# REINTRODUCTION AS A POPULATION RESTORATION TECHNIQUE AND MICRO-HABITAT ASSESSMENT OF TRANSLOCATED NORTHERN BOBWHITES

A Thesis

by

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MASTER OF SCIENCE

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ABSTRACT

As decades have passed there has been a noticeable decline in the northern bobwhite (*Colinus virginianus*; hereafter bobwhite) population. Only a handful of studies have been made in the assessment of the survival of translocated/reintroduced specimens of this species. I evaluated the effectiveness of reintroduction of northern bobwhite into the Gus Engeling Wildlife Management Area (GEWMA) where they have been extirpated, but now have suitable habitat. Prior to reintroduction, GEWMA was surveyed (spring call counts) to make sure no bobwhites were present on the site. Forty-six (26 males and 20 females) bobwhites were trapped for 7 March–5 April 2019 in South Texas, banded, radio-tagged, transported to GEWMA, and released. In addition, 17 (9 males and 8 females) bobwhites were trapped from 13–15 April 2019, banded, radio-tagged, and released back into the source population as a control for comparison of movements, reproduction, and survival estimate differences between the source and released bobwhite populations. Survival for bobwhites released at GEWMA only was 37.0% through 1 July 2019 and 70.6% for birds left on the ranch in South Texas. As of 1 July 2019, 3 nests (2 were predated; 1 by feral hogs and another by a snake) were found at GEWMA while none were found on the ranch in South Texas. Movement distances between daily locations for males and females did not differ at GEWMA or at the ranch in South Texas; however, there was a significant ($P \leq 0.001$) difference in daily movement for quail at GEWMA and the South Texas ranch. Female quail at GEWMA moved 5.4 times the distance of female quail in South Texas and male quail at GEWMA

moved 5.9 times the distance of male quail in South Texas. Quail at GEWMA were located in woody cover only 24.2% of the time, whereas quail in South Texas were located in woody cover 76.1% of the time. The grater daily movement and less use of woody cover for quail at GEWMA probably added to their lower survival.

## DEDICATION

This thesis is dedicated to everyone who like me has a dream and is willing to work hard and relentlessly to achieve it. To my friends, family, and mentors without whom I wouldn't have found the strength and encouragement to keep going. I am thankful. I also thank Dr. Silvy for believing in me and giving me the great opportunity to work besides him.

I also would like to dedicate this to my parents, for their love and support, and even though we were hundreds of miles from each other it felt they were by my side all along. My dad who believed in me and provided me with all the tools to accomplish my dreams and aspirations no matter how farfetched they would seem; and my mom who through her love and encouragement gave me the strength to overcome every obstacle I faced. Lastly, I want to dedicate it to everyone I met in this journey for their support and help that got me to where I had to be.

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CONTRIBUTORS AND FUNDING SOURCES


**Contributors**

This work was supervised by a thesis committee consisting of Dr. Nova Silvy and Dr. Roel Lopez of the Department of Range, Wildlife, and Fisheries Management and Dr. Fred Smeins of the Department of Ecosystem Science and Management.

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This graduate study was made possible by Dr. Jim Cathey who helped fund this project. Funding was provided through the Reversing the Quail Decline in Texas Initiative and the Upland Game Bird Stamp Fund based on a collaborative effort between Texas Parks and Wildlife Department and Texas A&M AgriLife Extension.

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# CHAPTER I

# INTRODUCTION

Northern bobwhite (*Colinus virginianus*; hereafter bobwhite) population declines have been acknowledged since the 1930s, and wide-spread declines across their historic range have been documented since the 1960s (Williams et al. 2003). Often attributed to a wide range of factors; the decline in Texas has primarily been the result of habitat loss and fragmentation (Brennan et al. 2005, Hernández and Peterson 2007). Northern bobwhites become isolated in fragmented populations, and these populations become vulnerable to local extinction with the occurrence of a catastrophic event (Brennan et al. 2005, Perez 2007).

Although the decline has been attributed to an array of factors, such as red imported fire ants (*Solenopsis invicta*) and ferral hogs (*Sus scrofa*). The 2 major reasons for the quail decline supported by most quail biologists are (1) lack of habitat and (2) catastrophic weather events. Weather events such as drought (Bridges et al. 2001), high (Hernandez et al. 211) and cold (e.g., ice storms/heavy snow [Chavarria et al. 2012]) temperatures or flooding events (Perotto-Baldivieso et al. 2011, Caldwell 2015) have been shown to have an adverse effect on quail populations. However, there are no or few management programs that can overcome catastrophic weather events. Drought conditions could be ameliorated with center-pivot irrigation systems, but would be expensive and temperature extremes also could be ameliorated in part by favorable habitat.

## Research Objectives

The objective of my study was to determine the feasibility of reintroducing bobwhites in Texas, (1) determine the survivability of reintroduced bobwhites, (2) compare nesting and brooding success between source and release populations, and (3) compare specific habitat used by source site and reintroduced quail. My specific objective was to assess the survival of translocated northern bobwhite from South Texas to the Gus Engeling Wildlife Management Area (GEWMA) to evaluate the feasibility of reintroducing and establishing a stable and self-sustainable population into areas where there are no longer bobwhites, but the habitat was suitable for them.

## Study Area

Research was conducted in 2 different sites, one being the site where bobwhites were trapped for translocation (origin source) and the second one the reintroduction site; 2 more sites were solely used to obtain bobwhite for translocation. The origin source was a ranch called Los Lazos Ranch located in the vicinity of the small community of Aguilares, Texas; roughly 48.3 km from the border city of Laredo, Texas (Fig1.1). This 145.7-ha ranch, was in a predominantly aridic region, mostly sandy clay loam and series of very deep, well-drained soils (https://soilseries.sc.egov.usda.gov/OSD_Docs/A/AGUILARES.html).

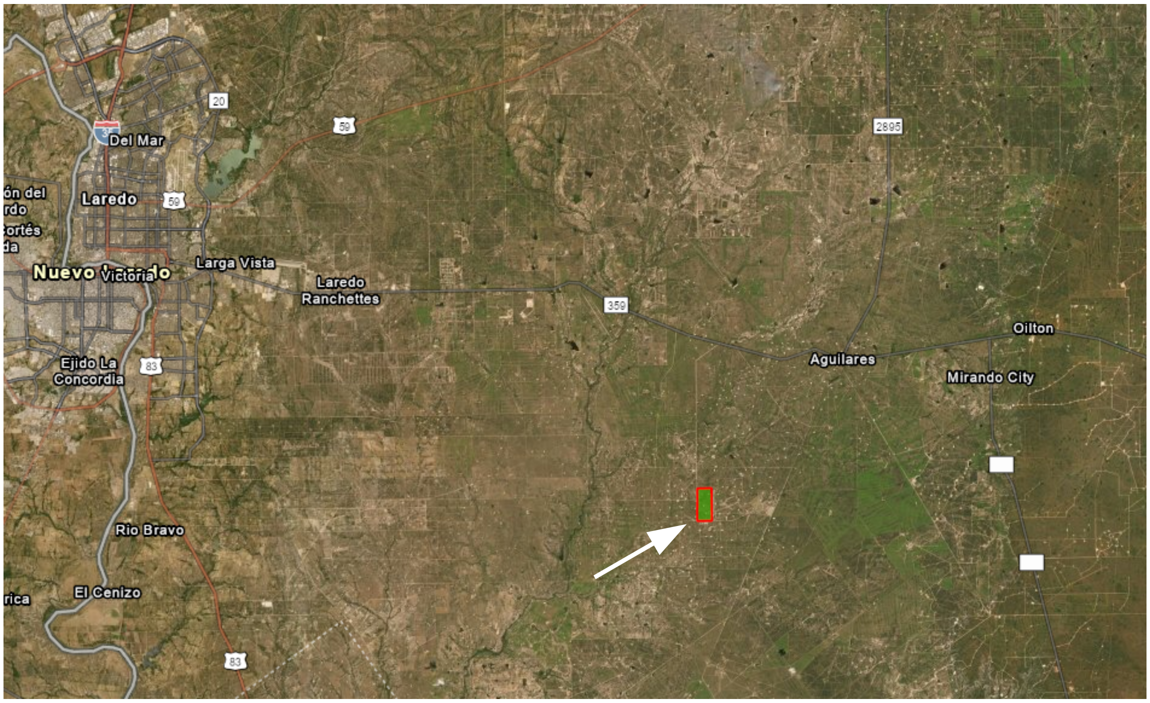


Figure 1.1. Map location of Los Lazos Ranch in perspective to Aguilares and Laredo, Texas.

The vegetation consisted of native brush, as well as native grasses, cacti, and buffelgrass (*Cenchrus ciliaris*). The ranch was used predominantly for white-tailed deer (*Odocoileus virginianus*) hunting, with no specific management plan except for corn feeding; during the non-hunting season the ranch supported 20 head of cattle which were restricted to 129.5-ha area (Fig. 1.2) and had supplemental feeding as well as water troughs.

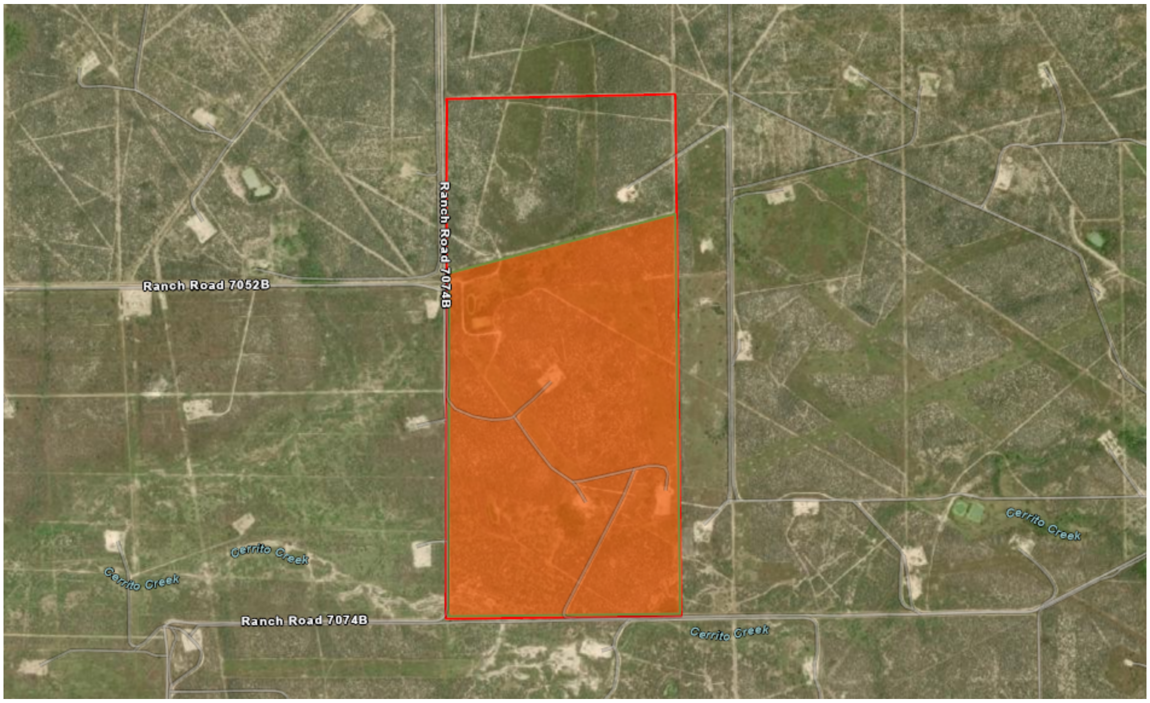

Figure 1.2. Los Lazos Ranch outline and area open to cattle February-September.

The other extraction areas were a ranch located near Carrizo Springs, Texas where only 12 birds were caught and the Santa Rita Ranch located in the county line dividing the Webb and Zapata counties southeast of Laredo (Fig. 1.3). The Santa Rita Ranch was an 80.9-ha low-fence ranch managed for white-tailed deer with an effective predator/hog control program; vegetation mostly consists of native brush, cacti, and buffelgrass.

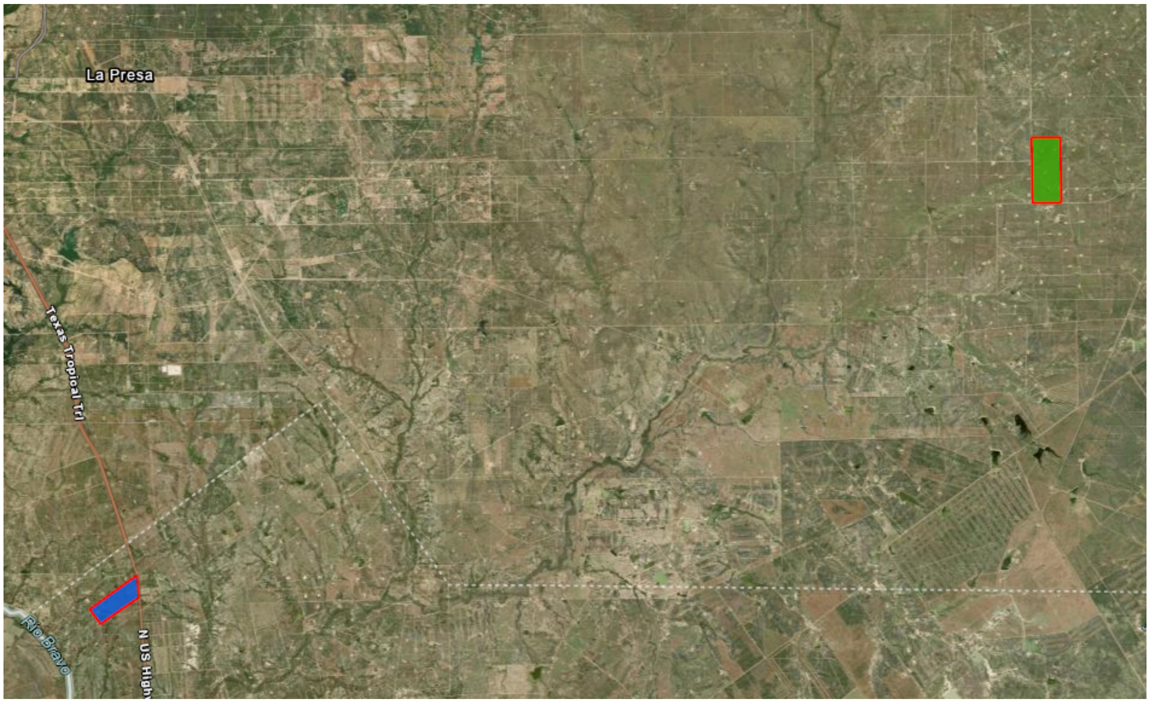


Figure 1.3. Map location of Santa Rita Ranch (blue) in reference to Los Lazos Ranch (green).

Precipitation during 2018 at the Los Lazos Ranch was below normal until September (Fig. 1.4). With a lack of precipitation during the normal bobwhite breeding season (May-July) bobwhite at the Los Lazos Ranch probably did not nest until September 2018 after the heavy rains that month; reason why a lot of the birds trapped in early March 2019 were juveniles with low body weight (Appendix). In 2019, monthly precipitation normalized (Fig. 1.5) and thus nesting started in May and continued through July 2019.

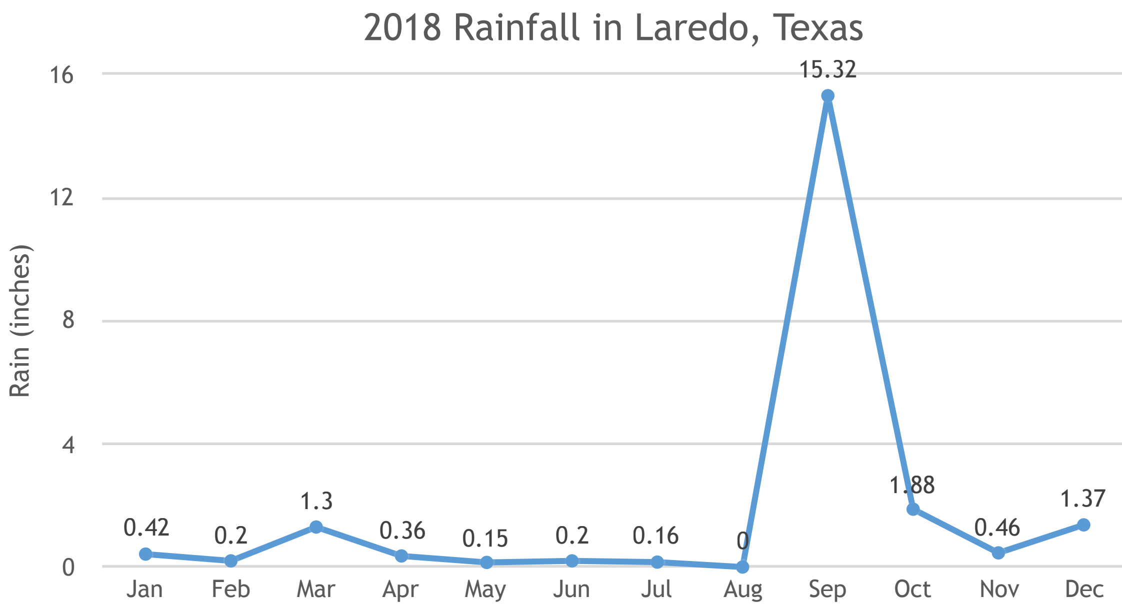


Figure 1.4. 2018 Monthly precipitation totals for Laredo, Texas (www.usclimatedata.com).

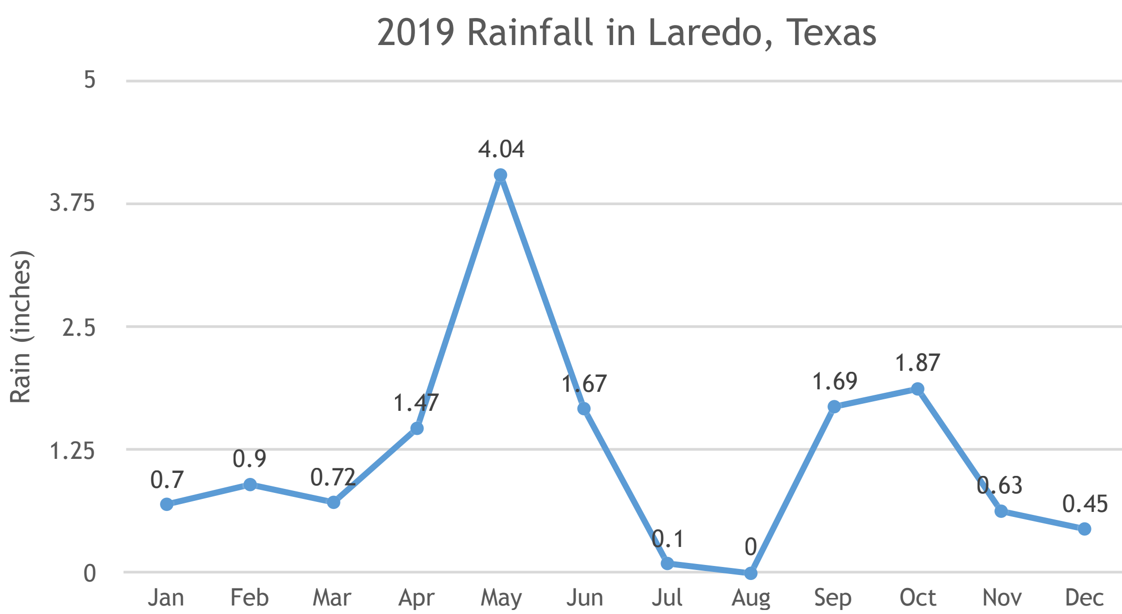


Figure 1.5. 2019 Monthly precipitation totals for Laredo, Texas (www.usclimatedata.com).

The bobwhite introduction site (GEWMA) was a well-managed property owned by the Texas Parks and Wildlife Department and was located near Tennessee Colony, Texas roughly 708 km northeast of the extraction locations (Fig. 1.6). GEWMA was a 4,435.5-ha area which was being managed for bobwhite and being returned to its original native state, a perfect place to conduct this bobwhite reintroduction project. Precipitation at GEWMA during 2018 and 2019 was similar to that of South Texas, but differed in that GEWMA had a late March 2019 freeze that delayed forb production.

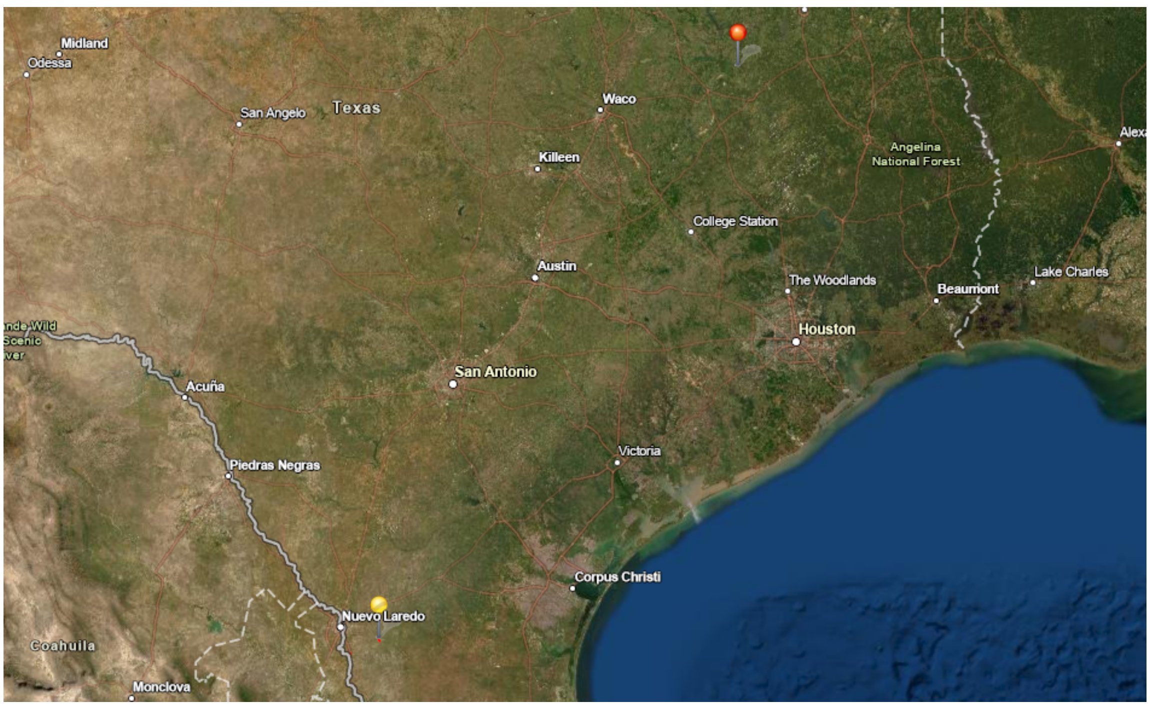


Figure 1.6. Map location of GEWMA (red pin), and Los Lazos Ranch (yellow pin).

**Methods**

Trap sites were selected based on northern bobwhite sitings, but were modified as needed to accommodate broods, pairs, or individuals that were frequently observed while conducting research/trapping. New sites with potential for successfully trapping bobwhite replaced unproductive sites that showed little to no bait disturbance between trapping days. Trap sites were baited regularly with commercial bird seed (Royal Wing Classic Mix Wild Bird Food, Tractor Supply, College Station, Texas) starting in February so that when trapping was conducted (March-August 2019), quail were already aware of these areas with readily available food and had become accustomed to frequenting the baited sites. Each trap location was supplied with approximately 0.5 kg of mixed grains including cracked corn, millet, milo, and black-oil sunflower seed once a week the month leading up to trap placement. The use of a grain variety for bait rather than using a single grain type allowed the bobwhites to selectively eat first the more palatable grains then slowly continue to consume the less preferable grains resulting in consistent access to a food source, even when the bait sites had been heavily utilized.

## CHAPTER II

## DIFFERENTIAL SURVIVAL OF SOURCE AND TRANSLOCATED NORTHERN BOBWHITE POPULATIONS

Reintroduction of northern bobwhites (*Colinus virginianus*; hereafter bobwhite) entails the release of bobwhites into an area that was once part of its range, but has since been extirpated (IUCN/SSC 2013, Seddon 2010). The International Union for Conservation of Nature (IUCN) Guidelines for the Re-Introduction of Galliformes for Conservation Purposes recommends defining success in 3 phases: (1) the survival of founders, (2) evidence of breeding by founders, and (3) long-term persistence of the translocated population (World Pheasant Association and IUCN/SSC Re-introduction Specialist Group 2009). Short-term goals may include survival of translocated bobwhites and successful reproduction. Long-term goals would include the persistence and growth of the population, to the point that it becomes self-sustaining and could withstand hunter harvest without significant reduction to the population size. This long-term condition defines the ultimate success for bobwhite population restoration.

There are a few examples of successful, in the short-term reintroductions of bobwhite in Texas and no long-term successful reintroductions of bobwhites in Texas. A major limitation to reintroductions of bobwhites in Texas is obtaining birds from source populations. However, some private landowners in Texas have historically been willing to allow trespassing on their property to obtain birds. It also may be possible to obtain bobwhite from Texas wildlife management areas.

In order to determine if survival of northern bobwhites translocated to the Gus Engeling Wildlife Management Area (GEWMA) were similar to that of the source population, I radio-tagged bobwhites and released them back into the source population. These bobwhites served as a control for comparison of survival differences between the source and translocated bobwhite populations.

**Study Area**

For a control population of bobwhite, I used the established quail population on the Los Lazos Ranch near to Aguilares, Texas. This 145.7-ha ranch, was located in a predominantly aridic region, with mostly sandy clay loams and series of very deep, well drained soils (https://soilseries.sc.egov.usda.gov/OSD_Docs/A/AGUILARES.html). Vegetation was native brush in majority, with some native grasses, cacti, and buffelgrass (*Cenchrus ciliaris*). The ranch had never been used for quail hunting, thus allowing me to tap into a well adapted population that hadn't been disturbed nor altered in any way.

The GEWMA was a very well-managed property owned by the Texas Parks and Wildlife Department and located near Tennessee Colony, Texas. This 4,434.5-ha area has been returned to its original native state, with the sole purpose of offering refuge to wildlife while allowing research in a controlled environment.

## Methods

Bobwhites were trapped using Kniffin modified funnel traps (Reeves et al. 1968), a walk-in style trap similar to that originally described by Stoddard (1946) for trapping quail (Fig. 2.1). Traps were placed at the pre-baited sites and baited with approximated 0.5 kg of mixed grains. Traps were checked no less and no more than once an hour to process captured animals. All northern bobwhites trapped were aged by primary covert color, sexed by head color (Lyons et al. 2012), weighed, banded with a size 7 silver colored band (National Band and Tag Company, Newport, Kentucky) on the right leg. These data, as well as the trap name and any additional notes, were recorded on a data sheet (Appendix). Non-target species captured were released and a tally was kept each trap day by species.

Bobwhites trapped at the source site were fitted with an 8.8 g VHF (approximately 4% body weight) radio transmitter (150 MHz; Wildlife Materials, Carbondale, Illinois; Fig. 2.2) and bled for further genetic studies. These bobwhites were monitored daily from March–July 2019 with each bird being located twice daily (morning and afternoon) using a handheld Yagi antenna to determine general location, movement, and survival status. A Chi-square test (Ott and Longnecker 2016) was used to determine if there was differential survival between the source and translocated populations.

Figure 2.1. A funnel trap baited with mixed grains used to trap bobwhites.

Figure 2.2. Female (left) and male (right) bobwhite fitted with bib-type radio transmitter attached with zip ties. Before release, feathers are pulled through to conceal the transmitter.

## Results

*Trapping and Marking*

For the source population survival assessment, 9 male and 8 female bobwhites were trapped from 13-15 April 2019, tagged, and released at the Los Lazos Ranch. In addition 46 bobwhites were trapped and translocated from Los Lazos Ranch to the GEWMA to assess survival of translocated bobwhites. Lastly 3 broods (24 quail) were trapped in July and translocated from Santa Rita Ranch to the GEWMA.

*Bobwhite Survival*

Survival for bobwhites released at GEWMA was 37.0% through 1 August 2019 compared to 70.6% for birds left on the ranch in South Texas. Survival of the first 12 bobwhites released at GEWMA was 9.5%, whereas the second 12 bobwhites released had a survival of 69.0% (Fig. 2.3).

Overall median survival was 39% for bobwhites at the GEWMA and 48% for the source population in South Texas (Fig. 2.4). This difference was significant ($X^2$ = 11.38, $df$ = 1, P = 0.0007).

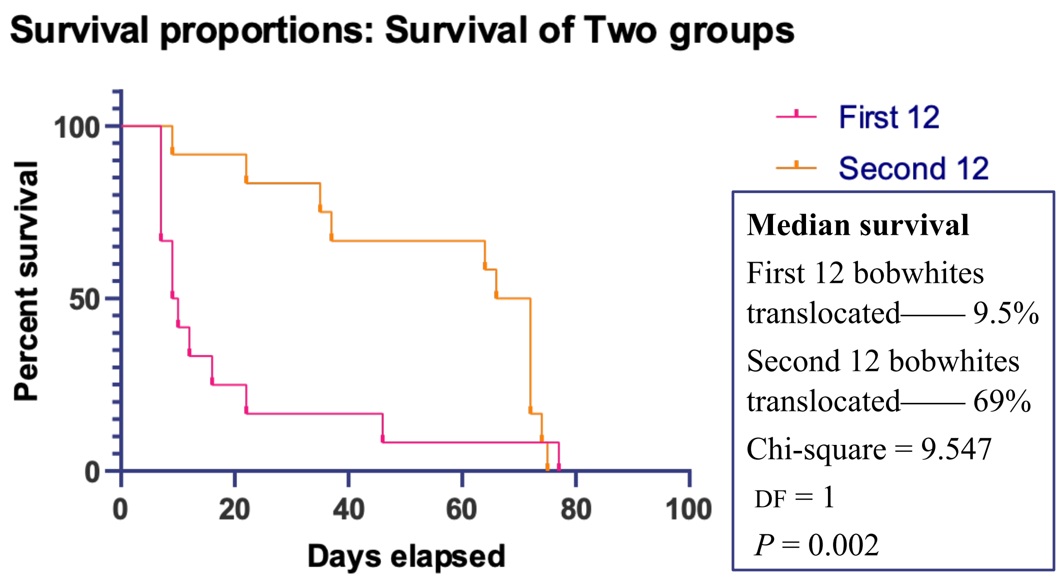


Figure 2.3. Survival of the first 12 bobwhites released at GEWMA compared to the second 12 bobwhites released at GEWMA.

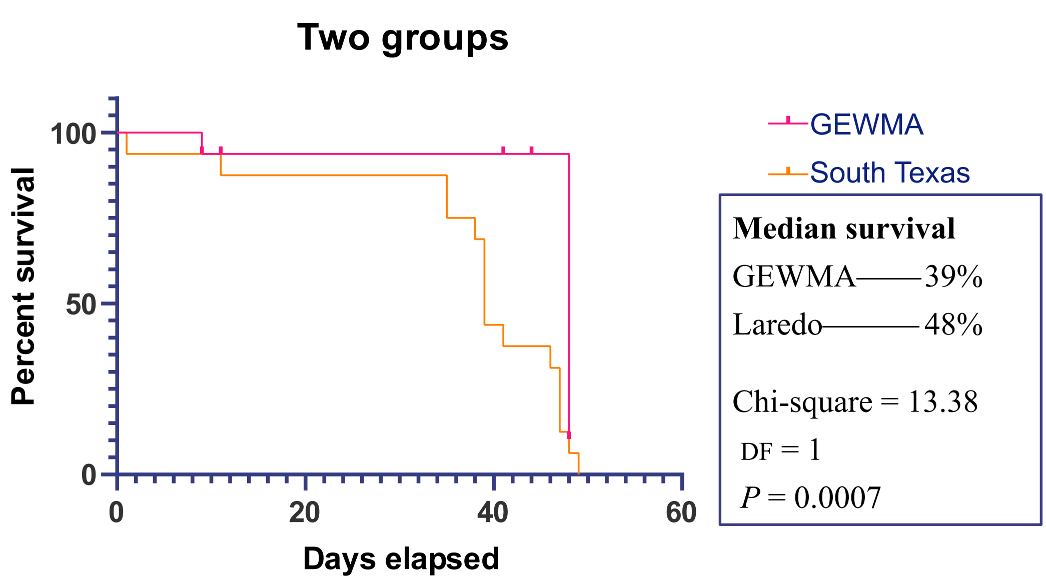


Figure 2.4. Median survival of northern bobwhite from source population (South Texas) and the translocated population (GEWMA).

**Discussion**

The lower survival of the first 12 bobwhites released at the GEWMA compared to the survival of the next 12 bobwhites released was probable due to the lack of available food caused by the late winter freeze. Food was not a problem on the South Texas ranches where bobwhites were trapped and then translocated.

Osborne (1993) suspected radio transmitters on released birds caused mortality. However, during my study, both the source bobwhites and translocated bobwhites were fitted with radio transmitter and therefore any addition mortality caused by the radio transmitters should have been similar for the 2 populations.

Scott et al. (2012), collaborating with Texas Department of Parks and Wildlife, translocated 550 bobwhites to 2 sites during 2004–2006. Radio-tagged, translocated bobwhites had lower survival compared to residents. Scott et al. (2012) speculated that restoring bobwhite populations in fragmented landscapes with few remaining bobwhites might be impractical.

The medium survival (38%) of my translocated bobwhite to the GEWMA was similar to that of Downey et al. (2017). They translocated 409 wild bobwhites (186 radio-marked females) to supplement 2 sites in Shackelford and Stephens counties, Texas, during March 2013 and 2014. Their spring-summer (Mar–Sep) survival ranged between 0.32 and 0.38. The translocation of their bobwhites failed to increase the bobwhite population beyond that of the control during this study. Downey et al. (2017)

recommended that future translocation research should aim to increase translocation success by investigating methods for increasing survival during the first month period following translocation.

CHAPTER III

# DIFFERENTIAL MOVEMENTS AND HABITAT USE OF SOURCE AND TRANSLOCATED NORTHERN BOBWHITE POPULATIONS

Reintroduction of northern bobwhites (*Colinus virginianus*; hereafter bobwhite) entails the release of bobwhites into an area that was once part of its range, but has since been extirpated (IUCN/SSC 2013, Seddon 2010). Dispersal from the release site has been a probably with several translocations of gallinaceous birds (Lawrence and Silvy 1987). Released birds also have increased movement which leads to lower survival (Baxter et al. 2008). Many of the bobwhite translocation studies (Terhune et al. Downey et al. 1917) have released birds into areas where current populations of bobwhite exist.

**Study Area**

Bobwhites to be translocated were trapped on the Los Lazos Ranch near Aguilares, Texas. This 145.7-ha ranch, was located in a predominantly aridic region, with mostly sandy clay loams and series of very deep, well drained soils (https://soilseries.sc.egov.usda.gov/OSD_Docs/A/AGUILARES.html). Vegetation was native brush in majority, with some native grasses, cacti, and buffelgrass (*Cenchrus ciliaris*). The ranch had never been used for quail hunting, thus allowing me to tap into a well adapted population that had not been disturbed nor altered in any way.

Trapped bobwhites were translocated to the GEWMA which was a well-managed property owned by the Texas Parks and Wildlife Department and located near Tennessee

Colony, Texas. This 4,434.5-ha area has been returned to its original native state (mainly little bluestem [*Schizachyrium scoparium*], native brush, and post oak [*Quercus stellata*] trees), with the sole purpose of offering refuge to wildlife while allowing research in a controlled environment. Prior to bobwhite reintroduction, areas to receive bobwhite were surveyed (spring call counts) to make sure no bobwhites were present on the sites.

## Methods

### *Bobwhite Movements*

To determine if translocated bobwhites displayed movement similar to those from the source population, I plotted daily locations of radio-tagged bobwhite on base maps of the source and translocated study areas. I then measured the distance between successive daily locations of male and female bobwhites to obtain a mean-daily-movement distance for the source and translocated populations. These mean-daily-movement distances for males and females from the source and translocated populations were then compared using a Student's *t*-test (Ott and Longnecker 2016) to determine if they differed.

### *Bobwhite Habitat Use*

Bobwhite use of grass and shrub vegetation on the source and translocation sites were compared to determine if these vegetation types were used similar by the source and translocated populations of bobwhites.

Bobwhites were trapped at source sites using walk-in traps and captured birds were fitted with a VHF transmitter collar, banded and bled for further genetic studies. Each bird was located daily to determine location within each vegetation type.

Vegetation data was collected by using the VHF location points to determine habitat use. Vegetation structure, habitat and movement data from the translocated bobwhites was then compared to the data obtained from the bobwhites left at the origin source site.

**Results**

*Trapping and Marking*

For the survival assessment 26 male and 20 female bobwhites were trapped in March 2019 and translocated to GEWMA (Appendix). In addition, 3 broods (24 bobwhites) were trapped in July 2019 and translocated to GEWMA.

*Bobwhite Movements*

Movement distances between daily locations for male and female bobwhites did not differ at the GEWMA or at Los Lazos Ranch; however there was a significant ($P <$ 0.001) difference in daily movement for quail at the GEWMA and the ranch. Female bobwhite at the GEWMA moved 5.4 times the distance of female bobwhite in the ranch and male bobwhite at the GEWMA moved 5.9 times the distance of male bobwhite on the ranch (Table 3.1).

Table 3.1. Mean distance traveled (m) between consecutive Daily locations by bobwhite by age and sex at GEWMA and Laredo, Texas during July 2019.

| Age/Sex | Location | *n* | Mean | SD |
|---|---|---|---|---|
| AM | GEWMA | 5 | 307 | 73 |
| JM | GEWMA | 2 | 451 | 113 |
| All males | GEWMA | 7 | 348 | 84 |
| AF | GEWMA | 2 | 217 | 37 |
| JF | GEWMA | 4 | 297 | 53 |
| All females | GEWMA | 6 | 270 | 48 |
| AM | Laredo | 5 | 57 | 9 |
| JM | Laredo | 1 | 66 | 22 |
| All males | Laredo | 6 | 59 | 11 |
| AF | Laredo | 4 | 49 | 10 |
| JF | Laredo | 2 | 53 | 13 |
| All females | Laredo | 6 | 50 | 11 |

*Habitat Use*

Bobwhites at the GEWMA were located in woody cover only 21.2% of the time, whereas bobwhites on the ranch were located in woody cover 76.1% of the time (Table 3.2). Bobwhite at the GEWMA were located most often in little bluestem (*Schizachyrium scoparium*) dominated areas. All nests found at the GEWMA were located in grass clumps. Most bobwhite mortalities at the GEWMA were located in areas dominated by post oaks, possibly due to raptor predation.

Table. 3.2. The percent of bobwhite locations within 3 vegetation types on the GEWMA and on the Laredo ranch during July 2019.

| Area | *n* | Vegetation type | | |
|---|---|---|---|---|
| | | % Grass | % Brush | % Trees |
| GEWMA | 12 | 75.8 | 21.2 | 3.0 |
| Laredo | 13 | 23.9 | 76.1 | 0.0 |

**Discussion**

Although bobwhites on the GEWMA moved more than birds at the Laredo ranch, movement was similar to that found by Terhune et al. (2006) for their translocated bobwhites in Georgia. Bobwhite at the GEWMA had limited areas of suitable habitat and therefore most bobwhites limited their movements within these areas. Bobwhite on the GEWMA spent most of the day in the grassland vegetation type. Terhune et al. (2010) suggested that 2 site-specific criteria should be met prior to instituting translocation: habitat management should be conducted to ensure that quality habitat exists and the patch size should be a minimum of 600 ha of quality habitat and poorer sites may warrant even larger patches. Terhune et al. (2006) translocated bobwhites associated with other bobwhites present on their release area which probably limited the movements of the translocated bobwhites.

Downey et al. (2017) evaluated site fidelity for 65 and 47 translocated, radio-marked bobwhites during March–August 2013 and 2014, respectively. The farthest distance documented for a translocated, radio-marked bobwhite from its release point was 13 km in 2013 compared to 7 km in 2014). In addition, 32% of translocated bobwhites were dispersers (i.e., >2 km) in 2013 compared to only 15% in 2014.

# CHAPTER IV

## REPRODUCTION OF TRANSLOCATED NORTHERN BOBWHITE

The International Union for Conservation of Nature (IUCN) Guidelines for the Re-Introduction of Galliformes for Conservation Purposes recommends defining success in 3 phases: (1) the survival of founders, (2) evidence of breeding by founders, and (3) long-term persistence of the translocated population (World Pheasant Association and IUCN/SSC Re-introduction Specialist Group 2009). This long-term condition defines the ultimate success for northern bobwhites (*Colinus virginianus*; hereafter bobwhite) population restoration; condition that cannot be met without a successful second phase.

Bobwhite's mating system is very flexible combining certain aspects of both monogamy and polygamy. This allows bobwhite populations to recover from low annual survival (Curtis et al. 1988, Burger et al. 1995) and decline due to periodic catastrophes (Roseberry 1962, Stanford 1972, Suchy et al. 1991). It is known in some cases, males will assume the incubation responsibility upon the hens demise (Stoddard 1931); but this strategy, in cases where both mates are alive, allows for females to become polyandrous and seek to mate and produce a new clutch (Persson and Ohrstrom 1989).

While assessing the survival of the translocated bobwhite population, one of the secondary goals was achieving a successful second phase based on those set by The International Union for Conservation of Nature (IUCN) Guidelines for the Re-

Introduction of Galliformes for Conservation Purposes. Being that the bobwhites were translocated before the normal bobwhite breeding season (May-July), and some already had mates; I deduced bobwhites would attempt to reproduce if (1) the bobwhites survived, and (2) the habitat was suitable/favorable. Thus tracking hens, and monitoring for nesting attempts was a crucial task during this experiment.

There is evidence that translocated northern bobwhite are less productive than resident bobwhite. Since most of the bobwhites trapped during my study were translocated, I only evaluated reproduction of the translocated bobwhites. Scott et al. (2012) noted the percent of hens nesting and nesting rate were lower for translocated bobwhites than for resident bobwhites.

**Study Area**

Bobwhites were translocated to the GEWMA which was a well-managed property owned by the Texas Parks and Wildlife Department and located near Tennessee Colony, Texas. This 4,434.5-ha area has been returned to its original native state (mainly little bluestem [*Schizachyrium scoparium*], native brush, and post oak [*Quercus stellata*] trees), with the sole purpose of offering refuge to wildlife while allowing research in a controlled environment. Prior to bobwhite reintroduction, areas to receive bobwhite were surveyed (spring call counts) to make sure no bobwhites were present on the sites.

**Methods**

Radio-collared females at GEWMA were tracked with a handheld Yagi antenna ≥4 times per week. I walked in on females once they had been found in the same location for 3–4 consecutive tracking sessions to determine if the hen was on a nest and flushing was avoided if possible. If a nest was found, it was marked with flagging tape tied to nearby, tall vegetation at least 10 m from the nest. Marking was done so that a nest could be relocated once it hatched or was destroyed. Nesting females were tracked once or twice daily ≥4 times per week. Once a female was located off the nest for 3–4 consecutive tracking sessions, the nest was checked to determine if the brood had hatched or failed.

For successful nests, notes were taken on the location of the nest, the number of hatched eggs, the number of unhatched eggs, and the date of hatch. For unsuccessful nests, notes were taken on location of the nest, the reason for failure, the number of unhatched or destroyed eggs if possible to determine, and the date it was destroyed. If a nest was successful, the female and brood was to be tracked twice daily ≥4 times per week and the number of chicks surviving in the brood would be recorded if a female and brood were sighted along a road. Any transmitter that emitted a mortality signal was checked immediately. If a collar was recovered, the site was examined for probable cause of mortality and the female was listed as deceased. A brood was considered to have survived if at least 1 chick remained at 3 weeks of age.

**Results**

Three bobwhite nests were located at the GEWMA. The first nest located was on 30 May 2019 and at that time contained 8 eggs and later 12 eggs (Fig. 4.1). This nest was destroyed by feral hogs (*Sus scrofa*) on 3 June. A second nest located on 4 June 2019, containing at least 13 eggs, was destroyed by an unknown cause. The third nest located on 14 June 2019 contained 15 eggs.  This nest was destroyed on 17 June by a snake (3 eggs still in nest).

Figure 4.1.  Bobwhite nest with 12 eggs (left) latter destroyed by feral hogs (right).

**Discussion**

Bobwhite females translocated to the GEWMA were able to establish and incubate nests; however, large number of feral hogs and other nest predators precluded any successful nests.  The small number (4) of adult females translocated to the GEWMA prior to and during the nesting season reduced the possibility of nesting as many of the juvenile females were hatched later in the summer (September when rains returned) due to early drought conditions in South Texas.

Downey et al. (2017) observed 74% of their translocated females that entered the nesting season produced a nest. They also found an apparent nest success of 46.1% and a nesting rate of 1.1± 0.1 (SE) nests per female. Rainfall was normal during their study and young hatch during May-July. Scott et al. (2012) found the percent of hens nesting (95% CI = 36 ± 16.4%) and nesting rate (95% CI = 1.1 ± 0.2 nests/hen) were lower for translocated bobwhites than for resident bobwhites (79 ± 12.4% and 1.6 ± 0.3 nests/hen, respectively). They consider their restoration efforts were unsuccessful.

# CHAPTER V

## CONCLUSION AND MANAGEMENT IMPLICATIONS

From my study of translocated northern bobwhite from South Texas to the GEWMA, I can make the following conclusions.

1. Translocated bobwhites do not survive as well as resident birds.

Established populations are adapted to the habitat they reside and evolved in; even the minor change in their habitat will lead to unbalanced. Thus moving them from one habitat to another, in different ecoregions, drastically affects their survival chances.

2. Translocation should only be made at the time of year when there is sufficient food available to them.

My study started early March, in time for spring greenup, unfortunately the late winter freeze delayed the vegetation sprouting/blooming at the GEWMA, leaving the first translocated bobwhites with little to no food sources.

3. Translocated bobwhites have greater daily movements than resident bobwhites.

Because translocated bobwhites are introduced into a new habitat, it takes time for them to settle down and thus a lot of movement is attributed to area recognition for foraging, nesting, and shelter.

4. Translocated bobwhites have a lower nesting rate and success than do resident bobwhites.

Bobwhites require certain conditions to successfully nest and when translocated hens are not only under the stress of transportation, but the lack of food sources, mates, and nesting grounds drastically diminish nesting success.

5. Bobwhites acquired for translocation should be from an area as close to the release site as possible.

Obtaining bobwhites from sites close to the release site should improve the chances of survival since the bobwhites would be accustomed to the climate as well as being more familiarized with the regional vegetation.

6. Bobwhites should be translocated later towards the end of the breeding season so that they are in broods instead of single individuals or couples.

Translocating bobwhites later in the season not only ensures the higher availability of food sources but also allows trapping and translocating entire broods/family groups.

In conclusion, I believe my project to have been mostly successful, for not only did the bobwhites attempt to nest; but it also shone a light on certain results that had been overlooked. From a personal perspective in order for bobwhite reintroduction to be fully successful, the previously mentioned conditions should be met, as well as a larger number of bobwhites for a successful translocation.

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APPENDIX

DATA FOR NORTHERN BOBWHITES TRAPPED DURING THIS STUDY.

| Band number | Radio frequency | Sex | Age | Weight (g) | Trap location | Date | Time |
|---|---|---|---|---|---|---|---|
| 1 | 150.659 | M | J | 146 | 13B | 03/07/19 | 6:45 p.m. |
| 2 | 150.578 | M | A | 149 | 13B | 03/07/19 | 9:27 a.m. |
| 3 | 151.074 | F | J | 146 | 13B | 03/07/19 | 9:27 a.m. |
| 4 | 150.550 | M | J | 151 | 9B | 03/09/19 | 9:25 a.m. |
| 5 | 151.083 | M | A | 150 | 9B | 03/09/19 | 9:25 a.m. |
| 6 | 151.064 | M | A | 160 | 13C | 03/11/19 | 10:10 a.m. |
| 7 | 151.018 | F | J | 160 | 3A | 03/14/19 | 7:30 p.m. |
| 8 | 150.630 | M | J | 157 | 3A | 03/14/19 | 7:30 p.m. |
| 9 | 150.539 | M | J | 130 | 13B | 03/15/19 | 11:50 a.m. |
| 10 | 151.000 | F | J | 145 | 13C | 03/15/19 | 11:50 a.m. |
| 11 | 150.578 | F | J | 145 | 13A | 03/16/19 | 11:59 a.m. |
| 12 | 151.480 | M | J | 130 | 13A | 03/16/19 | 11:59 a.m. |
| 13 | 150.520 | M | J | 175 | 13A | 03/16/19 | 7:55 PM |
| 14 | 150.227 | F | J | 165 | 3A | 03/17/19 | 8:45 a.m. |
| 15 | 150.493 | F | J | 150.5 | CS | 03/17/19 | Afternoon |
| 16 | 150.479 | M | A | 154 | CS | 03/17/19 | Afternoon |
| 17 | 150.000 | M | J | 150 | CS | 03/17/19 | Afternoon |
| 18 | 151.009 | M | A | 152 | CS | 03/17/19 | Afternoon |
| 19 | 150.470 | M | A | 153 | CS | 03/17/19 | Afternoon |
| 20 | 150.020 | F | J | 175 | 13A | 03/18/19 | 11:00 a.m. |
| 21 | 150.188 | M | A | 146 | CS | 03/20/19 | Afternoon |
| 22 | 151.074 | F | A | 157 | CS | 03/20/19 | Afternoon |
| 23 | 150.207 | M | A | 160 | CS | 03/20/19 | Afternoon |
| 24 | 150.319 | M | A | 136 | CS | 03/20/19 | Afternoon |
| 25 | 150.731 | F | J | 160 | CS | 03/20/19 | Afternoon |
| 26 | 150.082 | M | A | 155 | CS | 03/20/19 | Afternoon |
| 27 | 150.641 | F | J | 154 | CS | 03/20/19 | Afternoon |
| 28 | 150.630 | F | J | 160 | 19B | 03/21/19 | 5:50 p.m. |
| 29 | 150.342 | F | J | 145 | 19B | 03/21/19 | 5:50 p.m. |
| 30 | 151.064 | M | J | 150 | 19B | 03/21/19 | 5:50 p.m. |
| 31 | 150.092 | M | J | 130 | 19B | 03/21/19 | 5:50 p.m. |
| 32 | 150.369 | M | A | 150 | 13A | 03/22/19 | 5:10 p.m. |
| 33 | 151.709 | M | A | 165 | 4B | 03/22/19 | 5:40 p.m. |
| 34 | 151.685 | M | A | 165 | 4B | 03/22/19 | 5:40 p.m. |
| 35 | 150.569 | M | A | 155 | 19B | 03/22/19 | 7:55 p.m. |
| 36 | 151.451 | M | J | 160 | 19B | 03/22/19 | 7:55 p.m. |
| 37 | 150.958 | M | J | 135 | 19B | 03/26/19 | 4:45 p.m. |
| 38 | none | F | J | 170 | 7B | 03/27/19 | 7:00 p.m. |
| 39 | 151.379 | F | A | 180 | 17A | 03/27/19 | 7:20 p.m. |
| 40 | 150.596 | M | A | 160 | TPWD 16 | 03/29/19 | 12:05 PM |
| 41 | 150.443 | F | A | 175 | TPWD 16 | 03/29/19 | 12:05 PM |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42 | 150.038 | M | A | 180 | 19B | 04/04/19 | 1:40 p.m. |
| 43 | 150.198 | F | J | 165 | 19B | 04/04/19 | 1:40 p.m. |
| 44 | 150.422 | F | J | 175 | TPWD 11 | 04/04/19 | 6:30 p.m. |
| 45 | 150.818 | F | A | 195 | TPWD 13 | 04/04/19 | 7:45 p.m. |
| 46 | 150.122 | F | J | 170 | 22A | 04/05/19 | 11:38 a.m. |
| 47 | 150.195 | M | J | 165 | 22B | 04/13/19 | 1:00 p.m. |
| 48 | 150.296 | F | A | 180 | TPWD 13 | 04/13/19 | 1:35 p.m. |
| 49 | 150.665 | M | A | 145 | C5 | 04/14/19 | 3:00 p.m. |
| 50 | 150.946 | F | A | 160 | C5 | 04/14/19 | 3:00 p.m. |
| 51 | 150.395 | M | J | 145 | B1 | 04/14/19 | 4:00 p.m. |
| 52 | 150.805 | M | A | 150 | 22B | 04/15/19 | 6:00 p.m. |
| 53 | 150.065 | M | A | 155 | C1 | 04/18/19 | 6:26 p.m. |
| 54 | 150.035 | M | A | 165 | C5 | 04/22/19 | 4:00 p.m. |
| 55 | 150.885 | F | J | 170 | C5 | 04/22/19 | 4:00 p.m. |
| 56 | 150.865 | F | A | 170 | 17A | 04/22/19 | 4:50 p.m. |
| 57 | 150.975 | F | A | 185 | 22A | 04/22/19 | 7:30 p.m. |
| 58 | 150.505 | M | A | 140 | 22A | 04/22/19 | 7:30 p.m. |
| 59 | 150.046 | F | J | 160 | 1B | 04/23/19 | 6:50 p.m. |
| 60 | 150.824 | F | A | 180 | 22A | 04/26/19 | 7:00 p.m. |
| 61 | 150.845 | M | A | 150 | 1A | 04/26/19 | 7:00 p.m. |
| 62 | 150.536 | F | A | 170 | 1A | 04/26/19 | 7:00 p.m. |
| 63 | 150.505 | M | A | 175 | TPWD 13 | 04/26/19 | 7:30 p.m. |
| 64 | 150.520 | F | J | 115 | 1A | 07/15/19 | 7:45 PM |
| 65 | 150.578 | M | A | 140 | 1A | 07/15/19 | 7:45 PM |
| 66 | 150.227 | F | J | 120 | 1A | 07/15/19 | 7:45 PM |
| 67 | 150.398 | F | J | 110 | 1A | 07/15/19 | 7:45 PM |
| 68 | 150.659 | M | A | 155 | 1A | 07/15/19 | 7:45 PM |
| 69 | 150.480 | M | J | 110 | 1A | 07/15/19 | 7:45 PM |
| 70 | 150.249 | M | J | 110 | 1A | 07/15/19 | 7:45 PM |
| 71 | 151.009 | F | J | 120 | 1A | 07/15/19 | 7:45 PM |
| 72 | 150.369 | F | J | 115 | 1A | 07/15/19 | 7:45 PM |
| 73 | 150.968 | M | A | 155 | SR1 | 07/20/19 | 6:40 PM |
| 74 | 150.249 | M | A | 150 | SR1 | 07/20/19 | 6:40 PM |
| 75 | none | M | J | 115 | SR1 | 07/20/19 | 6:40 PM |
| 76 | none | F | J | 120 | SR1 | 07/20/19 | 6:40 PM |
| 77 | 150.227 | F | A | 175 | SR1 | 07/20/19 | 6:40 PM |
| 78 | none | M | J | 115 | SR1 | 07/20/19 | 6:40 PM |
| 79 | none | F | J | 120 | SR1 | 07/20/19 | 6:40 PM |
| 80 | none | F | J | 130 | SR1 | 07/20/19 | 7:50 PM |
| 81 | none | F | J | 115 | SR1 | 07/20/19 | 7:50 PM |
| 82 | none | M | J | 115 | SR1 | 07/20/19 | 7:50 PM |
| 83 | 151.796 | F | J | 140 | SR1 | 07/20/19 | 7:50 PM |
| 84 | 150.153 | F | A | 170 | SR1 | 07/20/19 | 7:50 PM |
| 85 | 151.857 | M | J | 130 | SR1 | 07/20/19 | 7:50 PM |
| 86 | none | F | J | 125 | SR1 | 07/20/19 | 7:50 PM |
| 87 | none | F | J | 125 | SR1 | 07/20/19 | 7:50 PM |