2015 Annual Report:
Golden-cheeked Warbler *(Setophaga chrysoparia)*
Monitoring Program
Balcones Canyonlands Preserve



Photo by Misa Soliz

City of Austin
Austin Water Utility
Wildland Conservation Div.
Balcones Canyonlands Preserve
Austin, Texas

Travis County
Department of Transportation &
Natural Resources
Balcones Canyonlands Preserve
Austin, Texas

U.S. Forest Service
Northern Research Station
Department of Fisheries &
Wildlife Sciences
University of Missouri
Columbia, Missouri

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Disclaimer: The data and information presented in this report are provisional and subject to revision.

2015 Golden-cheeked Warbler Monitoring Program

Balcones Canyonlands Preserve Annual Report

This was the eighteenth year of Golden-cheeked Warbler monitoring on the City of Austin's Balcones Canyonlands Preserve (BCP). It was the final year of a five-year agreement with the U.S. Forest Service (USFS) to develop models to better understand factors influencing the long-term viability of the Golden-cheeked Warbler and its habitat and to predict the fate of both under various management scenarios within the BCP. This collaborative project includes the USFS, University of Missouri, City of Austin, Travis County, BCP managing partners (Lower Colorado River Authority, St. Edwards University/Wild Basin, Travis Audubon Society, The Nature Conservancy), and a team of volunteers all playing key roles and contributing data. Preliminary findings to date are consistent with research on Fort Hood (Peak and Thompson 2013, 2014) that large blocks of mature, closed-canopy Ashe juniper (*Juniperus ashei*) and oak (*Quercus* spp.) woodlands support higher densities of Golden-cheeked Warblers (Reidy et al. 2015) and these adults are more productive and more site-faithful than adults in more fragmented woodlands. Development of the population viability and habitat suitability models commenced following the third year of the USFS project, and publications of the results are anticipated in 2016.

ACKNOWLEDGEMENTS

We would like to thank all of the BCP partners and staff for their collaboration in the 2015 survey efforts: Lower Colorado River Authority, Travis Audubon Society, and St. Edwards/Wild Basin. We would also like to thank the many volunteers who assisted with the 2015 survey effort. Without their support and perseverance, it would not have been possible to obtain these critical data: Kelly Alm, Paul Brick, Alan Carlin, Heidi Carlin, Paul Clements, Kathleen Collins, Crystal Datri, Lauren Dill, Nevin Durish, Angela England, Ayoola Folarin, Monica Ford, Mary Gilroy, Natalie Goldsworthy, Shelia Hargis, Ranleigh Hirsh, Joseph Hunt, Jim Ingram, Leigh Jandle, Adrian Johnson, Robin Laine, Jennifer Lueckemeyer, Stacy Marcus, Thom Marshall, Alyssa Martin, Mary Ann Robalino, Mike Rogan, Katherine Ross, Jenny Samford, Misa Soliz, Dale Thompson, Tam Tran, Julie Webber, Jim Weber, Lynne Weber, Christopher Weyenberg, Tracy White, and Laura Zebehazy.

INTRODUCTION

Background

The Golden-cheeked Warbler (Warbler) is a neotropical migrant passerine that breeds only in central Texas where mature Ashe juniper-oak woodlands occur (Ladd and Gass 1999). Due to accelerating loss of breeding habitat over the past several decades, 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 westward expansion of development from the City of Austin led to the creation of the Balcones Canyonlands Conservation Plan (a Habitat Conservation Plan) and issuance of a 10(a)(1)(B) permit in 1996 by the U.S. Fish and Wildlife Service 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 set aside as a preserve (the BCP) for these species. The BCP is owned and managed by a number of 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 percent of the Warbler's habitat in Travis County, management of the remaining habitat within the BCP is critical and must promote habitat sustainability, regeneration, and restoration to support a viable breeding population.

The Warbler requires large blocks of mature, closed-canopy woodlands for nesting and raising young (USFWS 1992, Peak 2007, Reidy et al. 2008, Peak and Thompson 2014). Active habitat management 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 to recover if negatively impacted by a poorly designed program (Biological Advisory Team 1990). Given the complexity of the threats to the Warbler, a more sophisticated analysis of the species and its habitat is needed to ensure effective management strategies are implemented.

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."

In February 2011, the City of Austin entered into a five-year agreement with the USFS to provide population viability and habitat suitability modeling for the Warbler populations within the BCP (Reidy and Thompson 2010). The USFS project focuses 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?

Answers to these questions are important to ensure the long-term viability of the Warbler, which is the goal of the Balcones Canyonlands Conservation Plan. In order to fill these knowledge gaps, understand species' response to management, and provide reasonable demographic measures based on real data for modeling population growth and persistence, more intense monitoring across the BCP is necessary. The

2015 field season continued the collaborative efforts initiated in 2011 to collect data on fecundity, recruitment, dispersal, abundance, and survival on a series of intensive study plots that cover a variety of habitat types in which the Warbler breeds on the BCP.

METHODS

A detailed description of the demographic methods used during the 2015 field season is described in Reidy and Thompson (2010). The methods closely followed the protocols outlined in the Tier IIA-7 land management plan guidelines (BCP 2007), but required intensive territory monitoring, including more frequent surveys of color-banded birds for territory delineations, and nest searching and monitoring. Population and productivity trends of color-banded individuals were tracked on a series of intensive study plots. BCP partners collected data on territory density, territory size and location, age structure, pairing success, breeding success, and productivity for each plot. BCP staff and volunteers also made a concerted effort to search for color-banded Warblers outside of the intensive study areas to gather data on site fidelity, dispersal, and return rates. Nests were located and monitored throughout the field season, and vegetation measurements were collected at each nest site at the end of the field season.

Intensive Study Plots

During field season 2015, an effort was made to intensively monitor as much of the BCP as possible given staff and resource limitations, to include previously established study sites, and to capture a diversity of habitats across the BCP. Warblers were banded and their territories were mapped on 18 intensive study plots, including twelve 40.5-hectare plots and six plots ranging from 27 to 180 hectares in size (Table 1, Exhibit A), and totaling about 1,027 hectares. Intensive study plots were located within six of the seven BCP macrosites (all but the Pedernales macrosite). In addition, a 100-meter buffer was established around each of the 40.5-hectare study plots (where access was permitted) to expand the search area for color-banded Warblers and obtain additional information on return rates, dispersal, and territory size and configuration. While staff limitations prevented inclusion of the Bohls, Canyon Creek, and Ribelin plots in the intensive monitoring effort, City of Austin BCP staff and volunteers conducted cursory surveys to resight color-banded Warblers on Bohls and Canyon Creek, and Travis County BCP staff continued to monitor the Ribelin plot. In addition, volunteers searched for banded Warblers outside the intensive study plots and 100-meter buffers to obtain additional information on return rates and dispersal.

The intensive monitoring plots cover about eight percent of the existing BCP. Including the 100-meter buffers around each 40.5-ha plot (where access was allowed) and additional areas surveyed by volunteers to search for color-banded Warblers, surveys for this project cover about 23 percent of the BCP (Table 1).

Table 1. Intensive study plots for each macrosite within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2015.

Plot Name, Ownership, and Size (hectares)	Barton Creek Macrosite	Bull Creek Macrosite	Cypress Creek Macrosite	No. Lake Austin Macrosite	So. Lake Austin Macrosite	West Austin Macrosite
Barton Creek (COA)	40.5					
Gus Fruh (COA)[1]	85					
Sunset Valley (COA)[1]	27					
3M/St. Edwards (COA)		40.5				
Canyon Vista (TC)		40.5				
Forest Ridge (COA)		40.5				
Butler (COA)		40.5				
Hamilton West (COA)		40.5				
Baker Sanctuary (Travis Audubon)			40.5			
Lake Perspectives/ McGregor (TC/LCRA)			40.5			
Vireo Ridge (TC)			46[2]			
Vista Point (TC)			40.5			
Emma Long Bike Park (COA)				96		
Coldwater (COA)				107		
Emma Long (COA)				40.5		
JJ&T (COA)					40.5	
Reicher (COA)					40.5	
Wild Basin/Vireo Preserve (COA, Wild Basin, St. Edwards, TC)						180
Total # BCP Hectares Owned (as of November 2015)[3]	2,479	2,025	3,761	2,265	1,643	188
% of macrosite intensively surveyed[4]	~6%	~10%	~4%	~11%	~5%	~96%

[1]Data for the Gus Fruh and Sunset Valley plots are combined into one plot in the results section.
[2]Plot boundaries vary slightly from year to year, and plot size has increased from 42 to 46 hectares since the plot was initially established in 2011; results for each year are based on the plot dimensions for that year.
[3]Does not include the Pedernales macrosite (105 ha).
[4]Does not include the 100-m buffers around the study plots (approx. 30 ha for each of the twelve 40.5-ha plots, where access was allowed, totaling about 360 ha), resighting on the Canyon Creek, Bohls, and Ribelin 40.5-ha plots (121.5 ha), or the resighting areas beyond the buffers (about 1327 ha, see Exhibit B).

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 upland vegetation. Most streams are intermittent, though a few have a permanent water source, such as a perennial spring. The predominant vegetation association is mature Ashe juniper-oak woodlands, except at Hamilton West, Vireo Ridge, and Wild Basin/Vireo Preserve, where the habitat includes more open canopy.

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 floral 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 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*). Descriptions of individual plots can be found in Abbruzzese and Koehler (2003) and the Tier III Land Management Plans for each property.

In selecting the intensive study plot locations, an effort was made to represent a diversity of habitat types across the BCP, including vegetation types (i.e., evergreen, deciduous, and mixed evergreen-deciduous forests), slope and aspect, habitat patch sizes, proximity to urban development, and land management activities. Resources used included aerial photos and mapped vegetation types from Phase 1 of the Texas Ecological Systems Classification (http://morap.missouri.edu/index.php/texas-ecological-systems-classification/).

Golden-cheeked Warbler Monitoring on Intensive Study Plots

Color Banding

Color banding of adult GCWAs was conducted in conjunction with territory mapping on all of the 18 intensive study plots, from March 20 through May 22. Methods consisted of mist netting within a male Warbler's territory using playback of a tape-recorded male Warbler's song to attract the bird to the net. Although a few females were caught using this method, most of the Warblers captured were males. All Warblers captured in mist nets were marked with a unique combination of a U.S. Geological Survey (USGS) numbered aluminum band and auxiliary color bands to allow identification of each individual. The biological staff at Ft. Hood Military Reservation issued the color-band combinations. 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), or after hatch-year (AHY) according to Pyle (1997) and Peak and Lusk (2009)), using data sheets developed by Ft. Hood staff. Each Warbler was photographed just prior to release to document band combinations.

In addition, Jennifer Reidy (USFS/University of Missouri) banded nestlings to collect data on hatch-year (HY) Warblers to determine length of dependence on adults, dispersal distances from the natal area within the season, and potentially to gather critical data about dispersal distances and survival over multiple

seasons. Nestlings were banded approximately 7 to 9 days after hatching. They were removed from the nest while the adults were absent, placed in a small pliable box with air holes and then in a soft cloth bag, and carried down to the banding site, where they were banded with a standard color combination (2-3 colors and 1 USGS numbered aluminum band). Nestlings were returned to the nest immediately after banding. The nest was monitored from a safe distance to verify adults resumed normal feeding behavior.

Territory Delineation. Surveys on each intensive study plot were conducted at least twice a week from March 15 through May 25 to delineate territories and at least once a week from May 25 through June 15 to gather data on reproductive success. During each visit, biologists attempted to identify the color combination of each banded Warbler, obtain multiple locations for each male to assist with delineating territory boundaries, and determine the presence of a female, nest, and/or fledglings for each territory. To allow adequate time to collect these data and minimize observer bias, plots with five or more Warblers were surveyed by two or more biologists. Exhibit B lists the lead surveyors and survey hours for each intensive study plot.

To delineate territory size and configuration as accurately as possible, an effort was made to obtain at least 33 locations for each male from March 15 through May 25 (Davis et al. 2010). Observations after May 25 were recorded, but were used to determine productivity and not to delineate territory boundaries. Males were considered territorial if they were observed in the same area on three different days, spread over a three week period, and those locations were separated by 30 meters or more.

Warbler observations were recorded with Garmin global positioning units (GPS), which have an accuracy of 3 to 9 meters. Other sightings were recorded on topographic maps, using a 100-meter 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® 10.2.2.

The Warbler monitoring program and data collection protocols are described in detail in Reidy and Thompson (2010), the Balcones Canyonlands Preserve Land Managers Handbook, Tier IIA, Chapter VII: Monitoring of the Golden-cheeked Warbler (BCP 2007); the City of Austin Golden-cheeked Warbler and Black-capped Vireo Monitoring Program (Abbruzzese and Koehler 2003); and Exhibit C of this document. As with previous years, no playback tapes of Warbler songs or calls were used during this season's monitoring, except for the purpose of mist netting and color banding.

Nest monitoring. Biologists located nests from mid-March through mid-June while working within and near the study plots. UTM coordinates were recorded for each nest location using Garmin GPS units, and flagging was placed at least five meters from the nest to mark its location. Staff monitored each nest every few days to confirm activity and nest stage, and predicted the expected fledge date based on nesting phenology, apparent nestling age, and adult behavior. Staff monitored the nest more frequently around

the expected fledge date (nestlings ≥9 days old), and searched for fledglings for any nest that was no longer active until fledglings were confirmed, evidence of re-building was confirmed, or until the end of the field season. A nest was considered successful only if one or both adults was detected tending to fledglings. If nesting activity ceased prior to possible fledging, we recorded the nest fate 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, we recorded nest fate as unknown. To better assess effects of increasing fragmentation and urbanization on nest survival, we searched for nests outside of the intensive monitoring plots in 2015 to include more marginal/edge habitat and more fragmented habitat. Additional search areas included Barton Creek Habitat Preserve and developed areas adjacent to Beard Trust, Kent Butler, and Long Canyon.

Once young had fledged, nest site and nest patch characteristics were recorded following methods developed by Reidy (2007). Data were recorded on the nest tree species, nest height from the ground to the rim of the nest, nest tree height, diameter at breast height (DBH), and canopy cover. Nest and tree heights were obtained in meters using a clinometer, and DBH was measured in centimeters using a Biltmore stick. For trees with multiple trunks, DBH was measured as the largest trunk plus one-half of each of the smaller trunks (City of Austin 2013). Canopy cover was estimated using a densiometer. Other nest site and nest patch data, including distance of the nest to the main trunk, average height of junipers and oaks, nest cover, percent ground cover, slope, and stem density, were also collected.

Surveys for Banded Warblers Outside of Intensive Study Plots

Surveys were conducted to search for and identify color-banded Warblers in areas outside of the intensive study areas (plots plus buffers). Thirty eight volunteers in 32 teams conducted surveys on approximately 1,327 hectares. For each survey, observers were directed to allow approximately six hours per visit for each 40.5 hectares of habitat for a minimum of three visits. The list of resighting plots where surveys were conducted and the survey effort for each plot are reported in Exhibit B.

RESULTS

Territory Delineations

Territory maps for each intensive study plot are presented in Exhibit A. Monitoring on the Coldwater site was suspended between May 20 and June 15 due to safety concerns.

Color Banding

A total of 132 adult Warblers (127 males, 5 females) and 41 nestlings were banded in 2015.

Nest Data

USFS, BCP staff, and BCP partners found and monitored a total of 186 active Warbler nests within the intensive study plots during the 2015 field season. The first nests were found on March 23, and fledging dates for observed nests ranged from April 26 through June 9. Of the 186 nests, 85 fledged one or more young (46%), 94 nests failed (50%), and 7 had an unknown fate (4%).

BCP staff collected vegetation data for 155 nests, of which the majority were in Ashe Juniper (67%) and Live Oak (18%). Nest tree height for all tree species averaged 8.1 meters, and nest tree DBH averaged 28 centimeters. Nest height averaged 6.4 meters. Canopy cover averaged 86 percent.

Parasitism

A Brown-headed Cowbird (*Molothrus ater*) was observed at one of the 186 Warbler nests; this nest was subsequently abandoned. No other observations of nest parasitism or of adult Warblers feeding cowbird chicks were reported in 2015.

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Exhibit A: Distribution of Intensive Study Areas (Figure 1) and Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015.
Disclaimer: these products are for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents 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.

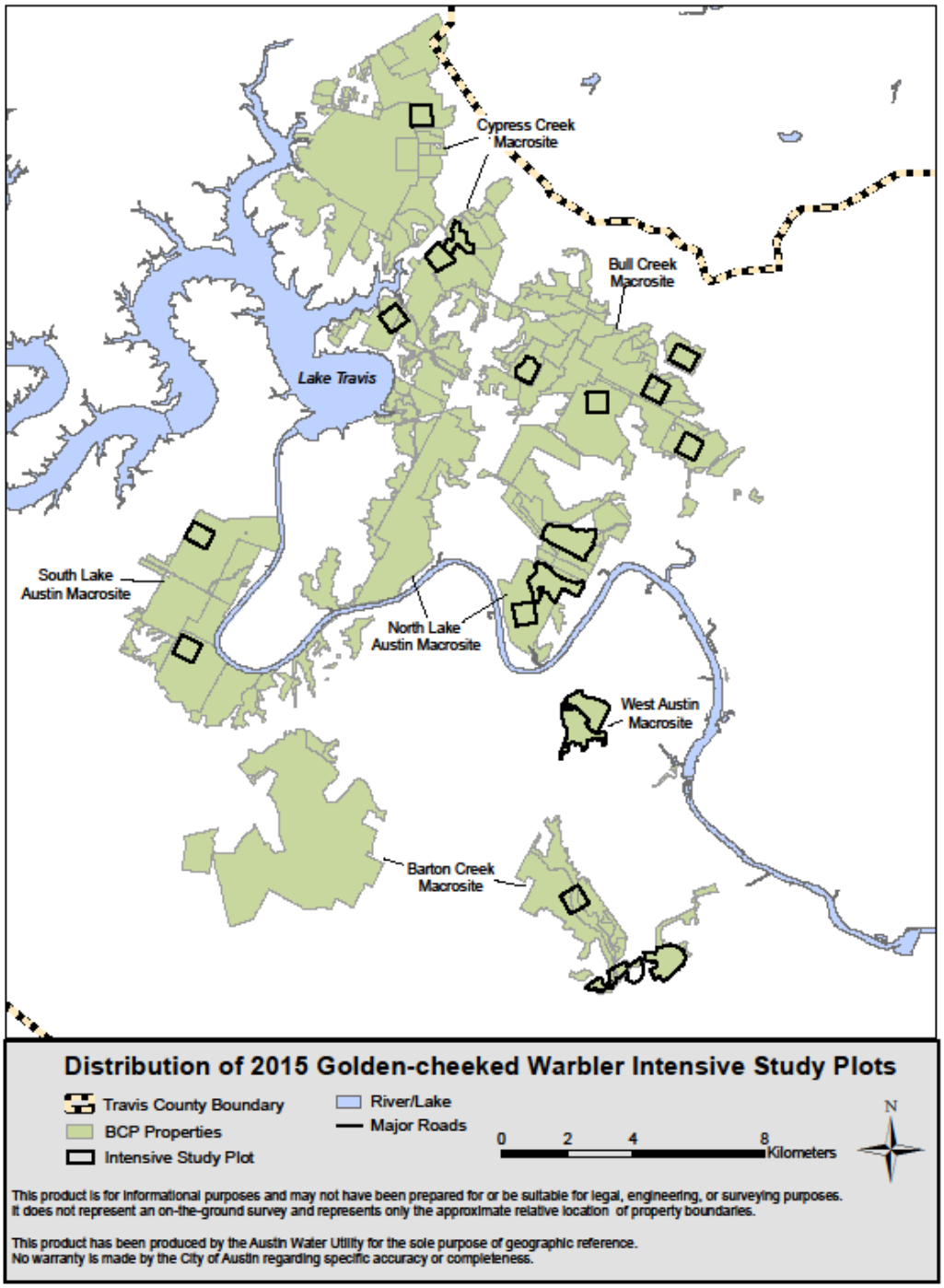


Figure 1

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

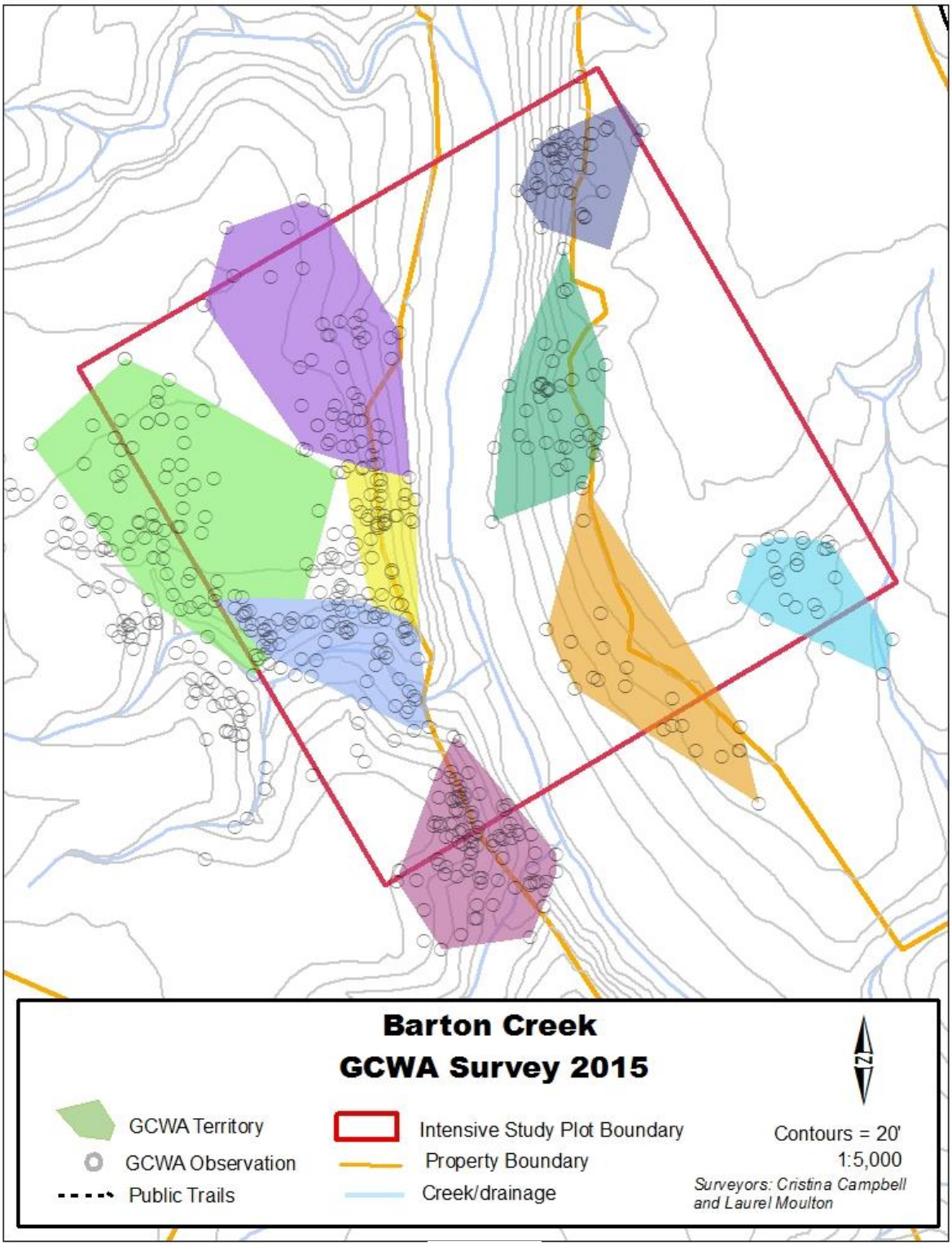


Figure 2

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

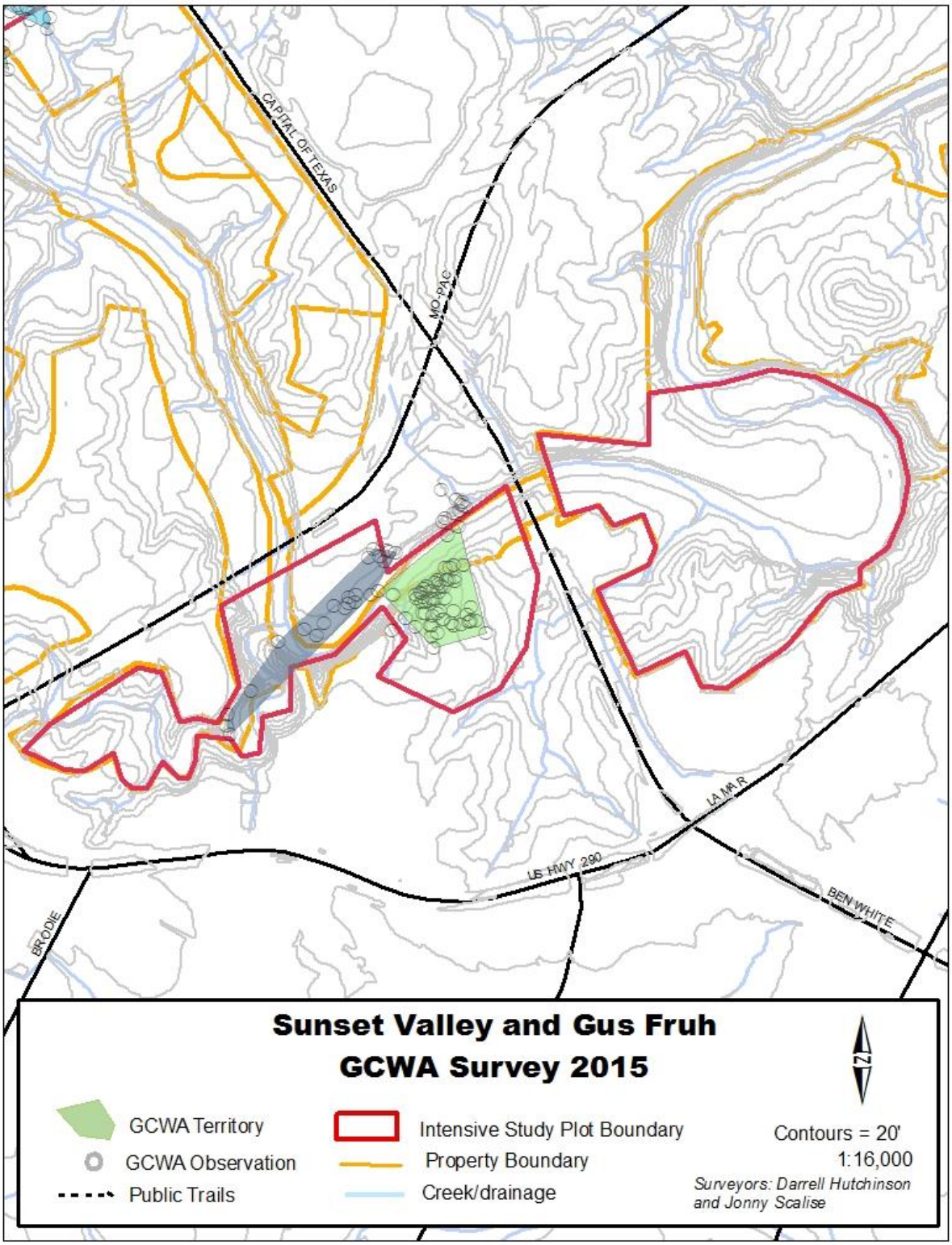


Figure 3

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

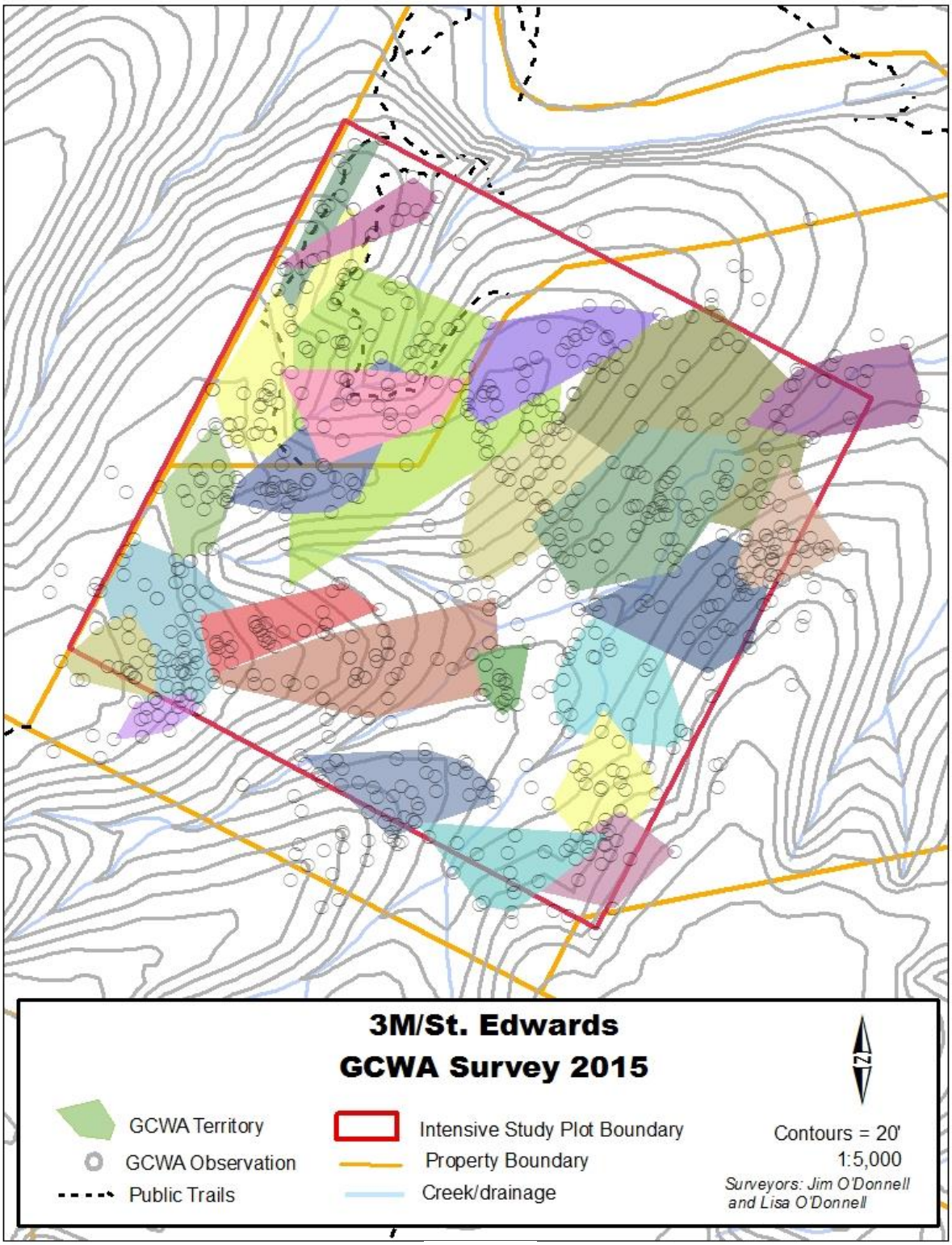


Figure 4

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

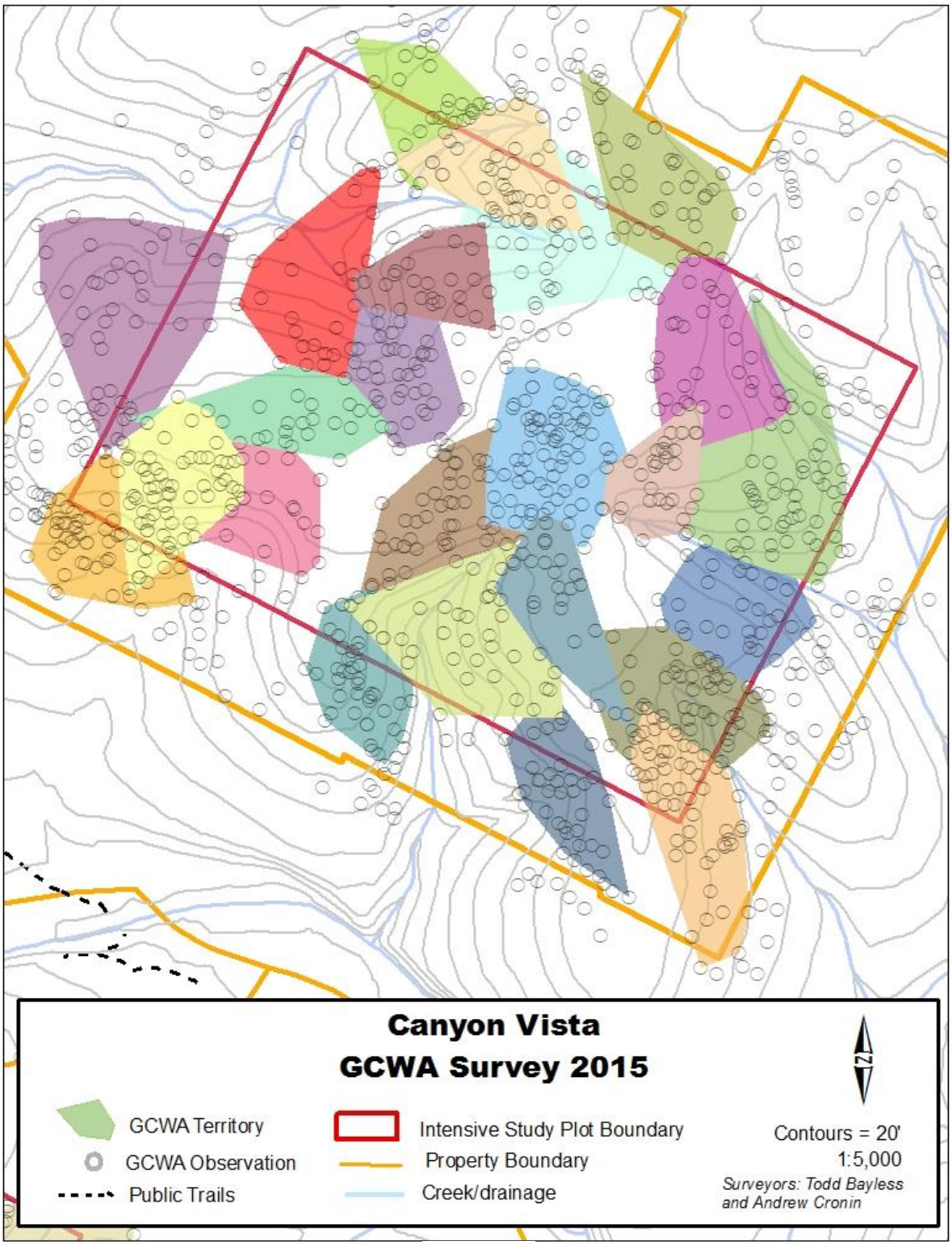


Figure 5

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

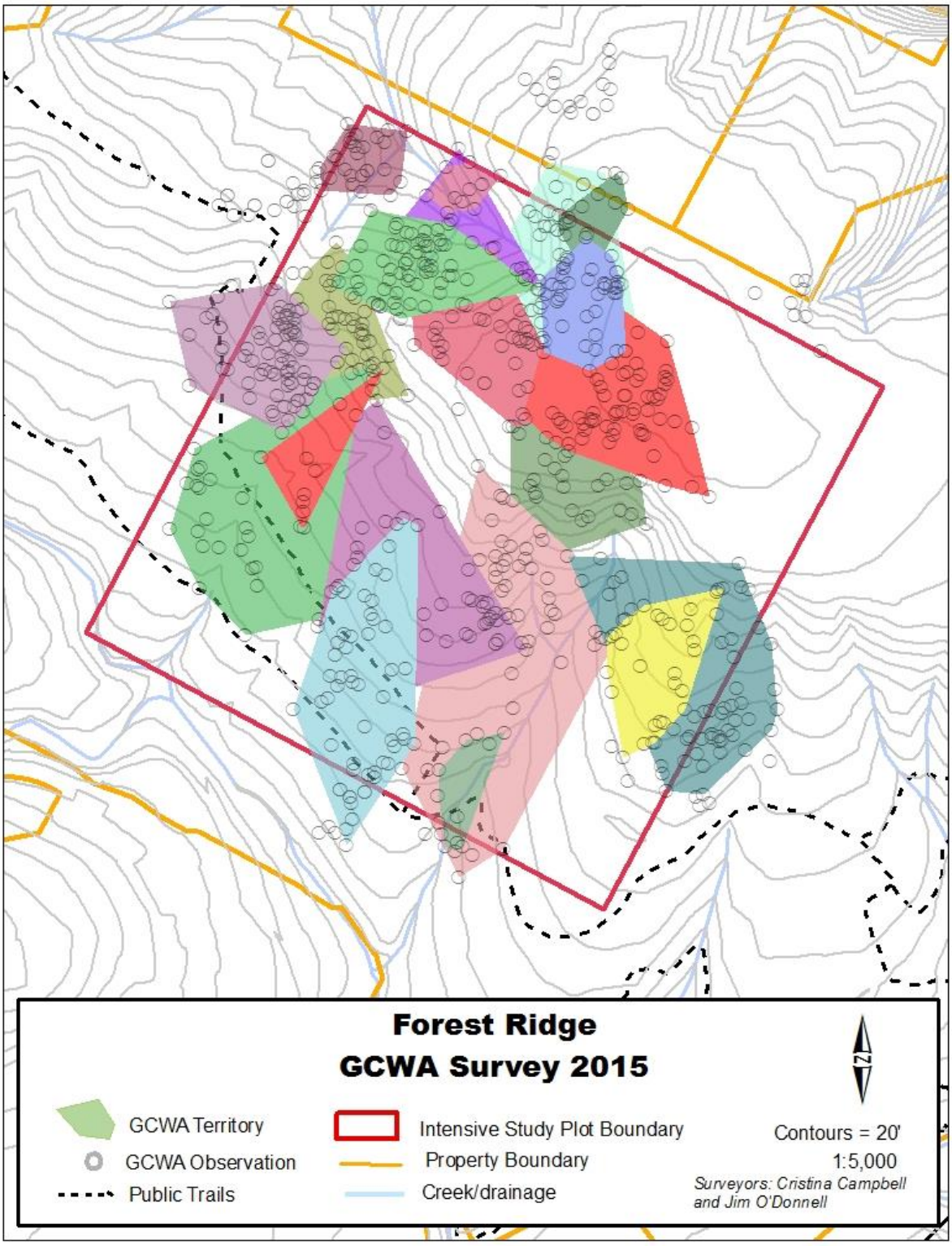


Figure 6

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

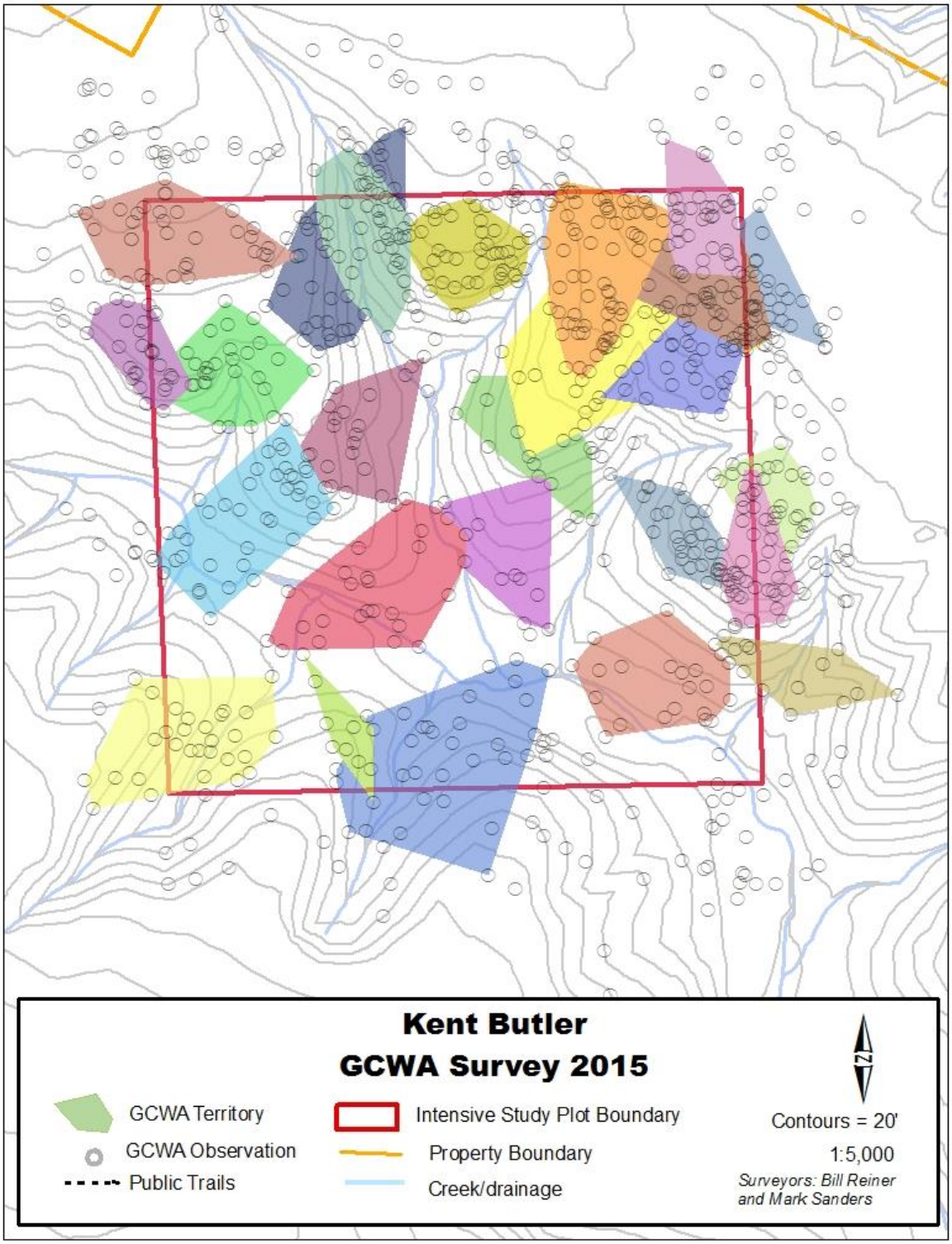


Figure 7

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

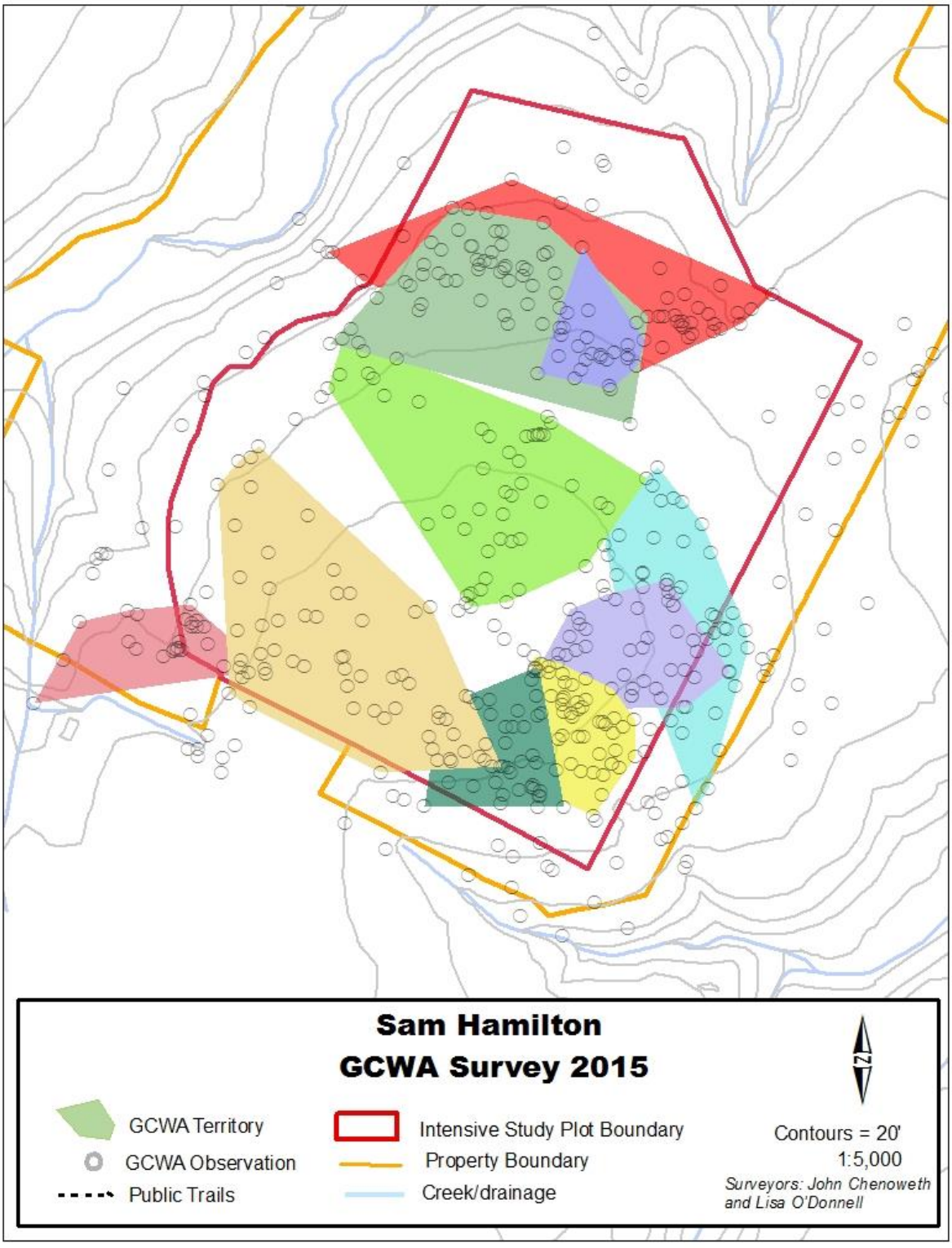


Figure 8

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

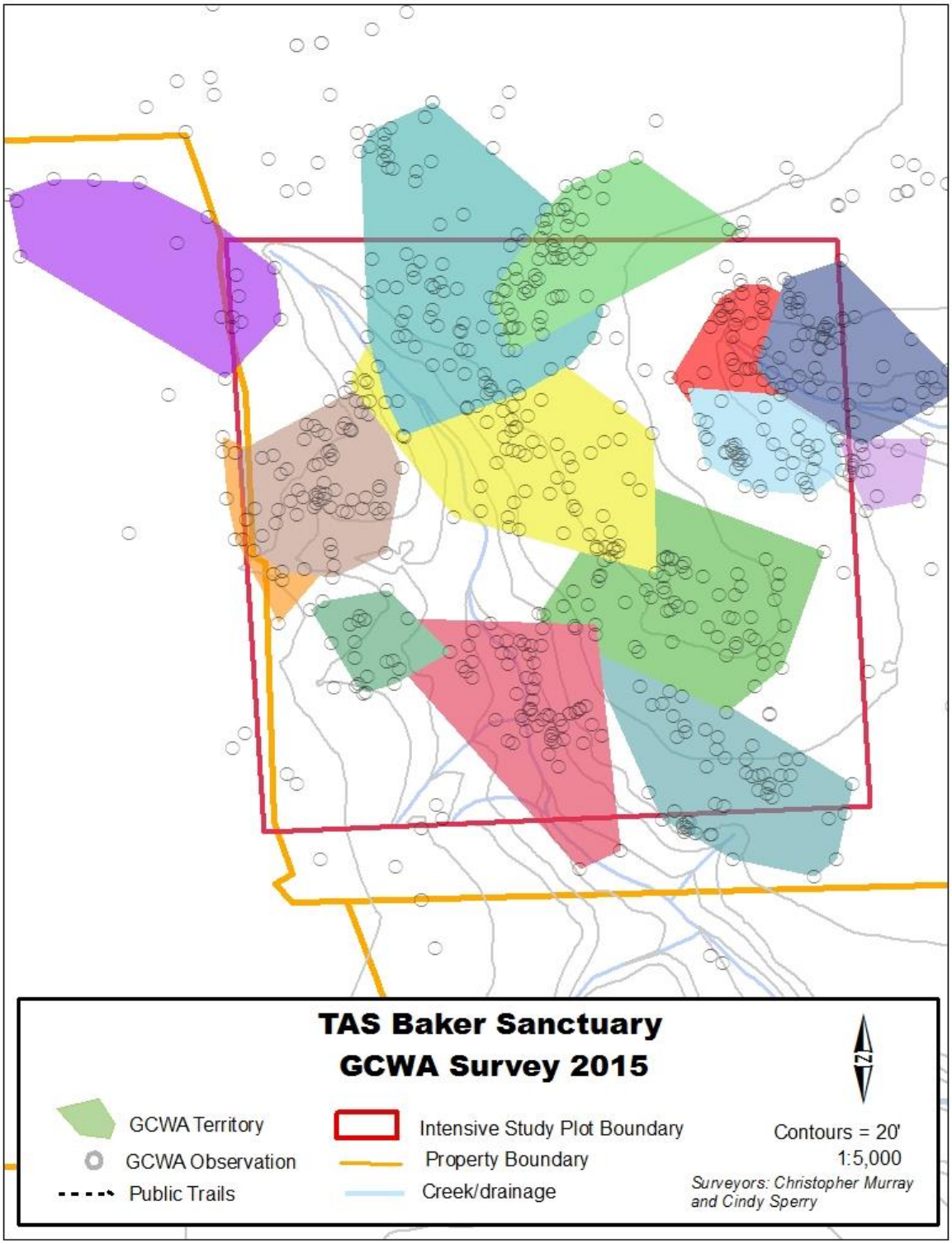


Figure 9

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

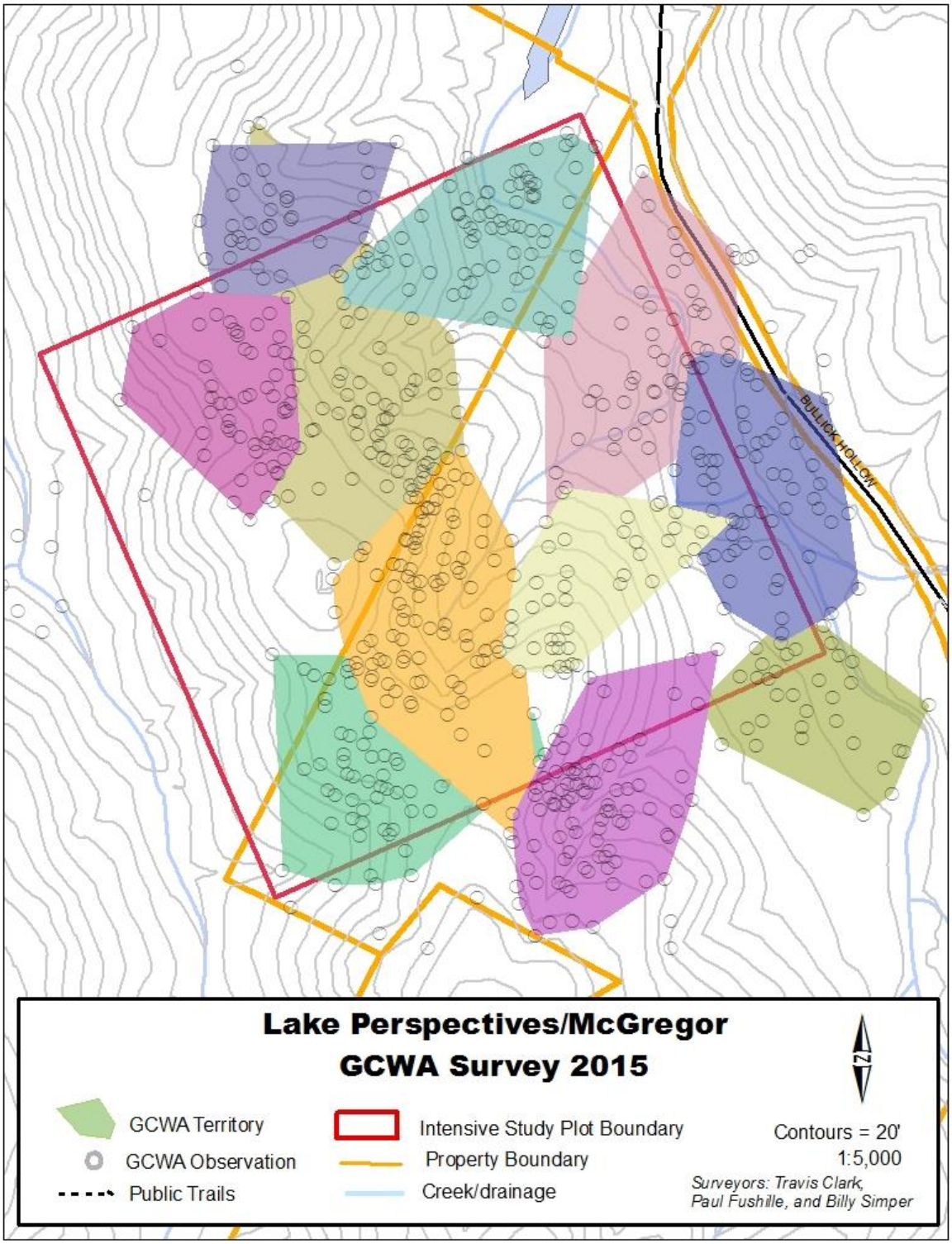


Figure 10

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

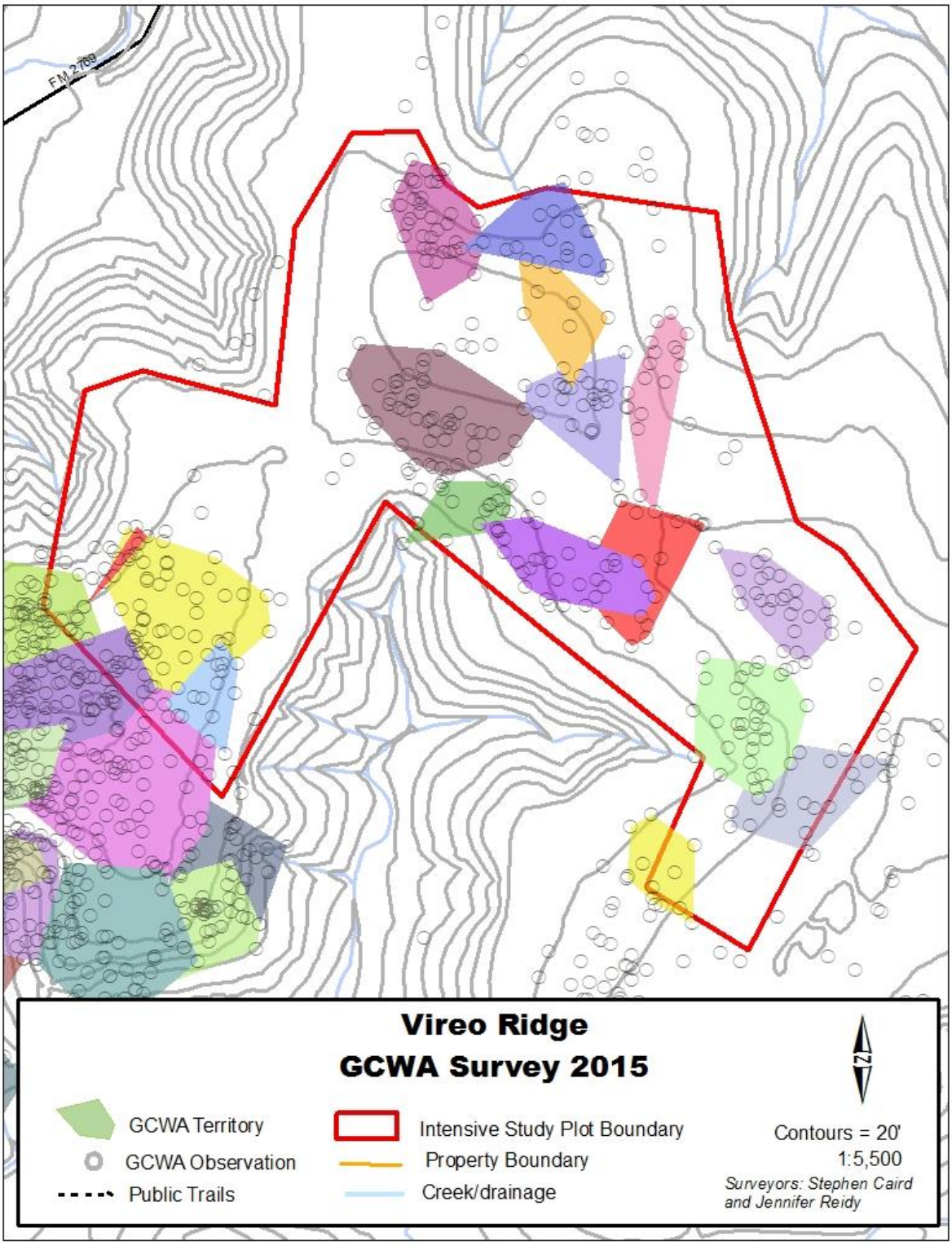


Figure 11

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

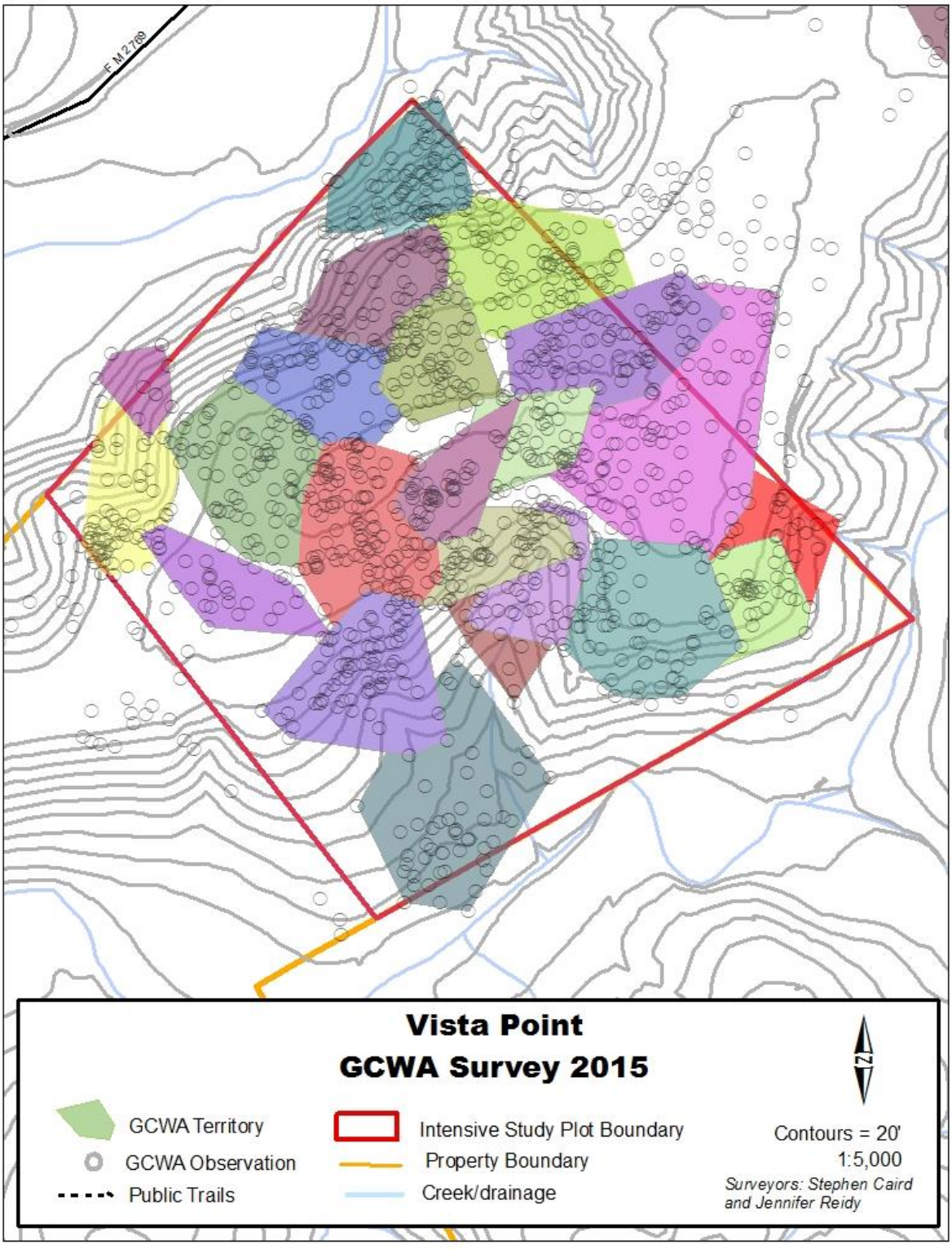


Figure 12

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

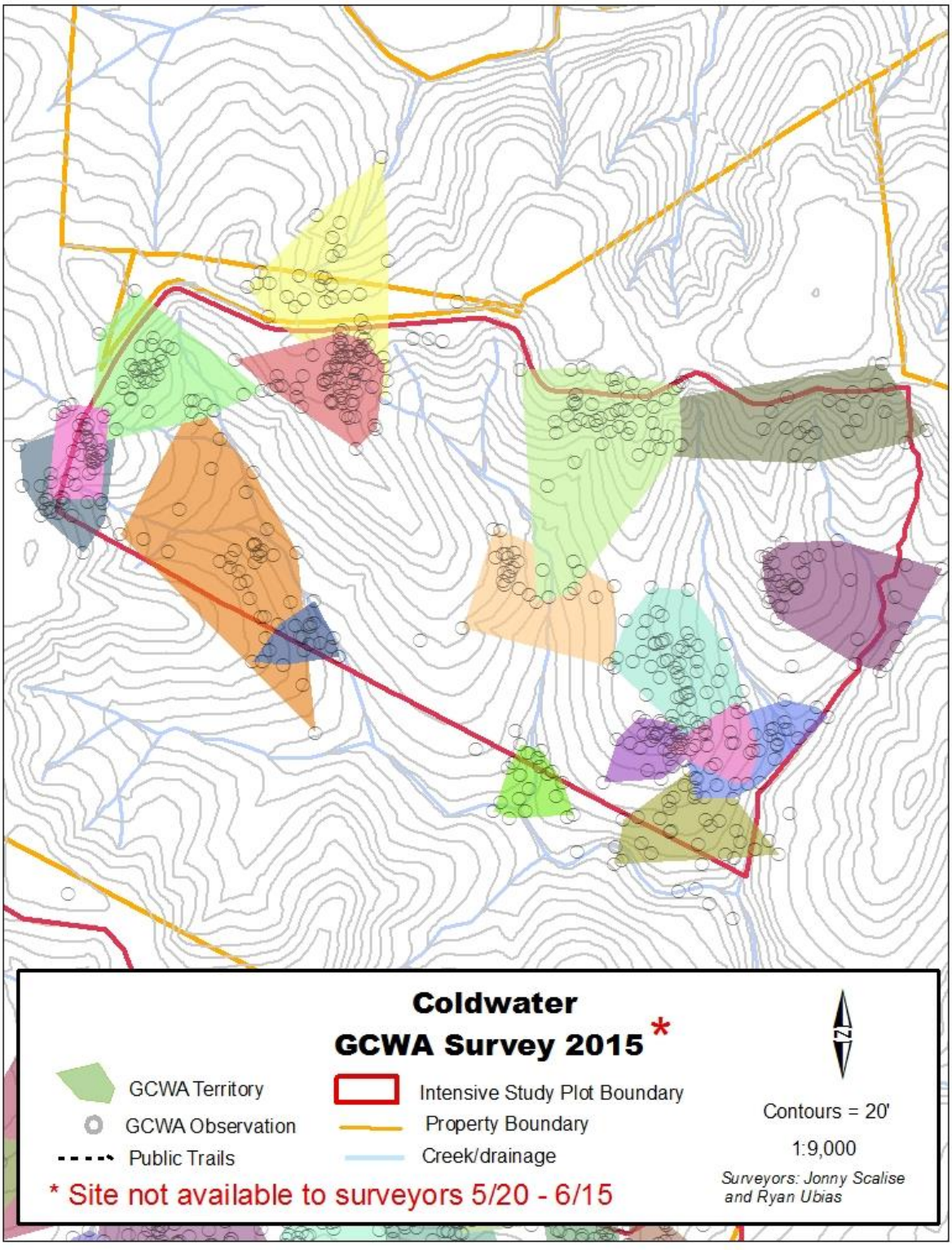


Figure 13

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

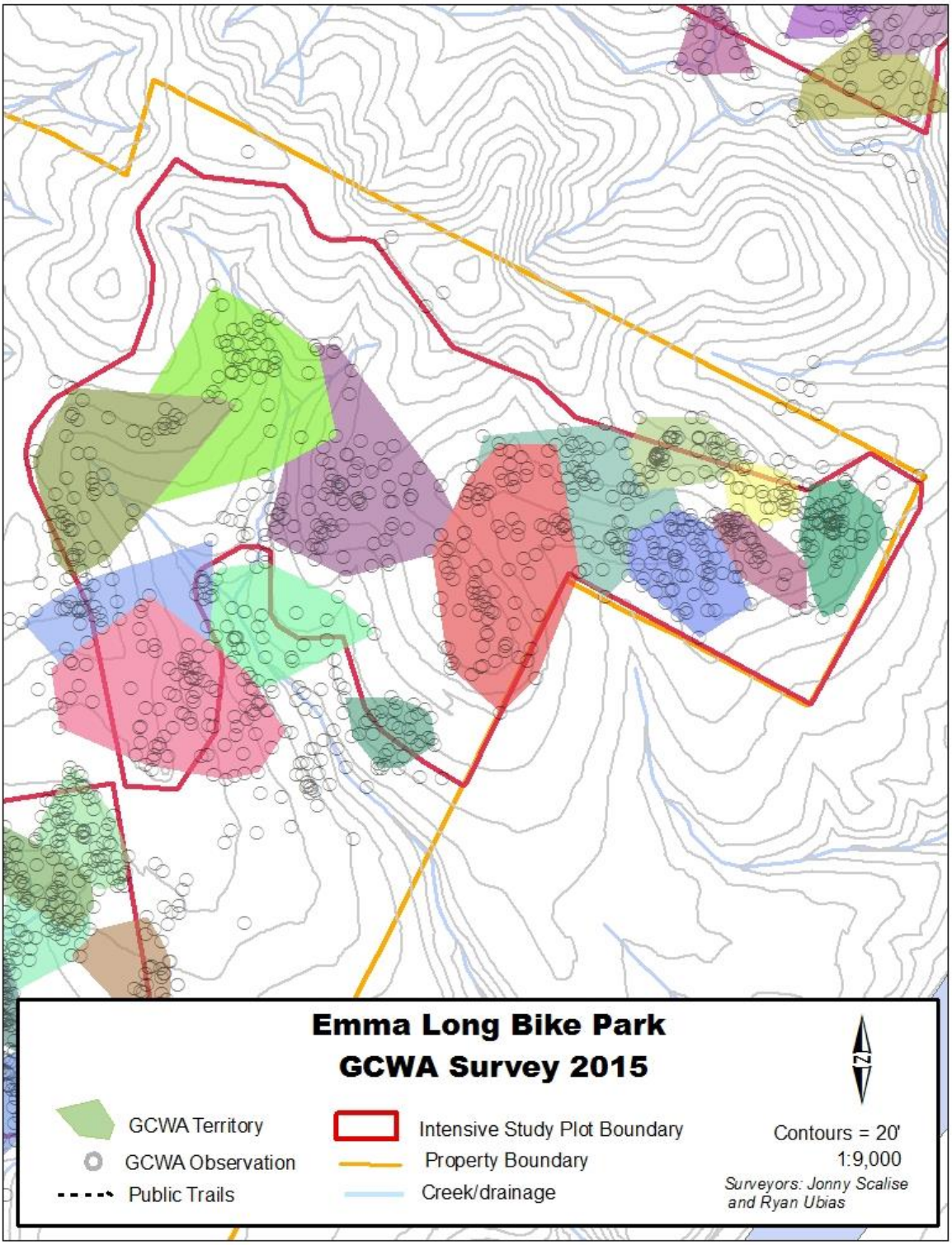


Figure 14

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

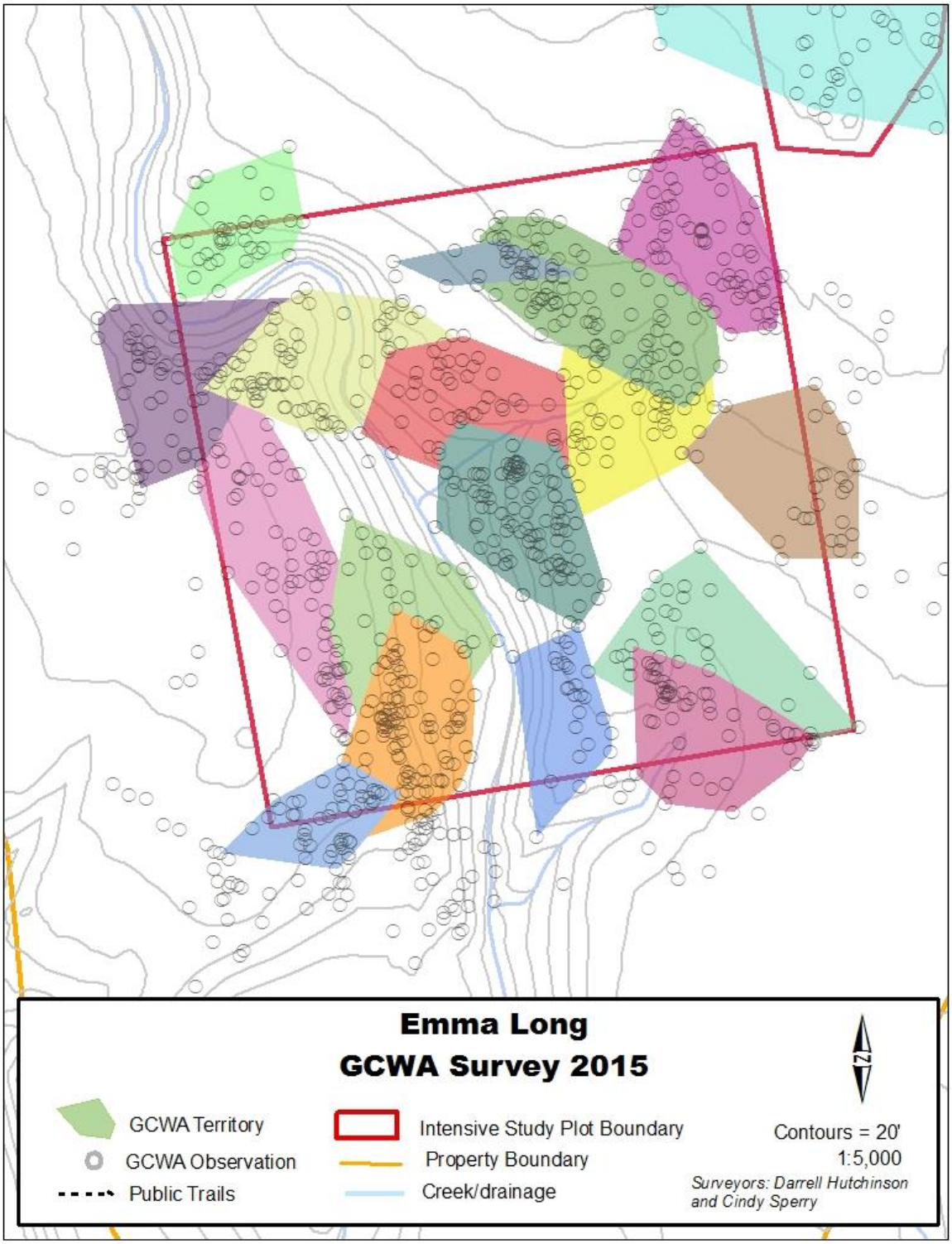


Figure 15

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

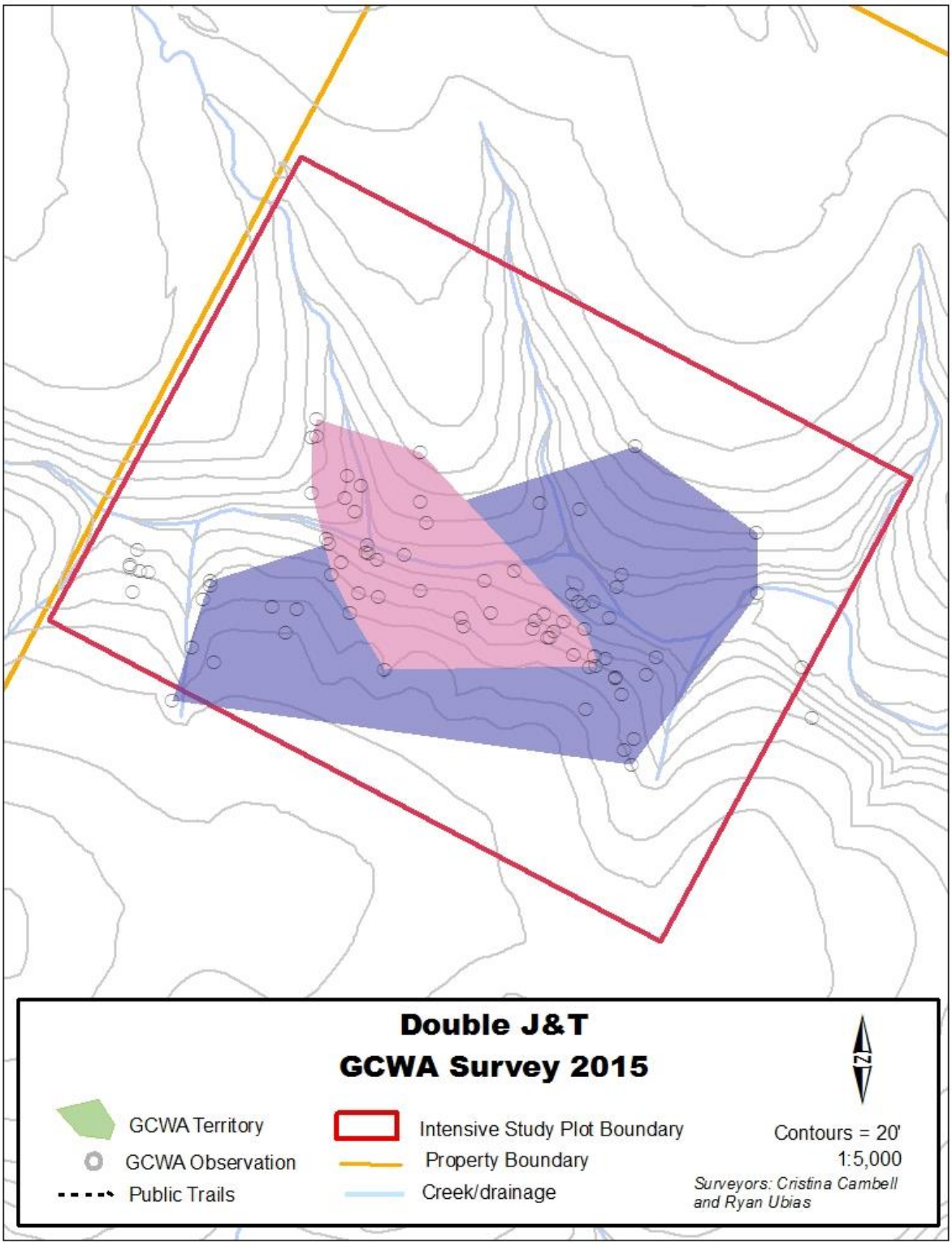


Figure 16

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

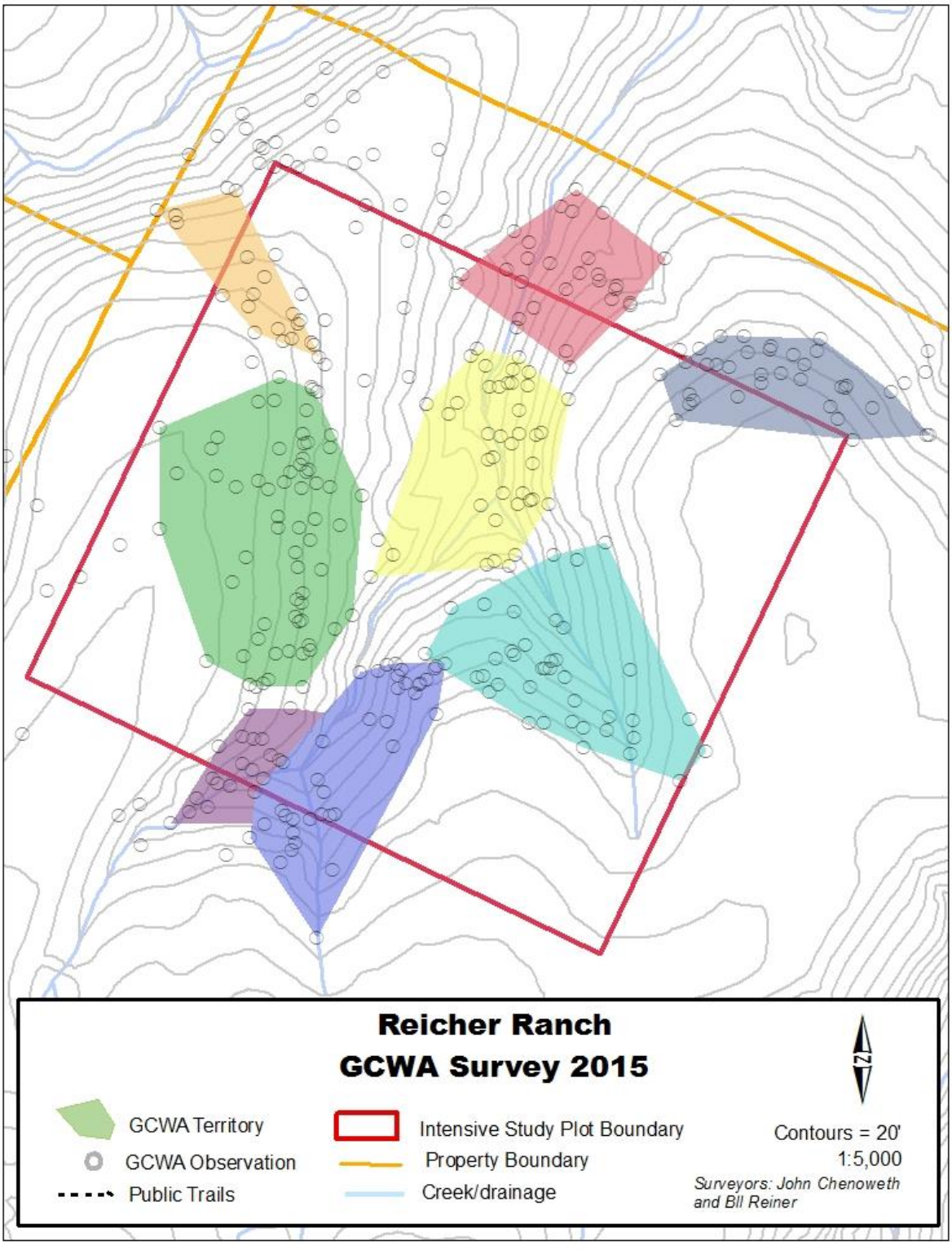


Figure 17

Exhibit A: Minimum Convex Polygons Representing Estimated Golden-cheeked Warbler Territory Boundaries for Intensive Study Plots (Figures 2-18), 2015 (continued).

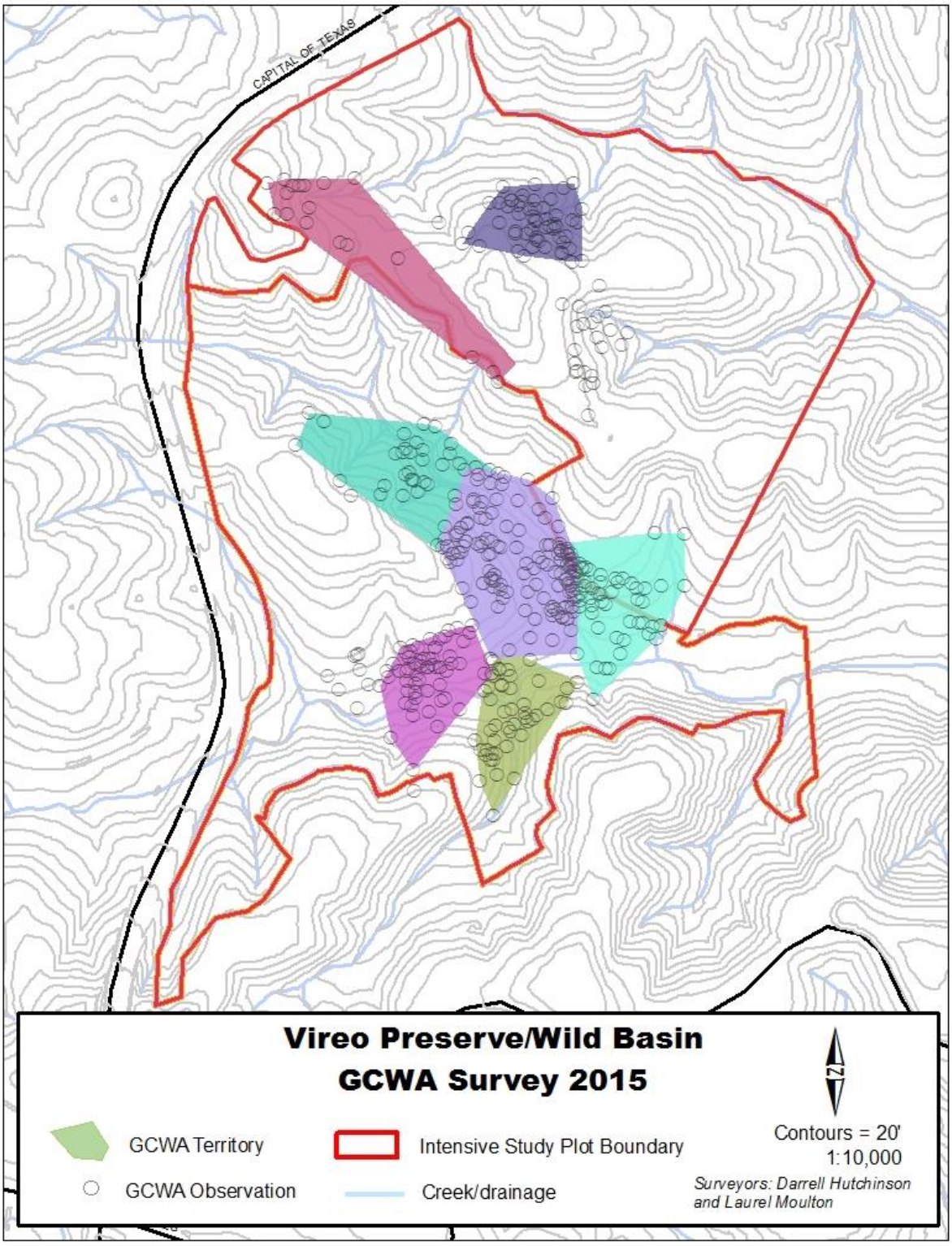


Figure 18

Exhibit B: Summary of Golden-cheeked Warbler Survey Effort on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2015.

Intensive Study Plots	Lead Surveyor(s)	Survey Hours (March 11-June 18)	Area Surveyed (hectares)
Barton Creek Macrosite			
Barton Creek	Cristina Campbell, COA; Laurel Moulton, USFS	305	40.5 + buffer
Gus Fruh/ Sunset Valley	Darrell Hutchinson, Jonny Scalise, COA	97	85 + 27
Bull Creek Macrosite			
3M/St. Edwards	Jim O'Donnell, Lisa O'Donnell, COA		40.5 + buffer
Canyon Vista	Todd Bayless, TC; Andrew Cronin, USFS	393	40.5 + buffer
Forest Ridge	Cristina Campbell, Jim O'Donnell, COA		40.5 + buffer
Butler	William Reiner, Mark Sanders, COA	311	40.5 + buffer
Hamilton West	John Chenoweth, Lisa O'Donnell, COA	195	40.5 + buffer
Cypress Creek Macrosite			
Baker Sanctuary	Chris Murray ,Travis Audubon; Cindy Sperry, COA	214	40.5 + buffer
Lake Perspectives/McGregor	Travis Clark, Paul Fushille, TC	229	40.5 + buffer
Vireo Ridge	Stephen Caird, Jennifer Reidy, USFS	205	46
Vista Point	Stephen Caird, Jennifer Reidy, USFS	433	40.5 + buffer
North Lake Austin Macrosite			
Bike Park	Jonny Scalise, COA, Ryan Ubias, USFS	450	96
Coldwater	Jonny Scalise, COA Ryan Ubias	257	107
Emma Long	Darrell Hutchinson, Cindy Sperry, COA	305	40.5 + buffer
South Lake Austin Macrosite			
Double J&T	Cristina Campbell, COA; Ryan Ubias USFS	60	40.5 + buffer
Reicher	John Chenoweth, William Reiner, COA	200	40.5 + buffer
West Austin Macrosite			
Vireo Preserve/Wild Basin	Darrell Hutchinson, COA; Laurel Moulton USFS	255	180
	Total		**1,027 + buffers**

COA = City of Austin, TC = Travis County, USFS = U.S. Forest Service.
Buffers = approx. 30 hectares for each 40.5-ha plot, where access was allowed.

Exhibit B: Summary of Golden-cheeked Warbler Survey Effort on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2015 (continued).

Resighting Plots*	***Surveyor(s)***	**Survey Hours (March 15-May 25)**
3M Northeast	Paul Brick	11.5
3M South	Thom Marshall Dale Thompson	13.5
3M Southeast	Christopher Weyenberg Laura Zebehazy	19
Baker Sanctuary North	Crystal Datri	18
Baker Sanctuary Southeast	Tam Tran	8
Baker Sanctuary – LCRA Northwest	Katherine Ross	19
Baker Sanctuary – LCRA Southwest	Leigh Jandle	16
Barton Creek Northwest	Kathleen Collins Mary Gilroy Shelia Hargis	18
Barton Creek Southeast	Misa Soliz	4.5
Barton Creek Southwest	Stacy Marcus	14
Bohls 40.5-hectare plot	Laura Zebehazy	12
Canyon Creek 40.5-hectare plot	Nevin Durish Mark Sanders, COA	15
Canyon Vista	Paul Clements Ayoola Folarin Ranleigh Hirsh	19
Emma Long East	Alan and Heidi Carlin	20
Emma Long West	Alan and Heidi Carlin Mary Ann Robalino	18
Emma Long South	Joseph Hunt Mike Rogan	18
Forest Ridge Northeast	Natalie Goldsworthy Jim Ingram	36
Forest Ridge Northwest	Jim and Lynn Weber	18
Forest Ridge Southeast	Jenny Samford	18
Forest Ridge Southwest	Jim and Lynn Weber	18
Hamilton Northeast	AJ Johnson	20
Hamilton West	Paul Brick Leigh Jandle	9
Interplot (33.4 ha) (between 3M and Forest Ridge plots)	Kathleen Collins Mary Gilroy	18
Kent Butler East	Kelly Alm Angela England Monica Ford Alyssa Martin	25
Kent Butler Northwest	Lauren Dill Tracy White	18
Kent Butler Southeast	Crystal Datri	19
Kent Butler Southwest	Julie Webber	12
Lake Perspectives South	Leigh Jandle	18

Resighting Plots*	***Surveyor(s)***	**Survey Hours (March 15-May 25)**
Lake Perspectives Northwest	Paul Clements Ranleigh Hirsh	20
Vista Point Southeast	Robin Laine	18.5
Vista Point Southwest	Crystal Datri	18
Vireo Ridge	Jennifer Lueckemeyer	18
Ribelin 40.5-Hectare plot	Travis County staff	--

*All resighting plots were approximately 40.4 ha except where noted.
COA = City of Austin.

Exhibit C: Golden-cheeked Warbler Intensive Study Plot Protocol, Balcones Canyonlands Preserve, 2015.

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 (actual number of young per territory) to estimate long-term trends in these parameters. This field season will continue the level of effort to obtain observations of females, nests, and newly-fledged young for each territory to provide more accurate estimates of productivity.

Study Sites: Within each intensive study plot, observers will focus on re-sighting color-banded GCWAs, mapping the location and extent of territories, searching for and monitoring nests, 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 better ascertain the fate of each banded GCWA and to provide better estimates of the size and extent of edge territories.

Survey Dates: March 1-May 25 (for territory delineations); March 15-June 15 (for documenting reproductive success). Each observer will visit their assigned study plot at least 2 days per week from March 15-May 25 for the purposes of mapping all observed GCWAs, finding and monitoring nests and fledglings, and resighting birds. Separate visits may be required to band territorial males but GCWA observations made during banding attempts are not to be reported as territory observations. Productivity visits will continue at least once a week from May 25-June 15.

Survey Effort for Territory Mapping: 6 hours per 100 acres per week *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. Surveyors will take as much time as needed to collect data for each territory (estimate about 45 minutes per territory on each visit). As a general rule, observers should strive to obtain a minimum of 5 locations separated by $\geq$30 meters, up to 10 locations, for birds in each territory per week. This is an additional criterion that fits within the 45+ min time allotment.

Mapping: Observers will obtain GPS locations for, and create hard copy maps of, all GCWA observations for every survey visit, following the Standards for Conducting and Documenting Golden-cheeked Warbler Surveys (COA 2015). 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: Two observers per plot averaging $\geq$5 territories, with a *minimum* 3 hours/50 acres/person (*minimum* 6 hours total per 100 acres) per week. Two observers will help ensure comprehensive coverage and address potential observer bias issues.

Training: All staff scheduled for the 2015 field season will have prior experience conducting 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 2015) during all field visits. The following additional procedures are specific to surveying intensive survey plots:

1. Surveys should start as soon as possible after sunrise, but not before light levels permit detection of color bands.
2. Each observer will cover half (for plots averaging 5 or more territories) or the entire plot (for plots with <5 territories) at least twice each week. For shared plots, 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.
3. Volunteers will be recruited to conduct searches for banded GCWAs outside the 100-m buffers surrounding each intensive study plot. These surveys will be conducted at least three times within the season, $\geq$ 2 weeks apart. These surveys will also follow the Standards for Conducting and Documenting Golden-cheeked Warbler Surveys (COA 2015).