Maryland Birdlife 68(1):23–37

Near Catastrophe to Recovery: A Northern Bobwhite (*Colinus virginianus*) Success Story in Maryland

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Abstract: Standardized fall covey counts and summer male whistling counts were conducted between 2009 and 2017 to monitor a wild Northern Bobwhite (*Colinus virginianus*) population on Chino Farms in Queen Anne's County, Maryland. The bobwhite population declined by an estimated 93% from 35 coveys to less than 3 between fall 2009 and fall 2010, presumably due to two historic blizzards in February 2010. Annual population increases resulted in approximately 43 coveys on the property by 2017. Summer male whistling counts increased from an average of 0.07 calling males per survey stop in 2010 to an average of 2.78 males per stop in 2017. Population recovery was greatest in grassland areas with a high proportion of native warm season grasses as well as in areas on the property that had higher bobwhite populations prior to the snow event. The results highlight the importance of creating and maintaining large, contiguous areas of grassland with interspersed early-successional woody habitat on the landscape.

Northern Bobwhite (*Colinus virginianus*; hereafter, bobwhite) populations have declined range-wide since the at least the 1960s, with some of the greatest declines occurring in the Mid-Atlantic region (Sauer et al. 2017). Declines have been attributed to various factors including increased development, habitat loss, changes in modern farming practices, and habitat succession (Brennan 1991, Guthery et al. 2000, Washburn et al. 2000, Williams et al. 2004, Brennan and Kuvlesky 2005, Flock 2006, Lohr et al. 2011). When habitat becomes limited or less than ideal, bobwhites suffer increased pressure from meso-mammal and avian predators which further stresses already dwindling populations (Hughes et al. 2005). Williams et al. (2003) demonstrated that there is greater variability in peripheral bobwhite population densities due to greater sensitivity to environmental fluctuations during October through January in Kansas.

Severe winter weather events have also been shown to have serious negative effects on bobwhite populations (Roseberry 1964, Roseberry and Klimstra 1984, Robel and Kemp 1997), particularly along the northern latitudinal edges of the bobwhite range (Errington 1936, Leopold 1937, Peterjohn 2001, Lohr et al. 2011, Janke and Gates 2012, Janke et al. 2017), or in small isolated populations (Williams et al. 2003). Intra-seasonal survivorship can fluctuate widely during the winter period when many selective pressures influence the number of birds that survive to enter the breeding season (Guthery et al. 2000). As in other northern parts of the bobwhite range, the Mid-Atlantic region can experience extreme snow events, either high snow accumulation over a short period of time or prolonged snow coverage, which present challenges for bobwhites (Lohr et al. 2011, Janke et al. 2017). Snow events can increase exposure to predation, limit access to food and cover (Janke et al. 2017, McLaughlin et al. 2019), and effect thermoregulation (Swanson and Weinacht 1997). Bobwhites utilize thick woody cover in the form of hedgerows and shrub thickets for protection. Areas that lack this appropriate winter cover often experience larger bobwhite population decreases than areas with extensive cover (Williams et al. 2000, Seckinger et al. 2008, Janke and Gates 2013, Janke et al. 2015), particularly in agricultural dominated landscapes (Hughes et al. 2005). Low breeding populations that exist after extreme winter snow events can take many years to recover (Janke et al. 2017). Using North America Breeding Bird Survey data, Janke and co-authors (2017) found a continued negative effect on bobwhite abundance for at least four years in Ohio after a severe winter snow event. If sufficient areas of nesting and brood rearing habitat exist, populations can rebuild, but populations in areas with marginal nesting habitat can take much longer to rebound or simply disappear (Guthery et al. 2000, Janke et al. 2017).

Here we present the monitoring results from 2009–2017 and discuss how habitat and management may be influencing the bobwhite population on the farm. We initiated bobwhite covey calling counts in fall 2009 and began male whistling counts in summer 2010. The counts have been conducted on an annual basis since, allowing us to monitor the population and assess management activities on the farm. In addition to helping us evaluate our management efforts and document population fluctuations our hope is that data presented here on bobwhite habitat associations will aid, guide and inspire other working lands throughout the Delmarva to increase and manage lands dedicated to Northern Bobwhite.

METHODS

Surveys were conducted on Chino Farms (39.231022°, -76.005853°) which is a 2,047 ha (5,059 ac) property in northern Queen Anne’s County, Maryland. The property was recently gifted to Washington College and the name of the property has been changed to the River and Field Campus, but for consistency and clarity we will refer to the property as Chino Farms here. Chino Farms is a multi-use property with approximately two-thirds of the land dedicated to modern precision agriculture, the remaining land is a mix of varied habitat types including large native grasslands, field buffers, mature deciduous woods, creeks, and rivers. Approximately 304 ha (750 ac) are managed as bobwhite habitat. An effort was made after 2010 to create additional areas of woody escape cover on the farm, this included planting shrub islands and altering our management activities in specific areas to allow for more shrub/scrub habitat.

We used two widely used monitoring methodologies to assess bobwhite populations: fall covey counts and summer whistle counts. These surveys are considered to be minimally intrusive techniques to provide a reasonable index of the population over the area surveyed when conducted by experienced observers (Wellendorf et al. 2004, Wellendorf and Palmer 2005, although see Norton et al. 1961 and DeMaso et al. 1992). These population indices can help in determining the effects of habitat management activities on local bobwhite populations.
In 2009, covey counts were initiated on Chino Farms as part of a radio telemetry study (see Janke et al. 2017 for more details). In fall, bobwhites give a distinctive “koi-lee” covey call in the morning. During covey count surveys, trained researchers recorded the number of individual coveys calling to index fall bobwhite abundance (Stoddard 1931, Stokes 1967). Covey call monitoring was conducted between 9 October and 5 November in years 2009–2012 and 2015–2017 on Chino Farms. Twelve point-count listening locations with a 500 m (1640 ft) radius were established in 2009 and surveyed each year (Figure 1), with the exception of point-count location #12 which was discontinued in 2015 because a released bobwhite hunting operation was established in close proximity to the count location.

The 12 point-count locations were located in areas with varying amounts of what we determined to be suitable bobwhite habitat. Assuming a 500-m (1640-ft) listening radius around each point, each point-count covered 78.5 ha (194 ac) for a total 942 ha (2,328 ac) sampled across the 2,047 ha (5,059 ac) property. In order to place all the count locations in appropriate habitat throughout the farm, some points had overlapping listening areas. Care was taken not to double count calling birds at these locations. Landscape attributes were classified and mapped within each listening area using ArcMAP 10.3 (Esri 2014; Table 1). While all landscape features were mapped, specific habitat types considered to be suitable quail habitat within each listening area included: native warm season grasses, early successional habitat, hedgerows, managed woods.

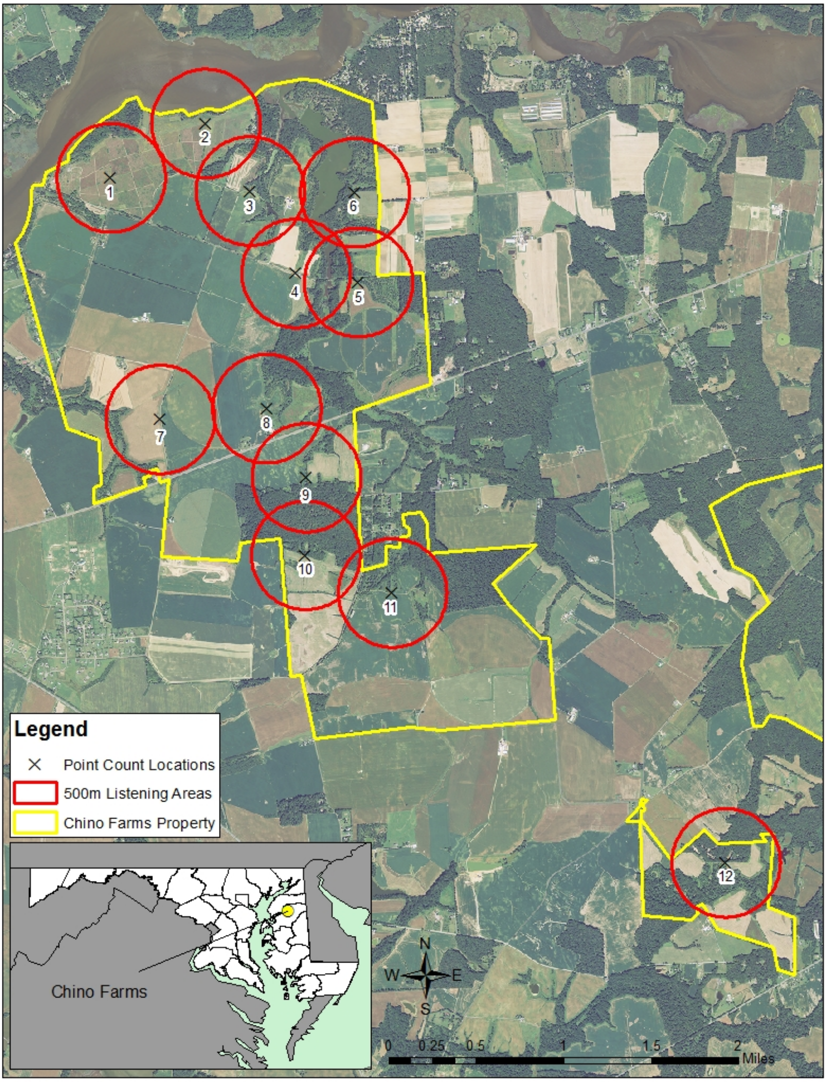

Figure 1. Map depicting 12 point-count locations and Chino Farms property boundaries located in Queen Anne's County, Maryland.

Table 1. Percentage of each habitat type located within each 78.5-ha (194-ac) point-count (PC) area on Chino Farms, Queen Anne's County, Maryland.

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11	PC 12
Warm Season Grass	59.1	39.6	5.6	6.2	6.4	1.6	0.8	16.3	1.4	0	0.6	3.4
Early successional Habitat	6.3	9.5	7.3	2.2	3.2	2.3	4.6	0.2	2.6	4.4	13.2	2.1
Hedgerow Rows	2.8	1.6	4.1	4.0	14.2	4.8	0	3.1	1.2	3.8	1.7	6.7
Managed woods	0	0	0	0	0	22.7	0	2.0	5.2	0	4.8	0
Other - Quail Habitat[1]	1.3	1.3	2.2	3.4	12.2	10.5	0	1.2	1.9	0.9	2.0	1.8
Agricultural Land	9.0	1.7	53.8	49.2	28.1	22.0	84.9	55.2	45.7	42.6	48.9	33.4
Deciduous Woods	15.4	7.5	20.5	24.2	27.3	12.5	5.7	12.8	39.7	47.9	25.0	51.3
Other - Non-Quail Habitat[2]	6.1	38.9	6.6	10.7	8.7	23.6	4.0	8.7	2.4	0.4	3.9	1.4

[1]Including: planted food plots, shrub islands, shrub lespedeza (*Lespedeza bicolor* Turcz. [Fabaceae]) plots, switchgrass (*Panicum virgatum* L. [Poaceae]) agricultural fields.
[2]Including: river, ponds, marsh, Delmarva Bays, pasture, tall fescue areas (*Festuca arundinacea* [Schreb.] Dumort., nom.cons. [Poaceae]), developed.

We visited each point-count location one or two times during the survey season when covey calling behavior was most active. For those years when two surveys were conducted, we combined and averaged the number of coveys heard for both surveys. Surveys began 45 minutes prior to local sunrise time and ended at sunrise. Surveys were only conducted when there was <50% cloud cover, <5mph wind velocity, and typically with steady or rising barometric pressure (Wellendorf et al. 2004). No surveys were conducted in rain. The number and location of coveys calling were recorded at each point. Because the calling rate is affected by several variables, we adjusted the raw data using a model that incorporated wind speed, temperature, cloud cover, and barometric pressure change following recommendations by Wellendorf et al. (2004).

Summer whistle surveys were conducted between 2 June and 2 August in years 2010–2017 on Chino Farms using the same 12 point-count listening stations used for the covey calling counts. As with the fall counts, point # 12 (Figure 1) was discontinued in 2015. Summer whistling counts record the number of calling males vocalizing in the morning as an index to the breeding population and can be used as a predictor of fall population levels (Bennitt 1951, Rosene 1957, Curtis et al. 1989, Church et al. 1993, Terhune et al. 2009). During summer, each point was surveyed for 5 minutes and the number of males heard calling was recorded. The survey started at local sunrise and all 12 points were completed <2 hours of sunrise. The route was reversed each day the survey was conducted so that starting times at each point varied across the season. The route was surveyed 5–8 times per summer and then route totals were averaged.

RESULTS

Our monitoring efforts documented a severe population crash following historic back-to-back winter weather events during February 2010. Regional average winter snow accumulation for November–March, 1893–2009, was 44.2 cm (17.4 in) (range 0–131.6 cm [0–51.8 in]) compared to a total of 124.2 cm (48.9 in) in winter 2009–2010 (NECI 2018). Average snow accumulation for the month of February, 1893–2009 was 16.5 cm (6.5 in) (range 0–87.4 cm [0–34.4 in]) compared to 98.8 cm (38.9 in) in February 2010 (NECI 2018; Figure 2). The number of estimated coveys in the surveyed area declined 93% from 35.2 in 2009 to 2.5 in fall 2010. However, covey numbers heard subsequently increased to a high of 43.0 coveys in 2017. With the exception of 2016 the number of coveys increased each year (Table 2, Figure 3). In 2017, 42.8 coveys were estimated to be present, surpassing the number prior to the snow storms. Summer male whistling counts followed a similar trajectory as the covey counts (Table 3). In 2010, the first season of counts, an average of 0.07 individual males were detected per survey stop compared to an average of 2.78 individuals per stop in 2017 (Figure 3).

Discounting temporal increases in the population, we saw higher average point-count density in areas dominated with native warm season grasslands and interspersed woody cover (which we additively term “suitable habitat”) which exhibited higher average population response following 2010 (fall $R^2 = 0.6951$ and summer $R^2 = 0.7042$) (Figure 4A). This is in contrast to areas with higher proportions of agricultural land (fall $R^2 = 0.4424$ and summer $R^2 = 0.4704$) or deciduous woods (fall $R^2 = 0.1994$ and summer $R^2 = 0.2536$) (Figures 4B and C). For example, an average of 4.6 calling males were heard around point-count #1, an area with the highest proportion of suitable habitat, compared to an average of only 0.5 calling males in the area with the highest proportion of agricultural land, point-count #7, and an average of 0.2 calling males in areas dominated by deciduous woodlands, point-count #10 (Tables 1 and 3). Number of calling coveys also varied by type and percent cover of habitat with more coveys detected in areas dominated by native grasses, e.g., points #1 and #2, compared to areas with a higher ratio of agricultural land, e.g., points #7 and #8, (Tables 1 and 2).

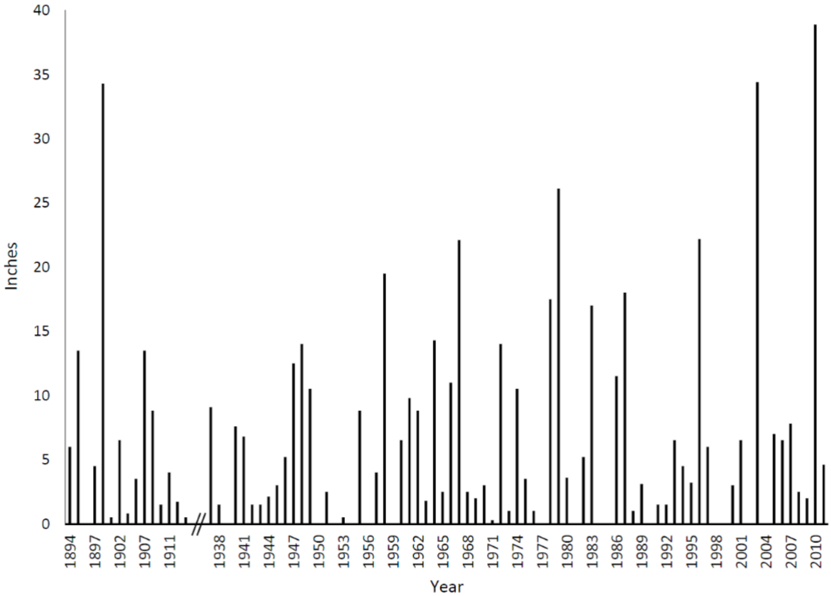

Figure 2. Snow fall accumulation for the month of February 1894–2011 (excluding years 1914–1936 when data were not collected) in Chestertown, Queen Anne's County, Maryland. (NECI 2018).

Table 2. Adjusted number of calling coveys at each point-count (PC) location between 2009–2017 on Chino Farms, Queen Anne's County, Maryland.

	Point-Count Locations												
Year	**PC 1**	**PC 2**	**PC 3**	**PC 4**	**PC 5**	**PC 6**	**PC 7**	**PC 8**	**PC 9**	**PC 10**	**PC 11**	**PC 12**	**Average**
2009	5.5	5.7	4.0	2.1	2.5	1.8	2.5	1.8	0.0	3.0	5.2	0.9	2.9
2010	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2011	3.8	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	0.0	0.7
2012	6.0	5.5	1.6	0.0	2.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	1.5
2013	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	5.9	7.2	6.0	1.7	5.0	3.1	0.0	0.0	0.0	5.9	0.0	-	3.2
2016	6.5	5.5	4.7	2.1	4.3	1.0	0.0	1.2	2.3	0.0	1.0	-	2.6
2017	8.5	5.1	3.4	3.5	4.2	4.2	5.1	3.3	1.8	2.0	1.8	-	3.9

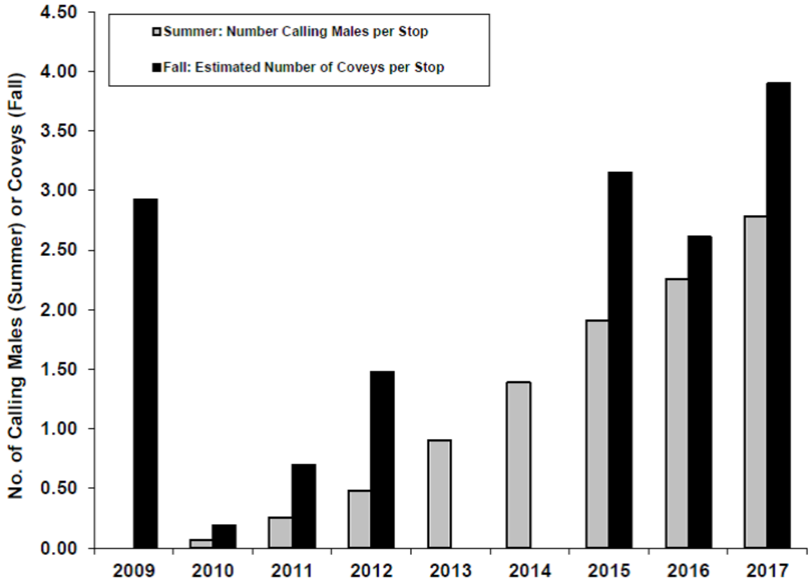

Figure 3. Number of calling males heard during the summer months (2010–2017) and estimated number of detected coveys heard during count surveys (2009–2012 and 2015–2017) on Chino Farms, Queen Anne's County, Maryland.

Table 3. Average number of calling male Northern Bobwhite at each point-count (PC) location between 2010–2017 on Chino Farms, Queen Anne's County, Maryland.

	Point-Count Locations												
Year	**PC 1**	**PC 2**	**PC 3**	**PC 4**	**PC 5**	**PC 6**	**PC 7**	**PC 8**	**PC 9**	**PC 10**	**PC 11**	**PC 12**	**Average**
2009	-	-	-	-	-	-	-	-	-	-	-	-	-
2010	0.1	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
2011	1.3	0.8	0.5	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.1	0.0	0.3
2012	2.2	2.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.5
2013	3.8	4.4	1.6	0.2	0.0	0.0	0.4	0.0	0.0	0.2	0.2	0.0	0.9
2014	6.9	4.8	1.4	0.8	0.3	0.1	0.4	1.0	0.8	0.1	0.3	0.0	1.4
2015	7.0	7.2	2.2	0.6	0.2	1.6	1.6	0.6	0.0	0.0	0.0	-	1.9
2016	8.0	7.3	3.0	1.6	1.3	1.0	1.1	0.8	0.5	0.1	0.1	-	2.3
2017	7.6	8.6	3.8	1.4	3.4	3.2	0.2	1.2	0.8	0.0	0.0	-	2.7

DISCUSSION

Prior to 2010, bobwhite densities at Chino Farms were thought to be among the highest in Maryland. We documented a severe population crash in this local bobwhite population, presumably due to major back-to-back snow events in February 2010. Through continued covey counts and summer whistling counts, we documented the rapid annual increase and eventual recovery of bobwhites on the property. The number of estimated coveys exceeded pre-storm levels for the first time in 2017 (Table 2). Janke et al (2017) documented how severe snow events can have significant impacts on populations along the northern periphery of the bobwhite range. Populations in Ohio were negatively affected for 4 years post storm. The Chino Farms population showed similar negative effects for 4 years, but were more than fully recovered 8 years after the crash (Figure 3).

While the property-specific bobwhite population has recovered, it has not done so evenly. We attribute the differences to three related factors throughout the property prior to the snow events: 1) relative bobwhite population densities were not equal, 2) appropriate habitat was not evenly distributed, and 3) habitat management varied in intensity. Both before and after the snow events of 2010, the bobwhite population was highest in the large native warm season grasslands on the farm. These grasslands provided large areas of appropriate nesting and brood rearing conditions which presumably helped with overall population recovery in this area. The 2009 covey counts showed that the bobwhite population was negatively correlated to the ratio of agricultural land (Tables 1 and 2). Higher densities were found in areas containing higher proportions of grassland and other early successional land (Figure 4A). Lower quail densities were generally found in areas that contained less nesting and brood rearing habitat. In these areas, the habitat is often more fragmented in the form of linear strips alongside mature deciduous woods and drainage ditches. For example, 11 coveys were heard in the grass-dominated areas (point-counts #1 and #2) compared to less than four coveys in the agriculture-dominated areas (point-counts #7 and #8) prior to the snow events in 2010. In 2017, 13 and eight coveys were found, respectively, in these same locations (Tables 1 and 2). Thus, even with increasing quail numbers over time, these areas do not support quail in higher densities. Lastly, management on the property has primarily consisted of prescribed fire and the removal of deciduous saplings by mechanical means and herbicide application. Management activity and intensity vary across the farm. While the large warm season grassland has always been an annual management priority, other areas of the farm only receive management when time allowed, likely affecting habitat quality.

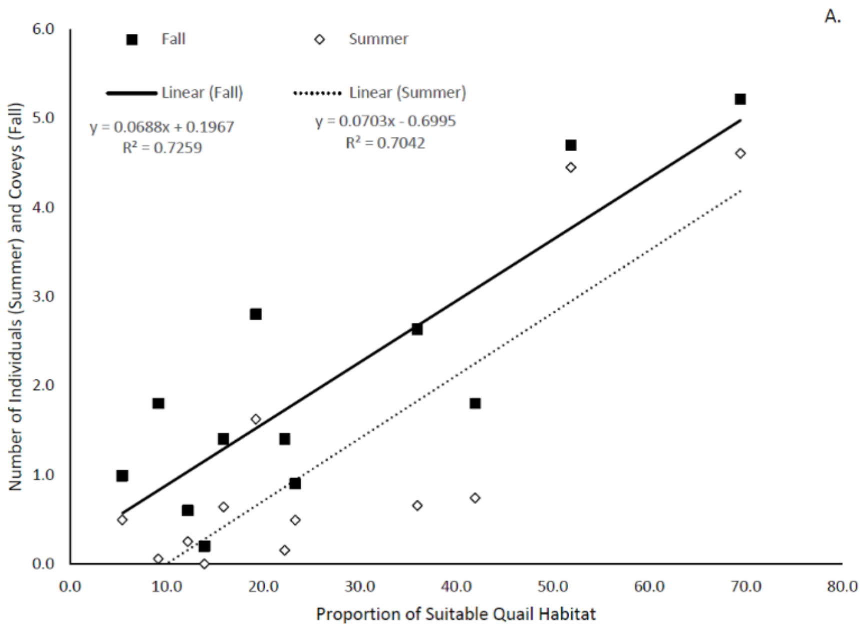

Figure 4A. Average number of calling males (2010–2017) and coveys (2009–2012 and 2015–2017) heard in relation to the proportion of suitable quail habitat (native warm season grasses, early successional habitat, hedgerows, managed woods) within each listening point-count area on Chino Farms, Queen Anne's County, Maryland, USA.

The recovery of the Chino Farms bobwhite population provides hope to land managers and researchers that small isolated populations can recover from severe weather events given the availability of suitable habitat. With the exception of an additional eight acres of new habitat, the overall amount of new habitat created between 2010 and 2017 did not increase significantly. However, the management frequency and intensity did change and varied substantially across the farm. While it is difficult to quantify the relationship between habitat, management, and pre-snow event population levels, we have seen a positive population response in areas that received management compared to areas that did not. In the grasslands, large fields (6.5–13.2 ha [16.1–32.6 ac]) were divided into smaller blocks (0.9–2.9 ha [2.2–7.2 ac]) and prescribed fire frequency was increased from a three-year rotation to a two-year rotation. In general, habitat management activities were less frequent in areas more distant to the large grasslands on the northern end of the property (Figure 1).

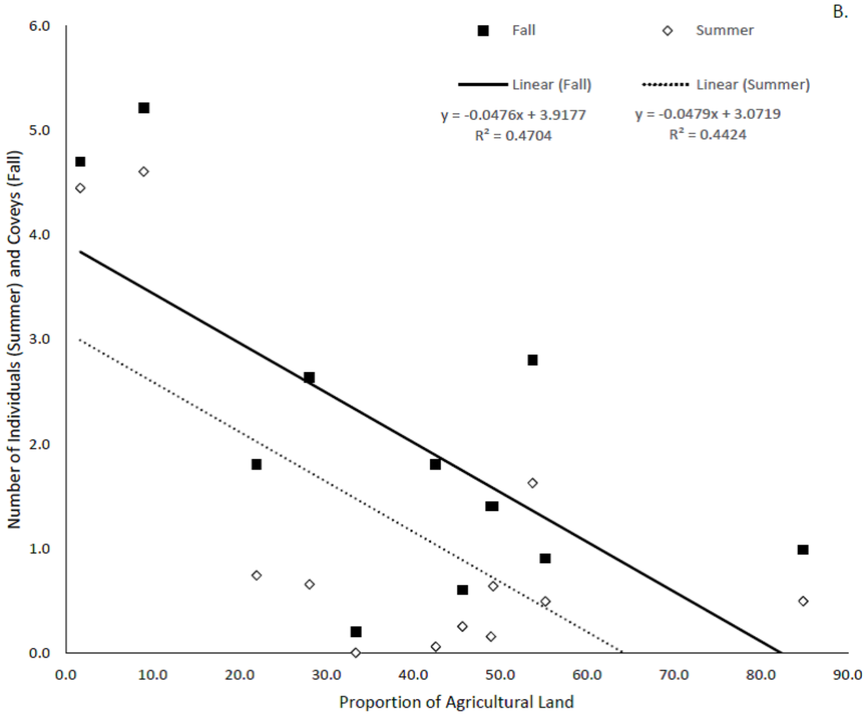

Figure 4B. Average number of calling males (2010–2017) and coveys (2009–2012 and 2015–2017) heard in relation to the proportion of agricultural land within each listening point-count area on Chino Farms, Queen Anne's County, Maryland, USA.

High-quality breeding habitat has been shown to improve adult survivorship during the breeding season in the Mid-Atlantic (Williams et al. 2004, Lohr et al. 2011) which is linked with the need of northern populations to maintain high breeding productivity for population sustainability (Roseberry and Klimstra 1984). Janke et al. (2015) showed increased survivorship in areas where a high portion of the habitat was dedicated to grass buffers and early successional woody cover. We observed similar responses in the large grasslands on Chino Farms. Creating and maintaining large areas of habitat that contains nesting habitat, brood rearing habitat, and low-growing woody escape cover in close proximity should allow isolated populations to recover after a significant collapse due to winter weather events.

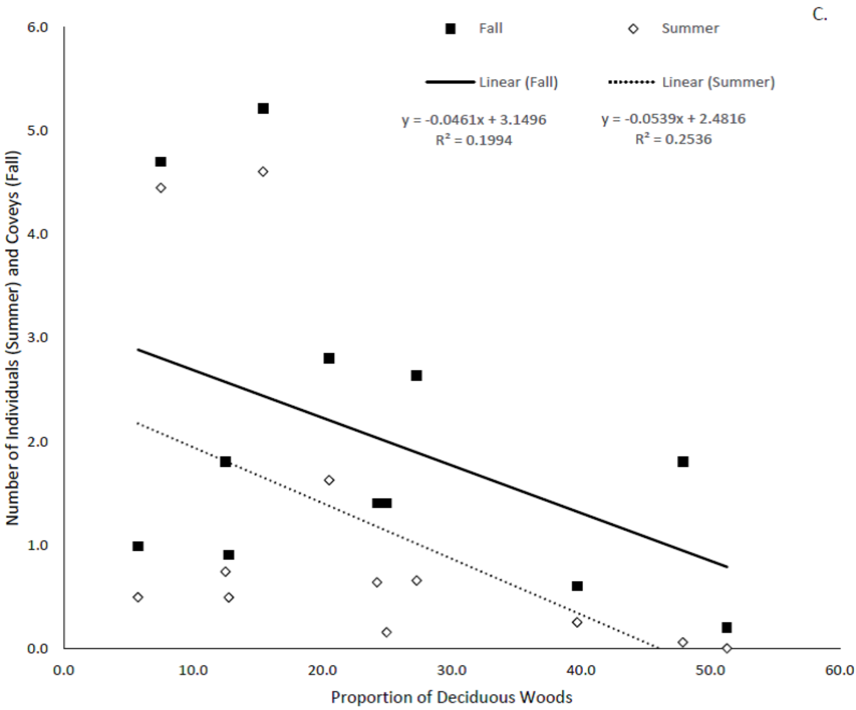

Figure 4C. Average number of calling males (2010–2017) and coveys (2009–2012 and 2015–2017) heard in relation to the proportion of deciduous woods within each listening point-count area on Chino Farms, Queen Anne's County, Maryland, USA.

ACKNOWLEDGMENTS

We thank the numerous Maryland Department of Natural Resources staff and other volunteers that helped with covey calling counts in the initial few years of the project. Thanks to Harry Sears, M.D., (owner of Chino Farms) for his dedication to supporting bobwhite restoration work and both Chino and Bluestem Farms staff for all the habitat management work conducted on an annual basis. Theron M. Terhune (Director of the Game Bird Program, Tall Timbers Research Station, Tallahassee, Florida) continues to offer invaluable advice and expertise about habitat management and all aspects of bobwhite ecology. Douglas E. Gill (Professor Emeritus, Department of Biology, University of Maryland, College Park, Maryland) provided valuable edits and suggestions that greatly improved an earlier draft of the manuscript. We thank Christopher K. Williams (Professor of Wildlife Ecology, Department of

Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware) and one anonymous reviewer for helpful advice, edits and comments that improved the manuscript.

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