FY 2012 Report on Monitoring Golden-cheeked warblers (*Setophaga chrysoparia*) on Travis County tracts of the Balcones Canyonlands Preserve

Photo: Julia Land, May 2009, private residence adjacent to the Lime Creek Unit

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division

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INTRODUCTION

In 1990, the USFWS listed the Golden-cheeked warbler (*Setophaga chrysoparia*, hereafter GCWA) as federally endangered as a result of habitat loss and fragmentation due to suburban development, reservoir construction, and agricultural use (USFWS 1990, Ladd and Gass 1999). The Golden-cheeked warbler breeds exclusively in central Texas where suitable oak-juniper woodlands and forest are present (Ladd and Gass 1999, Pulich 1976). In recent decades, development has expanded rapidly westward from the city of Austin, accelerating the loss and fragmentation of GCWA habitat in western Travis County. In 1996, the Balcones Canyonlands Conservation Plan (BCCP) was approved by the USFWS. This 10(a)1(B) permit is jointly held by the City of Austin and Travis County to mitigate for the incidental "take" of habitat due to development and to facilitate the local recovery of the warbler and seven other endangered species (USFWS 1996a). The permit requires a minimum of 30,428 acres of endangered species habitat in western Travis County be set aside as a preserve for these species. This preserve system, the Balcones Canyonlands Preserve (BCP), is managed by an assortment of organizations and government agencies, including Travis County. As of Fiscal Year 2012 (FY12), Travis County managed 7,616 acres within the BCP (Figure 1). Travis County has been monitoring GCWAs on the BCP and other county-managed properties annually since 1996.

METHODS

STUDY SITES

In FY12, Travis County Natural Resources staff and volunteers surveyed plots located on four BCP macrosites (BCP Land Management Plan, 2007) as well as in two areas managed by Travis County Parks, covering a total of 2117 acres (857 ha) as shown in Figure 2. Brief descriptions of individual survey sites follow, with an emphasis on more recently acquired tracts.

Cypress Creek Macrosite: Jollyville Unit

The Cypress Creek Macrosite is located in northwestern Travis County and contains the Jollyville and Lime Creek Management Units. The Jollyville Unit comprises the southwestern portion of the Jollyville plateau and its northern section contains the

Snowden, Bunten and Collins tracts, as well as the Bunten, Lake Perspective/McGregor, and Vista Point 100-acre prime plots (see Figures 1 and 2).

The Collins tract (112.98 ac / 45.72 ha) is bounded by Anderson Mill Road to the north, private property to the east, the Snowden tract of the BCP to the south, and FM 2769 to the west. The geologic formations underlying the Collins tract (from youngest to oldest) include the Edwards Limestone, Bee Cave Marl of the Fredericksburg Group, and Upper Glen Rose formations. Soils are part of the group known as the Tarrant Association, which are shallow, stony, calcareous, clay soils intermingled with shallow soils overlying limestone (USDA 1974). A grotto and spring-fed pool is located near the northern boundary. This spring, along with others located in the main stream channel and tributaries, provides base flow to the intermittent stream as it flows south. Vegetation includes closed canopy juniper-oak woodlands on the plateaus and canyon slopes with understory of white shin oak (*Quercus sinuata* var. breviloba), hackberry (*Celtis* spp.), ash (*Fraxius* spp.), and sumac (*Rhus* spp.). Large American sycamore (*Platanus occidentalis*), walnut (*Juglans* spp.), and elms (*Ulmus* spp.) grow in the riparian corridors. Many archeological sites exist, including rock walls and burned rock middens. Some middens were excavated before Collins became part of the BCP in July 2011. Several shelter caves, one large cave, and many smaller karst features also occur on the property. A stormwater outflow structure discharges into the headwaters of an intermittent tributary upstream of a small spring on the northern boundary. The Snowden and Bunten tracts are contiguous with the Collins tract and are similar in composition.

Cypress Creek Macrosite: Lime Creek Unit

The Lime Creek Unit (321.39 ac / 130.07 ha) contains thirty-one tracts that range in size from 1 to 110 acres. This management unit is bounded by Lime Creek and private land to the north and west, the Baker tract (Travis Audubon Society) to the east, and the Wheless tract (LCRA) to the south. Fisher Hollow Creek runs through the southern part of the unit, flowing east to join Lime Creek just upstream of the Sandy Creek arm of Lake Travis. Volente Complex soils occur along the bottom of the mesic valleys, at the foot of the Brackett soils on the steeper slopes. Volente Complex soils are deep, well-drained, and easily erodible soils that develop in the slope alluvium (USDA 1974). Vegetation includes juniper-oak woodlands and riparian corridors, with mixed hardwoods like escarpment black cherry (*Prunus serotina*), elm, ash, and hackberry.

Bull Creek Macrosite

The Bull Creek macrosite is located in north central Travis County, between RR 2222 and FM 620 to the south and west, U.S. Highway 183 to the north, and Loop 360 and Mesa Drive on the east. Most of the undeveloped land in this macrosite supports extensive Golden-cheeked warbler habitat, as well as botanically rich communities and numerous springs, seeps, and associated hydric habitats (BCP Land Management Plan, 2007). This macrosite contains the Concordia Preserve, Colina Vista, and Ribelin Mitigation tracts as well as the Ribelin 100-acre prime plot.

The Concordia Preserve (hereafter Concordia) tract a 250-acre (101 ha) conservation easement managed by Travis County in conjunction with Concordia Lutheran University. The tract adjoins residential and commercial areas and the Concordia University campus. Two extensive canyons, each containing a number of springs and intermittent creeks, bisect the tract. The uplands consist of both closed canopy oak-juniper woodlands and large open grass areas. The canyon areas support mature mesic hardwood species in the overstory and a diverse array of shrubs and forbs in the understory. Primary soils on this tract are found in the Tarrant and Volente series (Soil Conservation Service 1974). Previous human use of this tract is evident throughout in the form of trails, pond impoundment, roads, and ranch fencing.

The Colina Vista (11.2 acre / 4.5 ha) and Ribelin Mitigation (20.1 acre / 8.1 ha) tracts are small properties belonging to the Bull Creek macrosite bordering areas which have recently been developed to create Vandegrift high school and a condominium complex. These tracts are composed of the heads of steep and densely wooded canyons.

North Lake Austin Macrosite

The North Lake Austin macrosite is located south of the Cypress Creek and Bull Creek macrosites. RM 620 and RR 2222 generally form the northern boundary, with Lake Austin delineating the western, southern, and eastern sides (BCP Land Management Plan, 2007). This macrosite contains the Steiner Ranch Tract 1, Webb, and Franzetti tracts, among others.

Steiner Ranch Tract 1, referred to informally as “J-Canyon,” is a section of Steiner Ranch Preserve in the North Lake Austin macrosite. Consisting of steep canyons and rocky slopes and bounded by neighborhoods to the north and Ladybird Lake (formerly named

Lake Austin) to the south, the tract is mesic along canyon bottoms and xeric in its uplands and eroded slopes.

The Webb and Franzetti tracts are located centrally within the North Lake Austin macrosite, and are accessed from City Park Road, which bounds the Franzetti tract on the east. The properties adjoin one another and contain oak-juniper woodlands, a number of intermittent creeks, steep canyons and high plateaus. Some juniper thinning has taken place prior to acquisition in two portions of the Webb tract. Regrowth in this area may have the potential to eventually form shrubby deciduous habitat which is suitable for nesting Black-capped vireos (*Vireo atricapilla*), although browsing pressure in this area is extremely high and has noticeably affected woody species composition and age structure.

Pedernales River Macrosite

The Pedernales River macrosite is situated in the extreme western portion of the permit area and is separated geographically from the rest of the preserve system. It is located south of SH 71, east of the Blanco County line, north of the Hays County line, and west of a line which is west of Bee Creek (BCP Land Management Plan, 2007). This macrosite contains Hamiliton Pool Preserve, a County-managed tract of the BCP, as well as the associated 100-acre prime plot and Southwest Metropolitan Park which is managed by Travis County Parks Division.

Pogue Springs Preserve is a section of Southwest Metropolitan Park (also referred to as Reimers Ranch Park). The park itself is comprised of 4 tracts, totaling approximately 1500 acres (607 ha). It is located between SH71 and Hamilton Pool Road, approximately 12 miles southwest of the Village of Bee Caves in western Travis County. Site topography slopes to the west, with surface runoff flowing west towards the Pedernales River. Soils are generally comprised of Brackett and Volente series (Soil Conservation Service 1974). The park can be divided into the two general vegetation types: riparian and savannah areas. The riparian areas are characterized by large trees such as common bald cypress (*Taxodium distichum*), live oak (*Quercus fusiformis*), Texas oak (*Quercus Buckleyi*), cedar elm (*Ulmus crassifolia*), and pecan (*Carya illinoensis*) with an understory comprised of evergreen sumac (*Rhus sempervirens*), agarita (*Mahonia trifoliolata*), American beautyberry (*Callicarpa americana*), and frostweed (*Verbesina virginica*). The open meadow areas are savannah-like, characterized by wooded overstory trees such as live oaks, cedar elm, Texas persimmon (*Diospyros texana*), and

only a few understory shrubs such as agarita (*Berberis trifoliata*), as well as numerous grass and wildflower species. The tract was historic ranchland, and the upland areas were cleared for many years to improve their benefits for grazing. The canyon areas do not appear to have been cleared and the vegetation within them is diverse. Pogue Springs Preserve consists of one of these lush canyons. The portion of the canyon surveyed in 2012 comprises approximately 96 acres (39 ha) and is not part of the BCP system although public access is currently prohibited. Another section of the park adjoins the eastern bank of the Pedernales River, just north of Hamilton Pool Preserve. This area (47 ha) was surveyed for GCWA presence in 2012 and is referred to in this report as 'Pedernales River Section' in this report.

TRACT TERRITORY MAPPING

Data Collection: Territory Mapping

GCWA territory mapping of entire preserve tracts was conducted between March 11 and June 14, 2012 on the Bunten, Colina Vista, Collins, Concordia, Franzetti, Ribelin Mitigation, Snowden, Webb, Steiner Ranch Preserve Tract 1, tracts in the Lime Creek Unit (a subsection of the Cypress Creek Macrosite), and two areas of interest within Travis County's Southwest Metropolitan Park (Figure 2).

Warbler habitat at each site was surveyed repeatedly (typically weekly) over the course of the breeding season. Total survey hours varied according to tract size, terrain, population density of warblers, and number of surveyors (see Table 1). Due to limitations inherent to territory mapping methods (i.e. differences in observer ability and the stability of exclusive territories of the target species), results of all surveys should be interpreted as indices, rather than complete counts (Verner 1985). Surveys within the Lime Creek Unit were for the purpose of documenting and mapping GCWA presence. Although territory mapping methodology was employed on these tracts, the number of visits and total effort per survey area were substantially less than at other surveyed sites; hence this data may best be interpreted as a record of occurrence and a crude estimate of abundance.

Standard territory mapping techniques were used to estimate male abundance, territory density, and species distribution. All observations (visual and auditory) of male, female, and juvenile warblers were plotted on hard-copy digital orthophoto maps. For each observation, sex, age, presence of a mate, and number of fledglings observed were recorded. Song type and counter singing were also noted. Avian locations and

demographic data were later recorded in an ArcGIS 10 (ESRI, Inc., Redlands, California) geodatabase using a spatial reference of NAD 1983/UTM 14N.

Mapping methods generally followed IBCC guidelines (1970), and improvements on this method were incorporated to increase accuracy in assigning observations to specific territories or clusters (Verner 1985, Bibbey et al. 1992). Field observations (e.g., bird behavior, phenology, etc.) and general knowledge of the species (e.g., territory size, habitat requirements, etc.) were used to help differentiate individual males and delineate their territories. Any male that could be differentiated from surrounding males was given a unique territory number for further tracking. Females or fledglings associating with a unique male were given the same unique territory number. Bibbey's consecutive flush method (1992) was modified to allow no more than five sequential movements attempted at one time in order to minimize possible observer influence on bird behavior.

Observations of warblers that could not be differentiated from surrounding individuals with any confidence were designated as "unknown." All observations of brown-headed cowbirds (*Molothrus ater*) and any signs of nest parasitism were also noted.

Data analysis: Territory Mapping

Abundance was calculated as the sum of all individual male warblers detected at a given survey site, including those observed outside of tract boundaries. Species distribution refers to all locations where warblers were observed. This includes males, females, and fledglings and may include multiple sightings of the same individual.

An individual male was considered to have established a breeding territory if one or more of the following conditions were observed: 1) a male was observed with a female; 2) a nest was located for an individual male; 3) a male was observed with fledglings; and/or 4) a male was observed at least three times (on different days with at least one week between observations) using the same general location. Males that only used areas outside of tract boundaries were not included in the territory analysis.

In calculating territory type and number, territories that fell entirely within the tract boundaries were considered "full" territories. Territories that fell at least partially outside the tract were considered "edge" territories. In order to avoid an upward bias in calculating territory number, Verner (1985) suggested counting each edge territory as half (0.5) of a territory (referred to as modified territories hereafter). In the results section, a

"low" estimate (full territories only), "high" estimate (full and edge territories weighted the same), and the modified estimate based on Verner's (1985) method (number of full territories + 0.5 [number of edge territories]) are presented. For each of the surveyed tracts, territory density is calculated as the number of modified territories divided by the number hectares surveyed.

100-ACRE PLOTS

Data collection: 100-acre Plots

Establishment of 100-acre permanent plots allows standardized, long-term monitoring of GCWAs and statistical analyses of pair and breeding success and productivity, which is required by the USFWS Habitat Conservation Plan (1996b). In 2012, territory mapping was conducted on six 100-acre permanent plots on the following tracts: Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives/McGregor, Ribelin, and Vista Point (Figure 2). On each plot, data were collected on territory density and location, pairing success, breeding success, and productivity.

The 100-acre plots were surveyed according to the same general protocol used for territory mapping, with the following additional specifications. Surveys started one half hour after sunrise on days when the temperature was > 55° F, wind velocity was < 15 mph, and precipitation was light to none. Each of the 100-acre prime study plots were visited a total of 60 hours distributed evenly (i.e. ten 6-hour visits) throughout the season. Two different observers alternately monitored each 100-acre plot during the survey period. All territories, including edge territories, were monitored repeatedly to collect pairing, breeding, and productivity data. Pairing status of male warblers was determined by observing a male associating with a female, locating a nest for that male, and/or observing a male tending at least one fledgling. Observations of fledglings tended by a parent and the greatest number of fledglings observed at any one time provided data for breeding success and productivity. For further information, a general study protocol for 100-acre plots is outlined in the Balcones Canyonlands Preserve Land Management Plan (2007).

Data analysis: 100-acre Plots

Abundance, pair status, breeding status, and territory status for GCWAs on 100-acre plots were determined as described in the previous section on territory mapping. Territory

density is given in Table 3 and Table 4 as the number of modified territories (Verner 1985) per hectare. To calculate pair success, breeding success, and productivity, only full territory totals for each tract were used. Full territories were the territories that only fell completely within plot boundaries. Pair success was calculated as the number of males (on full territories) determined to have paired with a female divided by the number of full territories (Anders 2000). To determine breeding success rate, full territories with at least one fledgling observed with either the male or female parent were tallied, and then divided by the total number of full territories for the plot (Koloszar and Becker 2000).

Productivity was measured two ways for the 100-acre study plots:

1) Productivity for paired full territories = $\frac{\text{\# of fledglings*}}{\text{\# of paired full territories}}$

2) Productivity for all full territories = $\frac{\text{\# of fledglings*}}{\text{total \# of full territories}}$

*Sum of the highest number of fledglings observed at any one time

Differences between 'Conventional' and 'Intensive Study' 100-acre Prime Plots

In 2012 as in 2011, survey methods and data collection on the Canyon Vista, Lake Perspectives/McGregor and Vista Point prime 100-acre plots adhered to the protocol of the GCWA demography study being performed by the City of Austin (see BCCP Annual Report FY12, Appendix F). These plots are referred to as 'intensive study' plots, to differentiate them from the plots being surveyed under the 100-acre plot protocol described in the Balcones Canyonlands Preserve Land Management Plan (2007). Color-banding and resighting of adult GCWA was performed on these "intensive study" plots and supplemental survey effort was expended in order to collect the most complete record of productivity possible. Each site was visited at least once per week in addition to the standard six-hour weekly survey (see Table 1 for a detailed accounting of survey effort per plot).

Prior to beginning the survey season, the boundaries of the Lake Perspectives/McGregor survey plot were shifted slightly from "conventional" surveys completed in these locations in past years to better accommodate protocol requirements which call for a square or rectangular plot surrounded by a 100 meter 'collar'.

Researchers also initiated a 100-acre intensive plot on the Vireo Ridge tract (directly adjoining the Vista Point intensive study plot) in an area that has been manipulated to create shrub habitat for nesting Black-capped vireo. Although this survey plot lies within land managed by Travis County, survey information hasn't been included in this section, since the long-term survey status of this plot has yet to be determined; for maps and survey details see Appendix F (this volume).

There are slight differences in the values associated with intensive study plots and conventional 100-acre plots given in Table 3, Table 4 and Exhibit B. The three intensive study plots managed by Travis County, are included in these tables to maintain continuity with prior annual reports, and are marked with asterisks for clarity. In Table 3, abundance is not provided for intensive plots, since unmarked males were not tracked and recorded as unique territories (instead being referred to in data simply as 'UK' unknown). In Table 4 and Exhibit B, productivity measures are not calculated per full territory as for standard 100-acre plots, but instead the sum of full and edge territories was used (values are reproduced from Table 8 of Appendix F, which is analogous to Table 4 of this report). For territory maps and more detailed survey results covering the full set of intensive study plots, see Appendix F.

RESULTS AND DISCUSSION

TRACT TERRITORY MAPPING

Excluding 100 acre prime plots, 411 hours were spent surveying 1306 acres for GCWA territories during the 2012 field season (Table 1). The total abundance of GCWA males on all tracts surveyed (not including 100-acre study plots) was 143. Figures 3 through 10 illustrate territory distribution and abundance for each of the areas surveyed for GCWA in 2012.

Table 1. List of Travis County Balcones Canyonlands Preserve (BCP) tracts surveyed for Golden-cheeked Warblers (*Setophaga chrysoparia*) during the 2012 field season. Also included are tract acreages, survey dates and total survey hours for each tract. Plot acreages for Canyon Vista, Lake Perspectives/McGregor, and Vista Point plots include 100 m survey buffer. Survey hours for Canyon Vista, Lake Perspectives/McGregor and Vista Point tracts reflect the increased survey effort required by 'intensive plot' protocol (see "Differences between 'Conventional' and 'Intensive Study' 100-acre Prime Plots")

Tract	Acreage Surveyed	Survey Dates	Total Survey Hours
100-acre prime plots			
Bunten	100	3/21/2012-5/1/2012	60
Hamilton Pool	100	3/19/2012-4/30/2012	60
Ribelin	100	3/21/2012-5/21/2012	60
Canyon Vista	171	3/21/2012-6/14/2012	301
Lake Perspectives/McGregor	171	3/16/2012-6/14/2012	223
Vista Point	171	3/11/2012-6/5/2012	385
Total	**812**		**1089**
Territory Mapping			
Collins / Snowden / Bunten	207	3/21/2012-5/16/2012	131.45
Concordia	254	3/26/2012-5/16/2012	122.05
Webb / Franzetti	200	3/23/2012-5/16/2012	49.3
Steiner Ranch Preserve Tract 1	321	3/28/2012-5/24/2012	43.5
Reimers Ranch Pogue Canyon	96	3/22/2012-5/9/2012	19.75
Reimers Ranch Pedernales River	47	3/22/2012-5/9/2012	12.25
Lime Creek Unit tracts	149	3/06/2012-5/09/2012	15
Colina Vista / Ribelin Mitigation	31	3/22/2012-4/12/2012	17.6
Total	**1306**		**410.9**
Overall Total	**2117**		**1500**

Table 2. Results of the Golden-cheeked Warbler (*Setophaga chrysoparia*) conventional territory mapping on Travis County-managed Balcones Canyonlands Preserve tracts and properties surveyed during the 2012 field season. Golden-cheeked warbler male abundance, territory number (full, full and edge, and modified territory number[a]), and territory density per acre and hectare are summarized. See methods section for definition of full and edge territory.

Preserve tract or survey area	Abundance	No. of full territories	Total territories (full + edge)	Modified number of territories (MT)[a]	Territory density (Total / ha)	Territory Density (MT / ha)[b]
Collins / Snowden / Bunten	49	29	43	36	0.51	0.43
Concordia	39	13	34	23.5	0.33	0.23
Webb / Franzetti	22	14	20	17	0.25	0.21
Steiner Ranch Preserve Tract 1	4	2	4	3	0.03	0.02
Reimers Ranch Pogue Canyon	4	4	4	4	0.10	0.10
Reimers Ranch Pedernales River	0	0	0	0	0.00	0.00
Lime Creek Unit tracts	21	3	3	3	0.05	0.05
Colina Vista/Ribelin Mitigation	4	1	2	1.5	0.16	0.12
Average					**0.18**	**0.15**

[a] Number of full territories + 0.5 (number of edge territories) (Verner 1985)
[b] Calculated using the modified number of territories

100-ACRE PRIME PLOTS

Territory Density

In the 2012 field season, an average of 17.83 'modified' territories (Verner 1985) were established per 100 acres or an average of 44 modified territories per 100 hectares (Table 3).

Based on Verner's (1985) method for calculating territory number, territory density was highest on the Bunten tract, which accomodated 85 territories per 100 hectares (one male per 1.17 ha). Ribelin had the second highest territory density of 73 territories per 100 hectares or one male per 1.37 hectares. Hamilton Pool had the lowest territory density (12 territories per 100 ha or one male per 8.3 ha) (Table 3).

Exhibit A includes comprehensive territory density data for all 100-acre plots surveyed by Travis County since the initiation of 100-acre prime plot surveys. It is worth noting that recorded densities on the Bunten and Ribelin tracts reached a record high in 2012, while territory density on the Hamilton Pool plot reached a record low. A substantial

number of Ashe juniper (*Juniperus ashei*) and live oak trees growing on the upland areas of the Hamilton Pool study plot died in 2011 as a result of the intense drought that occurred in the summer and fall of that year, directly influencing the amount of nesting and foraging substrate available to breeding GCWA.

Table 3. Results of the 2012 Golden-cheeked warbler (*Setophaga chrysoparia*) territory mapping on Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives/McGregor, Ribelin, and Vista Point prime habitat 100-acre study plots on Travis County-managed Balcones Canyonlands Preserve tracts.

100-acre Prime Study Plot	Abundance	No. of full territories	Total territories (full + edge)	Number of modified territories (MT)	Territory density (Total / ha)	Territory Density (MT / ha)
Bunten	42	27	42	34.5	1.04	0.85
Canyon Vista*	NA	6	23	14.5	0.57	0.36
Hamilton Pool	8	4	6	5	0.15	0.12
Lake Perspectives/McGregor*	NA	4	10	7	0.25	0.17
Ribelin	44	21	38	29.5	0.94	0.73
Vista Point*	NA	13	20	16.5	0.49	0.41
Average	**31.33**	**12.50**	**23.17**	**17.83**	**0.57**	**0.44**

Results include abundance, number of territories (full, full and edge, and modified), and territory density.
[a] Number of full territories + 0.5 (number of edge territories) (Verner 1985)
[b] Based on calculation of the modified territory number listed in column 4

Figures 11 through 13 illustrate territory distribution and abundance for each of the 100-acre prime study plots surveyed (excluding those surveyed under the City of Austin's 'intensive' plot protocol).

Pairing Success, Breeding Success, and Productivity

Across all six 100-acre prime plots, the average pairing success (for full territories) was 91% (Table 4). The highest proportion of successfully paired full territories on the standard 100-acre survey plots occurred on the Bunten plot (93%). Plots surveyed according to the intensive study plots protocol, i.e. Canyon Vista, Lake Perspectives/McGregor, and Vista Point, recorded 100% pair success in 2012, possibly indicating that demographic estimates based on the current levels of survey effort (60 hours) and survey area (edge territories unmapped outside of 100-acre plot border) are biased low.

Breeding success on the 100-acre study plots ranged from 50-76% with an average of 63% of pairs successfully raising a brood. Plots averaged 1.89 fledglings per successfully paired territory (range: 0.67 to 2.68), and each full territory averaged 1.69 fledglings (range: 0.5 to 2.48) (Table 4).

Exhibit B includes comprehensive productivity data for all 100-acre study plots since the initiation of 100-acre prime plot surveys on Travis County BCP properties.

Table 4. Golden-cheeked warbler pairing success rate, breeding success rate, and productivity per successful pair and full territory for the six Travis County prime habitat 100-acre prime plots in 2012.

100-acre Prime Study Plot	No. of full territories	No. of full territories w/ female	No. of full territories producing ≥ 1 young	Pairing Success	Breeding Success	Productivity per successful pair	Productivity per full territory
Bunten	27	25	20	0.93	0.74	2.68	2.48
Canyon Vista*	23	18	13	1	0.57	1.7	1.3
Hamilton Pool	4	3	2	0.75	0.5	0.67	0.5
Lake Perspectives / McGregor*	10	10	6	1	0.6	1.8	1.8
Ribelin	21	17	16	0.81	0.76	2.47	2.00
Vista Point*	20	20	12	1	0.63	2.05	2.05
Average	**17.50**	**15.50**	**11.50**	**0.91**	**0.63**	**1.89**	**1.69**

Data collected during the 2012 field season on the Balcones Canyonlands Preserve in western Travis County, Texas. See methods section for a description of calculations.

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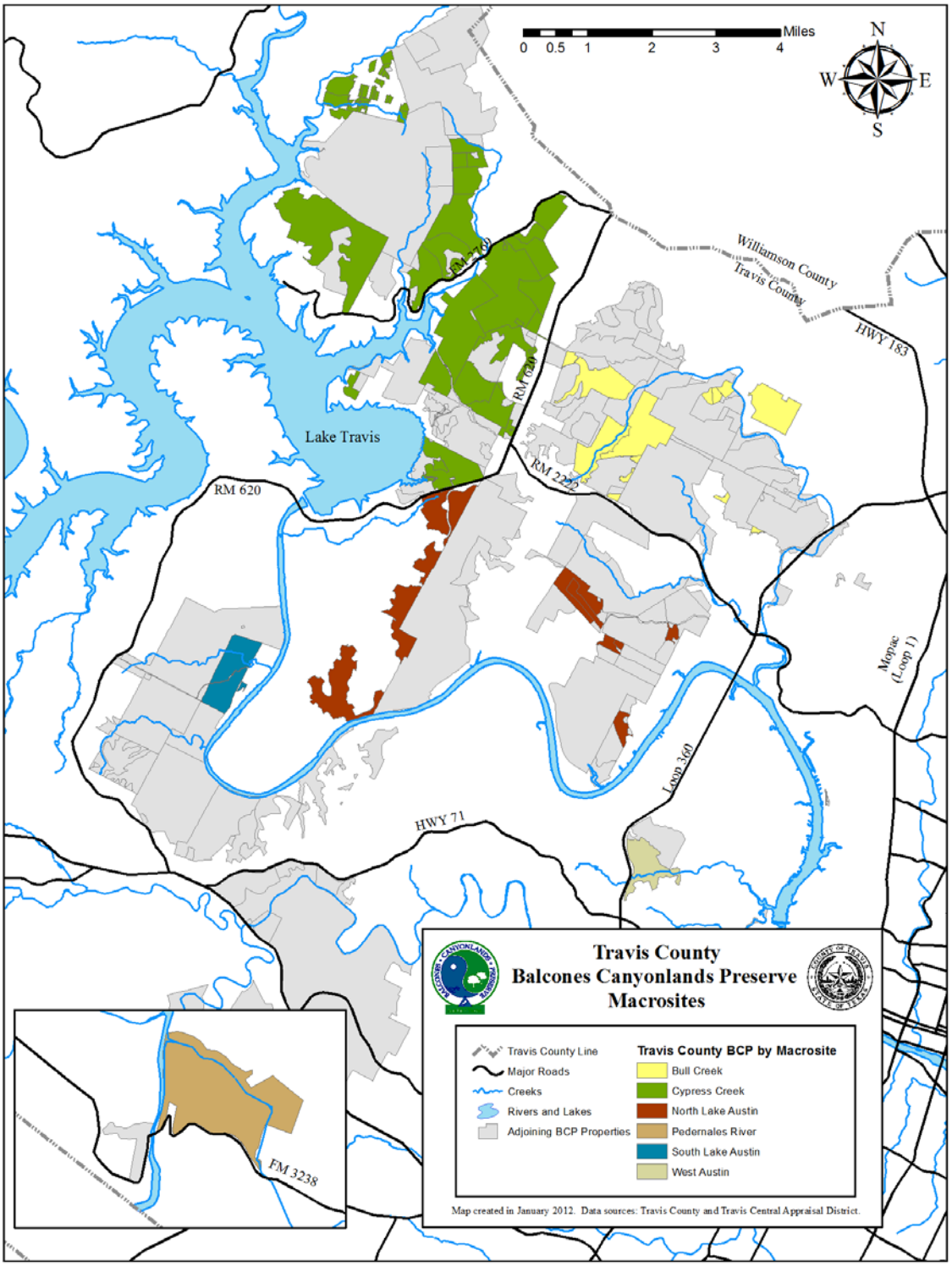

Figure 1. Location of Travis County Balcones Canyonlands Preserve tracts by macrosite.

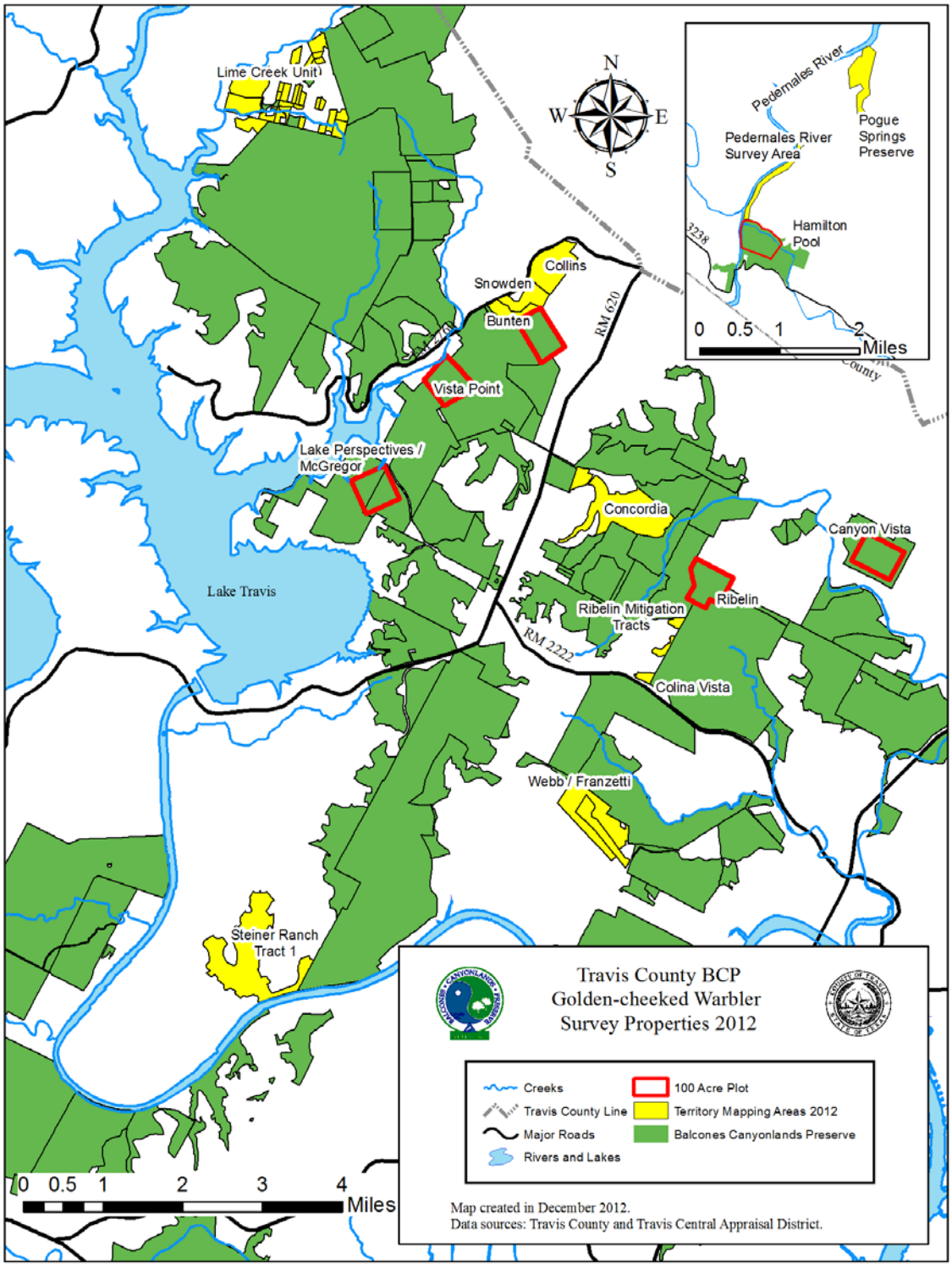

Figure 2. Locations of tracts surveyed for Golden-cheeked warblers in 2012.

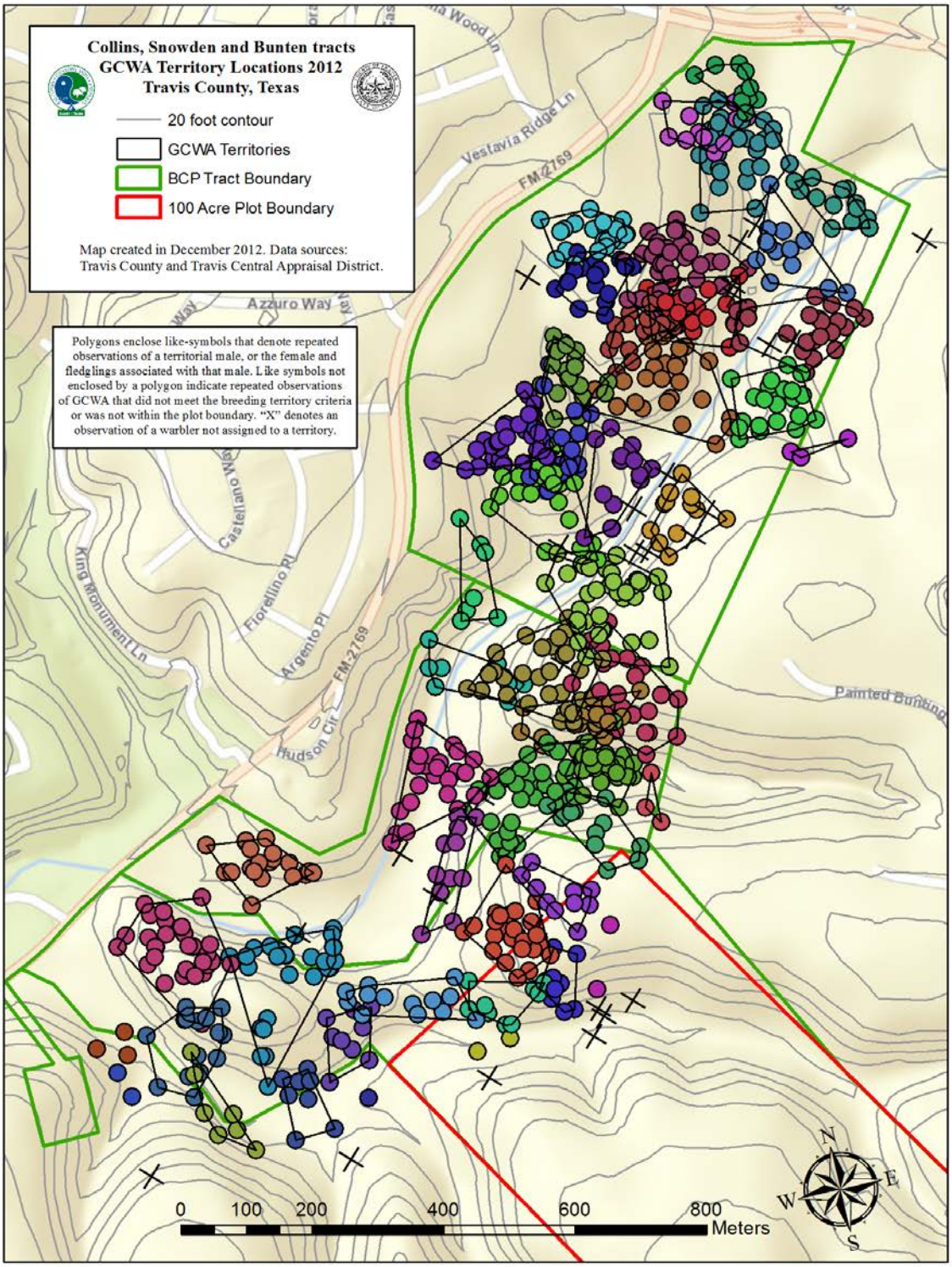

Figure 3. 2012 Golden-cheeked warbler observations and territory locations on the Collins, Snowden and Bunten tracts (excluding the Bunten 100 acre survey plot).

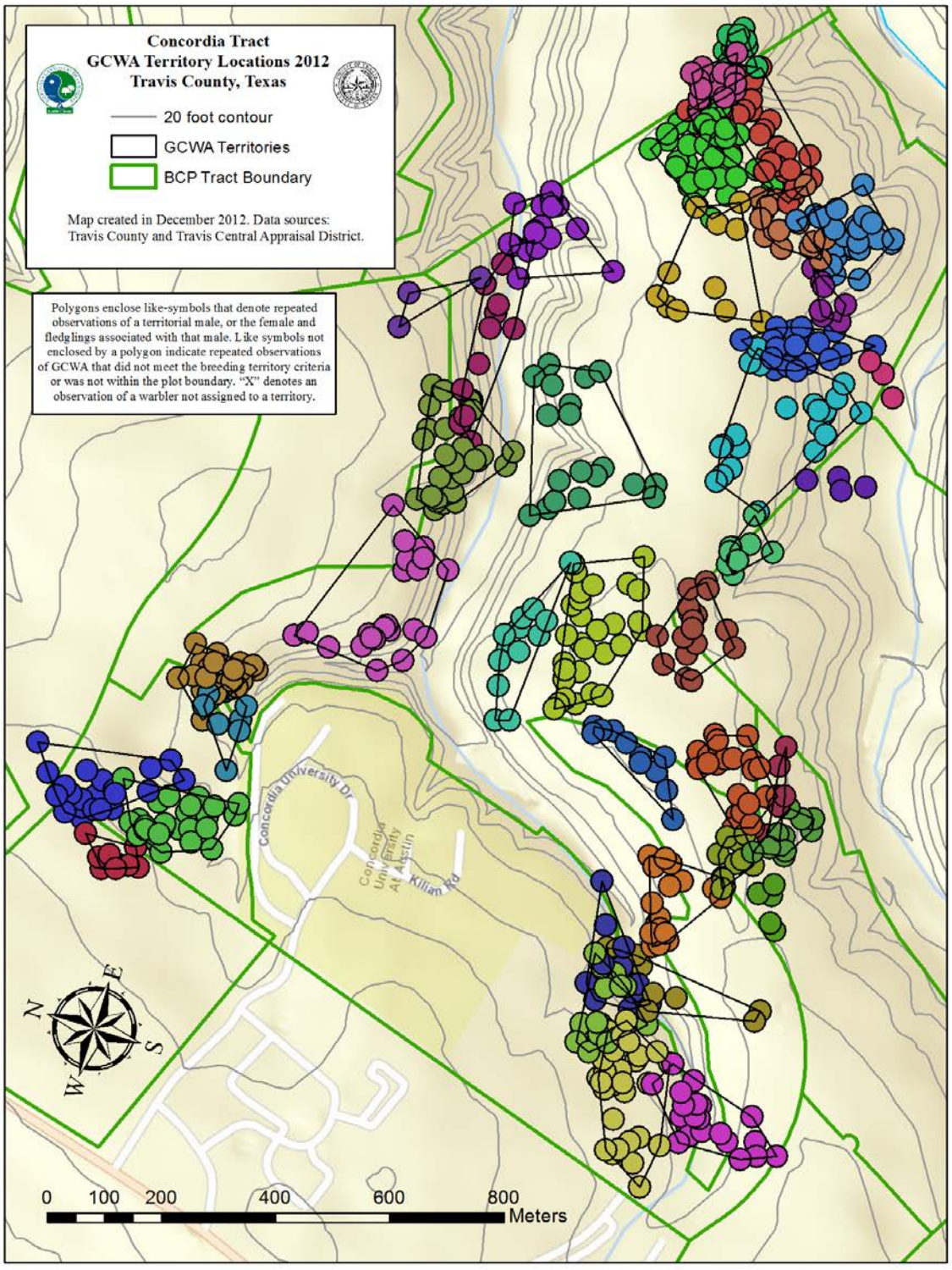

Figure 4. 2012 Golden-cheeked warbler observations and territory locations on the Concordia tract.

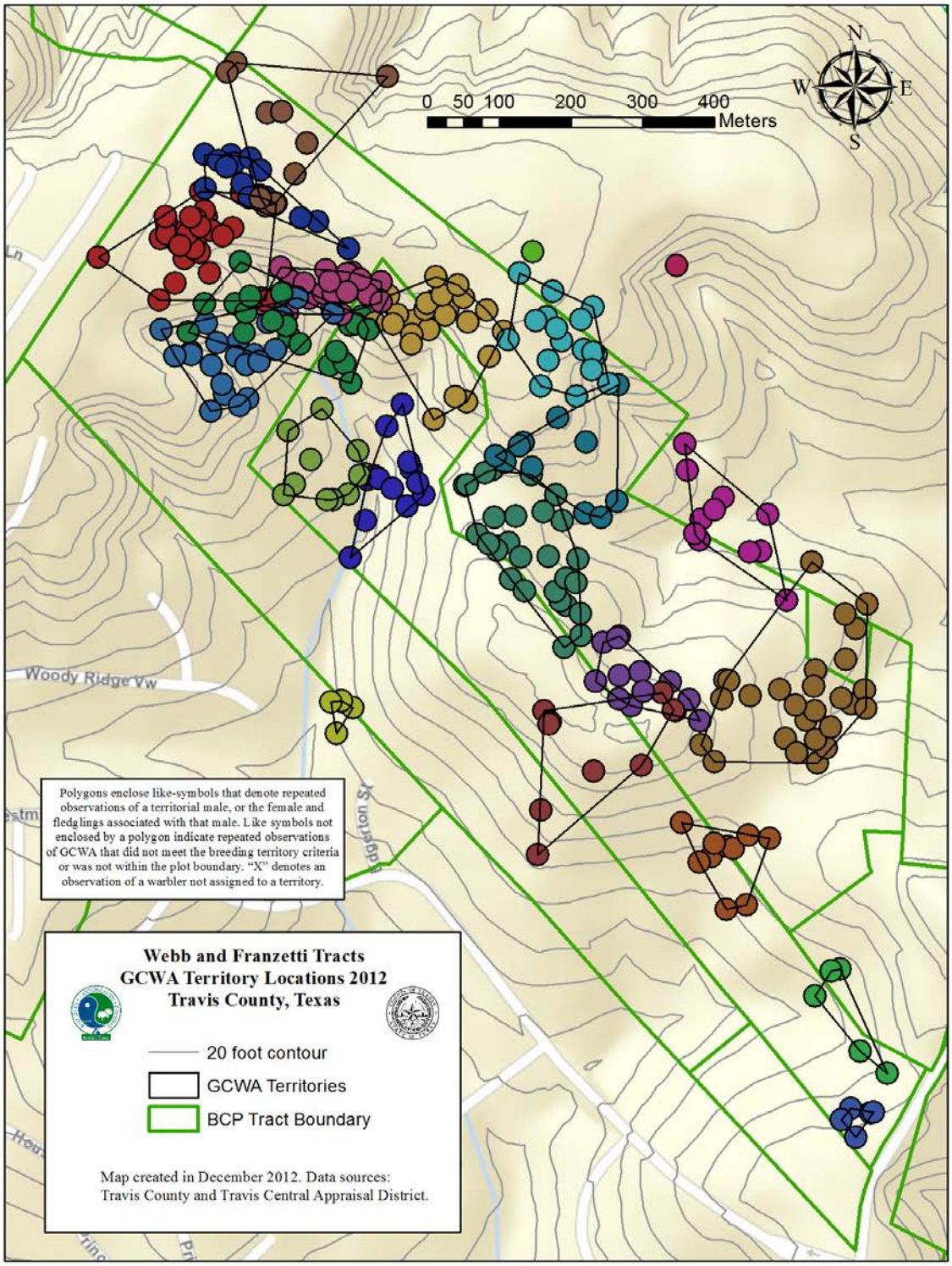

Figure 5. 2012 Golden-cheeked warbler observations and territory locations on the Webb and Franzetti tracts.

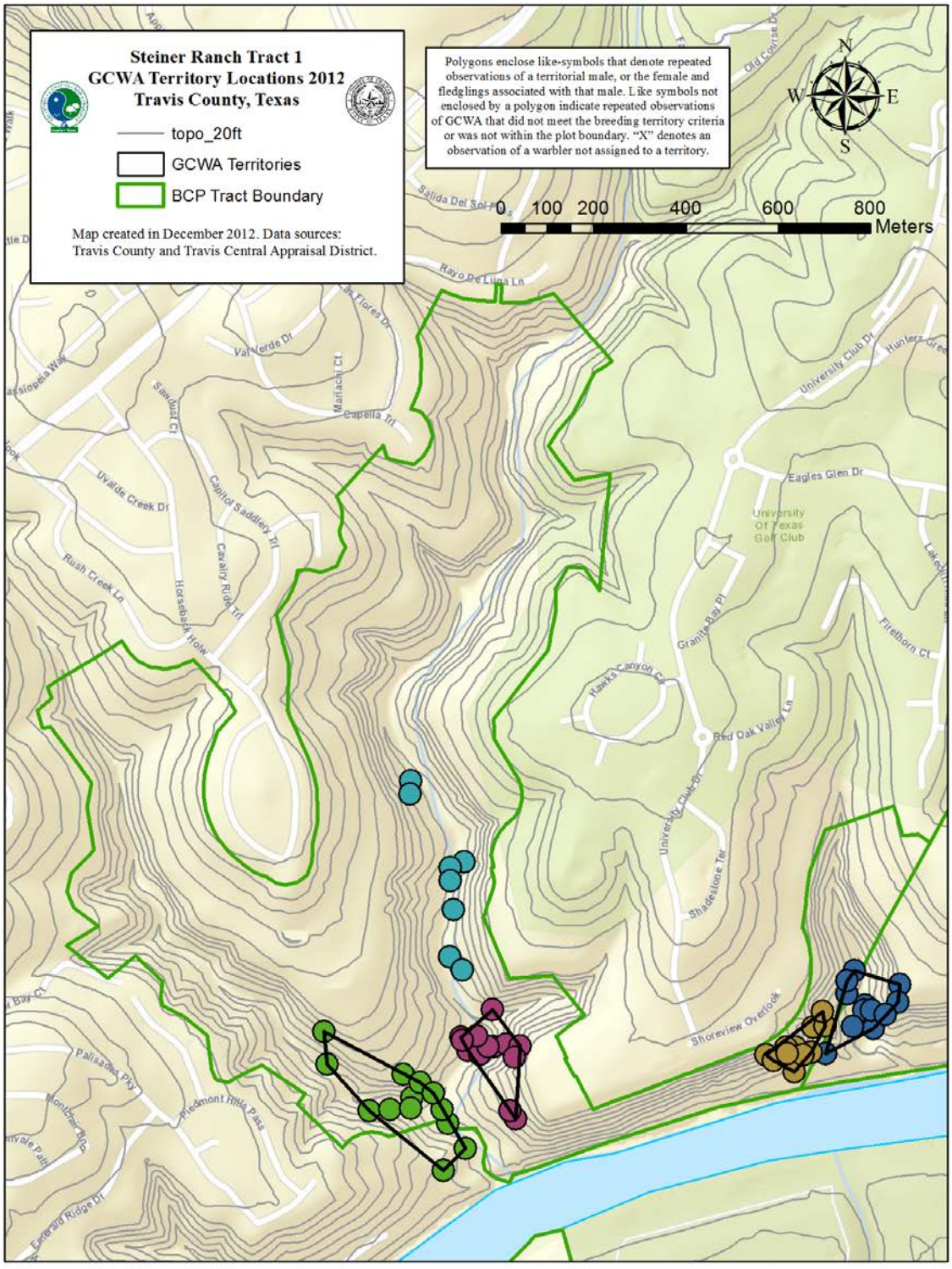

Figure 6. 2012 Golden-cheeked warbler observations and territory locations on the Steiner Ranch Preserve Tract 1 ("J-Canyon").

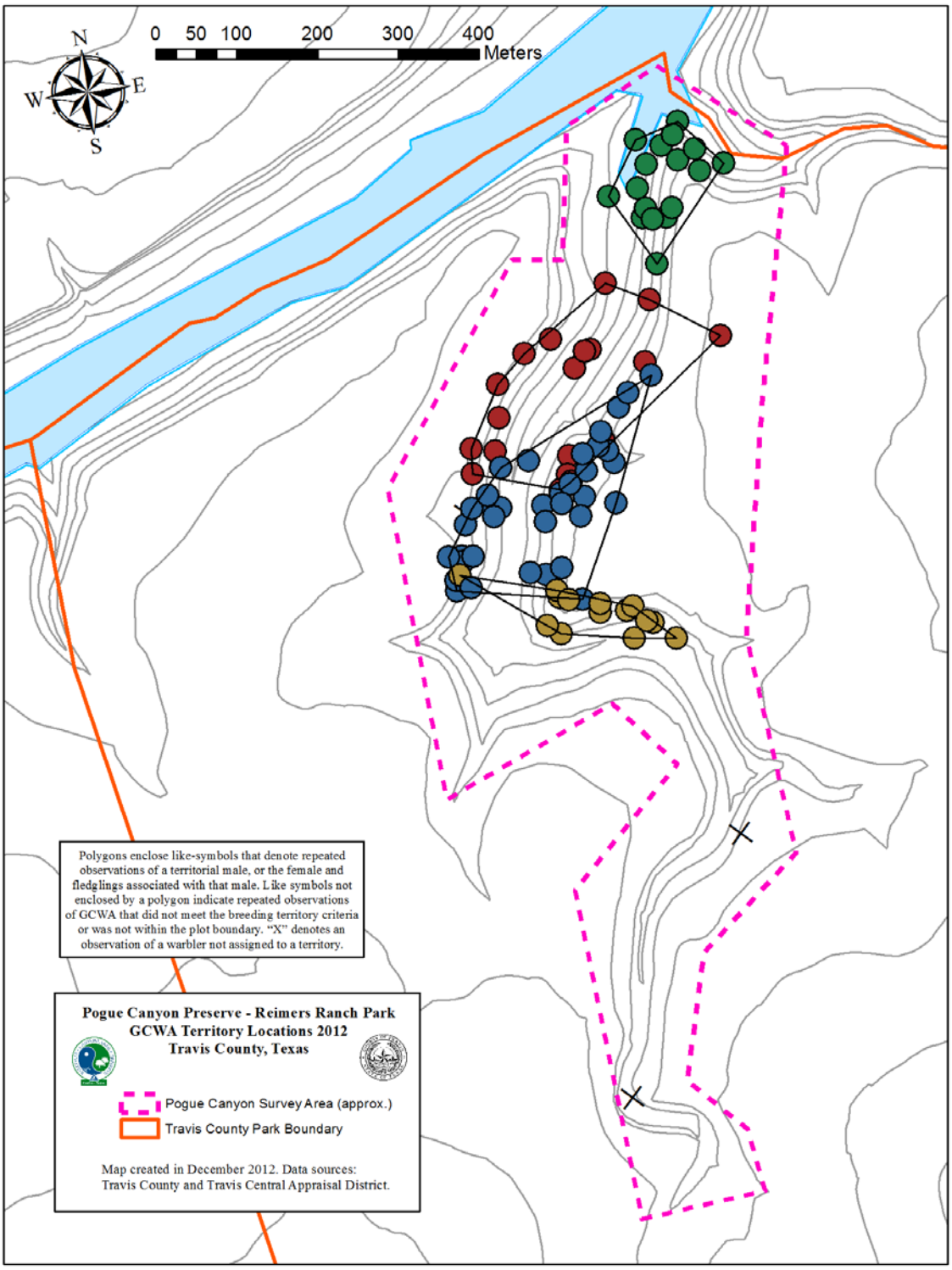

Figure 7. 2012 Golden-cheeked warbler observations and territory locations on the Pogue Canyon Preserve section of Reimers Ranch Park.

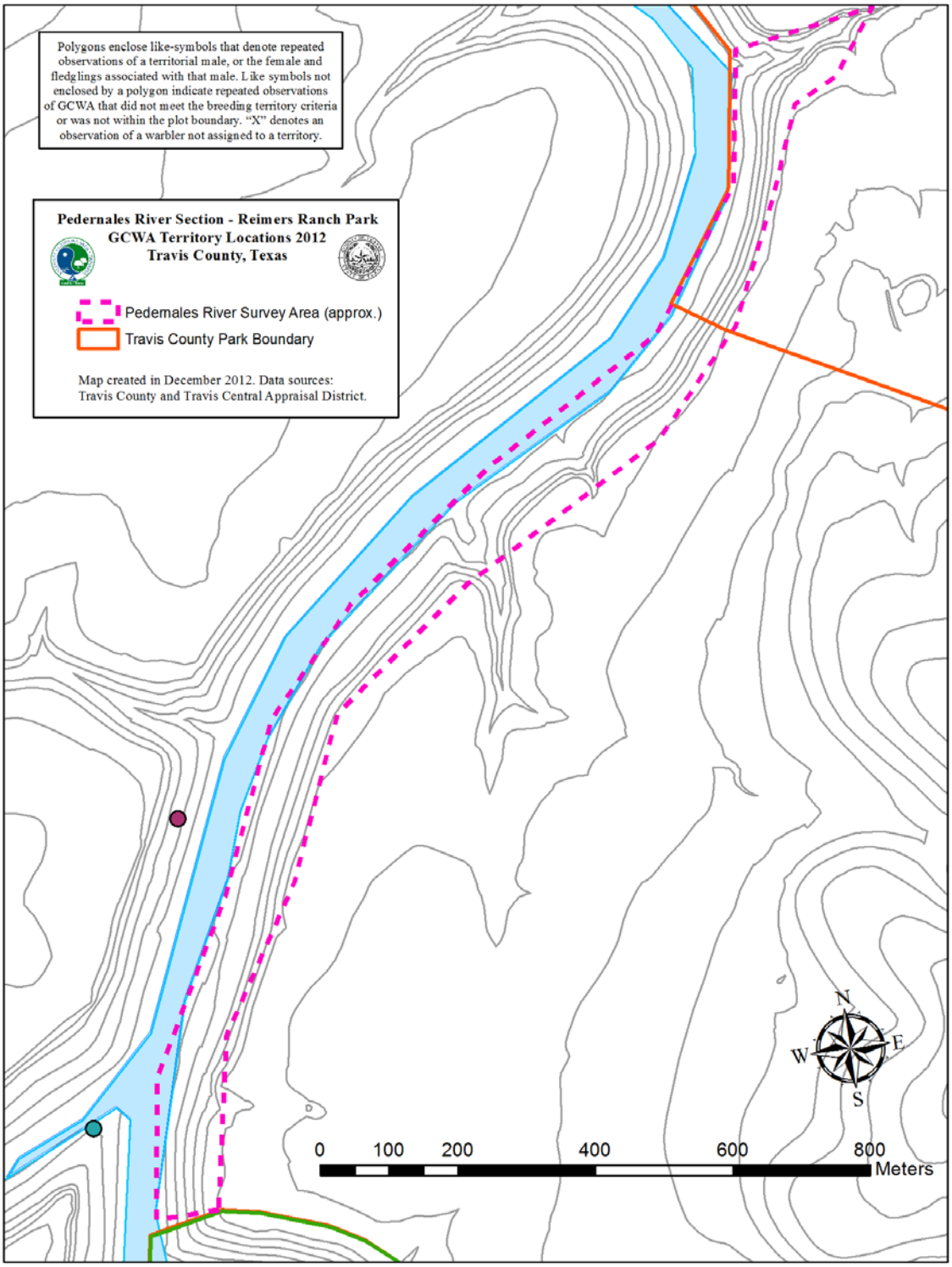

Figure 8. 2012 Golden-cheeked warbler observations and territory locations on the Pedernales River survey section of Reimers Ranch Park.

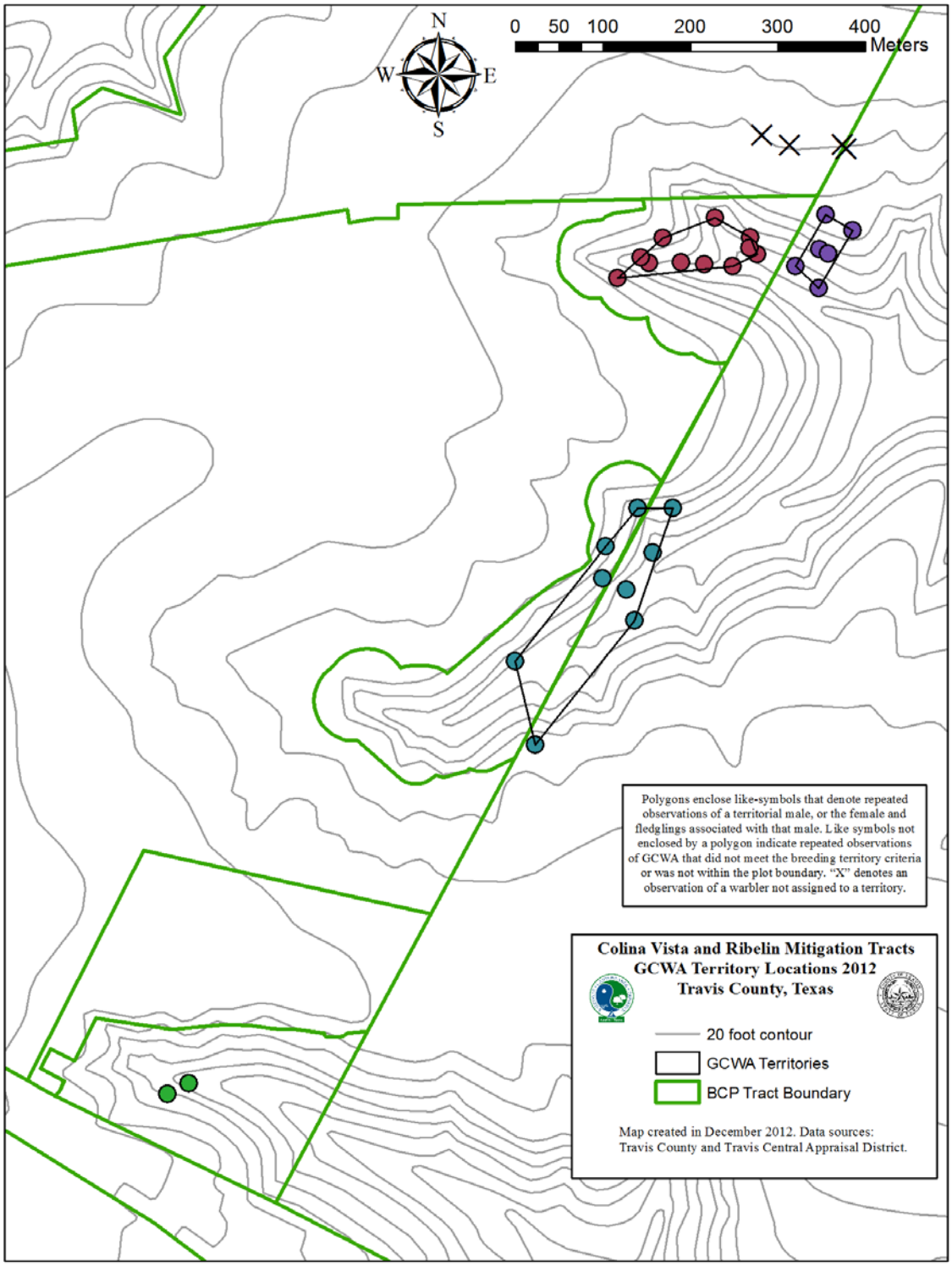

Figure 9. 2012 Golden-cheeked Warbler observations and territory locations on the Colina Vista and Ribelin Mitigation tracts.

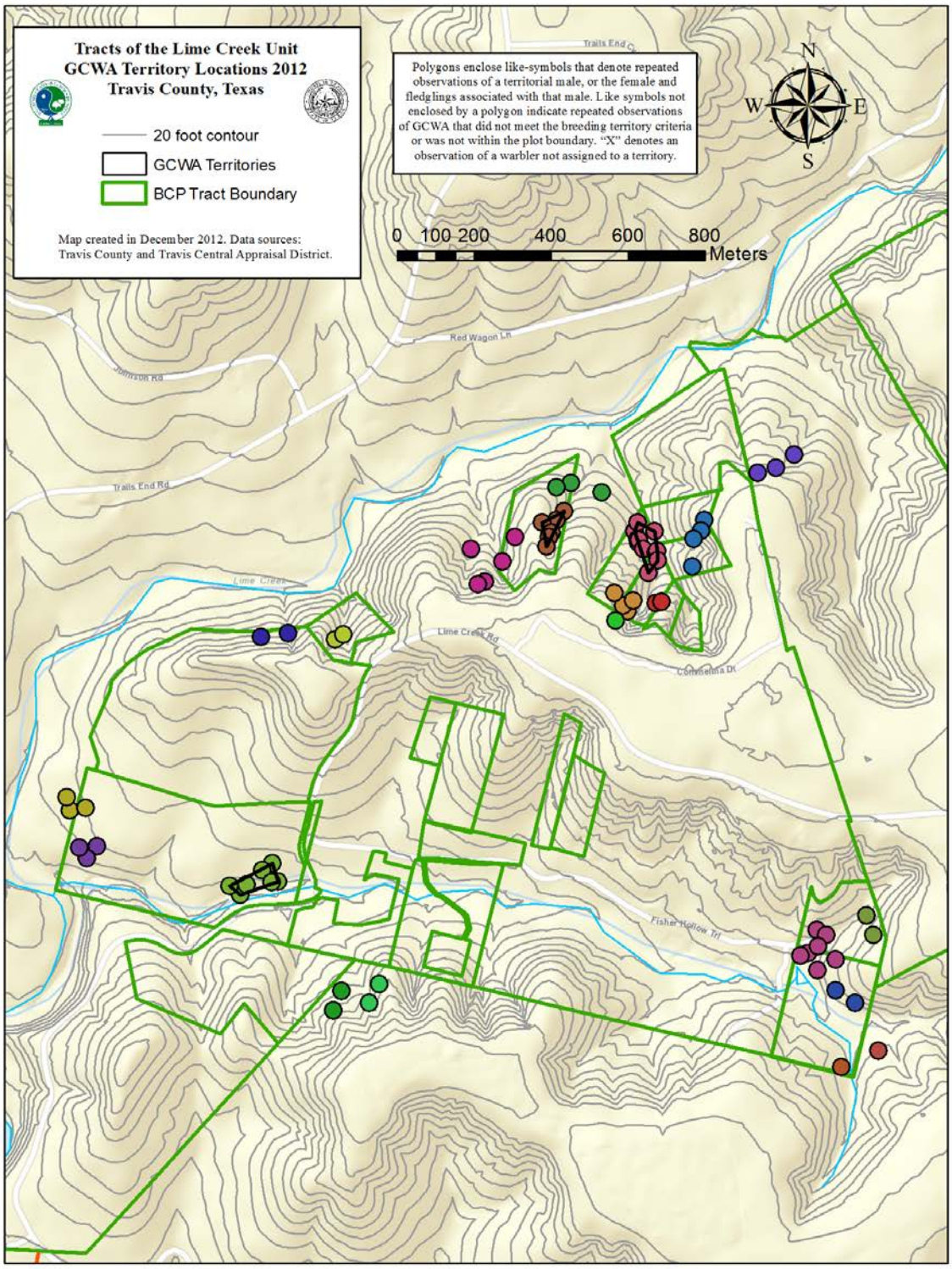

Figure 10. 2012 Golden-cheeked warbler observations and territory locations on tracts of the Lime Creek Unit.

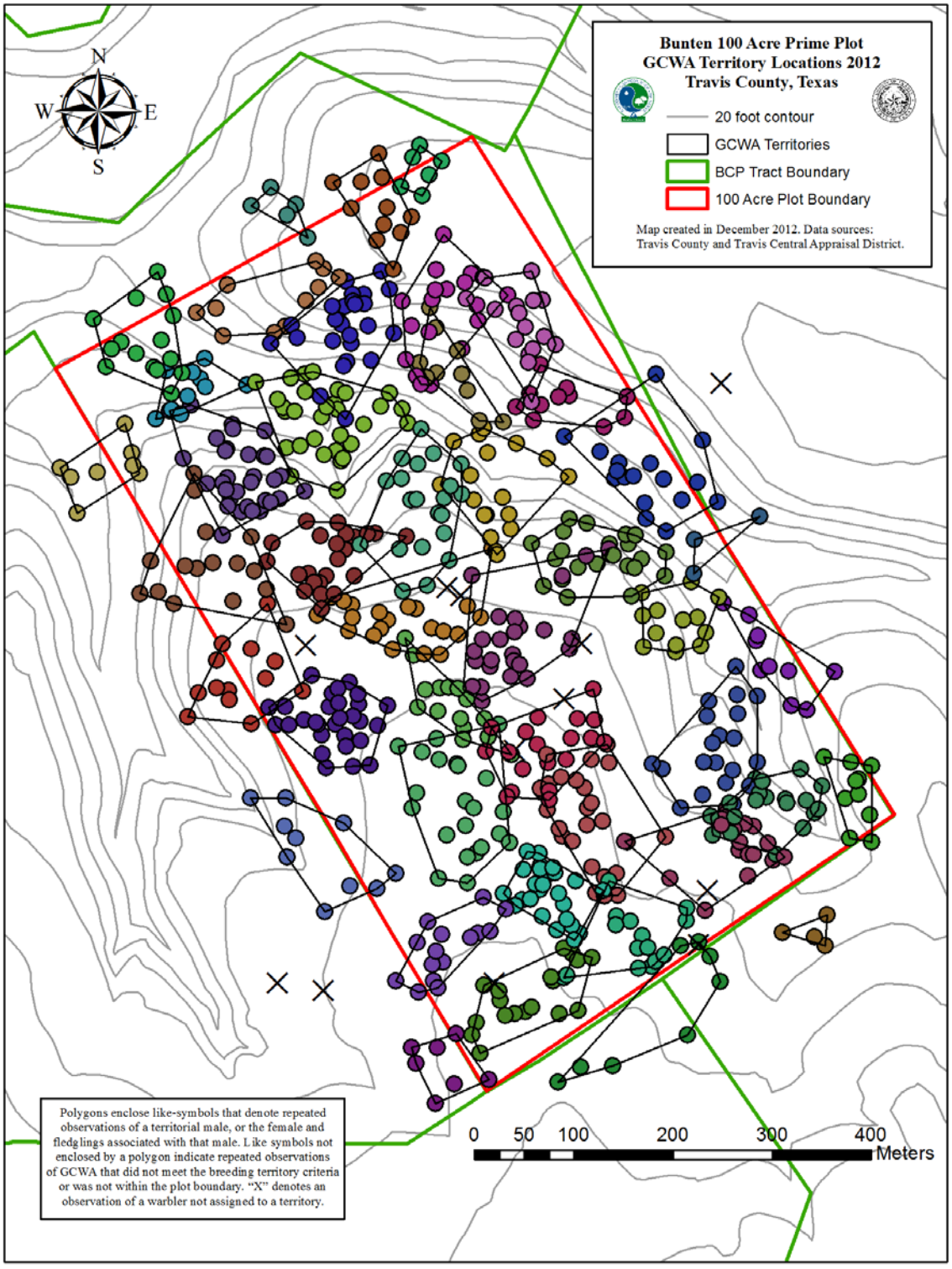

Figure 11. 2012 Golden-cheeked warbler observations and territory locations on the Bunten prime 100-acre study plot.

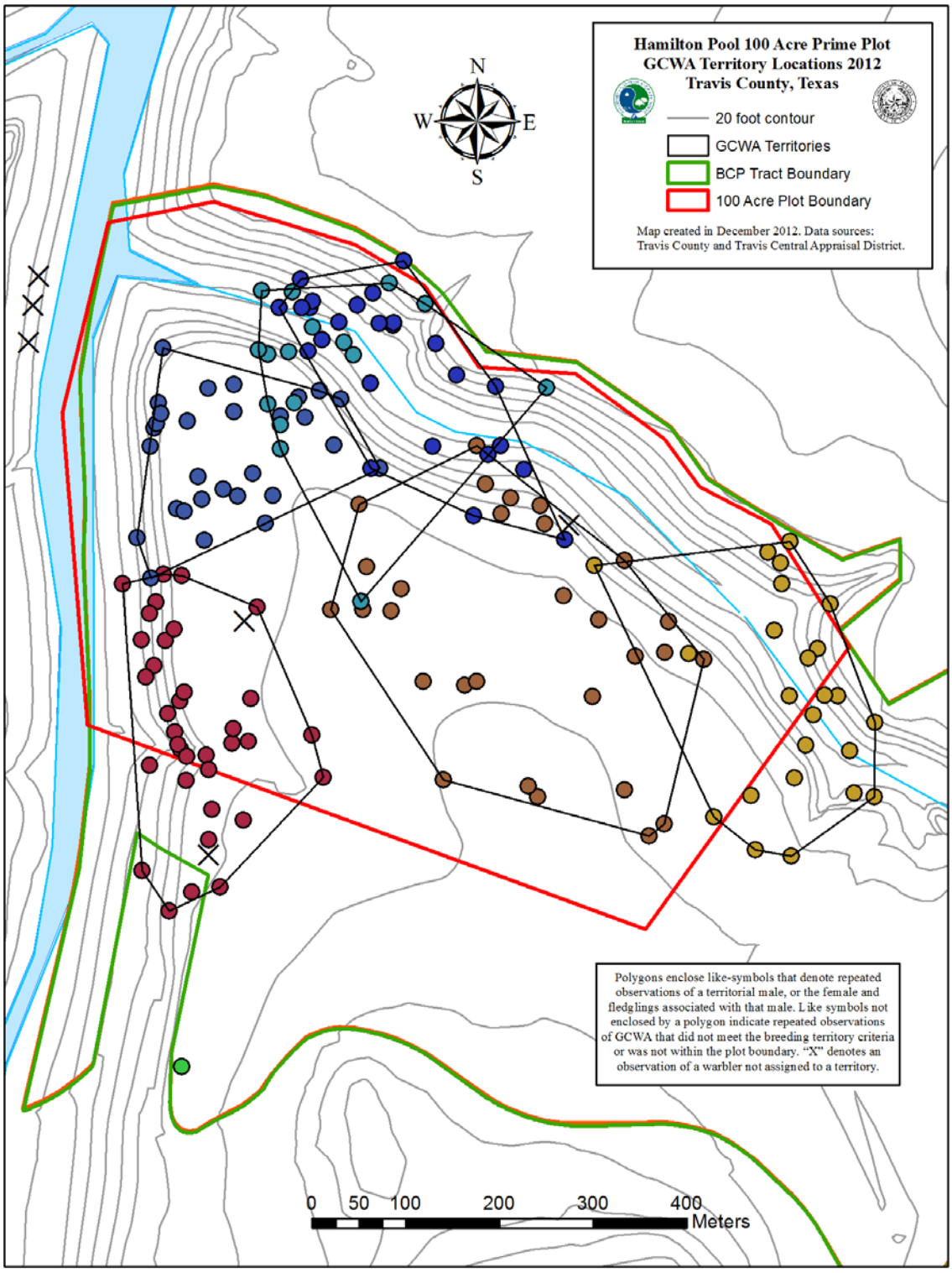

Figure 12. 2012 Golden-cheeked warbler observations and territory locations on the Hamilton Pool 100-acre study plot.

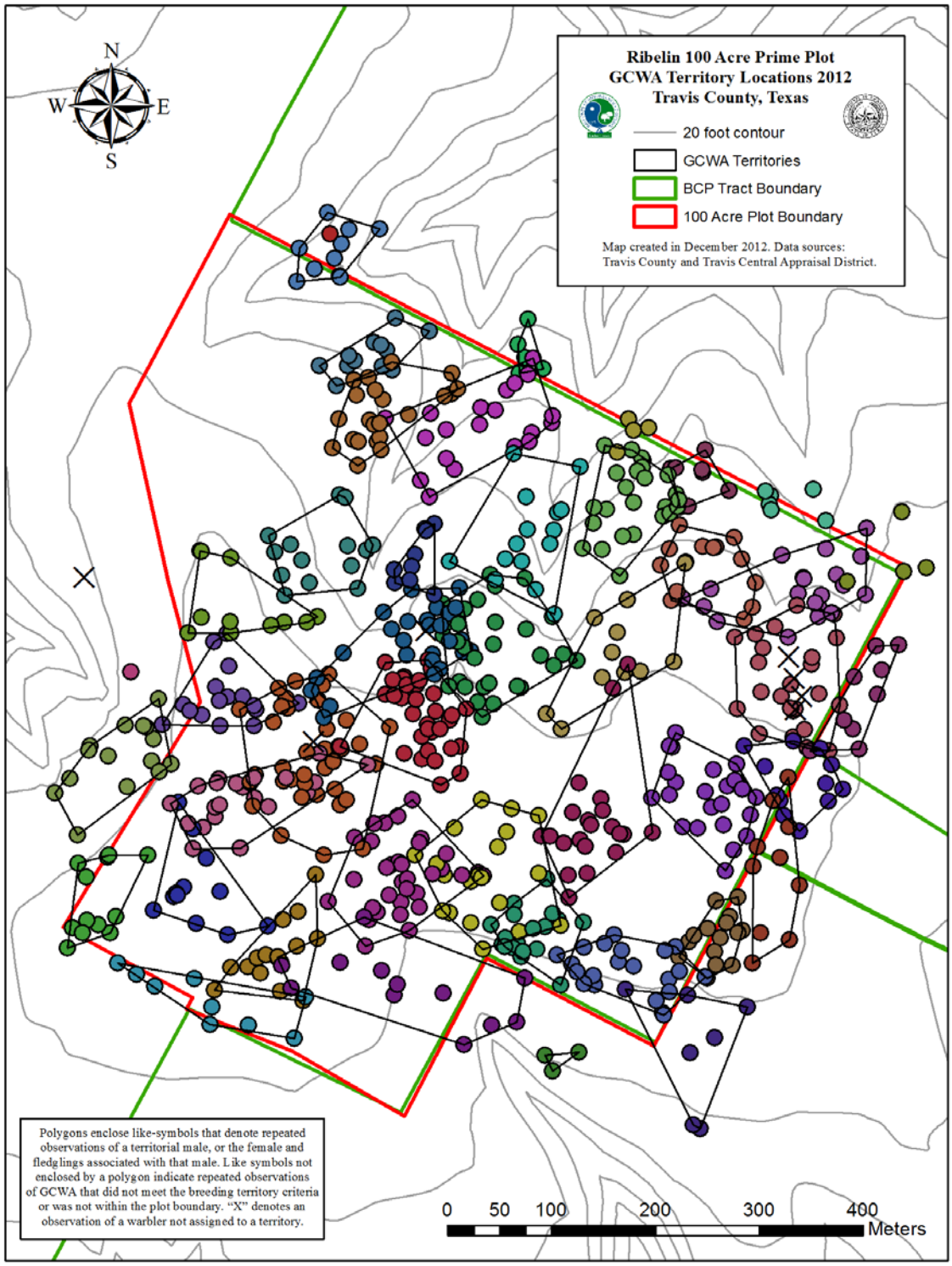

Figure 13. 2012 Golden-cheeked warbler observations and territory locations on the Ribelin prime 100-acre study plot.

Exhibit A. Past territory density (modified territories, Verner 1985) per 100 hectares of Golden-cheeked Warblers on the six Travis County prime 100-acre plots

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Bunten		45	52	56	65	64	58	52	56	61	85	**59.40**
Canyon Vista*							40	32	41	40	36	**37.80**
Hamilton Pool	16	19	20	17	22	21	20	28	21	17	12	**19.36**
Lake Perspectives*	28	25	26	24	33	35	33	27	16	19	17	**25.73**
Ribelin					50	57	51	46	62	56	73	**56.43**
Vista Point*								53	46	40	41	**45.00**
Average	**22.00**	**29.67**	**32.67**	**32.33**	**42.50**	**44.25**	**40.40**	**39.67**	**40.33**	**38.83**	**44.00**	**40.62**

Exhibit B. Past Productivity Data for Travis County prime habitat 100-acre Golden-cheeked warbler study plots.

Hamilton Pool	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	**Average**
Pair Success	0.8	0.83	0.86	1	0.38	1	0.71	0.63	0.86	0.83	0.75	**0.79**
Breeding Success	0.4	0.67	0.43	1	0.25	0.57	0.57	0.5	0.29	0.33	0.50	**0.50**
Estimated Brood Size	1.5	2	1.66	1.8	1.5	1.86	1.6	1.8	0.67	1.2	0.67	**1.48**
Productivity	0.6	1.33	0.71	1.8	0.38	1.86	1.14	1.13	0.57	1	0.50	**1.00**

Lake Perspectives*	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	**Average**
Pair Success	0.88	1	0.75	0.71	0.55	0.8	0.64	0.38	1	1	1	**0.79**
Breeding Success	0.75	0.86	0.5	0.71	0.18	0.7	0.36	0.13	0.75	0.6	0.6	**0.56**
Estimated Brood Size	1.83	2.16	2.25	2.2	0.33	1.88	1.43	0.66	1	3	1.8	**1.69**
Productivity	1.38	1.86	1.13	1.57	0.18	1.5	0.91	0.25	1	1.8	1.8	**1.22**

Bunten	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	**Average**
Pair Success	0.92	1	0.73	0.73	0.95	0.95	0.76	0.72	0.74	0.93	**0.84**
Breeding Success	0.75	0.8	0.67	0.68	0.89	0.58	0.24	0.39	0.63	0.74	**0.64**
Estimated Brood Size	1.89	2.5	2.8	1.75	1.55	1.33	0.85	1.31	2.5	2.68	**1.92**
Productivity	1.42	2	1.86	1.27	1.47	1.21	0.65	0.94	1.84	2.48	**1.51**

Ribelin	2006	2007	2008	2009	2010	2011	2012	**Average**
Pair Success	1	0.86	0.66	1	0.82	0.95	0.81	**0.87**
Breeding Success	0.93	0.86	0.6	0.92	0.41	0.84	0.76	**0.76**
Estimated Brood Size	2.14	2.33	1.8	1.83	1.5	1.72	2.47	**1.97**
Productivity	2.14	2	1.2	1.83	1.24	1.63	2.00	**1.72**

Canyon Vista*	2008	2009	2010	2011	2012	**Average**
Pair Success	0.57	0.8	0.77	0.7	1	**0.77**
Breeding Success	0.36	0.5	0.38	0.6	0.57	**0.48**
Estimated Brood Size	1	1.25	0.9	2.5	1.7	**1.47**
Productivity	0.57	1	0.69	1.5	1.3	**1.01**

Vista Point*	2009	2010	2011	2012	**Average**
Pair Success	0.88	0.87	0.93	1	**0.92**
Breeding Success	0.41	0.73	0.79	0.63	**0.64**
Estimated Brood Size	0.87	2	3.6	2.05	**2.13**
Productivity	0.77	1.73	2.86	2.05	**1.85**