2020 Annual Report:
Golden-cheeked Warbler *(Setophaga chrysoparia)*
Monitoring Program
Balcones Canyonlands Preserve

Male Golden-cheeked Warbler, City of Austin staff photo

City of Austin, Austin Water
Wildland Conservation Division
and
Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division
Balcones Canyonlands Preserve
Austin, Texas

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SUMMARY

This report summarizes the results of the golden-cheeked warbler (*Setophaga chrysoparia*) endangered species monitoring program on the Balcones Canyonlands Preserve (BCP) for the 2020 field season. In 2020, we faced an unprecedented challenge with the COVID-19 pandemic that resulted in a city-mandated stay-at-home order from March 27 until May 16. During that time, biologists collected data opportunistically while conducting security patrols and management activities. Because of the limited banding and survey effort during the peak of the warbler breeding season, 2020 survey results are not expected to be comparable with previous years. However, biologists reported that the soundscape across much of the BCP was noticeably quieter, and that productivity appeared to increase on several plots.

ACKNOWLEDGMENTS

We would like to thank all of the BCP partners, staff, and volunteers who assisted with the 2020 survey effort despite the additional challenges put in place due to COVID-19. Without their support and perseverance, it would not have been possible to obtain these critical data. Volunteers in 2020 included: Gaby Alvarez, Andy Balinsky, Sally Beadles, Pam Bullard, Gabi Casares, Eileen Cassidy, Paul Clements, Leneka Cook, Lauren Dill, Carla Dunda, Mark Dunda, Patrick Garnett, Tucker Garnett, Shelia Hargis, Elisabeth Harper, Lizzy Hingle, Ranleigh Hirsh, Joseph Hunt, Brad James, Leigh Jandle, Paula Levihn-Coon, Lori Malloy, Karen Mansfield, Stacy Marcus, Cheryl McGrath, Jasmine Mills, Dwight Monteith, Emily Novak, Tim Phillips, Elena Pinto-Torres, Stephanie Putnam, Paul Sanchez-Navarro, Shannon Slivinkse, Katie Snipes, Anna Stalcup, Larry Thatcher, Dale Thompson, Kelsey Tinoco, Tam Tran, John Walmsley, Jim Weber, Lynne Weber, Lewis Weil, Kerri Welch, Virginia Williams, and Gloria Wilson.

INTRODUCTION

Background

The golden-cheeked warbler (warbler) is a neotropical migrant passerine that breeds only in central Texas where mature Ashe juniper-oak (*Juniperus ashei–Quercus*) woodlands occur (Ladd and Gass 1999). Due to accelerating loss of breeding habitat, the warbler was listed as federally endangered by the U.S. Fish and Wildlife Service in 1990 (USFWS 1990). Warbler habitat in western Travis County is widely considered to be some of the highest quality and least fragmented of any county within this species' limited breeding range (Biological Advisory Team 1990, Duarte et al. 2013). Rapid expansion of development west of the City of Austin led to the creation of the Balcones Canyonlands Conservation Plan (a habitat conservation plan). The U.S. Fish and Wildlife Service issued a 10(a)(1)(B) permit in 1996 to the City of Austin and Travis County, to mitigate habitat loss due to development and to facilitate the recovery of the warbler and other endangered and rare species (USFWS 1996). The permit requires a minimum of 12,300 hectares (30,428 acres) of endangered species habitat in western Travis County be protected as a preserve (the BCP) for these species. The BCP is owned and managed by several public and private entities, including the City

of Austin, Travis County, Lower Colorado River Authority, The Nature Conservancy, Travis Audubon Society, and St. Edwards University/Wild Basin. Because the Balcones Canyonlands Conservation Plan allows for the loss of over 70% of the warbler's habitat in Travis County, protecting existing woodlands and promoting reforestation is critical to support a viable breeding population within the BCP.

The warbler requires large blocks of mature, closed-canopy woodlands for nesting and raising young (USFWS 1992; Peak 2007; Peak and Thompson 2013, 2014; Reidy et al. 2016-2020). Active habitat management within the BCP requires minimizing threats to this species, including disturbance from human activities; declining oak regeneration from white-tailed deer (*Odocoileus virginianus*), feral hogs (*Sus scrofa*), and oak wilt (*Ceratocystis fagacearum*); non-native plants; and nest predators (USFWS 1996). Because the warbler requires mature woodlands, habitat regeneration could take decades if negatively impacted by a poorly designed program (Biological Advisory Team 1990).

Objectives

The Balcones Canyonlands Conservation Plan (USFWS 1996) states that "baseline monitoring will be gathered in accordance with the Land Management Guidelines and approved land management plans and should concentrate on determining basic population levels on preserve lands, key population parameters, and other ecological parameters that may affect the target species." The Tier IIA-7 Land Management Plan (BCP 2007) identifies the following goals and objectives: "The warbler population within the BCP will be monitored through a regional program to determine population size, territory density and trends, distribution, productivity, use of marginal habitat, and to determine the effects of habitat manipulation, urbanization, and recreation." A 5-year study (2011-2015) with the U.S. Forest Service/University of Missouri focused on four primary questions:

1) What is the absolute abundance of the warbler on the BCP and on individual macrosites?
2) How do demographics (e.g. density, productivity, survival) vary with landscape and habitat factors?
3) How viable are these populations?
4) How do various management scenarios influence population viability?

Reidy et al. (2015-2020) summarize findings from the 5-year study that have been published to date. The current long-term monitoring plan is intended to continue collecting demographic data to augment this study and meet the objectives of the Balcones Canyonlands Conservation Plan and the 2007 land management plan.

SITE DESCRIPTION

The topography and vegetation of the BCP are typical of the eastern edge of the Edwards Plateau. Steep, wooded canyons and riparian corridors dissect drier uplands. Most streams are intermittent, though a few have a permanent water source, such as a perennial spring. The predominant vegetation association is mature, closed-canopy Ashe juniper-oak woodlands, although several sites include more open canopy and shrublands.

Woodlands in western Travis County were logged in the late 1800s and early 1900s and are currently in various stages of recovery (Bray 1904, Keddy-Hector 1996). After clearing, much of the topsoil was lost

due to subsequent goat and cattle overgrazing and erosion. On some steep slopes, this soil loss has greatly reduced the revegetation potential. Current and past over-browsing by white-tailed deer has reduced understory flora diversity and species abundance (Russell et al. 2001, Russell and Fowler 2004). Evidence of browse is visible on the majority of BCP tracts. A paucity of certain deciduous woody species is also evident throughout the BCP.

In woodlands and forests, the canopy is dominated by Ashe juniper, Texas red oak (*Q. buckleyi*), plateau live oak (*Q. fusiformis*), shin oak (*Q. sinuata* var. *breviloba*), escarpment black cherry (*Prunus serotina* var. *eximia*), Texas ash (*Fraxinus texensis*), and cedar elm (*Ulmus crassifolia*). Aside from seedlings of the canopy trees, common understory species include Texas mountain laurel (*Dermatophyllum secundiflorum*), Carolina buckthorn (*Frangula caroliniana*), yaupon holly (*Ilex vomitoria*), red buckeye (*Aesculus pavia* var. *pavia*), Mexican buckeye (*Ungnadia speciosa*), Lindheimer silk-tassel (*Garrya ovata* var. *lindheimeri*), and elbowbush (*Forestiera pubescens*).

Study Sites

Before alteration by the pandemic restrictions, the plan for 2020 was to continue surveying 16 intensive monitoring sites (City of Austin and Travis County 2019; Table 1, exhibits A-C), re-sighting on two discontinued intensive monitoring plots where banded warblers were still observed in 2019 (Table 1, Exhibit C), and volunteer search efforts for banded warblers on 33 search areas outside of the intensive monitoring and re-sighting plots (Exhibit C) to obtain additional information on return rates and dispersal.

COVID-19 Restrictions. Warbler surveys for all plots and search areas were suspended or reduced following a city-mandated stay-at-home order due to the COVID-19 pandemic. All surveys were halted from March 27 to April 5. From April 6 to May 16, warbler observations were recorded opportunistically by one or two biologists during security patrols and management activities, which were generally conducted every other week. For many of the plots, surveys resumed to once or twice per week on May 17 until June 15 or until breeding success had been determined, while surveys on other plots remained limited or could not be completed (see further details in Methods, below).

Table 1. Intensive monitoring and re-sighting plots for macrosites within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2020.

Plot Name, Ownership[1], and Size (ha)	Barton Creek Macrosite	Bull Creek Macrosite	Cypress Creek Macrosite	No. Lake Austin Macrosite	So. Lake Austin Macrosite	West Austin Macrosite
Intensive Monitoring Plots						
Barton Creek (COA)	40.5					
Barton Creek Habitat Preserve (TNC)*	81.5					
Barton West (COA) [2]	47					
Forest Ridge (COA)		40.5				
Hamilton West (COA)		40.5				
Kent Butler (COA)		40.5				
Collins (TC)			40.5			
Vista Point (TC)			40.5			
Wheless (TC)			40.5			
Cortaña (COA)				62		
Emma Long (COA)				40.5		
Emma Long Bike Park (COA)[2]				96		
Emma Long Expansion (COA)[2]				34[3]		
JJ&T (COA)					40.5	
Reicher (COA)					40.5	
Wild Basin/Vireo Preserve (COA, St. Edwards, TC)						180
Re-sighting Plots						
3M/St. Edwards (COA)		40.5				
Canyon Vista (TC)		40.5				

*Barton Creek Habitat Preserve was closed except for two surveys in late May due to COVID-19 restrictions.
[1]COA = City of Austin, TC = Travis County, TNC = The Nature Conservancy
[2]Emma Long Bike Park, Emma Long Expansion, and Barton West are not part of the long-term monitoring plan, but will continue to be intensively monitored contingent on staffing and budget.
[3]Plot size corrected from 2016 report (41 to 34 ha).

METHODS

Golden-cheeked Warbler Monitoring on Intensive Monitoring Plots

COVID-19 Restrictions. Except for the Vireo Preserve tract, where more frequent visits were permitted to maintain habitat restoration projects, survey hours for intensive monitoring plots in 2020 (Exhibit C) were about half of the 2019 effort (City of Austin and Travis County 2019). The Nature Conservancy (TNC)'s Barton Creek Habitat Preserve remained closed for the entire season, with the exception of two surveys conducted by TNC staff in mid to late May; the limited dataset precluded assigning territories and reproductive success, so this plot was excluded from the analyses.

Color Banding. Color banding was conducted from March 11 through June 3, 2020. With the COVID-19 restrictions, the majority of warblers were banded early or late in the field season. All warblers captured in mist nets were marked with a unique combination of a U.S. Geological Survey numbered aluminum band and auxiliary color bands to allow identification of each individual. We used color-band combinations issued by the biological staff at Ft. Hood Military Reservation. Other data collected during banding included date, time, banding location, temperature, and weather conditions. Individuals were sexed and aged

(second-year [SY], after second-year [ASY], hatching-year [HY], or after hatching-year [AHY] according to Pyle [1997] and Peak and Lusk [2009]). Each warbler was photographed just prior to release to document band combinations.

Territory Delineation. Before alteration by pandemic restrictions, surveys on each intensive monitoring plot were planned for at least once a week from March 15 through May 25 to delineate territories (at least 10 surveys). Biologists followed the intensive monitoring plot protocols (Exhibit D) prior to March 27 and after May 17. From April 6 to May 16, biologists collected data on color-band combinations and a limited number of locations of warblers encountered within the plot (and buffer, if any) while conducting patrols and other management activities. Male warblers were considered territorial if they were observed in the same area on three different days, spread over a 21-day period, between March 15 and May 25. Exhibit C lists the lead surveyors and level of effort, including number of survey weeks and survey hours, for each intensive monitoring plot.

Warbler observations were recorded with Garmin global positioning units (GPS), which have an accuracy of 3 to 9 m. All observations were recorded on topographic maps, using a 100-m Universal Transverse Mercator (UTM) grid. Date; color combination (for observations of banded birds); UTM coordinates; and presence of female, nest, and/or fledglings were recorded for each observation. The data were then entered into ArcGIS® (ESRI, Redlands, California) and displayed so that territories could be delineated. Territorial boundaries for each male were delineated using minimum convex polygons in ArcGIS® 10.6.1.

The number of territories on the monitoring plots was calculated three ways: 1) full territories (territories contained entirely within the plot); 2) full and edge territories, in which each is counted as 1.0 territory; and 3) applying Verner's (1985) method (each full territory counted as 1.0 territory and each edge territory counted as 0.5 territory). Verner's counting method was recommended by Weckerly and Ott (2008) and avoids the upward bias inherent in the IBCC (1970) method (both full territories and edge territories counted as 1.0 territory). This study assumes a full territory is one in which a male is observed singing outside the plot no more than once (could be multiple positions on one visit) between March 15 and May 25. A territory is considered outside the plot if the singing male is found within the plot no more than once (could be multiple positions on one visit). An edge territory is one in which the singing male is observed both inside and outside the plot on more than one visit each or where a nest was found within a few meters of the plot boundary. Territory density is calculated as the number of territories (using Verner's [1985] counting method) divided by the plot size.

Age Structure. To calculate age structure for each study plot, the number of territorial SY, ASY, and AHY males was divided by the total number of territorial males with a known age (i.e., color-banded males only).

Return Rate. Return rates are based on the total number of color-banded adult males present in 2019 (including returns from previous years and those banded in 2019) that were observed again in 2020.

Pairing and Reproductive Success. With the lifting of the stay-at-home order in mid-May, staff were able to resume surveys to collect productivity data through June 15. Mated status and reproductive success were

reported for both full and edge territories. Territories for which mated status and reproductive success were undetermined are not included in the analyses for these parameters. A male was determined to be paired if he was observed associating with a female, observed tending young, or a nest was located for that male. Pairing success is the percentage of males determined to have paired with a female for territories in which the pairing success is known. A territory was considered to have had breeding success if the male or female was observed tending one or more fledglings. Breeding success is the percentage of territories, of known breeding success, determined to have produced at least one fledgling. Reproductive success is presented as the total number of observed and adjusted number of fledglings (described below) for each plot and as a density estimate using Verner's (1985) method (number of fledglings per full + 0.5 territories divided by the plot size). To allow for comparison with previous years, productivity is also presented in two ways: as the sum of all fledglings divided by the total number of territories for which reproductive success or failure is known, and as the sum of all fledglings divided by the number of pairs that produced at least one or more fledglings.

Based on camera monitoring, Reidy et al. (2008) documented a mean number of 3.6 young fledged per successful nest in the Bull Creek and North Lake Austin macrosites. This estimate was applied to those territories where the number of fledglings was uncertain, and less than 4, to obtain adjusted estimates of the number of young produced and productivity estimates. Since the estimate of 3.6 young fledged per nest may be high for some habitat patches, the actual number of fledglings is likely somewhere between the observed and adjusted values.

A few territories produced double broods. Since documentation of double broods is opportunistic, they are not included in the estimated number of fledglings and productivity.

Nest monitoring. Due to COVID-19 restrictions, nests were located and monitored as staff and resources allowed. UTM coordinates were recorded for each nest location using Garmin GPS units. A nest was considered successful only if one or both adults was detected tending to fledglings. If nesting activity ceased prior to possible fledging, nest fate was recorded as failed. If nesting activity ceased around the time of anticipated fledging, and the pair was not detected or rarely detected for the remainder of the breeding season, nest fate was recorded as unknown.

Golden-cheeked Warbler Monitoring on Re-sighting Plots

Before pandemic restrictions, BCP staff and volunteers planned to conduct four weekly visits to the Canyon Vista and 3M/St. Edwards re-sighting plots from approximately March 20 through April 15, and one late-season visit to detect dispersing birds (approximately May 15-May 25), for a total of five visits. The purpose of these surveys was to visually confirm the banding status (banded or unbanded) and color combination of all warblers observed within the re-sighting plot (and buffer, if any) and recorded their geographic positions.

COVID-19 Restrictions. BCP biologists and a volunteer conducted a total of five weekly surveys on Canyon Vista. The volunteer made one visit in March before restrictions were implemented, and the biologists

conducted four surveys beginning at the end of April. Biologists conducted two surveys on 3M/St. Edwards in April (Exhibit C).

Search for Banded Warblers Outside of Intensive Monitoring/Re-sighting Plots

Before pandemic restrictions, the plan was for volunteers to conduct three surveys of six hours each (18 hours total) between March 20 and May 25, with the first survey conducted within the first two weeks of the season (March 20-April 2). One 6-hour survey could be divided into two or three outings within the course of one week. Separate surveys were to be at least one week apart and preferably earlier in the season. During each survey, volunteers would visually confirm the banding status (banded or unbanded) and color combination of all warblers observed within the search areas and record their geographic positions.

COVID-19 Restrictions. The volunteer re-sighting effort was suspended on March 27 and resumed on May 18. This reduced the number of 2020 search areas covered from 33 to 25. Forty-six volunteers conducted as many visits as possible given the COVID-19 restrictions. The list of search areas where surveys were planned, and the survey effort for each search area, are reported in Exhibit C.

Golden-cheeked Warbler DNA sampling

The City of Austin has been collaborating with Dr. Giri Athrey at Texas A&M University since 2018 to collect DNA samples across the warbler's breeding range. In 2020 we collected DNA samples from 104 warblers. These samples were collected from Kickapoo Caverns State Park, Garner State Park, Shield Ranch at Camp Wood, Government Canyon State Natural Area, Guadalupe River State Park , Colorado Bend State Park, Meridian State Park, and Palo Pinto State Park. These samples will be extracted and sequenced to examine changes in genetic diversity and levels of dispersal across the range. These data will be used to assess gene flow, effective population size, and ultimately, population health.

RESULTS AND DISCUSSION

Territory Delineations

A total of 137 territories were identified in field season 2020, adjusted to 109 territories using Verner's (1985) method, for 15 intensive monitoring plots. (Barton Creek Habitat Preserve was excluded due to only one survey between March 15-May 25, on May 15.) This represents an average estimated density of 0.13 territories per ha for the combined 824 ha of intensive monitoring plots, ranging from 0.02 to 0.37 territories/ha (Table 2). One territory that overlapped two plots (Emma Long Bike Park, Emma Long Expansion) was counted as an edge territory on both plots; to avoid double-counting across plots, this territory is noted in Table 2. Territory densities were highest in closed-canopy woodlands of the largest habitat patches (Bull Creek and Cypress Creek macrosites), and lowest in the small habitat patches surrounded by urban development (West Austin and Barton Creek macrosites) and areas with shorter (<3.35 m) canopy heights (Cortaña, JJ&T). A summary of the 2009-2020 territory data is provided in Exhibit E. Because the 2020 surveys did not follow protocols and results are not expected to be comparable with previous years, these data were not added to the trend analyses provided in City of Austin and Travis County (2019). Exhibit B shows warbler observations and territory delineations for the intensive monitoring plots.

Table 2. Golden-cheeked warbler territory number and estimated territory density (per hectare) within 16 intensive study plots on the Balcones Canyonlands Preserve, Travis County, Texas, field season 2020.

Plot Name	No. of Full Territories	No. of Full and Edge Territories	No. of Full Territories + (0.5 x Edge Territories)[1]	Territory Density Per Hectare[1]
Barton Creek Macrosite				
Barton Creek	2	2	2	0.05
Barton Creek Habitat Preserve[*]	--	--	--	--
Barton West	0	2	1	0.02
Bull Creek Macrosite				
Forest Ridge	10	17	13.5	0.33
Kent Butler	12	18	15	0.37
Hamilton West	6	12	9	0.22
Cypress Creek Macrosite				
Collins	6	11	8.5	0.21
Vista Point	11	16	13.5	0.33
Wheless	3	5	4	0.10
North Lake Austin Macrosite				
Cortaña	3	3	3	0.05
Emma Long	7	12	9.5	0.23
Emma Long Bike Park	5	13 (+1)[2]	9 (+0.5)[2]	0.10
Emma Long Expansion	4	5 (+1)[2]	4.5(+0.5)[2]	0.15
South Lake Austin Macrosite				
Double J&T	4	6	5	0.12
Reicher	3	8	5.5	0.14
West Austin Macrosite				
Wild Basin/Vireo Preserve	6	6	6	0.03
All Plots Combined	**82**	**137**	**109**	**0.13**

[*]Barton Creek Habitat Preserve was closed except for one survey between March 15-May 25 (May 15) due to COVID-19 restrictions.

[1]Calculation based on Verner's counting method (see Methods section for calculations). Plots average 40.5 ha except for Barton Creek Habitat Preserve (81.5 ha), Barton West (47 ha), Emma Long Bike Park (96 ha), Emma Long Expansion (34 ha), Cortaña (62 ha), and Wild Basin/Vireo Preserve (180 ha).

[2]Emma Long Bike Park and Emma Long Expansion are contiguous, so one or more territories may be on both plots. These territories are indicated in parentheses to ensure they are only counted once for all plots combined.

Color Banding

City of Austin and Travis County staff color-banded a total of 84 adult warblers (79 males, 4 females) and one hatch-year in 2020.

Age Structure

Of the 137 territorial males identified on the 15 intensive study plots in 2020, 90 were color-banded (Table 3). Of these males, 47 were ASY and 43 were SY. One interesting observation was a skew towards SY males on Kent Butler (12 SY, 2 ASY), which is unusual for this plot. Most other plots were split fairly evenly at least with respect to the banded males. The different age structures observed among plots may be due to the influence of habitat characteristics on the recruitment of young territorial males, immigration of warblers displaced due to habitat loss outside of the preserves, prior reproductive success (or lack thereof), juvenile and adult survival, and/or other factors. A summary of male age structure on intensive monitoring plots from 2009-2020 is presented in Exhibit F.

Table 3. Golden-cheeked warbler age structure data for color-banded territorial males observed within 16 intensive study plots on the Balcones Canyonlands Preserve, Travis County, Texas, field season 2020.

Plot Name	SY Males	ASY Males	AHY Males	Total Banded Males	Total Unbanded Males	% Banded Males
Barton Creek Macrosite						
Barton Creek	0	2	0	2	0	100
Barton Creek Habitat Preserve*	--	--	--	--	--	--
Barton West	0	1	0	1	1	50
Bull Creek Macrosite						
Forest Ridge	6	8	0	14	3	82
Kent Butler	12	2	0	14	4	78
Hamilton West	4	2	0	6	6	50
Cypress Creek Macrosite						
Collins	1	5	0	6	5	55
Vista Point	3	5	0	8	8	50
Wheless	0	1	0	1	4	20
North Lake Austin Macrosite						
Cortaña	2	1	0	3	0	100
Emma Long	4	5	0	9	3	75
Emma Long Bike Park	4 (+1)[1]	5	0	10	4	71
Emma Long Expansion	(+1) [1]	3	0	4	2	67
South Lake Austin Macrosite						
Double J&T	5	0	0	5	1	83
Reicher	0	6	0	6	2	75
West Austin Macrosite						
Wild Basin/Vireo Preserve	0	1	0	1	5	17
All Plots Combined	**42**	**47**	**0**	**89**	**48**	**65**

*Barton Creek Habitat Preserve was inaccessible for color banding due to COVID-19 restrictions.

[1]Emma Long Bike Park and Emma Long Expansion are contiguous, so one or more territories may be on both plots. These territories are indicated in parentheses to ensure they are only counted once for all plots combined.

Return Rates

The overall return rate of color-banded warbler males in 2020 was 32% (48/152), lower than the return rates observed in all other years. One of these returning males was banded as a hatch-year on Cortaña in 2018 and observed on the Lucas West tract in 2020. Other dispersers included three males banded as adults in 2019: a male banded on Emma Long Bike Park returned to Emma Long, a male banded on Barton Creek returned to Reicher Ranch, and a male banded on Cortaña returned to Emma Long Bike Park. Two returning females were also observed in 2020; both returned to the vicinity where they were banded in 2019.

Pairing and Reproductive Success

In 2020, a total of 137 territories were monitored for pairing and reproductive success on the 15 intensive study plots (Table 4). The average pairing and breeding success observed for all territories was 96% (range

73-100%) and 74% (range 31-100%), respectively. Staff detected 253 fledglings from 96 territories known to have been successful. Applying the Reidy et al. (2008) estimate of 3.6 young fledged per successful nest in the Bull Creek and North Lake Austin macrosites to the number of territories where the number of fledglings was uncertain and less than 4.0 resulted in an adjusted total estimate of 346 young fledged.

While results may not be directly comparable to previous years due to protocol changes, biologists reported that the soundscape across much of the BCP was noticeably quieter during the stay-at-home order, and that productivity appeared to increase on several plots. Both breeding success and fledgling counts were higher overall in 2020 than in 2019 on nine plots, including Barton Creek, Emma Long, Emma Long Bike Park, Forest Ridge, Hamilton, JJ&T, Kent Butler, Wheless, and Wild Basin/Vireo Preserve. The number of fledglings on the Emma Long Bike Park was higher than any previous survey except for the 2012 field season. Biologists observed three additional territories along the roads bordering the Bike Park in 2020, which contributed to the increased productivity. Whether this increase was the result of reduced traffic along the roads bordering the Bike Park or increased observer detection because of reduced traffic is unknown. All three warbler territories on the Vireo Preserve produced fledglings, and one warbler nested next to the Wild Basin visitor center, which was closed during most of the breeding season. Fledglings were also observed for the first time near the Barton Creek Habitat Preserve plot, although not on the plot. Lower breeding success and fledgling counts were reported for Vista Point and Reicher Ranch in 2020. A summary of the 2009-2020 reproductive success data is presented in Exhibit G.

Table 4. Golden-cheeked warbler reproductive success on 16 intensive study plots on the Balcones Canyonlands Preserve, Travis County, Texas, field season 2020. Data are based on observations for both full and edge territories.

Plot Name	No. of Territories	No. of Territories w/ Female	Percent Pairing Success[1]	No. of Territories Producing ≥ 1 Young	Percent Breeding Success[1]	Observed and Adjusted* Productivity	Observed and Adjusted* Productivity Per Successful Territory	Total No. of Fledglings Observed and Adjusted* Fledglings	Density of Observed and Adjusted* Fledglings Per Hectare**
Barton Creek Macrosite									
Barton Creek	2	2	100	2	100	2.5 / 3.6	2.5 / 3.6	5 / 7.2	0.12 / 0.18
Barton Creek Habitat Preserve	--	--	--	--	--	--	--	--	--
Barton West	2	2	100	1	50	1.0 / 1.8	2.0 / 3.6	2.0 / 3.6	0.02 / 0.04
Bull Creek Macrosite									
Forest Ridge	17	17	100	13	100	1.9 / 2.8	2.5 / 3.7	33 / 47.6	0.68 / 0.95
Kent Butler	18	17	100	14	88	1.9 / 2.5	2.5 / 3.3	35 / 45.8	0.73 / 0.91
Hamilton West	12	9	90	8	67	1.7 / 2.4	2.5 / 3.6	20 / 28.8	0.35 / 0.49
Cypress Creek Macrosite									
Collins	11	8	73	8	73	1.7 / 2.6	2.4 / 3.6	19 / 28.8	0.31 / 0.49
Vista Point	16	13	81	5	31	1.1 / 1.2	3.4 / 3.8	17 / 19.2	0.31 / 0.34
Wheless	5	5	100	5	100	3.6 / 3.8	3.6 / 3.8	18 / 19.2	0.37 / 0.39
North Lake Austin Macrosite									
Cortaña	3	3	100	3	100	2.0 / 3.6	2.0 / 3.6	6 / 10.8	0.10 / 0.18
Emma Long	12	12	100	10	83	2.3 / 3.1	2.7 / 3.7	27 / 36.8	0.56 / 0.73
Emma Long Bike Park	13 (+1)[2]	13 (+1)[2]	100	11 (+1)[2]	86	2.6 / 3.2	3.0 / 3.8	36 / 45.2	0.27 / 0.33
Emma Long Expansion	5 (+1)[2]	5 (+1)[2]	100	4 (+1)[2]	83	1.7 / 2.9	2.0 / 3.5	10 /17.4	0.25 / 0.46
South Lake Austin Macrosite									
JJ&T	6	5	100	2	33	1.0 / 1.2	3.0 / 3.6	6 / 7.2	0.11 / 0.13
Reicher Ranch	8	6	100	4	50	1.3 / 1.8	2.5 / 3.6	10 / 14.4	0.15 / 0.22
West Austin Macrosite									
Wild Basin/Vireo Preserve	6	6	100	4	67	1.5 / 2.4	2.3 / 3.6	9 / 14.4	0.05 / 0.08
All Plots Combined	**137**	**124**	**96**	**95**	**74**	**1.8 / 2.5**	**2.7 / 3.6**	**253 / 346.4**	**0.24 / 0.33**

*Based on mean number of 3.6 young per successful nest (Reidy et al. 2008) for territories where the number of fledglings was uncertain and less than 4. See Methods section for calculations.

**Density based on number of fledglings produced per full + 0.5 territories divided by the plot size.

[1]Calculations do not include territories where mated and/or breeding status was unknown.

[2]Emma Long Bike Park and Emma Long Expansion are contiguous, so one or more territories may be on both plots. These territories are indicated in parentheses to ensure they are only counted once for all plots combined.

Nest Data

BCP staff found and monitored a total of 64 active warbler nests within or around the intensive monitoring plots during the 2020 field season. The first nests were found on March 22, and fledging dates for observed nests ranged from April 22 through June 10. Of the 64 nests, 37 fledged one or more young (58%), 22

nests failed (34%), and 5 had an unknown fate (8%). There were no observations of brown-headed cowbird (*Molothrus ater*) parasitism at warbler nests in 2020.

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Exhibit A. Distribution of Intensive Monitoring Plots within the Balcones Canyonlands Preserve, 2020. **Due to COVID-19 restrictions, surveys were suspended or reduced from March 28 through May 16.** Disclaimer: these products are for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Property boundaries are not derived from an on-the-ground survey and represent only the approximate relative location of property boundaries. These products have been produced by the Wildland Conservation Division for the sole purpose of geographic reference. No warranty is made by the City of Austin regarding specific accuracy or completeness.

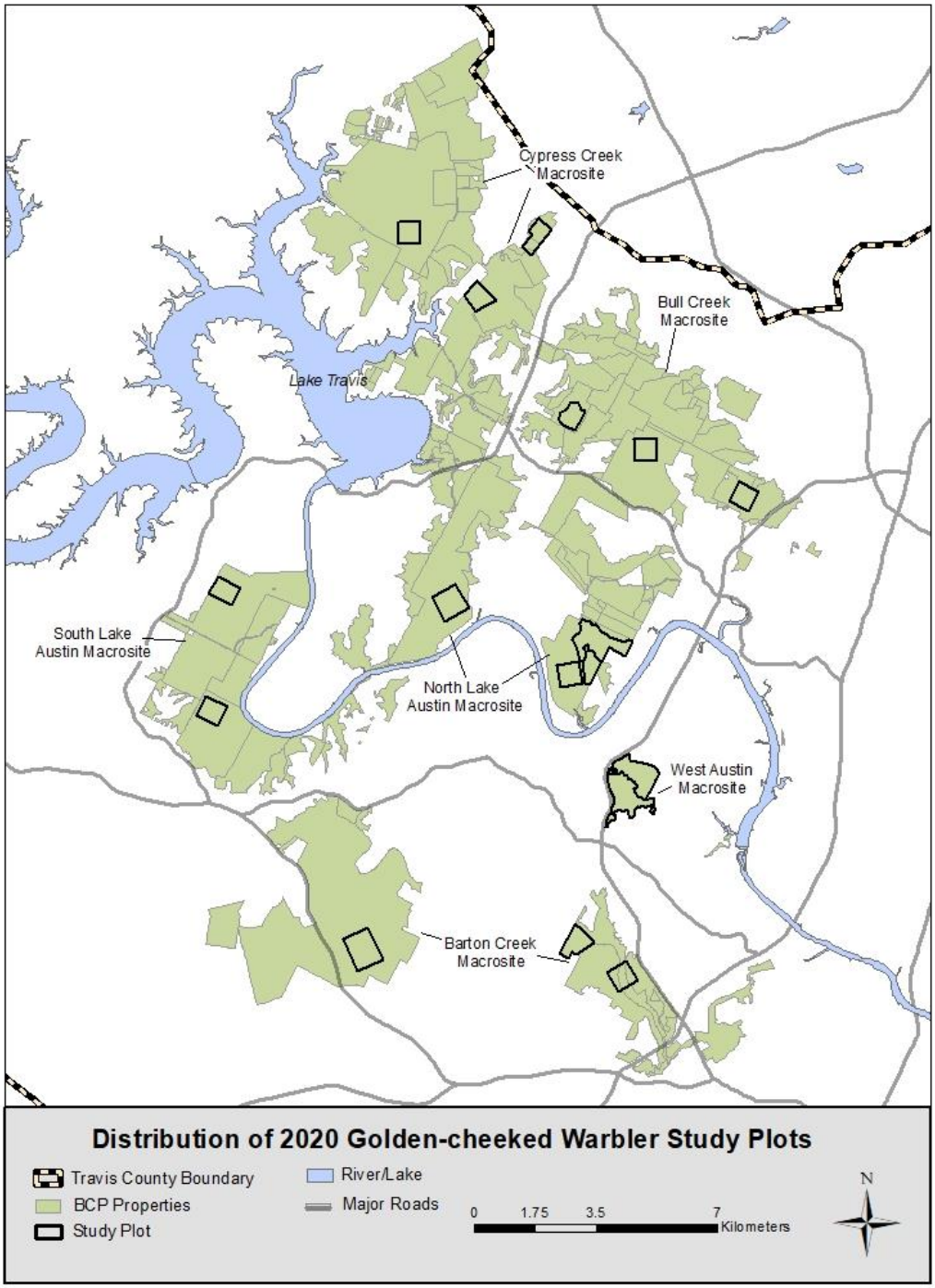

Figure 1

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots, (Figures 2-17), 2020.

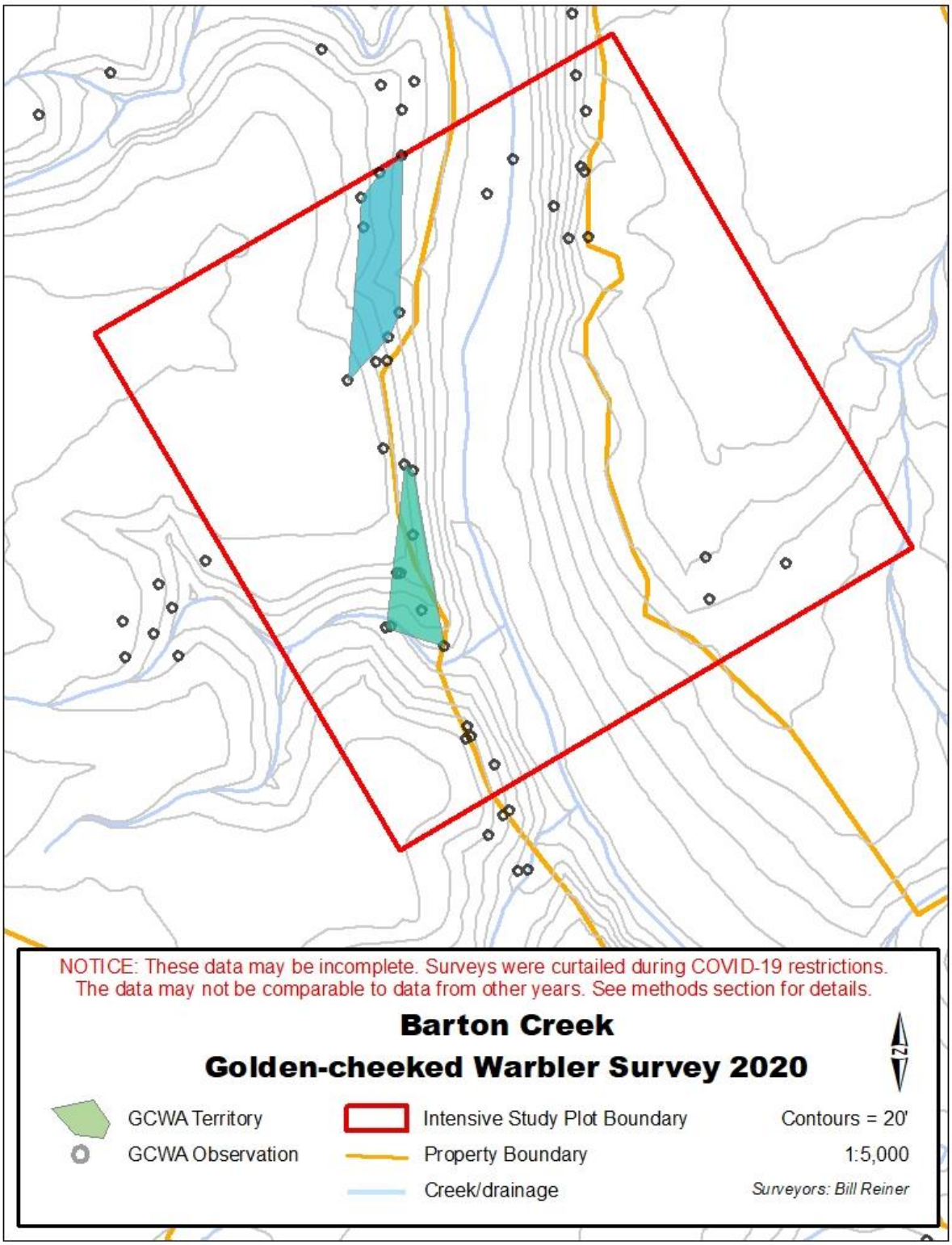

Figure 2

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

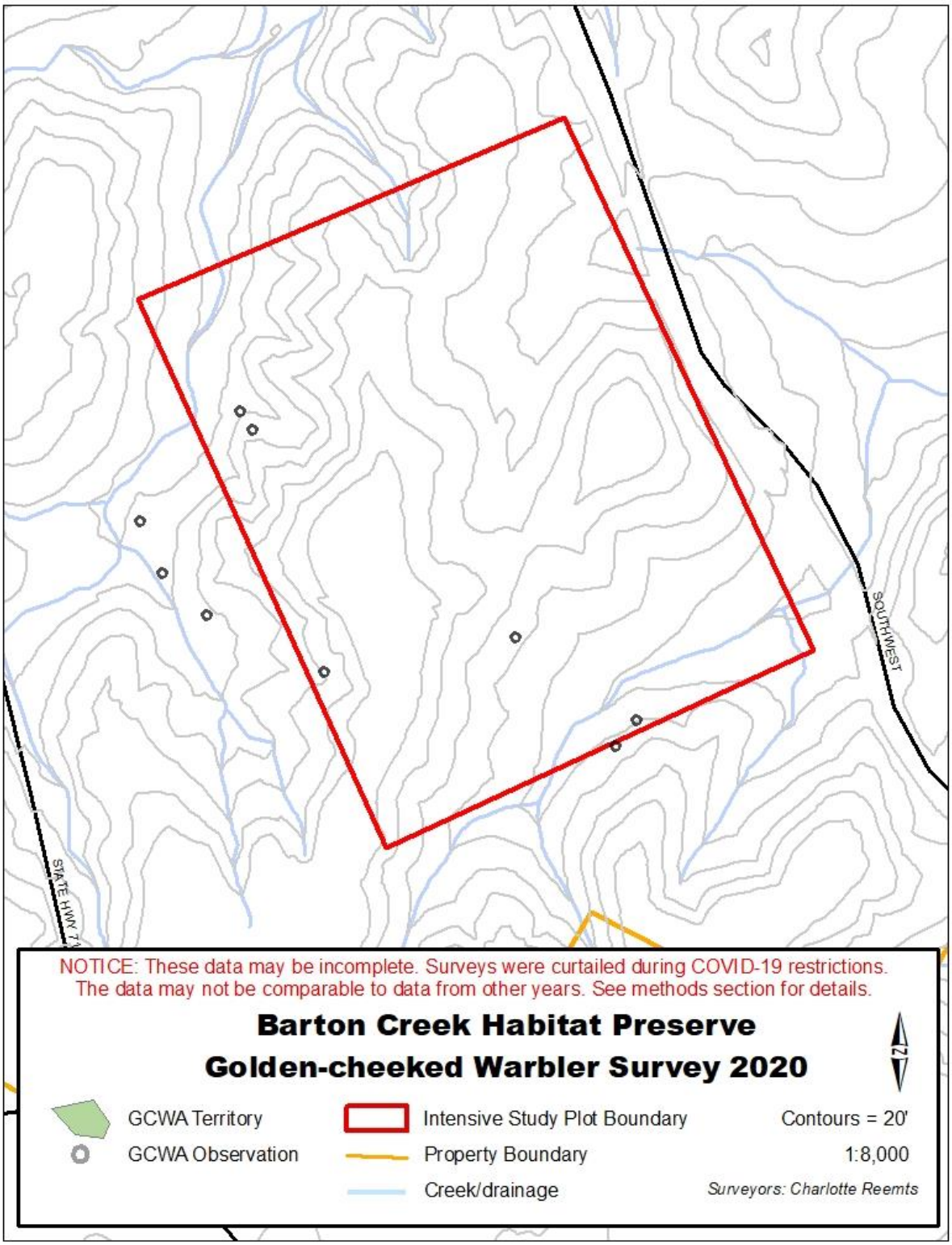

Figure 3

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

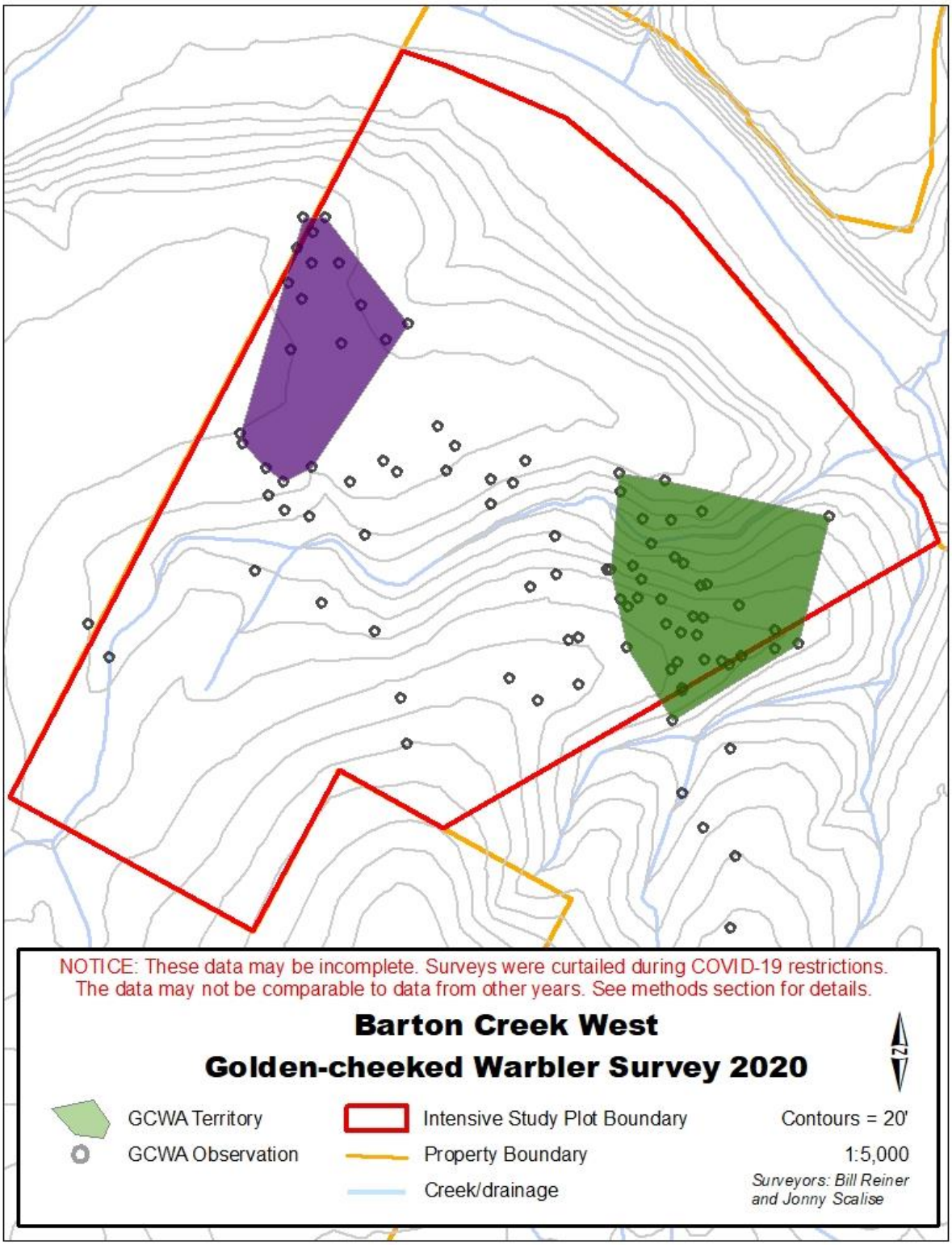

Figure 4

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

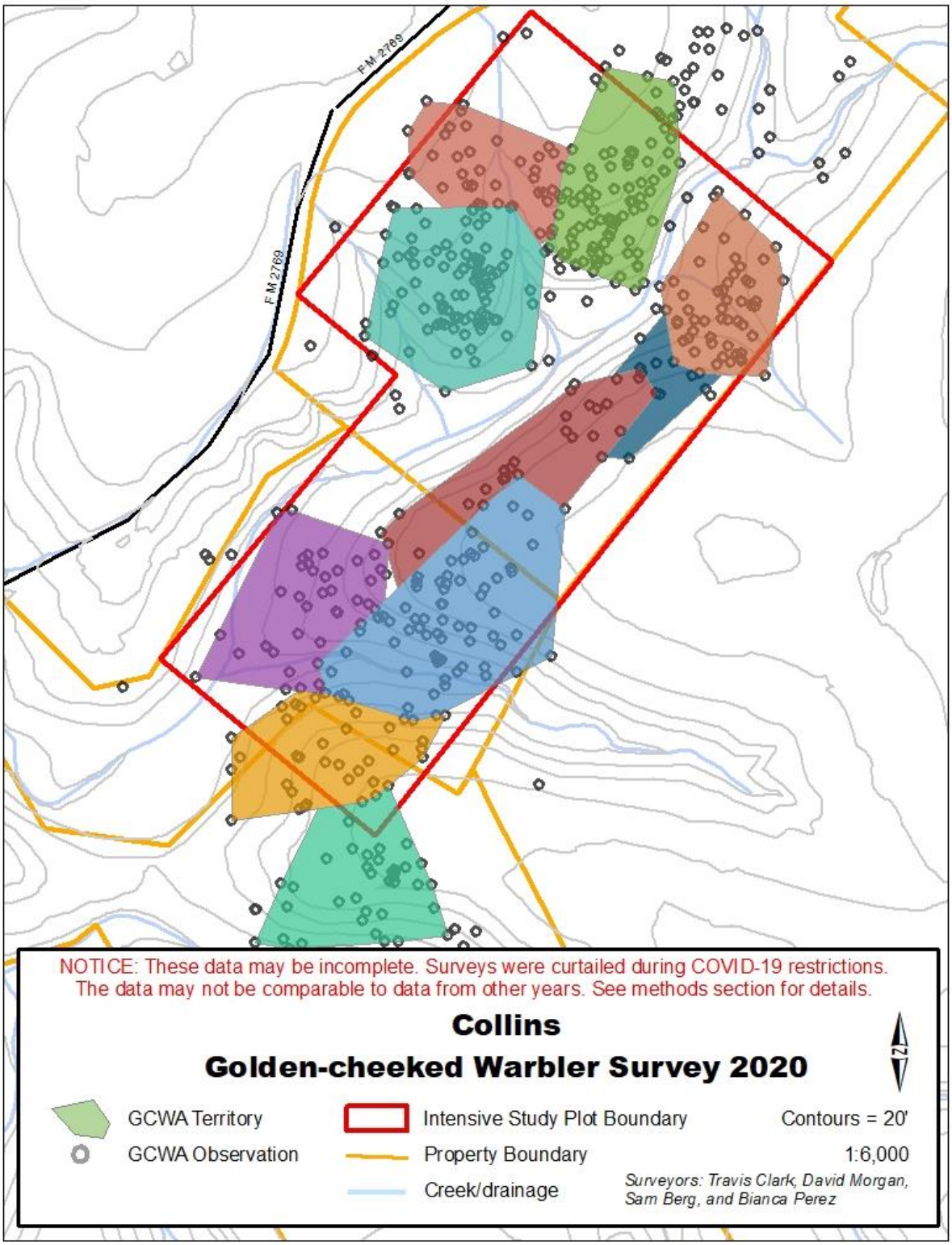

Figure 5

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

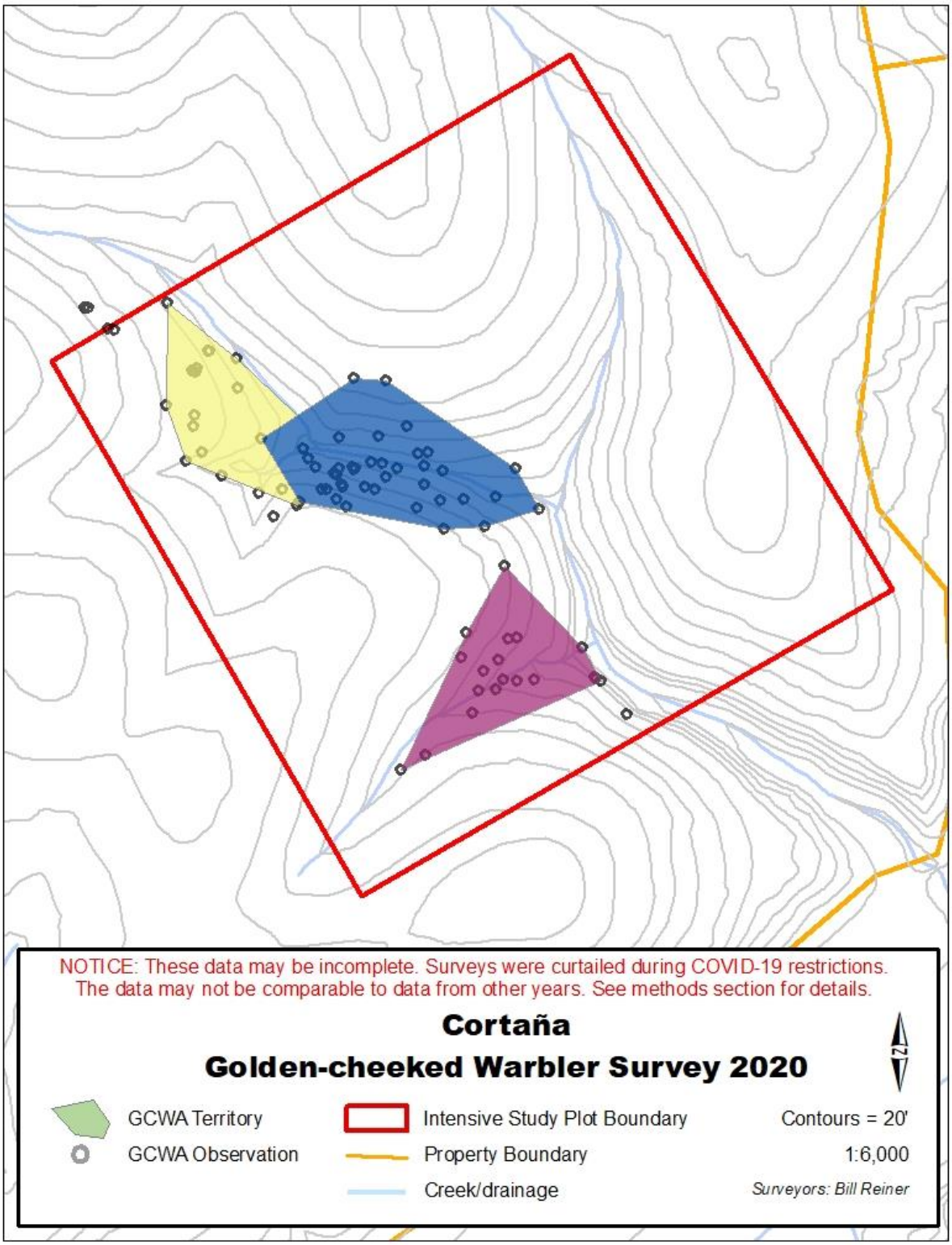

Figure 6

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

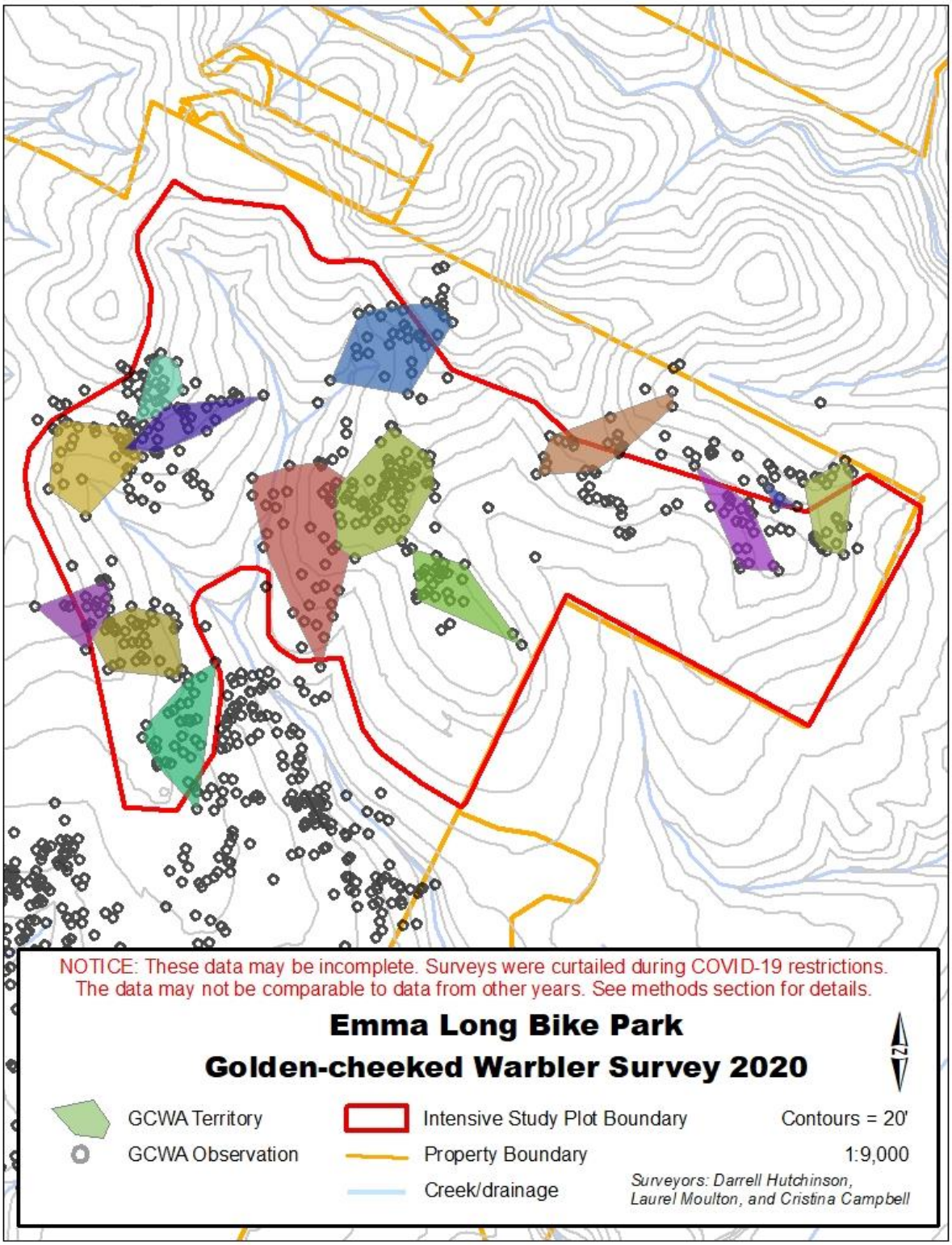

Figure 7

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

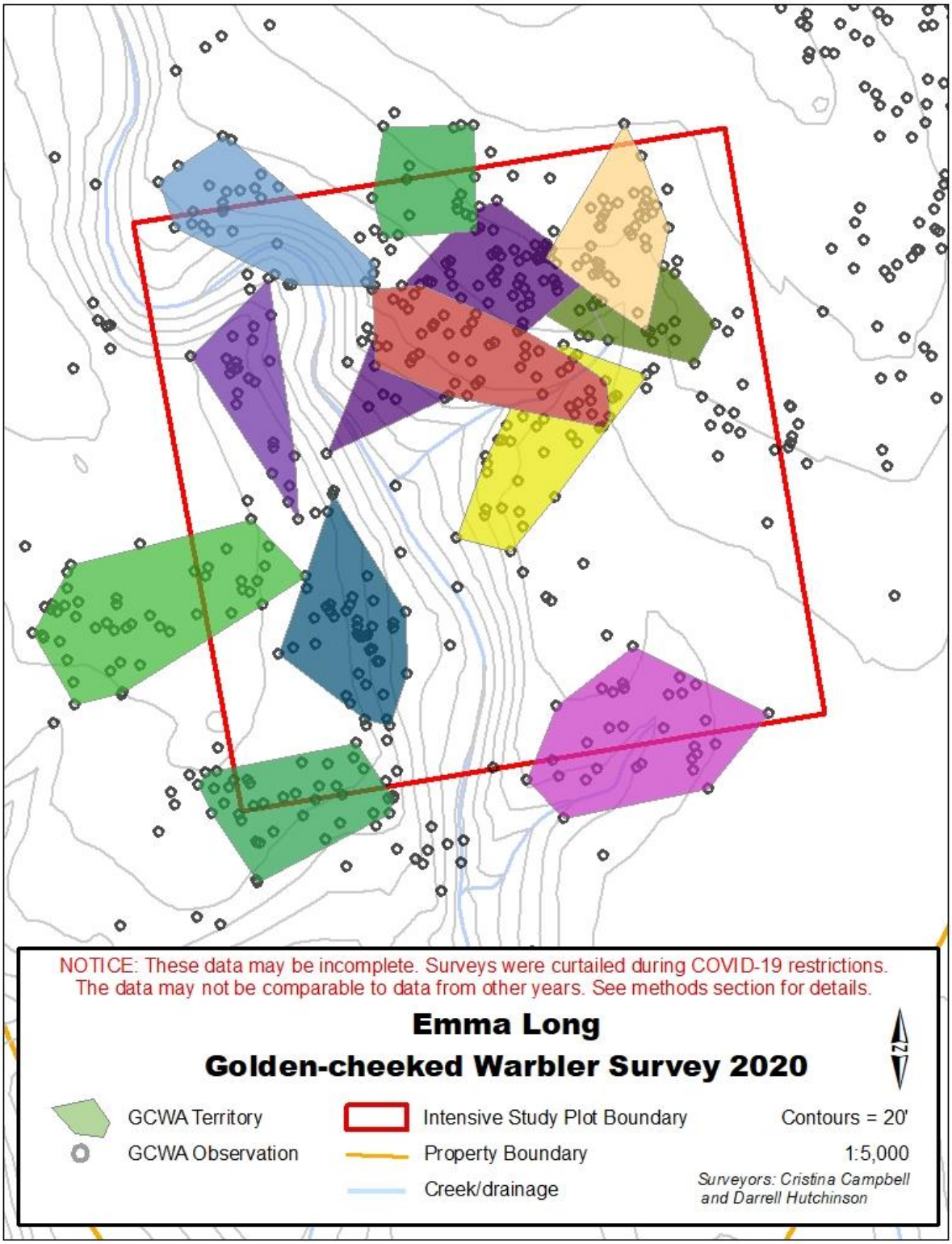

Figure 8

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

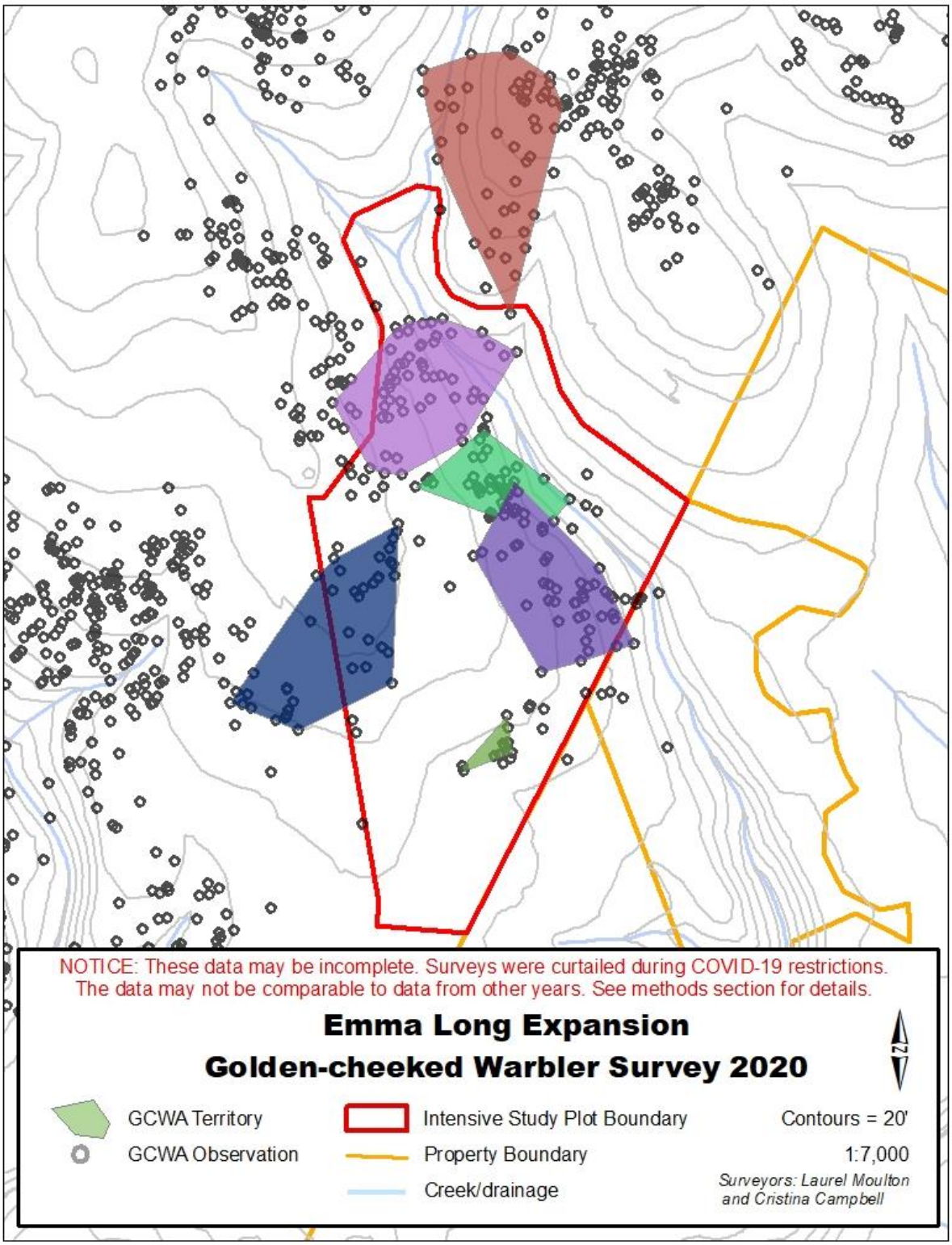

Figure 9

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

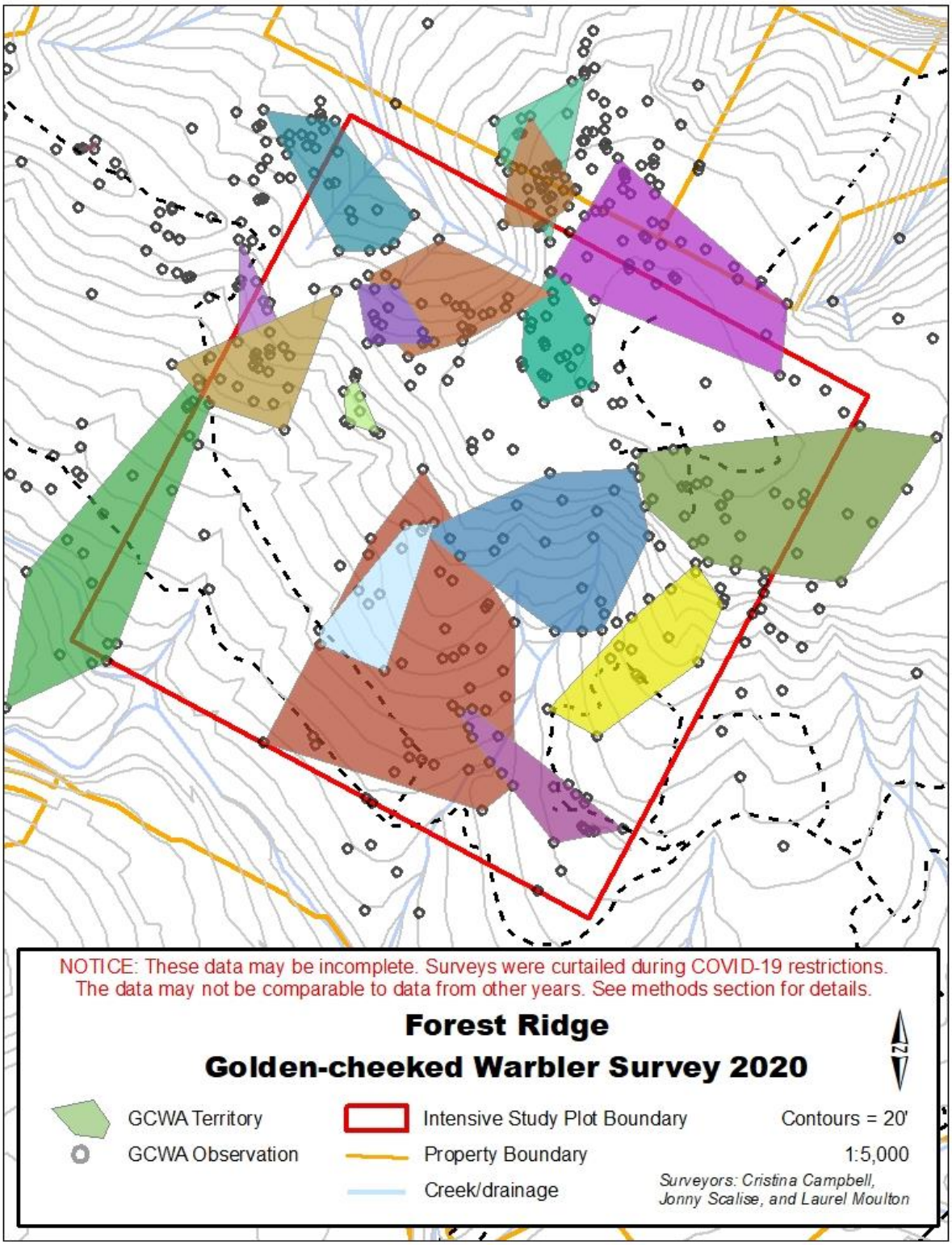

Figure 10

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

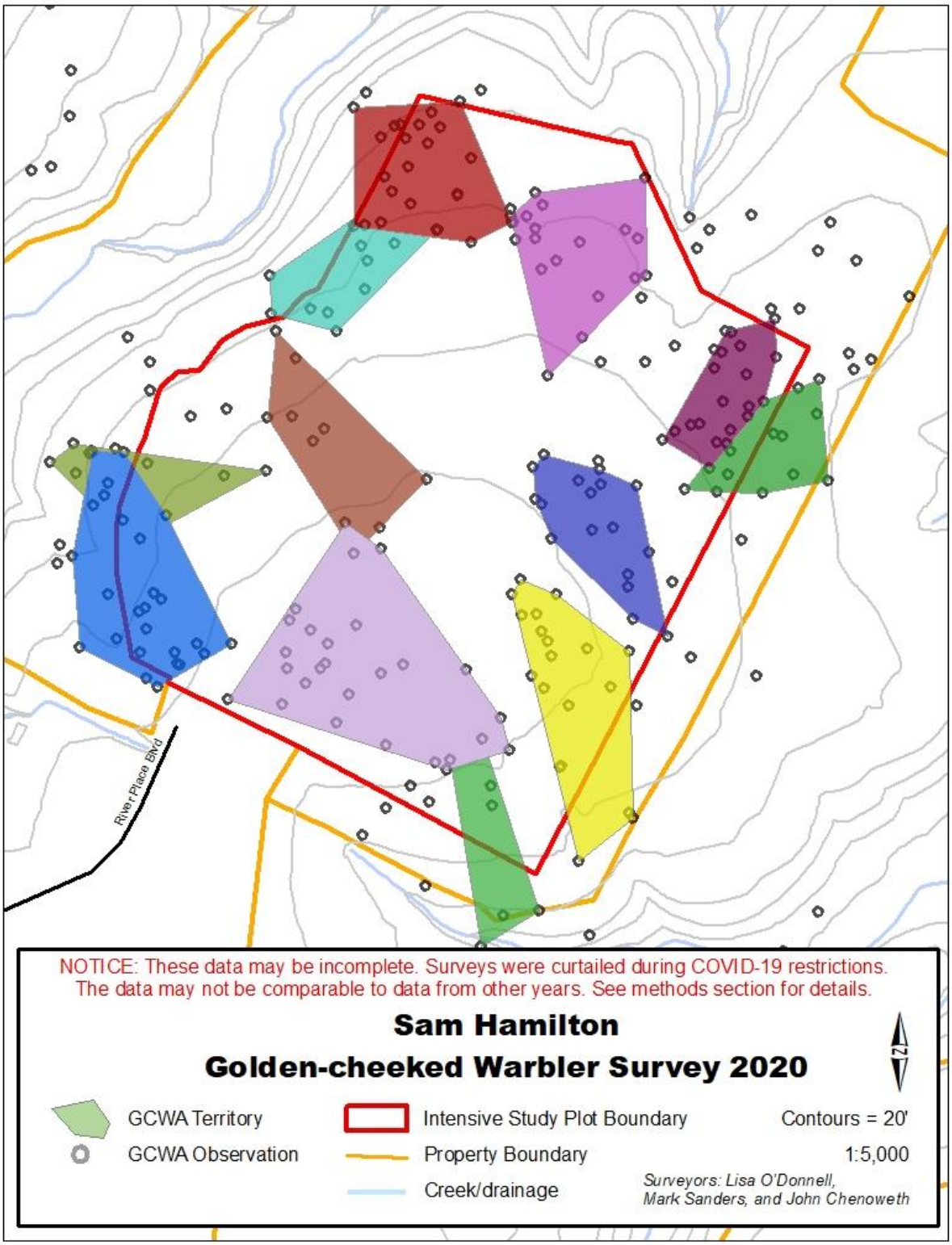

Figure 11

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

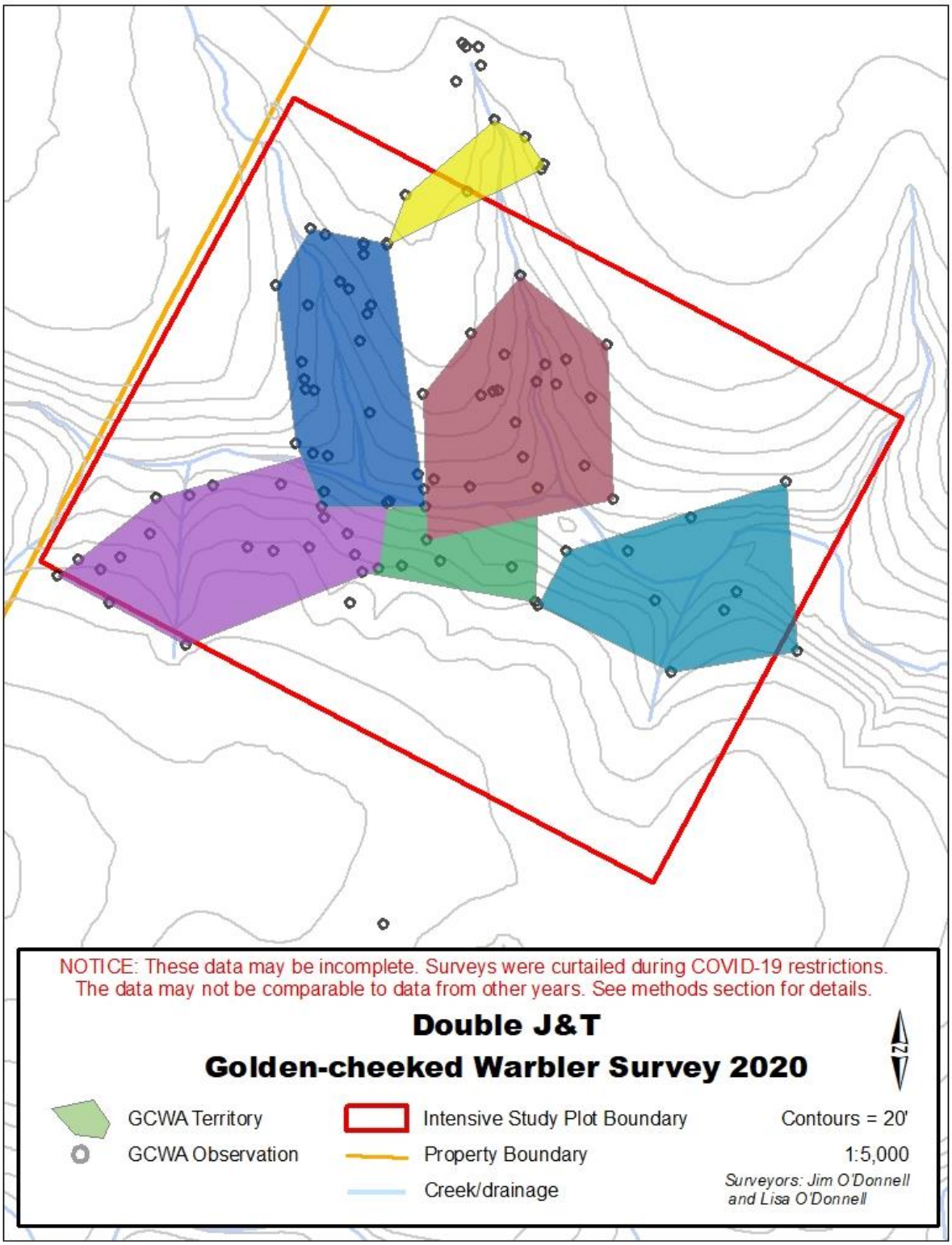

Figure 12

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

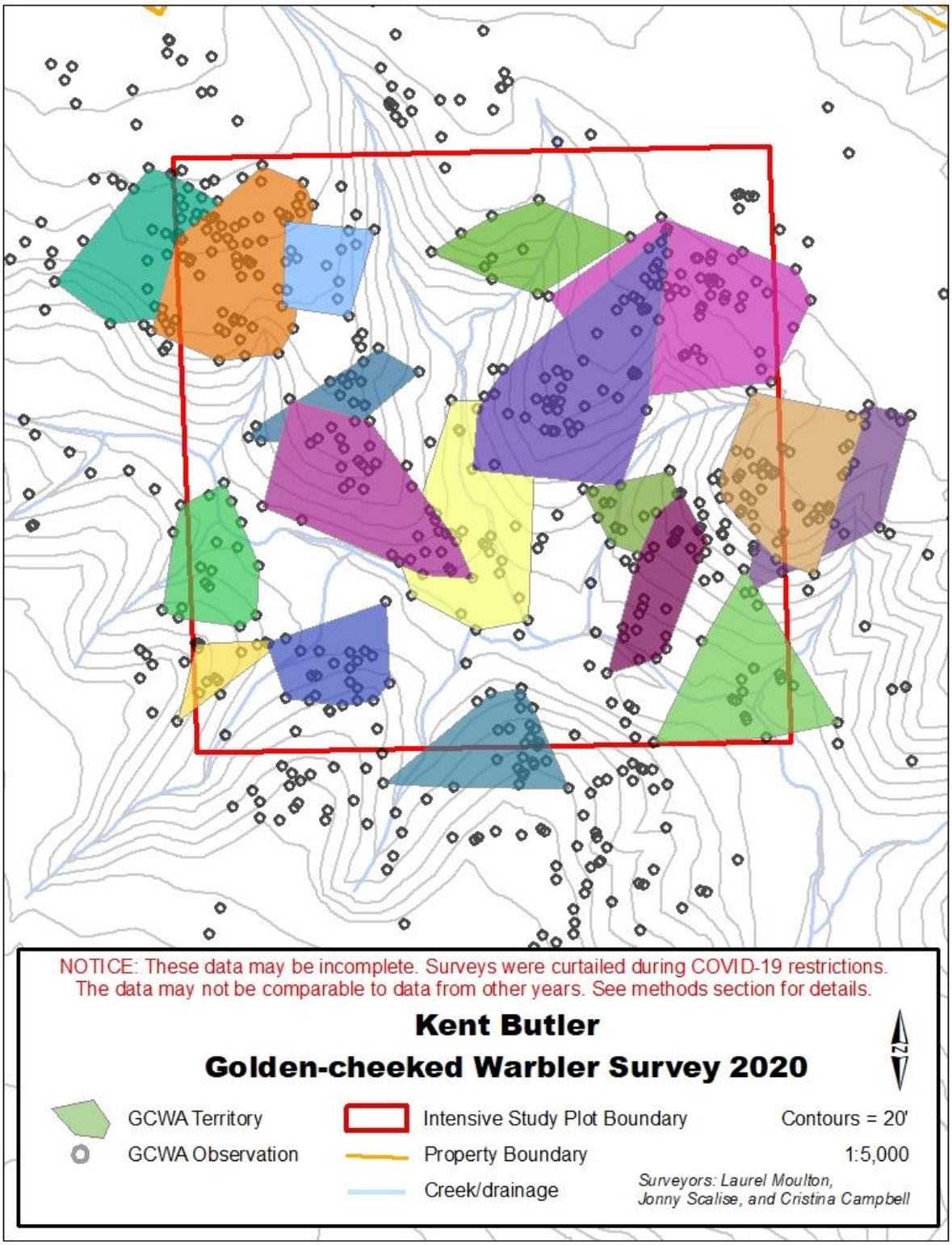

Figure 13

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

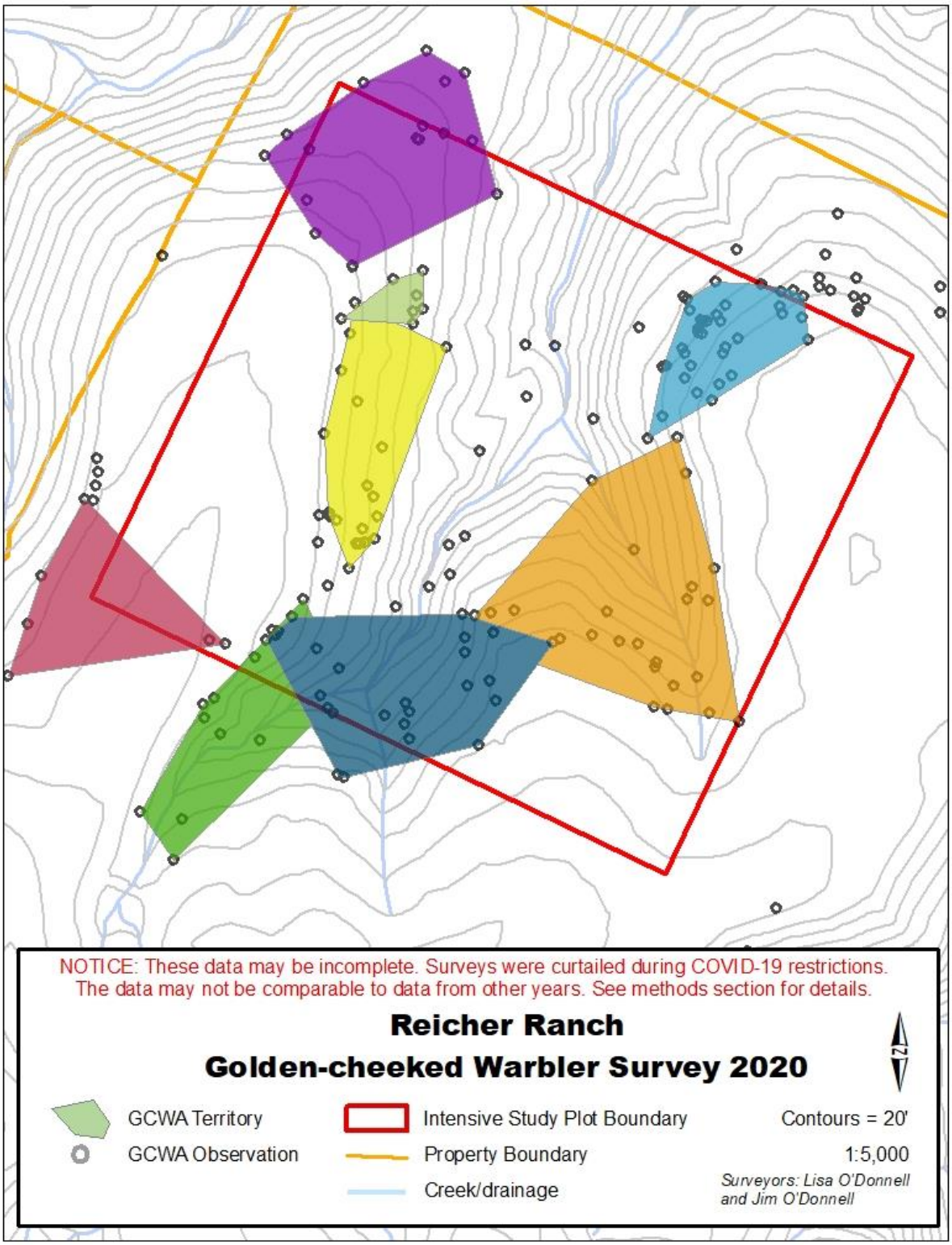

Figure 14

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

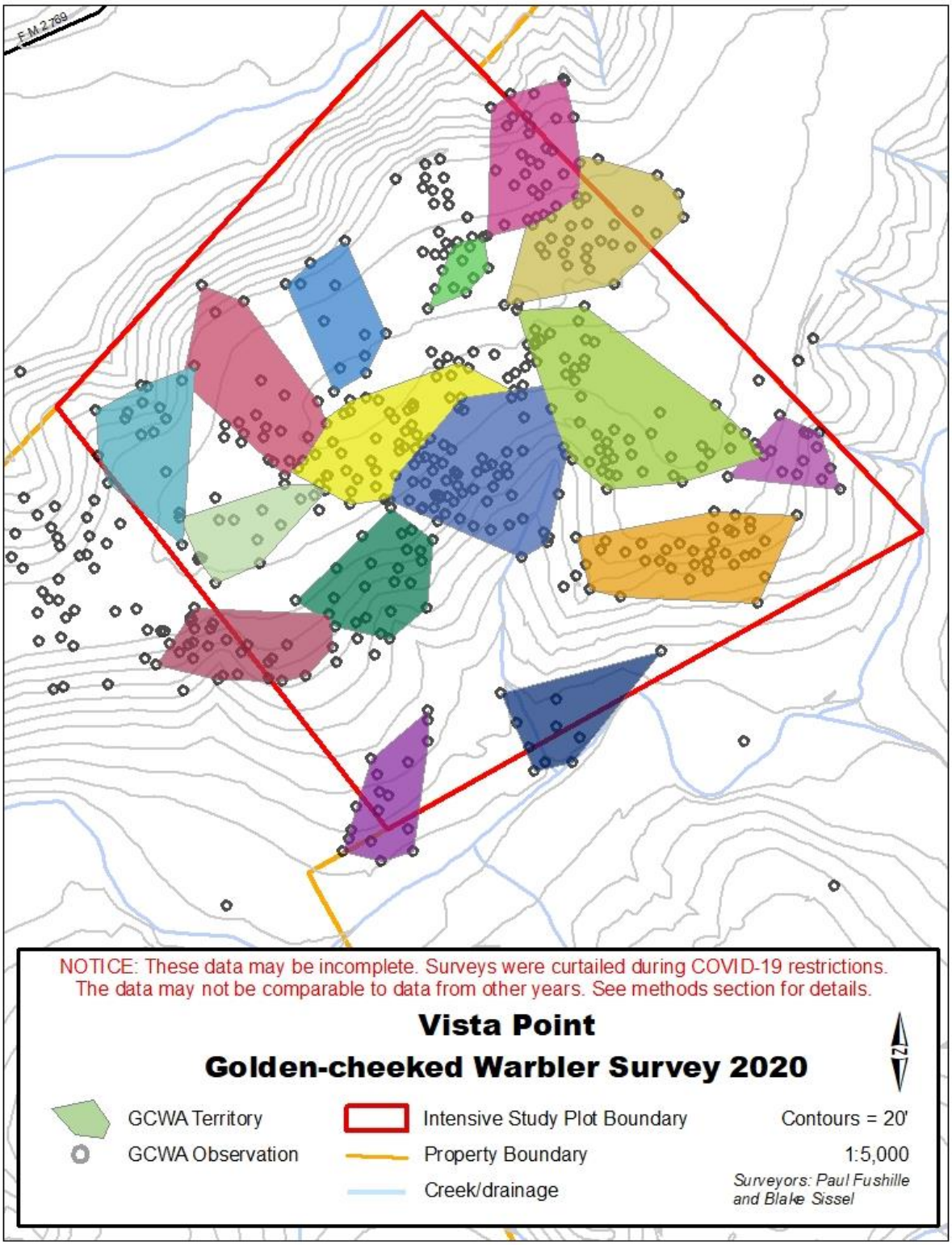

Figure 15

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

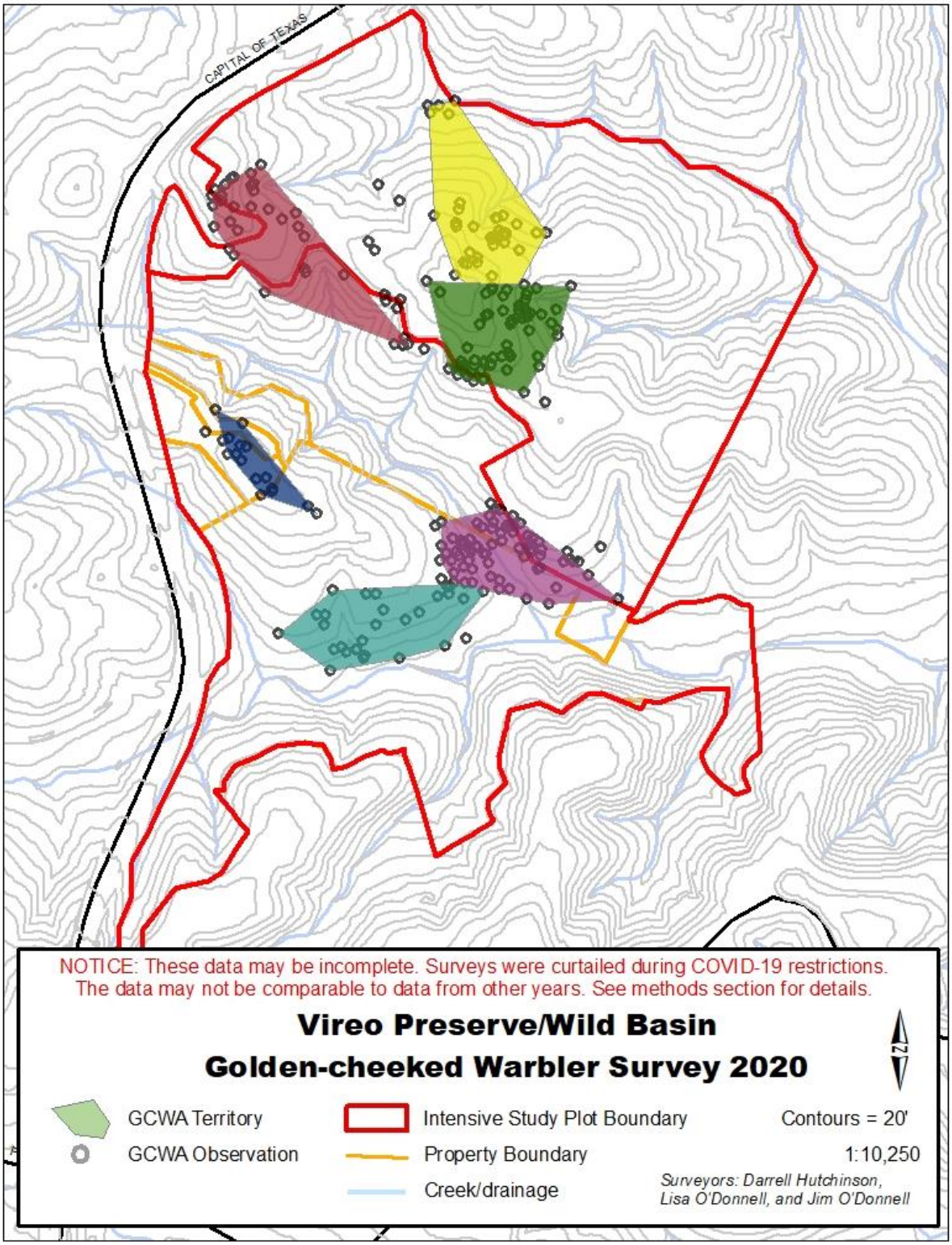

Figure 16

Exhibit B: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Monitoring Plots (Figures 2-17), 2020 (continued).

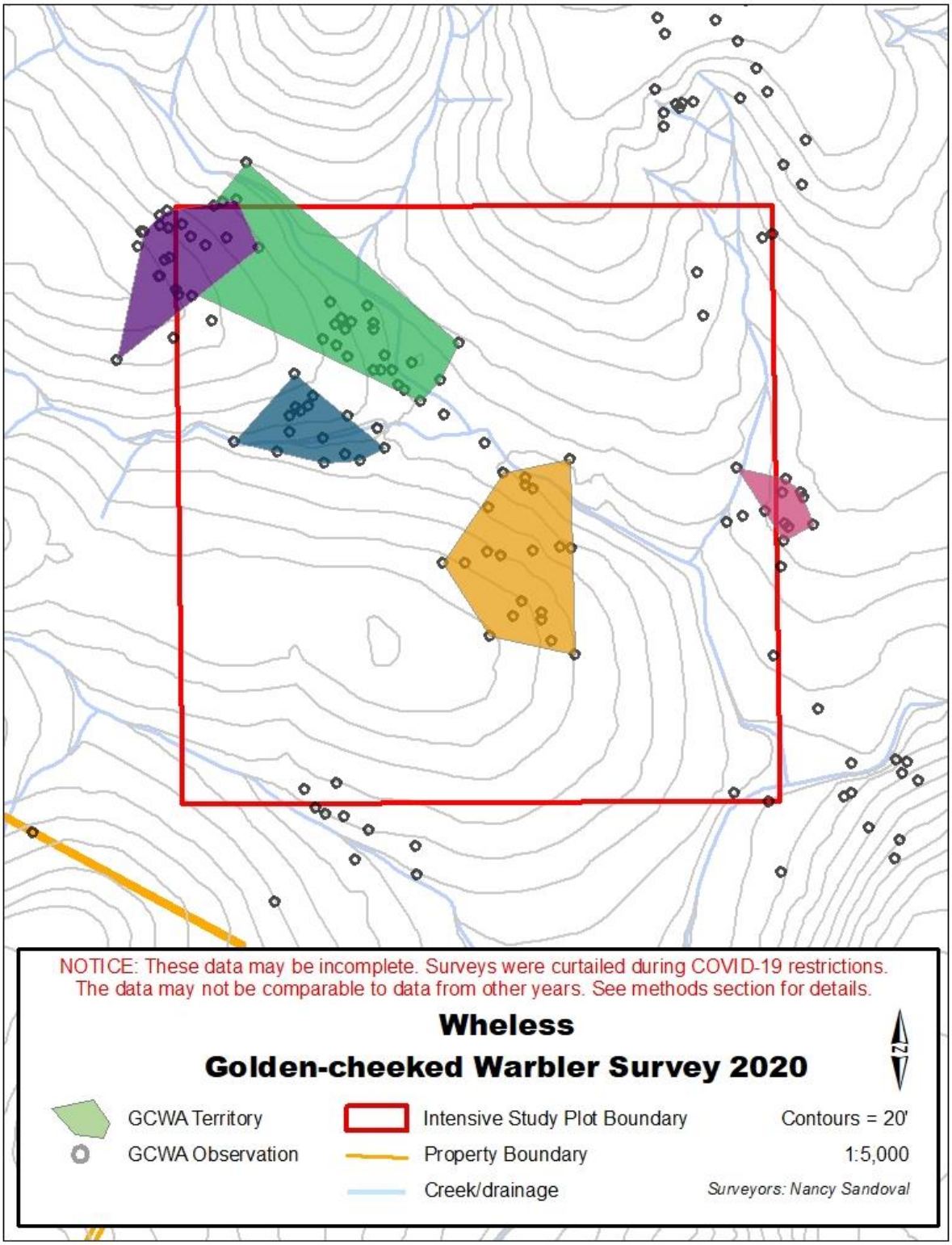

Figure 17

Exhibit C: Summary of Golden-cheeked Warbler Survey Effort on the Balcones Canyonlands Preserve, Travis County, Texas, 2020. **Due to COVID-19 restrictions, surveys were suspended or reduced from March 27 through May 16.**

Intensive Monitoring Plots	Lead Surveyor(s)	No. Survey Weeks (March 15-May 25)	Survey Hours (March 11-June 18)	Area Surveyed (hectares)
Barton Creek Macrosite				
Barton Creek	William Reiner, John Chenoweth (COA)	6	41.75	40.5 + buffer
Barton Creek Habitat Preserve	Charlotte Reemts (TNC)	1	6.50	81.5
Barton West	William Reiner, Jonny Scalise (COA)	6	38.50	47
Bull Creek Macrosite				
Forest Ridge	Jonny Scalise, Cristina Campbell, Laurel Moulton (COA)	7	171.25	40.5 + buffer
Kent Butler	Laurel Moulton, Jonny Scalise, Cristina Campbell (COA)	7	184.00	40.5 + buffer
Hamilton West	Lisa O'Donnell, Jim O'Donnell, John Chenoweth, Mark Sanders (COA)	7	61.50	40.5 + buffer
Cypress Creek Macrosite				
Vista Point	Paul Fushille, Blake Sissel, Kaitlin Lopez, Becky Woodward (TC)	8	105.75	40.5 + buffer
Wheless	Nancy Sandoval, Sam Berg (TC)	7	56.00	40.5
Collins	Travis Clark, Julie Murray, David Morgan, Sam Berg, Bianca Perez (TC)	8	124.00	40.5 + buffer
North Lake Austin Macrosite				
Emma Long	Darrell Hutchinson, Cristina Campbell (COA)	8	213.25	40.5 + buffer
Emma Long Bike Park	Darrell Hutchinson, Laurel Moulton (COA)	8	181.50	96
Emma Long Expansion	Cristina Campbell, Laurel Moulton (COA)	6	67.50	34
Cortaña	William Reiner (COA)	6	49.00	62
South Lake Austin Macrosite				
Double J&T	Jim O'Donnell (COA)	6	29.50	40.5 + buffer
Reicher	Lisa O'Donnell, Jim O'Donnell (COA)	8	59.00	40.5 + buffer
West Austin Macrosite				
Vireo Preserve/Wild Basin	Darrell Hutchinson, Lisa O'Donnell, Jim O'Donnell (COA)	10	139.75	180
	Total		**1528.75**	**905.5 + buffers**

COA = City of Austin, TC = Travis County, TNC = The Nature Conservancy. Buffers = approx. 30 ha for each 40.5-ha plot, where access was allowed.

Exhibit C: Summary of Golden-cheeked Warbler Survey Effort on the Balcones Canyonlands Preserve, Travis County, Texas, 2020 (continued).

Re-sighting Plots	Surveyor(s)	No. Survey Weeks (March 15-May 25)	Survey Hours (March 15-May 25)	Area Surveyed (hectares)
Bull Creek Macrosite				
3M/St. Edwards	Mark Sanders (COA)	2	8.0	40.5 + buffer
Canyon Vista	David Morgan (TC), Audrey Kuhl (TC), Nancy Sandoval (TC), B. Stubbs (TC), K. Gold (TC); Tam Tran (volunteer)	5	36.5	40.5 + buffer
	Total		44.5	**81.0 + buffers**

COA = City of Austin, TC = Travis County. Buffers = approx. 30 ha for each 40.5-ha plot, where access was allowed.

Exhibit C: Summary of Golden-cheeked Warbler Survey Effort on the Balcones Canyonlands Preserve, Travis County, Texas, 2020 (continued).

Search Areas*	Survey Effort (hours)	Search Areas*	Survey Effort (hours)
3M Southeast	24.75	Hamilton Northeast (38.5 ha)	0
3M South (42.1 ha)	0	Hamilton Northwest	21.25
Barton Creek downstream	16.50	Hamilton Southeast	16.75
Barton Creek Far Northwest	0	Interplot (33.0 ha) (between 3M and Forest Ridge plots)	3.00
Barton Creek Northwest	23.75	Kent Butler East	18.25
Barton Creek Southeast (37.5 ha)	0	Kent Butler Northwest	12.00
Barton Creek Southwest	6.00	Kent Butler Southeast	5.00
Canyon Vista (25.3 ha)	6.00	Kent Butler Southwest	17.50
Collins North (9.4 ha)	19.25	Lime Creek North	3.00
Collins South (39.3 ha)	11.50	Lime Creek South	0
Cortaña – Panther Hollow East	5.75	Long Canyon – Leaning Rock	0
Emma Long South	18.00	Long Canyon – Standing Rock	6.50
Emma Long West (42.1 ha)	18.00	Reicher East (35.7 ha)	12.50
Forest Ridge Northeast	5.75	Vista Point North	0
Forest Ridge Northwest (37.3 ha)	12.00	Vista Point Southeast	18.00
Forest Ridge Southeast	0	Vista Point Southwest	17.50
Forest Ridge Southwest (42.2 ha)	12.00		

*All search areas were approximately 40.5 ha except where noted.

Exhibit D: Golden-cheeked Warbler Intensive Monitoring Plot Protocol, Balcones Canyonlands Preserve, 2020 **[note: due to COVID-19 restrictions, these protocols were suspended or reduced from March 28 through May 16]**

Objective: To delineate golden-cheeked warbler territories as accurately as possible (>33 locations per male) and to document return rates, dispersal, pairing success, breeding success, and productivity (number of young per territory) to estimate long-term trends in these parameters.

For the 2020 field season, a concerted effort will also be made to locate and monitor nests and count fledglings on a select number of plots (for COA BCP, this will include the Kent Butler 100-acre plot, Barton West, Emma Long Bike Park, and Emma Long Expansion).

Study Sites: Within each intensive study plot, observers will focus on re-sighting color-banded warblers, mapping the location and extent of territories, and looking for females and fledglings. In addition, observers responsible for 100-acre study plots will search for color-banded birds within accessible portions of a 100-m buffer around each plot to provide better estimates of the size, extent, and breeding success of edge territories.

Survey Dates: March 15 - May 25 (for territory delineations); March 15-June 15 (for documenting reproductive success). Separate visits may be required to band territorial males but warbler observations made during banding attempts are not to be reported as territory observations.

Survey Effort for Territory Mapping: Six hours per 100 acres per visit *minimum*. There will be no maximum time constraints. The number of hours devoted to a plot will be based on territory densities, terrain, surveyor's physical condition, etc. and the time needed to cover the entire survey area. Surveyors will take as much time as needed to collect data for each territory and obtain a minimum of 33 locations separated by at least 30 meters for each territorial male by May 25.

Mapping: Observers will obtain GPS locations for, **and** create hard copy maps of, all warbler observations for **every** survey visit, following the **Standards for Conducting and Documenting Golden-cheeked Warbler Surveys (COA 2020)**. Timely and accurate survey maps serve as a means of sharing observation information with other observers assigned to the same study plot, are critical for conducting data QA/QC, and provide important supporting documentation for subsequent analyses and reports.

Staffing:

- For low density plots (<5 territories/100 acres): one observer will survey the plot/buffer once a week from March 15-June 15.
- For medium density plots (5-10 territories/100 acres): one observer will survey the plot/buffer once a week from March 15-June 15. To assist documenting fledglings, a second observer will assist with the weekly surveys from April 20-May 25 (see procedures for shared plots, below).
- For high density plots (>10 territories/100 acres): two observers will survey the plot/buffer once a week from March 15-May 25 (see procedures for shared plots, below), and one observer will survey the plot/buffer from May 25-June 15.
- For plots that include a focus on nest monitoring and fledgling counts (see Objective, above): two observers will survey the plot/buffer twice a week from March 15-May 25 (see procedures for shared plots, below), and one observer will survey the plot/buffer from May 25-June 15.

Training: All field staff will have prior experience conducting golden-cheeked warbler surveys or be trained by experienced personnel prior to the field season.

Survey Procedures: Observers are to follow the **Standards for Conducting and Documenting Golden-cheeked Warbler Surveys (COA 2020)** during all field visits. For shared plots with two observers (see Staffing, above), each observer will cover half of the plot/buffer during each survey, and observers will need to coordinate coverage. For the initial visit, observers will split and cover one-half of the plot. For each subsequent week, each observer will rotate the area covered by 90° in a clockwise direction, where this is practical. This will ensure each observer covers the entire plot and begins at a different corner of the plot each week.

Exhibit E: Summary of Golden-cheeked Warbler Territory Data for Intensive Study Plots on the Balcones Canyonlands Preserve, Travis County, Texas, Field Seasons 2009-2020. See Methods section for calculations. **Due to COVID-19 restrictions, surveys were suspended or reduced from March 28 through May 16, so results may not be comparable to previous years.**

Plot Name	Survey Year	No. of Full Territories	Number of Full and Edge Territories	No. of Full Territories + 50% of Edge Territories	Territory Density per Hectare
Barton Creek Macrosite					
Barton Creek	2009	2	8	5.0	0.12
	2010	2	10	6.0	0.15
	2011	4	9	6.5	0.16
	2012	2	7	4.5	0.11
	2013	4	10	7.0	0.17
	2014	5	12	8.5	0.21
	2015	6	9	7.5	0.19
	2016	3	6	4.5	0.11
	2017	3	6	4.5	0.11
	2018	2	4	3.0	0.07
	2019	3	3	3.0	0.07
	2020	2	2	2.0	0.05
Barton Creek Habitat Preserve	2017	0	2	1.0	0.01
	2018	1	2	1.5	0.02
	2019	0	2	1.0	0.01
	2020	--	--	--	--
Barton West	2019	4	7	5.5	0.12
	2020	0	2	1.0	0.02
Bull Creek Macrosite					
Forest Ridge	2009	10	18	14.0	0.35
	2010	10	20	15.0	0.37
	2011	13	20	16.5	0.41
	2012	13	23	18.0	0.44
	2013	8	14	11.0	0.27
	2014	9	19	14.0	0.35
	2015	14	20	17.0	0.42
	2016	8	15	11.5	0.28
	2017	11	20	15.5	0.38
	2018	6	17	11.5	0.28
	2019	7	19	13.0	0.32
	2020	10	17	13.5	0.33
Kent Butler	2009	11	25	18.0	0.44
	2010	11	20	15.5	0.38
	2011	12	22	17.0	0.43
	2012	11	24	17.5	0.43
	2013	18	32	25.0	0.62
	2014	15	20	17.5	0.43
	2015	13	25	19.0	0.47
	2016	11	20	15.5	0.38
	2017	7	19	13.0	0.32
	2018	8	15	11.5	0.28
	2019	8	19	13.5	0.33
	2020	12	18	15.0	0.37

Exhibit E: Summary of Golden-cheeked Warbler Intensive Study Plot Territory Data, continued.

Plot Name	Survey Year	No. of Full Territories	Number of Full and Edge Territories	No. of Full Territories + 50% of Edge Territories	Territory Density per Hectare
Hamilton West	2009	--	--	--	--
	2010	2	14	8.0	0.20
	2011	8	20	14.0	0.35
	2012	6	10	8.0	0.20
	2013	5	11	8.0	0.20
	2014	5	12	8.5	0.21
	2015	6	10	8.0	0.20
	2016	5	9	7.0	0.17
	2017	5	9	7.0	0.17
	2018	4	10	7.0	0.17
	2019	3	12	7.5	0.19
	2020	6	12	9.0	0.22
Cypress Creek Macrosite					
Collins	2018	2	13	7.5	0.19
	2019	1	9	5.0	0.12
	2020	6	11	8.5	0.21
Vista Point	2009	--	--	--	--
	2010	--	--	--	--
	2011	15	17	16.0	0.40
	2012	13	20	14.0	0.34
	2013	10	17	13.5	0.33
	2014	9	19	14.0	0.35
	2015	17	24	20.5	0.51
	2016	--	--	--	--
	2017	8	14	11.0	0.27
	2018	9	14	11.5	0.28
	2019	11	15	13	0.32
	2020	11	16	13.5	0.33
Wheless	2017	1	3	2.0	0.05
	2018	0	2	1.0	0.02
	2019	1	5	3.0	0.07
	2020	3	5	4.0	0.10
North Lake Austin Macrosite					
Cortaña	2017	4	5	4.5	0.07
	2018	2	2	2.0	0.03
	2019	4	6	5.0	0.08
	2020	3	3	3.0	0.07
Emma Long[1]	2009	9	19	14.0	0.35
	2010	10	16	13.0	0.32
	2011	10	16	13.0	0.33
	2012	11	18	14.5	0.36
	2013	11	20	15.5	0.38
	2014	9	17	13.0	0.32
	2015	10	17	13.5	0.33
	2016	--	--	--	--
	2017	3	11	7	0.17
	2018	4	9	6.5	0.16
	2019	5	9	7.0	0.17
	2020	7	12	9.5	0.23

Exhibit E: Summary of Golden-cheeked Warbler Intensive Study Plot Territory Data, continued.

Plot Name	Survey Year	No. of Full Territories	Number of Full and Edge Territories	No. of Full Territories + 50% of Edge Territories	Territory Density per Hectare
Emma Long Bike Park[1]	2009	--	--	--	--
	2010	9	9	9.0	0.09
	2011	12	15	13.5	0.14
	2012	12	17	14.5	0.15
	2013	5	13	9.0	0.09
	2014	12	19	15.5	0.16
	2015	6	14	10	0.10
	2016	4	13	8.5	0.09
	2017	3	10	6.5	0.07
	2018	6	10	8.0	0.08
	2019	6	11	8.5	0.09
	2020	5	14	9.5	0.10
Emma Long Expansion[1]	2016	7	11	9	0.26
	2017	4	10	7	0.21
	2018	4	7	5.5	0.16
	2019	4	9	6.5	0.19
	2020	4	6	5	0.15
South Lake Austin Macrosite					
Double J&T	2009	2	3	2.5	0.06
	2010	3	3	3.0	0.07
	2011	3	4	3.5	0.09
	2012	4	4	4.0	0.10
	2013	2	4	3.0	0.07
	2014	3	5	4.0	0.10
	2015	2	2	2.0	0.05
	2016	2	3	2.5	0.06
	2017	2	3	2.5	0.06
	2018	1	2	1.5	0.04
	2019	3	4	3.5	0.09
	2020	4	6	5.0	0.12
Reicher	2009	--	--	--	--
	2010	--	--	--	--
	2011	3	4	3.5	0.09
	2012	2	6	4.0	0.10
	2013	3	6	6.0	0.11
	2014	5	11	8.0	0.20
	2015	3	8	5.5	0.14
	2016	--	--	--	--
	2017	3	6	4.5	0.11
	2018	2	6	4.0	0.10
	2019	3	8	5.5	0.14
	2020	3	8	5.5	0.14
West Austin Macrosite					
Wild Basin/ Vireo Preserve	2009	--	--	--	--
	2010	--	--	--	--
	2011	8	11	9.5	0.05
	2012	6	6	6.0	0.03
	2013	8	8	8.0	0.04
	2014	9	10	9.5	0.05
	2015	7	7	7.0	0.04
	2016	4	4	4.0	0.02
	2017	4	4	4.0	0.02
	2018	4	4	4.0	0.02
	2019	5	5	5.0	0.03
	2020	6	6	6.0	0.03

[1]Updated to include overlapping territories on Emma Long Bike Park, Emma Long Expansion, and Emma Long.

Exhibit F: Summary of Golden-cheeked Warbler Age Structure Data for Territorial Males on Intensive Study Plots on the Balcones Canyonlands Preserve, Travis County, Texas, Field Seasons 2009-2020. **Due to COVID-19 restrictions, surveys were suspended or reduced from March 28 through May 16, so results may not be comparable to previous years.**

Plot	Survey Year	% SY Males	%ASY Males	%AHY Males	Total No. Banded Males	Total No. Unbanded Males	% Banded Males
Barton Creek Macrosite							
Barton Creek	2009	20	60	20	5	3	63
	2010	22	78	0	9	1	90
	2011	0	100	0	6	3	67
	2012	0	100	0	5	2	71
	2013	40	60	0	5	5	50
	2014	25	75	0	8	4	67
	2015	0	100	0	3	6	33
	2016	17	83	0	6	0	100
	2017	20	80	0	5	1	83
	2018	0	100	0	4	0	100
	2019	67	33	0	3	0	100
	2020	0	100	0	2	0	100
Barton Creek Habitat Preserve	2017	100	0	0	1	1	50
	2018	100	0	0	2	0	100
	2019	100	0	0	2	0	100
	2020	--	--	--	--	--	--
Barton West	2019	50	50	0	6	1	86
	2020	0	100	0	1	1	50
Bull Creek Macrosite							
Forest Ridge	2009	20	73	7	15	3	83
	2010	21	79	0	14	6	70
	2011	35	65	0	17	3	85
	2012	0	100	0	16	7	67
	2013	11	89	0	9	5	64
	2014	27	73	0	11	8	58
	2015	30	70	0	10	10	50
	2016	25	75	0	12	3	80
	2017	8	92	0	13	7	65
	2018	14	86	0	14	3	82
	2019	50	50	0	16	3	84
	2020	43	57	0	14	3	82
Kent Butler	2009	53	29	18	17	8	68
	2010	33	67	0	15	5	75
	2011	62	37	0	16	6	73
	2012	53	42	5	19	5	79
	2013	36	59	5	22	10	69
	2014	19	81	0	16	4	80
	2015	41	53	6	17	8	68
	2016	36	64	0	14	6	70
	2017	38	62	0	13	6	68
	2018	70	30	0	10	5	67
	2019	50	50	0	14	5	74
	2020	86	14	0	14	4	78

Exhibit F: Golden-cheeked Warbler Intensive Study Plot Age Structure Data for Territorial Males, continued.

Plot	Survey Year	% SY Males	%ASY Males	%AHY Males	Total No. Banded Males	Total No. Unbanded Males	% Banded Males
Hamilton West	--	--	--	--	--	--	--
	2010	40	60	0	10	4	71
	2011	60	27	13	15	5	75
	2012	29	57	14	7	3	70
	2013	63	38	0	8	3	73
	2014	50	50	0	8	4	67
	2015	62	38	0	8	2	80
	2016	57	43	0	7	2	78
	2017	38	62	0	8	1	89
	2018	0	100	0	6	4	60
	2019	17	83	0	6	6	50
	2020	67	33	0	6	6	50
Cypress Creek Macrosite							
Collins	2018	67	22	11	9	4	69
	2019	63	37	0	8	1	89
	2020	17	83	0	6	5	55
Vista Point	2009	--	--	--	--	--	--
	2010	--	--	--	--	--	--
	2011	24	76	0	17	0	100
	2012	12	88	0	17	3	81
	2013	29	71	0	14	3	82
	2014	9	91	0	11	8	59
	2015	67	33	0	12	12	50
	2016	--	--	--	--	--	--
	2017	9	91	0	11	3	79
	2018	27	73	0	11	3	79
	2019	28	72	0	18	5	78
	2020	37	63	0	8	8	50
Wheless	2017	33	67	0	3	1	75
	2018	100	0	0	1	1	50
	2019	33	67	0	3	2	60
	2020	0	100	0	1	4	20
North Lake Austin Macrosite							
Cortaña	2017	20	80	0	5	0	100
	2018	0	100	0	2	0	100
	2019	67	33	0	6	0	100
	2020	67	33	0	3	0	100
Emma Long[1]	2009	0	100	0	13	6	68
	2010	11	89	0	9	7	56
	2011	27	73	0	11	5	69
	2012	10	90	0	10	8	56
	2013	0	100	0	10	10	50
	2014	33	67	0	9	8	53
	2015	25	75	0	12	5	71
	2016	--	--	--	--	--	--
	2017	10	90	0	10	1	91
	2018	25	75	0	8	1	89
	2019	25	75	0	8	1	89
	2020	44	56	0	9	3	75

Exhibit F: Golden-cheeked Warbler Intensive Study Plot Age Structure Data for Territorial Males, continued.

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Plot	Survey Year	% SY Males	%ASY Males	%AHY Males	Total No. Banded Males	Total No. Unbanded Males	% Banded Males
Emma Long Bike Park[1]	2009	--	--	--	--	--	--
	2010	63	38	0	8	1	89
	2011	79	21	0	14	1	93
	2012	29	71	0	14	3	82
	2013	71	29	0	7	6	54
	2014	69	31	0	13	6	68
	2015	56	44	0	9	5	64
	2016	33	56	11	9	4	69
	2017	57	33	0	7	3	70
	2018	71	29	0	7	3	70
	2019	67	33	0	9	2	82
	2020	44	56	0	10	4	71
Emma Long Expansion[1]	2016	17	66	17	6	5	55
	2017	13	88	0	8	2	80
	2018	0	100	0	6	1	86
	2019	25	75	0	8	1	89
	2020	25	75	0	4	2	67
South Lake Austin Macrosite							
Double J&T	2009	100	0	0	1	2	33
	2010	67	33	0	3	0	100
	2011	100	0	0	2	2	50
	2012	100	0	0	1	3	25
	2013	100	0	0	4	0	100
	2014	0	100	0	3	2	60
	2015	0	100	0	1	1	50
	2016	33	67	0	3	0	100
	2017	33	67	0	3	0	100
	2018	50	50	0	2	0	100
	2019	67	33	0	3	1	75
	2020	100	0	0	5	1	83
Reicher	2009	--	--	--	--	--	--
	2010	--	--	--	--	--	--
	2011	33	67	0	3	1	75
	2012	50	50	0	2	4	33
	2013	25	75	0	4	2	67
	2014	38	50	12	8	3	73
	2015	20	80	0	5	3	63
	2016	--	--	--	--	--	--
	2017	25	75	0	4	2	67
	2018	20	80	0	5	1	83
	2019	43	57	0	7	1	88
	2020	0	100	0	6	2	75
Wild Basin/ Vireo Preserve	2009	--	--	--	--	--	--
	2010	--	--	--	--	--	--
	2011	78	22	0	9	2	82
	2012	20	80	0	5	1	83
	2013	33	67	0	6	2	75
	2014	50	50	0	8	2	80
	2015	67	33	0	6	1	86
	2016	50	50	0	4	0	100
	2017	25	75	0	4	0	100
	2018	67	33	0	3	1	75
	2019	60	40	0	5	0	100
	2020	0	100	0	1	5	17

[1]Updated to include overlapping territories on Emma Long Bike Park, Emma Long Expansion, and Emma Long.

Exhibit G: Summary of Golden-cheeked Warbler Reproductive Success Data for Full and Edge Territories within Intensive Study Plots on the Balcones Canyonlands Preserve, Travis County, Texas, Field Seasons 2009-2020. See Methods section for calculations. **Due to COVID-19 restrictions, surveys were suspended or reduced from March 28 through May 16, so results may not be comparable to previous years.**

Plot Name	Survey Year	Pairing Success	Breeding Success	Total No. of Observed and Adjusted Fledglings	Density of Observed and Adjusted Fledglings per Hectare
Barton Creek Macrosite					
Barton Creek	2009	75	63	12 / 14	0.22 / 0.27
	2010	100	80	24 / 29	0.40 / 0.44
	2011	100	67	17 / 21	0.33 / 0.40
	2012	100	100	24/ 27	0.37 / 0.44
	2013	90	70	24 / 27	0.43 / 0.48
	2014	100	58	17 / 21	0.36 / 0.41
	2015	100	78	22 / 25	0.51 / 0 58
	2016	83	50	7 / 7	0.12 / 0.12
	2017	100	17	4 / 4	0.10 / 0.10
	2018	100	50	5 / 6.6	0.10 / 0.12
	2019	33	0	0	0
	2020	100	100	5 / 7.2	0.12 / 0.18
Barton Creek Habitat Preserve	2017	0	0	0	0
	2018	100	0	0	0
	2019	100	0	0	0
	2020	--	--	--	--
Barton West	2019	83	50	7.5 / 9	0.16 / 0.19
	2020	100	50	2.0 / 3.6	0.02 / 0.04
Bull Creek Macrosite					
Forest Ridge	2009	83	78	25 / 50	0.49 / 0.98
	2010	80	65	30 / 47	0.53 / 0.89
	2011	100	74	29 / 47	0.59 / 0.99
	2012	83	74	55 / 65	1.10 / 1.28
	2013	86	71	28 / 37	0.62 / 0.77
	2014	100	89	49 / 57	0.89 / 1.02
	2015	100	88	33 / 47	0 68 / 1.00
	2016	93	73	30 / 41	0.53 / 0.73
	2017	100	70	37 / 51	0.73 / 0.99
	2018	100	71	29 / 41	0.54 / 0.73
	2019	100	68	28 / 44.6	0.52 / 0.82
	2020	100	100	33 / 47.6	0.68 / 0.95
Kent Butler	2009	92	72	39 / 65	0.73 / 1.20
	2010	95	70	35 / 50	0.68 / 1.02
	2011	95	67	40 / 50	0.75 / 0.94
	2012	96	79	60 / 71	1.06 / 1.23
	2013	90	58	50 / 61	1.00 / 1.16
	2014	95	85	47 / 64	0.98 / 1.33
	2015	88	63	46 / 54	1.01 / 1.13
	2016	95	70	40 / 50	0.77 / 0.94
	2017	95	74	35 / 48	0.60 / 0.80
	2018	100	67	26 / 37	0.51 / 0.73
	2019	84	47	22 / 33.6	0.37 / 0.55
	2020	100	88	35 / 45.8	0.73 / 0.91

Exhibit G: Golden-cheeked Warbler Intensive Study Plot Reproductive Success Data, continued.

Plot Name	Survey Year	Pairing Success	Breeding Success	Total No. of Observed and Adjusted Fledglings	Density of Observed and Adjusted Fledglings per Hectare
Hamilton West	2009	--	--	--	--
	2010	64	57	18 / 29	0.28 / 0.44
	2011	90	50	24 / 24	0.47 / 0/47
	2012	90	78	18 / 23	0.33 / 0.43
	2013	100	82	20 / 29	0.38 / 0.53
	2014	100	73	27 / 27	0.53 / 0.53
	2015	100	90	23 / 33	0.40/ 0.62
	2016	100	56	14 / 14	0.26 / 0.26
	2017	100	78	21 / 27	0.42 / 0.52
	2018	100	80	25 / 27	0.44 / 0.48
	2019	100	45	12 / 16.4	0.21 / 0.29
	2020	90	67	20 / 28.8	0.35 / 0.49
Cypress Creek Macrosite					
Collins	2018	92	31	12 / 15	0.20 / 0.24
	2019	89	78	18 / 25.6	0.22 / 0.32
	2020	73	73	19 / 28.8	0.31 / 0.49
Vista Point	2009	--	--	--	--
	2010	--	--	--	--
	2011	94	75	42 / 45	1.01 / 1.08
	2012	100	63	41 / 42	0.83 / 0.85
	2013	100	53	27 / 27	0.52 / 0.52
	2014	89	68	49 / 50	0.86 / 0.88
	2015	100	52	30 / 37	0.65 / 0.82
	2016	--	--	--	--
	2017	86	64	31 / 31	0.49 / 0.49
	2018	79	79	39 / 39	0.79 / 0.79
	2019	73	60	28 / 33.4	0.57 / 0.68
	2020	81	31	17 / 19.2	0.31 / 0.34
Wheless	2017	75	75	12 / 12	0.15 / 0.15
	2018	100	100	8 / 8	0.10 / 0.10
	2019	100	60	11 / 11	0.19 / 0.19
	2020	100	100	18 / 19.2	0.37 / 0.39
North Lake Austin Macrosite					
Cortaña	2017	80	40	5 / 7	0.08 / 0.11
	2018	100	100	5 / 7.6	0.08 / 0.12
	2019	50	33	7 / 7.6	0.11 / 0.12
	2020	100	100	6 / 10.8	0.10 / 0.17
Emma Long[1]	2009	100	84	29 / 58	0.52 / 1.02
	2010	94	63	19 / 36	0.33 / 0.67
	2011	100	100	41 / 52	0.96 / 1.19
	2012	100	94	54 / 62	1.05 / 1.20
	2013	89	59	34 / 36	0.63 / 0.68
	2014	88	81	47 / 50	0.94 / 1.01
	2015	94	41	21 / 22	0.38 / 0.40
	2016	--	--	--	--
	2017	90	50	14 / 16.2	0.22 / 0.25
	2018	89	56	15 / 17	0.27 / 0.31
	2019	89	78	23 / 26.4	0.42 / 0.47
	2020	100	83	27 / 36.8	0.56 / 0.73

Exhibit G: Golden-cheeked Warbler Intensive Study Plot Reproductive Success Data, continued.

Plot Name	Survey Year	Pairing Success	Breeding Success	Total No. of Observed and Adjusted Fledglings	Density of Observed and Adjusted Fledglings per Hectare
Emma Long Bike Park[1]	2009	--	--	--	--
	2010	89	56	8 / 18	0.08 / 0.19
	2011	92	58	24 / 27	0.23 / 0.26
	2012	100	100	33 / 38	0.29 / 0.34
	2013	92	69	26 / 32	0.17 / 0.21
	2014	84	59	28 / 32	0.24 / 0.26
	2015	100	79	26 / 32	0.21 / 0.26
	2016	85	38	13 / 16	0.11 / 0.12
	2017	90	70	19 / 21	0.14 / 0.15
	2018	90	40	12 / 12	0.10 / 0.10
	2019	82	64	24 / 27.2	0.18 / 0.20
	2020	100	86	36 / 45.2	0.27 / 0.33
Emma Long Expansion[1]	2016	91	45	15 / 15.6	0.38 / 0.40
	2017	100	80	16 / 21.4	0.32 / 0.44
	2018	100	86	14 / 14	0.32 / 0.32
	2019	100	56	13 / 14.6	0.24 / 0.26
	2020	100	83	10 / 17.4	0.25 / 0.46
South Lake Austin Macrosite					
Double J&T	2009	0	0	0	0
	2010	67	0	0	0
	2011	75	50	2 / 7	0.04 / 0.13
	2012	100	0	0	0
	2013	50	50	6 / 6	0.12 / 0.12
	2014	100	60	9 / 9	0.20 / 0.20
	2015	50	0	0	0
	2016	67	67	6 / 7	0.11 / 0.12
	2017	67	67	5 / 7	0.09 / 0.13
	2018	100	50	3 / 4	0.07 / 0.09
	2019	50	0	0	0
	2020	100	33	6 / 7.2	0.11 / 0.13
Reicher	2009	--	--	--	--
	2010	--	--	--	--
	2011	100	100	11 / 12	0.22 / 0.24
	2012	83	67	14 / 16	0.25 / 0.29
	2013	100	83	13 / 19	0.20 / 0.32
	2014	82	73	25 / 30	0.43 / 0.52
	2015	88	50	9 / 10	0.12 / 0.14
	2016	--	--	--	--
	2017	100	67	8 / 13	0.16 / 0.26
	2018	83	67	11 / 15	0.20 / 0.27
	2019	88	88	18 / 26	0.30 / 0.45
	2020	100	50	10 / 14.4	0.15 / 0.22
West Austin Macrosite					
Wild Basin/ Vireo Preserve	2009	--	--	--	--
	2010	--	--	--	--
	2011	73	45	9 / 18	0.08 / 0.15
	2012	100	75	7 / 10	0.04 / 0.06
	2013	86	43	9 / 11	0.05 / 0.06
	2014	56	11	3 / 3	0.02 / 0.02
	2015	86	14	4 / 4	0.02 / 0.02
	2016	75	25	4 / 4	0.02 / 0.02
	2017	50	0	0	0
	2018	75	75	6 / 11	0.03 / 0.06
	2019	80	20	3 / 3.6	0.02 / 0.02
	2020	100	67	9 / 14.4	0.05 / 0.08

[1]Updated to include overlapping territories on Emma Long Bike Park, Emma Long Expansion, and Emma Long.