Travis Audubon's Baker Sanctuary

2018 - 2019 Annual Report

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Travis County Transportation and Natural Resources Department Natural Resources Program

by

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Installation of shaded fuel break by Lake Travis Fire & Rescue and American Youth Works

(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 tracts belonging to Travis County 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 2019 the 65-acre Northeast plot was surveyed for golden-cheeked warblers (*Setophaga chrysoparia*) for the third and final consecutive season. In addition to the Northeast survey, an additional 130-acre golden-cheeked warbler (GCWA) survey (Northwest plot) was surveyed for the second consecutive season. 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. It is anticipated the Northwest plot survey will continue through 2020 before being discontinued after which efforts will focus on surveying the approximately 94-acre plot to its north. By continuing to rotate survey efforts the entire Sanctuary will 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 374 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 one edge territory were present in the Northeast plot for an adjusted total of 6.5 territories. Females were observed in five territories and a total of nine fledglings were observed in the 6.5 territories.

Territory density was calculated at 0.10 territories per acre. This calculation was based on the adjusted total of 6.5 territories in the 65 acres surveyed. The pairing success rate in the Northeast plot was 67% (females were observed in four of the six full territories). The breeding success was estimated at 67%, based on the fact that four of the six full territories were observed to have at least one fledgling. The estimated brood size was 2.25 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 270 GCWA observations including movement patterns, re-sighting of color banded males, counter-singing, and the presence of females and fledglings, it is estimated 11 full territories and two edge territories were present in the Northwest plot for an adjusted total of 12 territories. With the exception of one edge territory, females were observed in all the territories in addition to a total of 25 fledglings. Approximately two territories were established directly adjacent to the Northwest 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 12 territories in the 130 acres surveyed. The pairing success rate in the Northwest plot was 100% (females were observed in all of the full territories). The breeding success was estimated at 82%, based on the observation that nine of the 11 full territories produced fledglings. The estimated brood size was 2.8 fledglings based on the aforementioned criteria. Productivity was estimated at 2.3 based on the total of 25 fledglings observed in nine of the 11 full territories (**Appendix C**).

For the 2019 season, territory density between the two plots was nearly identical but the Northwest plot seemed to outperform the Northeast plot in pairing success, breeding success, average brood size, and productivity (**Appendix C**). This pattern also seems to hold when comparing the average results of the two plots, however a more meaningful comparison will be possible as additional Northwest plot data is collected over the 2020 season.

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 29 GCWA males, 23 ASY and six SY, have been captured and banded under TAS and Travis County permits during various survey efforts (**Table 1**). It is anticipated banding will continue during the 2020 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 10 in an effort to ascertain the most accurate survey interval for GCWA on the Sanctuary. The 10 minute count was utilized again for the 2019 effort which produced 54 GCWA male detections, 43 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 1, 2018 – January 20, 2019 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 two bucks during 333 hours of hunt effort, a decrease in take from the average harvest of 11 deer per season over the prior 17 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 2018 through the first week of October utilizing protocol outlined by Texas Parks and Wildlife

(Oetgen et al, 2008). Six camera trap sites **(Figure 2)** 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 4.8 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 2018 – 2019 whitetail deer season.

Vegetation Management

Approximately 135 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*).

Slash from cut vegetation was chipped prior to the onset of the GCWA breeding season yielding an estimated 24 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 2018 - 2019 a total of 465 woody and herbaceous plants were put in the ground at the Sanctuary, all donated by Paul and Georgean Kyle, City of Austin Watershed Protection Department, Carol Ray, and the City of Austin BCP (**Table 4**).

In 2015, TAS applied for a Federal Emergency Management Agency grant to install a shaded fuel break in the Wildland Urban Interface Baker Sanctuary shares with approximately 85 homes of the Cypress Canyon subdivision. In total, it was estimated the fuel break would span 6,666 linear feet and treat an area of approximately 15.4 acres (**Figure 5**). The application was approved and in the fall of 2018, TAS contracted Lake Travis Fire & Rescue (LTFR) to implement the grant and install the fuel break in accordance with the best management practices developed by USFWS and Travis County BCP. LTFR began work mid-January 2019 and completed approximately 98% of the northern section before work was halted for the GCWA breeding season. It is anticipated LTFR will complete the remainder of the shaded fuel break in the fall of 2019.

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 29 through May 26 of the 2019 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 four individuals (three males and one female) while TAS2 captured one male for a total of five individuals captured, results significantly lower than the average of 22 per season captured over the prior 17 recorded seasons (**Figure 5**). No non-target species were captured during the 2019 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 eight 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 (Grove 1) in a northern drainage of the Sanctuary is still being

actively monitored and treated. Over the last year, only 12 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 4,948 tree-of-heaven and 50 chinaberry (*Melia azedarach*) seedlings have been removed from the area. This area will continued to be monitored until three consecutive years have passed without detection of any emergent seedlings.

The less extensive population of tree-of-heaven discovered in May 2012 (Grove 2) approximately 1,000 feet downstream from the original tree-of-heaven site was again visited in 2019. For the third consecutive year no seedlings were observed so it is now considered eradicated and will no longer be monitored. Since the grove was discovered in 2012, a total of 3,228 seedlings were removed from the area (**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 323 chinaberry, five Chinese pistache (*Pistacia chinensis*), nine common horehound (*Marrubium vulgare*), seven medium-sized patches of Japanese honeysuckle (*Lonicera japonica*), six medium-sized patches of Johnsongrass (*Sorghum halepense*), 624 jujube (*Ziziphus zizyphus*), 56 large-leaf privet (*Ligustrum japonicum*), 389 heavenly bamboo (*Nandina domestica*), 1461 small-leaf privet (*Ligustrum sinense*), 51 tree-of-heaven, 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 of herbicide 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 81% with the first treatment and a mortality rate of 92% 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 7% of the figs continue to re-sprout requiring continued monitoring and treatment of the site.

Over the past fiscal year, 29 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 June 3 through June 12, the ninth 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 36 species recorded, the most abundant were northern cardinal (*Cardinalis cardinalis*) detected at 100% of the stations, black-crested titmouse (*Baeolophus bicolor*) at 84% of the stations, and painted bunting (*Passerina ciris*) at 61% of the stations. Golden-cheeked warblers were detected at 26% of the stations (**Table 6**) compared to 55% for the previous year. Point count data were analyzed with a linear regression test (log-transformed, 2-tail, 95% confidence level) for the nine years' worth of data. All populations appear stable with no statistically significant trends with the exception of lesser goldfinch, painted bunting (*Passerina ciris*), field sparrow (*Spizella pusilla*), and white-eyed

vireo (*Vireo griseus*) who demonstrated positive population trends and American crow (*Corvus brachyrhynchos*) and northern bobwhite (*Colinus virginianus*) which demonstrated negative population trends.

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 nine nest boxes, one was occupied during the 2019 breeding season by Carolina chickadees (*Poecile carolinensis*) and four 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 four chimney swift (*Chaetura pelagica*) towers on the Sanctuary were estimated to have successfully fledged a total of seven 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 2018 - 2019 and was expanded to include other hardwood species of concern in the 2016 – 2017 season. During the 2018 - 2019 season an additional three shin oak, 11 Spanish oak, five Texas ash, and 10 escarpment black cherry were caged throughout the Sanctuary. To date a total of 52 plateau live oak, 57 shin oak, 135 Spanish oak, 19 Texas ash, 23 escarpment black cherry, and one coma (*Bumelia lanuginosa*) have been caged, a total of 287 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. To date, caged Spanish oak have exhibited an annual average increase in height of 12.1 cm/season, plateau live oak 11.0 cm/season, shin oak 3.6 cm/season, escarpment black cherry 36.7

cm/season, Texas ash 9.0 cm/season, and coma 4.9 cm/season. With regard to basal diameter, caged Spanish oak have exhibited an annual average increase of 0.193 cm/season, plateau live oak 0.338 cm/season, shin oak 0.221 cm/season, escarpment black cherry 0.283 cm/season, Texas ash 0.334 cm/season, and coma 0.090 cm/season. To date, plateau live oak have demonstrated a 21% mortality rate for caged individuals, shin oak 29%, Spanish oak 10%, 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, 10 juniper seedlings were flagged and given a unique tag but they were not caged. Ten additional juniper were flagged and tagged in February 2016. With the goal to obtain growth rates (height and mid-stem diameter) to compare with those of hardwoods, trees were selected with the criteria that they were seedlings and growing in full sun. To date seedling juniper height has increased at an average of 36.9 cm/season and mid-stem diameter at a rate of 0.439 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 2018 - 2019 season, 10 water quality tests were performed, all at Baker Spring. Data were collected for water depth, water temperature, dissolved oxygen, specific conductance, pH, and nitrate nitrogen. All results fell within expected values (**Table 7**).

Education and Outreach

From October 2018 through September 2019 Baker Sanctuary experienced a total of 724 visitations from day hikers. Of those visitations, 673 were by TAS members and 51 were by non-members. An additional 695 visitations occurred during organized activities such as educational programs, TAS events, and guided hikes. A total of 716 volunteer hours were logged at the Sanctuary on a variety of activities (see below).

October: Grounds & facilities maintenance.
November: Grounds & facilities maintenance, outreach.
December: Grounds & facilities maintenance, habitat restoration.
January: Grounds & facilities maintenance, habitat restoration.
February: Grounds maintenance, habitat restoration, biological monitoring.
March: Grounds & trails maintenance, habitat restoration, biological monitoring.
April: Habitat restoration, biological monitoring.
May: Grounds maintenance, biological monitoring.
June: Biological monitoring.
July: Grounds & trails maintenance.
August: Grounds maintenance, data analysis.
September: Grounds maintenance, habitat restoration, outreach.

Other activities to enhance community involvement and increase awareness of Baker Sanctuary and the BCP mission included the Great Backyard Bird Count, participation in Austin Energy's Cool House Tour, 18 guided hikes for various community groups, one field trip for 120 Leander ISD (LISD) fourth grade students, two GCWA presentations to a total of 86 members of the Live Oak Unitarian Universalist Church and Williamson County Master Naturalists, four central Texas centered ecology presentations to a total of 373 LISD fourth grade students, participation in a presentation for the University of Texas' OLLI NOVA

lecture series serving 30 adults, and facilitation and supervision of three Eagle Scout projects (Troops 202 and 513).

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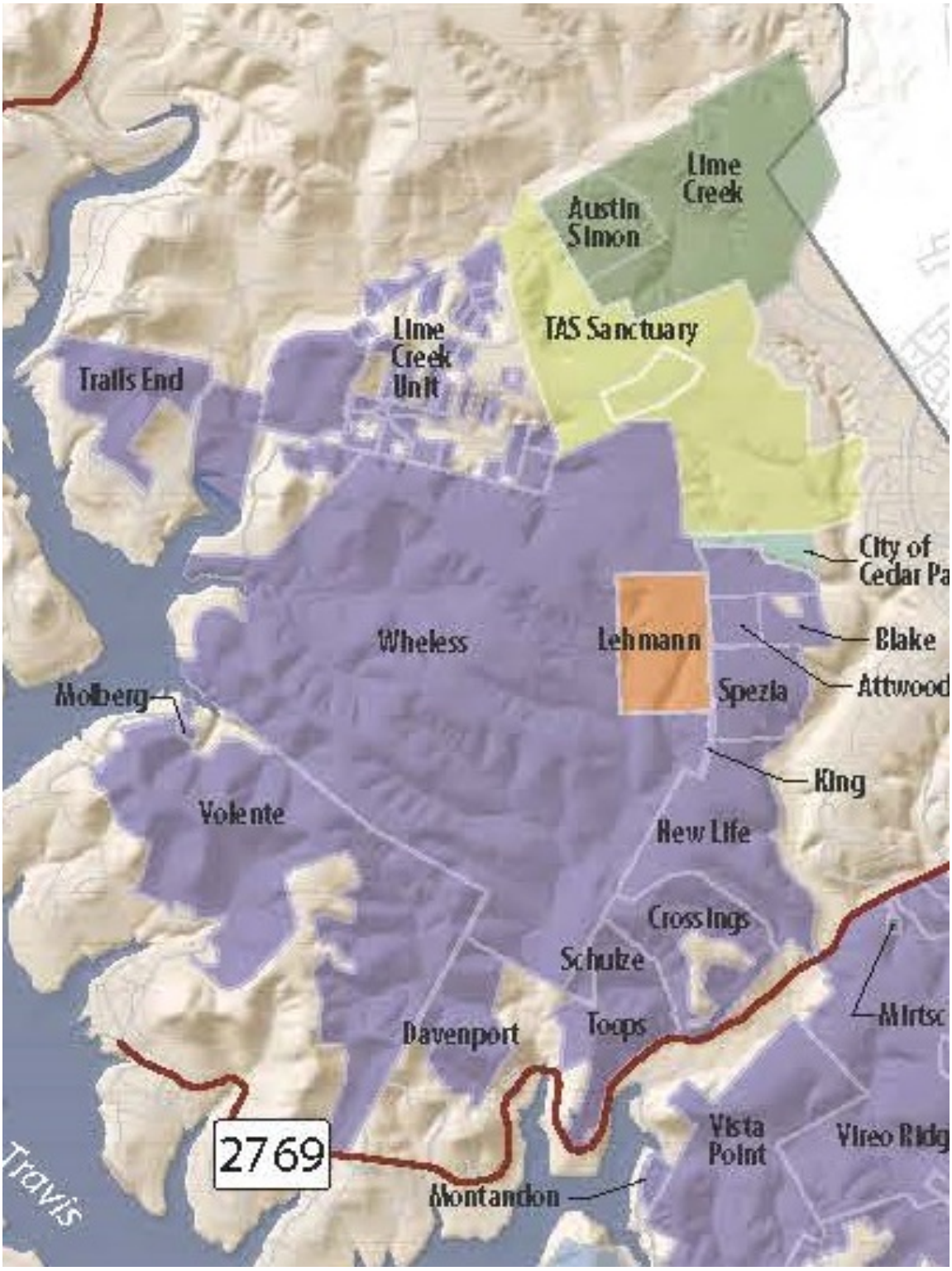
Appendix A

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 2019 TRAVIS COUNTY, TEXAS



TRAVIS AUDUBON

Listen. Look. And Learn.

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Poetry

Ode to Toni, Who Only Found Four-ish GCWAs During Her Survey This Morning. 20

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 properties owned and managed by various BCP 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 not 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. In the future 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 2019 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 Northeast 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 14 and concluded on June 11 for the Northeast survey and March 16 and June 10 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. Four surveyors, Jasmine Mills, Christopher Murray, Felicia Sawyers, and Celeste Treadway surveyed the Northeast study plot on a weekly basis and invested a total of 115.5 hours, or 44.4 hours per 25 acres. Three surveyors, Christopher Murray, Elizabeth Samuelson, and Toni Taylor, surveyed the Northwest plot on a weekly basis and invested a total of 96.5 hours, or 18.5 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 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 previously unbanded 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 24 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, 374 GCWA observations were recorded over the course of the survey effort. Six full territories and one edge territory were delineated in the study plot for an adjusted total of 6.5 territories (**Figure 2**). Females were observed in five territories and a total of nine fledglings were observed in the 6.5 territories (**Table 2**).

Territory density was calculated at 0.10 territories per acre. This calculation was based on the adjusted total of 6.5 territories in the 65 acres surveyed.

The pairing success rate in the Northeast plot was 67% (females were observed in four of the six full territories). The breeding success was estimated at 67%, based on the fact that four of the six full territories were observed to have fledglings. The estimated brood size was 2.25 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, 270 GCWA observations were recorded over the course of the survey effort. Eleven full territories and two edge territories were delineated in the study plot for an adjusted total of 12 territories (**Figure 3**). With the exception of edge territory UB4, females were observed in all the territories as well as a total of 25

fledglings (**Table 2**). Approximately 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 0.09 territories per acre. This calculation was based on the adjusted total of 12 territories in the 130 acres surveyed.

The pairing success rate in the Northwest plot was 100% (females were observed in all of the full territories). The breeding success was estimated at 82%, based on the fact that nine of the 11 full territories produced fledglings. The estimated brood size was 2.8 fledglings based on the aforementioned criteria. Productivity was estimated at 2.3 based on the total of 25 fledglings observed in nine of the 11 full territories.

5.0 DISCUSSION

For the 2019 season, territory density between the two plots was nearly identical but the Northwest plot seemed to outperform the Northeast plot in pairing success, breeding success, average brood size, and productivity (**Table 3**). This pattern also seems to hold when comparing the average results of the two plots, however a more meaningful comparison will be possible as more Northwest plot data is collected over the 2020 season. 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=3) 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 two data points for the Northwest survey exhibit 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 32 hours/25 acres and the Northwest surveys 18 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 may be 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 typically 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.

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7.0 ACKNOWLDGEMENTS

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Table 1. Golden-cheeked warblers banded on the Northeast and Northwest Baker Sanctuary plots, 2017 - 2019.

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
2019	YE/DG:RD/SI	Northeast	2770-41223	Male	ASY
2019	GR/SI:PI/PI	Northwest	2770-41224	Male	ASY
2019	WH/RD:BL/SI	Northwest	2770-41225	Male	SY
2019	BK/SI:DB/DB	Northeast	2770-41226	Male	ASY
2019	GR/PI:PI/SI	Northeast	2770-41228	Male	ASY
2019	WH/SI:YE/YE	Northeast	2770-41229	Male	SY

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, 2019.

Territory Designation	Plot	Full/Edge Territory	Number of Confirmed Detections	Female Detected	# Fledglings Detected
RD/RD:DG/SI	Northeast	Full	42	Yes	2
WH/WH:OR/SI	Northeast	Full	50	Yes	3
YE/DG:RD/SI	Northeast	Full	49	Yes	2
GR/PI:PI/SI	Northeast	Full	64	No	0
BK/SI:DB/DB	Northeast	Full	53	Yes	2
UB1	Northeast	Full	11	No	0
WH/SI:YE/YE	Northeast	Edge	16	Yes	0
MV/MV:MV/SI	Northwest	Full	19	Yes	3
PI/SI:YE/RD	Northwest	Full	17	Yes	2
WH/RD:BL/SI	Northwest	Full	16	Yes	0
GR/SI:PI/PI	Northwest	Full	13	Yes	3
YE/SI:WH/RD	Northwest	Full	15	Yes	1
OR/SI:BK/MV	Northwest	Full	16	Yes	0
BK/SI:GR/WH	Northwest	Full	26	Yes	4
BK/PI:OR/SI	Northwest	Full	16	Yes	2
BK/PI:OR/SI	Northwest	Full	16	Yes	2
UB1	Northwest	Full	17	Yes	4
UB2	Northwest	Full	30	Yes	2
UB3	Northwest	Full	15	Yes	2
BK/DB:MV/SI	Northwest	Edge	15	Yes	2
UB4	Northwest	Edge	7	No	0

Table 3. Summary of golden-cheeked warbler reproductive success on the Northeast, Northwest, and 100-acre Baker Sanctuary plots, 2011-2019.

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**
Northeast 2019	**0.10**	**67**	**67**	**2.25**	**1.50**	**44.4**
Northwest 2018	**0.10**	**92**	**83**	**1.90**	**1.58**	**17.7**
Northwest 2019	**0.09**	**100**	**82**	**2.80**	**2.30**	**18.5**
***Northeast Average**	**0.10**	**84**	**75**	**1.83**	**1.30**	**32.3**
****Northwest Average**	**0.10**	**96**	**83**	**2.35**	**1.94**	**18.1**
*****100-acre Average**	**0.11**	**93**	**68**	**2.80**	**1.85**	**52.1**

*Average for three seasons, 2017-2019

**Average for two seasons, 2018-2019

***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.

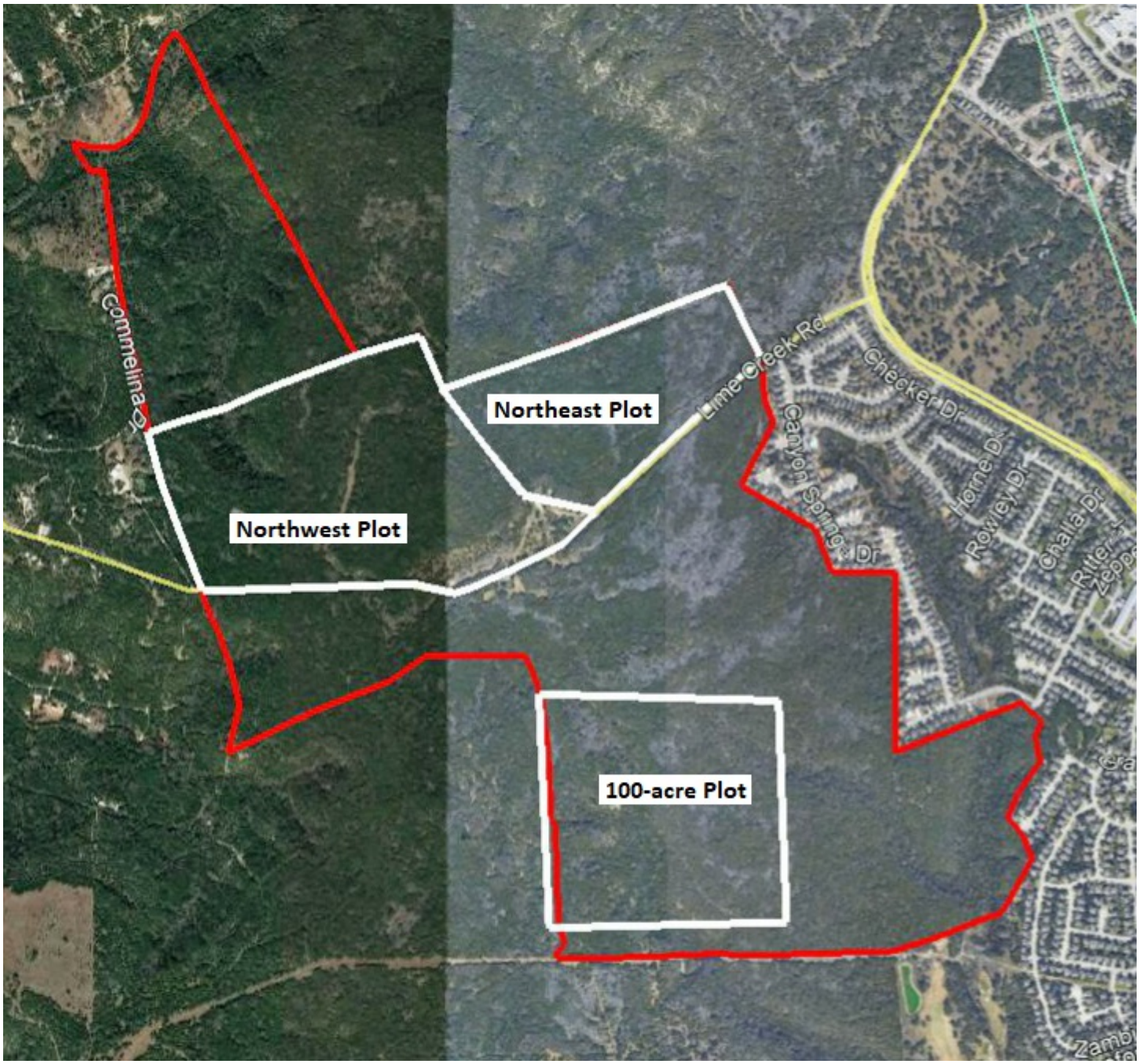


Figure 2. Golden-cheeked warbler territory distribution on the Northeast Baker Sanctuary plot, 2019.

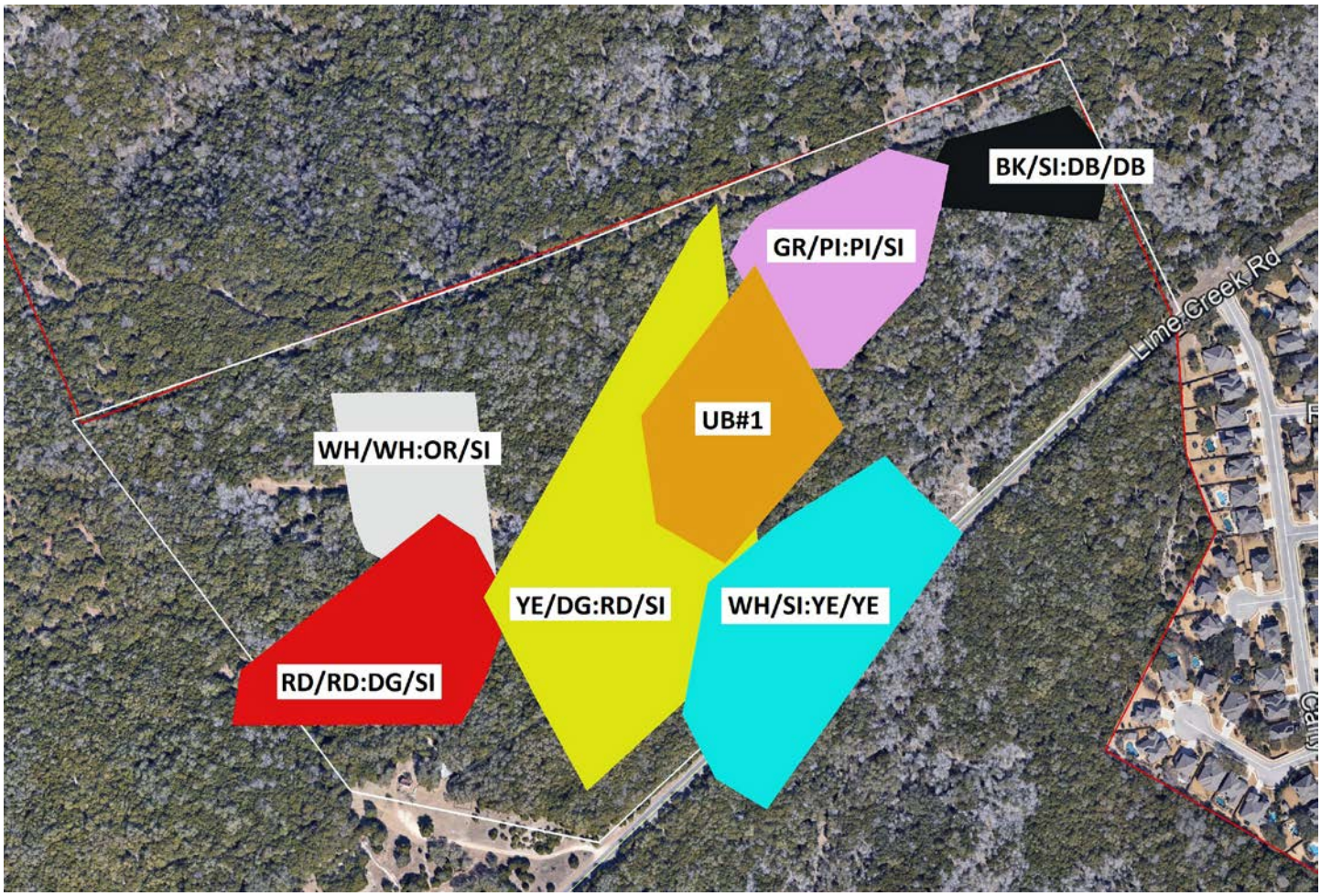
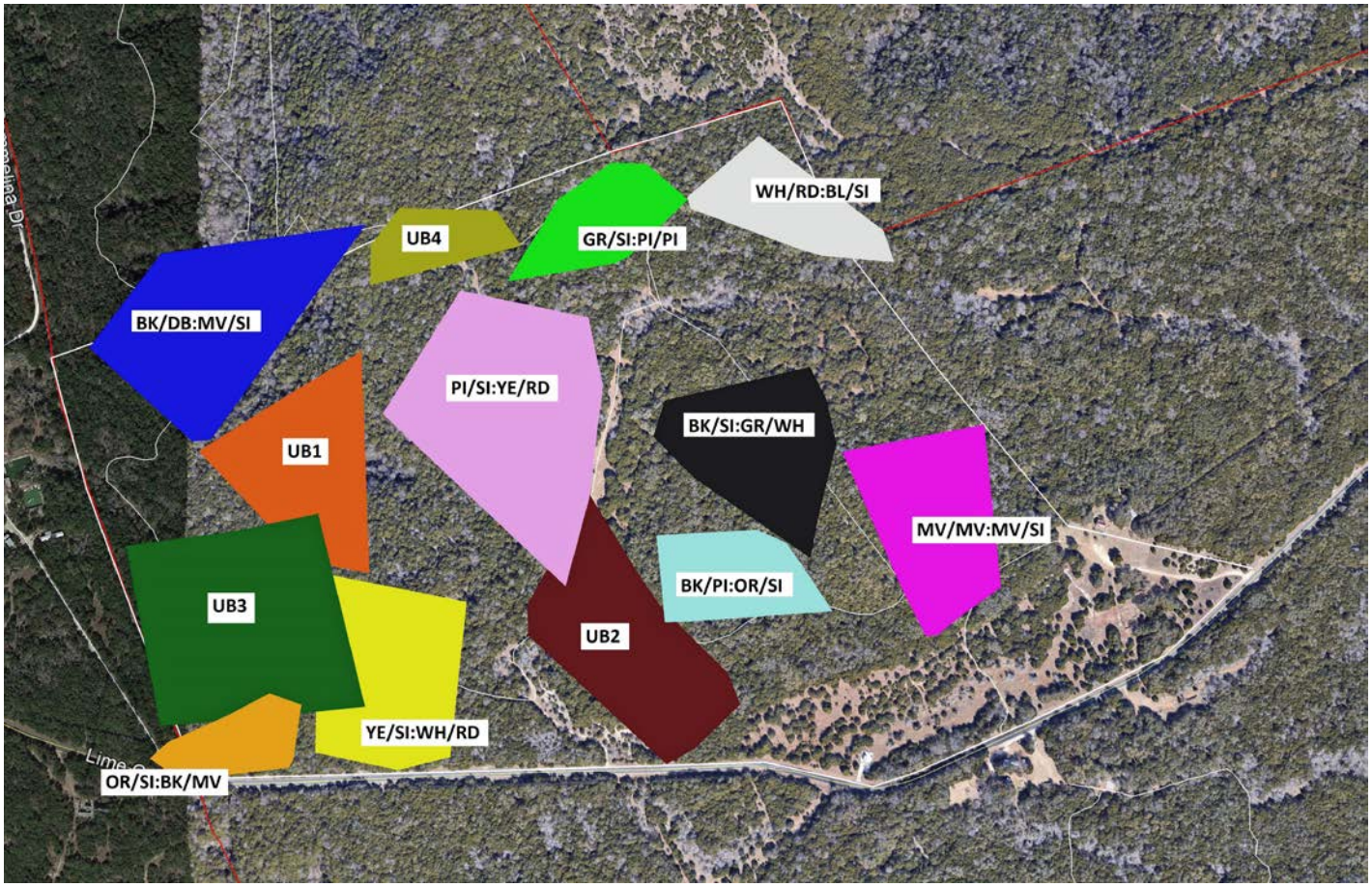


Figure 3. Golden-cheeked warbler territory distribution on the Northwest Baker Sanctuary plot, 2019



Ode to Toni, Who Only Found Four-ish GCWAs During Her Survey This Morning

By Toni Taylor

Swiftly slipping through the juniper,
waving spider stick like magic wand
to conjure up the symphonies of birds.
But silence greets her only on this dawn.

Then, hark! Is that a B-song on the wind?
She races to the spot, only to find
The cuss sang once, and never then again.
A flood of curses torrents through her mind.

Resignedly, she sighs and finds the trail
doggedly to seek the next faint song.
Though Sno Cones did she pledge, should she prevail,
The time for tasty treats is not yet come.

With this bitter reminder, she defers:
that she's here for the birds; not they for her.

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

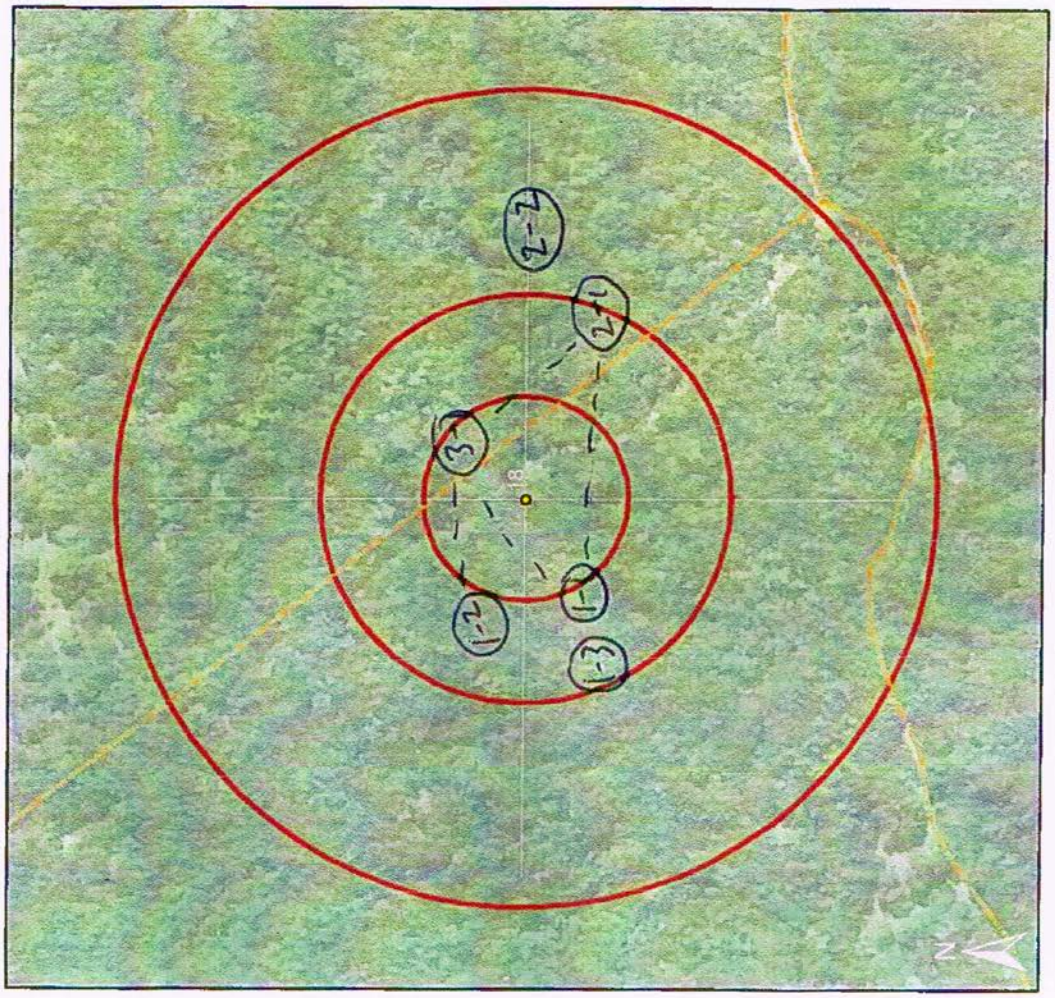


Figure 1. Baker Sanctuary VCP point counts stations, 2019.



Figure 2. Baker Sanctuary whitetail deer hunt and camera sites, 2018 - 2019.

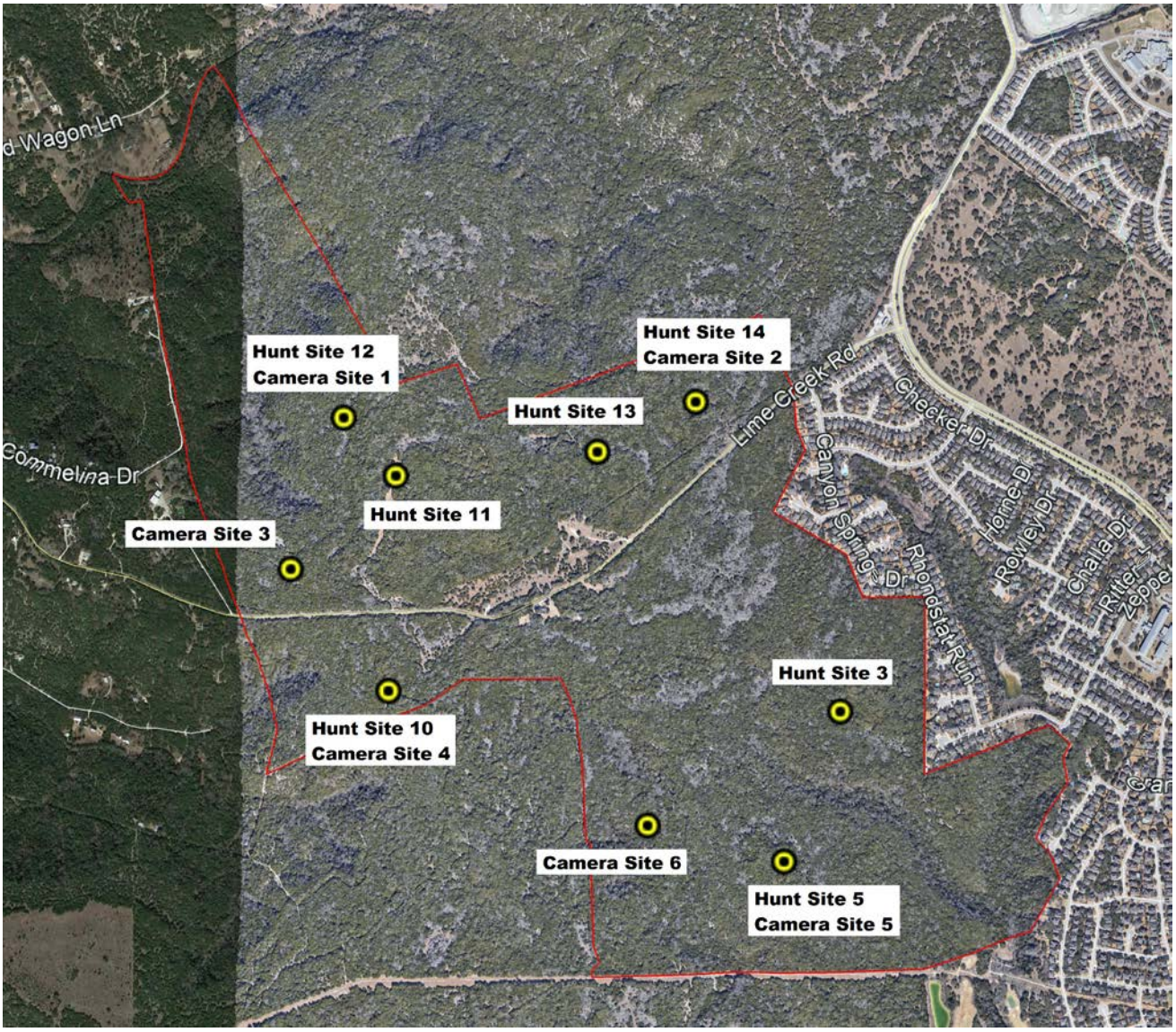


Figure 3. Summary of Baker Sanctuary whitetail deer harvest, 2000-2019. Juvenile deer are a year or less in age.

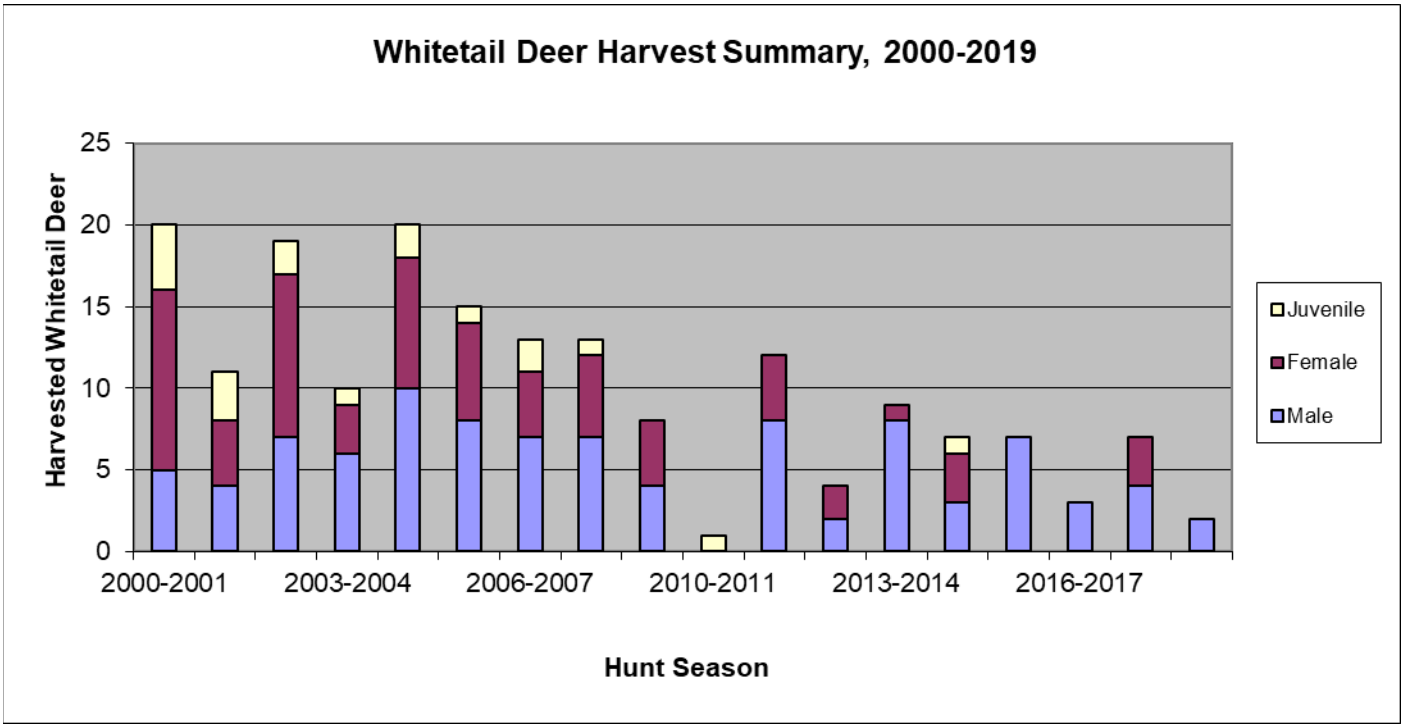


Figure 4. Baker Sanctuary shaded fuel break.

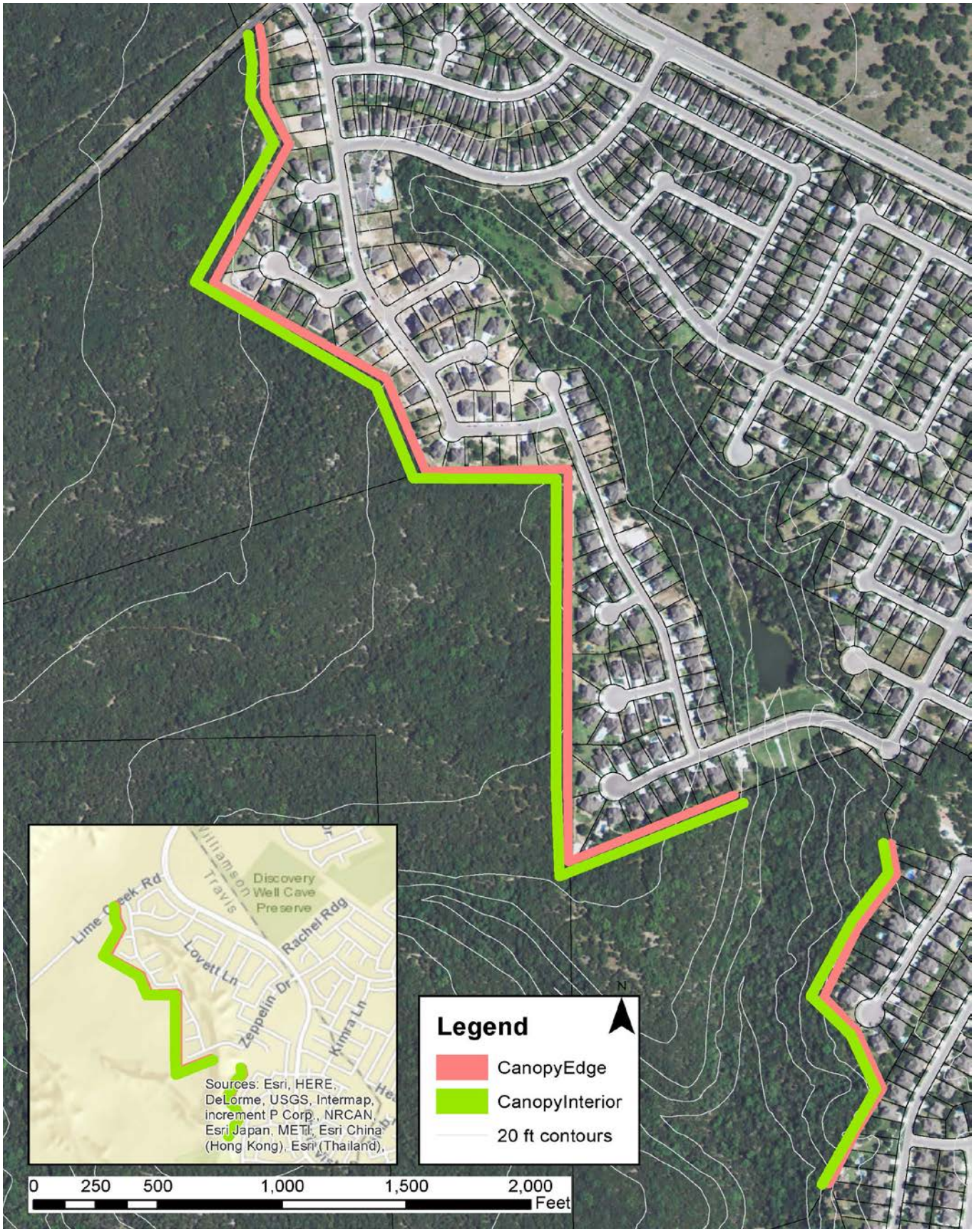


Figure 5. Summary of Baker Sanctuary brown-headed cowbird trapping effort, 2001-2019.

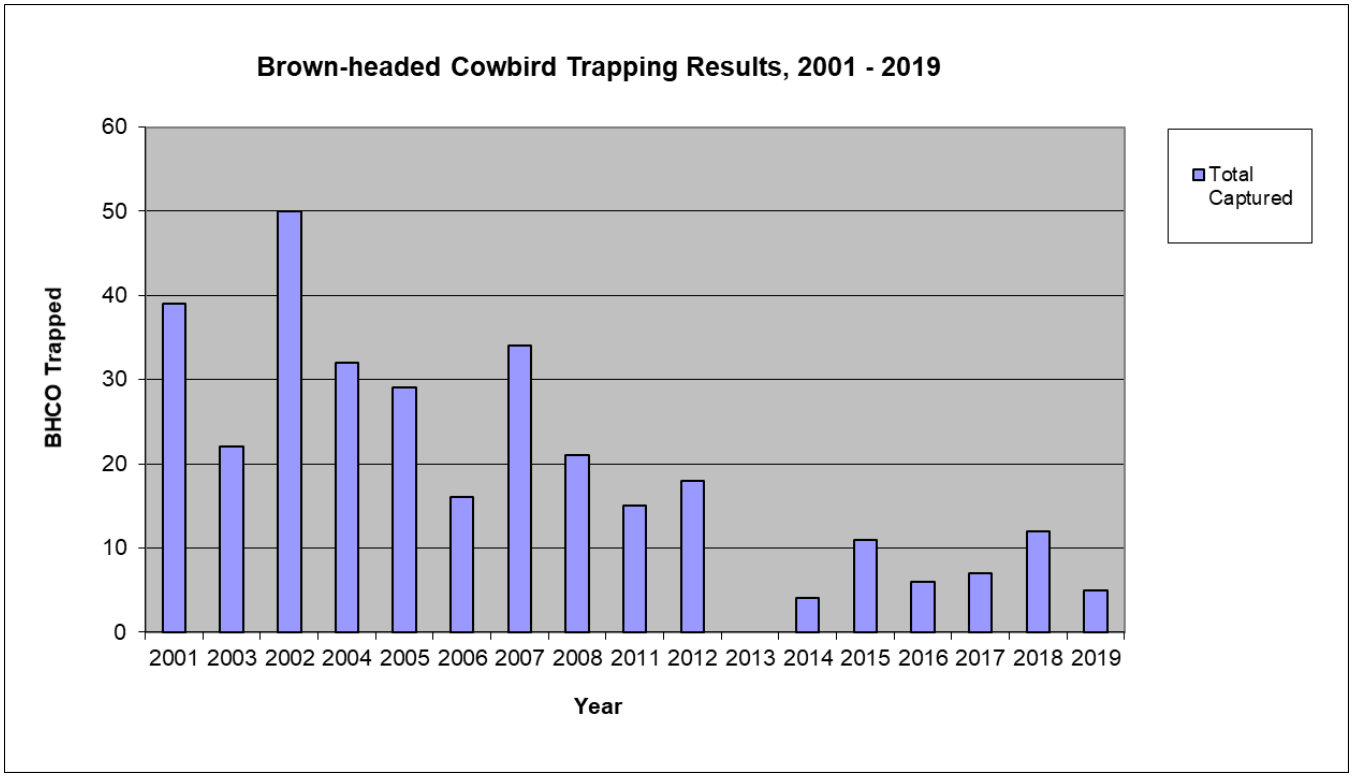


Figure 6. Summary of Baker Sanctuary tree-of-heaven eradication efforts, 2010-2019.

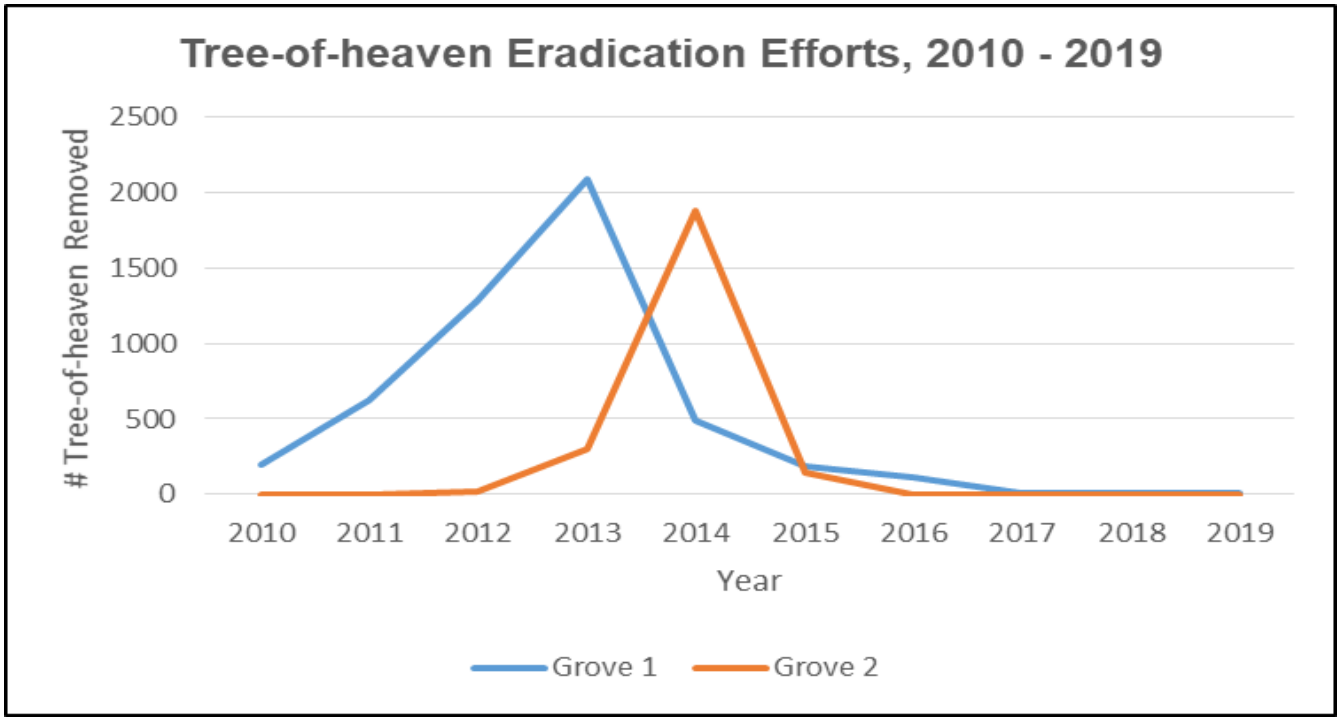


Figure 7. Baker Sanctuary BBS point count stations, 2019.



Table 1. Summary of GCWA banded at Baker Sanctuary, 2015 - 2019.

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
2019	2770-41223	YE/DG:RD/SI	Northeast	Male	ASY
2019	2770-41224	GR/SI:PI/PI	Northwest	Male	ASY
2019	2770-41225	WH/RD:BL/SI	Northwest	Male	SY
2019	2770-41226	BK/SI:DB/DB	Northeast	Male	ASY
2019	*2770-41228	GR/PI:PI/SI	Northeast	Male	ASY
2019	2770-41229	WH/SI:YE/YE	Northeast	Male	SY

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)
*Band 2770-41227 was misplaced deep in the forest, never to be found again.

Table 2. GCWA detected per VCP point count time interval, 2017 - 2019.

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
2019	24	8	7	2	2	43	2	2	4	2	1	54

Table 3. Baker Sanctuary whitetail deer population survey results, 2016 - 2018.

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
2018	0.12	9.00	3.24	1.68	13.92	4.80	0.36	51.9

Table 4. Baker Sanctuary plantings, 2018 – 2019.

Common Name	Scientific Name	Class	# Planted
Agarita	*Berberis trifoliata*	Tree/shrub	1
Baby blue-eyes	*Nemophilai phaceliodes*	Herbaceous/grass	4
Black dalea	*Dalea frutescens*	Herbaceous/grass	2
Blackfoot daisy	*Melampodium leucanthum*	Herbaceous/grass	15
Carolina buckthorn	*Frangula caroliniana*	Tree/shrub	4
Cedar sage	*Salvia roemeriana*	Herbaceous/grass	44
Daminita	*Chrysactinia mexicana*	Herbaceous/grass	5
Elbowbush	*Forestiera pubescens*	Tree/shrub	2
Englemann sage	*Salvia englemannii*	Herbaceous/grass	9
Escarpment black cherry	*Prunus serotina*	Tree/shrub	2
Evergreen sumac	*Rhus virens*	Tree/shrub	1
Foxglove	*Penstemon cobaea*	Herbaceous/grass	9
Frog fruit	*Phyla nodiflora*	Herbaceous/grass	40
Gayfeather	*Liatris mucronata*	Herbaceous/grass	20
Goldeneye	*Viguiera dentata*	Herbaceous/grass	Sowed
Golden groundsel	*Packera obovate*	Herbaceous/grass	12
Heart-leaf skullcap	*Scuteilia ovata*	Herbaceous/grass	5
Little bluestem	*Schizachyrium scoparium*	Herbaceous/grass	13

Mealy sage	*Savia farinacia*	Herbaceous/grass	12
Mexican buckeye	*Ungnadia speciose*	Tree/shrub	8
Mexican plum	*Prunus Mexicana*	Tree/shrub	1
Plains lovegrass	*Eragrostis intermedia*	Herbaceous/grass	6
Plateau live oak	*Quercus fusiformis*	Tree/shrub	1
Plateau spiderwort	*Tradescantia edwardsiana*	Herbaceous/grass	3
Poppy mallow	*Callirhoe pedata*	Herbaceous/grass	15
Prairie goldenrod	*Solidago nemoralis*	Herbaceous/grass	22 & Sowed
Prairie verbena	*Glandularia bipinnatifida*	Herbaceous/grass	4
Purple coneflower	*Echinacea angustifolia*	Herbaceous/grass	3
Purple threeawn	*Aristida purpurea*	Herbaceous/grass	2
Rain lily	*Zephyranthes* sp.	Herbaceous/grass	3
Scrambled eggs	*Corydalis curvisiliqua*	Herbaceous/grass	1
Shrubby boneset	*Eupatorium havanense*	Tree/shrub	15
Snake herb	*Dyschoriste linearis*	Herbaceous/grass	16
Snapdragon vine	*Maurandella antirrhiniflora*	Herbaceous/grass	1
Southwestern bristlegrass	*Setaria scheelei*	Herbaceous/shrub	2 & sowed
Spanish oak	*Quercus buckleyi*	Tree/shrub	1 & sowed
Square-bud primrose	*Calylophus drummondianus*	Herbaceous/grass	1
Standing Cypress	*Ipomposis rubra*	Herbaceous/grass	Sowed
Stork's bill	*Erodium texanum*	Herbaceous/grass	4
Straggler daisy	*Calyptocarpus vialis*	Herbaceous/grass	17
Swordleaf blue-eyed grass	*Sisyrinchium chilense*	Herbaceous/grass	16
Texas aster	*Symphyotrichum drummondii*	Herbaceous/grass	38
Texas bluebonnet	*Lupinus texensis*	Herbaceous/grass	24
Texas kidneywood	*Eysenhardtia texana*	Tree/shrub	5
Texas lantana	*Lantana horrido*	Herbaceous/grass	2
Texas persimmon	*Diospyros texana*	Tree/shrub	2
Turk's cap	*Malvaviscus arboreus*	Herbaceous/grass	14
Twist-leaf yucca	*Yucca rupicola*	Herbaceous/grass	3
Virgina creeper	*Parthenocissus quinquefolia*	Herbaceous/grass	7
Western Ironweed	*Vernonia baldwinii*	Herbaceous/grass	Sowed
Western red columbine	*Aquilegia canadensis*	Herbaceous/grass	10
White rock lettuce	*Pinaropappus roseus*	Herbaceous/grass	2
Winecup	*Callirhoe involucrate*	Herbaceous/grass	2
Yaupon	*Ilex vomitoria*	Tree/shrub	6
Yellow passionflower	*Passiflora lutea*	Herbaceous/grass	1
Zexmenia	*Zexmenia hispida*	Herbaceous/grass	7

Table 5. Efficacy of imazapyr treatments on non-native plants at Baker Sanctuary, 2016 – 2019.

Species	Imazapyr Solution	# Treated	% Mortality, 1 Treatment	% Mortality, 2 Treatments
Chinaberry	30%	52	75%	92%
Ligustrum sp	30%	15	100%	N/A
Heavenly Bamboo	30%	62	82%	91%
Paper Mulberry (*Broussonetia papyrifera*)	30%	1	0%	100%
Total		**130**		

Table 6. Baker Sanctuary BBS point count survey, 2019.

Common Name	Scientific Name	Number Observed	Mean	Frequency (%) (25 yd radius)	Frequency (%) (unlimited radius)
Ash-throated Flycatcher	*Myiarchus cinerascens*	3	0.08	8	11
Barn Swallow	*Hirundo rustica*	0	0.00	0	11
Bewick's Wren	*Thryomanes bewickii*	9	0.24	21	39
Black-and-white Warbler	*Mniotilta varia*	1	0.03	3	3
Black-chinned Hummingbird	*Archilochus alexandri*	7	0.18	18	18
Black-crested Titmouse	*Baeolophus atricristatus*	12	0.32	29	84
Blue Jay	*Cyanocitta cristata*	0	0.00	0	3
Blue-gray Gnatcatcher	*Polioptila caerulea*	25	0.66	50	50
Brown-headed Cowbird	*Molothrus ater*	1	0.03	3	3
Carolina Chickadee	*Poecile carolinensis*	18	0.47	37	45
Carolina Wren	*Thryoothorus ludovicianus*	7	0.18	16	29
Chimney Swift	*Chaetura pelagica*	0	0.00	0	5
Common Grackle	*Quiscalus quiscula*	1	0.03	3	32
Cooper's Hawk	*Accipiter cooperii*	0	0.00	0	3
Eastern Phoebe	*Sayornis phoebe*	5	0.13	8	11
Field Sparrow	*Spizella pusilla*	2	0.05	5	13
Golden-cheeked Warbler	*Setophaga chrysoparia*	6	0.16	13	26
House Finch	*Haemorhous mexicanus*	5	0.13	13	13
Ladder-backed Woodpecker	*Picoides scalaris*	6	0.16	11	18
Lesser Goldfinch	*Carduelis psaltria*	3	0.08	5	50
Mourning Dove	*Zenaida macroura*	0	0.00	0	37
Northern Cardinal	*Cardinalis cardinalis*	34	0.89	82	100
Northern Mockingbird	*Mimus polyglottos*	2	0.05	5	18
Painted Bunting	*Passerina ciris*	18	0.47	42	61
Purple Martin	*Progne subis*	0	0.00	0	8
Red-bellied Woodpecker	*Melanerpes carolinus*	1	0.03	3	3
Red-shouldered Hawk	*Buteo lineatus*	0	0.00	0	8
Red-eyed Vireo	*Vireo olivaceus*	1	0.03	3	16
Rufous-crowned Sparrow	*Aimophila ruficeps*	2	0.05	5	5
Summer Tanager	*Piranga rubra*	4	0.11	8	16
Turkey Vulture	*Cathartes aura*	0	0.00	0	8
Woodhouse's Scrub-jay	*Aphelocoma californica*	1	0.03	3	13
White-eyed Vireo	*Vireo griseus*	13	0.34	32	39
White-winged Dove	*Zenaida asiatica*	0	0.00	0	21
Wild Turkey	*Meleagris gallopavo*	0	0.00	0	13
Yellow-billed Cuckoo	*Coccyzus americanus*	5	0.13	13	32

Table 7. Baker Sanctuary water quality test results, 2015 - 2019.

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
Baker Spring	2018-2019	40.2	19.1	64.0	641.0	7.0	0.45