FACTORS CONTRIBUTING TO REINTRODUCTION SUCCESS FOR NORTHERN BOBWHITES ON LONG ISLAND, NEW YORK

by

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ABSTRACT

Pen-rearing young frequently fails as a reintroduction technique in game birds due to low post-release survival rates in the wild. This may be caused by a combination of poor genetics from domestication, unhealthy birds, birds that do not exhibit wild behavior, or birds that are unfamiliar with their surroundings after hard releases. Recent research suggests that parent-rearing, involving pre- and post-hatch imprinting of "wild-strain" northern bobwhite (*Colinus virginianus*) chicks by adults, may be a viable option for restoring populations. Imprinting potentially causes reintroduced birds to exhibit more natural behavior. I tested this method against a slightly modified traditional propagation tool (Surrogators) with "wild-strain" birds. I conducted my research on a 170 ha property containing a mixture of early successional and hardwood habitat on Long Island, New York during the summers of 2013 and 2014. I tested the effect of rearing methodology, mass at release (as a proxy for physical condition), release timing, and year on survival using Cox proportional hazard models. Hazard analysis revealed that only earlier release dates directly improved survival while treatment (parent-reared vs. Surrogator), body mass at release, and year did not affect survival. The methods tested on my study area did not result in 365 day survival rates high enough to re-establish quail in the area.

Chapter 1

FACTORS CONTRIBUTING TO REINTRODUCTION SUCCESS FOR NORTHERN BOBWHITES ON LONG ISLAND, NEW YORK

Introduction

Northern bobwhites (Colinus virginianus; hereafter bobwhite), are a widely distributed gamebird in eastern North America but have experienced range contractions and precipitous range-wide declines in abundance since the 1960s (Sauer et al. 2014). These declines have been contributed to by intensive agricultural practices related to increased mechanization and clean farming practices such as larger fields, urban/suburban sprawl, and habitat fragmentation (Brennan 1991, Church and Taylor 1992, Roseberry and Sudkamp 1998, Peterson et al. 2002, Williams et al. 2004). Historically, bobwhites were found in early-successional habitats ranging as far north as Ontario, Canada (Cadman et al. 1987). Although declines have occurred range-wide, populations at the northern end of the species' range, including those in the Mid-Atlantic, have experienced particularly serious declines. For example, populations in New Jersey have declined 10.9% per year between 1966 and 2013 compared to a range-wide decline of 4.1% per year over the same time period (Sauer et al. 2014). According to the construct of the "abundant center" hypothesis (where populations are more robust at the core of their range: Andrewartha and Birch 1954, Hengeveld and Haeck 1982), as range-wide populations decline, peripheral populations are more likely to go extinct and geographic ranges will contract (Goel and Richter-Dyn 1974, Tracy and George 1992, Mehlman 1997, Vucetich et al. 2000), often due to density independent stochasticity rather than density dependent maintenance (Williams et al. 2003). This prediction, along with other previously mentioned factors, is of concern for declining bobwhite populations along the northern edge of their range. For example, the northern bobwhites have been extirpated from their historic range in New York (primarily occurring on Long Island [Sauer et al. 2014]). Contracting ranges, along with decreased habitat connectivity due to fragmentation makes recovering these populations incredibly difficult.

Since bobwhites are near extinction in the periphery of their range (Sauer et al. 2014), it is a reasonable management decision to employ endangered species restoration techniques. There are 3 categories of management strategies for endangered species: habitat preservation, habitat restoration, and active management. While promotion of habitat is assumed to be the priority, Foin et al. (1998) found that 63% of endangered species would require more active management through initial habitat and population restoration or continued intervention. Many captive breeding programs fail to reestablish wild populations (Beck et al. 1994), especially due to problems with (1) establishing self-sufficient captive populations, (2) poor success in reintroductions, (3) high costs, (4) domestication, (5) preemption of other recovery techniques, (6) disease outbreaks, and (7) maintaining administrative continuity (Snyder et al. 1996). However, in some cases, captive breeding reintroduction programs have proven to be successful (e.g. California Condor [*Gymnogyps caliofornianus*] and black footed ferret [*Mustela nigripes*], Snyder and Snyner 1989, Jones et al. 1995). Therefore, to incorporate captive breeding reintroduction programs, careful field studies that examine habitat suitability, genetics, physiological health, site familiarity, and behavior must be conducted to provide measurable long-term success before their employment (Snyder et al 1996).

Physiological condition is also important for successful reintroduction programs. Being transferred from one place to another, whether from one wild population to a new area, or from captivity to the wild, puts stress on animals (Groombridge et al. 2004, Calvete et al. 2005, Franceschini et al. 2008) causing immune system suppression, leading to increased disease susceptibility, reduced reproductive capacity, and diminished fight-flight response which could lead to increased predation (Dickens et al. 2009). For example, Dickens et al. (2009) found that translocation of chukar partridge (*Alectoris chukar*) decreased corticosterone response past the point of being adaptive, suggesting that the translocation process induced chronic stress. Furthermore, Calvete et al. (2005) found that European wild rabbits with higher urea nitrogen concentration, an indicator of stress levels, had higher mortality rates after translocation.

Release methodology is also important for improving the chances of survival for animals. Hard releases, where animals are released directly into the wild without any acclimation period in a contained environment or other support, can unnecessarily stress animals. Soft releases gradually introduce animals to the wild, often by releasing them into an on-site enclosure with shelter and food for a period of time, in an effort to improve survival rates (Kleiman 1989). Using a soft release method may provide the animals time to safely learn about the environment (e.g., what type of food is available, what predators are on the landscape etc.) without the actual hazards associated with being fully in the wild (Bright and Morris 1994). For example, Western burrowing owls (*Athene cunicularia hypugaea)* that were kept in soft-release enclosures for 2 weeks prior to release exhibited higher site fidelity, breeding-season survival, fledgling survival, post-fledging survival, and first-year return rates than burrowing owls released directly from artificial burrows (i.e. hard-released owls) (Mitchell et al. 2011).

A number of management strategies have been tested to reestablish northern bobwhites in areas of suitable habitat, including release of pen-reared bobwhites and translocation of wild bobwhites (Roseberry et al. 1987, Terhune et al. 2010). Attempts to restore bobwhite populations in suitable habitat using game-farm or pen-reared quail have been made since the early 1900s and continue into the present (Handley 1938, Wilson 1986, Perez et al. 2002). Propagation of game birds in captivity has long been regarded as a "quick fix" for better hunting (Hart and Mitchell 1947) and has been well documented from the 1930–40s (McAtee 1930, Barron 1935, Poyner 1936, Bass 1937, Nestler and Bailey 1941, Hart and Mitchell 1947). However, this method of replenishing quail populations has proven unsuccessful for establishing sustainable populations. Animals raised in captivity don't always exhibit natural predator avoidance characteristics, or they fail to successfully reproduce (Snyder et al 1996). For example, pen-raised bobwhites often exhibit low rates of post-release survival (averaging 8–15 days, Roseberry et al. 1987, Perez et al. 2002) and long distance dispersal from release sites (Baumgartner 1944, Buechner 1950, Oakley et al. 2002). Additionally, pen-reared bobwhites that are released and survive until the following nesting seasons have been found to readily nest (Devos and Speake 1995, Eggert et al. 2009) but they tend to have poor parenting skills and therefore low recruitment of young (Cass 2009, Eggert et al. 2009).

In response to historic problems associated with failed attempts of using pen-reared individuals at population reintroduction and the difficulty of obtaining wild birds for translocation, Wildlife Management Technologies (WMT; Wichita, KS) developed a soft release methodology for pen-reared birds call "The Surrogator".

Surrogators are a game bird propagation tool that provides food, water, heat, and shelter for incubator raised chicks from day one through the first 5 weeks of life. Wildlife Management Technologies asserts 300,000 quail were released from Surrogators in 2006 with a survival rate of 0.65 (Wildlife Management Technologies 2009). WMT also claims home range behavior (i.e., site fidelity) is instilled in quail by raising them in the Surrogator and imprinting them to an area. Furthermore, WMT claim that releasing quail at 5 weeks of age, where minimal human contact and proper use of the Surrogator is maintained, results in retention of natural survival instincts and behaviors (Wildlife Management Technologies 2009). However, recent multistate research (Kinsey et al. 2012, Thackston et al. 2012) found these claims to be false and survival of Surrogator raised bobwhite have ~0% long-term survival or establishment. Bobwhites reared in Surrogators in Kansas had survival rates of 0.35 8 weeks after release. Additionally, only 7.2% of bands were returned from harvested bobwhites (Thacker et al. 2016).

As an alternative to releasing pen-reared birds, translocation of wild birds is the preferred and proven method to restore populations in suitable habitat. Translocation mitigates the behavioral and genetic problems associated with captive breeding programs thus producing survival rates, nest production, and nest survival that are comparable to resident bobwhites (Terhune et al. 2008, Terhune et al. 2010). However, translocation of wild bobwhites is often not an option due to legal (i.e. state restrictions to release birds to other states) and financial restrictions preventing the removal of wild birds from their current range (Hernández and Perez 2007).

In an attempt to combine the advantages of wild translocation along with the logistical ease of captive breeding, Palmer et al. (2012) developed a parent-rearing method for bobwhites that includes prenatal and postnatal learning with “wild-strain” (i.e. F1 hybrids of wild and pen-raised) bobwhites in normal brood sized groups (thus addressing the genetic and behavioral concerns described above). In the past, some captive rearing programs have been able to reduce behavioral issues by using conspecific foster parents (Snyder et al. 1987, Wiley et al. 1992). Filial imprinting is an early form of learning during short prenatal (Lickliter 1989, Lickliter 2005) and post-hatch periods in which the chicks learn to identify their parents (Jaynes 1956, Hess 1973). Avian imprinting facilitates behaviors that enhance survival of offspring through sexual identification, social learning, predator recognition, predator avoidance, recognition of alarm calls, food selection, and parenting skills (Hess 1973, Dowell 1992, Lickliter and Harshaw 2010). In gray partridge, red-legged partridge, and pheasants, it has been shown that greater survival and predator avoidance as well as reproduction occurred in chicks fostered with parents versus those artificially-reared (Brittas et al. 1992, Dowell 1992, Buner and Schaub 2008, Gaudioso et al. 2011). Snyder et al. (1996) suggest that if a captive bred species does not exhibit instinctive behavior, is not on the top of the food chain, or is not introduced in a predator-free or deficient environment, reintroduction efforts should use fostering to improve the chances of success.

Palmer et al.’s (2012) research on incorporating parent rearing of “wild-strain” chicks found nest success and chick survival was similar between parent-reared birds and wild birds, indicating the possibility that this method may be a successful alternative to the Surrogator for population restoration. However, this work was conducted in the Southern Georgia and South Carolina, where populations are more robust than those at the periphery of the bobwhite range. It is unknown if this methodology can maintain its success at the edge of the bobwhite's range where density independent stochasticity may introduce a complicating factor.

I tested these captive-rearing techniques on the bobwhite range periphery of Long Island, New York where the bobwhite population is at or near extirpation. This research is intended to fill knowledge gaps in the area of bobwhite restoration techniques in Northeastern/Mid-Atlantic states (Castelli et al. 2009); captive-bred bobwhites could be a valuable tool for preventing population collapse after major weather events in these peripheral populations. My study was conducted with three main objectives. The first objective was to test the effect of parent-rearing on bobwhites compared to those reared without parents (Surrogator). If parent-reared birds experienced higher survival rates, the results would point toward the importance of imprinting (i.e. natural behavior) for successful bobwhite reintroduction efforts. Second, I examined the effect of body mass at release date as a proxy for the effect of physiological condition on post release survival. I assumed that individuals with a higher body mass at time of release were in better physiological condition than individuals with a lower body mass. Finally, I examined the effect of release date on DSR. I did not examine the effects of habitat suitability or site familiarity since all of the bobwhites were released with a soft release methodology into the same habitat.

Study Area

I conducted my research from May-December of 2013 and 2014 at the Greentree Foundation, a 170 ha area in western Long Island, New York, USA (Figure 1). In 2006, the Greentree Foundation initiated an ecological approach to managing their property. This approach included native grass restoration in 4 areas of the property as well as an American Chestnut (*Castanea dentate*) research study. Approximately half of the property is made up of dense hardwood forest comprised mostly of oak (*Quercus* spp.), American beech (*Fagus grandifolia*), and maple (*Acer* spp.) trees. The remainder of the property consists of early successional and grassland habitat and facility buildings. Native grass restoration is an ongoing process on the property. Areas of non-native turf grass are gradually being replaced with native grass and forb mixes including species such as Indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardi*), and partridge pea (*Chamaecrista fasciculate*). Native grass and forb plantings provided nesting and foraging habitat. Food availability was supplemented with two food plot areas on opposite ends of the property consisting of mainly grain sorghum and proso millet. The predator community on the study area included feral cats (*Felis catus*), red foxes (*Vulpes vulpes*), Great Horned Owls (*Bubo virginianus*), and various *Accipiter* and *Buteo* species. The annual mean temperature at the Greentree Foundation from 1981–2010 was 12.4° C with 118.3 cm of precipitation. The mean summer temperature was 22.9° C with 30.4 cm of precipitation. Mean winter temperatures were 1.8° C with 26.6 cm of precipitation (60.5 cm of snow). The mean summer temperature at Greentree was 22.6° C in 2013 and 22.8° C in 2014 with 32.9 cm of precipitation in 2013 and 29.6 cm in 2014. The mean winter temperature was 2.1° C in

2013 with 30.7 cm of precipitation and 0.74° C in 2014 with 36.7 cm of precipitation (NOAA 2015). In 2011, the Greentree Foundation began raising bobwhites from domestic stock in Surrogators for release on the property. Overwinter survival of these bobwhites was low and none of the birds released prior to the study successfully reproduced.

Figure 1 Location of Greentree Foundation Property on Long Island, New York, US

Methods

General Methods

In order to assess the impact of imprinting and physiological condition on survival of pen-reared bobwhites, I performed 3 trials during June, July, and September each year for 2 years using 2 Surrogators and 2 outdoor rearing pens placed at different locations on the property (<1.5 km apart) in areas categorized as suitable bobwhite habitat. "Wild-strain" eggs were obtained through Quail Call Farms in Beachton, Florida, USA; although we could not definitively test the accuracy of their product. I placed eggs in 2 GQF Digital Sportsman cabinet style incubators for 23 days at the start of each trial. The incubators were maintained at 37.5° C and 60% humidity for the first 20 days of incubation. I raised the temperature to approximately 37.8° C with a humidity of 75% for the last 3 days of incubation and while chicks were hatching. I divided "wild-strain" chicks hatched from one incubator between 2 separate Surrogators at 1 day of age. "Wild-strain" chicks hatched in the other incubator were imprinted to adult bobwhites and moved to trapezoidal outdoor rearing pens (4.9 m long, 2 m wide, and 2.84 m tall on one end, and 1.82 m high on the other end) within 48 hours of hatching.

Non-parent-rearing Methods

I used the 2 Surrogators already established on the Greentree property since 2011. I removed all vegetation and leaf litter was removed from the immediate surrounding area for ease of maintenance. The Surrogators were set up and maintained according to all guidelines provided by the "Surrogator System Guide" (WMT 2009) during the 5-week-period between hatching and release. The only contact chicks had with humans was during weekly maintenance of the Surrogator and when removing daily mortalities.

Chicks received commercial gamebird starter feed (Purina, St. Louis, Missouri) with freestanding waterers. A wild bird seed mix (consisting of proso millet [*Panicum miliaceum*], grain sorghum [*Sorghum bicolor*], cracked corn [*Zea mays*], wheat [*Triticum spp.*], and black oil sunflower seeds [*Helianthus annuus*]) was mixed into the commercial feed when the chicks reached 3 weeks of age. I gradually reduced the brooder heaters from 21-35 days of age to prepare the chicks for ambient temperatures upon release.

Chicks received a color leg-band (corresponding to the treatment type, i.e. Surrogator vs. parent-reared) and a uniquely numbered metal leg band for future identification at 5 weeks of age. A randomly selected subset of bobwhite juveniles from the Surrogators were fitted with a 3 g expanding radio-transmitter (American Wildlife Enterprises QC 300 day necklace transmitter) before each release. I divided the bobwhites from each Surrogator into groups of approximately ~5–20 to simulate a natural brood size (Stoddard 1931) before their release. I radio-marked 2–3 birds in each brood. Each group was released at a unique site throughout the property, approximately 30 min after sunrise. Release sites were re-used for each trial.

Parent-rearing Methods

The Greentree Foundation constructed 2 sets of rearing pens housed 845 m apart from each other in early successional habitat. Each set of rearing pens consisted of 4 pens adjacent to one another (Stoddard 1931). Each pen was 4.9 m long, 2 m wide, and 2.84 m tall on the tall end, and 1.82 m tall on the short end. Each pen has a

1-m^2 shelter attached to its exterior to facilitate providing feed (Figure 2). A system of nipple waterers, similar to those used in the Surrogator, fed from a 5-gallon bucket of water was mounted to each pen. Sides and tops of the pens were covered in fine mesh wire fencing, thus allowing chicks to acclimate to local weather. Following some depredation by foxes in the summer of 2014, the pens were enclosed by an electric fence to exclude mammalian predators. Vegetation (e.g., grain sorghum, proso millet, etc.) was planted inside and outside of each pen to simulate natural brood habitat. I manually removed mat forming grasses from the pens before each trial in order to facilitate movement throughout the pens by small chicks.

Approximately 36 hours prior to hatching of designated parent-reared eggs, I played a recording of the calls hens produce on the nest when their chicks are hatching. This call series was recorded by Tall Timbers Research Station (Tallahasee, FL, Theron Terhune, personal communication) by placing a microphone in the clutch of wild bobwhite nests. Within 24 hours of hatching, chicks were subdivided into groups of 15–20 birds (again to simulate natural broods) and introduced to an adult bobwhite foster parent. In the first year, only domesticated bobwhites were available as a source for foster parents. However, in the second year, Quail Call Farms supplied F1 generation semi-wild adults that had undergone the same imprinting process.

I placed foster parents into 0.6 m long, 0.5 m wide, and 0.3 m tall adoption boxes with a 0.25 m2 screen inset on the wood top for observation alone for 15 min. If the adult appeared calm (e.g. was not flapping or running around trying to get out) after the 15 minute period, 15–20 chicks were added behind a 0.7 m long, 0.3 m tall Plexiglas divider that could be slid in and out of the box to divide the box into two equal halves. During this imprinting process, I played the hen recording (used before hatch) in order to facilitate filial imprinting. It has previously been found that parents of successfully adopted chicks brooded and vocalized with the chicks (Palmer et al. 2012). If the foster parent remained calm and vocalized to the chicks, the divider was removed so the chicks and adult birds could come into contact and begin the imprinting and adoption process. If the adult rejected the brood (i.e. the adult appeared agitated, did not vocalize to the chicks), I removed it and added another potential parent. I held the adopted chicks and foster birds in a brooding box overnight in an attempt to strengthen their bond (Stoddard 1931).

The following morning, the brood was released with the parent into the rearing pens where they remained until release. There was no supplemental heating provided for trials that began from June through September. In December of 2013 and 2014, I retrofitted a heater from the Surrogator to the wooden box attached to the pens to provide supplemental heat. Chicks were fed the same diet as described for the Surrogator birds. However, when the wild bird seed mix was added to their diet, it was spread on the ground of the pen instead of being mixed into the feeders. Spreading grain in the pen was intended to help prepare parent-reared chicks for foraging outside of the pens once they were released; this isn't possible in the Surrogator due to its design. I expected insects to naturally enter the pens allowing for additional protein and foraging training.

After 5-weeks, chicks received a color leg-band and a uniquely numbered metal leg band for future identification and 2–3 birds from each brood were fitted with an expanding radio-transmitter before each release. Each group was released at a unique location on the study area near a similar sized non-parent-reared group, approximately 30 min after sunrise.

After experiencing low survival rates in the pens for the first 2 trials, I made two modifications to the original pen design. First, a 1 m long, 2 m wide, 0.5 m tall plexiglass "greenhouse" with a door to the rest of the pen and a roof that slides open was built in each pen. Chicks were held in these "greenhouses" for 2 weeks before the door to the rest of the pen was opened. This allowed the chicks to grow to a size that allowed them to thermoregulate more effectively before being truly exposed to the environment. Once the door to the uncovered pen was opened, the lid to the greenhouse remained closed to allow for a warm refuge from cold temperatures and precipitation. Second, instead of holding to a rigid release schedule of 5 weeks old, I waited to release the juveniles until the majority of the birds were at least 100 grams; this was the minimum size where I could safely outfit the juveniles with radio-collars. Surrogator birds grew faster than parent-reared birds but they were held in the Surrogators until the parent-reared birds were ready for release to reduce the number of variables between the treatments. All care, housing, and capture of bobwhites in this study was in compliance with requirements of the University of Delaware's Institutional Animal Care and Use Committee (#1242-2013-0).

Radiotelemetry

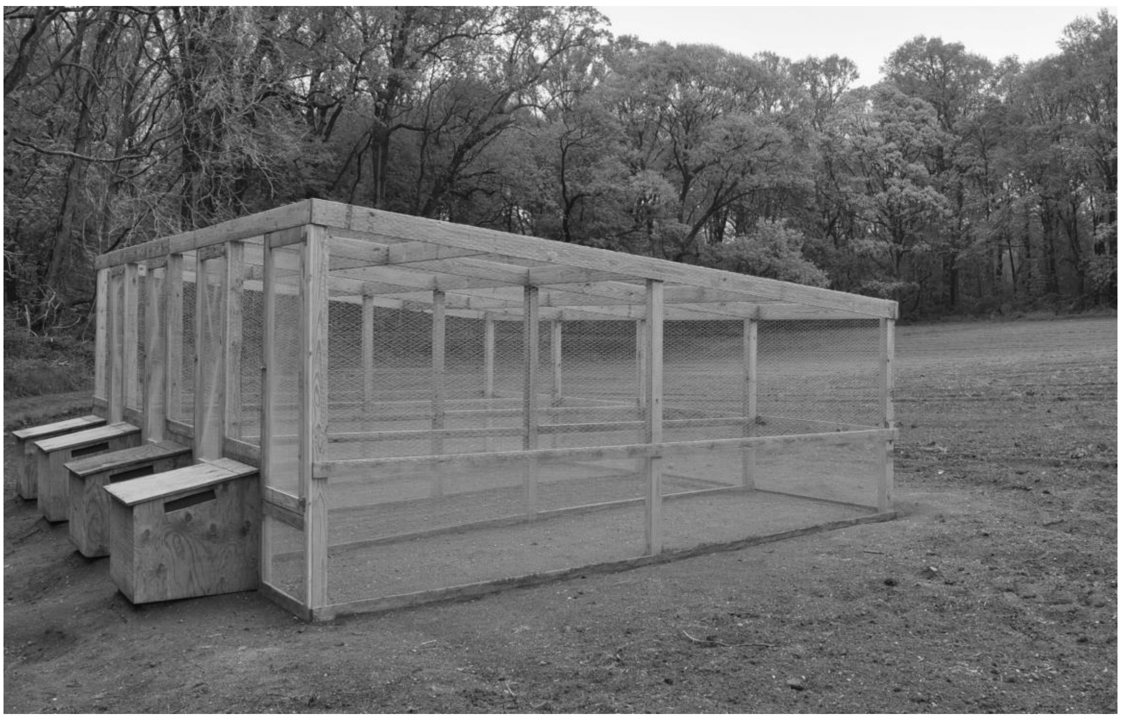
I used a telemetry receiver (Advanced Telemetry Systems Model R4000) with a 3 element Yagi antenna to locate every bobwhite released via homing (White and Garrott 1990) to determine individual locations. I tracked bobwhites 5–7 times per week until death between releases and the end of December to monitor survival. I monitored for survival once every other week between January-June. Beginning in June 2013, I used funnel traps (Stoddard 1931) and night-roost cast netting (Brinkley

2011) to trap bobwhites on the Greentree property in order to maintain an adequate sample size of radio-collared bobwhites. We replaced transmitters in each group as mortalities occurred when we were able to capture uncollared birds. We identified recaptured birds to their treatment group and release date based on their uniquely numbered aluminum leg band and corresponding color band. Over the course of the study, we captured and radio-collared 17 Surrogator birds and 8 parent-raised birds.

Analyses

I used radio-telemetry data to estimate and compare survival rates between the treatments. If a radio collar remained stationary for more than 18 hours, it began transmitting a mortality signal (i.e. pulsed twice as fast as live signals) so they were easily identified during daily telemetry. If a collar began to transmit a mortality signal, I located the collar and attempted to determine the cause of death for the bobwhite (Dumke and Pils 1973, Curtis et al. 1988). I pooled the data for all birds released from Surrogators throughout the study and used a Maximum Likelihood Estimator (Bart and Robson 1982) to calculate daily survival rates (Krebs 1999). In order to assess the effects of body mass (i.e. physiology) and imprinting (i.e. behavior), I created Cox proportional hazard models (Cox 1972) using package Survival in R (Therneau and Grambsch 2000, Therneau 2015). I tested 12 competing Cox proportional hazard models including: mass of birds at release, imprinting, trial (to account for effects of weather in different release months), and year effect. In order to avoid biasing the effect of trial on the models, we disregarded birds released in the third trial while creating our models since there were no Surrogator birds released in the third trial. I used Akaike's Information Criterion corrected for small sample size (AICc, Akaike 1976) to select the top model to explain effects on survival.

Figure 2 Pens to house parent-reared bobwhites on the Greentree Foundation Property, Manhasset, NY 2013–2014.



Results

Sample Sizes

I incubated 709 eggs over 4 trials for the Surrogator treatment. I released 278 Surrogator juveniles total and fitted 108 with radiocollars. I incubated 959 eggs over 6 trials for the parent-rearing treatment. I released 120 parent-reared juveniles total and fitted 54 with radiocollars (Table 1).

Survival Analysis

From 2013–2014, for the Surrogator control we placed 709 birds in the incubator over 4 trials (Table 1). Of those, 488 hatched (average hatchability rate = 68.8%) and 278 survived to release (average survival rate = 57.0%). Of those released, 108 were outfitted with radiocollars. For the parent-rearing treatment, we placed 959 birds in the incubator over 6 trials (Table 1). The third trial of each year was dedicated to only parent-reared birds as an effort to improve sample sizes for survival analysis. Of those, 642 hatched (average hatchability rate = 66.9%) and 120 survived to release (average survival rate = 18.7%). Numerous mortalities due possibly to loss of adoption by parents or lack of protection from the elements likely caused these low survival rates. Of those released, 54 were outfitted with radiocollars.

I pooled birds released from Surrogators each year into one group to calculate maximum likelihood estimates of daily survival rates due to low sample sizes. Daily survival rates of "wild-strain" chicks released on the Greentree Foundation was 0.95 (95% CI 0.84-1) thus producing <0.001 cumulative survival rate after 105 days.

I compared Kaplan Meier survival of radio-collared birds between parent-reared and Surrogator birds for the first 2 trials of each year without the examining potential interaction effects from other variables (e.g. year or mass) (Figures 3 and 4).

I did not examine the survival curve for trial 3 because there was no Surrogator group to compare to the parent-reared birds released in that trial. In 2013–14, the survival rate 31 weeks after initial release (regardless of release date) was 0.123 for Surrogator birds and 0.0 for parent-reared birds. In 2014–15, the survival rate 31 weeks after initial release (regardless of release date) was 0.033% for Surrogator birds and 0.0% for parent-reared birds. Despite the lack of long term survival in both treatments regardless of trial date, birds from each treatment survived longer in the second trial.

The top Cox proportional hazard models (ΔAICc <2) included only imprinting, mass, and trial number as covariates; study year was not a covariate in any of the top models. We used model averaging within the R package AICcmodavg (Mazerolle 2015) to calculate model averaged estimates of hazard covariates based on their slope coefficient for mass (0.00, 95% CI = -0.01–0.01), imprinting (0.29, 95% CI = -0.57–0.56), and trial (-0.6, 95% CI = -1.6–0.4) based on entire model set. All of the covariates for the model averaged data had confidence intervals that included 0; therefore, none of the model-averaged covariates were significant either (Table 2). Trial was the closest covariate to achieving significance and the trial only model was the top performing model aside from the null model. Maximum likelihood estimates of daily survival rates decreased for both Surrogator and parent-reared bobwhites from Trial 1 through 3 (Figure 5).

Table 1 Sample sizes for bobwhite eggs incubated, hatched, and released in each trial from June 2013 - December 2014 Manhasset, New York.

			Surrogator				Parent-rearing			
Initiation Date	Hatch Date	Release Date	Eggs in Incubator	Chicks Hatched	Birds Released	Radio-collared	Eggs in Incubator	Chicks Hatched	Birds Released	Radio-collared
6/5/13	6/28/13	8/10/13	180	125	97	23	180	130	17	9
7/18/13	8/10/13	9/17/13	186	90	68	30	186	112	18	4
9/10/13	10/4/13	12/18/13	0	0	0	0	50	35	24	5
5/21/14	6/14/14	8/6/14	138	109	45	25	138	123	21	16
6/2/14	6/26/14	9/21/14	205	164	68	30	205	147	18	9
9/9/14	10/3/14	12/4/14	0	0	0	0	200	95	22	11
Total			709	488	278	108	959	642	120	54

Table 2 Eleven Cox Proportional Hazards models comparing the effects of mass of birds at release (i.e. physiology), imprinting (i.e. behavior), trial (to account for effects of weather in different release months), and year effect on Greentree Property, New York, 2013 and 2014. ΔAIC values < 2.0 were considered to be the top competing models.

Model	K	AICc	ΔAICc	AICc Weight	Cumulative Weight
Trial	1	571.99	0.00	0.26	0.26
Imprint + Trial	2	572.25	0.26	0.23	0.48
Imprint	1	573.97	1.98	0.10	0.58
Mass + Trial	2	574.06	2.06	0.09	0.67
Imprint + Trial + Mass	3	574.06	2.07	0.09	0.76
Null	0	574.34	2.35	0.08	0.84
Mass + Imprint	2	574.95	2.96	0.06	0.90
Imprint*Year + Trial	4	575.94	3.95	0.04	0.93
Mass	1	576.28	4.29	0.03	0.96
Imprint*Year	3	577.36	5.36	0.02	0.98
Imprint*Year + Trial + Mass	5	577.36	5.37	0.02	1.00

Figure 3 Survival rates of radio-collared parent-reared and Surrogator bobwhite after release in the first trial of 2013 and 2014 on the Greentree Foundation Property with 95% confidence intervals, Manhasset, New York.

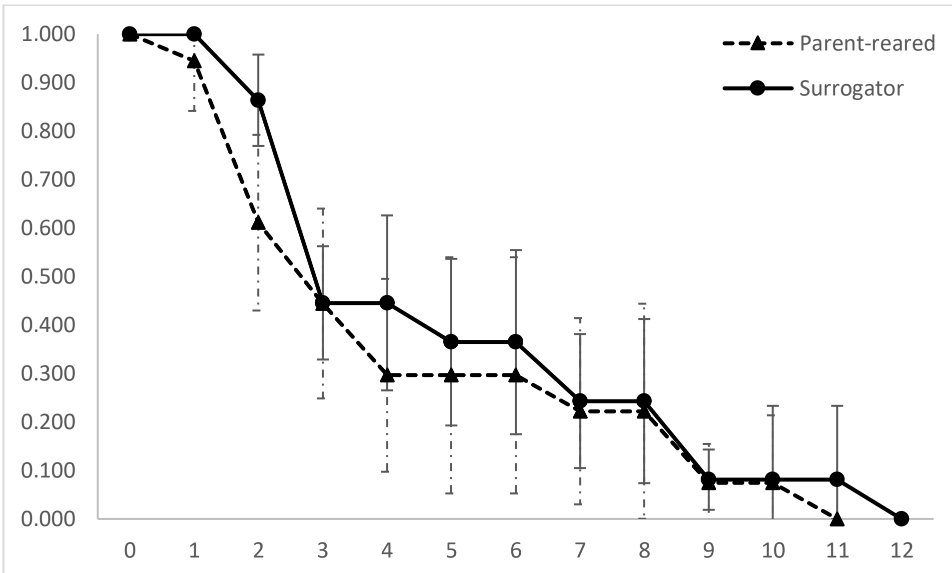


Figure 4 Survival rates of radio-collared parent-reared and Surrogator bobwhite after release in the second trial of 2013 and 2014 on the Greentree Foundation Property with 95% confidence intervals, Manhasset, New York.

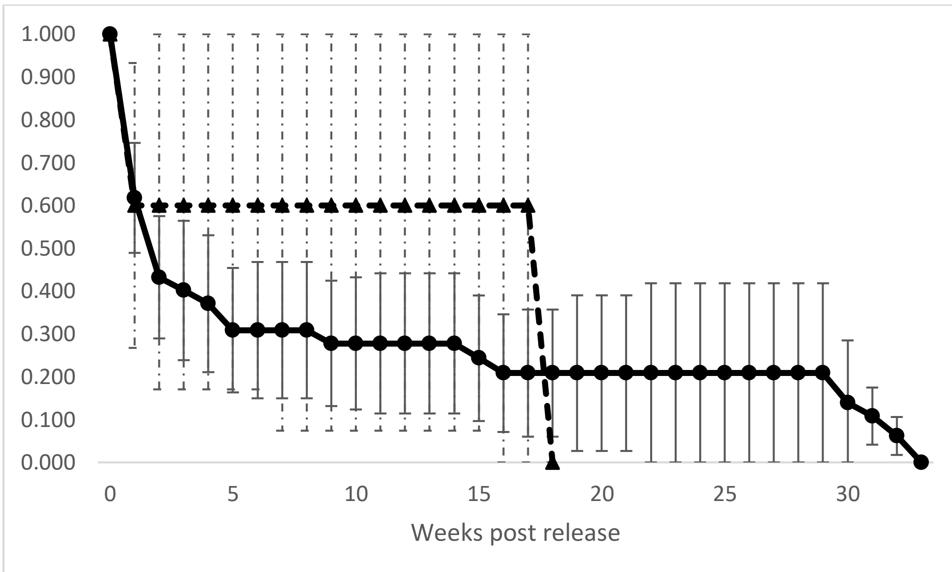
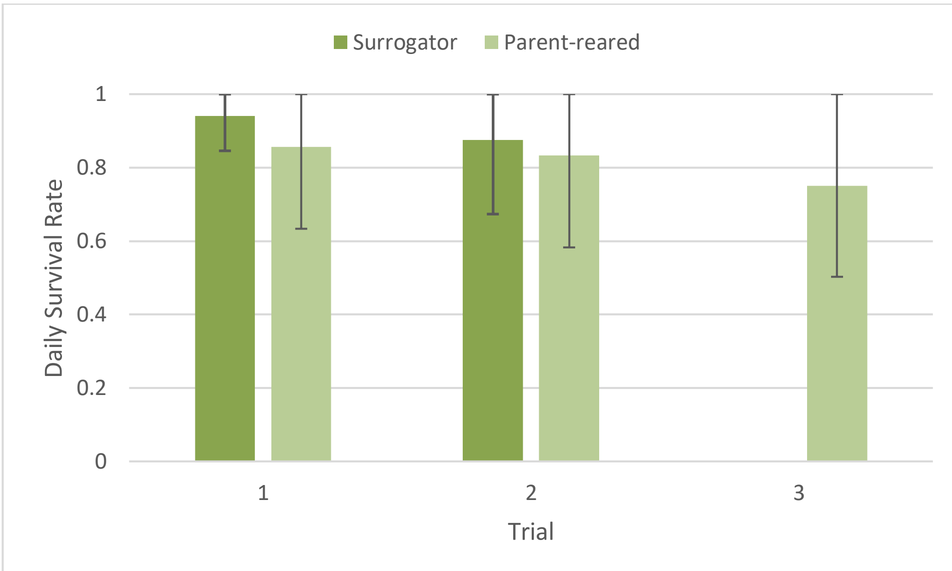


Figure 5 Mean daily survival rates of radio-collared bobwhites after release on the Greentree Foundation Property with 95% confidence intervals, Manhasset, New York comparing rates between first, second, and third trial of 2013 and 2014.



Discussion

Lohr (2009) found wild bobwhites in New Jersey had a daily survival rate of 0.9934 and a cumulative Oct-Mar survival rate of 0.3. Population models for bobwhites in the Mid-Atlantic predicted that bobwhite populations need a daily survival rate of 0.9968 (winter survival rate of 0.561) in order to maintain a stable population (Williams et al. 2012). Although our reintroduction efforts did not produce a sustainable population, there are possible improvements to foster parent-rearing that might enhance probability of success or future attempts.

First, habitat suitability is considered the primary factor in any reintroduction study. I did not conduct this research at multiple locations thus could not directly examine differences in habitat quality. Therefore, I acknowledge that my reintroduction into a fragmented northern landscape could have influenced the long-term success of this quail reintroduction on Long Island. Nevertheless, my research design still allowed for a direct comparison of reintroduction techniques for future efforts. Therefore, I encourage future reintroduction efforts to not only build upon my reintroduction methodology but increase it to multiple sites to evaluate habitat influences and thus potentially identify source habitats.

My estimated survival of "wild-strain" bobwhites raised in Surrogators throughout the course of this study was 0.95. While our rate is slightly higher than Kinsey et al.'s (2012) reported daily survival rates with domestic bobwhites raised in Surrogators of 0.92, both studies exhibited survival rates that approached zero after 105 days. This study did not provide evidence that improving the genetic makeup of bobwhites can significantly improve survival rates compared to the more traditional domestic birds. However, these results do not mean that genetics should be ignored when rearing bobwhites for reintroduction projects. Previous research with other species has proven that loss of genetic variability through domestication can negatively impact reintroduction efforts (Leopold 1944, Knoder 1959, Barbanera et al. 2010). Some might argue that "wild-strain" bobwhites used in this study came from Florida and could therefore contain different genetics than a source population at a higher latitude source site would have. While it would have been ideal to source the birds as close to the study area as possible, the reality is there was no other breeding program available to provide "wild-strain" bobwhite eggs. Furthermore, genetic studies of the current bobwhite population have shown little genetic variability between populations at different latitudes within the US (Ellsworth et al. 1989, Wehland 2006).

Variations in mass, as a proxy for physiological health, did not significantly change the chances of survival for bobwhites in this study. Previous research has tied body mass to survival for northern bobwhites (Buckley et al. 2015), but there may be other metrics to consider when assessing the effect of physiology on survival. For example, stress hormones could be collected from fecal samples to create an index of stress to compare survival rates to (Rothschild et al. 2008). Birds that survived longer in this study were in better physiological shape than their brood mates; metrics other than mass might have been able to reveal this correlation.

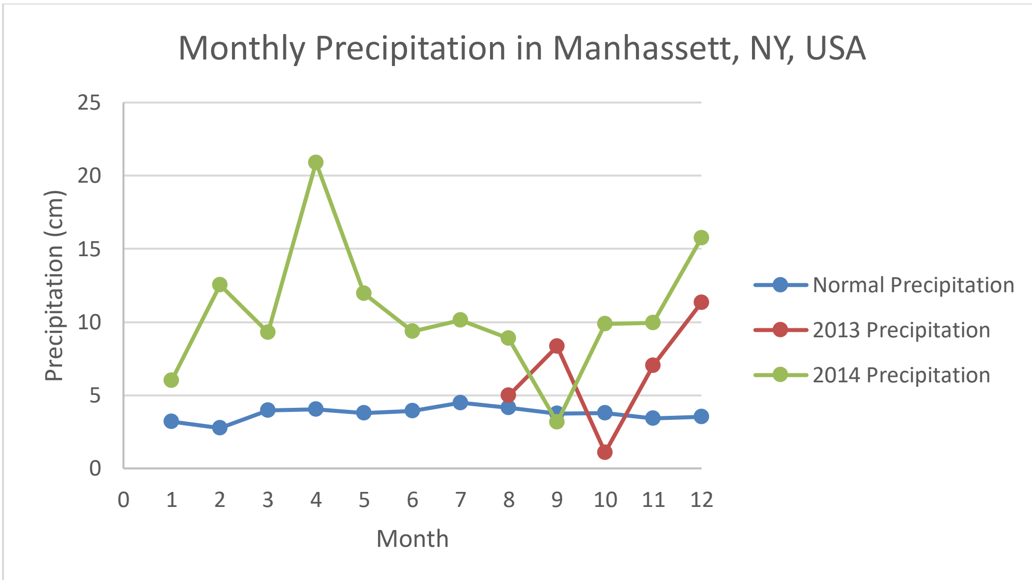
While imprinting was a variable in my top models, it was not a significant covariate in any of the models. Imprinting has been proven to have powerful behavioral consequences in other bird species (Hess 1973, Dowell 1992, Lickliter and Harshaw 2010), and has improved survival, predator avoidance, and reproduction for species other than bobwhites (Brittas et al. 1992, Dowell 1992, Buner and Schaub

2008, Gaudioso et al. 2011). Furthermore, in previous research, imprinting has shown promising results in producing bobwhites with similar survival rates and reproductive success as wild bobwhites (Palmer et al. 2012). It is difficult to explain the discrepancy between this study and past reintroduction efforts that incorporated imprinting. There could be a latitudinal or other geographic effect on survival using the parent-rearing methods. Further studies at latitudes between the two studies or in areas closer to or within the current bobwhite range would help determine the strength of these effects. Additionally, Palmer et al. (2012) speculated that the high survival rates of parent-reared bobwhites in their study might have been partially attributed to the wild bobwhites that already existed on their study area adopting the chicks post-release.

Daily survival decreased from Trial 1 through Trial 3. This suggests that bobwhites that are released later in the season face greater hazards compared to birds that are released earlier in the season. Weather can play a large role in the survival of bobwhites (Stoddard 1931); it stands to reason that releasing birds earlier in the season gives them time to adapt to the landscape before winter comes. Admittedly, our early release dates even may have been late compared to natural conditions, and our third trial was well outside typical fledging timing for wild bobwhites. However, when one considers the timing of availability and limited supply of “wild-strain” eggs, our release dates are not outside a typical timeline for reintroduction efforts in our area.

Despite my best efforts to improve the rearing and release methods from the first year of the study to the next, there was no significant year effect on survival for bobwhites in this study. Based on the Cox Proportional Hazard models, hazard rates were slightly higher in the second year of the study. It is difficult to determine why survival might have been lower in the second year compared to the first. It is possible that predation rates were higher due to an increased prevalence of predators on the study area. Predators may have developed a “search image” for quail or learned that prey was plentiful in the area because they were consistently being released there. This could have caused some predators to increase their hunting efforts within the study area. Kinsey et al. (2012) found a positive relationship between dispersal distance and survival duration. A larger study area would have allowed the released birds to avoid predation by dispersing further from the release site, or the release sites could vary more to avoid teaching the predators where their prey was likely to be. Weather might have also negatively affected survival more strongly in the second year of the study. Mean precipitation rates were below average from August-September and higher than average from October-December 2014 (Figure 5). The lack of precipitation in the late summer may have decreased available forage in 2014 while the increased precipitation in the fall and winter introduced extra stress to the birds so they needed to allocate more energy toward thermoregulation in the rain and snow.

Figure 6 Total precipitation rates from Manhassett, NY, USA from August 2013-December 2014 compared to the average monthly precipitation from 1981-2010.



Management Implications

My research has revealed that timing of release is one of the most important factors to consider when planning a bobwhite reintroduction effort. While imprinting was shown to improve success rates in other studies, it did not have a significant impact on survival in my study system. Future reintroduction efforts that attempt to use imprinting techniques might benefit by locating aviaries further away from the release site to prevent birds from returning to the aviaries where they could experience increased predation risk. Since body mass did not significantly contribute to the hazards experienced by bobwhites, it would be worth experimenting with releasing birds at a younger age. Wild adult bobwhites stop caring for their chicks after approximately 2 weeks (Rosene 1969). Releasing chicks at a younger age would decrease the amount of time spent in captivity and could result in birds that behave more like their wild counterparts. Additionally, holding chicks for shorter periods of time would free up pen space faster, allowing more trials to take place early in the season when survival rates are higher. Additionally, holding chicks for shorter periods of time would free up pen space faster, allowing more trials to take place early in the season when survival rates are higher. Future reintroduction efforts should strive to release birds early in the season, close to the average timing of bobwhite breeding to ensure success. Survival of parent-reared birds was higher compared to Surrogator birds in the second year of the study. This could have been due to improvements in learned behavior the second year since foster parents were also parent-reared “wild-strain” birds compared to the domestic bobwhites used in the first year. Further research on the effect of foster parent source could prove interesting and valuable to future parent-reared introduction efforts.

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Appendix A

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE APPLICATION TO USE ANIMALS IN RESEARCH AND TEACHING

RECEIVED
NOV 19 2012
IACUC

University of Delaware
Institutional Animal Care and Use Committee
Application to Use Animals in Research and Teaching

(Please complete below using Arial, size 12 Font.)

Title of Protocol: **Evaluation of the effectiveness of parent-reared vs. Surrogator raised northern bobwhite for reintroduction on Long Island, NY**

AUP Number: 1242-2013-0	**← (4 digits only — if new, leave blank)**

Principal Investigator: **Dr. Christopher K. Williams**

Common Name: Northern bobwhite

Genus Species: *Colinus virginianus*

Pain Category: ***(please mark one)***

USDA PAIN CATEGORY: *(Note change of categories from previous form)*	
Category	**Description**
☐ **B**	Breeding or holding where NO research is conducted
X C	Procedure involving momentary or no pain or distress
☐ **D**	Procedure where pain or distress is alleviated by appropriate means (analgesics, tranquilizers, euthanasia etc.)
☐ **E**	Procedure where pain or distress cannot be alleviated, as this would adversely affect the procedures, results or interpretation

Official Use Only

IACUC Approval Signature: ______________________

Date of Approval: 11/19/12

Principal Investigator Assurance

1. I agree to abide by all applicable federal, state, and local laws and regulations, and UD policies and procedures.
2. I understand that deviations from an approved protocol or violations of applicable policies, guidelines, or laws could result in immediate suspension of the protocol and may be reportable to the Office of Laboratory Animal Welfare (OLAW).
3. I understand that the Attending Veterinarian or his/her designee must be consulted in the planning of any research or procedural changes that may cause more than momentary or slight pain or distress to the animals.
4. I declare that all experiments involving live animals will be performed under my supervision or that of another qualified scientist. All listed personnel will be trained and certified in the proper humane methods of animal care and use prior to conducting experimentation.
5. I understand that emergency veterinary care will be administered to animals showing evidence of discomfort, ailment, or illness.
6. I declare that the information provided in this application is accurate to the best of my knowledge. If this project is funded by an extramural source, I certify that this application accurately reflects all currently planned procedures involving animals described in the proposal to the funding agency.
7. I assure that any modifications to the protocol will be submitted to by the UD-IACUC and I understand that they must be approved by the IACUC prior to initiation of such changes.
8. I understand that the approval of this project is for a maximum of one year from the date of UD-IACUC approval and that I must re-apply to continue the project beyond that period.
9. I understand that any unanticipated adverse events, morbidity, or mortality must be reported to the UD-IACUC immediately.
10. I assure that the experimental design has been developed with consideration of the three Rs: reduction, refinement, and replacement, to reduce animal pain and/or distress and the number of animals used in the laboratory.
11. I assure that the proposed research does not unnecessarily duplicate previous experiments. ***(Teaching Protocols Exempt)***
12. I understand that by signing, I agree to these assurances.

Christopher K. Williams   10/5/2012

Signature of Principal Investigator   Date

Rev 8/10   2

#1242-2013-0

NAMES OF ALL PERSONS WORKING ON THIS PROTOCOL

I certify that I have read this protocol, accept my responsibility and will perform only those procedures that have been approved by the IACUC.

Name	Signature
1. Christopher Williams	Christopher K. Williams
2.	
3.	
4.	
5.	
6.	
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10.	
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12.	
13.	
14.	

The Animal Use Protocol form has been developed to facilitate review of requests for specific research, teaching, or biological testing projects. The review process has been designed to communicate methods and materials for using animals through administrative officials and attending veterinarians to the Institutional Animal Care and Use Committee (IACUC). This process will help assure that provisions are made for compliance with the Animal Welfare Act, the Public Health Service Policy on Humane Care and Use of Laboratory Animals and the Guide for the Care and Use of Laboratory Animals.

Please read this form carefully and fill out all sections. Failure to do so may delay the review of this application. Sections that do not apply to your research must be marked "NA" for "Not Applicable."

This application form must be used for all NEW or THREE-YEAR RENEWAL protocols.

All answers are to be completed using Arial 12 size font.

All questions must be answered in their respective boxes and NOT as attachments at the end of this form.

Please complete any relevant addenda:

Hybridoma/Monoclonal Antibodies ("B")
Polyclonal Antibodies ("C")
Survival Surgery ("D")
Non-Survival Surgery ("E")
Wildlife Research ("F")

If help is needed with these forms, contact the IACUC Coordinator at extension 2616, the Facility Manager at extension 2400 or the Attending Veterinarian at extension 2980.

1. **Principal Investigator Information:**	
a. Name:	Dr. Christopher Williams
b. University/Company:	University of Delaware
c. Department:	Entomology and Wildlife Ecology
d. Building/Room:	253 Townsend Hall
e. Office Phone:	302-831-4592
f. Lab Phone(s):	302-831-4557
g. Home Phone:	302-369-6318
h. Mobile Phone:	302-354-9242
i. E-Mail Address:	ckwillia@udel.edu

2. **Protocol Status:**
a. **X** New Protocol ***OR*** ☐ Re-submission due to three (3) completed years. If re-submission, enter Protocol Number:
b. **X** Research ***OR*** ☐ Teaching
c. ☐ Laboratory Animals ***OR*** **X** Wildlife If "Wildlife" please complete Addendum "F"
d. Proposed Start Date: 1/1/2013
e. Proposed Completion Date: 5/1/2015
f. Funding Source: Greentree Foundation, Long Island, NY
g. Award Number: *In Process*

3. **Personnel involved in Protocol** ***(Include Principal Investigator):***

***Status*:** Indicate Prof, Post-Doc, Grad Student, Lab Manager, Research Assistant, Technician, etc.

***Qualifications*:** Include **procedures this person is proficient in performing** on proposed species and the time they have been doing the procedure.
Be specific (e.g. sub-mandibular bleeding on mice-2yrs, performing castrations on mice and rats-1yr, tail-vein injections on mice-2yrs, etc.) **(If no experience, list who will train.)**

***Responsibilities*:** Include **all responsibilities** this person will have with live animals on this protocol, including euthanizing animals.

Name	E-mail	Office Phone Number	Home/Cell Phone Number	Received Animal Facility Training	
				Yes	No
a. Christopher Williams	ckwillia@udel.edu	302-831-4592	302-354-9242	X	

Status: Associate Professor of Wildlife Ecology

Qualifications: Ph.D. in Wildlife Ecology and 17 years of field ecology/wildlife research with specialty on game birds (quail and waterfowl). Have 5 years direct field experience radio-collaring and pen raising northern bobwhite. I have an additional 8 years instructing graduate students how to radio-collar and handle birds.

Responsibilities: Oversee research design, protocol, and training of graduate student conducting field research.

Name	E-mail	Office Phone Number	Home/Cell Phone Number	Received Animal Facility Training	
				Yes	No
b. Unknown Graduate Student					

Status: I am conducting a national search for a graduate student to conduct this research. Once that person is found we will update this form to include the student.

Qualifications: B.S. in Wildlife Ecology or related field

Responsibilities: Graduate student will oversee rearing of bobwhite quail at the Greentree Foundation property on Long Island, NY during the summers of 2013 and 2014. Upon release some birds will be outfitted with radiocollars and tracked for survival and habitat use analysis. Please see attached proposal for more information.

4. Non-Scientific Summary: In language understandable to a ***high-school senior, very briefly describe*** the goals and significance of this study.

a. Specific Scientific Goals:

Northern bobwhite (*Colinus virginianus*; hereafter bobwhite) is a widely distributed gamebird in eastern North America, historically found in early-successional habitats ranging as far north as Ontario, Canada. However, bobwhites have experienced range contractions and precipitous range-wide declines in abundance since the 1960's. These declines have been attributed to urban/suburban sprawl, "clean" agriculture, loss of grasslands, and habitat fragmentation. Although declines have occurred range-wide, populations at the northern end of the species' range, including those in the Mid-Atlantic, have experienced especially serious declines. For example, populations in New Jersey have declined 6.3% per year between 1966-2007 and 13.0% per year between 1980-2007, as compared to a range-wide decline of 3.0% per year and 3.9% per year over the same time periods. Today New Jersey's population is on the edge of extinction. Such stories are worse as we move farther north. New York used to have more available grasslands and bobwhite thrived. For instance, naturalist writing of wildlife populations at the turn of the 20th century stated bobwhite were the most abundant hunted wildlife species in the horse abundant lands north of New York City on the road to Albany. However today, quail are also virtually extinct in New York with possibly only a remnant population on the eastern end of Long Island.

Recovering such populations are extremely difficult. A number of management strategies have been tested to reestablish bobwhites in areas of suitable habitat including release of pen-reared bobwhites and translocation of wild bobwhites. While studies have found that survival between translocated wild bobwhites and resident individuals are similar, pen-reared and released bobwhites often demonstrate survival rates too low to establish a population.

Attempts to restore bobwhite populations in suitable habitat using game-farm or pen-reared quail have been made since the early 1900s and continue into the present. Propagation of game birds in captivity has long been regarded as a "quick fix" for better hunting. However, this method of replenishing quail populations proved unsuccessful. Three of the most recognized problems associated with restoration of quail by pen-raised birds were: 1) low rates of post-release survival, 2) long distance dispersal from release sites, and 3) while individuals that survive until the following nesting season have been found to readily nest they tend to have poor parenting skills and therefore low recruitment of young.

While translocation of wild birds is the preferred and proven method to restore populations in suitable habitat, the availability of wild bobwhites for translocation may be limited (legally or biologically) and releasing pen-raised birds may be the only alternative. In response to historic problems at population reintroduction, there was the development of The Surrogator (hereafter, Surrogator). Surrogators are a game bird propagation tool that provides food, water, heat, and shelter for day-old chicks through the ensuing first 5 weeks of life. During the 5-week-period, the only contact chicks have with humans is during weekly maintenance of the Surrogator and when removing mortalities. After 5 weeks, chicks are released into the wild. Unfortunately, recent multistate research has found that survival of Surrogator raised bobwhite have near 0% chance at long-term survival or establishment in the wild.

The failure of the Surrogator may be related to the lack of early learning behavior between mother and chick as pen-reared bobwhites are reared "communally" in brooder pens without a parent. Chick imprinting is an early form of learning during short prenatal and post-hatch periods in which the chicks learn to identify their parents. Imprinting in birds has a suite of behavioral consequences including sexual selection, social-learning, predator recognition, predator avoidance, recognition of alarm calls, food selection, and parenting skills. In gray partridge, red-legged partridge, and pheasants it has been shown that greater survival and predator avoidance as well as reproduction occurred in chicks fostered with parents versus those artificially-reared.

To attempt to develop a captive breeding program that produces birds useful for population restoration, a new methodology has been developed that relies on a parent-rearing method for bobwhites that includes prenatal and postnatal learning. Research on this methodology has found nest success and chick survival was similar between wild birds and parent-reared pen raised birds indicating the possibility this method may be a successful improvement to the Surrogator. This work was conducted in the Southeastern United States where populations are relatively robust (as compared to peripheral populations). The next step is to test the parent reared reintroduction methods (as compared to the Surrogator birds) in an area with few or no birds to determine what would be a successful strategy for bobwhite reintroduction. Therefore, the objectives of this study will be to measure survival rates, dispersal rates, and habitat use/preferences made by birds using these 2 methods on Long Island, New York where the bobwhite population is near extinction.

b. Significance of this Research (including the possible benefits to human and/or animal health, the advancement of scientific knowledge, or the betterment of society):

This research will not only aid personnel at Greentree Foundation property on Long Island with improved knowledge to promote an effective release program; but it will also foster development of reintroduction plans for Northeastern/Mid-Atlantic states. There is a new long-term goal to attempt the development of a Long Island Wildlife Corridor comprising over 11,000 acres, in ten Parks, of New York State Parkland found along the North Shore of Long Island between the long island Expressway and Long Island Sound stretching approximately 70 miles to the east of Greentree. Therefore this research has the potential to provide a foundation and anchor to bobwhite reintroduction efforts along this proposed corridor. Lastly, because grassland habitat associated with bobwhite also has the potential to support many other grassland songbirds (many of which are also suffering population declines) this research will help toward long term promotion and restoration of grasslands in this region.

5. **Experimental Design:** Explain the experimental design. This description should allow the IACUC to understand fully the experimental course of an animal or group of animals from its entry into the experiment to the endpoint of the study.

The inclusion of flow charts, diagrams, and/or tables are greatly encouraged to explain experimental design or sequential events.

Be sure to include all animal events and related details, i.e.,

- **All Procedures**-bleedings, injections, surgical procedures, euthanasia, etc.
- **Procedural details**–number of animals involved in procedure, approximate animal weight, if relevant (for injections, bleeding, etc.), route, frequency, volume, etc.

- **Names of surgical procedures** (but reserve the surgical details for the proper Surgical Addenda)
- **Monitoring**–observations, measurements (animal weight, tumor size, etc)
- **Monitoring details**–criteria, frequency, names of personnel monitoring, conditions for removing an animal from the study, etc.
- **Endpoints**–include endpoints for the animals/study and how will they be determined.

(Describe):

We propose a minimum of two trials each year using 2 Surrogators and Outdoor Rearing Pens placed at different locations on the Greetree property (<1,500 m apart) in areas we categorize as suitable bobwhite habitat with shade during the hottest hours of the day.

Outdoor Rearing Pens for Parent-reared Chicks

We will construct 16 rearing pens (8 at each of the two release sites on the property) that are adjacent to one another (See picture). Each pen will be 16 feet long, 6 feet wide and 6 feet tall. Each pen will have a 2.5*2.5*2.5 foot shelter attached to the outside of each pen to facilitate changing water and providing feed. Tops of the pens will consist of netting to allow for chick acclimation to local weather. Pens will potentially be enclosed by a snake fence and a solar-powered electric fence to exclude mammalian predators. Vegetation will be allowed to grow in pens (e.g., Ragweed and other common forbes to the site) to simulate natural brood habitat.

We will obtain wild-strain bobwhite eggs from Quail Call Farms, (Beachton FL), which is important because many breeders in the country do not provide eggs that are verified to come from wild stock. This wild stock provides a genetic foundation for natural behaviors (such as anti-predator behaviors) that domestic quail may not have. Approximately 36 hours prior to hatching we will play a recording of the calls hens produce on the nest when their chicks are hatching. This call series was previously recorded by placing a recording microphone in the clutch of wild bobwhite nests. These calls within the egg allow the chicks to begin to imprint on the mother and begin the learning process for survival in the wild. Within 6 hours of hatching, chicks will be taken from the incubator and introduced to a wild adult female bobwhite (who will serve as the foster parent) from translocated wild birds at Tall Timbers Research Station, Tallahassee Florida. Translocating wild birds requires approval from the State Fish and Wildlife Association and tentative approval for this release is underway through Tall Timbers. We will first place foster parents in adoption boxes for 10–15 minutes; after which 20 chicks will be added behind a plexiglass divider. If the foster bird remains calm, the divider will be removed so chicks and adult birds can come into contact and begin the imprinting and adoption process. If a brood is rejected by the parent, we will remove the parent and add another potential parent. It has previously been found (Palmer et al. 2012) that parents of successfully adopted chicks brooded and vocalized with the chicks. We will hold the adopted chicks and foster birds in a brooding box overnight in an attempt to strengthen their bond (Stoddard 1931). The following morning, we will release the brood with parent into the rearing pens described previously where they will remain for 35–42 days until release. There will be no supplemental heating provided. Each 5-week-old chick will be color leg-banded for future identification and 15 randomly selected bobwhite chicks will be fitted with an expanding radio-transmitter (that will adapt to the changing size of the sub-adults into adults). Additionally all adults will be radio-collared to measure the survival of these wild birds. All care, housing and capture of bobwhites in this study will be in compliance with requirements of UD's Institutional Animal Care and Use Committee. The above methodology will be repeated in August for a second trial (thereby totaling 240 chicks over the summer). This entire methodology will be replicated for a second year during the summer of 2014.

Surrogator Methods

To serve as a control to the parent-rearing methodology, we will also use the more traditional Surrogator methodology to measure survival of chicks without parent-rearing. Once a suitable location is identified, all vegetation and leaf litter will be removed from the immediate surrounding area for ease of maintenance. We will possibly construct a 1.83 m x 3.05 m fence around each Surrogator using 1.83 m T-posts and cattle panels 1.52 m in height to keep resident wildlife from damaging or disturbing Surrogators. We will follow any guidelines set up following Surrogator System Guide.

In Mid-July, 2013 and 2014, 120 brooder-reared chicks (from the same wild-strain bobwhite eggs from Quail Call Farms, Beachton FL) will be removed from an incubator at hatching, placed into a Surrogator, and reared to 35 days of age. Chicks will receive commercial gamebird starter feed (Purina, St. Louis, Missouri) with free-standing waterers. At 2 weeks of age, proso millet (*Panicum miliaceum*) will be mixed into the commercial feed. At 4 weeks of age, grain sorghum (*Sorghum bicolor*) will be mixed into commercial feed. At 21-35 days of age, brooder heaters will be reduced to prepare chicks for ambient temperatures upon release. Each 5-week-old chick will be color leg-banded for future identification and 15 randomly selected bobwhite chicks will be fitted with an expanding radio-transmitter. We will release the bobwhites from each Surrogator by opening all doors approximately 30 min after sunrise the following morning. The area will be evacuated, allowing for a soft release. We will return to remove Surrogators and fencing material from each release site 12 h later, after confirming that all bobwhites had left the units. A second trial will begin in mid August and we will follow the same protocol as listed above.

Radiotelemetry

We will use a telemetry receiver to locate every bobwhite released from each of the three treatments to determine each individual's location. We will radiolocate bobwhites 5–7 times per week until death between summer release and the end of December for habitat use and survival. Monitoring for survival only will be conducted once every other week between January-June. Survival rates will be estimated using a staggered entry survival modeling approach. We will also assess habitat selection of different treatment radiocollared bobwhites to test whether bobwhites disperse randomly or select cover in the immediate area of release sites. We will also assess preference and avoidance of habitat types of the three treatments and compare them to wild birds observed in previous studies in the region.

Refinement, Reduction & Replacement

When using animals for research, it is important to consider the three Rs: reduction, refinement, and replacement to reduce both animal distress and the number of animals used in the laboratory.

Reduction: Minimizing the number of animals used
Refinement: Using techniques and procedures to reduce pain and distress
Replacement: Using non-animal methods or lower phylogenetic organisms

6. Justification for the Use of Animals (instead of *in vitro* methods)
(Check all that apply and explain):

a. X The complexity of the processes being studied cannot be duplicated or modeled in simpler systems: ***(Explain)***: This field research is simplified by using the minimum number of animals to assure significance in results.

b. X There is not enough information known about the processes being studied to design non-living models: ***(Explain)***: This research can only be conducted on live bobwhite instead of modeled theoretical populations because we are testing the impacts of unknown imprinting procceses.

c. ☐ Other: ***(Explain)***:

7. Justification for Species Appropriateness:
(Check all that apply and explain):

a. **X** A large database exists, allowing comparisons with previous data: ***(Explain)***: Bobwhite quail are perhaps the most research wildlife species in history. Never-the-less, we have not been able to stop their population declines. Therefore we need to continue to research new advances in their restoration.

	b. ☐ The anatomy or physiology is uniquely suited to the study proposed: ***(Explain)***:
	c. ☐ This is the lowest species on the phylogenic scale suitable to the proposed study: ***(Explain)***:
	d. ☐ Other: ***(Explain)***:
8.	**Justification for Number of Animals Requested**:
	a. ☐ Pilot study or preliminary project where group variances are unknown at the present time. Describe the information used to estimate how many animals will be needed: (Only a limited number of animals will be permitted.) ***(Explain)***:
	b. **X** Group sizes are determined statistically. Describe the statistical analysis used to estimate the number (N) of animals needed: N may be estimated from a power analysis for the most important measurement in the study, usually based on the expected size of the treatment effect, the standard error associated with the measurement, and the desired statistical power (e.g. $P < 0.05$). Data analysis methods should not be submitted unless directly applicable to the estimate of N. *An online calculator may be found at:* http://www.math.uiowa.edu/~rlenth/Power/ *or a stand-alone calculator that can be downloaded from* http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3 ***(Explain)***: Previous research (Winterstein et al. 2001, who used a Kaplan-Meier variance formula presented by Pollock et al 1989) found that a minimum of 50 radiocollared birds are necessary (per treatment) to statistically estimate survival and habitat use. Therefore we will have 30 radiocollared birds in the Surogator and Parent reared treatments each and we will then replicate over two years to produce a sample size of 60. We expect that some birds may be lost during the research period; therefore we believe 60 birds will allow us to conservatively make the 50 individual benchmark. Pollock, K. H., S. R. Wintersein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysisin telemetry studies: the staggered entry design. Journal of Wildlife Management 53:7–15. Wintersein, S. R., K. H. Pollock, and Christine M. Bunck. 2001. Analysis of survival data from radiotelemtery studies. Pages 351–380 in Millspaugh, J., and J. M. Marzluff, editors. Radio Tracking and Animal Populations. Acadmic Press, New York, New York, USA.

c.	☐ Group sizes are based on the quantity of harvested cells or the amount of tissue required for *in vitro* studies. Explain how much tissue is needed based on the number of experiments to be conducted and the amount of tissue you expect to obtain from each animal (e.g., 10g of tissues are needed: Each animal can provide 2g. 10g /2g per animal = 5 animals needed.) ***(Explain)***:
d.	☐ Teaching protocol. Specify the number of students in the class, the student to animal ratio and how that ratio was determined: Animal numbers should be minimized to the fullest extent possible without compromising the quality of the hands-on teaching experience for students or the health and welfare of the animals. ***(Explain)***:
e.	☐ Study involving feral or wild animals. Animals will be captured and released in an attempt to maximize the sample size within logistical constraints. Describe the process by which you estimate these numbers and estimate the precision needed: ***(Explain)***:
f.	☐ Observational, non-manipulative study. Animals will not be captured, their behavior will not be interfered with, and exact animal numbers cannot be predicted: ***(Explain)***:
g.	☐ Product testing. The number of animals needed is based on FDA guidelines. Provide the citation from the regulations, the IND tracking number, or relevant FDA correspondence: ***(Explain)***:
h.	X Other. Elaborate, indicating the method used to determine the group size. ***(Explain)***: It is typical that surrogators are used with ~125 birds per manufacturers recommendations. Therefore we will use an equal number of birds raised via the parent rearing method. This will be duplicated twice a summer and twice over two years. This will allow equal numbers of birds to be released by the 2 methodologies to adequately test differences in survival and habitat use. Additionally, for parent reared broods, these numbers will allow us to apply 2-3 collars per brood thereby sampling variations in different family units use of habitat.

9. Animals Requested:

Common Name	Genus and Species	Total Number of Animals for Three Years
1. Northern bobwhite	Colinus virginianus	1000
2.		
3.		
4.		
5.		

10. Where will animals be housed (or captured for wildlife)?

Approximately 40 wild birds will be captured by funnel trap (consistent with all bobwhite research) by staff at Tall Timbers Research Station in Talahassee FL during February-Marhc, 2013-2014. These birds will temporarily be housed by Tall Timbers staff at their facility. Tall Timbers will FedEx birds to Greentree Property where we will take control of the birds well being. Adults will be placed in outdoor pens (described before) with food and water available ad libitum, adequate shade, and with minimum human disturbance. Bobwhite eggs will be raised in an incubator in July and August 2013 and 2014 and once hatched will be placed with adults in outdoor pens for one month until grown. Birds will then be released into the wild.

11. Where will the experiments take place? Greentree Foundation, Manhassett, Long Island New York.

12. Will any animals be humanely killed, without treatment or manipulations, to be used to obtain tissue, cells, etc.? ☐ Yes X No

If **Yes,** list types of tissue, etc:

13. Physiological Measurements ☐ Yes X No

If **Yes,** list and explain:

14. Dietary Manipulations ☐ Yes X No

If **Yes,** list and explain:

15. Environmental Stress (e.g. cold, restraint, forced exercise) ☐ Yes X No If **Yes,** list and explain:	
16. Trauma or Burn Injury ☐ Yes X No If **Yes,** list and explain:	
17. Production of Hybridoma/Monoclonal Antibodies ☐ Yes X No If **Yes,** please complete Addendum "**B**".	
18. Production of Polyclonal Antibodies ☐ Yes X No If **Yes,** please complete Addendum "**C**".	
19. Study of the effects of drugs or toxins *in vivo* ☐ Yes X No If **Yes,** list and explain:	
20. Administration of hazardous or biological materials (e.g. pathogens, carcinogens, radioactive materials) ☐ Yes X No a. Type to be used:	
b. Describe the practices and procedures for the handling and disposal of contaminated materials associated with this study: *(For radioactive materials, include the methods for removal of radioactive wastes and monitoring for radioactivity, if applicable.)*	
c. Approval received from UD- Environmental Health and Safety? ☐ Yes ☐ No	
21. Study of Irradiation *in vivo*? ☐ Yes X No a. Type to be used:	
b. Approval received from UD- Environmental Health and Safety? ☐ Yes ☐ No	

22. **Any other procedures?** ☐ Yes X No

If **Yes,** explain:

23. **Will this study involve surgery?** ☐ Yes X No

If **Yes,** and it is "Survival Surgery," please complete Addendum "**D**".

If **Yes,** and it is "Terminal Surgery," please complete Addendum "**E**".

24. **Will any animal undergo anesthesia for any reason other than surgery?** ☐ Yes **X** No

If **Yes**,

a. List Procedures and Reason(s) for using anesthesia:

b. Check the type of anesthesia to be used.

☐ Isoflurane

☐ Injectable ***(For injectable, complete the following):***

Drug:
Dose:
Route:

25. **Animal Use and Pain Distress.** If you have indicated that **animals in your study will experience pain or distress**, even if it will be fully alleviated, please mark the appropriate check boxes below and fill in the requested information for each item marked.

You must conduct at least two (2) searches.

I have considered alternatives to the use of animals in my study. Alternatives refer to methods or approaches which result in refinement of procedures which lessen pain and/or distress; reduction in numbers of animals required; or replacement of animals with non-whole-animal systems or replacement of one animal species with another, particularly if the substituted species is non-mammalian or invertebrate. I have used the following methods and sources to search for alternatives:

Note: You may need to do more than one search per database to look for alternatives if there are multiple procedures that may cause pain and/or distress.

Database Used:

☐ **Medline** X **Agricola**

☐ **Toxline** ☐ **CAB Abstracts**

☐ **Biosis** ☐ **Other *(Specify)***:

Date of Search: 10/5/12
Years Covered: 1940-present
Keywords Used (must include the word *alternative*): bobwhite, alternative
Number of Papers Found: 0
Discussion of the Relevancy of the Papers Found:

Database Used:

☐ **Medline** ☐ **Agricola**
☐ **Toxline** ☐ **CAB Abstracts**
☐ **Biosis** X **Other *(Specify)***: Wildlife and Ecology Worldwide

Date of Search: 10/5/2012
Years Covered: 1940-present
Keywords Used (must include the word *alternative*): bobwhite, alternative
Number of Papers Found: 0

26. Unnecessary Duplication of Work. Activities involving animals must not unnecessarily duplicate previous experiments performed by you or others. Provide a written narrative that assures that the activities of this project comply with this requirement and support this assurance by performing a literature search.

The search should return, at minimum, the related previous work from your laboratory.

You must conduct at least two (2) searches.

(NOT REQUIRED FOR TEACHING PROTOCOLS)

Note: You may need to do more than one search per database to look for duplication of work, especially if you are doing more than one experiment.

Database Used:

☐ **Medline** X **Agricola**
☐ **Toxline** ☐ **CAB Abstracts**
☐ **Biosis** ☐ **Other *(Specify)***:

Date of Search: 10/5/12
Years Covered: 1940-present
Keywords Used (must include the word *alternative*): bobwhite, alternative, translocation, New York, Mid-Atlantic, Surrogator, Parent-rearing

Number of Papers Found: 0
Discussion of the Relevancy of the Papers Found:

Database Used:	
☐ **Medline**	☐ **Agricola**
☐ **Toxline**	☐ **CAB Abstracts**
☐ **Biosis**	X **Other *(Specify)***: Wildlife and Ecology Worldwide
Date of Search: 10/5/2012	
Years Covered: 1940-present	
Keywords Used (must include the word *alternative*): bobwhite, alternative, translocation, New York, Mid-Atlantic, Surrogator, Parent-rearing	
Number of Papers Found: 14	
Discussion of the Relevancy of the Papers Found: Previous literature focuses on basic ecology of bobwhite in the Mid-Atlantic with no work done on reintroductions in our area. Other reintroduction papers came up and all are referenced in the attached proposal. This research will be novel.	

27. What is the expected disposition of animals at the end of the experiments? *(Check all that apply)*:
☐ Euthanized
☐ Maintained
X Released ***(Wildlife Only)***
☐ Other ***(Specify)***:

28. Euthanasia*   Select methods that will be used in case of emergency and/or at the end of the procedure/experiment.   ***NOTE:**   • Methods must be approved by the AVMA or must be scientifically justified.   • A "Primary" and "Secondary" method must be selected (UD Double Kill Policy).   • **If different methods will be used for different groups** of animals, indicate the group after the procedure (e.g., write "Neonates" after Decapitation, "Adults" after CO_2, "Terminal Surgery Animals" after Isoflurane Anesthesia Overdose, etc.).
X Animals will NOT be under anesthesia when euthanasia is performed.
☐ Animals will be under anesthesia when euthanasia is performed. **(*Check drug used below*)**:
☐ Isoflurane

☐ Injectable (***Complete the following)***:
Drug:
Dose:
Route:
PRIMARY method(s) of euthanasia
☐ CO_2 by compressed gas cylinder ***(Not for animals already under anesthesia or neonates)***
☐ Barbiturate Euthanasia Solution - Injectable ≥150mg/kg (***Check route below)***: ☐ IV ☐ IP ☐ IC
☐ Isoflurane Anesthesia Overdose - Inhalant
☐ Cervical Dislocation ***(only under anesthesia)***
☐ Decapitation ***(only under anesthesia or neonates)***
☐ Exsanguination or Perfusion ***(only under anesthesia)***
☐ Incision of Chest Cavity – Bilateral Pneumothorax ***(only under anesthesia)***
☐ Pithing – Double pithing required ***(fish, amphibians, reptiles only)***
X Thoracic Compression ***(small birds only)***
☐ Removal of Vital Organ(s) ***(only under anesthesia) (Check all that apply):*** ☐ Brain ☐ Kidneys ☐ Heart ☐ GI Tract ☐ Liver ☐ Lungs ☐ Other Vital Organ(s) – ***(Specify):***
☐ Other Method of Euthanasia: ***(Describe and Scientifically Justify)***:
SECONDARY method(s) of euthanasia that will be used to ensure that the animal does not survive:

X Cervical Dislocation
☐ Decapitation
☐ Exsanguination or Perfusion
☐ Incision of Chest Cavity – Bilateral Pneumothorax
☐ Barbiturate Euthanasia Solution - Injectable ≥150mg/kg ***(Check route below)***: ☐ IV ☐ IP ☐ IC
☐ Pithing – Double pithing required ***(fish, amphibians, reptiles only)***
☐ Removal of Vital Organ(s): ***(Check all that apply)***: ☐ Brain ☐ Kidneys ☐ Heart ☐ GI Tract ☐ Liver ☐ Lungs ☐ Other Vital Organ(s) – ***(Specify):***
☐ Other Method of Euthanasia: ***(Describe and Scientifically Justify)***:

University of Delaware
Institutional Animal Care and Use Committee

Application to Use Animals in Research and Teaching

ADDENDUM "F"
Wildlife and Field Studies

(Please complete below using Arial, size 12 Font.)

AUP Number: 1242-2013-0	**← (4 digits only — if new, leave blank)**
Project: Evaluation of the effectiveness of parent-reared vs. Surrogator raised northern bobwhite for reintroduction on Long Island, NY	

1. Have all required federal, state, and local permits* been obtained?

X Yes ☐ No ☐ Pending

Greentree Foundation of Long Island, NY and I have both obtained 2 licenses from the State of NY including "License to collect or possess" and "License to liberate fish or wildlife". Tall Timbers Research Station in Tallahassee FL is obtaining permits to trap bobwhite and release them to another state.

If No or Pending, you must sign below to assure the IACUC that all necessary permits will be obtained and copies submitted to the IACUC before commencing with any animal work.

Signature: ______________________ Date: __________

***Please submit copies of all permits to the IACUC Coordinator**.*

2. Indicate the type of study:

X Live Capture and Release

☐ Non-survival Capture

X Other *(Describe):* Rear and Release

3. For animals that will be released, describe the possible impact of capture on subsequent behavior and survival of the animals:

Bobwhite quail could certainly show signs of changed behavior due to stress of capture. However, in my experience over the years researching quail, stress is relatively immediate and birds return to normal behavior within 24 hours.

4. Indicate area(s) where animals will be captured/manipulated: Bobwhite will be captures at Tall Timbers Research Station in Tallahassee Florida. Birds will be released on Greentree Foundation Property on Long Island, NY.

5. List all equipment (traps, nets, guns, electroshock, etc.) that will be used and include specifics (type, number to be used, net or trap dimensions, mesh size, etc.): Tall Timbers will use walk in funnel traps to capture quail. These are 1 by 1 meter and 8 inches high with 2 1-way funnel shaped doors. Quail enter traps to obtain bait placed in center. Birds will be transferred to larger aviaries of multiple size for approximately 1 month in FL. Once birds are shipped to Long Island, birds will be housed in 6x6x16 aviaries for several months while captured wild birds raise semi-wild chicks. The birds will then be released to the wild.

6. Indicate the **maximum** duration of time an animal will be held by capture equipment:

~ 6 hours in funnel trap and the ~5 months in aviaries.

7. Will the traps or capture equipment ever be "set to capture" and left unattended*?

X Yes ☐ No

If Yes, give detailed information below on how often the traps or capture equipment will be checked and by whom: Funnel traps are set each morning and are checked by Tall Timbers staff by late afternoon. Traps are turned over (and deactivated) over night.

Note:** *The Committee requires that a* ***bound log book, *with the pages sewn in, be kept for* ***each trap "set to capture" and left unattended.*** *This may be one book for all sites or a separate book for each site. Pages must be sewn in, not loose leaf or spiral bound. This log must include name or location of site, date site is visited, time of arrival, time of departure, condition of all animal(s) captured, all procedures performed (banding, blood collection, measurements, released to the wild, taken to the lab, etc.); name(s) and signature(s) of person(s) checking site.*

This log shall be made available at any time to the IACUC, immediately upon request.

8. Will any form of chemical restraint be used?

☐ Yes X No

If Yes - Complete the following:

Drug:			
Dose (mg/kg):			
Route:			
First administered:			
Frequency:			
Planned duration:			

Reason:			

9. Will any chemical reversal agent be used?

☐ Yes X No

If Yes - Complete the following:

Drug:			
Dose (mg/kg):			
Route:			
First administered:			
Frequency:			
Planned duration:			
Reason:			

10. Will any other drugs or pharmaceuticals be administered?

☐ Yes X No

If Yes - Complete the following:

Drug:			
Dose (mg/kg):			
Route:			
First administered:			
Frequency:			
Planned duration:			
Reason:			

11. Describe procedures/criteria used for monitoring an animal's health status during restraint and recovery when **chemical restraint is used**:

12. If any DEA Scheduled (Controlled) drugs will be used, indicate how they will be managed and stored in the field:

13. Describe how animals will be restrained when **no chemical restraint is used**: To leg band or radiocollar a quail we use a capture box where the bird sits on top of the box and its legs protrude through a hole on top of the box. A pair of wooden shackles are placed on the birds legs above the knee to prevent the bird from flying away. We can then very quickly (under 5 minutes) apply a leg band and radiocollar. The bird will then be released to aviary.

14. Describe procedures/criteria used for monitoring an animal's health status during and after capture when **no chemical restraint is used**: Birds in aviaries are checked ~ every 8 hours to assure food and water levels are adequate and birds are not exhibiting signs of lethargy or sickness. If birds do exhibit these signs they are removed from the aviary and other birds. These birds are typically transferred to a separate aviary for monitoring. If health improves, they are returned to primary aviary and if health degrades, usually euthanasia is performed.

15. Discuss the expected morbidity and/or mortality rates:

From personal experience, this is relatively low and is perhaps under 5%.

16. Describe precautions that will be taken to minimize morbidity and/or mortality:

Fresh water will be provided daily and aviaries are cleaned once per week.

17. In the event that a **target** animal is injured during capture/handling, what procedures will be followed?

We will perform euthanasia if target bird is injured during capture.

18. Will any samples (blood, tissues, feathers, saliva, etc) be taken from live animals?

☐ Yes X No

If Yes, list samples and include details on collection procedures, volumes, etc:

19. Will a telemetry package be attached to live animals?

X Yes ☐ No

If Yes – Complete the following:

Total weight of package:	~6 g
Dimensions of package (minus attachments and antenna):	0.5 x 0.75 inches
Type of antenna:	Rubber coated
Length of antenna:	5 inches
Method of attachment to animal:	collar
Method of removal from animal:	Because quail life span is not much more than a year, collars remain on animals for life

20. Will any animal be marked, tagged, banded, or altered in any way (excluding telemetry)?

X Yes ☐ No

If Yes – provide details, including size, shape, attachment point(s), color, etc:

Leg band - #7 (~0.25 inch diameter)

21. Discuss whether the marking, tagging, banding, or altering of an animal, or the attachment of a telemetry package is known/suspected to cause any pain, distress, or increased morbidity/mortality?

None

22. Describe any other procedure(s) that will be done to live animals:

None

23. Discuss the possibility of capturing **non-target** animals:

Funnel traps can occasionally capture song birds who walk in to eat grain. They are immediately released by just lifting the trap which has no floor.

24. What precautions will be taken to reduce **non-target** captures?

No options exist

25. Provide details for dealing with captured **non-target** animals:

As stated above, they are immediately released by lifting the trap. This requires researchers do not have to touch non-target birds.

26. In the event that a **non-target** animal is injured during capture/handling, what procedures will be followed?

Euthanasia by cervical compression.

27. Will live animals be transported?

X Yes ☐ No

If Yes, provide details: Birds captured at Tall Timbers in FL will most likely be Fed-Ex'ed to Greentree Foundation in Long Island NY.

28. Will captured animals be held for more than 12 hours?

X Yes ☐ No

If Yes,

a. How long will animals be held? Between 3-5 months
b. Location of confinement? Both at Tall Timbers Research facility in Tallahassee, FL and Greentree Foundation on Long Island, NY.

c. Type/size of cage/container? Aviaries are 6x6x16

d. Indicate how hydration and nutritional needs will be met: At the end of each aviary a box contains fresh water and food which researchers can change with minimal contact with wild birds to reduce stress.

29. Will animals be released?

X Yes ☐ No

If Yes,

a. Animals be released:

☐ At the site of capture

X Other *(Describe Location and Justify):* Birds are being captured in Florida and releasednin New York to test restoration techniques. Quail are extinct at release site.

If No,

a. How long will animals be held prior to euthanasia?

b. What will the tissues/carcasses be used for?

c. How will the carcasses be disposed of?

Rev. 06/2010

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
License to Liberate Fish or Wildlife # 163

LICENSE
Under the Environmental Conservation Law (ECL)

Licensee Information

License Issued To:
CHRISTOPHER K WILLIAMS
UNIVERSITY OF DELAWARE, EDPT OF
ENTOMOLOGY & WILDLIFE ECOLOGY
531 S COLLEGE AVE, RM 250 TOWNSEND
HALL
NEWARK, DE 19716

(302) 831-4592

DEC Contact Information

DIVISION OF FISH, WILDLIFE AND MARINE RESOURCES
SPECIAL LICENSES UNIT
625 BROADWAY, ALBANY, NEW YORK 12233-4752
PHONE: (518) 402-8985 FAX: (518) 402-8925
WEBSITE: www.dec.state.ny.us

License Authorizations

License to Liberate Fish or Wildlife
License # 163

New License | Effective Date: 6/1/2013 | Expiration Date: 9/1/2013

NYSDEC Approval

By acceptance of this license, the licensee agrees that the license is contingent upon strict compliance with the ECL, all applicable regulations, and all conditions included as part of this license.

License Regulations

6 NYCRR Part 175
ECL 11-0507

Issued License **Page 1 of 4**

LICENSE TO LIBERATE FISH OR WILDLIFE - LICENSE CONDITIONS

1. **LFW – Species Authorization** The licensee is authorized to possess, transport and release to the wild 480 Northern bobwhite (Colinus virginianus) which were legally acquired from captive bred sources.

2. **LFW - Authorized Release Site** The licensee is authorized to release the listed species only on property where the licensee has received permission to release, located at Greentree Foundation 220 Community Drive, Manhasset, NY 11030 described in the licensee's application on file with the Special Licenses Unit.

3. **LFW - Pheasant and Quail - Bill of Sale Requirement** The licensee shall provide the Special Licenses Unit, at the address listed on the front of this license, with a bill of sale containing the name, address and license number of the legal source.

4. **LFW – Bobwhite Quail Release Requirement** All Bobwhite quail held pursuant to this license shall be released by February 28, 2014.

5. **LFW – Bobwhite Quail Release Restriction** Bobwhite Quail shall not be released on property located in Sullivan County.

6. **LFW – Pheasant and Quail - Released Animals become Property of the State** Once released, all animals become the property of New York State and shall only be taken in accordance with the laws and regulations governing the hunting of said species.

7. **LFW – Pheasant and Quail - Sale, Transfer and Exhibition Prohibited** Species held pursuant to this license may not be sold, transferred or exhibited.

8. **Live Animal - Facilities Requirement** The licensee shall provide housing, holding and transport facilities designed and constructed to ensure that the listed animals cannot escape and to ensure that the public cannot come in contact with the listed animals.

9. **Live Animal - Providing Care for Animal(s)** The licensee shall provide food, water, care and caging facilities to ensure the physiological and psychological well-being of the listed animal(s).

GENERAL CONDITIONS - Apply to ALL Authorized Licenses

1. **GC – Licensee Shall Read All Conditions** The licensee shall read all license conditions prior to conducting any activities authorized pursuant to this license.

2. **GC – License is Not Transferrable** This license is not transferrable and is valid only for the person identified as the licensee.

3. **GC – Licensee Responsible for Federal, State or Local Permits/Licenses** The licensee is responsible for obtaining any and all necessary, corresponding Federal, State or local permits or licenses prior to conducting any activity authorized pursuant to this license.

4. **GC – Reasons for Revocation** This license may be revoked for any of the following reasons:

i. licensee provided materially false or inaccurate statements in his or her application, supporting documentation or on required reports;
ii. failure by the licensee to comply with any terms or conditions of this license;
iii. licensee exceeds the scope of the purpose or activities described in his or her application for this license;
iv. licensee fails to comply with any provisions of the NYS Environmental Conservation Law, any other State or Federal laws or regulations of the department directly related to the licensed activity;
v. licensee submits a check, money order or voucher for this license or application for this license that is subsequently returned to the department for insufficient funds or nonpayment after the license has been issued.

5. **GC – Licensee Shall Carry Copy of License** The licensee shall carry a copy of this license or a document provided by the department, if relevant, when conducting activities pursuant to this license.

6. **GC – Licensee Shall Notify of Change of Address** The licensee shall notify the Special Licenses Unit in writing, by mail or email, within five (5) days of the official change of residence.

7. **GC – Licensee is Liable for Designated Agents** If designated agents are authorized pursuant to this license, the licensee shall be liable and responsible for any activities conducted by designated agents pursuant to this license or any actions by designated agents resulting from activities authorized by this license.

8. **GC – Licensee Renewal** The licensee shall submit a written request for the renewal of this license prior to the expiration date listed on the license. The licensee shall include accurate and complete copies of any required reports with their renewal request. This renewal paperwork shall be sent to:

NYSDEC
Special Licenses Unit
625 Broadway
Albany, NY 12233-4752.

This license is deemed expired on the date of expiration listed on the license.

NOTIFICATION OF OTHER LICENSEE OBLIGATIONS

MN– Licensee is Liable
The licensee shall be liable and responsible for any activities conducted under the authority of this license or any actions resulting from activities authorized by the license.

MN – Access by Law Enforcement
The licensee shall allow representatives of the NYS DEC Division of Law Enforcement to enter the licensed premises to inspect his or her operations and records for compliance with license conditions.

Trespassing Prohibited

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
License to Liberate Fish or Wildlife # 163

This license is not a license to trespass. The licensee shall obtain permission from the appropriate landowner/land manager prior to conducting activities authorized pursuant to this license

Issued License **Page 4 of 4**

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
License to Collect or Possess: Scientific # 1859

LICENSE
Under the Environmental Conservation Law (ECL)

Licensee Information

License Issued To:
CHRISTOPHER K WILLIAMS
UNIVERSITY OF DELAWARE, EDPT OF
ENTOMOLOGY & WILDLIFE ECOLOGY
531 S COLLEGE AVE, RM 250 TOWNSEND
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625 BROADWAY, ALBANY, NEW YORK 12233-4752
PHONE: (518) 402-8985 FAX: (518) 402-8925
WEBSITE: www.dec.state.ny.us

License Authorizations

License to Collect or Possess: Scientific
License # 1859

New License Effective Date: 10/22/2012 Expiration Date: 10/21/2013

NYSDEC Approval

By acceptance of this license, the licensee agrees that the license is contingent upon strict compliance with the ECL, all applicable regulations, and all conditions included as part of this license.

License Regulations

6 NYCRR Part 175
ECL 11-0515 (1)

Issued License **Page 1 of 4**

6 NYCRR Part 189

LICENSE TO COLLECT OR POSSESS: SCIENTIFIC - LICENSE CONDITIONS

1. Collection from the Wild: Authorized Species, Specific The licensee is authorized to collect and possess the following species: 80 female Northern bobwhite (Colinus virginianus)

2. Scientific Collection - Authorized Activities The licensee is authorized to possess the collected species for the following activity(ies): Release of Bobwhite quail, for rearing research.

3. Scientific Collection - Location The licensee is authorized to collect species from the following locations only:
Greentree Property, Nassau County.

4. Scientific Collection – Gear Marking and Monitoring The licensee shall mark all gear deployed with the licensee's name, resident address and license type and number. All traps and nets shall be checked no less than once every twenty-four (24) hours.

5. Scientific Collection - Law Enforcement Notification The licensee shall notify the appropriate Regional Environmental Conservation Officer at least 48 hours prior to conducting activities pursuant to this license and within 24 hours upon the loss or theft of any collecting gear. Please use the following link for a listing of regional law enforcement phone numbers: http://www.dec.ny.gov/about/558.html

6. Scientific Collection - LCP - No Endangered or Threatened Species No endangered/threatened species may be collected or possessed pursuant to this license.

7. Collection from the Wild - Authority to Designate Agents The licensee is authorized to designate agents to assist the licensee with the activities authorized pursuant to this license provided that:

a. the licensee submits a written request to the NYSDEC Special Licenses Unit at the address listed on the front of this license containing the:
i) name
ii) address
iii) age
iv) phone number of the person he or she is nominating as a designated agent, and;

b. the licensee receives an amended license from the Special Licenses Unit listing the designated agent(s) he or she has nominated before that person can conduct activities authorized by this license.

8. Authorized Designated Agents The following Designated Agents are authorized: William E. Palmer, Theron Terhune, and Chip Hamilton.

9. Scientific Collection - Reporting Requirement - Prior to Expiration The licensee shall file a written annual report prior to the expiration date of this license. Such annual report shall contain: a) name of the licensee, b) license number, c) common name of the listed animals collected, d) location(s) of collection, e) date(s) of collection, f) biological data collected and g) final disposition of collected animals. The licensee shall send this report to the NYSDEC Special Licenses Unit 625 Broadway, Albany, NY 12233-4752.

10. Scientific Collection – Additional Reporting Requirement The licensee shall file duplicate reports with the following wildlife staff.

Michael Schiavone
625 Broadway
Albany, NY 12233-4751

Chip Hamilton
NYS DEC
SUNY Campus Bldg 40
Stony Brook, Ny 11790

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ii. failure by the licensee to comply with any terms or conditions of this license;
iii. licensee exceeds the scope of the purpose or activities described in his or her application for this license;
iv. licensee fails to comply with any provisions of the NYS Environmental Conservation Law, any other State or Federal laws or regulations of the department directly related to the licensed activity;
v. licensee submits a check, money order or voucher for this license or application for this license that is subsequently returned to the department for insufficient funds or nonpayment after the license has been issued.

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