Travis Audubon's Baker Sanctuary

2017 - 2018 Annual Report

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Travis County Transportation and Natural Resources Department Natural Resources Program

by

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Deer Creek Elementary (LISD) Field Trip (photo by Christopher Murray)

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Introduction

Baker Sanctuary (Sanctuary) is owned and operated by Travis Audubon Society (TAS) with approximately 715 acres managed as part of the Balcones Canyonlands Preserve (BCP). As of March 2015, Travis County purchased a conservation easement on approximately 675 acres of the Sanctuary. Forty acres, the 'Headquarters Tract;' are excluded from the easement (**Appendix A**). The management agreement for the easement permits TAS to continue to manage the Sanctuary with oversight from Travis County for as long as TAS retains ownership of the Sanctuary and adheres to the conditions of the management agreement.

Bisected by Lime Creek Road, the Sanctuary is within the Cypress Creek Macrosite and adjacent to several additional BCP tracts including the City of Austin's Lime Creek and Austin Simon tracts to the northeast, a small tract belonging to the City of Cedar Park to the south, and several recent additions to Travis County's Lime Creek Unit along the southwestern boundary, including the approximately 2300-acre Wheless tract formerly owned by the Lower Colorado River Authority (**Appendix B**). The Sanctuary is composed of densely wooded uplands, slopes, and canyons dominated by mature oak-juniper woodlands with occasional pockets of open and semi-open savannah which are slowly being encroached by Ashe juniper (*Juniperus ashei*).

Golden-cheeked Warbler Surveys

During the spring of 2018 the 65-acre Northeast plot was surveyed for golden-cheeked warblers (*Setophaga chrysoparia*) for the second consecutive season. In addition to the Northeast survey, an additional 130-acre golden-cheeked warbler (GCWA) survey (Northwest plot) was also initiated in 2018. The Northwest plot is located north of Lime Creek Road and to the west of the Northeast plot (**Appendix C**). Spot-mapping techniques as outlined in the USFWS protocol for GCWA presence/absence surveys (USFWS 2010) as well

as Bibby et al. (2003) and the Tier II Land Management Plan (2007a) were utilized for both surveys. In short, GCWA were color-banded if possible, territories mapped, and an attempt made to quantify productivity. The Northeast plot survey will be repeated once more in the spring of 2019 and the Northwest plot survey will continue through 2020 before being discontinued. By continuing to rotate survey efforts the entire Sanctuary should be covered by 2028, providing distribution and productivity data which will more effectively inform future land management plans and decisions. Upon completion of the Sanctuary-wide survey effort it is expected the color-banding and territory mapping effort will largely cease and future monitoring will be accomplished through a less intrusive and time intensive method such as variable circular plot point counts.

Northeast Plot Synopsis:

Based on the compilation and analysis of 234 GCWA observations including movement patterns, re-sighting of color banded males, counter-singing, and the presence of females and fledglings, it is estimated six full territories and no edge territories were present in the Northeast plot for an adjusted total of six territories. Females were observed in all territories and a total of nine fledglings were observed in the six territories. Three territories were established directly adjacent to the Northeast plot and were not included in the analysis.

Territory density was calculated at 0.09 territories per acre. This calculation was based on the adjusted total of six territories in the 65 acres surveyed. The pairing success rate in the Northeast plot was 100% (females were observed in all six of the full territories). The breeding success was estimated at 100%, based on the fact that all six territories were observed to have at least one fledgling. The estimated brood size was 1.5 fledglings based on the aforementioned criteria. Productivity was estimated at 1.5 based on the total of nine fledglings observed in the six full territories (**Appendix C**).

Northwest Plot Synopsis:

Based on the compilation and analysis of 298 GCWA observations including movement patterns, re-sighting of color banded males, counter-singing, and the presence of females and fledglings, it is estimated twelve full territories and one edge territory were present in the Northwest plot for an adjusted total of 12.5 territories. Females were observed in 11 of the 12 full territories and no female was observed in the only edge territory. A total of 19 fledglings were observed in the territories. Two territories were established directly adjacent to the Northwest plot and were not included in the analysis.

Territory density was calculated at 0.10 territories per acre. This calculation was based on the adjusted total of 12.5 territories in the 130 acres surveyed. The pairing success rate in the Northwest plot was 92% (females were observed in 11 of the 12 full territories). The breeding success was estimated at 83%, based on the observation that 10 of the 12 full territories produced fledglings. The estimated brood size was 1.9 fledglings based on the aforementioned criteria. Productivity was estimated at 1.58 based on the total of 19 fledglings observed in 10 of the 12 full territories (**Appendix C**).

In general, results from the 2018 surveys were quite similar with territory density, pairing success, and breeding success nearly identical. However, measures of fecundity represented by calculations for average brood size and productivity demonstrated more variation between plots, whether this reflects a true difference in productivity is not yet known (**Appendix C**). More meaningful comparisons will be possible as more data is collected over the next few seasons.

On April 5, Christopher Murray found GCWA male DG/PI:WH/SI dead and on the ground approximately 100 meters from where he was banded, an area that was later designated as the southwest corner of MV/SI:BL/YE's territory (**Appendix C**). The bird was in good condition with no ants or other scavengers present and

did not smell of decay, suggesting he had recently died. In the tree immediately above the body was an unbanded male GCWA singing B-song. On March 27, Murray observed DG/PI:WH/SI with a female approximately 50 meters from where he was later found dead. At the time he was acting normally; counter-singing B-song with a nearby unbanded male and following the female as she foraged. DG/PI:WH/SI was banded on March 24, 2018 by Murray who did not note any unusual circumstances during the banding process. The GCWA was in-hand for less than five minutes and did not exhibit any signs of stress while he was banded and data collected. Upon release, DG/PI:WH/SI immediately flew to a nearby tree where he intermittently sang A-songs and pecked at his new bands. Cause of death is unknown but may be due to disease, predation, or most likely, intraspecific competition.

In 2014 TAS initially obtained state and federal permits to band (plastic color-bands and USFWS aluminum bands) GCWA throughout the Sanctuary. Since then, a total of 23 GCWA males, 19 ASY and four SY, were captured and banded under TAS and Travis County permits during various survey efforts (**Table 1**). It is anticipated banding will continue during the 2019 survey effort.

In an effort to explore alternatives in assessing the GCWA population density and distribution at Baker, a pilot variable circular plot (VCP) point count study was initiated in the spring of 2016. Point count stations were established 250 meters apart for a total of 50 stations at the Sanctuary (**Figure 1**). Counts began 10 minutes after sunrise and concluded by 11 AM. GCWA were counted for five minutes at each station and their locations, activity, and movements recorded per minute at each station where they occurred. To reduce observer bias, the Sanctuary steward conducted all surveys. The point counts were performed again for the 2017 breeding season utilizing the 2016 protocol (**Appendix D)** but the counts were doubled from five minutes to ten in an effort to ascertain the most accurate survey interval for GCWA on the Sanctuary. The ten minute count was utilized again for the 2018 effort which produced 42 GCWA male detections, 28 if truncated to five minute counts, with the majority of the initial detections

occurring during the first minute of observation (**Table 2**). Due to the ease of truncating the point data if needed, the 10 minute count will be employed in future efforts until the entire Sanctuary has been methodically surveyed and the accuracy of the count interval tested over various seasons and habitat conditions.

Whitetail Deer Management

Baker Sanctuary was closed from November 4, 2017 – January 21, 2018 for the annual whitetail deer (*Odocoileus virginianus*) management hunt (rifle hunting only). Seven primary hunters hunted at sites 3, 5, 10, 11, 12, 13, and 14 (**Figure 2**) and harvested a total of seven deer (three does, four bucks) during 386 hours of hunt effort, a decrease in take from the average harvest of eleven deer per season over the prior 16 recorded seasons (**Figure 3**).

To gain a better understanding of the size and composition of the whitetail deer (WTD) population on the Sanctuary, a camera trap survey was initiated in fall 2016. The survey was again conducted from mid-September 2017 through the first week of October utilizing protocol outlined by Texas Parks and Wildlife (Oetgen et al, 2008). Six camera trap sites **(Figure 4)** were pre-baited with feed corn for five days prior to deploying the camera traps which were then left active for 10 consecutive days. Results from the survey (**Table 3**) suggest the Sanctuary has a WTD density of 8.1 deer/km2. It is difficult to put the results in context because little to no regional deer density data are available prior to the institutionalization of a regulated deer hunting season and prior to eradication of the screwworm (*Cochliomyia hominivorax*) parasite. According to the most recent version of the BCP Tier II LMP (2007b), TPWD recommends a density of approximately 13 deer/km2 but it is later acknowledged in the document that a density of approximately seven deer/km2 may be necessary for hardwood recruitment. References are not provided for either assertion so it so not clear how the recommendations were determined. Dey (2014) proposes a density of three deer/km2 as a reasonable estimate of historical deer densities for the area

but, once again, at best it is an educated guess. However, hardwood recruitment at the Sanctuary does not appear to be very robust with few preferred hardwood species such as Spanish oak (*Quercus buckleyi*), shin oak (*Quercus sinuata*), escarpment black cherry (*Prunus serotina*), and Texas ash (*Fraxinus texensis*) significantly regenerating, a pattern which may be occurring throughout the BCP (Russell and Fowler 1999, 2002, 2004).

The Hatfield Tract is a 50-acre parcel deeded to TAS in 1986 with the following stipulation: “it will never lease any portion of the property for hunting or trapping purposes”; as a result, no hunting took place on this tract during the 2017 – 2018 whitetail deer season.

Vegetation Management

Approximately 245 cubic yards of vegetation were trimmed from trails, maintenance roads, shooting lanes, and structures when it either encroached upon hiking trails or roads, posed a safety or structural hazard, or impeded hunting efforts. Unless it posed an immediate safety or structural concern, trimming was restricted to the GCWA non-breeding season (September 1 – February 28) and was performed so that canopy fragmentation, if it occurred, was kept to a minimum. When oaks (*Quercus spp.*) were trimmed, precautionary techniques such as disinfecting saws and painting wounds were utilized to prevent the spread of oak wilt fungus (*Ceratocystis fagacearum*). Due to tree mortality caused by the drought of 2011, especially with regard to Ashe juniper, more time was invested in slash removal than in previous years to keep trails, shooting lanes, and roads open and to ensure the safety of visitors.

Slash from cut vegetation was chipped prior to the onset of the GCWA breeding season yielding an estimated 20 cubic yards of material. Approximately 30% of the mulch was donated to Chaetura Canyon for its trail system with the remainder utilized on the Sanctuary’s trail system as well as to mulch individual

seedlings which were planted near Baker Cabin, the Steward's residence, and at the Kutac memorial garden.

During the fall and winter of 2017 - 2018 a total of 421 woody and herbaceous plants were put in the ground at the Sanctuary, all donated by Paul and Georgean Kyle, Diane Sherrill and Brush Freeman, and the City of Austin BCP (**Table 4**).

Baker Sanctuary is composed primarily of dense mature oak-juniper woodlands interspersed with pockets of open and semi-open savannah; there are nine Fire Behavior Prediction System fuel models that correspond with the habitats within the BCP. A fire management plan based upon these prediction systems is located in the Sanctuary headquarters and is available to assist the Steward in monitoring for fire safety and response readiness. The Sanctuary is also equipped with a wildfire call-down list and basic wildfire response tools to expedite early response to wildfires.

Brown-headed Cowbird Trapping

TAS operated two brown-headed cowbird (*Molothrus ater*) traps from March 19 through May 26 of the 2018 season. Trap TAS1 was located on the south side of Lime Creek Road in the side yard of the Steward's residence and trap TAS2 in the semi-open savannah near hunt site 11. Traps were checked daily and non-target species were released when discovered. This season, trap TAS1 captured 11 individuals (8 males and 3 females) while TAS2 captured one male for a total of 12 individuals captured, results significantly lower than the average of 23 per season captured over the prior 16 recorded seasons (**Figure 5**). No non-target species were captured during the 2018 trapping effort.

Exotics Control

Two distinct populations of Malta star-thistle (*Centaurea melitensis*) were known to occur at the Sanctuary, one centered near Baker Cabin to the north of Lime Creek Road (LCR) and another centered at the Steward's residence to the south of LCR. While both populations occurred in heavily disturbed, semi-open savannah habitat, the northern population was more established and extensive, typically forming a dense monoculture where it occurred. With a regime of consistent hand-pulling and limited use of glyphosate over the past seven years, both populations have been greatly reduced in density and distribution to the point where only occasional removal of scattered individuals is now required.

The extensive tree-of-heaven (*Ailanthus altissima*) grove discovered in December 2010 in a northern drainage of the Sanctuary is still being actively monitored and treated. Over the last year, only six tree-of-heaven seedlings were discovered and hand pulled, a significant decrease since management efforts were initiated. Since the grove was discovered in 2010, a total of 4936 tree-of-heaven and 47 chinaberry (*Melia azedarach*) seedlings have been removed from the area.

The less extensive population of tree-of-heaven discovered in May 2012 approximately 1000 feet downstream from the original tree-of-heaven site is also being actively monitored and treated. For the second consecutive year no seedlings were observed at the site. Since the grove was discovered in 2012, a total of 3228 seedlings have been removed from the area. It is anticipated both groves will be completely eradicated over the next several growing seasons (**Figure 6**).

Various non-native, invasive plants were either manually removed or stump-cut and treated with a 30% imazapyr solution when encountered throughout the Sanctuary. Species treated or removed included 147 chinaberry, 141 heavenly bamboo (*Nandina domestica*), eight medium-sized patches of Johnsongrass

(*Sorghum halepense*), 217 jujube (*Ziziphus zizyphus*), 54 privet (*Ligustrum* species), 237 tree-of-heaven, 68 common mullein (*Verbascum thapsus*), and one medium-sized patch of yarrow (*Achillea millefolium*).

To analyze the efficacy of the herbicide imazapyr (Arsenal formulation) in invasive, non-native plant control, individuals were treated with a 30% Arsenal solution and re-visited the following year to assess mortality. Treatment consisted of stump-cutting the individual and applying several milliliters to the wound. A small dropper-style container was used to carefully apply the imazapyr solution directly to the wound to negate the possibility of herbicide drift. Overall, non-native plants treated with a 30% Arsenal solution experienced a mortality rate of approximately 85% with the first treatment and a mortality rate of approximately 90% for those that required a second treatment (**Table 5**).

The 18 common figs (*Ficus carica*) initially treated on July 2013 near Walnut Spring were monitored over the course of the year and re-sprouts were removed when encountered. Approximately 20% of the figs continue to re-sprout requiring continued monitoring and treatment of the site.

Over the past fiscal year, 14 boiling water treatments were applied to visible red imported fire ant (*Solenopsis invicta)* mounds which occurred in high traffic, disturbed areas such as the Jackie Arnold Education Center, Steward's residence, and the public parking lot.

Research

In an effort to achieve a more complete understanding of the composition, distribution, and density of avian species which inhabit the Sanctuary, the fixed-radius point count methodology proposed by Hutto *et al.* (1986) has been employed in an annual breeding bird survey since 2011. From May 21 through June 6, the eighth annual count was performed at a total of 38 point count stations (**Figure 7**). While in the past the survey had been conducted over the

course of one morning with the help of volunteer surveyors, beginning in 2016 one observer, Christopher Murray, conducted all the surveys over the course of several weeks. Of the 37 species recorded, the most abundant were northern cardinal (*Cardinalis cardinalis*) detected at 97% of the stations, black-crested titmouse (*Baeolophus bicolor*) at 92% of the stations, and lesser goldfinch (*Spinus psaltria*) at 74% of the stations. Golden-cheeked warblers were detected at 55% of the stations (**Table 6**) compared to 32% for the previous year. Point count data were analyzed with a linear regression test (log-transformed, 2-tail, 95% confidence level) for the eight years' worth of data. All populations appear stable with no statistically significant trends with the exception of lesser goldfinch, painted bunting (*Passerina ciris*), blue-gray gnatcatcher (*Polioptila caerulea*), canyon wren (*Catherpes mexicanus*), field sparrow (*Spizella pusilla*), Hutton's vireo (*Vireo huttoni*), white-eyed vireo (*Vireo griseus*), and northern cardinal who demonstrated positive population trends and American crow (*Corvus brachyrhynchos*) which continued to demonstrate a negative population trend.

From 2011 – 2014, 15 nest boxes were installed throughout the Sanctuary as a community outreach activity and to provide additional nesting opportunities for cavity nesting birds. Of the remaining 11 nest boxes, four were occupied during the 2018 breeding season by Carolina chickadees and one by either Carolina (*Thryothorus ludovicianus*) or Bewick's wrens (*Thryomanes bewickii*), as determined by nest composition and egg shell fragments. In addition to the nest boxes, the three chimney swift (*Chaetura pelagica*) towers on the Sanctuary were estimated to have successfully fledged a total of five young, determined by analysis of nesting detritus accumulated on the bottom plates of the towers.

To enhance survivorship and to investigate factors which may contribute to hardwood seedling growth rates and mortality, an oak caging project was initiated in December 2013. The oak caging effort has continued through 2017 - 2018 and was expanded to include other hardwood species of concern in the 2016 – 2017 season. During the 2017 - 2018 season an additional seven shin oak, 17 Spanish oak, seven plateau live oak, seven Texas ash, and seven

escarpment black cherry were caged in throughout the Sanctuary. To date a total of 52 plateau live oak, 54 shin oak, 124 Spanish oak, 14 Texas ash, 13 escarpment black cherry, and one coma (*Bumelia lanuginosa*) have been caged, a total of 258 hardwood individuals of concern. In conjunction with the caging effort, data such as habitat type, basal stem diameter, seedling height, percent cover, and distance to nearest mature individual were collected to potentially better understand factors which may affect seedling growth and survival. Currently, analysis of the data set has only focused on growth rates per species and has not yet explored possible effects related to habitat type or density of canopy cover. Caged Spanish oak have exhibited an annual average increase in height of 10.8 cm/season, plateau live oak 10.1 cm/season, shin oak 3.3 cm/season, escarpment black cherry 27.7 cm/season, Texas ash 7.8 cm/season, and coma -2.2 cm/season. To date, plateau live oak have demonstrated a 21% mortality rate for caged individuals, shin oak 29%, Spanish oak 7%, and no mortality has yet been recorded for the caged escarpment black cherry, Texas ash, or coma.

Following the extreme drought of 2011, Baker Sanctuary experienced significant, localized Ashe juniper mortality centered primarily on the east portion of the preserve near Lime Creek Road. In September 2014 ten juniper seedlings were flagged and given a unique tag but they were not caged. Ten additional juniper were flagged and tagged in February 2016. Trees were selected with the criteria that they were seedlings and growing in full sun with the goal of obtaining growth rates (height and mid-stem diameter) to compare with those of hardwoods. To date seedling juniper height has increased at an average of 38.6 cm/season and mid-stem diameter at a rate of 0.31 cm/season. Mortality has been low with only one individual (5%) expiring to date.

Water quality tests were continued for Baker Spring on a monthly basis, flow and time permitting, and intermittently for Audubon Spring. Both sites have been documented to support populations of the threatened Jollyville plateau salamander (*Eurycea tonkawae*). As a participating member of the Colorado

River Watch Network (CRWN), water quality data collection followed CRWN protocols. During the 2017 - 2018 season, only five water quality tests were performed, all at Baker Spring. For the first time since onset of monitoring, Baker Spring was dry from April 2018 through September 2018. Data were collected for water depth, water temperature, dissolved oxygen, specific conductance, pH, and nitrate nitrogen. All results fell within expected values (**Table 6**).

Education and Outreach

From October 2017 through September 2018 Baker Sanctuary experienced a total of 507 visitations from day hikers. Of those visitations, 472 were by TAS members and 35 were by non-members. An additional 590 visitations occurred during organized activities such as educational programs, TAS events, and guided hikes. A total of 863 volunteer hours were logged at the Sanctuary on a variety of activities (see below).

October: Trail maintenance & patrol, outreach.

November: Trails & grounds maintenance.

December: Trails, grounds, & facilities maintenance.

January: no volunteer activities.

February: Trails, grounds, & facilities maintenance, education, biological monitoring.

March: Trails & grounds maintenance, education, biological monitoring, habitat restoration.

April: Trails & grounds maintenance, education, biological monitoring.

May: Education, biological monitoring, grant administration.

June: Grounds maintenance.

July: Grounds maintenance.

August: Trails & grounds maintenance, grant administration.

September: Grounds & facilities maintenance.

Other activities to enhance community involvement and increase awareness of Baker Sanctuary and the BCP mission included the Baker Nature Day, Great Backyard Bird Count, 13 guided hikes for various community groups, one field trip for 110 Leander ISD (LISD) fourth grade students, one GCWA presentation to a total of 180 Round Rock ISD third grade students, one GCWA themed Youth Nature Camp for elementary students, four ecology presentations to a total of 455 LISD fourth – eighth grade students, installation of plants at the Deer Creek Elementary (LISD) Nature Path, and supervision of two Eagle Scout projects.

Literature Cited

BCP. 2007a. Balcones Canyonlands Preserve land management plan, Tier IIA, chapter VII: golden-cheeked warbler management. 35 pp.

BCP. 2007b. Balcones Canyonlands Preserve land management plan, Tier IIA, chapter X: animal management. 46 pp.

Bibby, C. J., N. D. Burgess, D. A. Hill, and S. Mustoe. 2003. Bird census techniques; chapter 3: territory mapping methods. Academic Press, London.

Dey, Daniel. 2014. Sustaining oak forests is eastern North America: Regeneration and recruitment, the pillars of sustainability. Forest Science 60(5).

Hutto, R.L., Pletschet, S.M., and Hendricks, P. 1986. A fixed-radius point count for nonbreeding and breeding season use. Auk 103: 593-602.

Oetgen, J.G., Lambert, Jr, B.C., Whiteside, J.D. 2008. Surveying white-tailed deer populations using infrared-triggered cameras. Texas Parks and Wildlife.

Russell, F. Leland and Norma L. Fowler. 1999. Rarity of oak saplings in savannas and woodlands of the eastern Edward's Plateau, Texas. The Southwestern Naturalist, 44(1).

Russell, F. Leland and Norma L. Fowler. 2002. Failure of adult recruitment in *Quercus buckleyi* populations on the eastern Edward's Plateau, Texas. The American Midland Naturalist, 148(2).

Russell, F. Leland and Normal L. Fowler. 2004. Effects of white-tailed deer on the population dynamics of acorns, seedlings, and small saplings. Plant Ecology, 173:59-72.

U.S. Fish and Wildlife Service (USFWS). 2010. USFWS Section 10(a)(1)(A) scientific permit requirements for conducting presence/absence surveys and habitat assessments for endangered golden-cheeked warblers. USFWS Ecological Services Field Office, Austin, Texas. 10 pp.

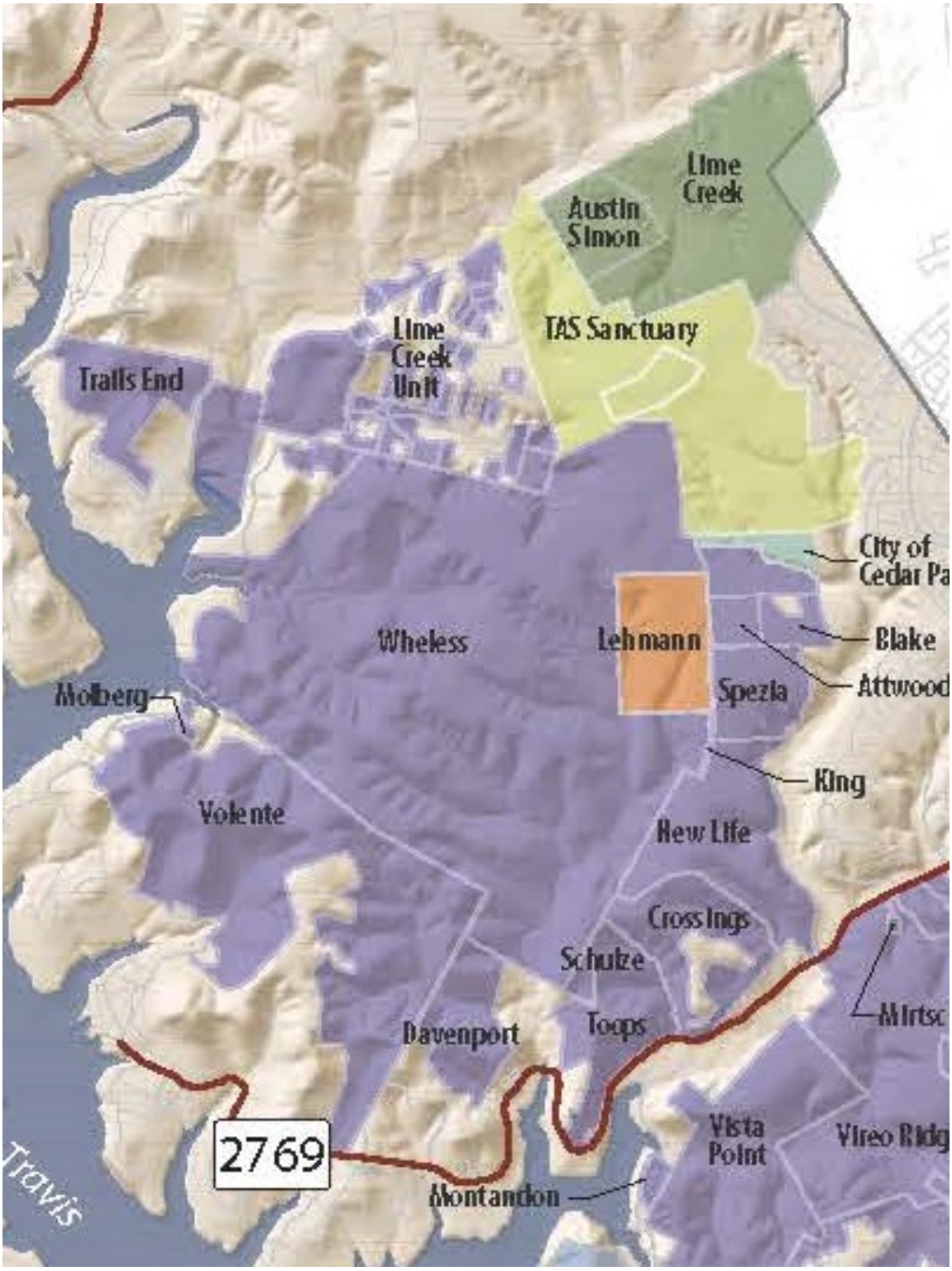
Appendix A

Baker Sanctuary 40-acre headquarters tract



Appendix B

Baker Sanctuary and adjacent BCP partner properties



Appendix C

RESULTS OF THE GOLDEN-CHEEKED WARBLER SURVEYS FOR THE NORTHEAST AND NORTHWEST BAKER SANCTUARY PLOTS SPRING 2018 TRAVIS COUNTY, TEXAS

TRAVIS AUDUBON
Listen. Look. And Learn.

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1.0 INTRODUCTION

Travis Audubon Society (TAS) owns and operates the 715-acre Baker Sanctuary and is a Managing Partner in the Balcones Canyonlands Preserve (BCP) system. The BCP was formed in 1996 with the adoption of the Balcones Canyonlands Conservation Plan (BCCP), a 30-year regional permit issued by the US Fish and Wildlife Service (USFWS) of which the City of Austin and Travis County are the joint Permit Holders. The BCCP set aside a minimum of 30,428-acres throughout Travis County for the protection of two federally endangered Neotropical passerine species, the golden-cheeked warbler (*Setophaga chrysoparia*) and the black-capped vireo (*Vireo atricapilla*). The Permit Holders are also required to protect six federally endangered karst invertebrate species as well as twenty-seven other species of concern.

Baker Sanctuary is bordered primarily by BCP properties owned and managed by various partners, including the City of Austin, Travis County, and the City of Cedar Park. In addition to preserve lands, Baker is bordered by several small rural lots to the west and north comprised of Fisher Hollow and Red Wagon Estates, and a large suburban development to the southeast, Cypress Canyon. Lime Creek Road, which runs from east to west, effectively divides the Sanctuary into two roughly equal parcels. It is estimated Baker Sanctuary contains 690 acres of high-quality golden-cheeked warbler (GCWA) habitat.

The purpose of this report is to present the results of the GCWA surveys conducted on two separate study areas, the Northeast and Northwest plots. Data from the two plots were not combined and instead were kept as discrete surveys for several reasons. Surveyors and survey effort varied between the two study areas and due to the staggered, rotating nature of the full Sanctuary survey effort, both plots will not always be surveyed during the same season.

Both study plots are located north of Lime Creek Road with the Northeast plot to the east of the Baker Cabin complex and the Northwest plot to the west. (**Figure 1**). The full Sanctuary survey effort was initiated in 2017 as part of an effort to gain a more complete understanding of the density, distribution, and fecundity of GCWA throughout the entire Sanctuary, data which had never been collected in the past. The survey effort began with the Northeast plot in 2017 with the intent of surveying for three successive years before rotating to an adjacent plot (Murray 2017). However, due to an influx of qualified survey volunteers, the Northwest plot was added in 2018 and was surveyed in addition to the Northeast plot. Going forward, it is expected two plots will be surveyed per breeding season until the entire Sanctuary has been covered. Ideally the Sanctuary should be surveyed in its entirety over the course of one breeding season for successive seasons but, due to financial constraints, the rotating survey method is the second best option currently available.

The methods for the 2018 Sanctuary surveys followed the USFWS recommended minimum procedures for determining the presence/absence of GCWA (USFWS 2010), as outlined in TAS's Federal Fish and Wildlife Permit (Permit No. TE94739A-0), issued May 10, 2013. In addition, GCWA territory mapping followed procedures outlined in Bibby et al. (2003) and the BCCP Tier II Land Management Plan (BCCP 2007) unless otherwise stated.

2.0 DESCRIPTION OF SURVEY AREAS

Northeast Plot

In general, the 65-acre plot shares a vegetation community that is typical of GCWA habitat throughout the central Texas Hill Country where mixed woodlands are dominated primarily by Ashe juniper (*Juniperus* ashei) and plateau live oak (*Quercus fusiformis*) and lightly interspersed with Spanish oak (*Quercus buckleyi*), shin oak (*Quercus sinuata*), cedar elm (*Ulmus crassifolia*), post oak (*Quercus stellata*), escarpment black cherry (*Prunus* serotina), and Texas ash

(*Fraxinus texensis*). A limited variety of deciduous and evergreen understory species such as Texas persimmon (*Diospyros texana*), possumhaw (*Ilex decidua*), yaupon (*Ilex vomitoria*), wafer ash (*Ptelea* trifoliata), flameleaf sumac (*Rhus lanceolata*), agarita (*Berberis trifoliata*), Lindheimer's silktassel (*Garrya* ovata), elbow bush (*Forestiera pubescens*), poison ivy (*Toxicodendron radicans*), prickly pear (*Opuntia* sp*.),* and twist leaf yucca (*Yucca rupicola*) can also be found throughout the survey area.

Topography throughout the 65-acre plot is fairly uniform and ranges between 1060 feet above mean sea level (msl) to 1020 feet above msl. In the eastern portion of the plot there is a relatively contiguous, seven acre section of woodland which experienced high Ashe juniper mortality during the severe drought of 2011 (**Figure 1**). This area is characterized primarily by standing or fallen Ashe juniper snags, poverty weed (*Baccharis neglecta*), and plateau live oak which successfully weathered the drought.

Northwest Plot

In general, the vegetation community found throughout the 130-acre plot is functionally identical to that represented in the Northeast plot with the exception that the Northwest plot has not experienced any concentrated Ashe juniper mortality.

Topography throughout the majority of the 130-acre plot is fairly uniform and ranges between 1080 feet above mean sea level (msl) to 1040 feet above msl. Approximately six acres of the plot intersects the southern drainage for Harris Creek where topographical relief is considerable, ranging from 1040 feet above msl to 940 feet above msl. In the southeastern portion of the plot there is a 12-acre savannah (**Figure 1**) which is dominated by the non-native, invasive grass King Ranch bluestem (*Bothriochloa ischaemum*) and interspersed with Ashe juniper, plateau live oak, and native grasses such as little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), red grama

(*Bouteloua trifida*), fall witchgrass (*Digitaria cognate*), and Halls panicum (*Panicum hallii).*

3.0 METHODS

Surveys began on March 20 and concluded on May 24 for the Northeast survey and March 13 and May 26 respectively for the Northwest survey. Surveys occurred in the morning hours and were not conducted if sustained wind speeds were greater than 15 mph or during precipitation other than a light drizzle. Three surveyors, Christopher Murray, Wesley Collins, and Teresa Johnson surveyed the Northeast study plot on a weekly basis and invested a total of 83.75 hours, or 32.2 hours per 25 acres. Two surveyors, Christopher Murray and Elizabeth Samuels, surveyed the Northwest plot on a weekly basis and invested a total of 92.25 hours, or 17.7 hours per 25 acres. Spot-mapping techniques as outlined in the USFWS protocol for GCWA presence/absence surveys (USFWS 2010) as well as Bibby et al. (2003) and the Tier II Land Management Plan (2007) were utilized by the surveyors.

During each visit the surveyor hiked through the study area and searched for GCWA by sight and/or sound. If a GCWA was detected, the surveyor recorded the location of the bird on a field map and also with a Garmin eTrex GPS receiver. GPS locations were designated as precise or imprecise with precise locations indicating a visual and/or auditory observation within 30 feet of the observer. Imprecise locations were auditory detections only and were estimated locations extending 30 to 120 feet from the observer. At each location the surveyor also recorded the time of day, song type (A or B), whether the GCWA was color banded, presence of a female or fledglings, and territorial interactions such as counter-singing or conspecific chases. Auditory recordings were not utilized during any surveys to lure GCWA to the observer.

After the surveys were complete, data were compiled with GPS Trackmaker and uploaded into GoogleEarth for analysis. Territories were determined primarily by utilizing defensive cues, such as counter-singing and chases, exhibited by males at or near territory boundaries. In addition to territorial behavior, re-sighting of color bands, sequential movement patterns, presence of females and fledglings, and age of fledglings were used to conservatively estimate the amount and distribution of territories throughout the survey area.

To increase the accuracy and ease of delineating territories, an effort was made to mist net and capture all breeding males on both plots. Males were captured by setting up a mist net (2.6 x 6 meters, 30 mm mesh, 2 ply) in the target male's territory and using a play-back recording to draw the bird to the net. If captured, the male was outfitted with an aluminum USFWS band and two to three color bands. All color combinations were coordinated with researchers throughout the state so that all banded individuals had a unique color-band/aluminum band combination. Since 2017 a total of 18 male GCWA have been banded on the study plots (**Table 1**).

Reproductive success was determined as follows:

1. Territory density: number of territories per acreage surveyed;
2. Calculation of edge territories: each territory that significantly straddled plot boundary counted as a half territory (i.e., 0.5 territory) (Verner 1985); and
3. Productivity measures (Anders 2000) - calculated for full territories ONLY, as follows:
    a. Pairing success: pairing success of male GCWA determined by observing one or more of the following conditions: a territorial male observed with a female and/or a male tending at least one fledgling. Pairing success rate = number of territories determined to have pairing success / total number of full territories;

b. Breeding success: breeding success rate = number of territories that successfully fledged at least one young / total number of full territories;
c. Estimated brood size: average brood size per successful pair (based on “breeding success”); and
d. Productivity = sum of the highest number of fledglings recorded at any one time for each full territory / total number of full territories.

4.0 RESULTS

Northeast Plot

In total, 234 GCWA observations were recorded over the course of the survey effort. Six full territories and no edge territories were delineated in the study plot for an adjusted total of six territories (**Figure 2**). Females were observed in all six territories and a total of nine fledglings were observed in the six territories (**Table 2**). Three territories were established directly adjacent to the 65-acre plot and were not included in the analysis nor indicated on the territory map.

Territory density was calculated at 0.09 territories per acre. This calculation was based on the adjusted total of six territories in the 65 acres surveyed.

The pairing success rate in the Northeast plot was 100% (females were observed in all six of the full territories). The breeding success was estimated at 100%, based on the fact that all six territories were observed to have fledglings. The estimated brood size was 1.5 fledglings based on the aforementioned criteria. Productivity was estimated at 1.5 based on the total of nine fledglings observed in the six full territories.

Northwest Plot

In total, 298 GCWA observations were recorded over the course of the survey effort. Twelve full territories and one edge territory were delineated in the study plot for an adjusted total of 12.5 territories (**Figure 3**). Females were observed in

11 of the 12 full territories and no female was observed in the only edge territory. A total of 19 fledglings were observed in the territories (**Table 2**). Two territories were established directly adjacent to the 130-acre plot and were not included in the analysis nor indicated on the territory map.

Territory density was calculated at 0.10 territories per acre. This calculation was based on the adjusted total of 12.5 territories in the 130 acres surveyed.

The pairing success rate in the Northwest plot was 92% (females were observed in 11 of the 12 full territories). The breeding success was estimated at 83%, based on the fact that 10 of the 12 full territories produced fledglings. The estimated brood size was 1.9 fledglings based on the aforementioned criteria. Productivity was estimated at 1.58 based on the total of 19 fledglings observed in 10 of the 12 full territories.

On April 5 Christopher Murray found DG/PI:WH/SI dead and on the ground approximately 100 meters from where he was banded, an area that was later designated as the SW corner of MV/SI:BL/YE's territory. The bird was in good condition with no ants or other scavengers present and the bird did not smell of decay, suggesting he had recently died (**Figure 4**). In the tree immediately above the body was an unbanded male GCWA singing B-song. On March 27, Murray observed DG/PI:WH/SI with a female approximately 50 meters from where he was later found dead. At the time he was acting normally, following the female as she foraged and counter-singing B-song with UB1. DG/PI:WH/SI was banded on March 24, 2018 by Murray who did not note any unusual circumstances during the banding process. He was in-hand for less than five minutes and did not exhibit any sign of stress while he was banded and data collected. Upon release, DG/PI:WH/SI immediately flew to a nearby tree where he intermittently sang A-songs and pecked at his new bands. Cause of death is unknown but likely due to disease, predation, or most likely, intraspecific competition.

5.0 DISCUSSION

In general, results from the 2018 surveys were quite similar with calculated territory density, pairing success, and breeding success nearly identical. However, measures of fecundity represented by calculations for average brood size and productivity demonstrated more variation between plots, whether this reflects a true difference in productivity is not known (**Table 3**). More meaningful comparisons will be possible as more data is collected over the next few seasons. In the interim, results from the survey effort can be cautiously compared with six years of data collection (2011-2016) from Baker Sanctuary's 100-acre plot.

Beginning in 1999, a 100-acre survey plot was established in the southern Sanctuary (**Figure 1**) whose function was to provide monitoring data for GCWA as part of a larger sampling effort throughout the BCP. The Baker 100-acre plot was one of an initial 13 'prime' plots defined as containing a minimum of 75% GCWA habitat as described in Campbell (1995), and at least 70% canopy cover. Observations of warbler density were not a criteria in the selection of prime plots (BCCP 2007).

While the 100-acre survey has been performed at Baker since 1999, intensity and methodology have varied enough to make comparisons between years problematic. With the onset of color-banding and adoption of a standardized survey protocol beginning in the 2011 season, the results of six years of data collection on the 100-acre plot can cautiously be compared with results of the Northeast and Northwest Sanctuary surveys. The comparison is worthwhile to begin to ascertain if certain areas of the Sanctuary are more productive than others and, if so, what the possible causes of such a difference could be. Ultimately the goal is to elucidate management techniques which would increase productivity, if possible, in areas where it is comparatively lower.

When the averages of the 100-acre (n=6) and Northeast surveys (n=2) were compared, territory density, pairing success, and breeding success were fairly similar while productivity and especially average brood size seemed to be higher in the 100-acre plot. The single data point for the Northwest survey exhibits a similar pattern (**Table 3**). One interpretation of these data is that the 100-acre plot is simply more productive but other variables may be a factor, primarily time spent surveying and field techniques.

The more time surveyors spend on plot, the more likely it is that observations will be collected, especially when discovering and counting fledglings. On average, 52 survey hours/25 acres were invested on the 100-acre plot while the Northeast surveys averaged 26 hours/25 acres and the single Northwest survey 17.7 hours/25 acres (**Table 3**). To determine average brood size and productivity all fledglings must be located which can be difficult if the nest location is not known. If the nest is located, the surveyor is typically more successful documenting the true extent of the fledged brood the closer the survey effort aligns with the fledging event. In many instances once the nestlings fledge, the brood is split between the parents, with the female tending half the brood and the male the other half (Ladd and Gass, 1999). Fledglings can be quite cryptic and difficult to detect (City of Austin, 2017) especially those tended by the female who does not sing or offer many clues to her location, unlike the male who actively defends his territory through song and intraspecific chases. As a result, it is not uncommon to discover fledglings 20 days or more fledged in a territory where no fledglings had previously been detected. It is also not uncommon that the only indication of breeding status may consist of a female sighted in a territory or a parent carrying prey items to a nestling or fledgling.

As fledglings mature they become more mobile and do not necessarily stay within established territories (City of Austin, 2017), adding another layer of complexity to interpreting fecundity data. Since the fledglings and, typically, the females are unbanded, determining which fledglings belong to which territory can

be difficult unless the color-banded male is observed feeding the fledglings (Reidy *et al*, 2015) or they are observed substantially within the interior of an established territory. Finally, the more time it takes to make the initial fledgling detection, the more likely it is that one or more of the fledglings may have fallen prey to a predator or disease (Cox *et al*, 2014). This could bias the data to have a higher fledgling count for instances where the nest was found and the surveyor was present near the time of fledging. When all factors are considered it is difficult to make meaningful brood size or productivity comparisons between seasons or plots, especially when survey time per plot is highly variable.

While consistent fecundity data can be difficult to attain, territory density, pairing success, and breeding success are not. Prior to 2011 and the initiation of color-banding, territory density for the 100-acre plot varied widely between seasons and surveyors (**Table 4**). When color-banding became part of the survey protocol, in any one season an average of 66% of singing males on plot were banded, decreasing surveyor subjectivity and resulting in territory density stabilization. If color-banding had not been utilized, territory density data would most likely vary widely between seasons as it had prior to the color-banding effort. With color-banded individuals present, pairing success also became easier to determine as females were assigned to the appropriate territory when seen in association with a particular color-banded, male.

The breeding success rate is determined by the number of territories that successfully fledged at least one young divided by the total number of full territories. This may be the most precise measurement of fecundity currently available since it requires the detection of only one fledging per territory, minimizing some of the variables present when attempting a direct count of all fledglings, which is necessary to calculate the average brood size and productivity. While it may be more precise, the accuracy is not ideal but when making management decisions it may be better to err on the conservative side

rather than interpreting measurements of average brood size and productivity as accurate and precise indicators of fecundity.

The average territory density, pairing success, and breeding success for the 100-acre, Northeast, and Northwest survey plots are very similar while measurements for average brood size and productivity are higher for the 100-acre plot (**Table 3**). Due to uncertainties involved with determining average brood size and productivity, the higher fecundity rates found in the 100-acre plot should be interpreted with a degree of caution as they may be influenced by a host of variables, such as time spent in the field, whether the nest was discovered, timing of first detection, presence of color-banded males, and others. As more data is collected and time spent in the field becomes more consistent between plots and years, it is expected more meaningful interpretations of fecundity will be possible between various areas of the Sanctuary.

6.0 REFERENCES

Anders, A. D, J. S. Horne, and L. L. Sanchez. 2000. Relationship between habitat characteristics and demography of golden-cheeked warblers on Ft. Hood, Texas. In Endangered species monitoring and management at Ft. Hood, Texas: 2000 annual report. Fort Hood Project, The Nature Conservancy of Texas, Ft. Hood, Texas, USA.

Balcones Canyonlands Conservation Plan (BCCP). 2007. Balcones Canyonlands Preserve land management plan, Tier II: golden-cheeked warbler.

Bibby, C. J., N. D. Burgess, D. A. Hill, and S. Mustoe. 2003. Bird census techniques; chapter 3: territory mapping methods. Academic Press, London.

Campbell, L. 1995. Endangered and Threatened Animals of Texas: Their Life

History and Management. Golden-cheeked Warbler (Dendroica chrysoparia). Texas Parks and Wildlife Department, Austin, Texas.

City of Austin. 2017. City of Austin 2017 golden-cheeked warbler (*Setophaga chrysoparia*) monitoring program: Blacones Canyonlands Preserve annual report FY 2016-17. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

Cox, W. A., F. R. Thompson, A. S. Cox, J. Faaborg. 2014. Post-fledging survival in passerine birds and the value of post-fledging studies to conservation. The Journal of Wildlife Management 78:183-193.

Ladd, C. and L. Gass. 1999. Golden-cheeked warbler (*Dendroica chrysoparia*). The Birds of North America, No. 420. A. Poole and F. Gill, eds. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

Murray, C. 2017. Results of the golden-cheeked warbler survey for the Northeast Baker Sanctuary plot, spring 2017. Travis Audubon Society, Austin, Texas. 13 pp.

Reidy, J.L., L. O'Donnell, F.R. Thompson. 2015. Evaluation of a reproductive index for estimating songbird productivity: Case study of the golden-cheeked warbler. Wildlife Society Bulletin, 9999.

U.S. Fish and Wildlife Service (USFWS). 2010. USFWS Section 10(a)(1)(A) scientific permit requirements for conducting presence/absence surveys and habitat assessments for endangered golden-cheeked warblers. USFWS Ecological Services Field Office, Austin, Texas. 10 pp.

Verner, J. 1985. Assessment of counting techniques. Current Ornithology 2:247-302.

7.0 ACKNOWLDGEMENTS

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Table 1. Golden-cheeked warblers banded on the Northeast and Northwest Baker Sanctuary plots, 2017 - 2018.

Year Banded	Color Combination	Plot	USFWS Band #	Gender	Age
2017	RD/RD:DG/SI	Northeast	2770-41206	Male	ASY
2017	DG/DB:OR/SI	Northeast	2770-41207	Male	ASY
2017	BK/WH:BL/SI	Northeast	2770-41208	Male	ASY
2017	PI/SI:WH/RD	Northeast	2770-41209	Male	ASY
2017	WH/BL:MV/SI	Northeast	2770-41210	Male	ASY
2018	MV/MV:MV/SI	Northwest	2770-41211	Male	ASY
2018	PI/SI:YE/RD	Northwest	2770-41212	Male	ASY
2018	WH/BL:DB/SI	Northwest	2770-41213	Male	ASY
2018	BK/DB:MV/SI	Northwest	2770-41214	Male	ASY
2018	YE/SI:WH/RD	Northwest	2770-41215	Male	SY
2018	OR/SI:BK/MV	Northwest	2770-41216	Male	ASY
2018	DG/PI:WH/SI	Northwest	2770-41217	Male	ASY
2018	BK/SI:GR/WH	Northwest	2770-41218	Male	ASY
2018	MV/SI:BL/YE	Northwest	2790-44711	Male	ASY
2018	WH/WH:OR/SI	Northeast	2770-41219	Male	SY
2018	MV/OR:RD/SI	Northeast	2770-41220	Male	ASY
2018	BK/PI:OR/SI	Northwest	2770-41221	Male	ASY
2018	WH/SI:WH/YE	Northwest	2770-41222	Male	ASY

Red (RD), Orange (OR), Yellow (YE), Green (GR), Dark Green (DG), Blue (BL), Dark Blue (DB), Mauve (MV), Pink (PI), Black (BK), White (WH), USFWS band (SI), no band (NB)

Table 2. Golden-cheeked warbler territory status and enumeration of females and fledglings detected on the Northeast and Northwest Baker Sanctuary plots, 2018.

Territory Designation	Plot	Full/Edge Territory	Number of Confirmed Detections	Female Detected	# Fledglings Detected
RD/RD:DG/SI	Northeast	Full	28	Yes	2
WH/WH:OR/SI	Northeast	Full	22	Yes	1
BK/WH:BL/SI	Northeast	Full	25	Yes	2
MV/OR:RD/SI	Northeast	Full	38	Yes	1
UB1	Northeast	Full	52	Yes	2
UB2	Northeast	Full	19	Yes	1
MV/MV:MV/SI	Northwest	Full	18	Yes	1
PI/SI:YE/RD	Northwest	Full	20	Yes	2
WH/BL:DB/SI	Northwest	Full	20	Yes	1
BK/DB:MV/SI	Northwest	Full	17	Yes	2
YE/SI:WH/RD	Northwest	Full	17	Yes	2
OR/SI:BK/MV	Northwest	Full	25	Yes	2
BK/SI:GR/WH	Northwest	Full	22	Yes	1
MV/SI:BL/YE	Northwest	Full	24	Yes	0
BK/PI:OR/SI	Northwest	Full	41	No	0
WH/SI:WH/YE	Northwest	Full	31	Yes	2
UB1	Northwest	Full	35	Yes	4
UB2	Northwest	Full	17	Yes	2
UB3	Northwest	Edge	5	No	0

Table 3. Summary of golden-cheeked warbler reproductive success on the Northeast, Northwest, and 100-acre Baker Sanctuary plots, 2011-2018.

Survey	Territory Density	% Pairing Success	% Breeding Success	Average Brood Size	Productivity	Survey Time/25 Acres (Hours)
Northeast 2017	0.11	86	57	1.75	1.00	20.4
Northeast 2018	0.09	100	100	1.50	1.50	32.2
Northwest 2018	0.10	92	83	1.90	1.58	17.7
*Northeast Survey	0.10	93	79	1.63	1.25	26.3
**100-acre Survey	0.11	93	68	2.80	1.85	52.1

*Average for two seasons, 2017-2018.

**Average for six seasons, 2011-2016.

Table 4. Summary of golden-cheeked warbler territory density and presence of color-banded males on the 100-acre Baker Sanctuary plot, 2003-2016.

Year	Territory #	Presence of Color-banded Males
2003	17.5	No
2004	15	No
2005	19	No
2006	23	No
2007	21.5	No
2009	13.5	No
2010	8.5	No
2011	10.5	Yes
2012	10	Yes
2013	10	Yes
2014	8.5	Yes
2015	11.5	Yes
2016	10.5	Yes

Figure 1. Locations of the Northeast, Northwest, and 100-acre Baker Sanctuary plots.

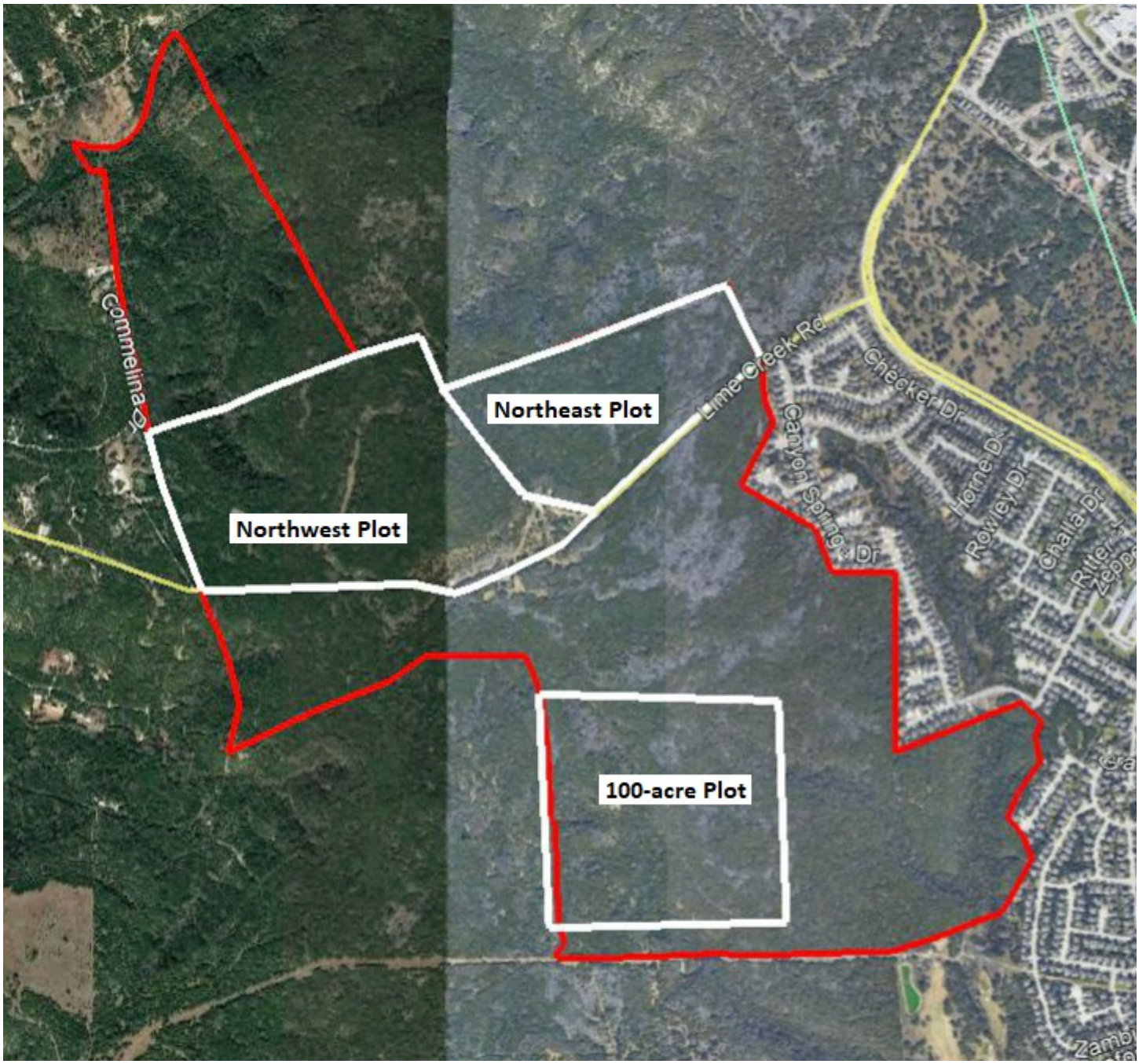


Figure 2. Golden-cheeked warbler territory distribution on the Northeast Baker Sanctuary plot, 2018.



Figure 3. Golden-cheeked warbler territory distribution on the Northwest Baker Sanctuary plot, 2018

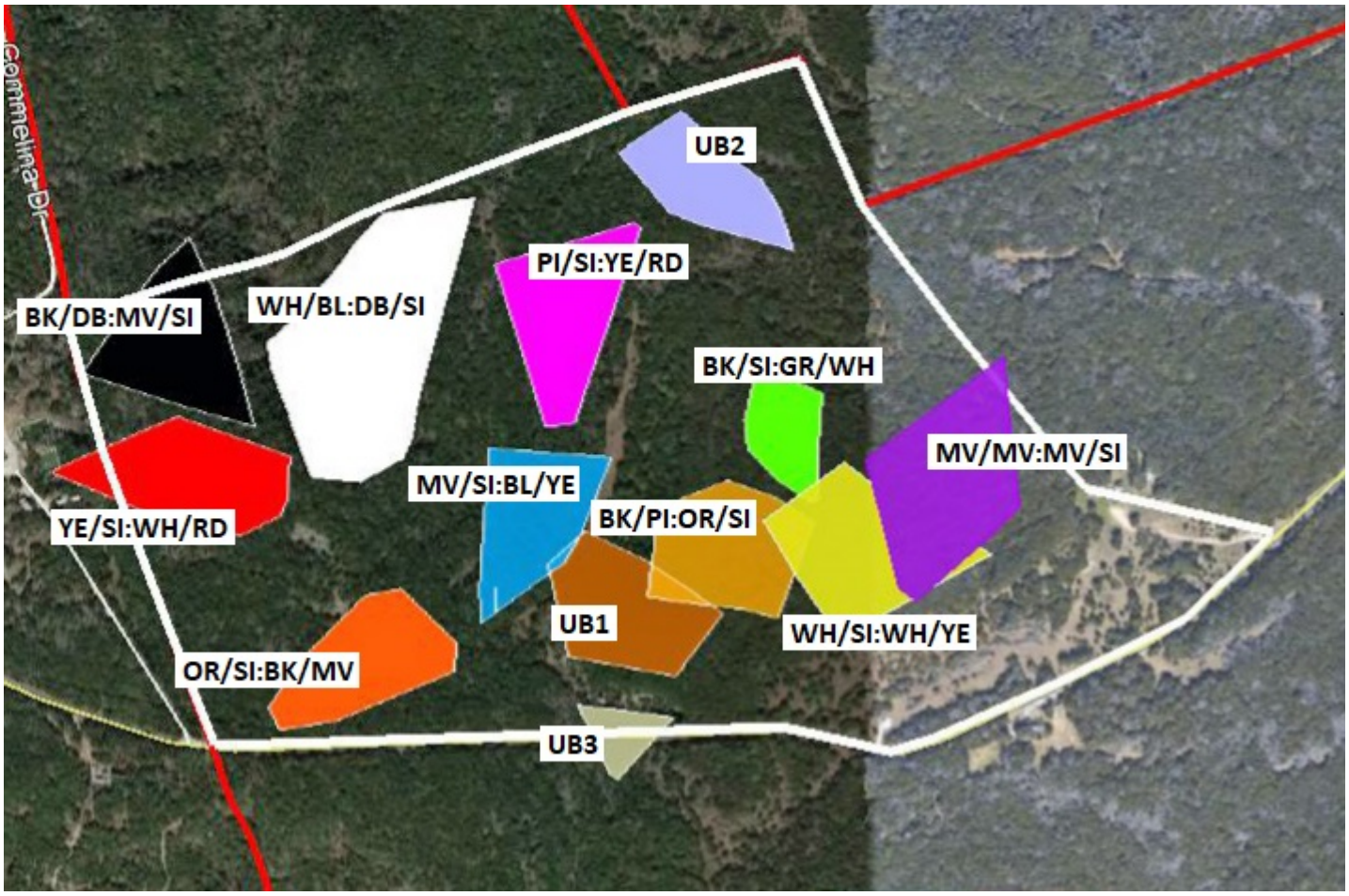


Figure 4. Recovered golden-cheeked warbler DG/PI:WH/SI, April 5, 2018.



Appendix D

Baker Sanctuary GCWA VCP point count example, 2017

Date	Station	Time Begin	Time End	Wind Spd (mph)	Temp (F)	Precipitation	Female	BoC
4/6/17	18	09 54.00	10.04.00	0	56°	N/A	Y (N)	WESJ BLJA NOBO

Bird	Position	Time	Detect	Dist (m)
1	1-1	9:54.05	A	26
2	2-1	9:54.15	B	46
1	1-1	9:55	A	46
2	2-1	9:55	B	46
3	3-1	9:56.05	B	71
1	1-1	9:56	A	46
2	2-1	9:56	B	46
1	1-1	9:57	A	46
2	2-1	9:57	B	46
3	3-1	9:57	B	71
2	2-1	9:58	B	46
3	3-1	9:58	B	71
1	1-2	9:58	A	36
1	1-2	9:59	A	36
2	2-1	9:59	B	46
3	3-1	9:59	B	71
1	1-2	10:00	A	36
2	2-1	10:00	B	46
3	3-1	10:00	B	71
3	3-1	10:01	B	71
1	1-2	10:01	A	36
2	2-2	10:01	A	56
1	1-2	10:02	A	36
1	1-3	10:03	A	39

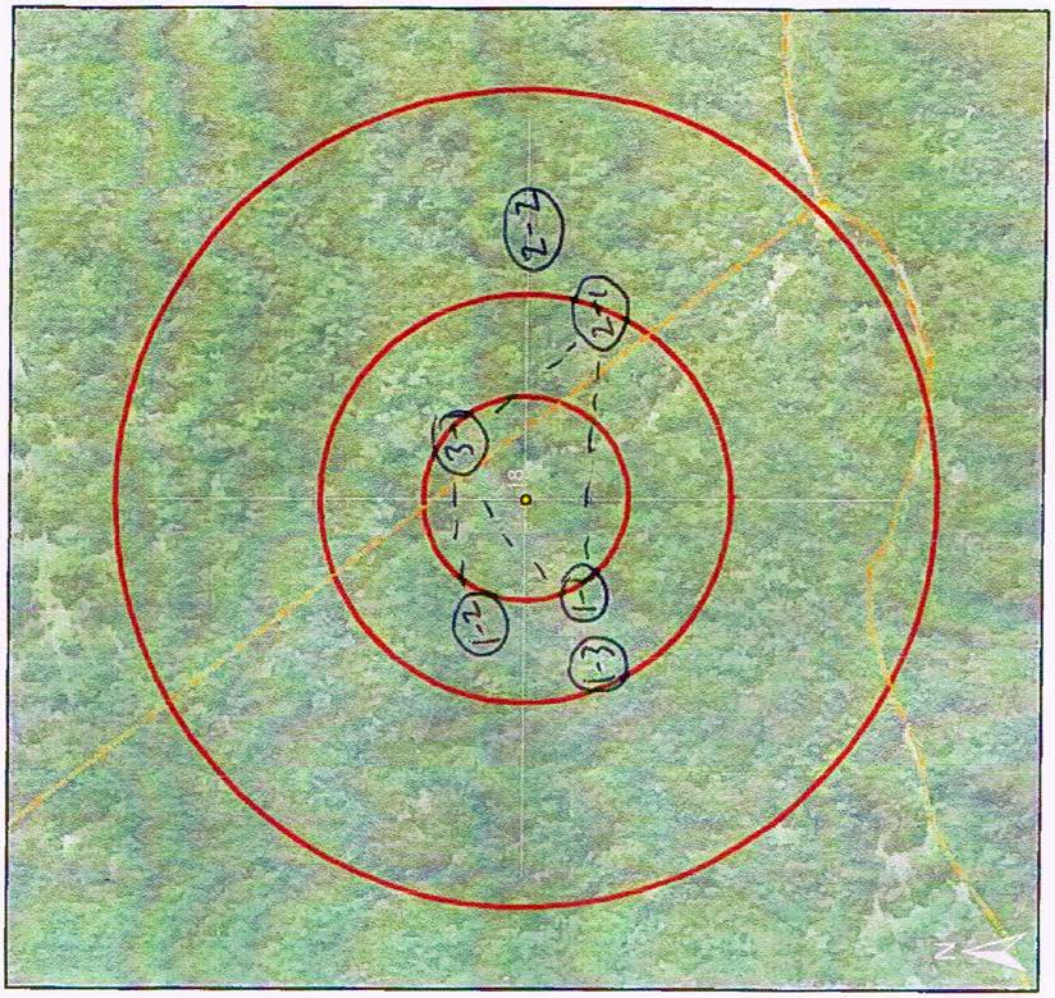


Figure 1. Baker Sanctuary VCP point counts stations, 2018.



Figure 2. Baker Sanctuary whitetail deer hunt sites, 2017 - 2018.

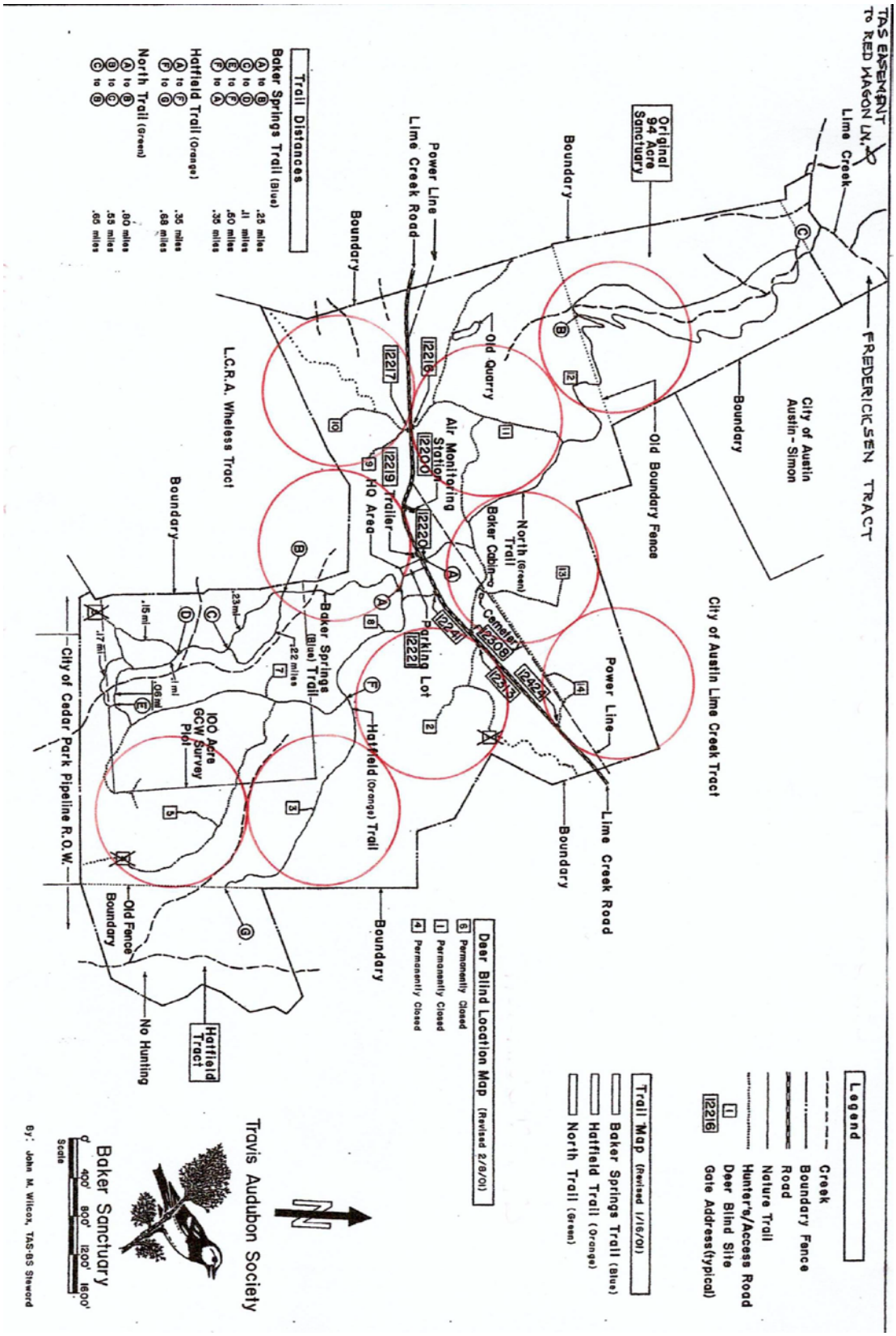


Figure 3. Summary of Baker Sanctuary whitetail deer harvest, 2000-2018. Juvenile deer are a year or less in age.

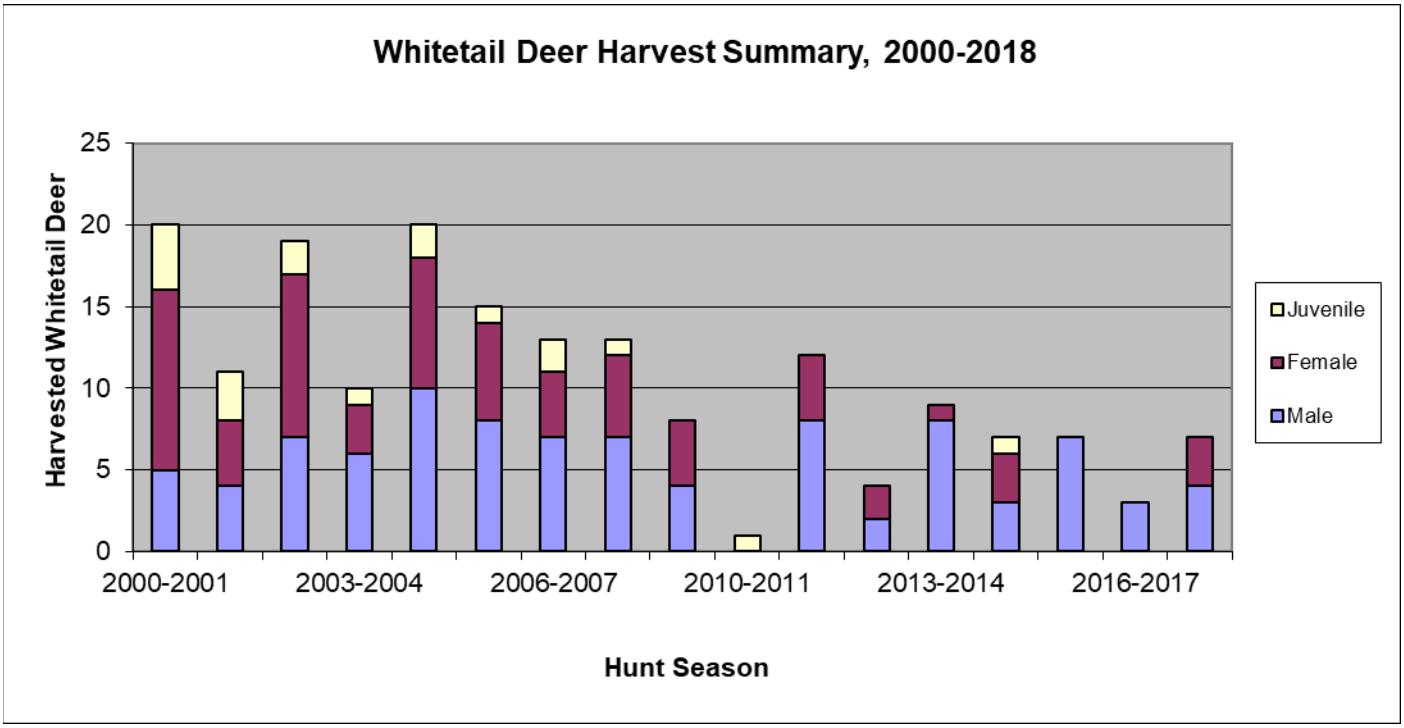


Figure 4. Baker Sanctuary whitetail deer camera trap sites, 2017.



Figure 5. Summary of Baker Sanctuary brown-headed cowbird trapping effort, 1986-2018.

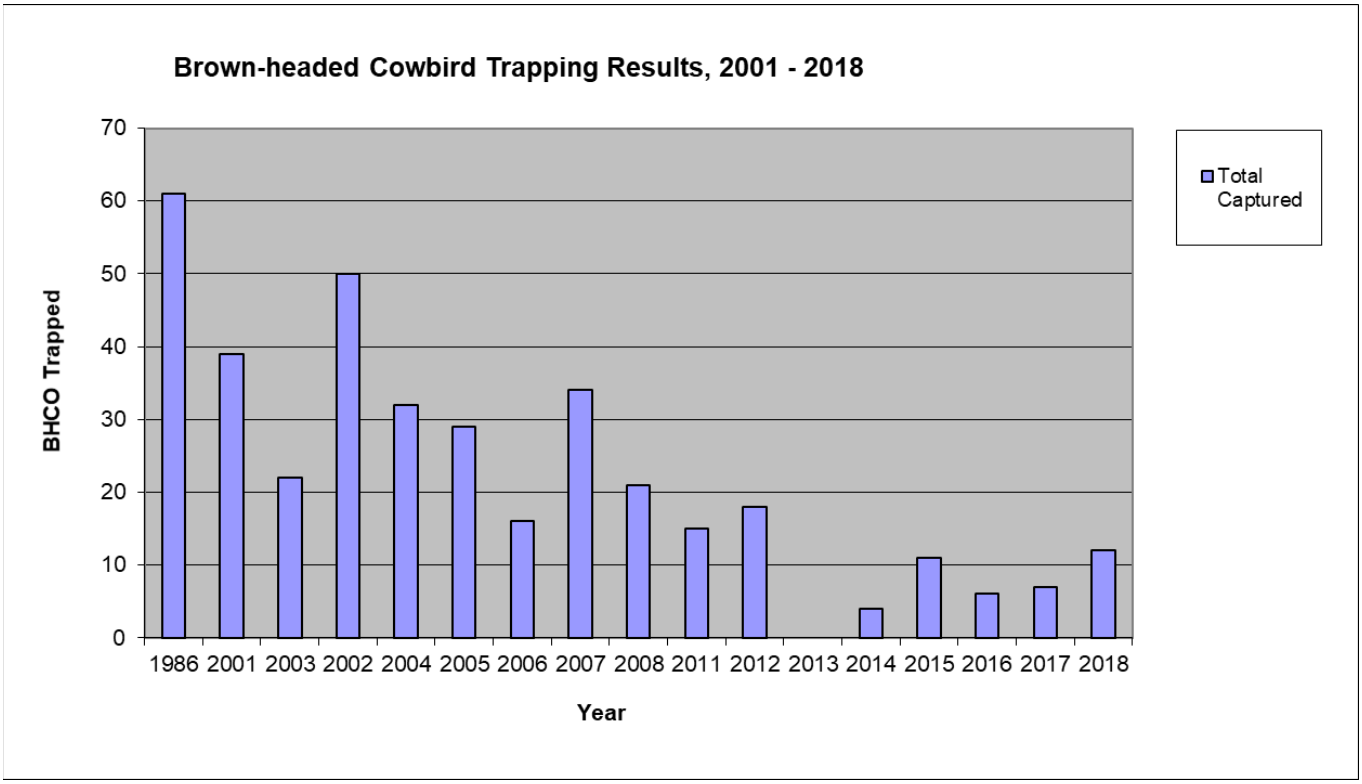


Figure 6. Summary of Baker Sanctuary tree-of-heaven eradication efforts, 2010 - 2018.

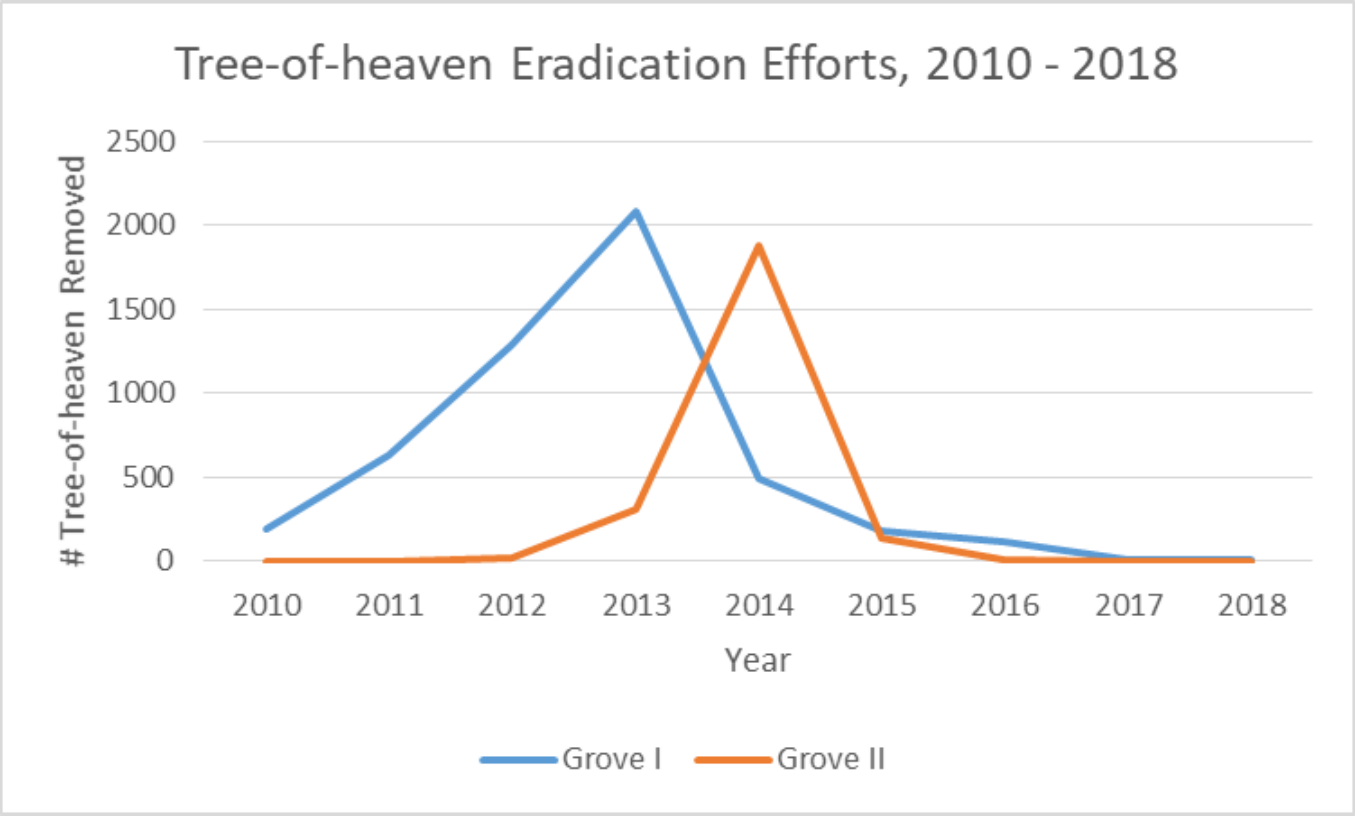


Figure 7. Baker Sanctuary BBS point count stations, 2018.



Table 1. Summary of GCWA banded at Baker Sanctuary, 2015 - 2018.

Year Banded	USFWS Serial Number	Color Band Combination	Survey Plot	Sex	Age
2015	2770-41201	RD/SI:RD/DB	100-acre	Male	SY
2015	2770-41202	MV/MV:YE/SI	100-acre	Male	ASY
2016	2770-41203	NB/SI:OR/DB	100-acre	Male	ASY
2016	2770-41205	BL/DG:BK/SI	100-acre	Male	ASY
2016	2550-99699	WH/SI:BK/WH	100-acre	Male	SY
2017	2770-41206	RD/RD:DG/SI	Northeast	Male	ASY
2017	2770-41207	DG/DB:OR/SI	Northeast	Male	ASY
2017	2770-41208	BK/WH:BL/SI	Northeast	Male	ASY
2017	2770-41209	PI/SI:WH/RD	Northeast	Male	ASY
2017	2770-41210	WH/BL:MV/SI	Northeast	Male	ASY
2018	2770-41211	MV/MV:MV/SI	Northwest	Male	ASY
2018	2770-41212	PI/SI:YE/RD	Northwest	Male	ASY
2018	2770-41213	WH/BL:DB/SI	Northwest	Male	ASY
2018	2770-41214	BK/DB:MV/SI	Northwest	Male	ASY
2018	2770-41215	YE/SI:WH/RD	Northwest	Male	SY
2018	2770-41216	OR/SI:BK/MV	Northwest	Male	ASY
2018	2770-41217	DG/PI:WH/SI	Northwest	Male	ASY
2018	2770-41218	BK/SI:GR/WH	Northwest	Male	ASY
2018	2790-44711	MV/SI:BL/YE	Northwest	Male	ASY
2018	2770-41219	WH/WH:OR/SI	Northeast	Male	SY
2018	2770-41220	MV/OR:RD/SI	Northeast	Male	ASY
2018	2770-41221	BK/PI:OR/SI	Northwest	Male	ASY
2018	2770-41222	WH/SI:WH/YE	Northwest	Male	ASY

Red (RD), Orange (OR), Yellow (YE), Green (GR), Dark Green (DG), Blue (BL), Dark Blue (DB), Mauve (MV), Pink (PI), Black (BK), White (WH), USFWS band (SI), no band (NB)

Table 2. GCWA detected per VCP point count time interval, 2017 - 2018.

Year	< 1 min.	1-2 min.	2-3 min.	3-4 min.	4-5 min.	GCWA Detected 5-min. Interval	5-6 min.	6-7 min.	7-8 min.	8-9 min.	9-10 min.	GCWA Detected 10-min. Interval
2017	27	5	4	3	6	45	2	2	0	3	4	57
2018	12	5	5	3	3	28	3	1	4	2	4	42

Table 3. Baker Sanctuary whitetail deer population survey results, 2016 - 2017.

Year	Buck Ratio	Buck Estimate	Doe Estimate	Fawn Estimate	Total Population Estimate	Deer/km2	Doe:Buck Ratio	Fawn Production (%)
2016	0.05	10.00	8.41	1.85	20.26	7.00	0.84	22.0
2017	0.06	17.00	5.52	1.08	23.60	8.10	0.32	19.6

Table 4. Baker Sanctuary plantings, 2017 – 2018.

Common Name	Scientific Name	Class	# Planted
Agarita	*Berberis trifoliata*	Tree/shrub	4
Black-foot daisy	*Melampodium leucanthum*	Herbaceous/grass	1
Blue-eyed grass	*Nemastylis geminiflora*	Herbaceous/grass	113
Box elder	*Acer negundo*	Tree/shrub	1
Broadleaf woodoats	*Chasmanthium latifolium*	Herbaceous/grass	3
Carolina buckthorn	*Frangula caroliniana*	Tree/shrub	2
Cedar Elm	*Ulmus crassifolia*	Tree/shrub	3
Cedar sage	*Salvia roemeriana*	Herbaceous/grass	3
Coma	*Bumelia lanuginosa*	Tree/shrub	1
Damiantia	*Chrysactina mexicana*	Herbaceous/grass	1
Escarpment black cherry	*Prunus serotina*	Tree/shrub	8
Flame acanthus	*Anisacanthus wrightii*	Herbaceous/grass	1
Frostweed	*Verbesina virginica*	Herbaceous/grass	8
Gay-feather	*Liatris mucronata*	Herbaceous/grass	5
Giant spiderwort	*Tradescantia gigantea*	Herbaceous/grass	2
Golden groundsel	*Senecio obovatus*	Herbaceous/grass	3
Goldeneye	*Viguiera dentata*	Herbaceous/grass	23
Hog plum	*Colubrina texensis*	Tree/shrub	1
Ironweed	*Vernonia baldwinii*	Herbaceous/grass	3
Lindheimer's silktassel	*Garrya ovata*	Tree/shrub	2
Little bluestem	*Schizachyrium scoparium*	Herbaceous/grass	11
Meadow dropseed	*Sporobolus compositus*	Herbaceous/grass	1
Pigeon-berry	*Rivina humilis*	Herbaceous/grass	18
Pink evening primrose	*Oenothera speciosa*	Herbaceous/grass	89
Plateau live oak	*Quercus fusiformis*	Tree/shrub	3
Possumhaw	*Ilex decidua*	Tree/shrub	3
Prairie verbena	*Verbena bipinnatifida*	Herbaceous/grass	1
Purple coneflower	*Echinacea angustifolia*	Herbaceous/grass	3
Rain-lily	*Cooperia pedunculata*	Herbaceous/grass	12
Rockrose	*Helianthemum georgianum*	Herbaceous/grass	4
Rusty Blackhaw	*Viburnum rufidulum*	Tree/shrub	1
Shin oak	*Quercus sinuata*	Tree/shrub	3
Shrubby boneset	*Eupatorium havanense*	Tree/shrub	2

Snake herb	*Dyschoriste linearis*	Herbaceous/grass	4
Southwestern bristlegrass	*Setaria scheelei*	Herbaceous/grass	7
Spanish oak	*Quercus buckleyi*	Tree/shrub	12
Stork's bill	*Erodium texanum*	Herbaceous/grass	5
Straggler daisy	*Calyptocarpus vialis*	Herbaceous/grass	3
Texas ash	*Fraxinus texensis*	Tree/shrub	2
Texas aster	*Aster texanus*	Herbaceous/grass	7
Texas bluebonnet	*Lupinus texensis*	Herbaceous/grass	7
Texas indigo-bush	*Amorpha texana*	Tree/shrub	13
Texas kidneywood	*Eysenhardtia texana*	Tree/shrub	1
Texas madrone	*Arbutus xalapensis*	Tree/shrub	1
Texas mountain laurel	*Sophora secundiflora*	Tree/shrub	2
Texas persimmon	*Diospyros texana*	Tree/shrub	2
Tropical sage	*Salvia coccinea*	Herbaceous/grass	3
Turk's cap	*Malvaviscus drummondii*	Tree/shrub	5
Twist-leaf yucca	*Yucca rupicola*	Herbaceous/grass	2
Wafer ash	*Ptelea trifoliata*	Tree/shrub	1
Wood-sorrel	*Oxalis drummondii*	Herbaceous/grass	4
Zexmenia	*Zexmenia hispida*	Herbaceous/grass	1

Table 5. Efficacy of imazapyr treatments on non-native plants at Baker Sanctuary, 2016 – 2018.

Species	Imazapyr Solution	# Treated	% Mortality, 1 Treatment	% Mortality, 2 Treatments
Chinaberry	30%	44	82%	80%
Ligustrum sp	30%	6	100%	N/A
Heavenly Bamboo	30%	43	80%	100%
Paper Mulberry (*Broussonetia papyrifera*)	30%	1	0%	100%
Total		**94**		

Table 6. Baker Sanctuary BBS point count survey, 2018.

Common Name	Scientific Name	Number Observed	Mean[1]	Frequency (%)[2] (25 yd radius)	Frequency (%)[3] (unlimited radius)
Ash-throated Flycatcher	*Myiarchus cinerascens*	0	0.00	0	8
Barn Swallow	*Hirundo rustica*	0	0.00	0	16
Bewick's Wren	*Thryomanes bewickii*	7	0.18	16	32
Black-and-white Warbler	*Mniotilta varia*	5	0.13	13	16
Black-chinned Hummingbird	*Archilochus alexandri*	8	0.21	21	21
Black-crested Titmouse	*Baeolophus atricristatus*	10	0.26	26	92
Blue-gray Gnatcatcher	*Polioptila caerulea*	28	0.74	55	58
Brown-headed Cowbird	*Molothrus ater*	1	0.03	3	5
Canyon Wren	*Catherpes mexicanus*	0	0.00	0	8
Carolina Chickadee	*Poecile carolinensis*	28	0.74	50	71
Carolina Wren	*Thryoothorus ludovicianus*	8	0.21	18	24
Chimney Swift	*Chaetura pelagica*	0	0.00	0	11
Common Grackle	*Quiscalus quiscula*	0	0.00	0	8
Eastern Phoebe	*Sayornis phoebe*	3	0.08	3	13
Field Sparrow	*Spizella pusilla*	2	0.05	5	32
Golden-cheeked Warbler	*Setophaga chrysoparia*	16	0.42	37	55
Great Crested Flycatcher	*Myiarchus crinitus*	0	0.00	0	3
Greater Roadrunner	*Geococcyx californianus*	0	0.00	0	5
House Finch	*Haemorhous mexicanus*	1	0.03	3	3
Hutton's Vireo	*Vireo huttoni*	2	0.05	5	11
Inca Dove	*Columbia inca*	0	0.00	0	3
Ladder-backed Woodpecker	*Picoides scalaris*	1	0.03	3	8
Lesser Goldfinch	*Carduelis psaltria*	7	0.18	18	74
Mourning Dove	*Zenaida macroura*	0	0.00	0	47
Northern Cardinal	*Cardinalis cardinalis*	27	0.71	55	97
Northern Mockingbird	*Mimus polyglottos*	1	0.03	3	18
Painted Bunting	*Passerina ciris*	16	0.42	34	66
Purple Martin	*Progne subis*	0	0.00	0	26
Red-eyed Vireo	*Vireo olivaceus*	1	0.03	3	13
Red-shouldered Hawk	*Buteo lineatus*	1	0.03	3	13
Rufous-crowned Sparrow	*Aimophila ruficeps*	3	0.08	8	8
Summer Tanager	*Piranga rubra*	2	0.05	5	18
Western Kingbird	*Tyrannus vociferans*	0	0.00	0	3
White-eyed Vireo	*Vireo griseus*	9	0.24	24	34
White-winged Dove	*Zenaida asiatica*	1	0.03	3	21
Woodhouse's Scrub-jay	*Aphelocoma californica*	3	0.08	8	18
Yellow-billed Cuckoo	*Coccyzus americanus*	5	0.13	13	47

Table 7. Baker Sanctuary water quality test results, 2015 - 2018.

Site	Year	Average Water Depth (cm)	Average Water Temperature (°C)	Average Dissolved Oxygen (% Saturation)	Average Specific Conductance (µS/cm)	Average pH	Average Nitrate Nitrogen (mg/L)
Baker Spring	2015-2016	43.7	18.1	64.9	628.7	7.0	0.47
Baker Spring	2016-2017	40.2	19.1	51.8	648.0	7.0	0.24
Baker Spring	2017-2018	33.1	12.3	47.2	628.0	7.0	0.03