City of Austin 2010
Golden-cheeked Warbler *(Dendroica chrysoparia)* and Black-capped Vireo *(Vireo atricapilla)* Monitoring Program

Balcones Canyonlands Preserve Annual Report
Fiscal Year 2009-10



Black-capped Vireo Nestlings © William Reiner



Golden-cheeked Warbler female feeding young fledgling
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City of Austin Water Utility
Wildland Conservation Division
Balcones Canyonlands Preserve Program

TABLE OF CONTENTS

I. GOLDEN-CHEEKED WARBLER MONITORING 2

INTRODUCTION 2
Background 2
Objectives 2
METHODS 2
Study Sites 3
Site Description 3
Region-wide Monitoring Program: 100-acre Study Plots 4
Searches for Banded Warblers Outside Prime Study Plots 6
Pilot Study to Further Examine Effects of Recreation 7
RESULTS AND DISCUSSION 8
100-acre Study Plots 8
Nest Data 13
Recreation Study 15
Other Observations 17
Habitat Suitability and Population Viability Analyses 18
ACKNOWLEDGEMENTS 18

II. BLACK-CAPPED VIREO MONITORING 19

INTRODUCTION 19
Background 19
Objectives 19
METHODS 20
Sites and Survey Effort 20
Data Collection and Analysis 20
RESULTS AND DISCUSSION 20
Territory Mapping on the Cortaña Study Site 20
Pairing, Breeding Success, and Productivity on the Cortaña Study Site 21
Vireos on Other Tracts 21
Parasitism 21
Golden-cheeked Warblers in Black-capped Vireo Habitat 22

III. BLACK-CAPPED VIREO HABITAT MANAGEMENT 22

IV. LITERATURE CITED

V. APPENDICES

APPENDIX A: Distribution of City of Austin Study Plots, 2010
APPENDIX B: 100-Acre Study Plot Protocol
APPENDIX C: 2010 Survey Summary
APPENDIX D: Golden-cheeked Warbler 100-acre Study Plot Territory Data
APPENDIX E: Golden-cheeked Warbler 100-Acre Study Plot Age Structure Data
APPENDIX F: Golden-cheeked Warbler 100-Acre Study Plot Return Rates
APPENDIX G: Golden-cheeked Warbler 100-acre Study Plot Reproductive Success Data
APPENDIX H: Survey Maps (Figures 1-14)

City of Austin

2010 Golden-cheeked Warbler and Black-capped Vireo Monitoring Program

Balcones Canyonlands Preserve Annual Report

FY 2009-10

This report summarizes the results of the City of Austin's 2010 golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapilla*) endangered species monitoring program. The 2010 field season was the thirteenth year of endangered species monitoring on the City of Austin's Balcones Canyonlands Preserve tracts.

Highlights of the 2010 golden-cheeked warbler field season include a second year of color banding, a volunteer effort to search for color-banded warblers near the 100-acre prime plots, the addition of a transitional plot on the Sam Hamilton Memorial Reserve West (former Water Treatment Plant 4) tract, a pilot study to further examine the effects of recreation on the warbler, and nest searching and monitoring. The overall return rate of warbler males banded in 2009 was 45 percent (54% prime plots, 11% transitional plots). All three of the females banded in 2009 were observed in 2010. All of the returning adult warblers were observed within the same habitat patch/macrosite, and only two dispersal events were documented (1.7 and 3 km), corroborating the high site fidelity exhibited by adults of this species. Warbler territory densities averaged 0.26 territories/ha (average 0.34 territories/ha in prime habitat, 0.13 territories/ha in transitional habitat). The prime study plots in the Bull Creek macrosite supported the highest territory densities (0.37-0.48/ha) and produced the greatest number of fledglings, consistent with findings that the warbler requires large patches of mature, closed-canopy Ashe juniper-oak woodlands with minimal internal disturbance (Peak 2007). The intensive study plots in the Barton Creek and North Lake Austin macrosites had lower reproductive output due to lower densities and breeding success, respectively. Territory densities at the Emma Long Bike Park in the North Lake Austin macrosite appear to have declined since a previous study conducted in 2002-2003 by Davis et al. (2010), suggesting that habitat fragmentation and/or concentrated, intensive recreational uses that are limited to mountain biking and motorized dirt bikes may be having a negative effect.

Highlights for the black-capped vireo include continued occupation of the Cortaña/River Place and Forest Ridge tracts; implementation of habitat restoration and management on about 50 acres of the Vireo Research Area, including a pilot prescribed burn on seven acres; and preparation of 11 acres on Cortaña for a prescribed burn.

A project with Baylor University is underway to estimate stand ages, composition changes, and fire histories within the BCP's woodlands based on analyses of a decadal series of aerial photographs (1940 to present) and dendrochronology. The results of these analyses will be used to identify priority (mature) woodlands for the warbler and potential management areas (earlier successional stages) for the vireo.

I. GOLDEN-CHEEKED WARBLER MONITORING

INTRODUCTION

Background

The golden-cheeked warbler (hereafter, warbler) is a neotropical migrant passerine that breeds only in central Texas where mature Ashe juniper-oak (*Juniperus ashei* - *Quercus* spp.) habitat occurs (Ladd and Gass 1999). Due to accelerating loss of breeding habitat over the past several decades, this species was listed as federally endangered by the U.S. Fish and Wildlife Service in 1990 (USFWS 1990). The Balcones Canyonlands Preserve (BCP) was established in 1996 in part to mitigate for continuing loss of warbler breeding habitat in western Travis County and to aid in the species' local recovery (BCP 1998). The BCP is managed by a number of public and private entities, including the City of Austin. The City of Austin manages approximately 13,600 acres of the BCP.

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 identifies the following goals and objectives: "The GCWA 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. Occupancy, survivorship, and productivity data are critical to assess population viability." Since the inception of the City of Austin's warbler monitoring program in 1998, the primary focus has been to estimate population size, territory density and trends, productivity, and distribution. To ensure the accuracy of the 100-acre plot methodology and allow for a more comprehensive examination of the warbler's demography within the BCP, the City of Austin initiated a pilot color banding study during the 2009 field season (City of Austin 2008a). The banding program is intended to provide information needed to understand underlying trends in abundance, including age structure/recruitment, return rates/survival, and dispersal, and more reliable estimates of territory densities and reproductive success.

METHODS

The warbler populations on the BCP and on the Balcones Canyonlands National Wildlife Refuge (BCNWR) are monitored in accordance with the Tier IIA-7 land management plan guidelines using a standardized, region-wide program (BCP 2007). Population and productivity trends are tracked on a series of 100-acre plots located on the BCP and BCNWR. The City of Austin collects data on territory density, territory location, pairing success, breeding success, and productivity for each 100-acre plot. The City of Austin also conducts territory enumerations over a larger area of the BCP to ascertain warbler distribution and to attempt to get a rough estimate of overall territory density. During the 2010 field season, staff and volunteers focused on searching for color-banded warblers outside of the intensive study areas rather than enumerating territories.

Study Sites

In field season 2010, warbler territories were mapped on five 100-acre "prime" study plots and three "transitional" study plots. Prime plots are defined as those with a minimum of 75 percent excellent warbler habitat (mature juniper-oak woodlands), and at least 70 percent canopy cover (BCP 2007). Prime plots are located on five BCP tracts in three macrosites: Emma Long Metropolitan Park (North Lake Austin macrosite), Barton Creek Wilderness Preserve and Greenbelt (Barton Creek macrosite), Ivanhoe, Forest Ridge, and 3M/St. Edwards (Bull Creek macrosite). Staff biologists monitor these plots annually. Data for 1998 through 2010 are presented in Appendix A.

Transitional plots are located on three BCP tracts in two macrosites: Canyon Creek (Bull Creek macrosite), Bohls, and Double J&T (South Lake Austin macrosite) (Appendix A). These plots comprise areas containing zero to a few warbler territories and may improve as warbler habitat within the next 30 years (BCP 1998). With the exception of the Bohls plot, transitional plots were monitored every other year until 2009. The Bohls plot was changed from a prime plot to transitional in 2008 (City of Austin 2008b), and so has consistently been monitored every year. With the onset of the color banding program, all of the transitional plots are now monitored annually to collect return rate and dispersal data. In addition to the three 100-acre transitional plots, a new transitional plot was added to the Sam Hamilton Memorial Reserve West (former Water Treatment Plant 4 site, Bull Creek macrosite, hereafter "Hamilton West") in 2010.

A 100-meter buffer was established around each of the 100-acre plots in 2010 to expand the search area for color-banded warblers and obtain additional information on return rates, dispersal, and territory size and configuration.

To further evaluate the effects of recreation, intensive monitoring was conducted at the Bike Park in Emma Long Metropolitan Park and the Coldwater tract in the North Lake Austin macrosite (see Pilot Study to Further Examine Effects of Recreation, below).

Site Description

The topography and vegetation of the surveyed tracts 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.

It is thought that woodlands in western Travis County were logged in the late 1800s and early 1900s and are currently in various stages of recovery (Keddy-Hector 1996). After clearing, much of the topsoil was lost due to chaining and 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 (*Odocoileus virginianus*) has reduced understory floral diversity and species abundance. 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*). Common understory species include young Ashe juniper, 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 elbow bush (*Forestiera pubescens*). Descriptions of individual prime plots can be found in Abbruzzese and Koehler (2003), as well as in Tier III Land Management Plans for each property.

Region-wide Monitoring Program: 100-acre Study Plots

Color Banding

Color banding was conducted in conjunction with territory mapping (BCP 2007) on all of the eight 100-acre study plots and on the new Hamilton West plot, from March 18 through May 27. 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. 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 Nature Conservancy (TNC) staff at Ft. Hood Military Reservation issued the color band combinations. Other data collected during banding included date, time, GPS coordinates of the banding location, temperature, weather conditions, and, as time allowed, wing chord length. Individuals were sexed and aged (second-year (SY), after second-year (ASY), after hatch-year (AHY)) according to Pyle (1997), using data sheets developed by Ft. Hood TNC staff. Each warbler was photographed just prior to release to document band combinations and plumage characteristics.

Surveys on each of the prime plots and the Hamilton West transitional plot were conducted once a week from mid-March through mid-June to delineate territories (dates used: March 15-May 25) and gather data on reproductive success (entire season). 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 (including all five prime plots, Canyon Creek, Hamilton West) were surveyed by two biologists. Due to the low densities of warblers, the Bohls and Double J&T transitional plots were surveyed by one biologist. The new Hamilton West tract was surveyed once a week, while the other three transitional plots were monitored every other week from March 15 through May 25. Because of the reduced level of effort on these transitional plots (surveys conducted every two weeks), productivity data are not considered as reliable as for plots that were surveyed every week.

Warbler observations were recorded with Garmin global positioning units (GPS), which have an accuracy of 9 to 30 feet. Other sightings were recorded on topographic maps, using a 100-meter Universal Transverse Mercator (UTM) grid. For each observation, date, color combination (for observations of banded birds), UTM coordinates, and presence of female, nest, and/or fledglings were recorded. The data were then entered into ArcGIS and displayed so that territories could be delineated.

The monitoring program and data collection protocol are described in detail in 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 Appendix B 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. Appendix C lists surveyors and survey hours per plot.

Territory Delineation and Density. Territory size and configuration were based on observations during at least ten visits between March 15 and May 25. 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 and those locations were separated by 30 meters or more. Territorial boundaries for each male were delineated using minimum convex polygons in ArcGIS.

In 2010, the number of territories on 100-acre plots was calculated two ways: 1) full territories (territories contained entirely within the plot) and 2) applying Verner's (1985) method (each full territory counted as 1.0 territory and each edge territory counted as 0.5 territories). Verner's counting method was recommended by Weckerly and Ott (2008) and avoids the upward bias inherent in the IBCC (1970) methodology (both full territories and edge territories counted as 1.0 territories). Finally, territory density is given as the number of territories (using Verner's counting method) per 100 hectares (ha). These calculations were also applied during the previous twelve survey years for the 100-acre plots (Appendix D).

Age Structure. To calculate age structure for each 100-acre plot, the number of territorial SY males was divided by the total number of territorial males with a known age. The percentage of ASY and AHY males was also estimated for each plot. A summary of the 2009 and 2010 age structure data are provided in Appendix E.

Return Rate. Return rates were based on the number of males color-banded in 2009 that were observed again in 2010, divided by the total number banded within and near the plots in 2009. Return rates were derived for the entire banding and resighting dataset and for each 100-acre plot. These data are presented in Appendix F.

Pairing and Reproductive Success. Mated status and reproductive success are reported for full territories only. 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 number of males determined to have paired with a female divided by the number of full territories.

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 number of full territories determined to have produced at least one fledgling divided by the total number of full territories. Reproductive success is presented at the territory level (productivity) and by plot (total number of fledglings for all full territories). Productivity is

the sum of the number of fledglings observed for all full territories. Average productivity is presented in two ways: 1) as the sum of all fledglings divided by the number of pairs that successfully bred (as defined above), and 2) as the sum of all fledglings divided by the total number of full territories. Fecundity was derived by multiplying the total number of fledglings observed for all full territories within each prime plot by 0.5 [based on studies indicating a 1:1 ratio of male and female offspring for this species (Anders 2000)] and then dividing by the number of full territories with females. To allow for comparison with previous years, an estimate of the number of male offspring per territorial male was also calculated. A summary of reproductive success data for each survey year since 1998 is provided in Appendix G.

Because nests and fledglings are difficult to locate, breeding success, productivity, and fecundity represent minimum estimates only. Females and males often split their broods and can travel long distances from nests shortly after their young have fledged. Also, young are often difficult to detect unless they are vocalizing. Reidy et al. (2008) has documented a mean number of 3.6 young fledged per successful nest in the BCP. This estimate was applied to the number of territories with observed fledglings to obtain adjusted estimates of the number of young produced and productivity estimates.

Nest monitoring. Biologists located nests from mid-March through mid-June while working within and near the 100-acre plots. UTM coordinates were recorded for each nest location using Garmin GPS units, and flagging was placed at least three meters from the nest to mark its location. Staff time limitations prevented frequent follow-up monitoring required to determine nest fate and number of fledglings produced for most nests. If nest fate was not observed directly, a nest within a banded male's territory was assumed to have been successful only if that male was tending young shortly after the anticipated fledging date. Otherwise, the fate of the nest was recorded as unknown.

As part of a separate and ongoing study of nest success and nest predation within the BCP, Jennifer Reidy placed miniature video cameras on a subset of active nests found. Methodology for the camera monitoring is described in Reidy (2007) and Reidy et al. (2008).

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. 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 shrub cover, slope, stem density, basal area, and distance from trails were collected but will be analyzed by Jennifer Reidy as part of a separate study.

Searches for Banded Warblers Outside Prime Study Plots

During the 2010 field season, surveys were conducted to search for and identify color-banded warblers in areas outside of the intensive study areas (100-acre prime plots plus 100-meter buffer). Twelve teams of

19 experienced, trained volunteers conducted surveys on approximately 1500 acres. For each survey, observers were directed to allow roughly six hours per visit in each 100 acres of habitat for a minimum of three visits. A complete list of properties on which searches were conducted, acres surveyed, surveyors, and survey effort for each tract are reported in Appendix C.

Pilot Study to Further Examine Effects of Recreation

During the 2002 and 2003 field seasons, a study to evaluate the effects of mountain biking on the warbler was conducted on the Emma Long Bike Park (Bike Park) and Forest Ridge within the BCP and at Fort Hood (Davis et al. 2010). The study found that warbler territory sizes were 1.5 time larger, nest success was lower, and nest abandonment was higher in areas with bikes compared to non-biking sites. The study concluded that fragmentation and alteration of habitat by mountain biking trails may reduce the quality of nesting habitat. While disturbance from mountain biking was not reflected in the daily activity budgets of warblers, direct observations of warbler encounters with mountain bikers documented a flushing response of over 20 meters.

To document both temporal and spatial changes in warbler demographics, a follow-up study was initiated at the Bike Park in 2010. The control site in the Davis et al. study was in the immediate vicinity of the Forest Ridge 100-acre prime plot, which was the focus of the 2010 survey effort. In addition, surveys were conducted on the Coldwater tract to determine the suitability of this tract as another potential control site.

The Bike Park has a high trail density, is composed of open and closed-canopy trails, and allows the use of both mountain bikes and motorized dirt bikes during the warbler breeding season. The Bike Park is on the east side of City Park Road, northeast from the Emma Long 100-acre prime plot. The Coldwater tract lies to the north of Emma Long Metropolitan Park. It contains Ashe juniper-oak woodlands as well as open areas with bare ground and shrubby growth that are currently not suitable warbler habitat. There is no public access to the Coldwater tract, and only a couple of closed-canopy trails and open-canopy ranch roads exist.

Warblers were color banded to determine territory size and configuration, pairing success, breeding success, and nest success, consistent with the Davis et al. 2010 study. Methods for delineating territories on the Bike Park and Coldwater were the same as for the 100-acre plots, except that observations over the entire field season (March through June) were included to maintain consistency with the Davis et al. 2010 study, and all territories were used to estimate density and reproductive success. Nests were monitored with cameras when possible on the Bike Park, Forest Ridge, and Coldwater tracts. Vegetation data were collected for each nest (see Nest Monitoring, above).

Craig Davis provided all of the raw field data from the 2002 and 2003 study. The 2003 data were entered into an Excel spreadsheet and then into ArcGIS to create the minimum convex polygons for each territory. Hard copy maps of the 2003 data for the Bike Park and Forest Ridge from the Davis et al. study

were scanned and georeferenced to provide confirmation of the warbler locations and territory assignments. The 2002 data have been entered into Excel but have not yet been imported into ArcGIS.

BCP staff mapped the trail density at the Bike Park during July 2010 using Trimble GPS units (accuracy averaged 5 to 7 feet for this project). These data are currently being processed. Resources were not available to document the level and intensity of trail use.

This report provides a qualitative description of the data collected in 2010 and comparison with the 2003 data. A more in-depth analysis is being proposed as part of a separate study in cooperation with the U.S. Forest Service (see Habitat Suitability and Population Viability Analyses).

RESULTS AND DISCUSSION

100-acre Study Plots

Territory Densities and Locations. Warbler territory densities for the 100-acre plots in field season 2010 were similar to the 2009 estimates. Average territory density (based on the full + 0.5 edge calculation) for all eight plots was 26 territories/100 ha in 2010 compared to 27 territories/100 ha in 2009. Average territory density for the five prime plots was 34 territories/100 ha (15 to 48 territories/100 ha) in 2010 and 35 territories/100 ha (12 to 44 territories/100 ha) in 2009. Average territory density for the transitional plots was 13 territories/100 ha in both 2010 (7 to 25 territories/100 ha) and in 2009 (6 to 25 territories/100 ha). Data on territory densities are presented in Table 1 for field season 2010 and in Appendix D for field seasons 1998-2010. A comparison of data collected prior to and following initiation of the color banding program is discussed in the City of Austin's 2009 report.

Territory densities were highest in the Bull Creek and North Lake Austin macrosites. Densities in prime habitat in the Bull Creek macrosite ranged from 37 to 48 territories/100 ha, while densities in Bull Creek transitional habitat (Hamilton West, Canyon Creek) ranged from 20 to 25 territories/100 ha. The two transitional plots in Bull Creek are both surrounded by prime warbler habitat. Territory density in the Emma Long prime plot in the North Lake Austin macrosite was 32 territories/100 ha. Barton Creek had the lowest density of the prime plots (15 territories/100 ha) and about half the density of the Canyon Creek transitional plot in Bull Creek. The Bohls and Double J&T transitional plots in the South Lake Austin macrosite each supported seven territories/100 ha.

Figures 1-8 (Appendix H) depict warbler territory locations for the five prime plots and three transitional plots. Figures 9-12 depict warbler territory locations for the recreation study plots (Bike Park 2010, 2003; and Coldwater 2010) and the new Hamilton West transitional plot.

Because the 2010 survey effort outside of the intensive study areas focused on searches for color-banded warblers rather than territory enumerations, the locations of warblers observed outside of the intensive study areas are not presented in this year's report. However, these data are in the City of Austin's database and available upon request.

Table 1. Golden-cheeked warbler territory number (per 100 acres) and estimated territory density (per 100 hectares) for each of the eight 100-acre study plots and the Hamilton West transitional plot on the City of Austin Balcones Canyonlands Preserve, Travis County, Texas, field season 2010. See Methods section for calculations.

Plot Name	No. of Full Territories	No. of Full and Edge Territories	No. of Full Territories + (0.5 x Edge Territories)	Territory Density 100 ha[1]
Prime Plots				
Barton Creek	2	10	6	15
Emma Long	10	16	13	32
Forest Ridge	10	20	15	37
Ivanhoe	11	20	15.5	38
3M/St. Edwards	13	26	19.5	48
Average	9		14	34
Transitional Plots				
Double J&T	3	3	3	7
Bohls	3	3	3	7
Canyon Creek	6	14	10	25
Average	4		5	13
New Transitional Plot (added 2010)				
Hamilton West	2	14	8	20

[1]Calculation based on Verner's counting method.

Color Banding. A total of 95 warblers were banded in 2010, including 91 males, three females, and one hatch year. Fifty-two males, three females, and one hatch year were banded on the eight 100-acre plots, and 11 males were banded on the new Hamilton West transitional plot. As part of the recreation study, 13 males were banded on Coldwater, and eight males were banded on the Bike Park. In addition, seven males were banded in coordination with Travis County on their 100-acre Ribelin plot. Of the 91 males, 44 were aged ASY and 47 were aged SY. Two of the three females were aged SY, and one was aged AHY. The sex of the hatch year was recorded as unknown.

Age Structure. We identified 112 territories on the eight 100-acre plots in 2010, including 80 territorial males (71%) that were banded in 2009 or 2010, and 32 unbanded males (29%) (Table 2). Of the 80 territorial males banded within the eight 100-acre plots, 25 (31%) were SY and 55 (69%) were ASY. Emma Long had the highest percentage of ASY males (89%), while the Bohls and Double J&T plots had the highest percentage of SY males (67%). The age structure on the new Hamilton West plot was

comparable to the overall average (40% SY, 60% ASY). The different age structures observed among plots suggest habitat characteristics may be influencing recruitment of young territorial males, but additional data are needed to understand the significance and potential underlying mechanisms.

Table 2. Golden-cheeked warbler age structure data for all territorial males within each 100-acre plot.

Plot Name	% SY Males	%ASY Males	%AHY Males	Total # Banded	Total # Unbanded	% Banded
Prime Plots						
Barton Creek	22	78	0	9	1	90
Emma Long	11	89	0	9	7	56
Forest Ridge	21	79	0	14	6	70
Ivanhoe	33	67	0	15	5	75
3M/St. Edwards	38	63	0	16	10	62
Transitional Plots						
Double J&T	67	33	0	3	0	100
Bohls	67	33	0	3	0	100
Canyon Creek	36	64	0	11	3	79
Overall Average	**31**	**69**	**0**			**71**
New Transitional Plot (added 2010)						
Hamilton West	40	60	0	10	4	71

Return Rate. The overall return rate for the eight 100-acre plots was 45 percent (44 of the 96 males banded in 2009 returning in 2010). The return rate was 54 percent for the prime plots (42 of 78 males) and 11 percent for the transitional plots (2 of 18 males). None of the three males banded on the Bohls and Double J&T plots in 2009 were observed in 2010. All three of the females banded in 2009 were observed in 2010. Four males were banded on the Hamilton West plot in 2009 as part of a public outreach event. Two of these males (50%) returned and held territories in 2010.

Dispersal. All 44 of the returning males from 2009 were observed within the same habitat patch/macrosite in 2010, and all but one of the returning males were observed on or near the same 100-acre plot. The one exception was a male banded as an SY in 2009 on the 3M/St. Edwards plot; in 2010, this male held a territory on the Forest Ridge plot, a distance of about 1.7 km.

A female banded as SY on the Canyon Creek plot in 2009 was resighted near the Ivanhoe plot in 2010, a distance of about three km. The other two females banded in 2009 were resighted near their banding sites in 2010.

BCP staff surveyed both the 100-acre plots and the 100-meter buffer around each plot (where access was available). In addition, 12 teams of 19 volunteers devoted more than 300 hours and covered about 1500 acres (Appendix C) searching for banded warblers outside of the intensive study areas. No male warblers banded in 2009 were observed outside of the intensive study areas (100-acre plots and buffers), suggesting low dispersal rates of adult male warblers. Documenting the location of returning warblers is critical to understanding survival, dispersal, and site fidelity, all of which influence the viability of the warbler populations.

The two confirmed dispersal events in 2010 were of adult warblers (one male, one female) banded as SY in 2009, both of which were resighted within the same habitat patch/macrosite. These observations combined with the volunteer survey efforts corroborate the high site fidelity exhibited by adults of this species.

Pairing and Reproductive Success. In 2010, a total of 46 full territories were monitored for pairing and reproductive success on the five 100-acre prime plots (Table 3). The average pairing and reproductive success observed for the prime plots in 2010 was comparable to that observed in 2009 (Appendix G). Forty-two of the 46 territorial males (91%) observed in 2010 were paired (range 70 to 100%), similar to the average pairing success per full territory of 93 percent in 2009 (range 80 to 100%). Barton Creek, Ivanhoe, and 3M/St. Edwards had 100 percent pairing success, Emma Long had 90 percent, and Forest Ridge had 70 percent pairing success. These estimates were similar to those observed in 2009. In contrast, the Bohls transitional plot, which had 100 percent pairing success in 2008 when it was surveyed every week, had a pairing success of 50 percent in 2009 and 33 percent in 2010 when surveys were reduced to every other week. The Double J&T and Canyon Creek transitional plots had an observed 67 and 33 percent pairing success, respectively.

Average breeding success for full territories on the five prime plots was 78 percent in 2010 (range 50 to 100%) and in 2009 (range 67 to 100%). The two full territories on the Barton Creek tract each produced at least one fledgling, as did each of the 13 full territories on 3M/St. Edwards. Emma Long had the lowest breeding success, with only half of the ten full territories producing one or more fledglings (50%). One of the six full territories (17%) on Canyon Creek was observed with one or more young. No fledglings were observed on the Bohls or Double J&T transitional plots. However, the survey effort on these three transitional plots is much lower than that of the prime plots (Appendix C), and thus the data are less reliable.

At least 82 fledglings were observed in the 46 full territories on the five prime plots in 2010, compared to 69 observed in 41 full territories in 2009. For those territories that did produce offspring, the average productivity based on the observed number of fledglings for all five plots was 2.28. Average productivity for all full territories on the five prime plots was 1.78 fledglings. Number of male offspring per territorial male in the prime plots averaged 0.89. Fecundity (number of female offspring per full territory with a female) averaged 0.98.

Applying the Reidy et al. (2008) estimate of 3.6 young fledged per successful nest in the BCP to the number of full territories that produced young on each prime plot gives an adjusted total estimate of 129 young fledged and an average productivity per full territory of 2.82 (the adjusted productivity estimate in 2009 was 2.81). Adjusted number of male offspring per territorial male in the prime plots averaged 1.41, and fecundity averaged 1.54.

Based on both the observed and adjusted number of fledglings, the Bull Creek prime plots (Ivanhoe, 3M/St. Edwards, and Forest Ridge) produced the greatest number of fledglings, while Barton Creek and Emma Long had the lowest reproductive output.

A few territories appeared to have double broods, including Ivanhoe (three territories), Barton Creek (two territories), and 3M/St. Edwards (one territory). Since double broods are rare for the warbler, and documentation is opportunistic, they are not included in the estimated number of fledglings and productivity. Thus, these estimates are likely higher than those reported. Favorable weather conditions, increased survey effort, and/or other factors may have contributed to the observations of double-brooding during the 2010 field season.

Table 3. Golden-cheeked warbler reproductive success on 100-acre study plots on the City of Austin's Balcones Canyonlands Preserve, Travis County, Texas, field season 2010. Data are based on observations of full territories only. See Methods section for calculations.

Plot Name	No. of Full Territories	No. of Full Territories w/ Female	Pairing Success	No. of Full Territories Producing ≥ 1 Young	Breeding Success	Total No. of Fledglings Observed	Product. per Full Territory	Adjusted Number of Fledglings*	Adjusted Product. per Full Territory*
Prime Plots									
Barton Creek	2	2	1.00	2	1.00	8	4.00	7	3.60
Emma Long	10	9	0.90	5	0.50	8	0.80	18	1.80
Forest Ridge	10	7	0.70	7	0.70	13	1.30	25	2.52
Ivanhoe	11	11	1.00	9	0.82	20	1.82	32	2.95
3M/St. Edwards	13	13	1.00	13	1.00	33	2.54	47	3.60
Average			**0.91**		**0.78**		**1.78**		**2.82**
Transitional Plots									
Double J&T	3	2	0.67	0	0	0	0	0	--
Bohls	3	1	0.33	0	0	0	0	0	--
Canyon Creek	6	2	0.33	1	0.17	3	0.50	4	0.60
Average			**0.42**		**0**		**0**		**--**
New Transitional Plot (added 2010)									
Hamilton West	2	2	1.00	2	1.00	5	2.50	7	3.60

*Based on mean number of 3.6 young per successful nest (Reidy et al. 2008); does not include territories with double broods.

Nest Data

City of Austin staff found a total of 50 warbler nests during the 2010 field season (Table 4). The first nest was found March 27, and the last nest was found June 2. Thirty-three nests were found in Ashe juniper (66%), nine were in live oak (18%), six were in cedar elms (12%), one was in a shin oak (2%), and one was in an escarpment black cherry (2%). Nest tree height for all tree species averaged 9.13 meters (range 5.00-19.11 m), and dbh averaged 29 centimeters (range 10.5-65.25 cm). Nest height averaged 6.89 meters (range 2.5-16.66 m). Canopy cover averaged 89 percent (range 72-96%).

Twenty-six nests fledged one or more young (52%), one nest was partially depredated (2%), 16 nests failed (32%), one nest was abandoned (2%), and six nests had an unknown fate (12%).

Nine of the 50 nests were monitored with cameras until the nest failed or produced young. Of the nine nests, five nests fledged four young (56%), one nest was partially depredated by a western scrub jay (*Aphelocoma californica*) but fledged three young (11%), one nest was completely depredated by a scrub jay (11%), one nest was depredated by a Texas rat snake (*Elaphe obsoleta lindheimeri*) (11%), and one nest was abandoned (11%). Nests were monitored with cameras on the Coldwater, Bike Park, and Forest Ridge tracts.

No signs of brood parasitism by the brown-headed cowbird (*Molothrus ater*) were observed in warbler nests or in family groups.

The nest data are part of a growing dataset of nests monitored on the BCP. These data will be used to analyze the relationships between habitat characteristics and nest success.

Table 4. Summary of data collected for 50 Golden-cheeked warbler nests found on the City of Austin's Balcones Canyonlands Preserve, Travis County, Texas, field season 2010.

COA Tract	Date Found	Tree Species	Tree Height (m)	Tree DBH (cm)	Nest Height (m)	% Canopy Cover	Camera Monitored ?	Fate
3M/St. Edwards	4/09/10	Cedar elm	12.56	28	8.97	90		Fledged
3M/St. Edwards	4/09/10	Ashe juniper	9.60	24	7.80	90		Depredated
3M/St. Edwards	4/14/10	Ashe juniper	9.12	33	5.60	85		Failed
3M/St. Edwards	4/18/10	Ashe juniper	9.00	40	6.00	91		Unknown (09 nest?)
3M/St. Edwards	4/18/10	Ashe juniper	7.04	40	6.08	91		Fledged
3M/St. Edwards	5/01/10	Ashe juniper	6.40	10.5	6.00	89		Fledged
3M/St. Edwards	5/04/10	Ashe juniper	11.00	32	6.50	90		Failed
3M/St. Edwards	5/04/10	Escarp. black cherry	11.00	33	6.80	80		Fledged

Table 4. Summary of data collected for 50 Golden-cheeked warbler nests (continued).

COA Tract	Date Found	Tree Species	Tree Height (m)	Tree DBH (cm)	Nest Height (m)	% Canopy Cover	Camera Monitored ?	Fate
Barton Creek	3/27/10	Live oak	10.10	31.5	~10	92		Failed?
Barton Creek	4/26/10	Ashe juniper	10.10	37.5	7.80	93		Fledged
Barton Creek	4/26/10	Cedar elm	11.25	20	9.42	94		Fledged
Barton Creek	5/12/10	Ashe juniper	7.52	33.25	4.88	95		Fledged
Barton Creek	5/17/10	Live oak	9.66	24.5	7.06	91		Fledged
Barton Creek	6/01/10	Live oak	6.42	15	4.74	92		Fledged
Canyon Creek	4/05/10	Cedar elm	10.72	25	7.76	96		Failed
Canyon Creek	4/05/10	Ashe juniper	6.65	24.5	4.90	76		Failed
Coldwater	4/05/10	Ashe juniper	9.80	22.5	6.00	89	Y	Depredated
Coldwater	4/08/10	Ashe juniper	12.32	48	10.34	96		Fledged
Coldwater	4/13/10	Ashe juniper	8.00	14	4.70	87	Y	Fledged/Partially Depredated
Coldwater	4/16/10	Ashe juniper	9.70	50	6.48	92	Y	Fledged
Coldwater	4/20/10	Ashe juniper	9.00	14	7.00	91		Depredated
Coldwater	4/24/10	Ashe juniper	7.65	24	4.50	91	Y	Fledged
Coldwater	5/15/10	Ashe juniper	9.36	42	7.12	72	Y	Fledged
Coldwater	5/20/10	Ashe juniper	5.00	25	4.10	82		Depredated
Coldwater	5/31/10	Shin oak	5.75	20	5.70	84		Depredated
Coldwater	found inactive	Ashe juniper	9.84	15	6.90	95		Unknown
Bike Park	4/09/10	Ashe juniper	5.60	30	4.55	88	Y	Fledged
Bike Park	4/29/10	Live oak	8.00	22	8.10	92		Fledged
Bike Park	4/30/10	Live oak	9.60	45.75	8.80	92		Fledged
Emma Long	4/05/10	Ashe juniper	8.00	18	7.20	76		Fledged
Emma Long	4/30/10	Cedar elm	14.20	41.5	12.40	95		Failed
Emma Long	4/30/10	Live oak	11.00	53	9.50	90		Failed

Table 4. Summary of data collected for 50 Golden-cheeked warbler nests (continued).

COA Tract	Date Found	Tree Species	Tree Height (m)	Tree DBH (cm)	Nest Height (m)	% Canopy Cover	Camera Monitored ?	Fate
Forest Ridge	4/05/10	Ashe juniper	5.70	21	4.34	86		Fledged
Forest Ridge	4/19/10	Ashe juniper	6.93	18	5.67	94	Y	Fledged
Forest Ridge	4/26/10	Ashe juniper	5.70	65.25	3.90	93		Unknown
Forest Ridge	4/26/10	Ashe juniper	8.01	13	4.20	94		Fledged
Forest Ridge	4/26/10	Ashe juniper	7.00	21	3.90	94	Y	Depredated
Forest Ridge	4/26/10	Ashe juniper	12.50	39	9.06	94		Fledged
Forest Ridge	4/29/10	Ashe juniper	7.40	11	4.68	93		Fledged
Forest Ridge	4/29/10	Live oak	8.16	21	5.94	84		Depredated
Forest Ridge	5/02/10	Ashe juniper	8.12	39	6.72	89	Y	Abandoned
Forest Ridge	5/18/10	Ashe juniper	5.60	33.5	4.20	89		Failed
Forest Ridge	5/31/10	Live oak	6.25	21	6.42	90		Fledged
Ivanhoe	3/30/10	Cedar elm	19.11	33	15.30	96		Abandoned?
Ivanhoe	3/30/10	Cedar elm	17.65	37	16.66	95		Fledged
Ivanhoe	4/20/10	Ashe juniper	7.35	21	6.00	82		Fledged?
Ivanhoe	5/04/10	Ashe juniper	7.75	42	5.10	90		Fledged
Ivanhoe	6/02/10	Ashe juniper	8.56	28	4.80	88		Fledged
Ivanhoe	6/02/10	Ashe juniper	15.50	47	11.40	77		Depredated
Reicher Ranch	5/11/10	Live oak	8.10	21.5	2.50	90		Depredated
Average			**9.13**	**29**	**6.89**	**89**		

Recreation Study

A total of nine warbler territories were mapped on the 245-acre Bike Park in 2010 compared to 16 territories in 2003, an apparent decrease of over 40 percent. Eight of the territorial males were observed with females in 2010 (89% pairing success); 13 were observed in 2003 (81% pairing success). Breeding success was similar in 2010 and 2003, with five of the nine territories producing one or more young in 2010 (56% breeding success) and eight of the 16 territories producing fledglings in 2003 (50% breeding

success). At least eight fledglings were observed in 2010, with an adjusted estimate (based on the mean average of 3.6 young per nest from Reidy et al. 2008) of 18 fledglings. In 2003, 20 fledglings were observed, with an adjusted estimate of 29 fledglings. Productivity per full territory based on the adjusted number of fledglings was 2.00 in 2010 and 1.80 in 2003. The 2010 data are presented in Table 5.

Eight of the nine males holding territories in 2010 were banded (89%), of which five were aged SY (63%) and three were ASY (38%). In 2003, eight of the 16 territorial males were banded (50%), of which two were aged AHY (25%) and six were aged ASY (75%). Thus the age structure appears to have shifted toward higher occupancy by younger males. In contrast, the Emma Long 100-acre plot, which is across the road from the Bike Park, has a high percentage of ASY males (100% in 2009, 89% in 2010). These data are presented in Table 6.

Three nests were found on the Bike Park in 2010 (Table 4), all of which fledged young. One of the nests was monitored with a camera and produced 4 fledglings. Five nests were found in 2003, three of which produced young and two of which failed.

The trail mapping project is still in progress. However, field observations found trail networks extending into and crisscrossing the creekbeds and slopes along the creeks, which are often where warbler territories tend to be concentrated. BCP staff did not have the resources to document trail use, which includes weekly mountain bike races from late May through June.

Data for the Forest Ridge 100-acre plot are presented in the preceding results and discussion and include data spanning 13 years (1998-2010). The Davis et al. 2010 study covered a broader area surrounding the 100-acre plot in 2002 and 2003. Future survey efforts may attempt to survey the same area for a more comprehensive comparison. However, there does not appear to have been a comparable decrease in territory densities on the 100-acre plot.

The 265-acre Coldwater tract was surveyed intensively for the first time in 2010. Past land use and vegetation data will be analyzed to determine the suitability of the Coldwater tract as another potential control site. During the 2010 field season, 12 territories were observed, of which 42% of the males were aged SY and 58% ASY (Table 6). Pairing and breeding success were comparable to the Bike Park and Emma Long 100-acre plot, with females observed on 11 of the territories (92% pairing success), and seven of the 12 territories (58%) producing an estimated 25 fledglings (Table 5). Productivity based on the adjusted estimate of fledglings was 2.10. Ten nests were found on Coldwater, of which four fledged young (40%), one was partially depredated but fledged three young (10%), four were depredated (40%), and one had an unknown fate (10%). Six nests were monitored with cameras, of which four fledged four young (67%), one was partially depredated by a western scrub jay but fledged three young (17%), and one was completely depredated by a scrub jay (17%).

The decrease in warbler territory density at the Bike Park is consistent with the findings in the Davis et al. 2010 study and suggests that habitat fragmentation and/or concentrated, intensive recreational uses that are limited to mountain biking and motorized dirt bikes may be having a negative effect. While not directly comparable, a similar decrease in warbler density was not apparent at the Forest Ridge 100-acre plot. These sites will be surveyed again in 2011 to determine whether the observed trends persist.

Additional analyses of these datasets are being proposed as part of a separate project in cooperation with the U.S. Forest Service (see Habitat Suitability and Population Viability Analyses, below).

Table 5. Golden-cheeked warbler reproductive success on the City of Austin's recreation study plots, field season 2010. Data are based on observations of all territories.

Plot Name	No. of Territories	No. Territories w/ Female	Pairing Success	No. of Territories Producing ≥ 1 Young	Breeding Success	Adjusted Number of Fledglings*	Adjusted Product. per Territory*	Territory Density/ 100ha**
Bike Park (2003)	16	13	0.81	8	0.50	29	1.80	16
Bike Park (2010)	9	8	0.89	5	0.56	18	2.00	9
Coldwater (2010)	12	11	0.92	7	0.58	25	2.10	11

*Based on mean number of 3.6 young per successful nest (Reidy et al. 2008).

**Based on approx. 245 acres (99 ha) for the Bike Park, 265 acres (107 ha) for Coldwater

Table 6. Golden-cheeked warbler age structure data for all territorial males within each recreation study plot.

Plot Name	% SY Males	%AHY Males	%ASY Males	Total # Banded	Total # Unbanded	# Territories	% Banded
Bike Park (2003)	0	25	75	8	8	16	50
Bike Park (2010)	63	0	38	8	1	9	89
Coldwater (2010)	42	0	58	12	0	12	100

Other Observations

Male warblers appeared to have arrived a couple of weeks later than usual in 2010, with full territory establishment occurring in late March/early April. Females appeared to arrive at about the same time, so this delay did not seem to postpone nesting activities.

As in previous years, field staff observed female warblers on the ground collecting nesting material. Both males and females were observed collecting food on the ground, and fledglings were often seen in dense mid-story vegetation and near the ground. Warblers were also occasionally seen bathing in springs. These behaviors underscore the importance of ground habitat and water to this species in addition to the tree canopy and mid-story vegetation.

Consistent with Beardmore (1994), adult warblers appear to shift from foraging primarily in oaks and other hardwoods early in the season to foraging primarily in Ashe juniper later in the season. This shift appears to correspond with timing of young fledging from nests, around late April.

During the 2008 field season, staff videotaped an adult warbler distraction display (City of Austin 2008), and staff observed male and female warblers feigning wing injuries in 2009 and 2010 as well. Warblers displayed this injury-feigning behavior when field biologists were near newly fledged young.

Habitat Suitability and Population Viability Analyses

The City of Austin has contracted with Baylor University to analyze a decadal series of aerial photographs (1940 to present) and conduct a dendrochronology study to estimate stand ages, composition changes, and fire histories within the BCP's Ashe juniper-oak woodlands. This project was initiated in September 2009 (aerial photo analysis) and 2010 (dendrochronology). It will be used to evaluate the influence of land use changes on warbler demographics and habitat suitability, and to identify potential management sites for the black-capped vireo (see Black-capped Vireo Habitat Management, below).

A project is currently being proposed in cooperation with the U.S. Forest Service to develop models to better understand factors influencing the long-term viability of the warbler and its habitat and to predict the fate of both under various management scenarios. Analyses will include effects of landscape metrics (i.e., land use, stand age, habitat composition, amount of edge) and more localized effects. This project will build on existing monitoring and research, including the work being conducted by Baylor University to estimate woodland stand age, successional pathways, and fire histories within the BCP. Existing species and habitat monitoring programs will be evaluated, including the potential use of point counts, and revised as necessary to ensure collection of data needed to develop the models. This project would also fund a more in-depth analysis of the data collected for the recreation study.

With a third year of banding data at the conclusion of the 2011 field season, future data analyses will also be conducted using the MARK program to estimate adult survival, recruitment, and nest survival.

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II. BLACK-CAPPED VIREO MONITORING

INTRODUCTION

Background

The black-capped vireo (hereafter, vireo) is an endangered, neotropical migrant that breeds in portions of Oklahoma, Texas, and Mexico (Grzybowski 1995). The U.S. Fish and Wildlife Service listed this species in 1987. Major threats to the species' survival are habitat loss, habitat fragmentation, and parasitism by brown-headed cowbirds. The Balcones Canyonlands Preserve was established in 1996 to mitigate for loss of vireo habitat in western Travis County due to exurban sprawl, and to aid vireo recovery.

The vireo has been documented on several BCP tracts managed by the City of Austin. The largest colony formerly existed at the Black-capped Vireo Research Area. That colony declined steadily from 32 territories in 1987 to one territory in 1997 (Grzybowski 1989, Steed 1988, Abbruzzese 1998) and an intermittent sighting of a male in 2004 (Becker and Koehler 2004). A small breeding colony of vireos (three to five territories) has occupied habitat on the Cortaña tract every year since 2000. A part of this colony spills onto the adjacent River Place mitigation tract to the northeast. Vireos also returned in 2010 to the Forest Ridge tract, where they had nested successfully in 2009. However, no vireos were sighted in the electric transmission line corridors of the Ivanhoe tract, where they had nested in 2008 and 2009. Other records for vireos on the City of Austin's BCP tracts for the past decade include intermittent sightings of males on the Commons Ford, Parke West, and Hamilton West tracts.

Objectives

The City of Austin's vireo monitoring program focuses on estimating population size, trends, and productivity. To monitor population trends, surveys for vireos are conducted every year. Data are collected on abundance, pairing, nesting, and productivity. Survey effort on the established Cortaña colony is roughly equivalent to effort on golden-cheeked warbler 100-acre prime plots. When vireos establish territories elsewhere on the Preserve, BCP staff make a concerted effort to determine the extent of territories and nesting success.

Because of the threat posed by cowbirds, monitoring for direct and indirect signs of cowbird parasitism during field surveys is a high priority. BCP staff are committed to intensive management of cowbirds at all vireo colonies. BCP staff and volunteers have managed cowbirds at the Cortaña colony every year since vireos were first observed there in 2000, and have also maintained a cowbird trap on the Ivanhoe tract, near the area where vireos have nested.

Vireos occupy shrublands of mixed deciduous and evergreen species with irregular height and distribution. Open spaces between clumps of woody vegetation are also important, so optimal vireo habitat appears as a mosaic of grassy or rocky spaces and clumps of shrubs. Shrubs that have a skirt of vegetative cover extending down to the ground are especially important to conceal nests. Because this is an early successional stage habitat that must continually be manipulated to remain viable, restoration projects are typically undertaken every year on various City of Austin tracts. In February 2010, City of

Austin staff, with assistance from other partners, ran a pilot prescribed burn through a seven-acre patch of former vireo habitat on the Vireo Research Area (see Black-capped Vireo Habitat Management, below). A prescribed burn planned for 11 acres on the Cortaña tract did not proceed due to inappropriate weather conditions.

METHODS

Sites and Survey Effort

In field season 2010, vireos were censused on a 39-acre section of the Cortaña tract. Combined with an 18-acre section of the adjacent River Place mitigation tract, this parcel makes up the 57-acre vireo habitat study area that was originally restored in 1996. Vireos detected during other endangered species surveys were also recorded and mapped, and attempts were made to determine their breeding status.

From the Cortaña colony, City of Austin staff biologists collected the following data: number of territories, territory location, pairing success, breeding success, parasitism, and productivity. Staff biologists used territory mapping (IBCC 1970, Bibbey 1992) methods to determine numbers and locations of territories, conducting surveys from 15 April to 17 June 2010 for a total of 40.0 hours. We also returned to the site on July 7 and 15 to search for a nest, and to determine nest success, for 10 hours.

Data Collection and Analysis

Vireo observations were recorded with Garmin global positioning units (GPS), which have an accuracy of 9 to 30 feet. Other sightings were recorded on topographic maps at a scale of 1:2,400 or 1:3,600, using a 100-meter UTM grid. Pairing status, breeding success, and number of fledglings produced per pair were determined for each territory. For methodology and calculations, see Region-wide Monitoring Program: 100-acre Study Plots, in the section on Golden-cheeked Warbler Monitoring. No playback tapes of vireo songs or calls were used during this season's monitoring.

RESULTS AND DISCUSSION

In 2010, staff found vireos on two City-owned BCP tracts: Cortaña and Forest Ridge.

Territory Mapping on the Cortaña Study Site

Three male vireos defended territories on the restored portions of Cortaña and the adjacent River Place mitigation tract, a decrease of one territory from 2009. A fourth male was detected countersinging with one of the territorial males on two occasions, but was not confirmed to be holding a territory. Figure 13 (Appendix H) depicts territory locations for the Cortaña tract during 2010.

Two of the three males banded by William Simper (Texas State University) in 2008, and the one male banded in 2009, returned to establish territories in 2010. The oldest male, banded Red/White:Black/ Silver (RD/WH:BK/SI, more than 4 years old) again settled near the gate into the northwest part of the tract. He was present beginning the day of the first survey, April 15. Male Blue/Silver:Yellow/Black (BL/SI:YE/BK, 4 years old) was not detected until May 21, when he was circling an area, singing persistently, from the east side of the knoll south and west to the main road. The male banded Orange/Silver:Red/Red (OR/SI:RD/RD, 3 years old) again settled on the River Place mitigation tract. The

other male banded here in 2008, Dark Blue/Silver:Dark Blue/Green (DB/SI:DB/GR) was not detected on the site this year.

Pairing, Breeding Success, and Productivity on the Cortaña Study Site

Pairing success was 100 percent. Each of the territorial males was observed associating with a female.

City biologists found a nest (see photo on the cover page of this report) with three young on July 7, tended by male BL/SI:YE/BK and his mate; these young had fledged by July 15, and the parents were feeding them in thicker brush west of the nest site. RD/WH:BK/SI and his mate apparently built two different nests, but neither was successful. Breeding success was, therefore, at least 33 percent. Productivity was three fledglings for the one successful territory, and at least 1.00 fledgling/territory for all territories. Vireo fledglings can be difficult to detect, so productivity results represent minimum numbers.

Vireos on Other Tracts

No vireos returned to the Ivanhoe tract this year, where a pair had nested each of the past two years along a utility line corridor near the northwest corner of the Ivanhoe 100-acre plot.

Two territorial males were observed on and adjacent to the Forest Ridge 100-acre plot in April, May, and June 2009 (Figure 14, Appendix H). Both vireos were first detected on April 19: an unbanded male on the eastern edge of the 100-acre plot, which overlapped with the territory of a male banded Orange/Silver:Blue/Green (OR/SI:BL/GR, 3 years old) a short distance off the plot. Both males were detected through the final 100-acre plot survey on June 15 and again during a brief visit on August 26. A female was sighted briefly on one occasion in the territory occupied by the banded male. The unbanded male appeared to be unmated. While no fledglings were observed, the dense vegetation and steep terrain made searching for vireos challenging in this area, so reproductive success was undetermined.

2009 was the first year vireo territories were established on the Forest Ridge tract since annual surveys were initiated in 1998. In 2007, a male vireo, which appeared to be SY, sang persistently in the northeast corner of the plot on May 2, but was not relocated on later visits (O'Donnell et al. 2007). In 2001, a male vireo was observed on one occasion along the eastern edge of the 100-acre plot, near where the two territories were established this year (Abbruzzese 2001). DLS Associates (1990) also documented a vireo in this area. The 2009 report has a brief description of the vegetation in this area, which is mature juniper-oak woodland with an older shrub understory and shrubs along the woodland edges (City of Austin 2009).

Parasitism

No brown-headed cowbirds were observed during vireo surveys at either Forest Ridge or Cortaña, though several were caught in a trap at the latter site. Cowbirds were rarely observed flying over the Ivanhoe tract during warbler surveys. The trap on the Cortaña study area caught a total of 13 brown-headed cowbirds; five of these were female cowbirds. A wooden megatrap on the Ivanhoe tract caught eight male and five female brown-headed cowbirds. No vireos were observed tending cowbird fledglings.

City staff observed no interactions between vireos and potential predators, nor any harassment of vireos by other species.

Golden-cheeked Warblers in Black-capped Vireo Habitat

In some areas, vireo habitat may progress to golden-cheeked warbler habitat through natural succession. Likewise, natural or anthropogenic disturbance patterns may convert warbler habitat to the early successional stage preferred by the vireo. These habitat types often overlap. During 2010 within the City of Austin BCP, warblers and vireos were observed in the same or neighboring areas on the Cortaña and Forest Ridge tracts.

Golden-cheeked warblers were incidentally mapped during vireo surveys around the 39-acre vireo habitat area on the Cortaña tract. Male warblers were usually detected singing near the perimeter of the vireo habitat area; the canyons surrounding the upland study site are excellent golden-cheeked warbler habitat. One male warbler was observed feeding a pair of fledgling warblers at the eastern edge of the vireo habitat. They drifted into the shrubland about 30 meters before returning to the woodland edge.

On the Forest Ridge tract, the vireos established territories within prime golden-cheeked warbler habitat on and near the 100-acre study plot. Warbler territories observed on the Forest Ridge 100-acre plot are shown in Figure 4 (Appendix H).

III. BLACK-CAPPED VIREO HABITAT MANAGEMENT

Background. The BCCP Land Management Plan (BCP 1998) requires maintaining or creating 2,000 acres of vireo habitat within the BCP. The plan originally identified specific acreages as potential vireo habitat. Much of this acreage is currently mature juniper-oak woodland that is prime habitat for the warbler. Focal areas for vireo habitat management on City of Austin BCP lands currently include Cortaña, Vireo Research Area, Bohls, and infrastructure corridors (Ivanhoe).

Maintenance of Currently Occupied Habitat – Cortaña. The Cortaña tract (1,752 acres) in the North Lake Austin Macrosite is the only City of Austin BCP property under active management that is currently occupied by vireos. In 1996, about 57 acres of juniper-oak woodlands were manipulated on upper Cortaña and the adjacent, privately managed, River Place mitigation tract. Approximately 39 acres were manipulated on Cortaña and 18 acres on River Place. Both hand-clearing and hydro-axing methods were applied. In each year since 2000, three to five males have established territories in this area.

During winter 2009-10, City of Austin staff created fire lanes in anticipation of a prescribed burn to enhance habitat on approximately 11 acres of the Cortaña tract. The site has been prepared and the prescribed burn will be conducted as soon as staff and logistical conditions permit.

Restoration of Formerly Occupied Habitat – Vireo Research Area. The Vireo Research Area and adjacent Wild Basin tract supported at least 32 vireo territories during the mid-1980s. This colony declined steadily thereafter, and the last territory was detected in 1997 (Abbruzzese 1998). This site was

once part of a larger ranch that burned in April 1961 but has not been burned since. City of Austin staff hand-cleared Ashe juniper and topped some of the oaks from portions of the Vireo Research Area during the mid-1990s. However, much of the broad-leaved component of the habitat, which has grown out of suitability as nesting substrate, was not manipulated. In particular, the predominant nesting shrub, the evergreen sumac (*Rhus virens*), appears to be too tall and/or lacks vigor, with thick trunks and stems and sparse foliage, to be suitable for concealing vireo nests from potential predators.

Analysis of a decadal series of aerial photos of the Vireo Research Area shows habitat succession progressing steadily since the 1961 fire. Assuming vireo habitat in western Travis County has a typical life-span of 20 to 30 years following intense manipulation, the decline of this colony would be expected during the 1980s-1990s. Complicating this issue, however, is the simultaneous increase in urbanization (including the building of Loop 360 and surrounding subdivisions) that occurred during this same time period.

The Vireo Research Area and adjoining Wild Basin tract collectively support over 250 acres of former vireo habitat (13% of the 2,000 acre requirement). To determine whether this area can again support a viable breeding colony of vireos, habitat restoration plans have been developed and are currently being implemented. The plans include perimeter fencing, white-tailed deer management, mechanical manipulation, and prescribed burns. The primary focus of the habitat restoration program is to encourage resprouting of evergreen sumac and other broad-leaved species, protecting regenerating plants from browse, creating a more open habitat, and maintaining a diverse height structure.

Following the preparation of fire lanes during the fall of 2008, City of Austin conducted a prescribed burn (about seven acres) on a knoll near the center of the tract. This area was the epicenter of the Vireo Research Area colony and the location of the most recent sightings in 2004 (Becker and Koehler 2004) and 1997 (Abbruzzese 1998). The burn was implemented on February 16, 2010. While the burn top-killed some hardwood plants and consumed all of the brush piles, there was not enough fuel to carry the fire over the entire knoll. Thus, City of Austin staff developed a mechanical manipulation plan for this knoll and the surrounding uplands, totaling about 50 acres, which was initiated during the fall of 2010. Follow-up prescribed burns are also planned for portions of the Vireo Research Area. Installation of the perimeter fencing should be complete by early 2011, and discussions are underway with Wild Basin staff to coordinate additional management activities.

Creation of New Habitat – Bohls. A combination of mechanical manipulation followed by a prescribed burn was conducted on about 30 acres of the Bohls tract during the winter of 2003-04 and September 2005 in an effort to create vireo habitat. City of Austin staff continue to monitor habitat succession on this site, which has not yet been occupied by vireos. Additional work is planned to expand the vireo habitat management area, including another prescribed burn near the established shinnery.

Monitoring Effects of Habitat Management Efforts. During the fall of 2009, BCP staff and a volunteer monitored habitat restoration efforts on the Cortaña and Bohls tracts, and recorded baseline data

for the Vireo Research Area. On Cortaña and Bohls, monitoring consisted of taking photographs from established photo points, and collecting data along vegetation transects (point-intercept and line-transect methods). At Vireo Research Area, staff established and collected data along five vegetation transects on the knoll during the fall of 2008 and 2009, prior to conducting the prescribed burn (none of the transects were affected by the burn). During the fall of 2010, staff established 16 photo points just prior to the mechanical manipulation.

Identifying Other Potential Management Sites. Travis County and City of Austin BCP staff are currently working on a comprehensive plan to identify existing and potential sites for vireo habitat management. A GIS database is being developed to assess site characteristics and to locate suitable sites. Data layers include geology, soils, topography, historic vireo sightings, and warbler observations. Because vireo and warbler habitat are similar in composition but differ in successional stages, a map of composition and stand age is needed to help identify priority (mature) woodlands for the warbler and potential management areas (earlier successional stages) for the vireo. To assist with this effort, the City of Austin has a contract with Dr. Joseph White/Baylor University to analyze a decadal series of historic aerial photographs (1940 to present) and conduct a dendrochronology study to approximate stand ages, composition, and fire histories within the BCP's Ashe juniper-oak woodlands. The aerial photo analyses should be completed in early 2011. Other variables that will be considered in identifying sites for vireo management include size of the potential restoration area, history of occupation by vireos, proximity to the nearest vireo colony, proximity to urban development, and feasibility of management (for example, prescribed burns). BCP partners will use all of this information to assess whether additional areas have the potential to be managed as vireo habitat without impacting the warbler.

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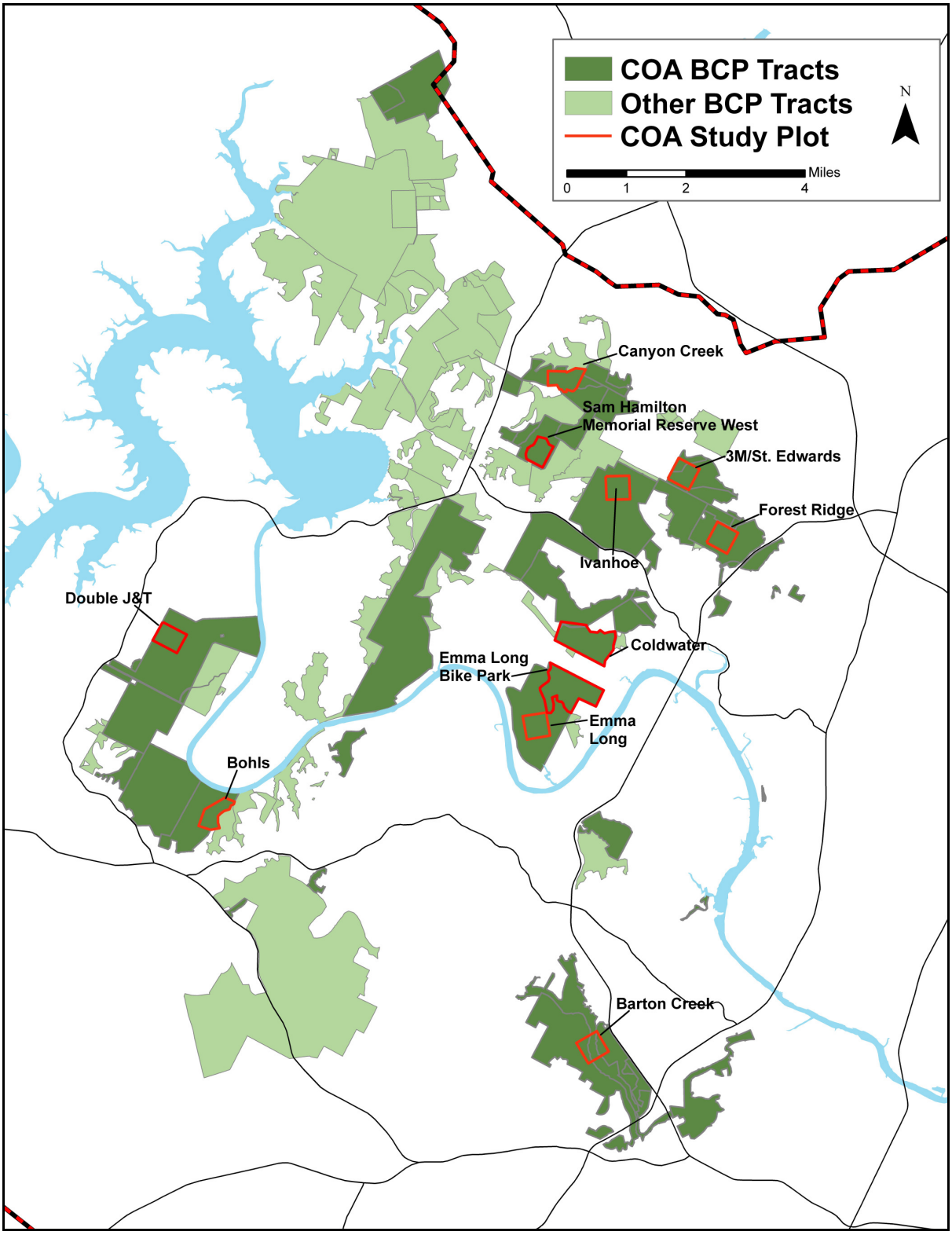
V. APPENDICES

Appendix A: Distribution of City of Austin Study Plots, 2010.



Appendix B: 100-acre Study Plot Protocol.

Golden-cheeked Warbler Monitoring
Balcones Canyonlands Preserve, City of Austin
100-Acre Plot Protocol, 2010

The primary goals of the Golden-cheeked Warbler (GCWA) monitoring program are to map the location and extent of territories as accurately as possible and to determine pairing success, breeding success, and productivity to estimate long-term trends in these parameters. This field season will increase the level of effort to obtain observations of females, nests, and newly-fledged young for each territory to provide more accurate estimates of productivity. Additionally, two people will split 100-acre plots that average 5 or more territories to ensure comprehensive coverage and help address potential observer bias issues.

Study Sites:

Prime Study Plots are located in excellent GCWA habitat with greater than 70% canopy cover.
Transitional Study Plots are situated in areas that have zero to a few warbler territories but have the potential to improve as GCWA habitat.
Plot Buffers (100m), located around each 100-acre plot where access is permissible.

Within each 100-acre plot, observers will continue to focus on resighting color-banded GCWAs, map the location and extent of territories, search for and monitor nests, and look for females and fledglings. In addition, observers will search for color-banded birds within 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 15 - May 25, with 10 visits (one visit/week) for prime plots and 5 visits (one visit/every other week) for transitional plots.

Survey effort: 6 hours per 100 acres *minimum*. There will be no maximum time constraints. The level of effort will be based on territory densities, terrain, surveyor's physical condition, etc. Surveyors will take as much time as is needed to collect data for each territory (estimate about 45 minutes per territory). Additionally, a minimum of 5 locations separated by >30 meters (use your judgment), up to 10 locations, should be collected for each territory during every survey. This is additional criteria that fits within the 45+ min time allotment.

Staffing: Two people per plot averaging ≥5 territories, with a *minimum* 3 hours/50 acres/person (*minimum* 6 hours total).

Training: All staff scheduled for the 2010 field season will have prior experience conducting 100-acre plot surveys.

1) Each observer will cover half (for plots averaging ≥5 or more territories) or the entire plot (for transitional plots with ≤5 territories) on each visit. 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 visit, each observer will rotate the area covered by 90° in a clockwise direction. This will ensure each observer covers the entire plot and begins at a different corner of the plot on each visit.
2) At the start and end of each site visit, record on the field map the time, date, and weather conditions – temperature, wind speed, cloud cover, and any precipitation. Starting and ending times are important so we can report how many hours we devoted to each site this year.
3) Record each observation of a GCWA on a field map, using the symbols on the attached sheet. Observations should include birds seen or heard, and nests. Standardized notation, especially symbols showing where a bird moved and counter-singing males, will be especially important when we group observations into territories.
4) For each observation, use a different number or letter, unless you are certain the bird is the same as an earlier one. For a female GCWA, use the female symbol: "♀". (Do not use the male symbol "♂" for a male GCWA, because it could be confused for a singing bird that has moved to the upper right.) For a fledgling GCWA, use a lowercase "f".
5) Write any details of the observation (plumage characteristics of the bird, song type, behavior, etc.) on the reverse side of the field map or on the survey form. These details can help distinguish individual birds,

especially females. This year, it will be particularly important to look for leg bands, and to record the color combinations of any seen.

6) Record other information requested on the survey form. You may either use a copy of the form or record the data on the back of the field map.
7) Do not survey GCWAs in steady rain or thunderstorms (light drizzle is okay).
8) Do not conduct a GCWA survey if sustained wind is stronger than 12 miles/hour (> Beaufort 3).
9) Do not use playback of songs or calls to elicit a response.
10) If you see a warbler carrying nesting material or food, try to follow it, unobtrusively. Locations of GCWA nests are important information, but do not warrant disturbance of the nesting pair. If the parents appear agitated, move away to watch from a respectful distance. If you locate a GCWA nest, mark its location as a waypoint in your GPS (and write it down in your notebook in case something should happen to the waypoint). Flag the location at least 3 meters from the nest. Nests should be monitored ideally ~3-4 days after activity is confirmed (more often close to fledging). Monitor the nest long enough to determine status (inactive, active) and stage. At a minimum, monitor after each survey and stay up to 30 mins to confirm status (active nests will almost always be visited within this time frame).
11) Record numbers of potential predators observed, such as Blue Jays, Western Scrub-Jays, American Crows, Common Ravens, grackles, hawks, owls, Texas Rat Snakes, and Eastern Fox Squirrels. Numbers of Brown-headed Cowbirds, and sightings of GCWAs feeding fledgling cowbirds are especially important.
12) If you are surveying in an area where GCWAs encounter the public, please note any interactions and the warblers' response.
13) Materials to bring with you for monitoring visits:
    - Field maps
    - Survey form
    - Pens/pencils
    - Binoculars
    - Compass and/or GPS
    - Thermometer
    - Flagging (pink)

Appendix C. Summary of Golden-cheeked Warbler Surveys on the City of Austin's Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2010.

Tract Name	Surveyor(s)	Survey Hours (March 15-May 25)	Acres Surveyed
100-acre Prime Plots			
Barton Creek	J. Chenoweth W. Reiner	128	100
Emma Long	K. Nesvacil C. Sperry	126	100
Ivanhoe	W. Reiner M. Sanders	162	100
3M/St. Edwards	L. O'Donnell C. Sperry J. O'Donnell	171	100
Forest Ridge	L. O'Donnell J. Reidy J. O'Donnell	156	100
Prime Plot Totals		**743**	**500**
100-acre Transitional Plots			
Bohls	J. Reidy J. O'Donnell	38	100
Canyon Creek	M. Sanders J. O'Donnell	45	100
Double J&T	S. Rowin	27	100
Transition Plot Totals		**110**	**300**
Hamilton West (added 2010)	J. Chenoweth K. Nesvacil	92	100
Additional Areas Searched for Banded Warblers			
Emma Long East	J. Bailey L. Legett N. Radding Deb and Lee Wallace	55	100
Forest Ridge NE	J. Beach	14	100
Ivanhoe East	D. Blackburn	18	100
3M South, Forest Ridge SE	A. Burke	24	200
Ivanhoe SE	C. Davis	17	100
Canyon Creek SE, West	N. Durish A Pringle	55.5	200
Canyon Creek East	E. Fair	14	100
Emma Long South	K. Greuter	18	100
Barton Creek SW	S. Hargis L. Foss	18.5	100
3M East	J. Mundy	14.5	100
3M SE	M. Rogan	17	100
Forest Ridge SW, NW	Jim & Lynne Weber	36.5	200
Additional Search Area Totals		**302**	**1500**
Recreation Study Plots			
Coldwater	J. Reidy C. Sperry J. O'Donnell	153	265
Bike Park	J. Reidy C. Sperry	112	245
Recreation Tract Totals		**265**	**510**

Appendix D: Golden-cheeked Warbler 100-Acre Study Plot Territory Data. A summary of Golden-cheeked warbler territory number per 100 acres and per 100 hectares for five 100-acre prime study plots, three 100-acre transitional study plots, and the Hamilton West 100-acre transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 1998-2010. See Methods section for calculations.

Plot Name	Survey Year	No. of Full Territories	No. of Full Territories + 50% of Edge Territories	No. of Territories per 100 ha
Prime Plots				
Barton Creek	1998	2	5.0	12
	1999	6	9.0	22
	2000	5	7.0	17
	2001	3	5.0	12
	2002	2	5.0	12
	2003	2	5.5	14
	2004	3	6.5	16
	2005	4	7.0	17
	2006	6	9.0	22
	2007	6	7.5	17
	2008	4	6.5	16
	Average	4	7.0	17
	Initiation of Color Banding			
	2009	2	5.0	12
	2010	2	6.0	15
Emma Long	1998	6	8.5	21
	1999	7	9.5	23
	2000	12	16.5	41
	2001	14	18.5	46
	2002	18	20.0	49
	2003	14	16.5	41
	2004	11	16.5	41
	2005	14	18.0	44
	2006	19	24.5	61
	2007	5	10.5	26
	2008	9	13.5	33
	Average	12	16.0	39
	Initiation of Color Banding			
	2009	9	14.0	35
	2010	10	13.0	32
Ivanhoe	1998	7	10.0	25
	1999	8	12.5	31
	2000	7	13.0	32
	2001	2	8.0	20
	2002	9	15.5	38
	2003	13	21.5	53
	2004	12	21.0	52
	2005	15	20.5	51
	2006	20	24.0	59
	2007	16	20.0	49
	2008	16	21.5	53
	Average	11	17.0	42
	Initiation of Color Banding			
	2009	11	18.0	44
	2010	11	15.5	38

Appendix D: Golden-cheeked Warbler 100-Acre Study Plot Territory Data (continued).

Plot Name	Survey Year	No. of Full Territories	No. of Full Territories + 50% of Edge Territories	No. of Territories per 100 ha
3M/St. Edwards	1998	6	9.0	23
	1999	7	11.0	28
	2000	7	12.0	30
	2001	3	6.0	15
	2002	9	12.5	31
	2003	8	12.5	31
	2004	6	11.5	28
	2005	7	13.0	32
	2006	8	11.5	28
	2007	6	11.5	28
	2008	7	13.0	32
	Average	7	11.0	28
	Initiation of Color Banding			
	2009	9	18.0	44
	2010	13	19.5	48
Forest Ridge	1998	7	10.5	26
	1999	11	14.0	35
	2000	7	10.5	26
	2001	9	12.5	31
	2002	11	13.0	32
	2003	9	12.5	31
	2004	13	17.5	43
	2005	11	15.0	37
	2006	16	21.0	52
	2007	4	9.0	22
	2008	7	10.5	26
	Average	10	13.0	32
	Initiation of Color Banding			
	2009	10	14.0	35
	2010	10	15.0	37
Average, All Prime Plots	1998	6	9.0	22
	1999	8	11.0	27
	2000	8	12.0	30
	2001	6	10.0	25
	2002	10	13.0	32
	2003	9	14.0	35
	2004	9	14.5	36
	2005	10	15.0	37
	2006	14	18.0	44
	2007	7	12.0	30
	2008	9	13.0	32
	Average	9	13.0	32
	Initiation of Color Banding			
	2009	8	14	35
	2010	9	14	34

Appendix D: Golden-cheeked Warbler 100-Acre Study Plot Territory Data (continued).

Plot Name	Survey Year	No. of Full Territories	No. of Full Territories + 50% of Edge Territories	No. of Territories per 100 ha
Transitional Plots				
Bohls	1998	3	4.0	10
	1999	1	4.0	10
	2000	1	3.0	7
	2001	5	6.5	16
	2002	4	5.5	14
	2003	4	6.5	16
	2004	5	8.0	20
	2005	6	8.0	20
	2006	3	6.5	16
	2007	1	4.0	10
	2008	1	3.0	7
	Average	4	5.0	13
	Initiation of Color Banding			
	2009	2	3.5	9
	2010	3	3.0	7
Canyon Creek	1998	0	4.0	10
	1999	2	4.5	11
	2000	0	4.0	10
	2001	3	7.5	19
	2003	0	3.5	9
	2005	3	8.0	20
	2007	3	6.5	16
	Average	2	5.0	13
	Initiation of Color Banding			
	2009	3	10.0	25
	2010	6	10.0	25
Double J&T	1998	2	2.5	6
	1999	0	0.5	1
	2000	0	0.5	1
	2001	2	3.0	7
	2003	3	3.5	9
	2005	6	6.5	16
	2007	3	3.5	9
	Average	2	3.0	6
	Initiation of Color Banding			
	2009	2	2.5	6
	2010	3	3.0	7
Average, All Transitional Plots	1998	2	3.5	7
	1999	1	3.0	7
	2000	0	2.5	6
	2001	3	5.5	14
	2003	2	4.5	11
	2005	5	7.5	19
	2007	2	4.5	12
	Average	2	4.0	11
	Initiation of Color Banding			
	2009	2	5	13
	2010	4	5	13
Transitional Plot (Added in 2010)				
Hamilton West	2010	2	8	20

Appendix E: Golden-cheeked Warbler 100-Acre Study Plot Age Structure Data for All Territorial Males. A summary of Golden-cheeked warbler male age structure data for five 100-acre prime study plots, three 100-acre transitional study plots, and the Hamilton West transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 2009-2010. See Methods section for calculations.

Plot	Survey Year	% SY Males	%AHY Males	%ASY Males	Total # Banded Males	Total # Unbanded Males	% Banded Males
Prime Plots							
Barton Creek	2009	20	20	60	5	3	63
	2010	22	0	78	9	1	90
Emma Long	2009	0	0	100	13	6	68
	2010	11	0	89	9	7	56
Forest Ridge	2009	20	7	73	15	3	83
	2010	21	0	79	14	6	70
Ivanhoe	2009	53	18	29	17	8	68
	2010	33	0	67	15	5	75
3M/St. Edwards	2009	30	0	70	20	7	74
	2010	38	0	63	16	10	62
Transitional Plots							
Double J&T	2009	100	0	0	1	2	33
	2010	67	0	33	3	0	100
Bohls	2009	0	0	100	2	3	40
	2010	67	0	33	3	0	100
Canyon Creek	2009	27	7	67	15	2	88
	2010	36	0	64	11	3	79
Average, All Plots	**2009**	**27**	**7**	**66**			**72**
	2010	**31**	**0**	**69**			**71**
Transitional Plots (Added in 2010)							
Hamilton West	2010	40	0	60	10	4	71

Appendix F: Golden-cheeked Warbler 100-Acre Study Plot Return Rates for All Banded Males. A summary of Golden-cheeked warbler banding and resighting data for five 100-acre prime study plots, three 100-acre transitional study plots, and the Hamilton West transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 2009-2010. See Methods section for calculations.

Plot Name	Survey Year	Total # Males Banded On and Off Plot	Total # Returning Males	% Returning Males
Prime Plots				
Barton Creek	2009 2010	6 6	-- 4	-- 67
Emma Long	2009 2010	14 3	-- 9	-- 64
Forest Ridge	2009 2010	16 6	-- 7	-- 44
Ivanhoe	2009 2010	21 11	-- 10	-- 48
3M/St. Edwards	2009 2010	21 11	-- 12	-- 57
Transitional Plots				
Double J&T	2009 2010	1 3	-- 0	-- 0
Bohls	2009 2010	2 4	-- 0	-- 0
Canyon Creek	2009 2010	15 8	-- 2	-- 13
Total, All Plots	2009 2010	96 52	-- 44	
Average, All Plots	2009 2010			-- 46
Transitional Plot (Added in 2010)				
Hamilton West	2009 2010	4 11	-- 2	-- 50

Appendix G: Golden-cheeked Warbler 100-Acre Study Plot Reproductive Success Data. A summary of Golden-cheeked warbler reproductive success data for five 100-acre prime study plots and the Hamilton West transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 1998-2010. See Methods section for calculations.

Plot Name	Survey Year	Pairing Success	Breeding Success	Productivity per Successful Territory	Productivity per Full Territory
Prime Plots					
Barton Creek	1998	0.50	0.50	2.00	1.30
	1999	1.00	1.00	2.20	2.20
	2000	0.80	0.40	1.50	0.60
	2001	1.00	0.67	2.50	1.67
	2002	1.00	0.50	2.00	1.00
	2003	1.00	1.00	1.50	1.50
	2004	1.00	0.67	1.50	1.00
	2005	1.00	1.00	3.00	3.00
	2006	0.83	0.67	2.25	1.50
	2007	0.83	0.83	2.60	2.17
	2008	1.00	1.00	2.75	2.75
	Average	0.91	0.75	2.16	1.70
	Initiation of Color Banding				
	2009	1.00	1.00	3.00	3.00
	2010	1.00	1.00	4.00	4.00
Emma Long	1998	1.00	1.00	2.30	1.30
	1999	0.86	0.86	2.30	2.00
	2000	0.42	0.17	2.00	0.33
	2001	0.71	0.64	1.78	1.06
	2002	0.67	0.39	1.70	0.66
	2003	0.71	0.50	2.40	1.21
	2004	0.82	0.45	2.60	1.18
	2005	0.86	0.43	2.17	0.93
	2006	0.90	0.71	2.27	1.62
	2007	0.80	0.80	2.25	1.80
	2008	0.89	0.78	2.43	1.89
	Average	0.79	0.61	2.20	1.27
	Initiation of Color Banding				
	2009	1.00	0.78	1.86	1.44
	2010	0.90	0.50	1.60	0.80
Ivanhoe	1998	0.43	0.43	2.70	1.30
	1999	0.50	0.50	2.80	1.30
	2000	0.14	0.14	3.00	0.43
	2001	1.00	1.00	3.00	3.00
	2002	0.67	0.56	3.00	1.70
	2003	0.69	0.69	2.70	1.80
	2004	0.58	0.33	3.00	1.00
	2005	0.53	0.27	2.50	0.67
	2006	0.70	0.30	2.17	0.65
	2007	0.75	0.63	2.40	1.50
	2008	0.63	0.38	2.33	0.88
	Average	0.60	0.48	2.69	1.29
	Initiation of Color Banding				
	2009	1.00	0.82	2.22	1.82
	2010	1.00	0.82	2.22	1.82

Appendix G: Golden-cheeked Warbler 100-Acre Study Plot Reproductive Success Data (continued).

Plot Name	Survey Year	Pairing Success	Breeding Success	Productivity per Successful Territory	Productivity per Full Territory
3M/St. Edwards	1998	0.83	0.33	2.50	0.80
	1999	0.71	0.43	1.70	0.70
	2000	0.43	0.29	2.50	0.71
	2001	0	0	0	0
	2002	0.22	0.11	1.00	0.10
	2003	0.38	0.50	1.50	0.43
	2004	0.67	0.50	2.00	1.00
	2005	0.71	0.71	1.60	1.14
	2006	1.00	1.00	2.38	2.38
	2007	0.83	0.83	3.20	2.67
	2008	0.86	0.71	2.00	1.43
	Average	0.60	0.49	1.85	1.03
	Initiation of Color Banding				
	2009	0.89	0.67	2.50	1.67
	2010	1.00	1.00	2.54	2.54
Forest Ridge	1998	0.57	0.43	2.30	1.10
	1999	0.67	0.55	2.70	1.50
	2000	0.86	0.71	2.80	2.00
	2001	0.78	0.44	2.50	1.30
	2002	0.82	0.45	2.60	1.20
	2003	0.78	0.67	2.30	1.60
	2004	0.54	0.54	3.00	1.62
	2005	0.91	0.73	1.75	1.27
	2006	1.00	0.78	2.50	1.94
	2007	1.00	1.00	2.00	2.00
	2008	1.00	0.57	2.50	1.43
	Average	0.81	0.62	2.45	1.54
	Initiation of Color Banding				
	2009	0.80	0.80	1.88	1.50
	2010	0.70	0.70	1.86	1.30
Average, All Prime Plots	1998	0.67	0.54	2.36	0.97
	1999	0.74	0.67	2.34	1.30
	2000	0.53	0.34	2.36	0.81
	2001	0.70	0.55	1.96	1.56
	2002	0.68	0.40	2.06	0.93
	2003	0.71	0.67	2.08	1.30
	2004	0.72	0.50	2.42	1.16
	2005	0.80	0.63	2.20	1.40
	2006	0.89	0.70	2.31	1.62
	2007	0.84	0.82	2.49	2.03
	2008	0.88	0.69	2.40	1.68
	Average	0.74	0.59	2.27	1.34
	Initiation of Color Banding				
	2009	0.93	0.78	2.16	1.68
	2010	0.91	0.78	2.28	1.78
Transitional Plot (Added 2010; Surveyed Weekly)					
Hamilton West	2010	1.00	1.00	2.50	2.50

Appendix H: Survey Maps (Figures 1-14).

100-acre Study Plots

Figures 1–8 depict estimated territories from 100-acre plot surveys. 100-acre plot maps depict territories relative to topographic features and to other warbler territories. Territories are represented by minimum convex polygons drawn to connect the outermost observations of each territorial male. An "O" symbol on the figures represents an observation of a male warbler that does not have enough sightings or other information, such as identification of color band combinations or contemporaneous vocalizations, to assign it to an existing territory or to estimate territory boundaries. The "O" symbol on the figures is also used to represent floater males. Floaters are typically young males observed later in the season only on one or two occasions. Each territory with a female and at least one fledgling depicted for each plot.

Figure 1: 3M/St. Edwards

Figure 2: Barton Creek

Figure 3: Emma Long

Figure 4: Forest Ridge

Figure 5: Ivanhoe

Figure 6: Bohls

Figure 7: Canyon Creek

Figure 8: Double J&T

Recreation Study Sites and Hamilton West Transitional Plot (added in 2010)

Figures 9-12 depict estimated warbler territories using the same methodology as the 100-acre study plots (see above).

Figure 9: Bike Park (2010)

Figure 10: Bike Park (2003)

Figure 11: Coldwater

Figure 12: Sam Hamilton Reserve West

Black-capped Vireo Surveys

Figures 13-14 depict estimated vireo territories. Territories were mapped using the same methodology as the 100-acre study plots (see above).

Figure 13: Cortaña

Figure 14: Forest Ridge

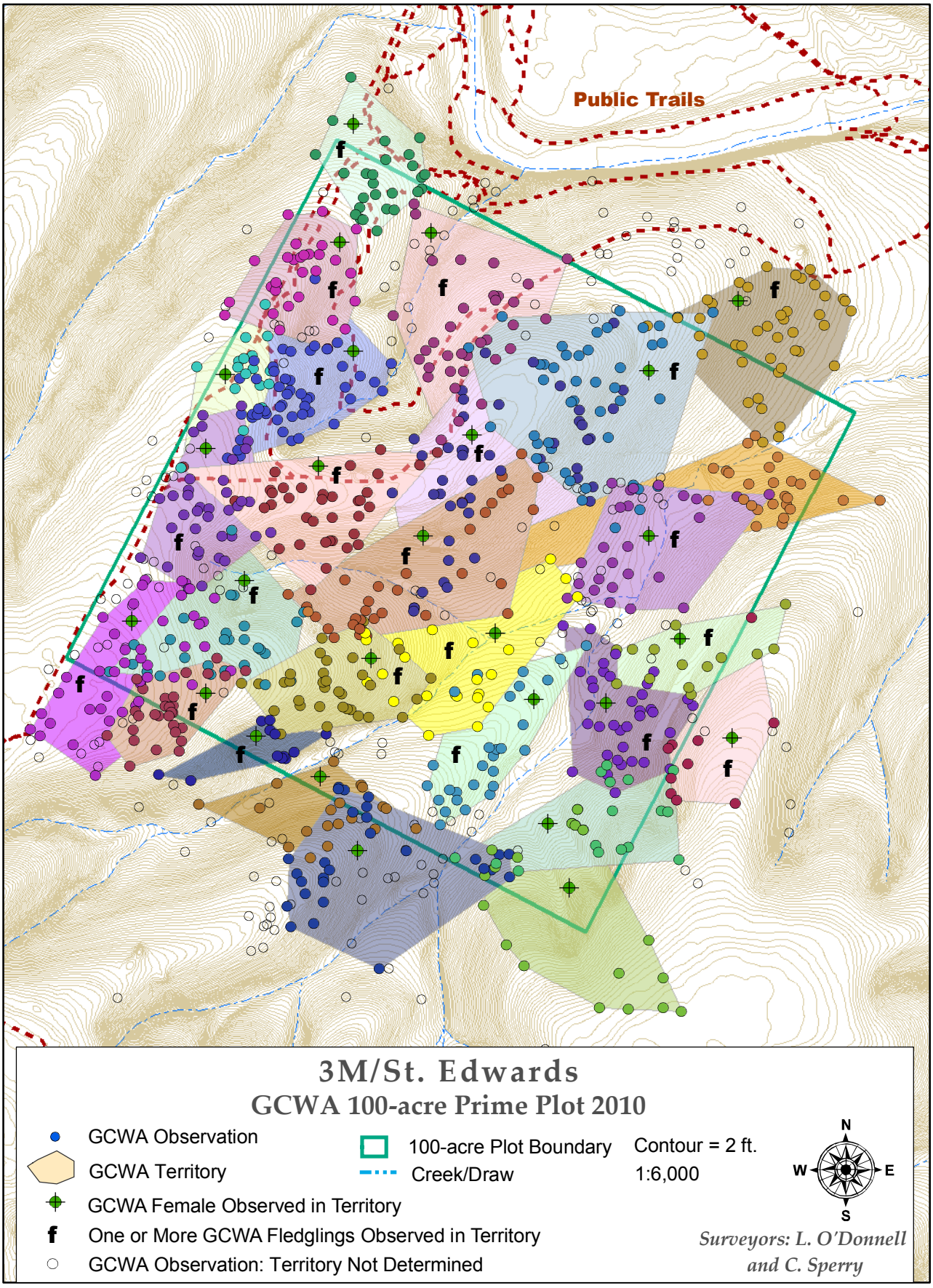

Public Trails
3M/St. Edwards
GCWA 100-acre Prime Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:6,000
N
W
E
S
Surveyors: L. O'Donnell and C. Sperry

Figure 1

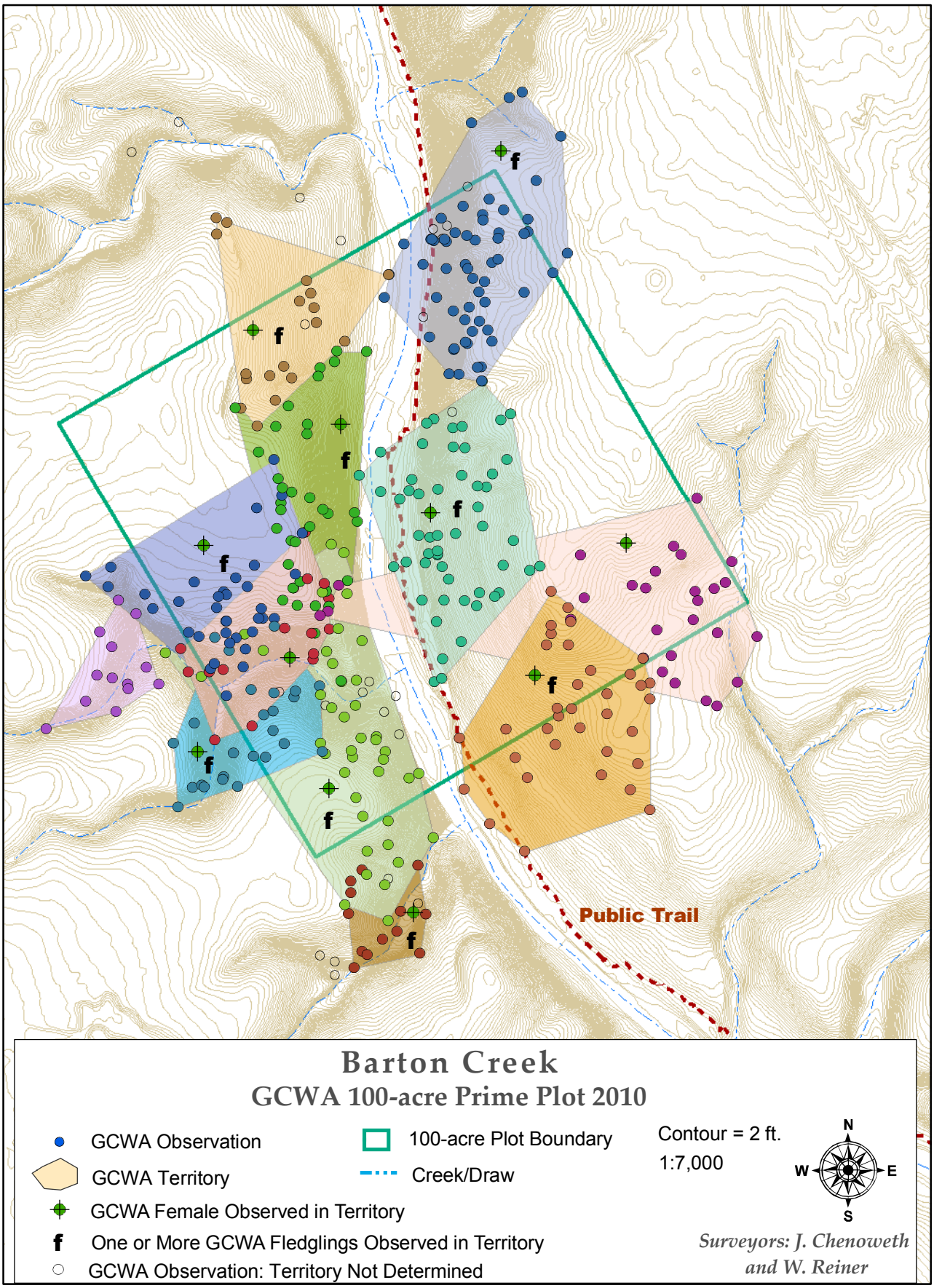

Public Trail
Barton Creek
GCWA 100-acre Prime Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:7,000
N
W
E
S
Surveyors: J. Chenoweth
and W. Reiner

Figure 2

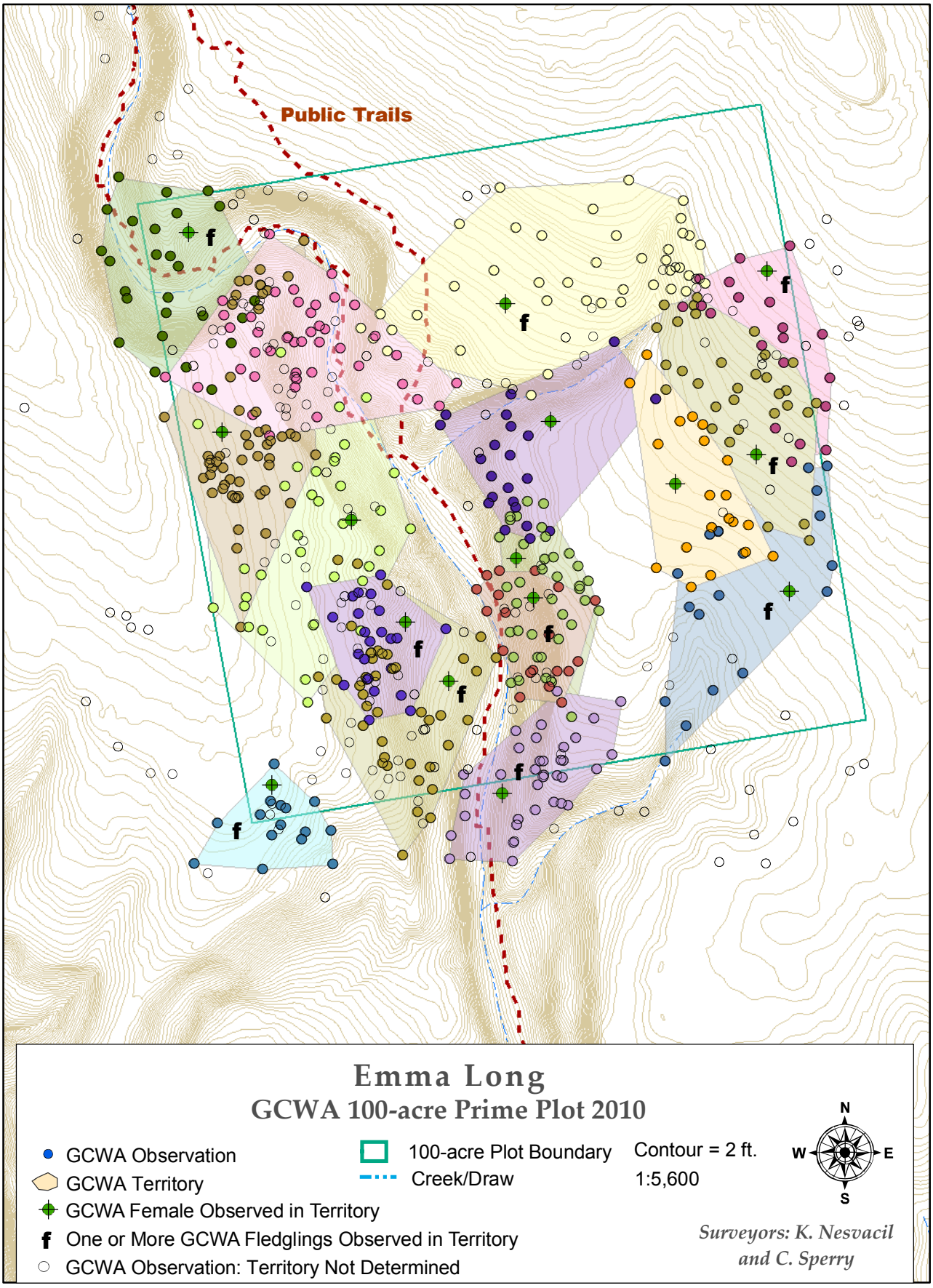

Public Trails
Emma Long
GCWA 100-acre Prime Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:5,600
N
W
E
S
Surveyors: K. Nesvacil and C. Sperry

Figure 3

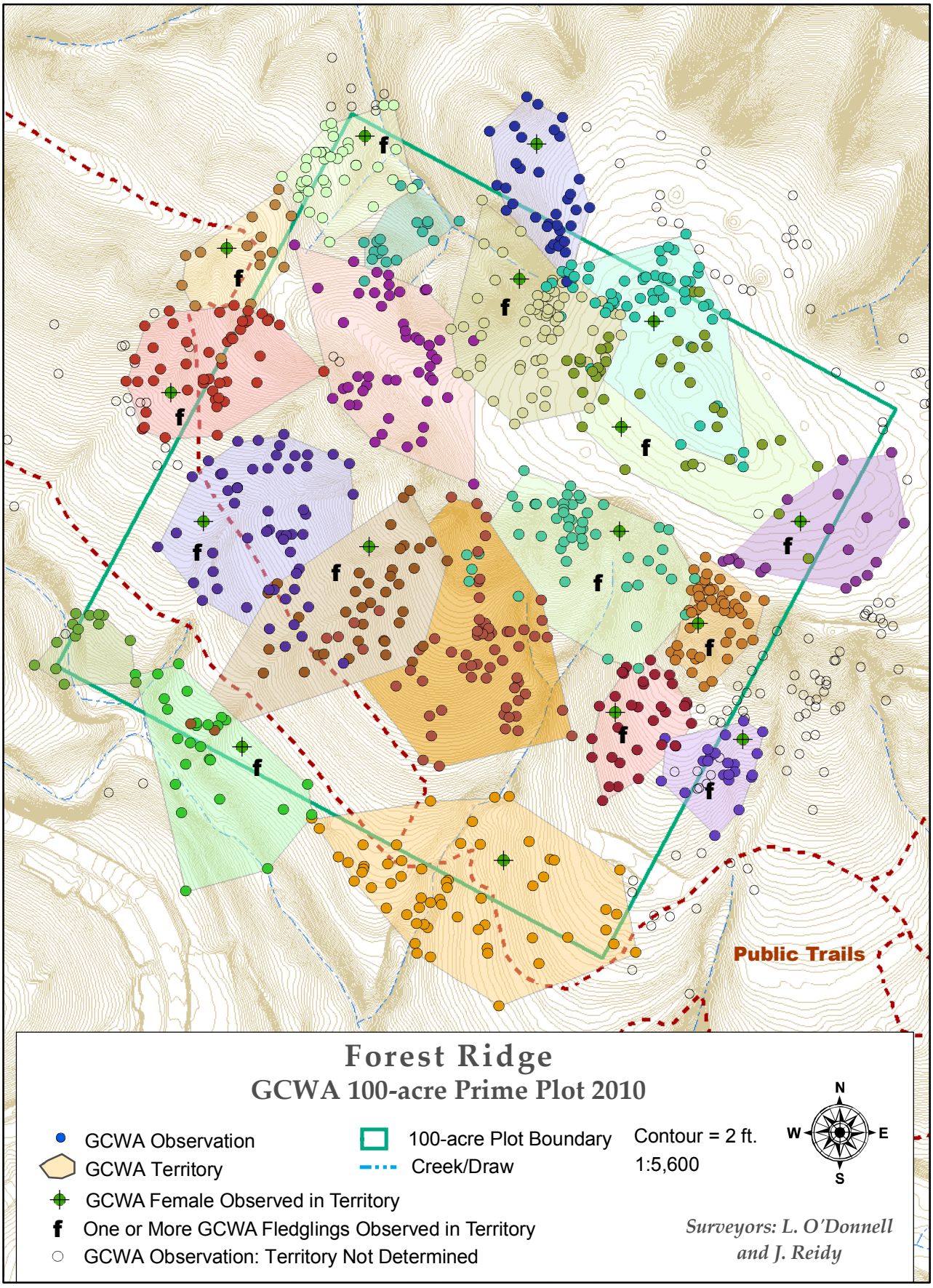

Public Trails
Forest Ridge
GCWA 100-acre Prime Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:5,600
N
W
E
S
Surveyors: L. O'Donnell and J. Reidy

Figure 4

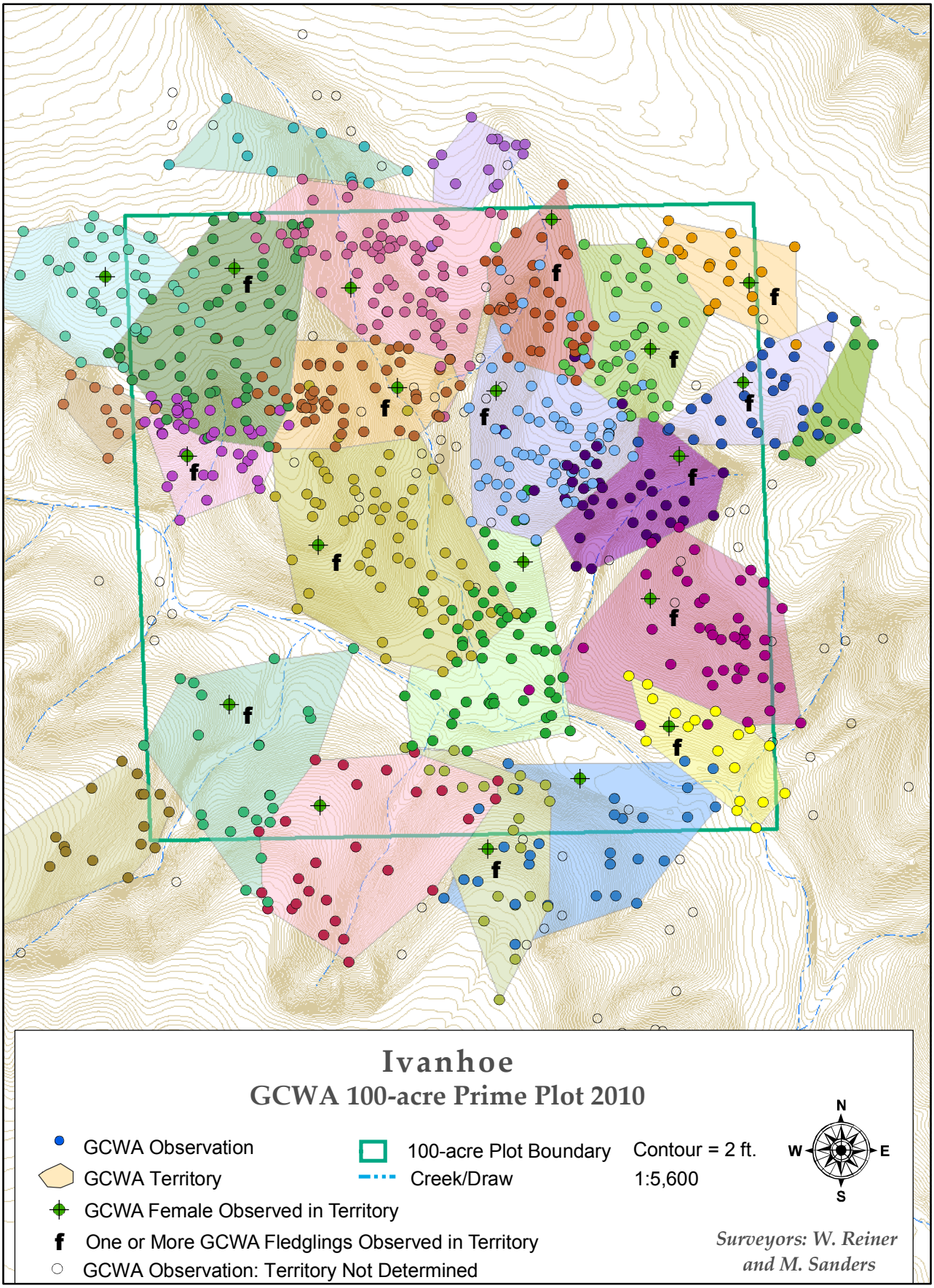

Ivanhoe
GCWA 100-acre Prime Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:5,600
N
W
E
S
Surveyors: W. Reiner and M. Sanders

Figure 5

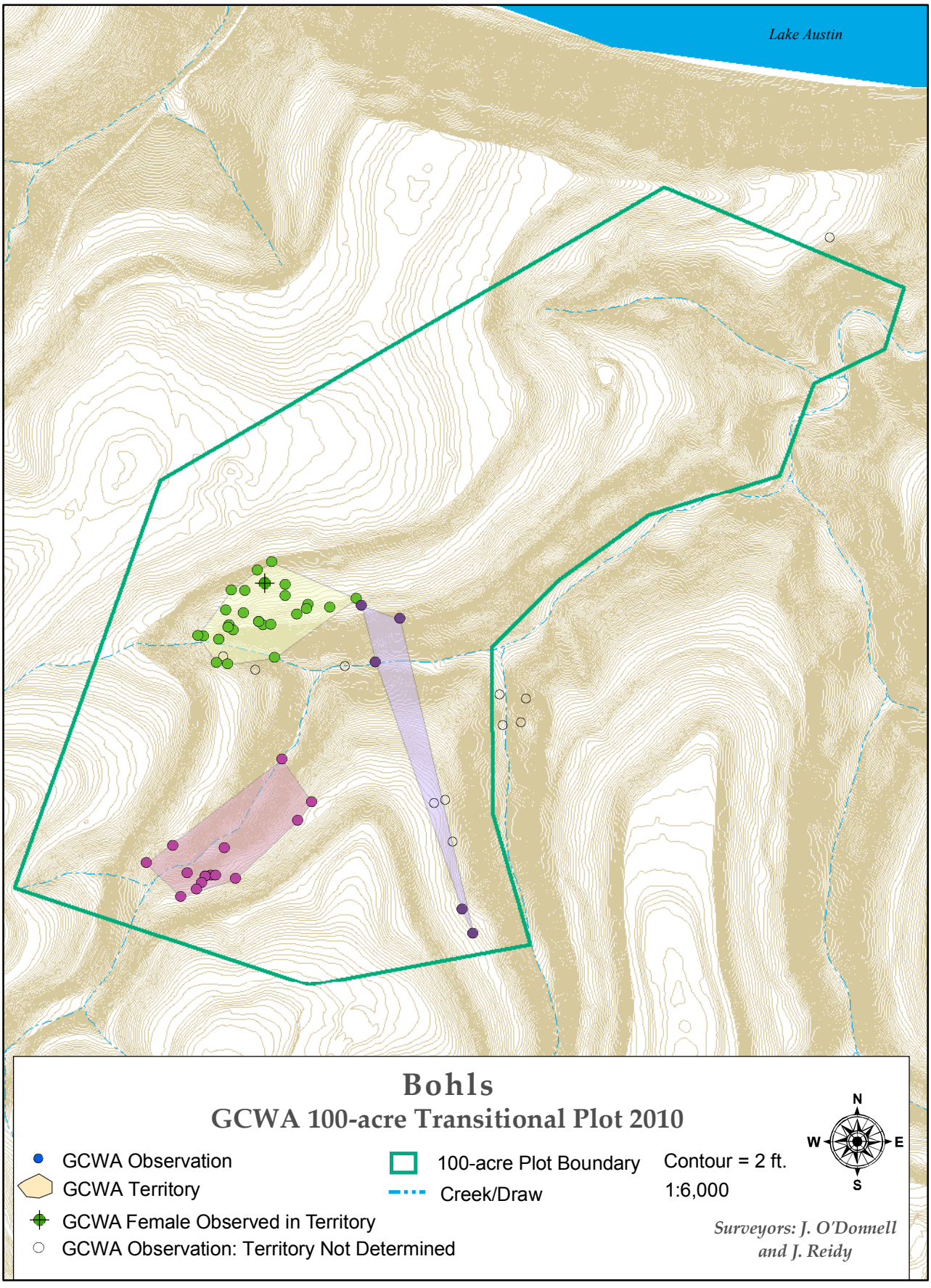

Lake Austin
Bohls
GCWA 100-acre Transitional Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:6,000
N
W
E
S
Surveyors: J. O'Donnell and J. Reidy

Figure 6

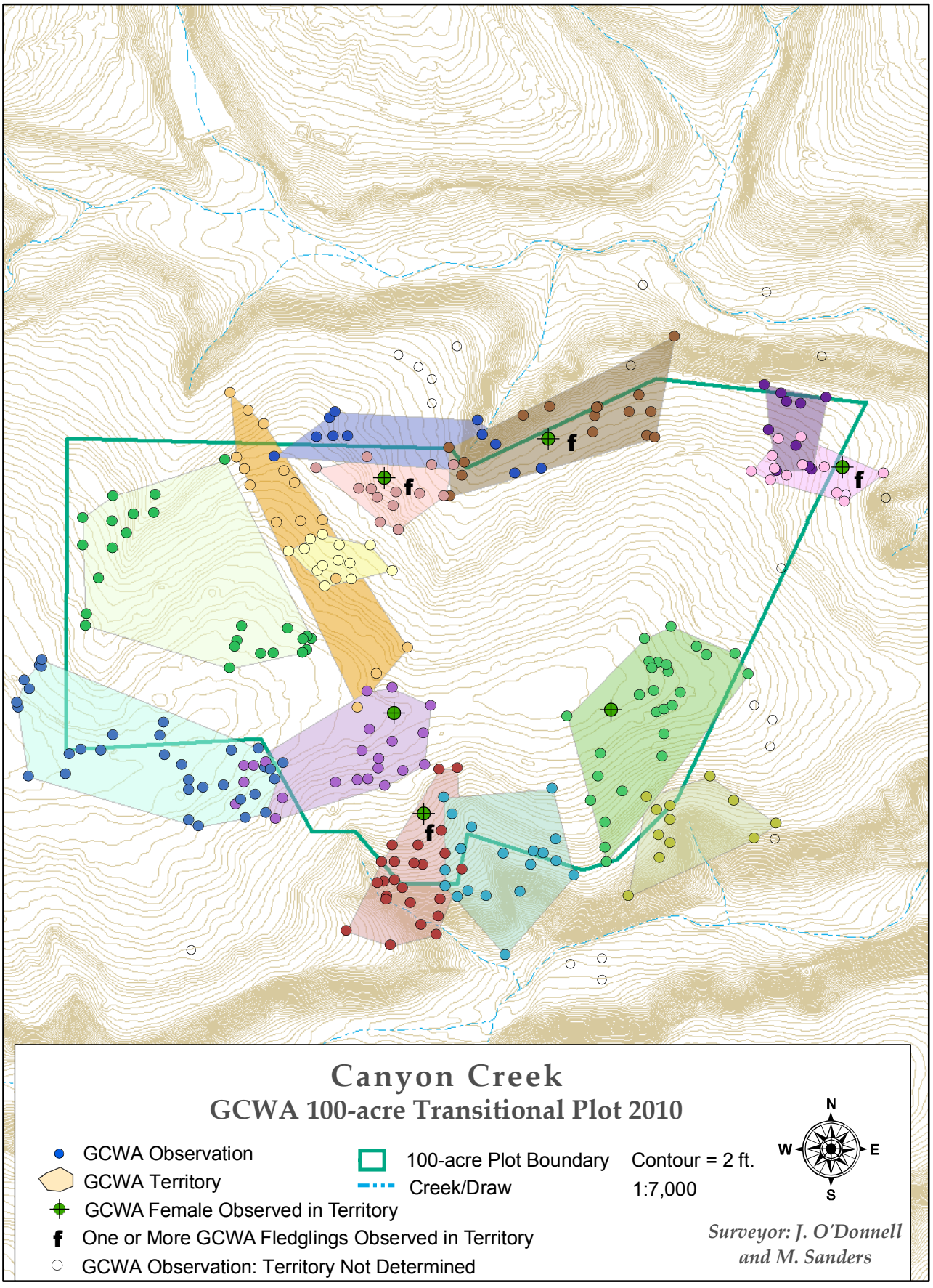

Canyon Creek
GCWA 100-acre Transitional Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:7,000
N
W
E
S
Surveyor: J. O'Donnell and M. Sanders

Figure 7

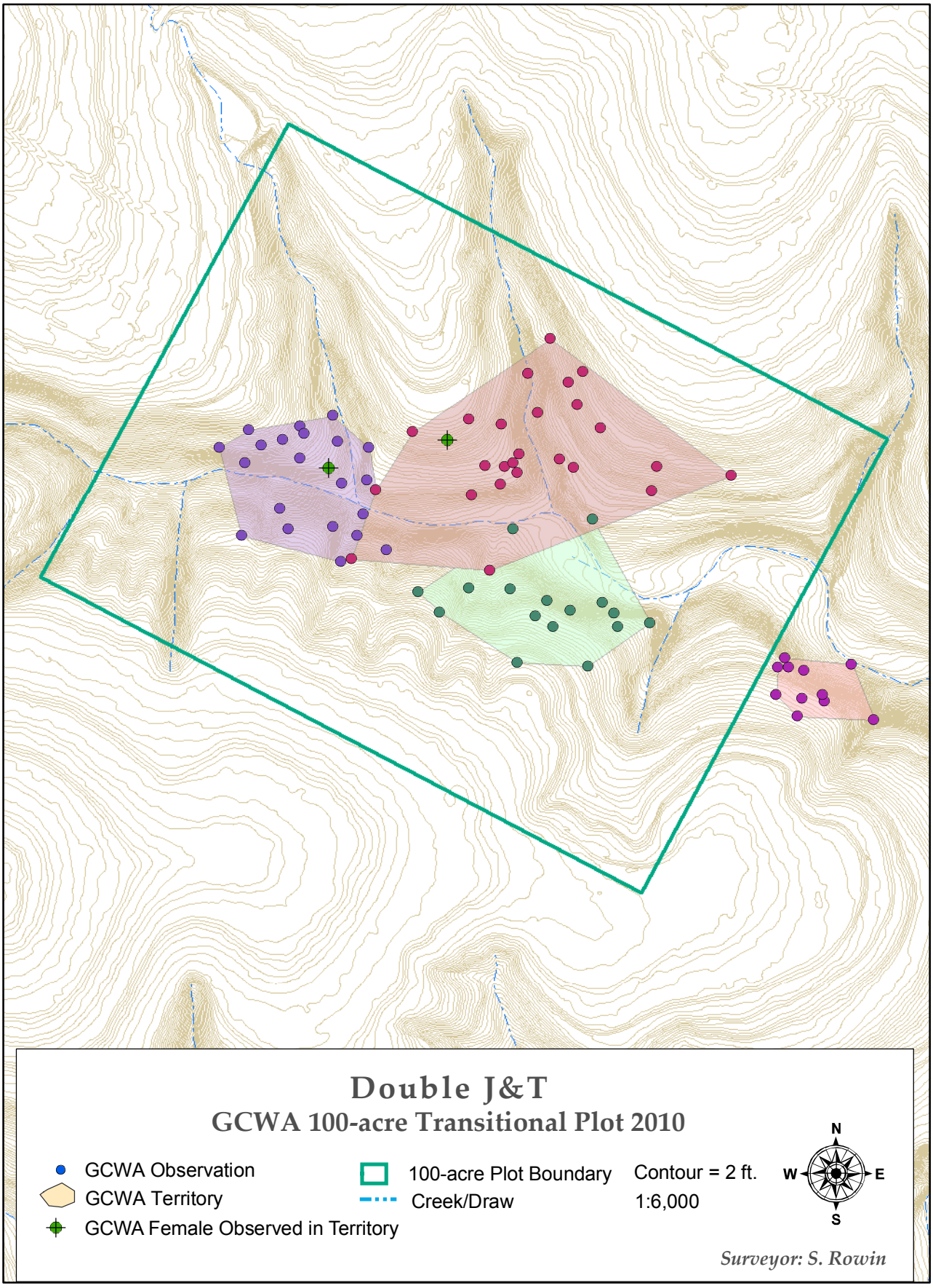

Double J&T
GCWA 100-acre Transitional Plot 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:6,000
N
W
E
S
Surveyor: S. Rowin

Figure 8

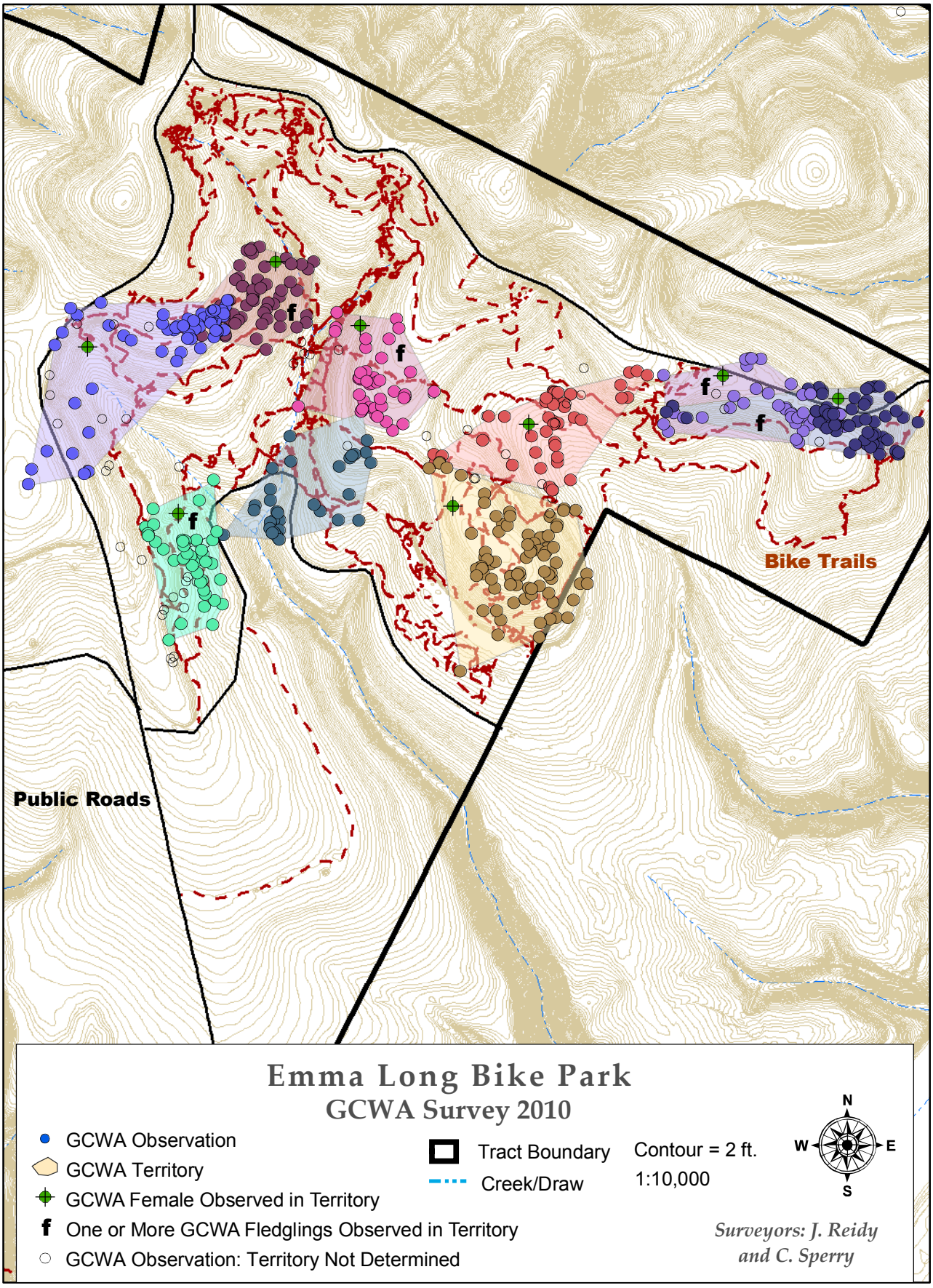

Public Roads
Bike Trails
Emma Long Bike Park
GCWA Survey 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
Tract Boundary
Creek/Draw
Contour = 2 ft.
1:10,000
N
W
E
S
Surveyors: J. Reidy and C. Sperry

Figure 9

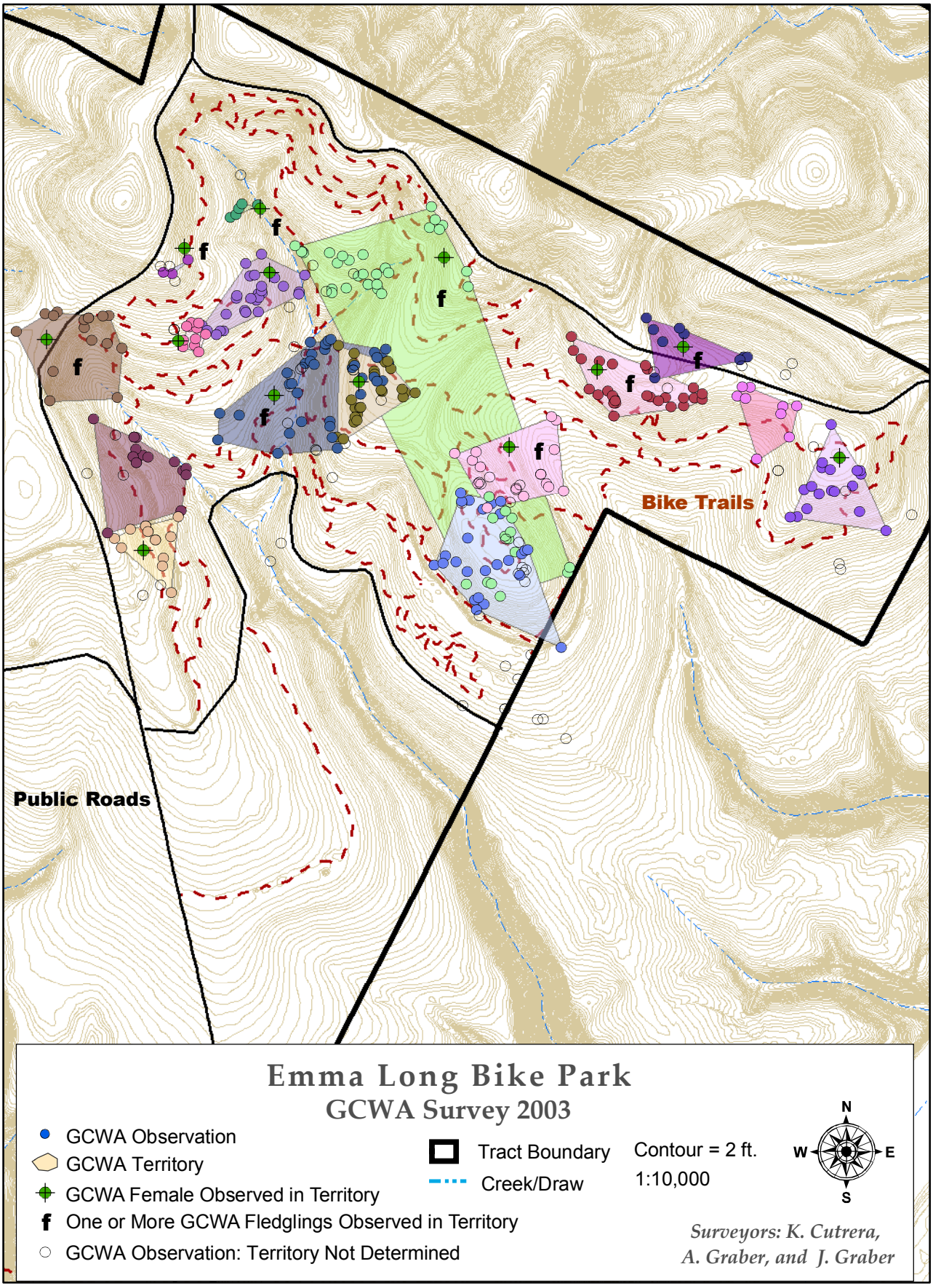

Bike Trails
Public Roads
Emma Long Bike Park
GCWA Survey 2003
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
Tract Boundary
Creek/Draw
Contour = 2 ft.
1:10,000
N
W
E
S
Surveyors: K. Cutrera, A. Graber, and J. Graber

Figure 10

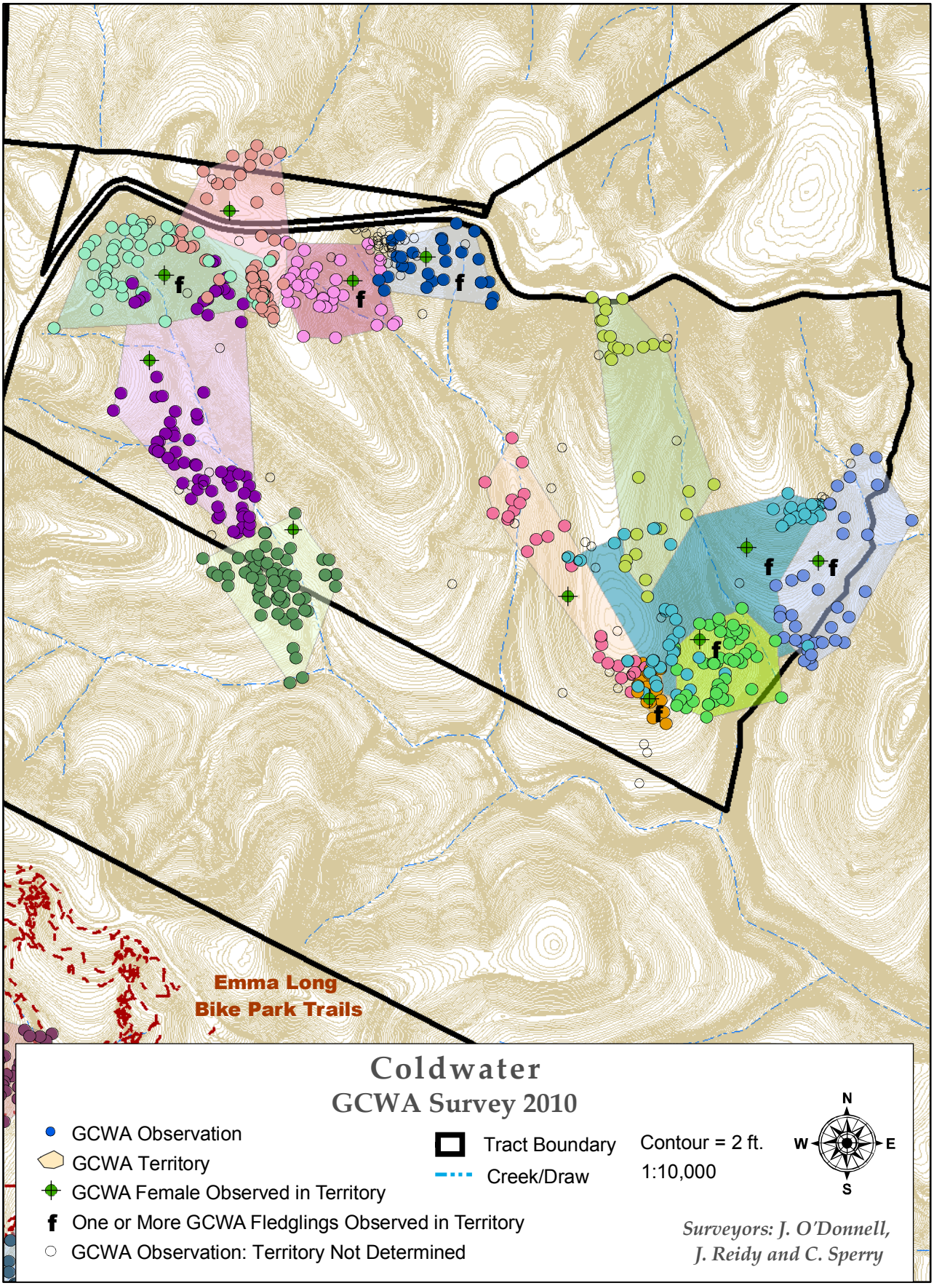

Emma Long
Bike Park Trails
Coldwater
GCWA Survey 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
Tract Boundary
Creek/Draw
Contour = 2 ft.
1:10,000
N
W
E
S
Surveyors: J. O'Donnell,
J. Reidy and C. Sperry

Figure 11

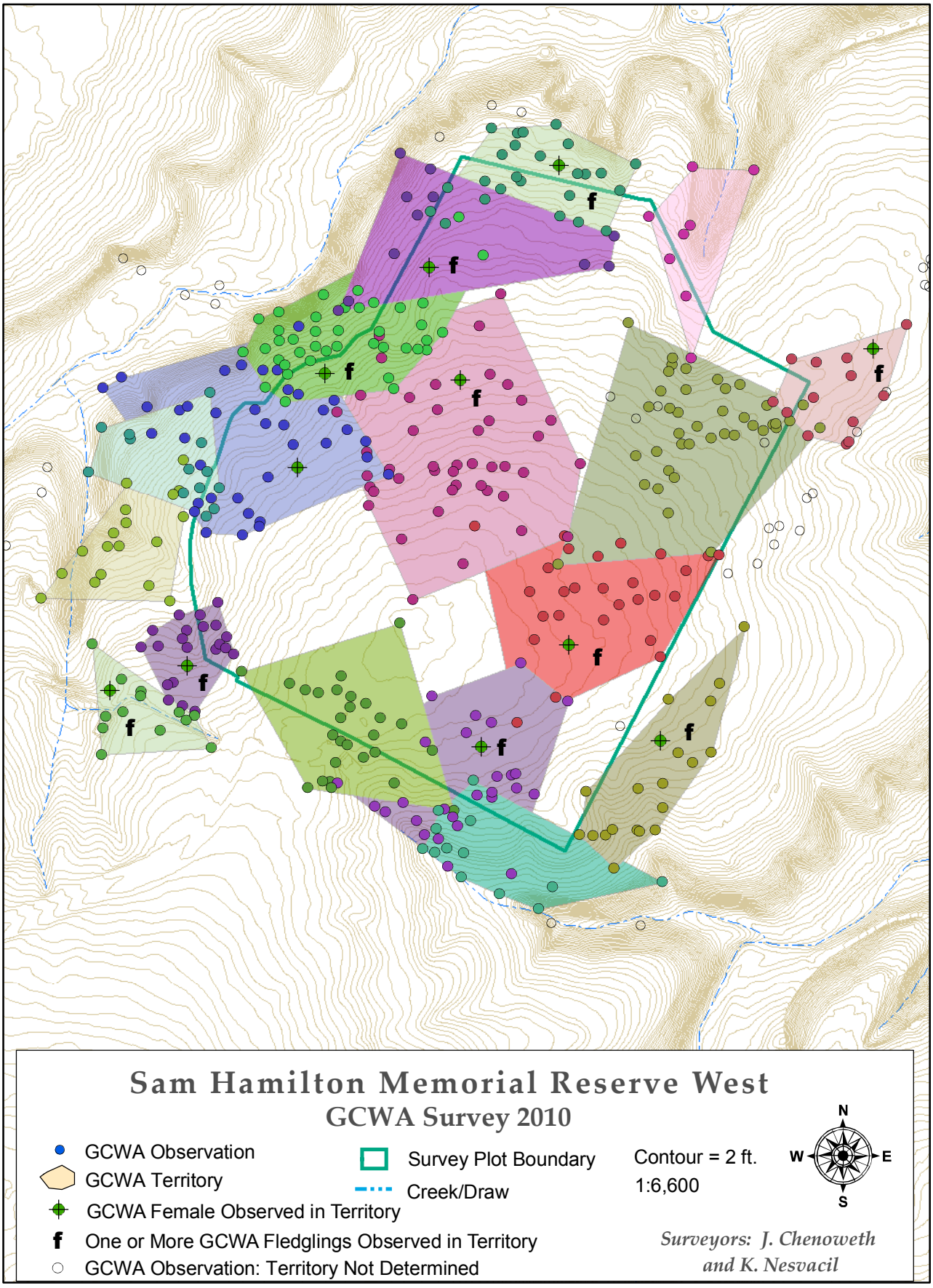

Sam Hamilton Memorial Reserve West
GCWA Survey 2010
GCWA Observation
GCWA Territory
GCWA Female Observed in Territory
f One or More GCWA Fledglings Observed in Territory
GCWA Observation: Territory Not Determined
Survey Plot Boundary
Creek/Draw
Contour = 2 ft.
1:6,600
N
W
E
S
Surveyors: J. Chenoweth and K. Nesvacil

Figure 12

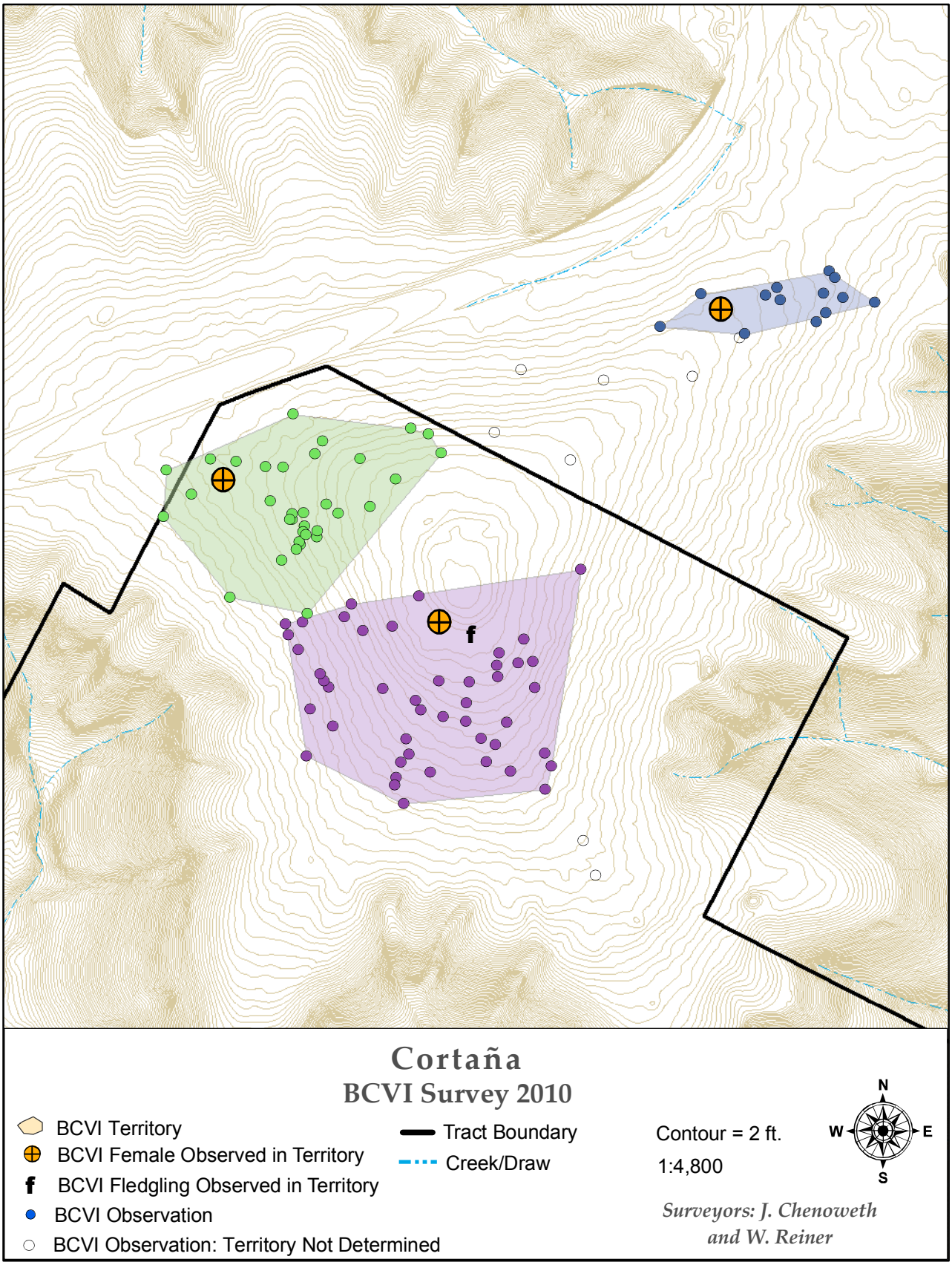

Cortaña
BCVI Survey 2010
BCVI Territory
BCVI Female Observed in Territory
f BCVI Fledgling Observed in Territory
BCVI Observation
BCVI Observation: Territory Not Determined
Tract Boundary
Creek/Draw
Contour = 2 ft.
1:4,800
N
W
E
S
Surveyors: J. Chenoweth and W. Reiner

Figure 13

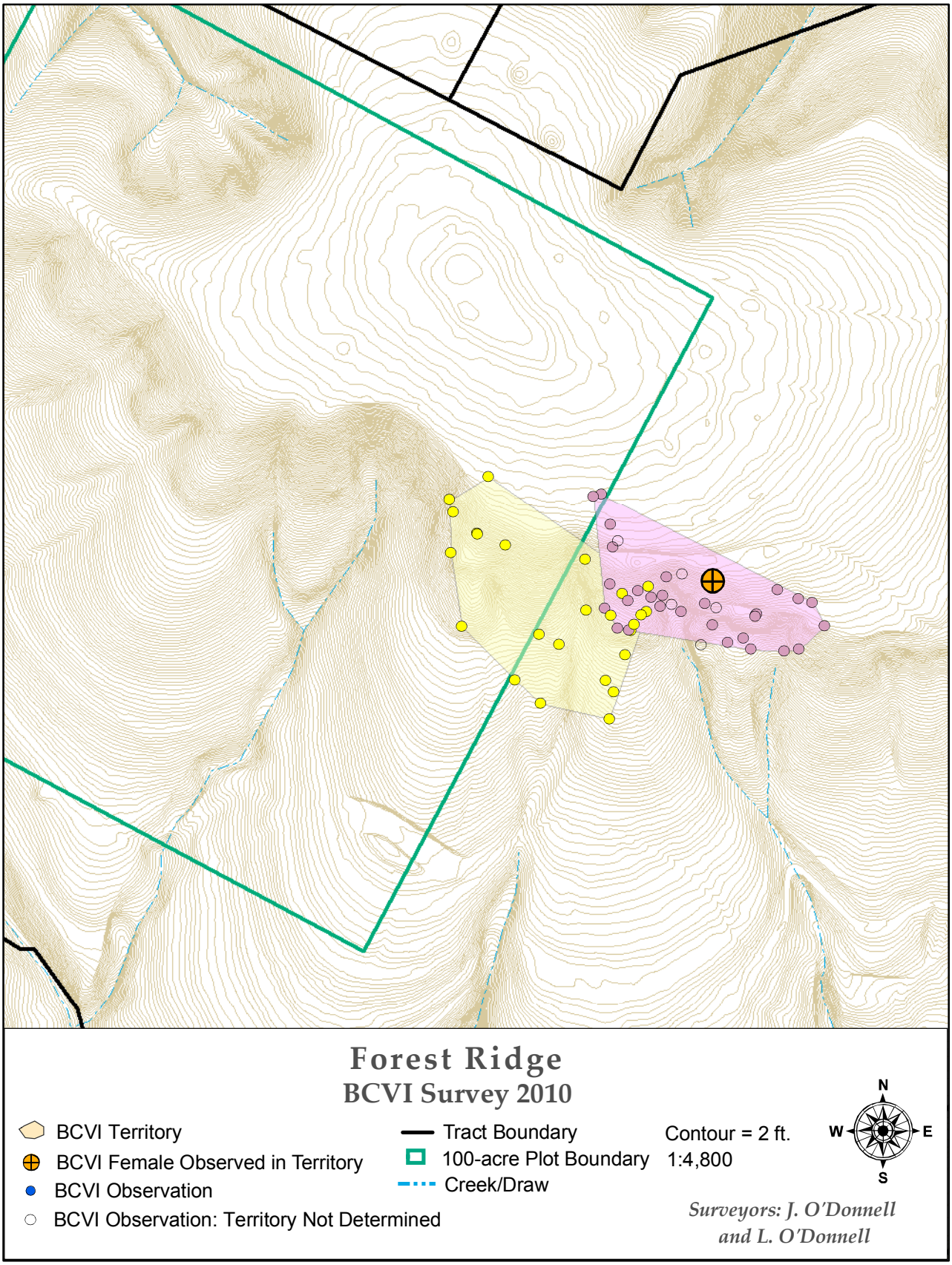

Forest Ridge
BCVI Survey 2010
BCVI Territory
BCVI Female Observed in Territory
BCVI Observation
BCVI Observation: Territory Not Determined
Tract Boundary
100-acre Plot Boundary
Creek/Draw
Contour = 2 ft.
1:4,800
N
W
E
S
Surveyors: J. O'Donnell
and L. O'Donnell

Figure 14