observed between early season (mean = 4.79 ± 0.27 , $n = 157$) and late season hunting success (mean = 4.74 ± 0.20 , $n = 275$) with no consistent pattern among years (Table 1). Conversely, we observed higher hunting success for

afternoon hunts (mean = 5.13 ± 0.22 , $n = 217$) compared to morning hunts (mean = 4.39 ± 0.22 , $n = 215$), which was consistent among all years (Table 1).

We used the same 23 models on Baker Plantation for the weather analysis as on Grady Plantation. Baker Plantation had the same selected best model as Grady Plantation ($AIC_c = 1635$; $\Delta AIC_c = 0.0$; $w_i = 0.89$). Variable parameter estimates were similar, which included intercept (32.47 ± 57.92), time of day (AM) (-0.86 ± 0.33), AIRPRES (-0.27 ± 0.35), PRESCHANGE (-155.59 ± 106.38), and AIRPRES x PRESCHANGE (1.53 ± 1.04). The selected best model had a low overall coefficient of determination ($R^2 = 0.07$) even with model convergence and multiple variables with significant slopes.

There were 295 observations on Baker Plantation from 3 hunting seasons, 2007-08, 2008-09, and 2009-10, used to analyze the impact of days since supplemental feeding on coveys pointed/hr. Multiple regression revealed a significant year effect ($F_{2,289} = 14.9$, $P = 0.0001$), but no effect from days since supplemental feed was spread ($F_{1,289} = 0.02$, $P = 0.88$), nor was there an effect of a year by days since supplemental feed interaction ($F_{2,289}$

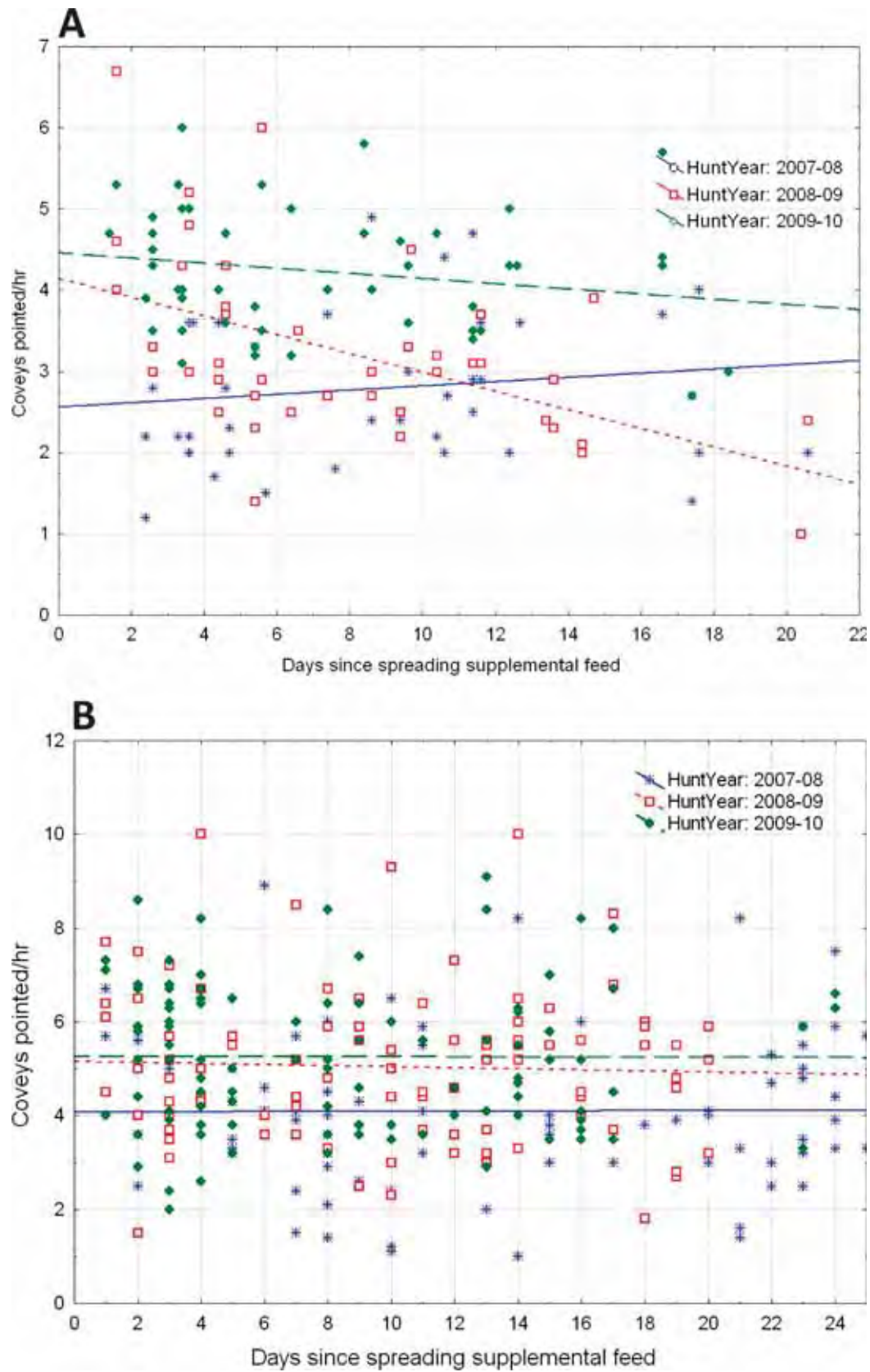


Fig. 2. The relationship between the number of bobwhite coveys pointed/hr and number of days since supplemental food was spread on Grady Plantation (A) and Baker Plantation (B) for the hunting seasons, 2007–08, 2008–09, and 2009–10.

= 0.08, $P = 0.92$) (Fig 2B). The model had a low coefficient of determination ($R^2 = 0.09$).

DISCUSSION

Hunting methods on these plantations were complex and incorporated many variables that potentially impacted hunting success. Our models explained little of the daily variation among hunts on either study area. We anticipated that weather variables, coupled with the consistency of hunting methods, would have had a more significant impact on hunting success. The systematic way hunting is conducted on our study areas, as compared to walk hunting by hunters and their dogs with varied skill levels (Guthery and Mecozzi 2008, Mecozzi and Guthery 2008), should have helped estimate the effect of weather conditions on hunting success. The success of hunting on our study areas was a function of some measured variables, such as time of day, but many unmeasured variables, such as how the hunt manager changed to accommodate to existing conditions, population size, and bobwhite behavior, likely ameliorated the strength of observed relationships. The ability of skilled hunt managers to compensate for environmental conditions appeared to reduce the effect of our measured explanatory variables. The hunting manager had a primary goal of pointing as many coveys possible during the hunt, and adjustments to the routine and style were made on a daily and annual basis to accomplish this goal. Bobwhite coveys were uniformly scattered across managed lands with few areas that are not accessible or covered by dogs. This consistency of habitat likely helped hunters find coveys at some time during the hunt when scenting conditions were not as favorable. Our data on hunting success were summarized by hunt, rather than in continuous time, and may be too crude to assess the effect of highly variable weather conditions on hunting success.

Differences between morning and afternoon hunting success may be caused by when the hunts actually took place during those time periods. The average start time of morning hunts was 0916 hrs, which may have been after most of the covey activity for the morning had occurred for many days. Sisson and Stribling (2009) documented the highest covey activity, on average, for the entire day was from 0730 to 0830 hrs. Lower morning hunting success observed during our study may have been due to hunt times inconsistent with the peak activity periods of coveys. Conversely, afternoon activity periods for coveys peaked from 1645 to 1815 hrs (Sisson and Stribling 2009), which were within the typical afternoon hunting period. Our results suggest hunting times that correlated with peak covey activity periods can improve hunt success.

Time of season had minimal effects on hunt success and had no consistent pattern among years or study areas. There are many perceived factors associated with seasonal timing that can influence hunting success such as habitat quality and quantity that decreases as the winter progresses, and covey avoidance behavior that increases as the hunting season progresses. We did not evaluate the

effects of these seasonally-correlated variables on hunting success and our results support the hypothesis that their overall impacts were minimal when analyzed seasonally on plantations. This hypothesis is based within the context of those hunting plantations where hunting pressure was light with a hunting course being visited every 2 to 3 weeks. We also investigated the monthly effects on key weather parameters used in the analysis. There were some differences in the monthly averages for all weather parameters, but they all had broad distributions that overlapped the monthly averages. This outcome supported the conclusion that weather effects on hunting success are not correlated with seasonal impacts.

Changes in weather had the potential to improve hunt success in 2 ways in our study; (1) by increasing bobwhite activity and the probability of detection, and (2) by improving the pointing-dogs' abilities to detect and point bobwhite coveys through better scenting conditions. Hunts for both study areas associated with rapid increases in barometric pressure resulting in high barometric pressure had the highest hunting success. These types of weather events in South Georgia were associated with a rapidly passing low pressure system followed by a high pressure system with a strong frontal boundary. As a high pressure system moves in, it typically brings colder temperatures, more stable air, and wind directions from the west and north. These weather conditions, tend to be short-lived, but could have significant impacts on bobwhite activity and scenting conditions. Sisson and Stribling (2009) observed more activity by coveys when there was colder weather, higher humidity, and light winds, which are similar conditions to hunts we observed with the highest hunting success. Higher bobwhite covey activity may be a potential factor for increased hunting success.

We observed no differences in hunting success between both study areas for 5 of 6 years relative to the number of days since supplemental feed was broadcast on a hunting course. There should be higher hunt success immediately after spreading feed and a decline in hunt success as food resources decline, if supplemental feed was acting as bait and concentrating coveys along feed lines. We observed no change in hunting success regardless of the number of days since supplemental feed was broadcast out to 25 days. An exception was during the 2008-09 hunt year on Grady Plantation, which had 2 below average hunts after 20 days since spreading feed that greatly affected the linear relationship. However, the majority of hunts for most years were conducted up to 15 days since spreading feed when supplemental food was still available (Miller 2011) and average hunt success remained consistent.

MANAGEMENT IMPLICATIONS

Successful bobwhite hunts are a function of bobwhite populations, daily timing, weather, habitat conditions, knowledge of the hunting party, and skill of the pointing dogs. Time of hunting had a significant effect with afternoon hunting adding 1–3 more coveys per 3-hr hunt.

We found that weather has a minor impact on hunting success on average on intensively managed lands with high density bobwhite populations. Experience indicates that at times unsuitable weather impacts hunting success temporarily, but it would be difficult to attempt to schedule hunts based on weather conditions to maximize hunting success. A better perspective would be to schedule hunting based on convenience rather than based on conditions, recognizing that certain conditions outlined in this paper may potentially impact hunting success. We recognize the best way to have high hunt success is for hunt managers to focus on maintaining high bobwhite densities through sound habitat management and using high quality bird dogs.

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