COLORADO PARKS AND WILDLIFE - AVIAN RESEARCH PROGRAM
Progress Report
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TITLE: Pilot study to assess northern bobwhite response to short-duration intensive grazing on Tamarack State Wildlife Area

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EXTENDED ABSTRACT

Widespread suppression of historic disturbance regimes have reduced heterogeneity in vegetation communities on which many wildlife rely for various life events and stages. Northern bobwhites require areas of thicker grass cover for nesting within close proximity to more open areas with bare ground and abundant food producing forbs for brood rearing and feeding. Altered or eliminated vegetation disturbance has been implicated in the rangewide decline of northern bobwhite populations. Lack of disturbance on state wildlife areas in Northeast Colorado has caused the vegetation to become uniformly dense and tall which is likely not meeting the needs of all parts of the northern bobwhite life cycle. Some type of disturbance is required to reduce the vegetation biomass and create some of the open structure on which bobwhites rely. Grazing represents one of the only options for disturbance at Tamarack State Wildlife Area and other similar riparian areas in northeast Colorado. Whereas unmanaged continuous grazing has been linked to degradation of bobwhite habitat quality, short-duration intensive grazing holds promise to reduce the vegetation biomass and rejuvenate the habitat to become more attractive to bobwhites.

The objectives of this project are to assess the efficacy of using short-duration high-intensity grazing as a tool to improve northern bobwhite habitat. We will use a randomized block design in which we divide the study site into groups of four plots, one of which is grazed each year over a three year period and one is a control (Fig. 1). Beginning in late winter each year, we will capture bobwhites using walk-in traps and affix necklace-style VHF radio transmitters on 50 females. We will locate each radio-marked bobwhite three times per week and determine nest sites by observing birds in the same location on subsequent days. When nests hatch we will continue to monitor broods and on day 14 post-hatch we will flush the brood, and weekly thereafter to count chicks and assess brood status. To assess nest and brood site selection, we will sample vegetation at nest and brood sites and paired random points to represent available habitat. The overall goal is to estimate adult, nest, and brood survival as well as nest and brood site selection in relation to grazing treatment and other general habitat characteristics.

In 2016, we conducted a pre-treatment pilot study to estimate general baseline demographics and habitat preferences of bobwhites at Tamarack. We captured and affixed radio transmitters on 26 female northern bobwhites in 2016. Overall survival from May through August was 0.63 ± 0.1. Estimated nest survival was 0.42 ± 0.19 based on 11 monitored nests. Nest survival was positively affected by vegetation height (Fig. 3) and density (Fig. 4) around the nest. Bobwhite nest sites exhibited a greater percentage of grass cover than associated random sites (36.6 ± 11.5 % and 21.1 ± 6.7 %, respectively). We monitored six broods and survival to 21 days post-hatch was 0.65 ± 0.2. The results from this pilot study are generally consistent with previous research on northern bobwhites and provide a good baseline on which to build with grazing treatments beginning in 2017.

INTRODUCTION

Historically, periodic disturbance due to fire or grazing by native herbivores maintained a mosaic of distinct vegetation communities in prairie regions. These distinct communities, together, satisfied the different requirements of species' various life-stages (Brennan and Kuvlesky 2005). With the widespread suppression of wildfire and declines in some native prairie herbivores, many environments are lacking the disturbance that historically kept them attractive to wildlife. Without periodic disturbance, grasses or other vegetation may become too dense with little bare ground (McCoy et al. 2001) making them less attractive to certain species of wildlife; like northern bobwhite (*Colinus virginianus*; Klimstra and Ziccardi 1963, Hammerquist-Wilson and Crawford 1981). Therefore, managers are left with the task of periodically disturbing habitat to maintain availability of different seral stages to satisfy demands of wildlife. Many modes of disturbance have been implemented including grazing, burning, disking, mowing, and others, with each occurring in a wide range of intensities.

Northern bobwhites are a popular game species and the target of much habitat management. Northern bobwhites need a diversity of habitats to satisfy various life-stage needs: "(1) brushy cover for resting and protection, (2) forbs and/or grain fields for feeding, (3) and grass for nesting" (Snyder 1978:59). Bobwhites are declining across the majority of their range due primarily to the loss or conversion of suitable habitat (Brennan 1991, Brennan 1994, Brennan and Kuvlesky 2005). Bobwhite population dynamics have been intensively studied and populations appear to be more sensitive to changes in factors relating to reproduction as opposed to adult survival. In Texas, DeMaso et al. (2011) found that parameters directly relating to reproduction (nesting attempts/female, nest survival, proportion nesting, female sex ratio at hatch) had greatest impacts on fall population size. In Illinois, bobwhite recruitment was most influenced by number of chicks hatched per hen (Klimstra and Roseberry 1975) and was much more sensitive to juvenile mortality than adult mortality (Roseberry 1974). However, Folk et al. (2007) suggested a dependency on location; in the North, population growth rate was most sensitive to nonbreeding season survival in the earliest age class, whereas fertility was most influential in the South. Sandercock et al. (2008) found that adult winter and summer survival greatly influenced the rate of population change, as well as chick survival. With the importance of reproductive characteristics to population dynamics, nest survival has been widely studied and chick survival has also received attention. Out of 68 published estimates of nest success, Sandercock et al. (2008) reported median nest success was 0.42 (range = 0.19 – 0.70) and out of 9 studies, chick survival to 30 days was 0.41 (0.14 – 0.72). Depredation is the main cause of nest failure and mammals (coyote, striped skunk, badger, raccoon) have been found to be the main nest predators, although snakes and fire ants have also been implicated (Staller et al. 2005, Lusk et al. 2006, Rader et al. 2007).

Domestic livestock grazing is one of the most common land use practices in western North America (Fleischner 1994). Whereas unmanaged continuous grazing has caused substantial grassland degradation throughout the West (Fleischner 1994), managed grazing can be a valuable tool to manage habitat for wildlife (Holechek et al. 1982). In certain cases, where the terrain does not permit access by machinery or restrictions preclude the use of prescribe fire, grazing may be the only viable option to create disturbance. Short duration grazing is a system in which pastures are grazed intensively (high cattle density) for a short period of time (e.g., 5 days grazed – 7 weeks ungrazed; Holechek 1983). The high cattle density in grazed pastures may increase water infiltration of the soil due to hoof action, reduce forage selectivity of cattle, improve leaf area index, and support a more even use of pastures (Holechek 1983).

High intensity-low frequency grazed pastures were shown to support more bobwhites than in continuously or four-pasture, deferred rotation managed pastures in South Texas (Hammerquist-Wilson and Crawford 1981). The authors attributed this finding to the most bare ground and least grass density occurring in high intensity-low frequency managed pastures. Also in South Texas, Schulz and Guthery (1988) reported bobwhite density to be 2.3 times greater on short duration grazed pastures as opposed to continuously grazed pastures and visual obstruction was substantially greater on continuously grazed pastures. In Kansas, Taylor et al. (1999*a*) found that broods selected habitat with a high proportion of bare ground and forbs. They recommend using intensive grazing to create bare ground and facilitate invading forbs. Wilkins and Swank (1992) recommended short duration grazing based on their findings that bobwhites selected sites with increased species richness, forb cover, and bare ground, and decreased plant height and litter accumulations in Texas. Bareiss et al. (1986) found no difference in nest trampling by cattle between short-duration and continuously grazed fields in Texas. However, a model developed by Lusk et al. (2001) predicted bobwhite counts to decrease as cattle density increased, however this model did not take into account duration that cattle were present. Overall, high intensity short duration grazing appears promising for providing quality bobwhite habitat. However, these results should be applied cautiously to other regions due to differences in environmental factors (e.g., productivity, Spears et al. 1993).

Colorado lies on the northwestern edge of the bobwhite range (Brennan et al. 2014). In Colorado, bobwhites are generally limited to riverbottom riparian areas where there is sufficient woody cover (Snyder 1978). Although bobwhites are a very popular gamebird and heavily hunted in many states, only about 1,800 hunters hunted bobwhites in Colorado in 2012, harvesting 3,811 birds (Colorado Parks and Wildlife 2012). Due to bobwhites' restricted range in Colorado, it is imperative that habitat management on areas where bobwhites occupy, or have the potential to occupy, are conducted in a way that provides the greatest benefits in terms of producing bobwhites to maximize recreational opportunities. In an effort to gain a better understanding of the optimal habitat management strategy and begin to examine population dynamics and limiting factors, we will monitor northern bobwhite demographic parameters in relation to grazing scheme on Tamarack State Wildlife Area in northeastern Colorado.

OBJECTIVES

1. Estimate adult female, nest, and brood survival of northern bobwhites at Tamarack State Wildlife Area and evaluate effects of short-duration intensive grazing on these characteristics.

2. Assess nest and brood site selection of northern bobwhites in relation to grazing scheme.

METHODS

Study design and site selection

Tamarack State Wildlife Area is located in Logan County in northeastern Colorado, encompassing 4,775 ha along the South Platte River. Tamarack is composed of riverbottom riparian shrubland/forest near the river and grassland/sandhill habitat further away from the river. Northern bobwhite have been identified as a focal species for the riverbottom area in the official grazing plan (Verquer 2013). Public hunting is permitted for northern bobwhite, deer, dove, pheasant, rabbit, squirrel, turkey, and waterfowl. Tamarack is divided into 0.4 km 'segments' (~ 32 ha each) along the river which are available for hunting and which will be used in this study. We will group these segments into six 'blocks' of four segments each (Fig. 1). Within each block we will randomly assign each segment to be grazed during year one, two, three, or serve as a control and not receive any grazing. We will work with managers to establish and maintain one or more cattle herds from February through April each year (2016 – 2018) and randomly select a starting segment. Every two weeks (flexible based on conditions), we will rotate the herd to another segment designated for grazing that year (randomly selected). We will attempt to maintain a very high cattle density of about 1 animal unit/ha to ensure substantial effects of grazing on the vegetation and soil.

Field methods

Bobwhite capture

Beginning in mid-March, we will capture bobwhites using baited walk-in traps (Smith et al. 1981). We will place 10 traps throughout Tamarack to attempt to capture a spatially representative sample and check traps twice daily (mid-morning and at sunset). All captured bobwhites will receive a numbered, aluminum leg band. On 50 females, we will weigh and affix a ≤ 6.5 g necklace-style radio transmitter (Burger et al. 1995, DeMaso et al. 1997, Taylor et al. 1999*a*, 3.8% of average female mass [170 g], Nelson and Martin 1953). We will not deploy transmitters on females weighing less than 130 g because it would result in the transmitter weighing greater than 5% of female mass. Terhune et al. (2007) concluded that 6 g necklace style transmitters affixed on bobwhites weighing ≥ 132 g had no effect on survival.

Nest and brood monitoring

We will locate each radio-marked bobwhite three times per week using a homing technique (White and Garrott 1990). Observers will walk toward the bird and when they approach it, they will circle the bird at around 30 m to pinpoint an exact location. We will then estimate the location based on the compass bearing and distance to the bird from the observers location. Every attempt will be made to avoid flushing birds. Nests sites will be determined by observing bobwhites in the same location on multiple, subsequent days. When a hen is deemed to be nesting, we will approach her to about 10 m and place a stake with or without flagging, 5 m to the North and South of the estimated nest location. Nesting bobwhites rarely flush when observers stay >1m from the incubating bird (A. Behney personal observation). If visually oriented nest predators (e.g., ravens) are regularly observed around study areas, flagging will not be used near nests. We will continue to locate birds at least 3 times per week and when a hen is off her nest we will go to the nest location, check status, count eggs, and get an exact location with a GPS. If we do not have the chance to visit the nest while the incubating hen happens to be off the nest, we will flush the adult during the last week of incubation to get an exact location and count eggs. We will continue to approach nests every time hens are vacant until the nest is deemed to succeed (≥ 1 egg hatch) or have failed (depredated or abandoned). Observers will approach nest sites circuitously from different routes each visit to avoid creating a path for predators to follow directly to nest site. For hens with successful nests and thus, a brood, we will use homing to estimate a location 3 times per week without flushing the hen or chicks. At day 14, we will flush the hen and brood and weekly thereafter (DeMaso et al. 1997) to count chicks to estimate chick (probability of a chick surviving) or brood survival (probability of at least one chick in a brood surviving).

Vegetation sampling

We will sample vegetation at nest sites, brood flush sites, and random points associated with each. Within one week of nest completion we will sample vegetation at nest sites and a paired random site less than 200 m away (i.e., within the distance bobwhites typically move in a day; Taylor et al. 1999*a*, Taylor et al. 1999*b*) within the same treatment section. Similarly, within one week of each brood flush, we will sample vegetation at the brood flush site and an associated random point less than 100 m away (i.e., within the distance broods typically move in a day; Taylor and Guthery 1994, Taylor et al. 1999*a*, Taylor et al. 1999*b*). At each nest, brood site, or random point we will note the percent coverage of bare ground and each species of vegetation within a 1 m^2 sampling frame. We will also note the lowest decimeter visible on a 2.5 cm diameter pole, read from 4 m in four directions, 90° apart, from 1 m above the ground (Robel et al. 1970). We will also digitize the study area into a GIS so that each point can be classified by landcover category. Landcover categories will include 1) grazed treatment areas, 2) control areas, 3) sandsage rangelend, and 4) cropland. We will also calculate the percentage of each landcover type within 200 m, 400 m, and 600 m of each point.

Statistical analyses

Adult survival

We will use the nest survival model in Program Mark (White and Burnham 1999, Dinsmore et al. 2002) to estimate the daily survival rate of adult female northern bobwhites. The nest survival model is useful for estimating survival when detections did not occur at regular intervals (i.e., lacks some of the assumptions of the known-fate data type). To extrapolate from daily survival rate (DSR) to breeding season survival (May – August) we will raise DSR to the power of the number of days in May, June, July and August and calculate the standard error using the delta method (Powell 2007). For the first year pilot study, we present estimates from a null model (constant survival) only, but thereafter we will assess covariates related to date and percentage of locations in habitat treatment areas and compare models using an information-theoretic approach (Burnham and Anderson 2002).

Nest and brood survival

We will use the nest survival model in program Mark (White and Burnham 1999, Dinsmore et al. 2002) to estimate nest and brood survival. We will group the predictor variables into a vegetation group (% coverage of bare ground, forb, grass, warm-season grasses, cool-season grasses, and woody vegetation, visual obstruction, and tallest vegetation around the nest), a landcover group (landcover of site, % landcover at various scales), and date. We will find the most parsimonious model within the vegetation and landcover groups and then compare those models to each other and combine variables from the most parsimonious models in each group. Lastly, we will add date and date^2 to account for temporal effects if it increases model parsimony. We will also include a null model for comparison. We will evaluate candidate models using an information-theoretic approach (Burnham and Anderson 2002), using ΔAIC_c and model weights (w_i). To extrapolate estimated DSR to the entire nesting attempt, we will raise DSR to the power of 23 (the average incubation period for northern bobwhites) and for brood survival to the power of 21 (the period we monitored broods) and calculate standard errors using the delta method (Powell 2007).

Nest and brood site selection

We will use conditional logistic regression to evaluate nest and brood site selection (Duchesne et al. 2010) using the clogit command of the survival package (Therneau 2015) in program R (R Core Team 2015). Each nest or brood site and associated random point will be grouped together in the analysis. We will use the same modeling strategy and variables as described above.

RESULTS AND DISCUSSION FROM YEAR ONE PILOT STUDY

Capture and adult female survival

We captured and affixed radio transmitters on 26 female northern bobwhites during late winter 2016. Throughout the year we had a total of 13 mortalities. One radio-marked bobwhite died in a trap when it was recaptured. Of the collars we were able to recover and assess cause of mortality, we estimated that one was avian predation, and four were mammalian predation. Based on initial analysis, a model estimating constant survival over the breeding season predicted a daily survival rate of 0.996 ± 0.001. Extrapolating over the entire four month breeding season (May – August), the estimated overall breeding season survival was 0.632 ± 0.097. This is substantially greater than estimates reported by Terhune et al. (2006) who found March – August (six month) survival between 0.26 and 0.37 in Georgia and Burger et al. (1995) who found April – September (six month) survival of 0.332 in Missouri. For comparison, my estimate of daily survival rate extrapolated to six months is 0.506. My estimate is also on the high end of the 16 published estimates of six month breeding season survival presented in Sandercock et al. (2008) which range from 0.10 to 0.63.

Nest site selection

The most parsimonious model of nest habitat selection indicated that percent grass cover around the nest was the most influential factor determining nest site selection (Table 1) and this relationship was positive (Fig. 2). Mean percent grass ± SE within the 1 m^2 sampling frame centered on nests and random points were 36.6 ± 11.5 and 21.1 ± 6.7 percent, respectively. Bobwhites are well known to select nest sites with taller, denser vegetation, particularly grasses, with less bare ground (Taylor et al. 1999*a*, Arredondo et al. 2007, Rader et al. 2007, Sands et al. 2011) to which our results are congruent.

Nest survival

In 2016, we monitored 11 bobwhite nests. Of these, nine were first nest attempts and two were second nest attempts. Apparent nest success was 54.5% and the only cause of failure was depredation. We found substantial model selection uncertainty when modeling bobwhite nest survival, however, the most parsimonious model included tallest vegetation near the nest, followed by visual obstruction, and then the null model (Table 2). Nests with taller vegetation (Fig. 3) and more visual obstruction (Fig. 4) had greater daily survival rates. Based on the top model (tallest vegetation) and holding tallest vegetation at its mean, daily survival rate was 0.963 ± 0.019 giving a 23 day nest survival estimate of 0.417 ± 0.187. This is comparable and towards the middle of the 22 published values presented in Sandercock et al. (2008; median = 0.45, range 0.63 – 0.25).

Brood survival

We monitored 6 bobwhite broods. Four broods survived (at least one chick) to the 21 day brood flush giving apparent brood survival to 21 days of 67%. Based on a model holding brood survival constant, daily survival rate for broods was 0.980 ± 0.014. Extrapolating to the 21 day brood rearing period gives a 21 day brood survival estimate of 0.655 ± 0.196. Sandercock et al (2008) present six published estimates of chick survival to 30 days ranging from 0.19 to 0.72. However, these estimates are individual chick survival whereas we estimated overall brood survival because the thick vegetation precluded counting chicks accurately when they flushed.

Brood habitat selection

Due to time constraints we did not sample vegetation with regard to bobwhite broods in 2016.

CURRENT PROGRESS

We are currently finishing analyses from the 2016 pilot study and planning for the 2017 field season. The field staff at Tamarack State Wildlife Area are preparing for grazing treatments to begin in early 2017.

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Table 1. Nest site selection models for northern bobwhites at Tamarack State Wildlife Area in northeastern Colorado.

Model	K[a]	ΔAIC_c	w_i[b]
Percent grass	1	0.0	0.5
Visual obstruction	1	2.1	0.2
Percent forb	1	3.6	0.1
Percent cool-grass	1	4.0	0.1
Percent warm-grass	1	4.5	0.1
Percent woody	1	4.8	0.0
Tallest vegetation	1	5.2	0.0
Percent bare ground	1	5.7	0.0

[a] Number of parameters in the model
[b] Model weight

Table 2. Nest survival models for northern bobwhites at Tamarack State Wildlife Area in northeastern Colorado.

Model	K[a]	ΔAIC_c	w_i[b]
Tallest vegetation	2	0.0	0.3
Visual obstruction	2	0.5	0.2
Null	1	0.5	0.2
Percent forb	2	1.2	0.1
Percent bare ground	2	1.7	0.1
Percent grass	2	1.9	0.1

[a] Number of parameters in the model
[b] Model weight

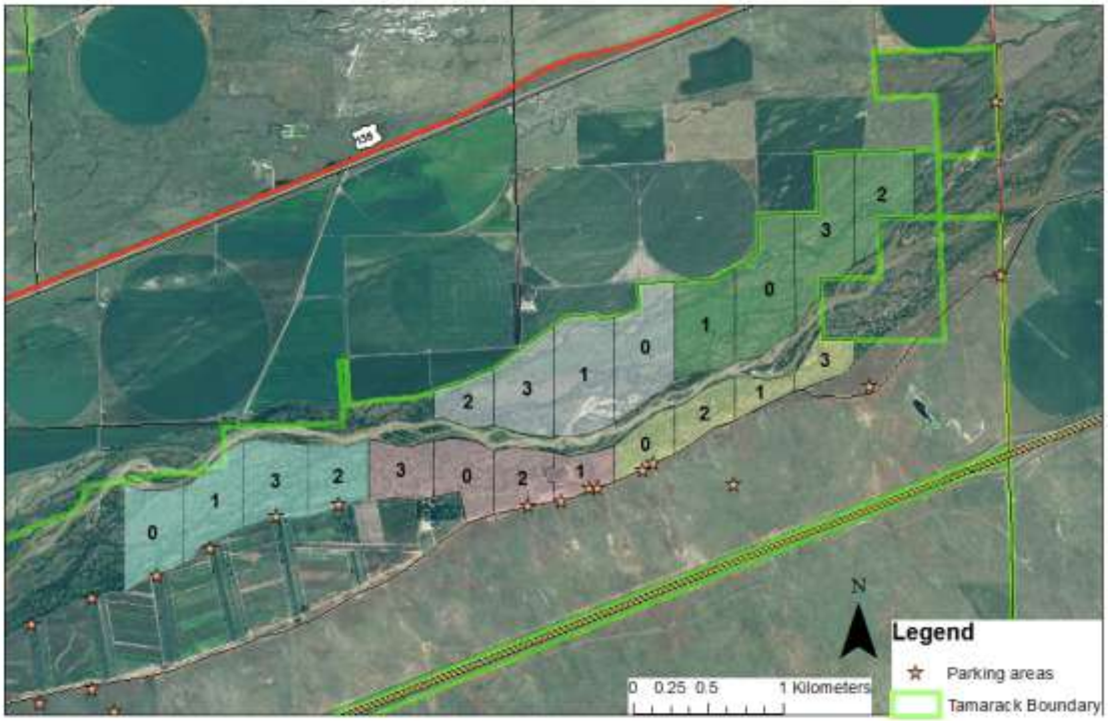

Figure 1. Proposed grazing treatment plot layout for the eastern portion of Tamarack State Wildlife Area. Numbers represent the year of treatment, zeros indicate control plots.

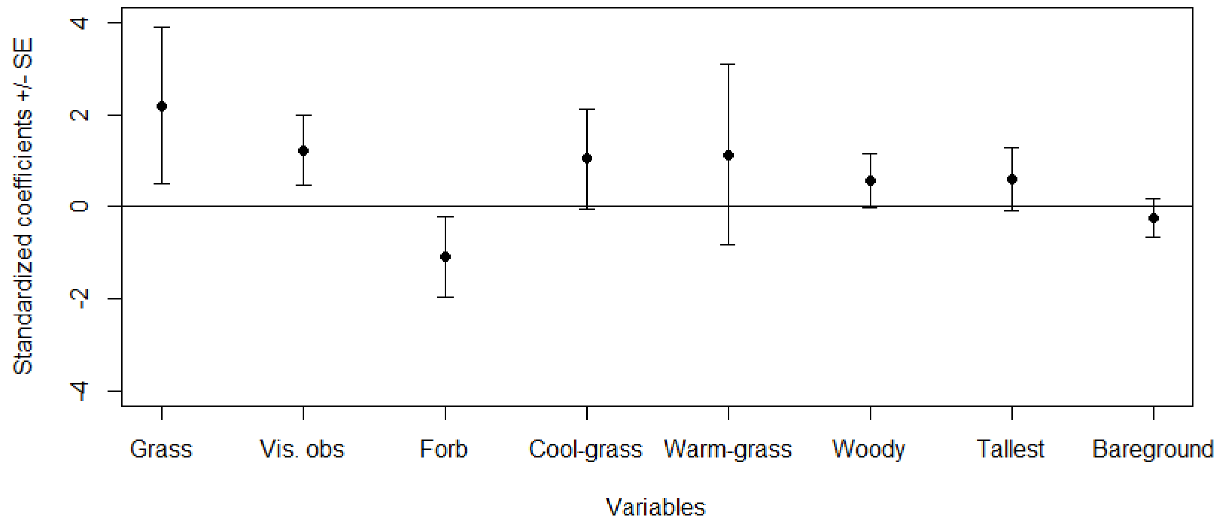

Figure 2. Standardized coefficients ± SE from conditional logistic regression models predicting nest site selection of northern bobwhites at Tamarack State Wildlife Area. Positive values indicate selection for a variable and negative values indicate selection against a variable. All coefficients are taken from single variable models.

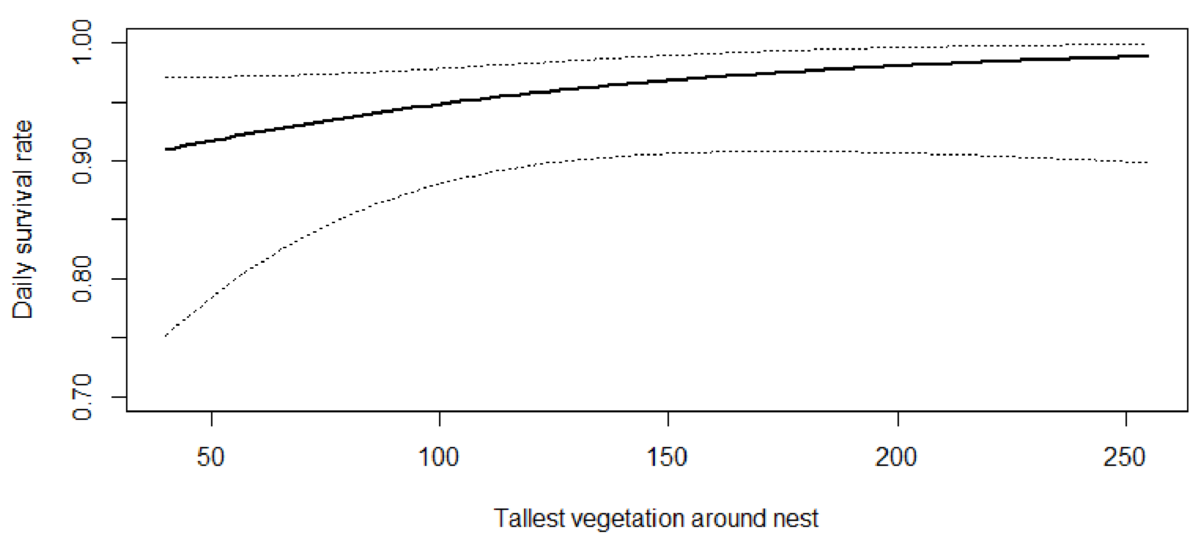

Figure 3. Model predicted values and 95% confidence interval of nest daily survival rate in relation to the tallest vegetation in 1 m^2 sample frame centered on nest.

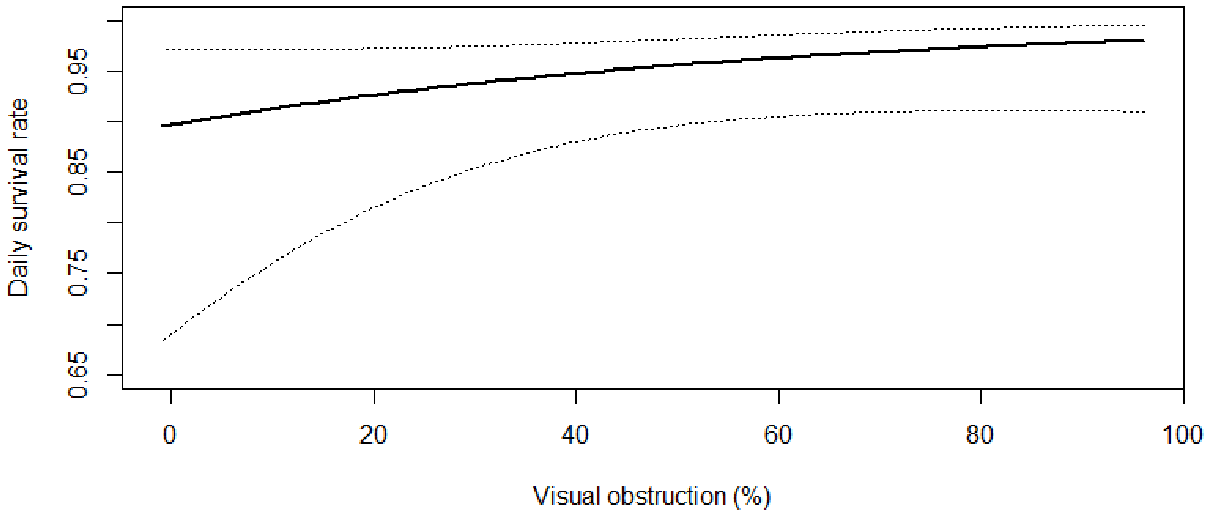

Figure 4. Model predicted values and 95% confidence interval of nest daily survival rate in relation to the visual obstruction measurement taken at the nest.