Baker Sanctuary

2015 - 2016 Annual Report

(October 1, 2015 - September 30, 2016)

prepared for the

Travis County Transportation and Natural Resources Department

Natural Resources Program

by

Christopher Murray, Baker Sanctuary Steward



Photo: GCWA fledgling being fed by female (Christopher Murray)

Table of Contents

Introduction 1
Golden-cheeked Warbler Survey 1-2
Whitetail Deer Management 3
Vegetation Management 3-5
Brown-headed Cowbird Trapping 5
Exotics Control 5-7
Research 7-9
Education and Outreach 9-11
Literature Cited 11
Appendix A: Baker Sanctuary 40-acre headquarters tract 12
Appendix B: Baker Sanctuary and adjacent BCP partner properties 13
Appendix C: Baker Sanctuary 100-acre GCWA survey, 2016 14-27
Appendix D: Baker Sanctuary GCWA VCP point count example, 2016 28
Figure 1: Baker Sanctuary VCP point count stations, 2016 29
Figure 2: Baker Sanctuary whitetail deer hunt sites, 2016 30
Figure 3: Summary of Baker Sanctuary whitetail deer harvest, 2000-2016 31
Figure 4: Summary of Baker Sanctuary brown-headed cowbird trapping results, 1986-2016 31
Figure 5: Summary of Baker Sanctuary tree-of-heaven eradication efforts, 2010-2016 32
Figure 6: Baker Sanctuary BBS point count stations, 2016 33
Figure 7: Baker Sanctuary nest box locations and occupancy, 2016 34
Figure 8: Baker Sanctuary caged oak locations, 2013-2016 35
Table 1: Summary of GCWA banded at Baker Sanctuary, 2015-2016 36
Table 2: Baker Sanctuary imazapyr efficacy results, 2016 36
Table 3: Baker Sanctuary BBS point count survey, 2016 37
Table 4: Baker Sanctuary water quality test results, 2015-2016 38

Introduction

Baker 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;' is excluded from the easement (**Appendix A**). The management agreement for the easement permits TAS to continue to manage Baker Sanctuary with oversight from Travis County.

Bisected by Lime Creek Road, the Sanctuary is within the Cypress Creek Macrosite and adjacent to several other BCP tracts including the City of Austin's Lime Creek and Austin Simon tracts to the northeast, the Lower Colorado River Authority's Wheless tract to the southwest, 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 western boundary (**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 2016 the annual 100-acre survey saw its sixth year of participation with Travis County and the City of Austin in a multi-year study to determine golden-cheeked warbler (*Setophaga chrysoparia*) population viability and habitat suitability throughout the BCP (**Appendix C)**. Based on the compilation and analysis of 398 golden-cheeked warbler observations including movement patterns, re-sighting of color banded individuals, counter-singing, and the presence of females and fledglings, it is estimated nine full territories and three edge territories were delineated in the Baker Sanctuary 100-acre plot for an adjusted total of 10.5 territories. Females were observed in all territories and a

total of 17 fledglings were observed in eight territories. One monitored territory, BK/SI:OR/BK, was established directly adjacent to the 100-acre plot and was not included in the analysis.

In 2014 TAS obtained state and federal permits to band (plastic color-bands and USFWS aluminum bands) golden-cheeked warblers throughout the Sanctuary. Two golden-cheeked warbler males were captured and banded under TAS permits and one under City of Austin permits (WH/SI:BK/WH) during the 2016 100-acre survey (**Table 1**). It is anticipated banding will continue during the 2017 survey effort.

In an effort to explore alternatives in assessing the GCWA population density and distribution at Baker, a pilot variable circular plot point count study was performed in the spring of 2016. Point count stations were located 250 meters apart for a total of 50 stations at the Sanctuary (**Figure 1**). Counts began 10 minutes after sunrise and concluded at 11 AM. GCWA were counted for five minutes at each station and their locations, activities, and movements recorded per minute at each station where they occurred (**Appendix D**). To reduce observer bias, the Sanctuary steward conducted all surveys. As a result it was calculated that 44 individual males were detected during the survey period, from April 25 to May 25. If every male were to have a mate, this would suggest Baker is home to at least 88 GCWA. In the past the 100-acre data were extrapolated throughout the Sanctuary, with anecdotal corrections made for habitat quality, and a population estimate of 65-70 GCWA was generated. Additional point counts combined with several years of Sanctuary-wide color-banding and territory mapping will help generate a more accurate and repeatable population estimate which can then be used to efficiently track the GCWA population at the Sanctuary.

Whitetail Deer Management

Baker Sanctuary was closed from November 1, 2015 – January 17, 2016 for the annual whitetail deer (*Odocoileus virginianus*) management hunt (rifle hunting only). Seven primary hunters hunting at sites 3, 5, 10, 11, 12, 13, and 14 (**Figure 2**) harvested a total of seven bucks during 370 hours of hunt effort, a decrease from the average harvest of twelve deer per season over the prior 14 recorded seasons (**Figure 3**). The Sanctuary will be closed for the 2016 - 2017 season from November 5, 2016 – January 15, 2017 for rifle hunting.

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 2015 – 2016 whitetail deer season.

Vegetation Management

Approximately 185 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 concern, trimming was restricted to the golden-cheeked warbler 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 and roads open and to ensure the safety of visitors.

Slash from cut vegetation was chipped prior to the onset of the golden-cheeked warbler breeding season yielding approximately ten cubic yards of material. Approximately 40% of the mulch was donated to Chaetura Canyon for its trail system with the remainder utilized on Baker's trail system as well as to mulch individual tree seedlings which were planted near Baker Cabin and the steward's residence.

During the fall of 2015, due to a generous donation by the City of Austin, eight individuals of four plant species were planted in the JAEC and Steward's residence areas. The following lists the species and total number of individuals planted: (4) Carolina buckthorn (*Rhamnus caroliniana*), (2) Eve's necklace (*Sophora affinis*), (1) Mexican plum (*Prunus rivularis*), and (1) Mexican buckeye (*Ungnadia speciosa*). In addition to seedlings donated by the City of Austin, Al and Nancy Morgan donated two Mexican buckeye which were planted in the JAEC native plant garden.

In October 2015, fifty-four little bluestem (*Schizochyrium scoparium*) were planted near the Baker Spring trailhead in an area dominated by the invasive grass King Ranch bluestem (*Bothriochloa ischaemum*). A combination of mulching and manual removal was employed to remove existing King Ranch bluestem in the treatment area. As of August 2016 survivorship for the little bluestem was 89%.

To create a less hazardous environment for outdoor educational activities, approximately four cubic yards of prickly pear (*Opuntia spp.*), an invasive native, was manually removed from the JAEC semi-open savannah and disposed off-site.

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 Baker 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 calldown 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 25 through June 1 of the 2016 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 five individuals (3 males and 2 females) while TAS2 captured one male for a total of six individuals captured, results significantly lower than the average of 22 per season captured over the prior 13 recorded seasons (**Figure 4**). No non-target species were captured during the 2016 trapping effort.

Exotics Control

Two extensive, distinct populations of Malta star-thistle (*Centaurea melitensis*) are 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 occur in heavily disturbed, semi-open savannah habitat, the northern population is more established and extensive, typically forming a dense monoculture where it occurs. Due to vigorous growth triggered by the wet, mild fall, Malta star-thistle management began on November 2015 and continued through May 2016.

For the second year both populations (north and south of LCR) were effectively managed solely with the utilization of hand-removal techniques. In the past, the

north population was selectively treated with glyphosate due to the extensive nature of the invasion. While plants continued to germinate in 2015-2016, they did so in a more 'patchy' fashion, which allowed effective control via hand-removal only. All removed plants were disposed off-site.

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 112 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 4925 tree-of-heaven and 45 chinaberry 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. Over the last year only three seedlings were discovered and hand pulled. 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 5**).

Various invasive plants were either manually removed or treated with a 10-30% imazapyr solution when encountered throughout the Sanctuary. Species treated included 241 chinaberry, six common figs (*Ficus* carica), 57 heavenly bamboo (*Nandina domestica*), four small patches of Johnsongrass (*Sorghum halepense*), 411 jujube (*Ziziphus zizyphus*), one paper mulberry (*Broussonetia papyrifera*), 14 privet (*Ligustrum* species), 32 tree-of-heaven (*Ailanthus altissima*), and two yarrow (*Achillea millefolium*). In the Baker Cabin/JAEC area 546 common mullein (*Verbascum thapsus*) and 136 common horehound (*Marrubium vulgare*) were also manually removed.

To analyze the efficacy of the herbicide imazapyr (Arsenal formulation) in invasive plant control, individuals were treated with either 10% or 30% Arsenal solution and re-visited the following year to document mortality. Treatments consisted of either stump-cutting the individual and applying several milliliters to the stump or girdling the individual and applying the solution to the cut. In both cases a small dropper-style container was used to carefully apply the Arsenal solution directly to the wounds to negate the possibility of herbicide drift. Overall, plants treated with the 30% Arsenal solution experienced a mortality rate of 78.3% while the 10% Arsenal solution yielded a 60.4% mortality rate (**Table 2**).

The 18 common figs cut down July 2013 near Walnut Spring were monitored over the course of the year and re-sprouts were removed when encountered. Approximately 70% of the figs continue to re-sprout requiring continued monitoring of the site.

Over the past fiscal year, eight boiling water treatments were applied to visible red imported fire ant (*Solenopsis invicta)* mounds which occurred in high traffic, disturbed areas such as the JAEC, 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 found throughout 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 31 through June 22, the sixth annual count was performed at a total of 38 point count stations (**Figure 6**). In the past, the count had been performed over the course of one morning but due to a lack of volunteers and inclement weather, the count was extended over three weeks while the Steward performed all of the point counts. Of the 36 species recorded, the top three detected were northern

cardinal (*Cardinalis cardinalis*) at 97% of the stations, black-crested titmouse (*Baeolophus bicolor*) at 84% of the stations, and painted bunting (*Passerina ciris*) at 79% of the stations. Golden-cheeked warblers were detected at 24% of the stations (**Table 3**) compared to 61% for the previous year. Point count data were analyzed with a linear regression test (log-transformed, 2-tail, 95% confidence level) for the six years' worth of data. All populations appear stable with no statistically significant trends with the exception of lesser goldfinch (*Carduelis psaltria*) and painted bunting (*Passerina ciris*) who demonstrated weakly positive population trends.

Travis County biologists Julie Murray and Blake Sissel conducted the first Jollyville Plateau salamander (*Eurycea tonkawae*) survey at Baker Spring since 2010. Several hours of searching yielded only one individual.

From 2011 – 2014, 15 nest boxes were installed throughout the Sanctuary (**Figure 7**) to provide additional nesting opportunities for cavity nesting birds. Of the 15 nest boxes, five were occupied during the 2016 breeding season by Carolina chickadees and four by either Carolina (*Thryothorus ludovicianus*) or Bewick's wrens (*Thryomanes bewickii*), judging by nest composition and egg shell fragments. In addition to the nest boxes, the chimney swift (*Chaetura pelagica*) tower adjacent to the Steward's residence (**Figure 7**) appears to have successfully fledged no young, judging by analysis of nesting detritus accumulated on the bottom plate of the tower.

To enhance survivorship and to investigate factors which may contribute to seedling growth rates and mortality, an oak caging project was initiated in December 2013. The caging effort continued during 2016 with the protection of an additional 12 plateau live oak, one post oak (*Quercus stellate*), five shin oak (*Quercus sinuata)*, and six Spanish oak (*Quercus texana*) in the northern portion of the Sanctuary (**Figure 8**). To date a total of 34 plateau live oak, 1 post oak, 38 shin oak, and 84 Spanish oak have been caged. In addition to the caging effort,

data such as habitat type, mid-stem diameter, seedling height, percent cover, and distance to nearest mature individual were collected to better understand factors affecting seedling growth and survival. All caged seedlings will be visited annually to collect data and, if necessary, determine and document causes of mortality. Of the oak cohort caged the prior two seasons, mortality due to unknown causes has been documented for five plateau live oak, four shin oak, and four Spanish oak. In all but one of the cases the seedlings were observed to be desiccated yet intact. In the case of one shin oak the cage was compromised by an unknown animal and the seedling was missing. All cages were left in place due to the propensity of seedlings to re-sprout and will be checked again in 2017.

Water quality tests were continued for Baker Spring on a monthly basis, flow permitting, and intermittently for Audubon Spring. Both sites have been documented to support populations of the threatened Jollyville plateau salamander. As a participating member of the Colorado River Watch Network (CRWN), water quality data collection followed CRWN protocols. During FY 2015-2016, 11 water quality tests were performed, one at Audubon Spring and ten at Baker Spring. Data were collected for water depth, water temperature, dissolved oxygen, specific conductance, pH, and nitrate nitrogen. All results fell well within expected values (**Table 4**).

Education and Outreach

From October 2015 through September 2016 Baker Sanctuary experienced a total of 457 visitations from day hikers. Of those visitations, 398 were by TAS members and 59 were by non-members. An additional 786 visitations occurred during organized activities such as educational programs, TAS events, and guided hikes. A total of 572.5 volunteer hours were logged at the Sanctuary on a variety of activities (see below).

October: Education, grounds, trails, & facilities maintenance, habitat

restoration.

November: Grounds, trails, & facilities maintenance, grant procurement, invasive species removal.

December: Invasive species removal and grounds maintenance.

January: Invasive species removal and grounds & facilities maintenance.

February: Invasive species removal, grounds & facilities maintenance, and biological monitoring.

March: Education and grounds maintenance.

April: Education, grounds, trails, & facilities maintenance

May: Education, grounds & trails maintenance, invasive species removal, and biological monitoring.

June: Invasive species removal, education, grounds & facilities maintenance.

July: Facilities maintenance.

August: Grounds maintenance.

September: Education, grounds, trails, & facilities maintenance.

The Hiking Club with Whitestone Elementary of the Leander Intermediate School District (LISD) convened for sessions in both the spring and fall. For six consecutive weeks per session, approximately 20 fifth grade English Language Learner students spent two hours per session hiking the Sanctuary, learning about central Texas flora, fauna, and habitats. The program was developed with support from Linda Lippe, the former LISD elementary science curriculum coordinator, and Charlie Ciernia, an educator at Deer Creek Elementary. The program was designed to augment grade-appropriate science concepts as outlined in the Texas Essentials Skills and Knowledge.

Other activities to enhance community involvement and increase awareness of Baker Sanctuary and the BCP mission included the Baker Open House, Great Backyard Bird Count, 12 guided hikes for various community groups, one BCP sponsored guided hike, three field trips for LISD fourth grade students, two GCWA presentations to a total of 247 LISD fifth grade students, one GCWA

themed Youth Nature Camp for elementary students, one ecology presentation to a total of 140 LISD fourth grade students, one kinesthetic lesson on bird migration at El Ranchito, and one presentation at the Longhorn Village Beak Week Celebration.

Literature Cited

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.

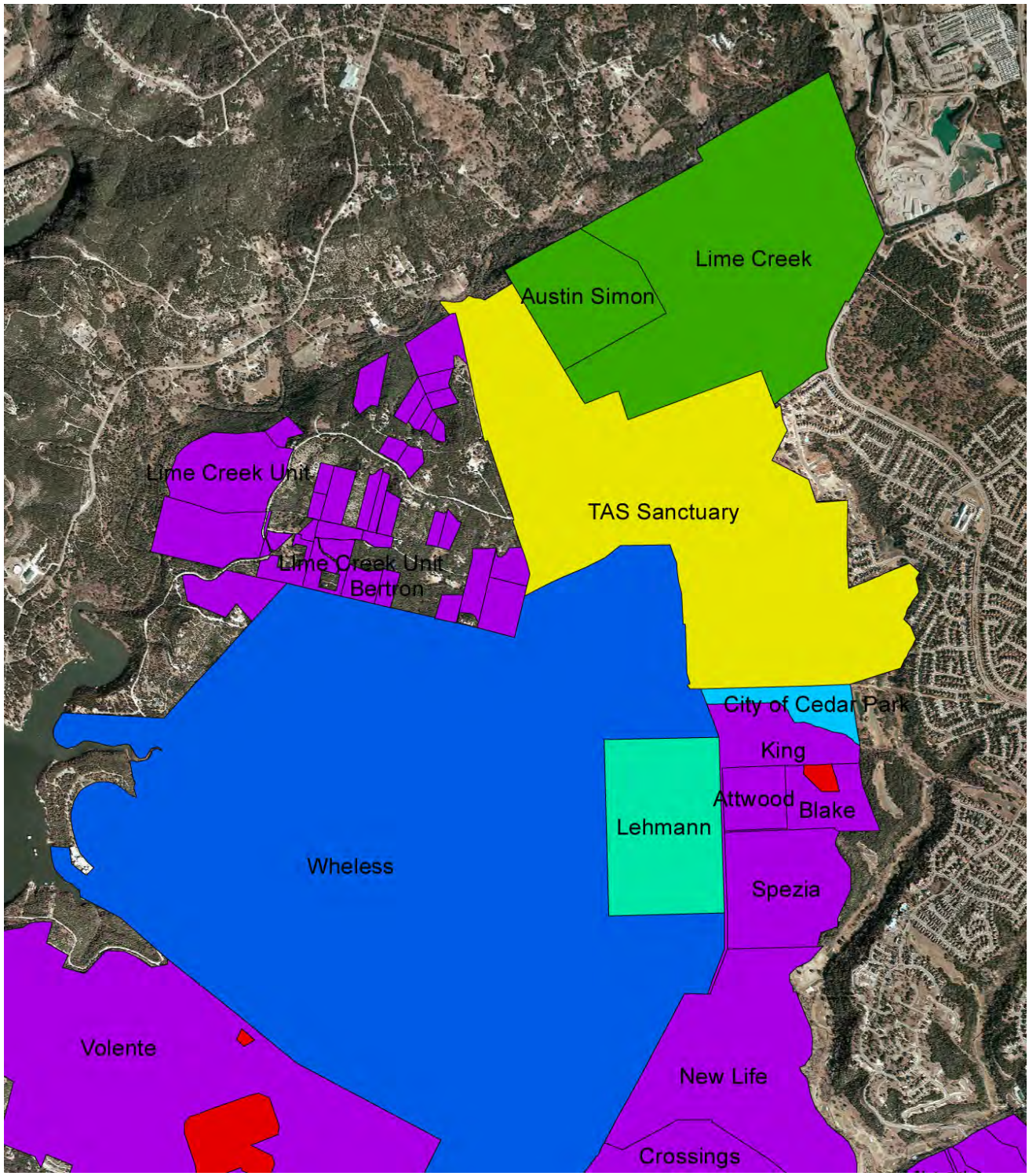
Appendix A

Baker Sanctuary 40-acre headquarters tract



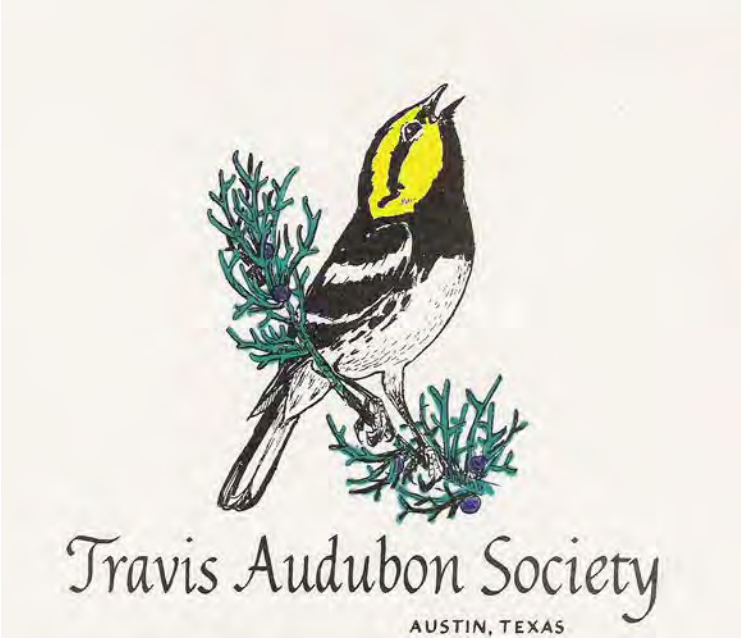
Appendix B

Baker Sanctuary and adjacent BCP partner properties



Appendix C

RESULTS OF THE GOLDEN-CHEEKED WARBLER SURVEY FOR THE BAKER SANCTUARY 100-ACRE PRIME PLOT SPRING 2016 TRAVIS COUNTY, TEXAS



Prepared for:

Travis Audubon Society
3710 Cedar St., Box 5
Austin, Texas 78705

Prepared by:

Christopher Murray
Baker Sanctuary Steward
12219 Lime Creek Road
Leander, TX 78641

Surveyors:

Beth Samuelson
Christopher Murray

August 2016

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1-2
2.0 DESCRIPTION OF SURVEY AREAS 2-3
3.0 METHODS 3-5
4.0 RESULTS 5
5.0 DISCUSSION 6
6.0 REFERENCES 6-7
7.0 ACKNOWLEDGEMENTS 7

Tables

Table 1. GCWA banded on the Baker Sanctuary 100-acre plot, 2011 - 2016. .. 8-9
Table 2. GCWA territory status and enumeration of females and fledglings Detected on the Baker Sanctuary 100-acre plot, 2016 9
Table 3. Summary of GCWA reproductive success on the Baker Sanctuary 100-acre plot, 2011 - 2016 10

Figures

Figure 1. Location of the Baker Sanctuary 100-acre plot 11
Figure 2. GCWA territory distribution on the Baker Sanctuary 100-acre plot, 2016 12

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, City of Cedar Park, Lower Colorado River Authority (LCRA), and conservation easements held on privately owned land. In addition to preserve lands, Baker is bordered by several small rural lots to the west and north composed 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. Baker Sanctuary contains approximately 690 acres of high-quality golden-cheeked warbler (GCWA) habitat.

The purpose of this report is to present the results of the Baker Sanctuary 2016 GCWA 100-acre survey. The Baker 100-acre plot is located in the southern half of the sanctuary (**Figure 1**) and has been surveyed on an annual basis, at varying levels of intensity, since its establishment on February 13, 1999. The 100-acre plot system was established throughout the BCP by the BCP Monitoring Committee as a way to monitor a sub-set of the GCWA population since direct surveys of all 30,428 acres would be impractical. Plots were

designated as ‘prime’ if they contained at least 75% GCWA habitat or ‘transitional’ if zero to a few GCWA territories were present but had the potential to become prime habitat given time (BCCP 2007). The Baker 100-acre plot is considered a prime plot.

The methods for the 2016 Baker Sanctuary 100-acre Survey 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 AREA

In general, the 100-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 interspersed with Spanish oak (*Quercus buckleyi*), shin oak (*Quercus sinuata*), cedar elm (*Ulmus crassifolia*), 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*), flameleaf sumac (*Rhus lanceolata*), rusty blackhaw (*Viburnum rufidulum*), and Carolina buckthorn (*Rhamnus caroliniana*) are distributed between upland areas, slopes, and canyon bottoms where plant species diversity increases.

Topography throughout the 100-acre plot is fairly uniform with the majority of the plot consisting of upland habitat and the only significant topographical relief occurring in the southern and eastern portions of the plot. Elevations in the upland portion of the plot range from 1020 – 960 feet above mean sea level (msl). The canyon bottom in the southern portion of the plot is at approximately

920 feet above msl and contains Baker Spring, an intermittent spring and the headwaters for Baker Creek which feeds into Cypress Creek. The canyon bottom in the eastern portion of the plot is at approximately 900 feet above msl and contains Kutac creek which also drains into Cypress Creek.

3.0 METHODS

Surveys began on March 20 and concluded on May 25. Surveys occurred in the morning hours and were not conducted if wind speeds were greater than 15 mph or during precipitation other than a light drizzle. Two surveyors, Beth Samuelson and Christopher Murray, rotated survey effort through the plot in an effort to reduce observer bias. For example, if the first week Murray surveyed the northern section, Samuelson would cover the southern section. The following week Murray would survey the eastern section and Samuelson the western, and so on, rotating through the plot in a clockwise fashion. When splitting the plot in half, no hard line was set as a boundary, rather each observer estimated where the halfway mark was located and used discretion if a GCWA needed to be pursued over the imaginary division. Murray invested 53.75 hours surveying the plot and Samuelson 49.25 for a total of 103 survey hours for the season, or 25.8 hours per 25 acres. Surveyors used 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).

During each visit, the surveyors hiked through the survey area and searched for GCWA by sight and/or sound. If a GCWA was detected, the surveyors 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 surveyors also recorded the time of day, song type (A or B), whether the GCWA was color

banded, presence of a female or fledglings, territorial interactions such as counter-singing or chases between males, and whether the detected male was an After Second Year (ASY) or Second Year (SY) bird. Auditory recordings were not utilized during any surveys.

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, beginning in 2011 efforts were made to mist net and capture all breeding males on the 100-acre plot. 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. On the infrequent occasion a female was captured they were also given aluminum and color bands. To date 44 GCWA have been banded on Baker Sanctuary's 100-acre plot (**Table 1**).

Reproductive success was determined as follows:

1. Territory density: number of territories per 100 acres;
2. Calculation of edge territories: each territory that 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

In total, 398 GCWA observations were recorded over the course of the survey effort. Nine full territories and three edge territories were delineated in the 100-acre plot for an adjusted total of 10.5 territories. Females were observed in all territories and a total of 17 fledglings were observed in eight territories (**Table 2**). One territory, BK/SI:OR/BK, was established directly adjacent to the 100-acre plot and was not included in the analysis.

Territory density was estimated at 10.5 territories. This calculation was based on the adjusted total of twelve territories (nine full and three edge) in the 100 acres surveyed.

The pairing success rate in the southern sanctuary was 100% (females were observed at all nine of the full territories). The breeding success was estimated at 56%, based on five of the nine full territories were observed to have fledglings. The average brood size was 2.4 fledglings based on the aforementioned criteria. Productivity was estimated at 1.3 based on the total of 12 fledglings observed in the nine full territories.

5.0 DISCUSSION

While the 100-acre survey has been performed at Baker since 1999, intensity and protocols have varied significantly enough to make comparisons between years difficult. With the onset of color-banding and adoption of a standardized survey protocol in the 2011 season, the results of the last six years can be cautiously compared with the understanding that survey time invested has varied considerably, ranging from 103 – 327 hours/season.

Results from the 2016 100-acre survey are fairly similar to the preceding five seasons (**Table 3**) with territory density and % pairing success for 2016 slightly higher than average and % breeding success, estimated brood size, and productivity slightly below average. It is important to note that of the six surveys listed in **Table 3**, 2016 is the first year where nest searching was not stressed and fecundity data (ie % breeding success, estimated brood size, and productivity) were collected solely by the observed presence or absence of fledglings. It is quite likely with the investment of more time in the field spent nest searching and monitoring productivity data for 2016 would have been closer to the mean.

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.

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

Many thanks go out to Beth Samuelson who helped make the study possible. Beth spent a great deal of her free time during the spring traipsing about the sanctuary, enduring the heat and braving chiggers, the scratchy embrace of ubiquitous Ashe juniper, uneven terrain, and the occasional venomous snake.

Table 1. Golden-cheeked warblers banded on the Baker Sanctuary 100-acre plot, 2011 – 2016.

Date Banded	Color Combination	USFWS Band Number	Gender	Age
2011	MV/SI:NB/YE	Unknown	Male	Unknown
2011	MV/BL:PI/SI	Unknown	Male	Unknown
2011	OR/OR:DG/SI	Unknown	Male	Unknown
2011	BK/YE:DG/SI	Unknown	Male	Unknown
2011	YE/DG:DB/SI	Unknown	Male	Unknown
2011	DB/BK:MV/SI	Unknown	Male	Unknown
2011	RD/SI:BK/DG	Unknown	Female	Unknown
2011	NB/SI:PI/MV	Unknown	Male	Unknown
2011	WH/SI:OR/BL	Unknown	Male	Unknown
2011	NB/MV:GR/SI	Unknown	Male	Unknown
2011	WH/BK:WH/SI	Unknown	Male	Unknown
2011	OR/SI:MV/DG	Unknown	Female	Unknown
2011	RD/SI:DB/YE	Unknown	Male	Unknown
2012	BL/DB:RD/SI	Unknown	Male	Unknown
2012	BL/WH:RD/SI	Unknown	Male	Unknown
2012	BK/DG:DB/SI	Unknown	Male	Unknown
2012	WH/SI:DG/YE	Unknown	Male	Unknown
2012	RD/SI:BL/PI	Unknown	Female	Unknown
2012	WH/DG:BK/SI	Unknown	Male	Unknown
2012	OR/SI:WH/RD	Unknown	Male	Unknown
2012	PI/SI:GR/YE	Unknown	Male	Unknown
2012	PI/SI:NB/DG	Unknown	Male	Unknown
2013	MV/SI:BL/MV	Unknown	Male	Unknown
2013	DB/SI:OR/YE	Unknown	Male	Unknown
2013	MV/SI:DG/DG	Unknown	Male	Unknown
2014	BK/SI:OR/BK	Unknown	Male	Unknown
2014	BL/SI:OR/RD	Unknown	Male	Unknown
2014	OR/SI:DG/DB	Unknown	Male	Unknown
2014	PI/DG:NB/SI	Unknown	Female	Unknown
9-Apr-15	RD/SI:RD/DB	2770-41201	Male	SY
2015	WH/OR:PI/SI	Unknown	Male	SY
2015	RD/WH:MV/SI	Unknown	Male	ASY
2015	YE/SI:PI/BL	Unknown	Female	SY
2-Apr-15	MV/MV:YE/SI	2770-41202	Male	ASY
2015	OR/SI:DB/YE	Unknown	Male	ASY
2015	NB/MV:MV/SI	Unknown	Male	SY
2015	DB/SI:RD/DB	Unknown	Unknown	HY

2015	**WH/SI:NB/YE**	**Unknown**	**Unknown**	**HY**
2015	**WH/YE:YE/SI**	**Unknown**	**Unknown**	**HY**
2015	**BL/SI:BL/MV**	**Unknown**	**Unknown**	**HY**
2015	**YE/DG:DG/SI**	**Unknown**	**Male**	**Unknown**
8-Apr-16	**BL/DG:BK/SI**	**2770-41205**	**Male**	**ASY**
8-Apr-16	**NB/SI:OR/DB**	**2770-41203**	**Male**	**ASY**
16-Apr-16	**WH/SI:BK/WH**	**2550-99699**	**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 Baker Sanctuary 100-acre plot, 2016.

Territory Designation	Full/Edge Territory	Female Detected	# Fledglings Detected
OR/SI:DB/YE	**Full**	**Yes**	**2**
MV/MV:YE/SI	**Full**	**Yes**	**4**
RD/WH:MV/SI	**Full**	**Yes**	**2**
WH/SI:BK/WH	**Full**	**Yes**	**0**
YE/DG:DG/SI	**Full**	**Yes**	**0**
UB1	**Full**	**Yes**	**0**
UB2	**Full**	**Yes**	**2**
UB3	**Full**	**Yes**	**0**
UB4	**Full**	**Yes**	**2**
BL/DG:BK/SI	**Edge**	**Yes**	**1**
NB/SI:OR/DB	**Edge**	**Yes**	**1**
UB5	**Edge**	**Yes**	**3**
BK/SI:OR/DB	**Out**	**Yes**	**0**

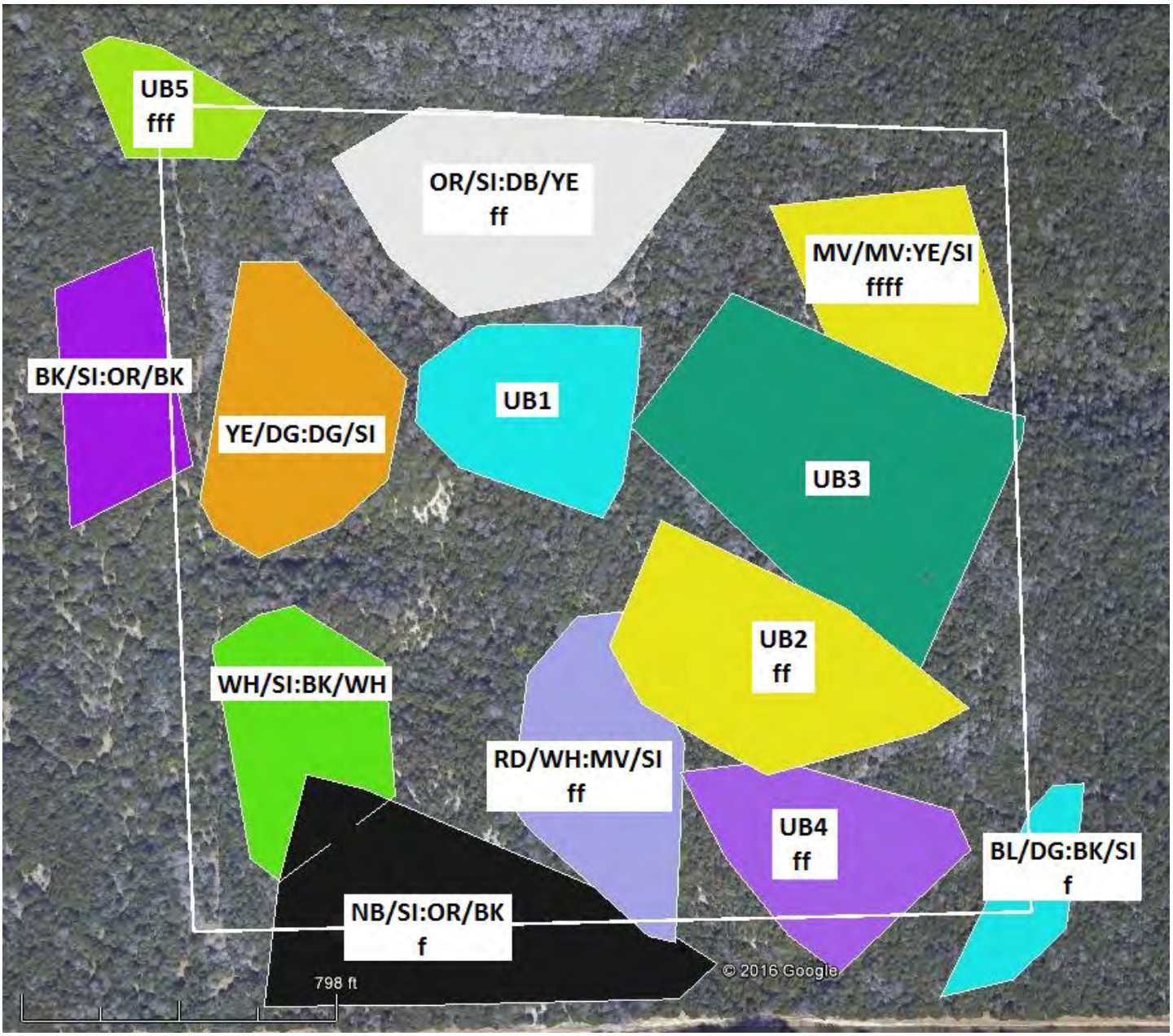
Table 3. Summary of golden-cheeked warbler reproductive success on the Baker Sanctuary 100-acre plot, 2011 – 2016.

Year	Territory Density	% Pairing Success	% Breeding Success	Estimated Brood Size	Productivity	Survey Time (Hours)
2011	10.5	83	50	2.3	1.2	150
2012	10	100	75	3.4	2.1	327
2013	10	100	50	2.7	1.3	234
2014	8.5	100	100	2.4	2.4	241
2015	11.5	75	75	3.7	2.8	195
2016	10.5	100	56	2.4	1.3	103
Avg.	10.2	93	67	2.8	1.9	208

Figure 1. Location of the Baker Sanctuary 100-acre plot.



Figure 2. Golden-cheeked warbler territory distribution on the Baker Sanctuary 100-acre plot, 2016.



Appendix D

Baker Sanctuary GCWA VCP point count example, 2016

Date	Station	Time Begin	Time End	Wind Spd (mph)	Temp (F)	Precipitation	Female	BoC	
							Y N	WESJ BLJA	NOBO
4/27/16	37	10:47	10:52	1-3	73°	None			

Bird	Position	Time	Detect	Dist (m)
~~1~~	1-1	10:47	B	43
2	2-1	10:47	B	61
1	2-1	10:48	B	61
2	2-1	10:48	B	61
1	1-1	10:49	B	43
2	2-2	10:49	B	45
1	1-1	10:50	B	43
2	2-2	10:50	B	45
1	1-1	10:51	B	43
2	2-2	10:51	B	45
3	3-1	10:51	C	47

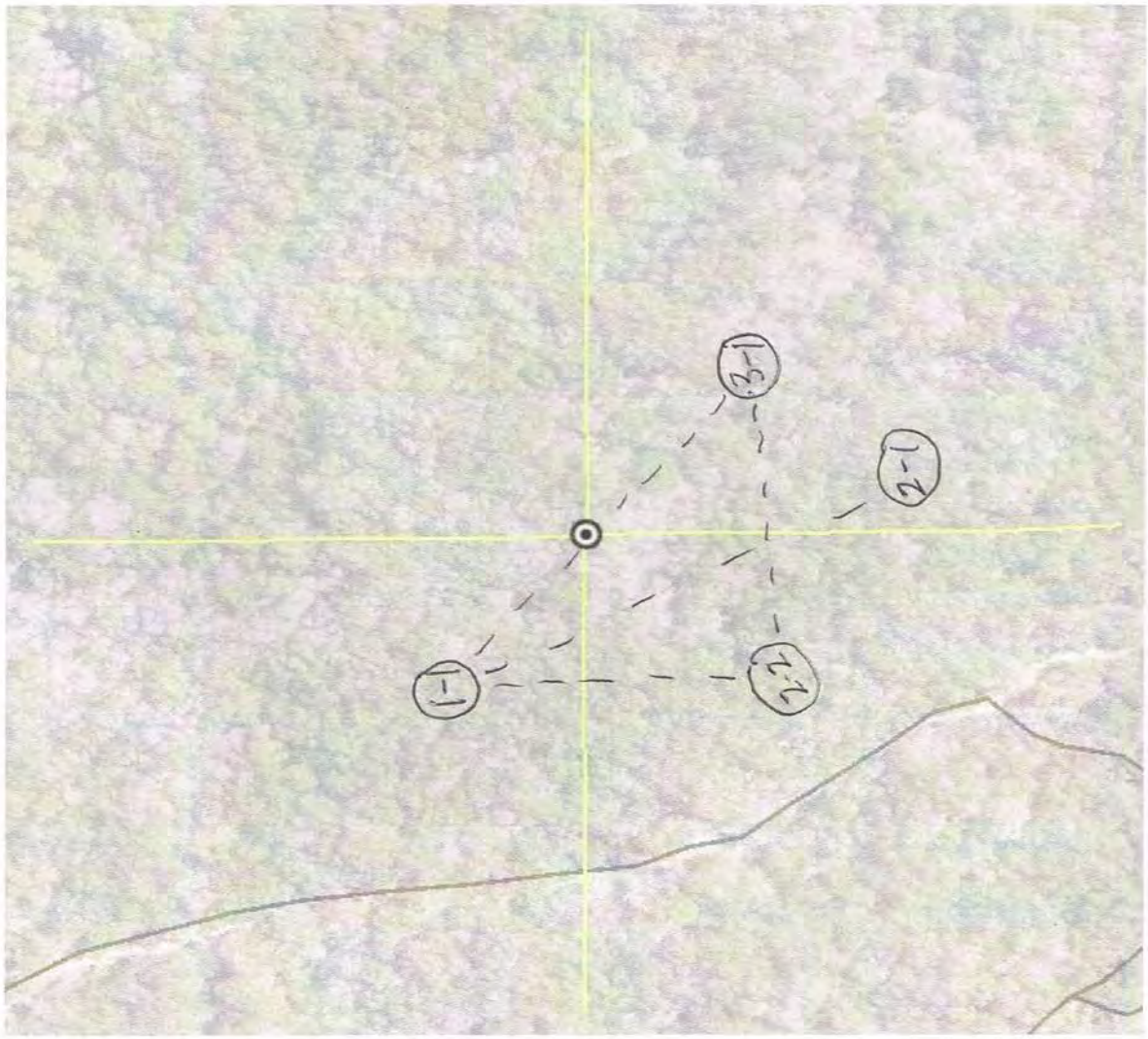


Figure 1. Baker Sanctuary VCP point counts stations, 2016.



Figure 2. Baker Sanctuary whitetail deer hunt sites, 2016.

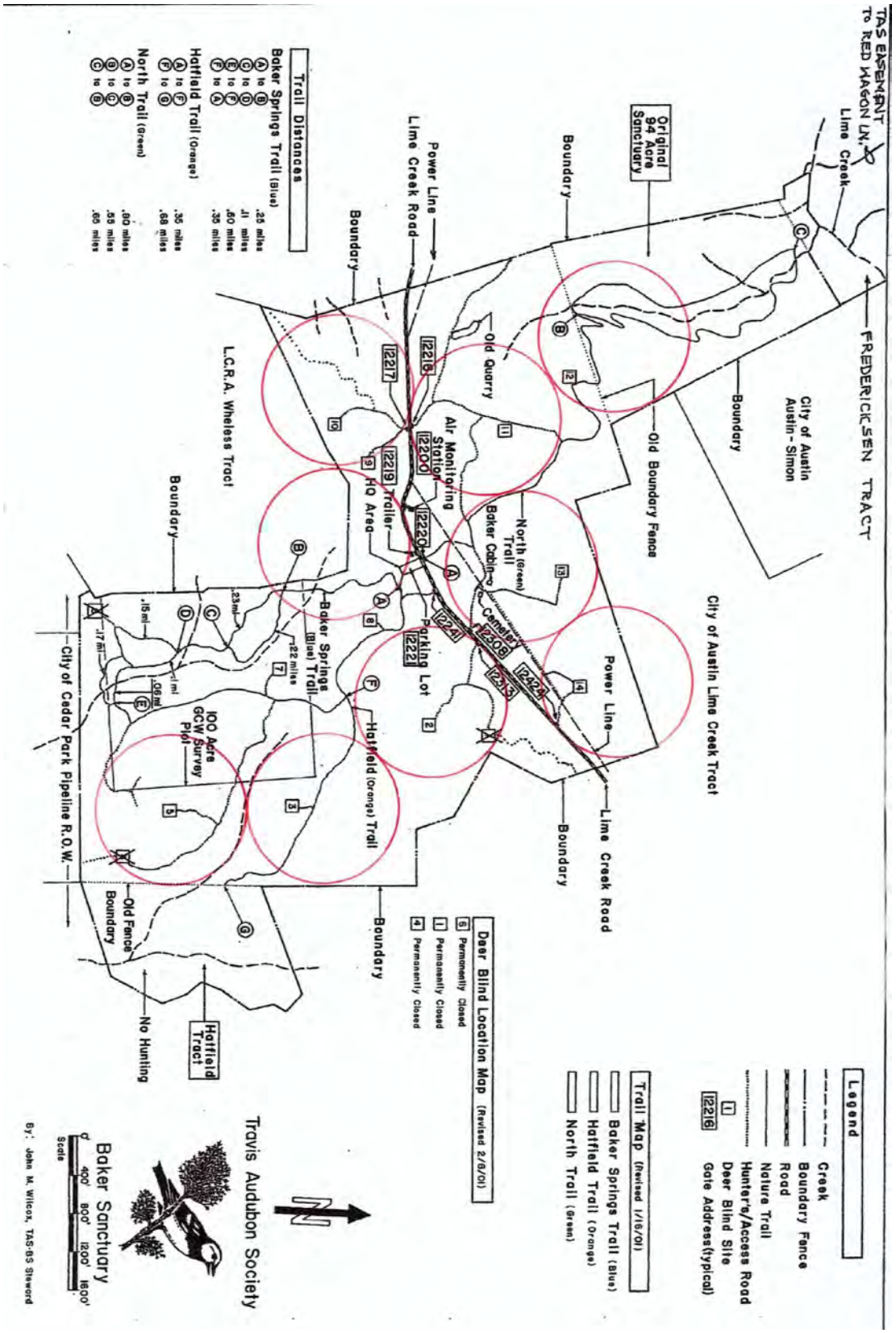


Figure 3. Summary of Baker Sanctuary whitetail deer harvest, 2000-2016. Juvenile deer are a year or less in age.

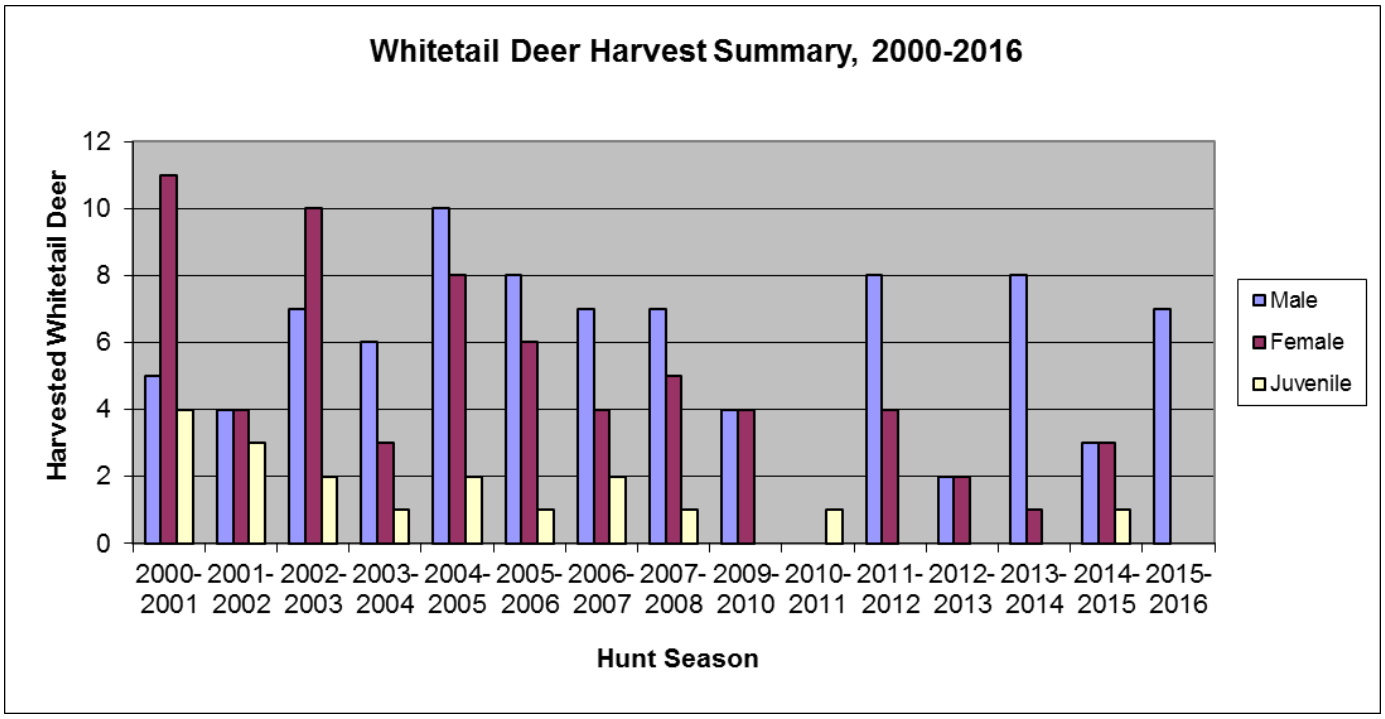


Figure 4. Summary of Baker Sanctuary brown-headed cowbird trapping results, 1986-2016.

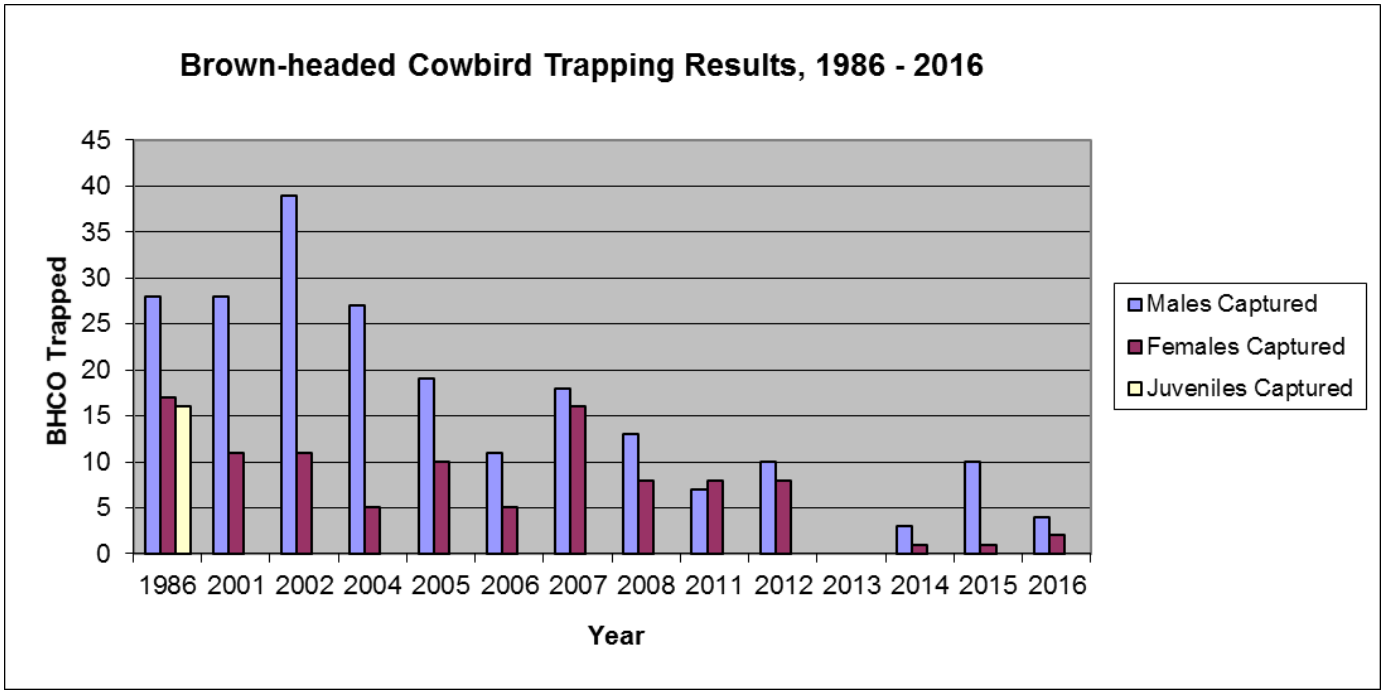


Figure 5. Summary of Baker Sanctuary tree-of-heaven eradication efforts, 2010-2016.

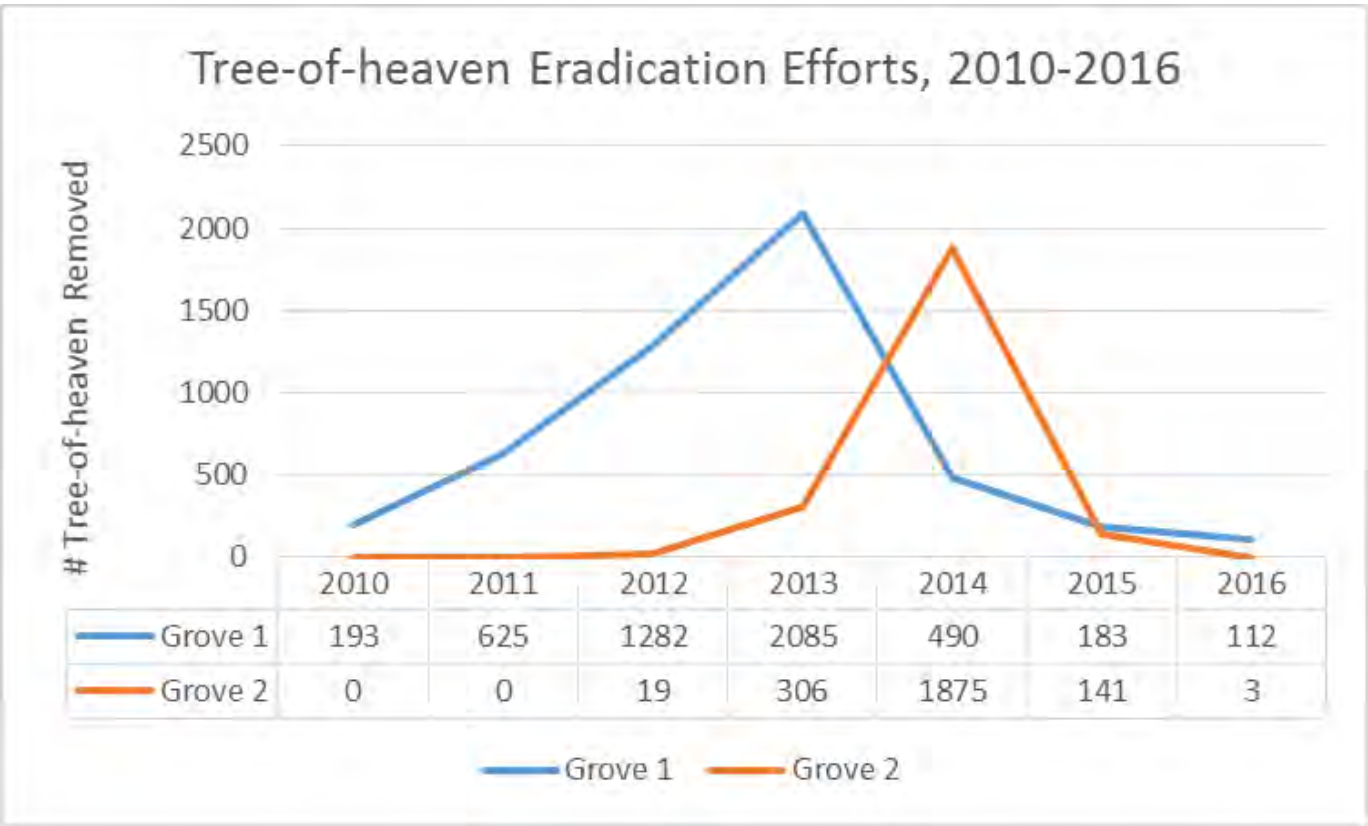


Figure 6. Baker Sanctuary BBS point count stations, 2016.



Figure 7. Baker Sanctuary nest box locations and occupancy, 2016.

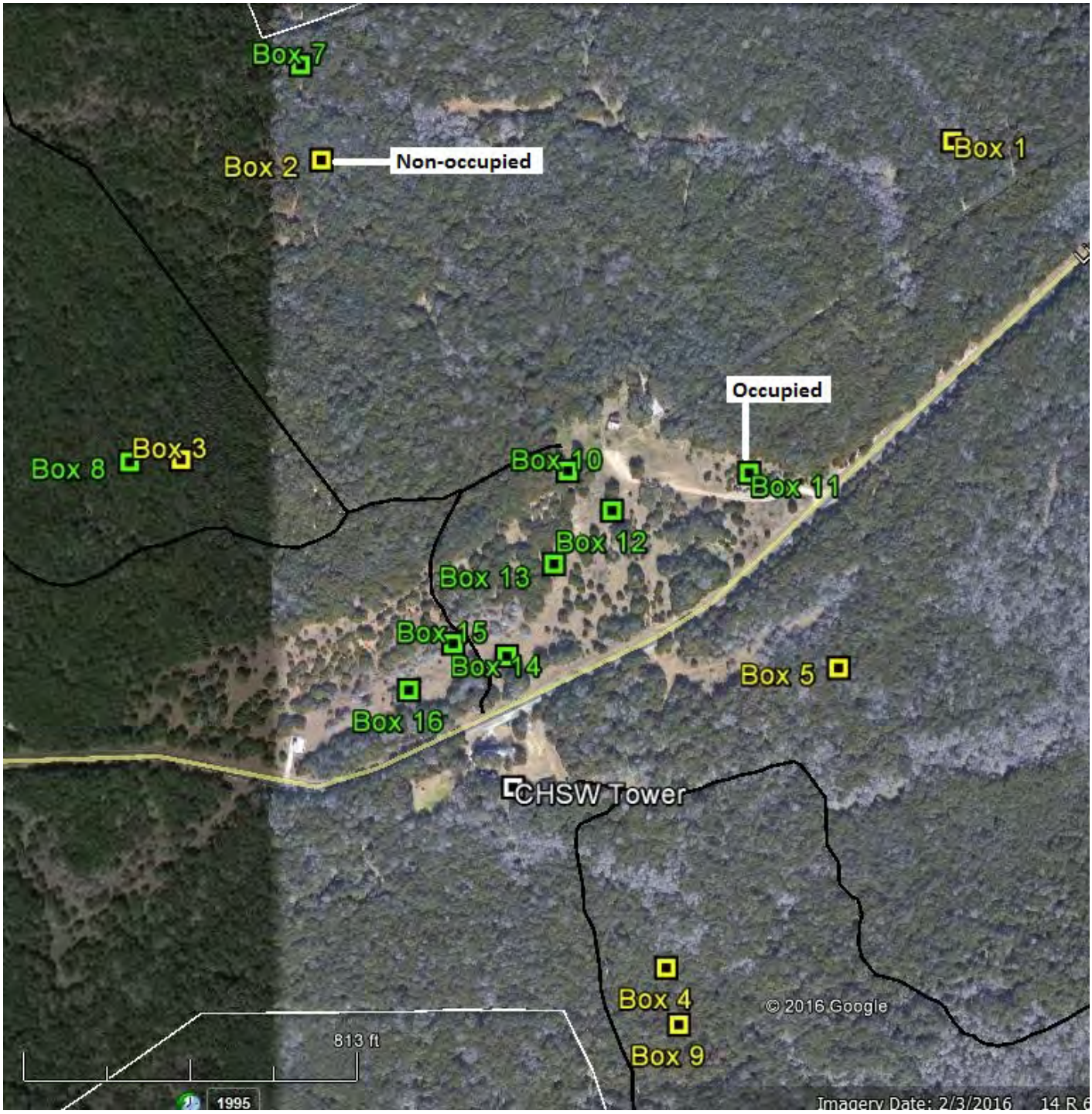


Figure 8. Baker Sanctuary caged oak locations, 2013-2016.

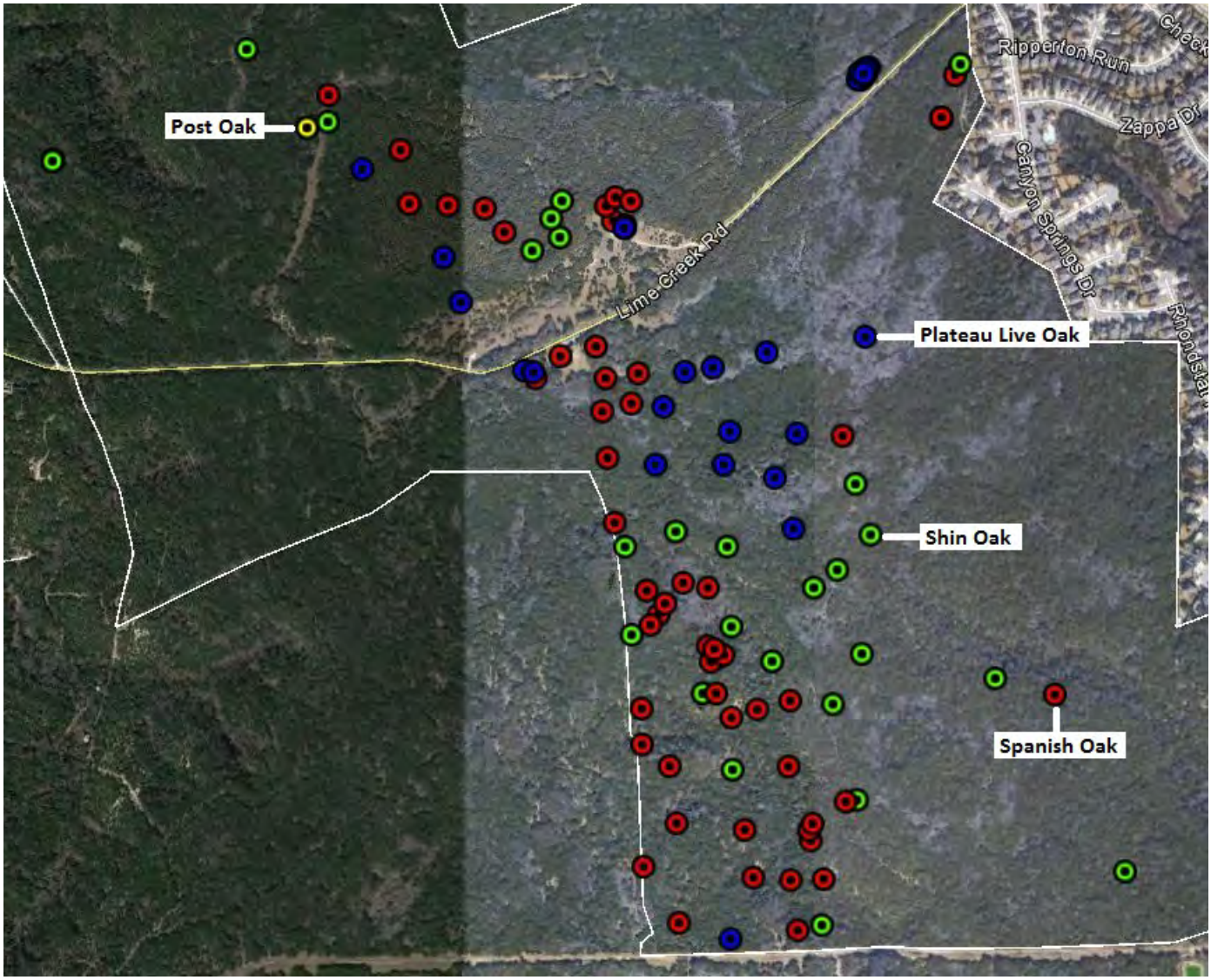


Table 1. GCWA banded at Baker Sanctuary, 2015-2016.

Year Banded	USFWS Serial Number	Color Band Combination	Sex	Age
2015	2770-41201	RD/SI:RD/DB	Male	SY
2015	2770-41202	MV/MV:YE/SI	Male	ASY
2016	2770-41203	NB/SI:OR/DB	Male	ASY
2016	2770-41205	BL/DG:BK/SI	Male	ASY
2016	2550-99699	WH/SI:BK/WH	Male	SY

Table 2. Baker Sanctuary imazapyr efficacy results, 2016.

Species	Imazapyr Solution	# Treated	# Dead	% Mortality
Tree-of-heaven	10%	4	3	75.0
Chinaberry	10%	34	20	58.8
Chinese Tallow Tree	10%	1	0	0.0
Ligustrum sp	10%	2	2	100.0
Heavenly Bamboo	10%	7	4	57.1
Total		**48**	**29**	**60.4**

Species	Imazapyr Solution	# Treated	# Dead	% Mortality
Chinaberry	30%	16	12	75.0
Ligustrum sp	30%	3	3	100.0
Heavenly Bamboo	30%	4	3	75.0
Total		**23**	**18**	**78.3**

Table 3. Baker Sanctuary BBS point count survey, 2016

Common Name	Scientific Name	Number Observed	Mean	Frequency (%) (25 yd radius)	Frequency (%) (unlimited radius)
American Robin	*Turdus migratorius*	7	0.18	13	13
Ash-throated Flycatcher	*Myiarchus cinerascens*	1	0.03	3	5
Bewick's Wren	*Thryomanes bewickii*	8	0.21	18	42
Black-chinned Hummingbird	*Archilochus alexandri*	4	0.11	11	11
Black-crested Titmouse	*Baeolophus atricristatus*	20	0.53	45	84
Blue J**ay**	*Cyanocitta cristata*	0	0.00	0	18
Blue-gray Gnatcatcher	*Polioptila caerulea*	36	0.95	63	66
Carolina Chickadee	*Poecile carolinensis*	24	0.63	37	50
Carolina Wren	*Thryoothorus ludovicianus*	3	0.08	8	32
Chimney Swift	*Chaetura pelagica*	0	0.00	0	13
Cliff Swallow	*Petrochelidon pyrrhonota*	0	0.00	0	3
Common Grackle	*Quiscalus quiscula*	1	0.03	3	13
Common Raven	*Corvus corax*	0	0.00	0	5
Cooper's Hawk	*Accipiter cooperii*	0	0.00	0	5
Dickcissel	*Spiza americana*	0	0.00	0	3
Eastern Phoebe	*Sayornis phoebe*	1	0.03	3	11
Field Sparrow	*Spizella pusilla*	2	0.05	5	24
Golden-cheeked Warbler	*Setophaga chrysoparia*	4	0.11	11	24
House Finch	*Haemorhous mexicanus*	4	0.11	5	5
House Sparrow	*Passer domesticus*	1	0.03	3	3
Ladder-backed Woodpecker	*Picoides scalaris*	1	0.03	3	13
Lesser Goldfinch	*Carduelis psaltria*	11	0.29	24	74
Mourning Dove	*Zenaida macroura*	2	0.05	3	37
Northern Cardinal	*Cardinalis cardinalis*	35	0.92	74	97
Northern Mockingbird	*Mimus polyglottos*	2	0.05	5	32
Painted Bunting	*Passerina ciris*	27	0.71	63	79
Purple Martin	*Progne subis*	0	0.00	0	32
Red-eyed Vireo	*Vireo olivaceus*	0	0.00	0	5
Red-shouldered Hawk	*Buteo lineatus*	0	0.00	0	11
Rufous-crowned Sparrow	*Aimophila ruficeps*	2	0.05	5	5
Summer Tanager	*Piranga rubra*	3	0.08	8	11
Turkey Vulture	*Cathartes aura*	0	0.00	0	5
Woodhouse's Scrub-jay	*Aphelocoma woodhouseii*	7	0.18	13	21
White-eyed Vireo	*Vireo griseus*	7	0.18	18	21
White-winged Dove	*Zenaida asiatica*	0	0.00	0	24
Yellow-billed Cuckoo	*Coccyzus americanus*	7	0.18	16	34

Table 4. Baker Sanctuary water quality test results, 2015-2016.

Site	Test Date (mdy)	Water Depth (cm)	Water Temperature (°C)	Dissolved Oxygen (% Saturation)	Specific Conductance (µS/cm)	pH	Nitrate Nitrogen (mg/L)
Baker Spring	10/20/2015	42.0	17.5	58.8	660	7.0	0.25
Baker Spring	11/11/2015	46.0	18.5	65.3	630	7.0	0.5
Baker Spring	12/09/2015	50.0	17.0	68.6	640	7.0	0.5
Baker Spring	01/21/2016	44.6	15.5	65.7	640	7.0	0.75
Baker Spring	02/19/2016	41.5	17.0	52.0	640	7.0	0.5
Baker Spring	03/23/2016	45.0	18.0	59.4	660	7.0	0.5
Baker Spring	04/20/2016	51.0	19.0	75.6	470	7.0	<0.3
Baker Spring	05/18/2016	46.5	19.0	69.1	670	7.0	0.6
Baker Spring	06/29/2016	45.0	20.0	69.3	650	7.0	0.6
Baker Spring	08/19/16	47.2	21.0	66.1	630	7.0	0.3
Baker Spring Average (2016)		**45.9**	**18.3**	**65.0**	**629**	**7.0**	**~0.5**
Baker Spring Average (2015)		**43.8**	**18.0**	**65.2**	**641**	**7.0**	**~0.3**
Audubon Spring	11/11/2015	40.0	20.0	50.6	610	6.5	<0.5