FY 2010 Report on Monitoring of the Golden-cheeked Warbler (*Dendroica chrysoparia)* on Travis County's Balcones Canyonlands Preserve



Photo: Travis County Natural Resources 2010

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INTRODUCTION

In the United States and Canada, 448 native bird species breed in terrestrial habitats (Rich et al. 2004). About 200 of those species, commonly known as neotropical migrants, breed in North America and winter in Mexico, Central America, South America, and the Caribbean (Sibley 2001). A majority of neotropical migratory bird species face population declines due to a wide array of threats including habitat loss, degradation, and fragmentation (Rich et al. 2004). Partners in Flight, the U.S. Fish and Wildlife Service (USFWS), and many other cooperating agencies are actively developing recovery and conservation plans, acquiring critical habitat, and educating the general public about bird conservation issues in order to slow or prevent further population declines.

In 1990, the USFWS listed the golden-cheeked warbler (*Dendroica chrysoparia,* hereafter GCWA), a neotropical migrant, 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 only in central Texas where suitable oak-juniper (*Quercus spp.-Juniperus ashei*) woodlands and forest are present (Ladd and Gass 1999, Pulich 1976). During the last two decades in Travis County, development has expanded westward from the city of Austin at a rapid pace, accelerating the loss and fragmentation of GCWA breeding habitat. In 1996, the Balcones Canyonlands Conservation Plan (a Habitat Conservation Plan) was approved by the USFWS. This 10(a)1(b) permit was issued and 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 and owned by various governmental and private entities, including Travis County. As of Fiscal Year 2010 (FY10), Travis County currently manages 5,931 acres within the BCP as well as an additional 819 acres at Steiner Ranch Preserve (Figure 1). Steiner Ranch Preserve is not yet included in the acreage requirement set by the USFWS.

Travis County has been monitoring GCWAs on the BCP and other county-managed properties annually since 1996. (Travis County Natural Resources 1996; 1997; 1998; 1999; 2000; 2001; 2002; 2003; 2004; 2005; 2006; 2007; 2008; 2009). In FY10, Travis County Natural Resources staff monitored GCWAs on 15 BCP tracts covering 1,792 acres (725

hectares) (Figure 2; Table 1). Territory mapping of entire preserve tracts was conducted on Cuevas (partial tract), Cuevas East, Gann, Greenshores, Hereford, Karnik, Origer, Richards, Romberg and Volente. On each tract, data were collected on the following bird population parameters: male abundance, species distribution, territory density, and territory location.

In addition to these surveys, territory and productivity data were collected on six permanent prime habitat 100-acre (40.4 ha) study plots on the Bunten, Canyon Vista, Hamilton Pool Preserve, Lake Perspectives, Ribelin, and Vista Point tracts (surveyed annually). Also, surveys were conducted on Steiner Ranch Preserve Tract #2, which has a permanent, transitional habitat 100-acre study plot within its boundaries (surveyed bi-annually). On these plots, data were collected on territory density and location, pairing success, breeding success, and productivity.

METHODS

STUDY SITES

The Jollyville Unit (1,909 ac/773 ha) is located in northwest Travis County in the Cypress Creek Macrosite (Balcones Canyonlands Preserve 2007) (Figure 1), and includes the tracts of **Bunten**, **Cuevas**, **Cuevas East**, and **Vista Point** (Figure 2). **Steiner Ranch Preserve** (819 ac/332 ha) is located off RM 620 (Figures 1 and 2) in the North Lake Austin Macrosite (Balcones Canyonlands Preserve 2007). Detailed physical descriptions of these units within the BCP can be found in the Jollyville Unit and Steiner Ranch Land Management Plans (Balcones Canyonlands Preserve 2007). The Lake Travis Unit of the Cypress Creek Macrosite encompasses **Lake Perspectives** and **Romberg** with a total acreage of 442 ac (171 ha).

Travis County acquired the 12-acre **Origer** tract in 2009. Located within the Bull Creek Macrosite, Origer is contiguous with the City of Austin's Jester BCP tract to the east and is bordered by the Jester neighborhood elsewhere (Figures 1 and 2). The terrain consists of canyon slopes and an intermittent stream that drains southeast to Bull Creek. The Brackett soil series occurs on the benches of the steep slopes interspersed with Rock outcrops (USDA 1974). Vegetation includes closed canopy juniper-oak woodlands on the canyon slopes and riparian vegetation along the creek, including black walnut (*Juglans nigra*), oaks (*Quercus* spp.), and elms (*Ulmus* spp.). A power line corridor runs along the boundary between Origer and the City of Austin's Jester BCP tract.

The **Greenshores** (52 ac/21 ha), tract is located in the North Lake Austin Macrosite and management unit (Figures 1 and 2). Greenshores is located near the Oak Shores and Pearce

Roads off of City Park Road, south of RM 2222. Conner's creek and several side tributaries dissect Greenshores and drain southward toward Lake Austin, a reservoir on the Colorado River. It is comprised of gently sloping uplands dominated by mature oak-juniper woodlands, and it gives way to a steep, mesic canyon. The **Hereford** (10 ac/ 4 ha) tract is located in the North Lake Austin macrosite, directly off of City Park Road (Figures 1 and 2), and consists of sloped oak-juniper woodland.

The **Volente** tract, located within the Cypress Creek Macrosite adjacent to FM 2769 and Lime Creek Road, is the largest single BCP tract managed by Travis County totaling 827 ac (335 ha)(Figures 1 and 2). The tract was acquired in 2009 and is bordered by the LCRA's Wheless and Davenport tracts to the north and east, and by private lands to the south, east, and west. The Volente tract also surrounds a 297 ac (120 ha) parcel of undeveloped private land which is slated for residential development.

Due to the varying topography, a diverse set of vegetation types are found throughout this tract. The slopes of the canyons are comprised mostly of mature oak-juniper woodlands that give way to both re-growth of dense woodland and open woodland along the upland plateaus, both of which are dominated by young to mid-aged Ashe juniper. Many of the small ravines created by the canyons contain interspersed riparian vegetation dominated by American sycamore (*Platanus occidentalis*) and cedar elm (*Ulmus crassifolia*). Primary soil types include those from the Tarrant and Brackett series (USDA 1974). The Volente tract also demonstrates signs of human impact, such as several unimproved roads and man-made clearings, old dumps, and a large man-made stock tank located in the eastern portion of the tract. Recent human development includes a cellular transmission tower on the south-eastern part of the tract with a paved access road.

Acquired in 2009, the **Cuevas East** tract is 22 acres (8.9 ha) and is located within the Cypress Creek Macrosite (Figures 1 and 2). The tract is bordered on the east by RM 620 and on the south by Bullick Hollow Road (FM 2769). Topography consists of a relatively flat upland plateau, with one small ravine on the tract's southwestern portion. Vegetation includes mainly closed canopy oak-juniper woodlands interspersed with small clusters of shin oak (*Quercus sinuata* var. *breviloba*). Primary soils on this tract are found in the Tarrant and Tarrant and Speck series (USDA 1974). Several karst features also exist throughout this tract. Human impacts include the presence of two power line corridors, one completely bisecting the tract and the other running along its eastern boundary. Sections of undeveloped private land also border this tract, which may become future commercial development areas.

The **Gann** tract is a 16-acre property located at the eastern end of Fisher Hollow Trail within the Cypress Creek Macrosite (Figures 1 and 2). Gann is bordered by private land to the west and three other tracts of the BCP: the Bender tract (Travis County) to the north, the Wheless tract (LCRA) to the east and south, and the Baker Sanctuary (Travis Audubon Society) near the northeast corner. The Gann tract contains canyons, mesic slopes, and intermittent tributaries that flow into the Sandy Creek arm of Lake Travis. Volente Complex soils occur along the bottom of Fisher Hollow valley, 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 at Gann includes juniper-oak woodlands and riparian corridors, with mixed hardwoods including black cherry (*Prunus serotina*), elms, ash (*Fraxius* spp.), and hackberry (*Celtis* spp.). Before Travis County acquired Gann in 2009, it was privately owned. A single home site exists on this tract, along with several small household dumps, and an impoundment.

The **Ribelin** tract is located within the Bull Creek macrosite (Figures 1 and 2). This 319-acre tract is located off of RM 2222 and McNeil Drive. The tract is located adjacent to the City of Austin's Ivanhoe tract and the Upper Bull Creek Unit. The tract contains a short section of Bull Creek, and the topography includes upland plateaus that give way to irregular, steep slopes and ravines. Primary soils on this tract are found in the Tarrant series (Soil Conservation Service 1974). Closed canopy oak-juniper woodlands cover the majority of the canyons and slopes. Humans have heavily impacted the lands comprising the Ribelin tract. There are several ranch roads, a substantial power line corridor (which makes up the south boundary of the property line), man-made clearings, old dumps, and fences found throughout the tract. In recent history, the land was utilized for livestock ranching.

The **Karnik** and **Richards** tracts, together totaling 47 ac (9 ha), are located along Spicewood Springs Road within the Bull Creek Macrosite (Figures 1 and 2). These adjacent tracts are bordered by private land to the north, south, and west, and Bull Creek to the east. Topography consists of a main central upland plateau with evidence of recent clearing surrounded by closed canopy oak-juniper woodlands on the canyon slopes. A run-off creek flows along the northern border, creating a rich riparian area with diverse vegetation dominated by black walnut and American sycamore. A small seasonal pool with cattails (*Typha spp*.) is also present on the Karnik tract. Primary soils on these tracts are from the Tarrant series (USDA 1974). Human impacts consist of a large power line corridor and several unimproved roads, including one that provides access to an adjacent cellular tower site.

The **Canyon Vista** tract is 237 acres with 236 acres owned by Travis County and a 1-acre conservation easement that provides legal road access. The tract is located off of Spicewood Springs Road (Figures 1 and 2). Topography includes upland plateaus that give way to irregular, steep slopes and ravines. Vegetation ranges from open juniper-brakes on uplands and shallow slopes to closed canopy oak-juniper woodlands on steeper, mesic slopes. Brackett series soils predominate on rolling uplands and gentle slopes and Tarrant series soils occur on steep slopes and in canyons (USDA 1974). Humans have heavily impacted the lands by constructing several ranch roads, recreational trails, and man-made clearings. Old dumps and fences are found intermittently throughout the tract. Dense residential areas border the preserve, and larger tracts of privately-owned land are found along the southern boundary.

Hamilton Pool Preserve (232 ac/94 ha) is located in far southwestern Travis County near the Hays County boundary in the Pedernales Macrosite off of RM 3238 (Hamilton Pool Road) (Figures 1 and 2). River and creek terrain support mixed, evergreen-deciduous woodland dominated by Ashe juniper, Texas oak (*Quercus buckleyi*), and cedar elm (Carr 1996), which provides habitat for the Golden-cheeked Warbler. A detailed description can be found in the Hamilton Pool Preserve Land Management Plan (Balcones Canyonlands Preserve 2007).

TRACT TERRITORY MAPPING

Data Collection

Territory mapping of GCWAs was conducted from March 15 to June 14, 2010, on the following Travis County preserve tracts: Cuevas, Cuevas East, Gann, Greenshores, Hereford, Karnik, Origer, Richards, and Volente (Figure 2). Territory mapping was used to estimate territory density and male abundance, as well as species distribution and territory location for each tract. All observations (both visual and auditory) of male, female, and juvenile warblers were plotted on hard-copy digital orthophoto maps with a resolution of 2' (scale 1:5,000 or less). For each observation, the following demographic data were recorded: sex, age, presence of a mate, and number of fledglings observed. Song type and counter singing were also noted. Avian locations and demographic data were later recorded in an ArcGIS 9.2 (ESRI, Inc., Redlands, California) database using the NAD 1983 Texas State Plane Coordinate System.

All potential warbler habitat at each site was surveyed repeatedly throughout the breeding season. Total survey hours varied according to tract size, terrain, population density of warblers, and number of surveyors (Table 1). Due to limitations inherent to territory

mapping methods including 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).

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. Also, Bibbey's consecutive flush method (1992) was modified to allow no more than five sequential movements attempted at one time in order to minimize influencing bird behavior.

Observations of warblers that could not be differentiated from surrounding individuals with any confidence were designated as "unknown." Playback tapes of warbler vocalizations were not used to elicit warbler responses. Systematic nest searching was not conducted during this field season. However, incidental observations of any warbler nests were noted and mapped on hard-copy digital orthophoto maps. All observations of brown-headed cowbirds (*Molothrus ater*) and any signs of nest parasitism were also noted.

Data analysis

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 comprises 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, i.e. 1.00), 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 PLOT

Data collection

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 2010, territory mapping was conducted on six 100-acre permanent plots on the following tracts: Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives, Ribelin, and Vista Point. All of the aforementioned tracts are classified as "prime" sites, which means that more than 75% of each plot contains excellent warbler habitat (Balcones Canyonlands Preserve 2007). The 100-acre plot methodology was also used on a plot established on tract #2 of the Steiner Ranch Preserve. On this tract, the warbler habitat is considered "transitional"; in other words, the habitat supports none or very few warbler territories and has the potential to become prime warbler habitat in the next 30 years (Balcones Canyonlands Preserve 2007).

The 100-acre plots were surveyed following the same procedure outlined in the Tract Territory Mapping section, with some exceptions. Territory mapping was conducted between March 23 and June 14, 2010, on both the prime and transitional plots. 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. Transitional 100-acre plots are surveyed a total of 18 hours over six 3-hour visits. Also, the transitional 100-acre plots are only surveyed on alternate years and not every year like the prime plots. No playback tapes were used to elicit warbler responses and systematic nest searching was not performed. However, incidental observations of any warbler nests were noted and mapped on the hard-copy digital orthophoto maps. Two different observers alternately monitored each 100-acre plot during the survey period. For further information, a general study protocol for 100-acre plots is outlined in the BCP Land Management Plan (Balcones Canyonlands Preserve 2007).

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.

Data analysis

Abundance, pair status, breeding status, and territory status for GCWAs on 100-acre plots were determined according to the same criteria as outlined in the previous section on territory mapping. Territory density is given in Table 2 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 within the 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

RESULTS AND DISCUSSION

Golden-cheeked Warbler surveys were conducted between March 15 and June 14, 2010 on a total of 1,792 acres. The total amount of time spent surveying was 603.6 hours (Table 1).

Table 1. List of Travis County Balcones Canyonlands Preserve (BCP) tracts surveyed for Golden-cheeked Warblers (*Dendroica chrysoparia*) during the 2010 field season. Also included are tract acreages, survey dates and total survey hours for each tract.

Tract	Acreage Surveyed	Survey Dates	Total Survey Hours
100-acre prime plots			
Bunten	100	3/31-6/14/2010	60
Canyon Vista	100	3/26-6/3/2010	60
Hamilton Pool	100	3/25-6/10/2010	60
Lake Perspectives	100	3/23-5/25/2010	60
Ribelin	100	3/31-6/7/2010	60
Vista Point	100	3/23-5/25/2010	60
Total	**600**		**360**
100-acre transitional plot			
Steiner #2	100	4/9-6/3/2010	18
Total	**100**		**18**
Territory Mapping			
Cuevas-Cuevas East	88.1	3/26-6/14/2010	19.75
Gann	16	3/18-5/17/2010	9.50
Greenshores	52.3	3/22-6/14/2010	25.10
Hereford	10	3/29-4/26/2010	6.25
Karnik-Richards	46.38	3/23-6/15/2010	22.00
Origer	12.3	3/22-4/26/2010	9.92
Romberg	40	3/29-6/4/2010	10.25
Volente	827	3/15-6/10/2010	122.83
Total	**1092.08**		**225.60**
Overall Total	**1792.08**	**3/15-6/14/2010**	**603.60**

TRACT TERRITORY MAPPING

Overall, 1,092 acres were surveyed for GCWA territories during the 2010 field season (Table 1). The total abundance of GCWA males on all tracts surveyed (not including 100-acre study plots) was 126. Abundance was greatest on Volente (64), and lowest on Romberg (2) (Table 2). The Volente tract also had the greatest number of modified territories (42.5), but the survey area on the Cuevas and Cuevas East tracts had the greatest territory density (0.43 modified territories/ ha). Romberg had the lowest territory density (0.07 modified territories / ha).

Table 2. Results of the Golden-cheeked Warbler (*Dendroica chrysoparia*) territory mapping on Travis County-managed Balcones Canyonlands Preserve tracts surveyed during the 2010 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	Abundance	No. of full territories	Total territories (full +edge)	Modified number of territories (MT)[a]	Territory density (Total / ha)	Territory Density (MT / ha)[b]
Cuevas, Cuevas East	20	13	18	15.5	0.50	0.43
Gann	5	0	2	1.0	0.28	0.14
Greenshores	12	5	8	6.5	0.38	0.31
Hereford	3	0	2	1.0	0.55	0.27
Karnik, Richards	16	3	12	7.5	0.65	0.40
Romberg	2	0	2	1.0	0.13	0.07
Origer	4	0	3	1.5	0.60	0.30
Volente	64	34	51	42.5	0.15	0.13
Average					**0.41**	**0.26**

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

Figures 3 through 10 illustrate territory distribution and abundance for each of the tracts surveyed for GCWA in 2010. Territorial male observations indicate only the general location of a territory relative to other territories and to tract features and are not meant to represent actual territorial boundaries or territory sizes.

100-ACRE PRIME PLOTS

Territory Density

In the 2010 field season on the 100-acre prime plots, an average of 16.25 'modified' territories (Verner 1985) were established per 100 acres or an average of 40 modified territories per 100 hectares (Table 3).

Based on Verner's (1985) method for calculating territory number, territory density was highest at Ribelin with 62 territories per 100 hectares (one male per 1.6 ha). Bunten had the second highest territory density of 56 territories per 100 hectares or one male per 1.8 hectares. Lake Perspectives had the least number of territories overall (16 territories per 100 ha or one male per 6.25 ha) (Table 3).

Exhibit A includes comprehensive territory density data for all 100-acre plots surveyed by Travis County since the inception of the BCP.

Table 3. Results of the 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) territory mapping on Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives, Ribelin, and Vista Point prime habitat 100-acre study plots on the Travis County-managed Balcones Canyonlands Preserve. Results include abundance, number of territories (full, full and edge, and modified), and territory density.

100-acre Prime Study Plot	Abundance	No. of full territories	Total territories (full +edge)	Modified number of territories (MT)	Territory density (Total / ha)	Territory Density (MT / ha)
Bunten	36	18	27	22.5	0.67	0.56
Canyon Vista	30	13	20	16.5	0.49	0.41
Hamilton Pool	15	7	10	8.5	0.25	0.21
Lake Perspectives	11	4	9	6.5	0.22	0.16
Ribelin	40	17	33	25.0	0.82	0.62
Vista Point	33	15	22	18.5	0.54	0.46
Average	**27.50**	**12.33**	**20.17**	**16.25**	**0.50**	**0.40**

[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 16 illustrate territory distribution and abundance for each of the 100-acre prime study plots surveyed. Differences in territory density between prime plots may be attributed to site-specific characteristics, although other factors such as age structure of the local population, inter-specific competition, and conspecific attraction may also play a role. Although all prime study plots contain areas of excellent warbler habitat, there are differences between plots with regard to the proportion and spatial distribution of excellent and marginal habitat, as well as, the length of the perimeter along plot boundaries (see Campbell 1995 for descriptions of *excellent* and *marginal* warbler habitat). Ribelin and Bunten study plots are comprised almost exclusively of excellent warbler habitat. In contrast, the Lake Perspectives study plot contains several areas considered marginal warbler habitat. Perhaps more importantly, Vista Point, Bunten, and Ribelin study plots are situated entirely within a much larger block of continuous excellent warbler habitat, while Lake Perspectives is bounded by Bullick Hollow Road to the east and residential development to the south. The center of the plot is comprised mostly of grasslands with intermittent large hardwood trees. This habitat type is generally considered unsuitable for breeding GCWAs. Canyon Vista represents a tract that has moderately excellent habitat, but is almost completely surrounded by residential development. Studies have indicated that densities of forest-dwelling migrant songbirds tend to be higher on larger blocks of continuous habitat and this may be a function of decreasing edge effects (Biological Advisory Team 1990; Friesen et al. 1995; Wahl 1990).

The Hamilton Pool Preserve study plot usually has the lowest warbler territory density. However, during the 2010 field season it outranked Lake Perspectives (one male per 3.7 ha) slightly with a territory density of one male per 3.57 ha. At Hamilton Pool Preserve, only

half of the study plot contains excellent warbler habitat; the remaining percent is marginal to poor breeding habitat. In recent years, individual males have been establishing territories in the uplands more frequently, which may be an indication that the habitat is improving in that area over time. In 1996, Hamilton Pool Preserve was designated as a prime plot in the Balcones Canyonlands Preserve Land Management Plan (2007) and has been surveyed as such over the years. However, it does not fit the criteria for prime plots (i.e., >75% of the plot must contain excellent warbler habitat) as outlined in the Land Management Plan. Because the Hamilton Pool Preserve study plot is officially designated as a prime plot, it will continue to be surveyed and analyzed as prime for the sake of consistency. Staff is optimistic that over time the upland habitat at Hamilton Pool will continue to improve and provide additional data to support this perception.

Pairing Success, Breeding Success, and Productivity

Across all six 100-acre prime plots, the average pairing success was 84% (Table 4). The highest proportion of successful pairs (100%) occurred at Lake Perspectives with one female or at least one observed fledgling for every full territory.

Breeding success on the 100-acre study plots ranged from 0.29 to 0.75 with an average of 49% of pairs successfully raising a brood. Each successfully paired territory averaged 1.23 fledglings (range: 0.67 to 2), and each full territory averaged 1.03 fledglings (range: 0.57 to 1.73) (Table 4). A total of 109 fledglings were observed in 48 broods across all six 100-acre study plots.

Exhibit B includes comprehensive productivity data for all 100-acre study plots surveyed by Travis County since the inception of the BCP.

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, Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives, Ribelin, and Vista Point. Data collected during the 2009 field season on the Balcones Canyonlands Preserve in western Travis County, Texas. See methods section for a description of calculations.

100-acre Prime Study Plot	No. of full territories	No. of territories w/ female	No. of territories producing ≥ 1	Pairing Success	Breeding Success	Productivity per successful pair	Productivity per full territory
Bunten	18	13	7	0.72	0.39	1.31	0.94
Canyon Vista	13	10	5	0.77	0.38	0.90	0.69
Hamilton Pool	7	6	2	0.86	0.29	0.67	0.57
Lake Perspectives	4	4	3	1.00	0.75	1.00	1.00
Ribelin	17	14	7	0.82	0.41	1.50	1.24
Vista Point	15	13	11	0.87	0.73	2.00	1.73
Average				**0.84**	**0.49**	**1.23**	**1.03**

100-ACRE TRANSITIONAL PLOT

A 100-acre 'transitional habitat' study plot on the tract #2 of the Steiner Ranch Preserve was surveyed between April 9 and June 3, 2010, for a total of 18 survey hours. The plot was determined to hold one edge territory, which was not documented to have successfully paired.

COLOR BANDING

Color banding of adult GCWAs was conducted, in conjunction with City of Austin BCP field staff on the Ribelin tract in 2010. A total of seven males were marked (see Exhibit C for details).

ADDITIONAL OBSERVATIONS

The first GCWA was detected on Travis County BCP property on 15 March 2010 on the King tract located within the Cypress Creek macrosite.

Two nests were discovered on the Volente tract in FY10; one was situated in an Ashe juniper, the other nest was in a Texas oak. Fledglings were not documented from territories associated with either nest. A GCWA nest was also discovered on the Hamilton Pool 100-

acre plot. The nest was situated approximately 20m high in a Bald cypress (*Taxodium distichum*). Interestingly, the nest site was approximately at the same height and less than 10m from a nest being constructed by a Cooper's hawk (*Accipter cooperii*). The female GCWA was observed behaving extremely nervous or agitated, but nevertheless entered and sat on the nest. Fledglings were not documented for this GCWA nest.

On March 31, 2010 while performing a 100-acre GCWA survey plot on the Ribelin tract, field staff recovered the carcass of a color-banded GCWA. This warbler, (band combo OR/SI:OR/RD) had been banded five days earlier in the same general location by City of Austin staff. The deceased GCWA had been detected and observed alive between 0800 hours and 0900 hours at the beginning of the survey. After some investigation, it was determined that this individual was under some duress, possibly weakened from an unknown injury or malnourishment. It was first observed in a clump of low-growing Ashe juniper trees between three other territorial males. At least one of these males was observed flying into the area where the individual was seeking refuge, and staff observed this bird attacking the color-banded bird. At the end of the survey the area was searched again to determine the fate of the color-banded bird. This warbler could not be found where it had been observed earlier; however a nearby male GCWA was detected singing nearby. This male was followed and was found to be attacking the remains of the color-banded GCWA on the ground. After photo-documenting the event, the carcass was collected and returned to the Travis County BCP Field Office. City of Austin staff and USFWS were notified and the remains were eventually transferred to the National Wildlife Health Center (USGS) for necropsy (Exhibit D). In Exhibit D, Bird 001 is the bird collected from the Ribelin tract by Travis County staff. Bird 002 was collected by City of Austin staff on a City-managed BCP tract.

RECOMMENDATIONS

- It is recommended that GCWA habitat enhancement be performed in areas with a high density of juniper saplings to encourage hardwood regeneration by selectively removing juniper saplings.

- It is recommended that GCWA monitoring be continued on Travis County BCP tracts with ongoing Black-capped Vireo habitat restoration, to evaluate the response of warblers to vireo management activities.

- It is recommended that any GCWA nests that are discovered during surveys should undergo nest substrate/vegetation surveys to collect important data about nest selection sites versus habitat availability. Vegetation surveys should be conducted after the breeding season is completed to avoid negatively impacting breeding or nestling success.

- It is recommended, to the degree practicable, GCWA color banding on BCP tracts should be continued in order to collect site-specific data on survival, reproduction, recruitment, and dispersal.

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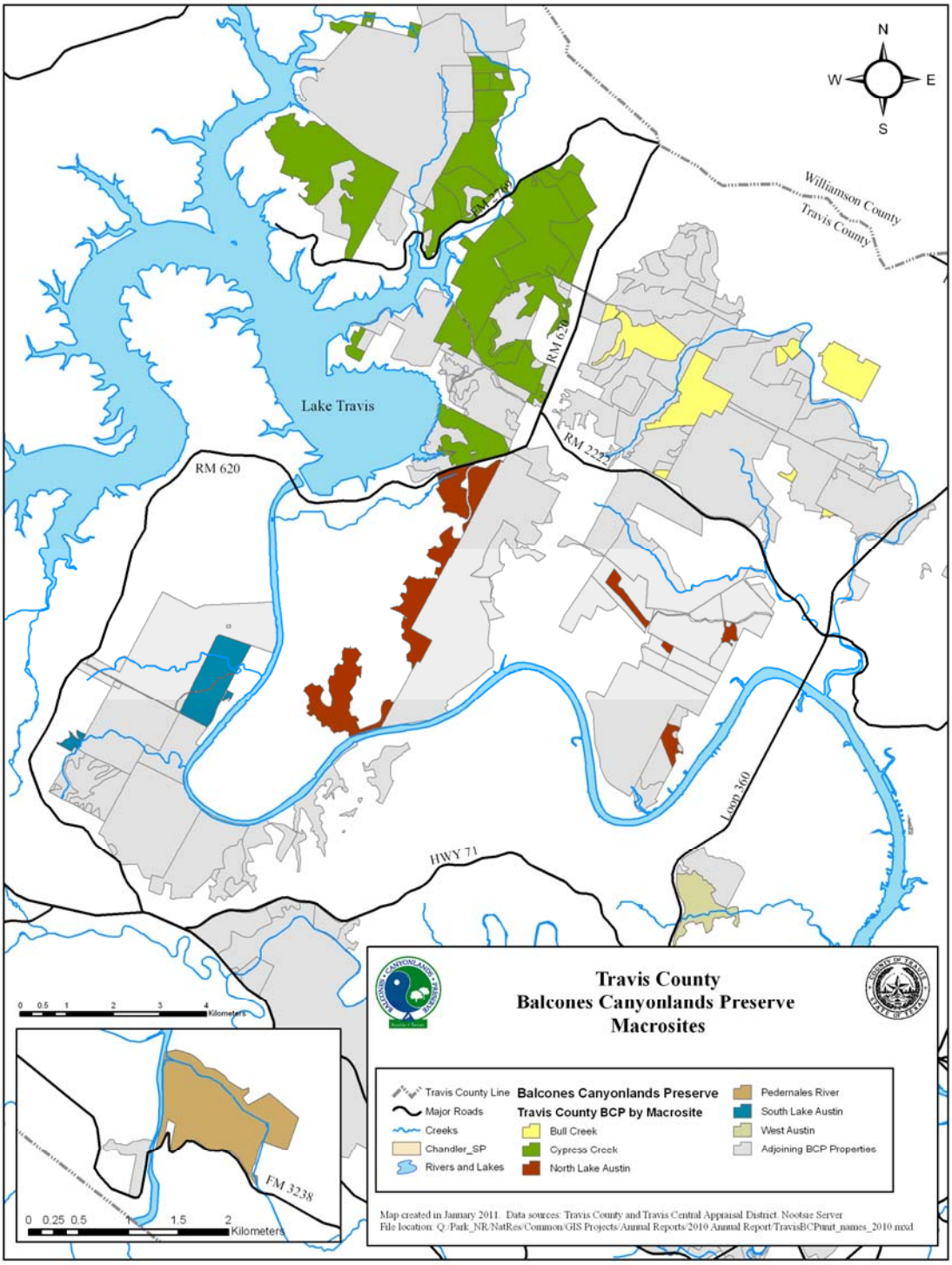

Figure 1. Location of Travis County Balcones Canyonlands Preserve properties by macrosite throughout western Travis County, Texas.

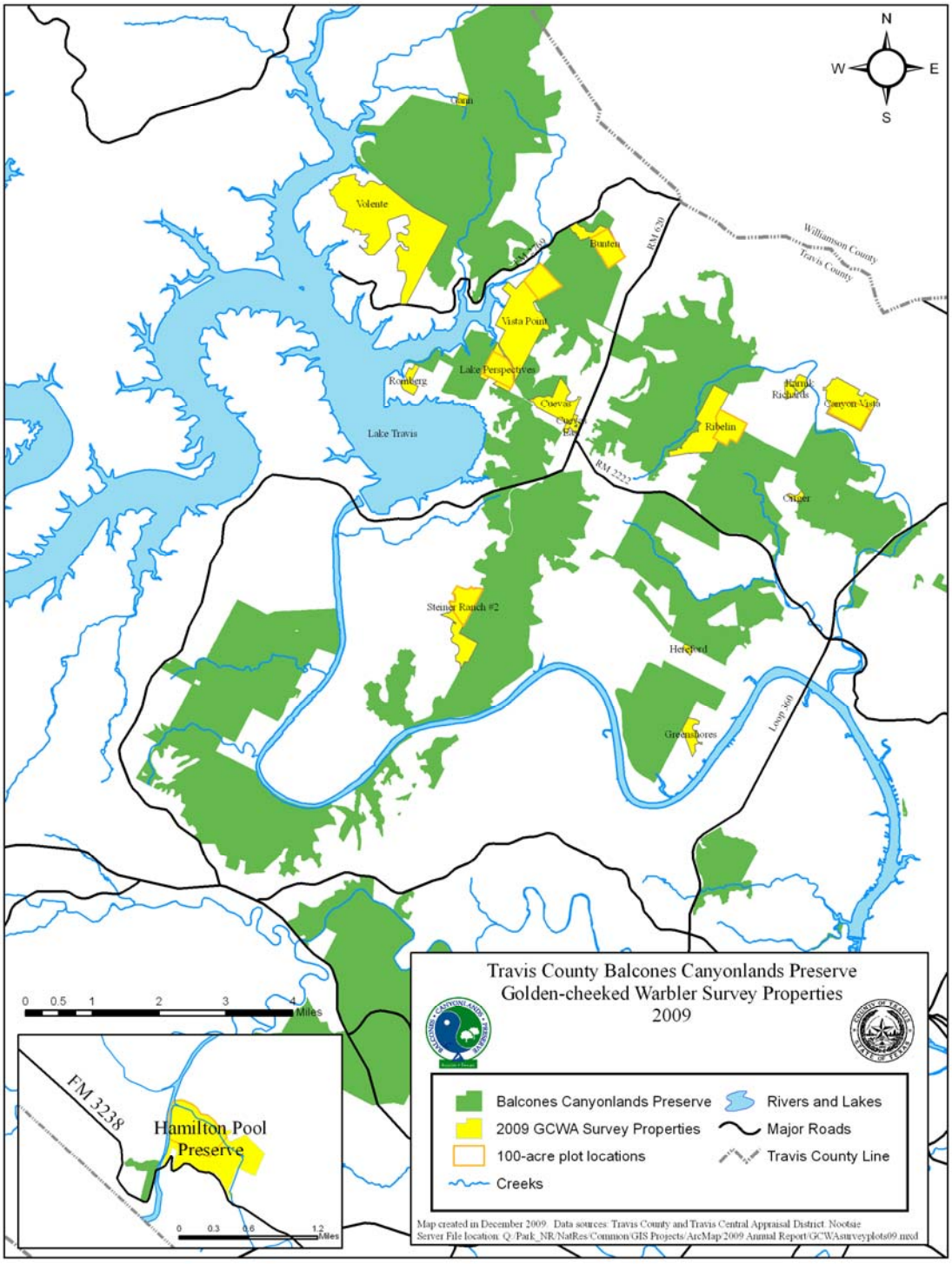

Figure 2. Location of Travis County-managed Balcones Canyonlands Preserve tracts surveyed for Golden-cheeked Warblers (*Dendroica chrysoparia*) in 2010.

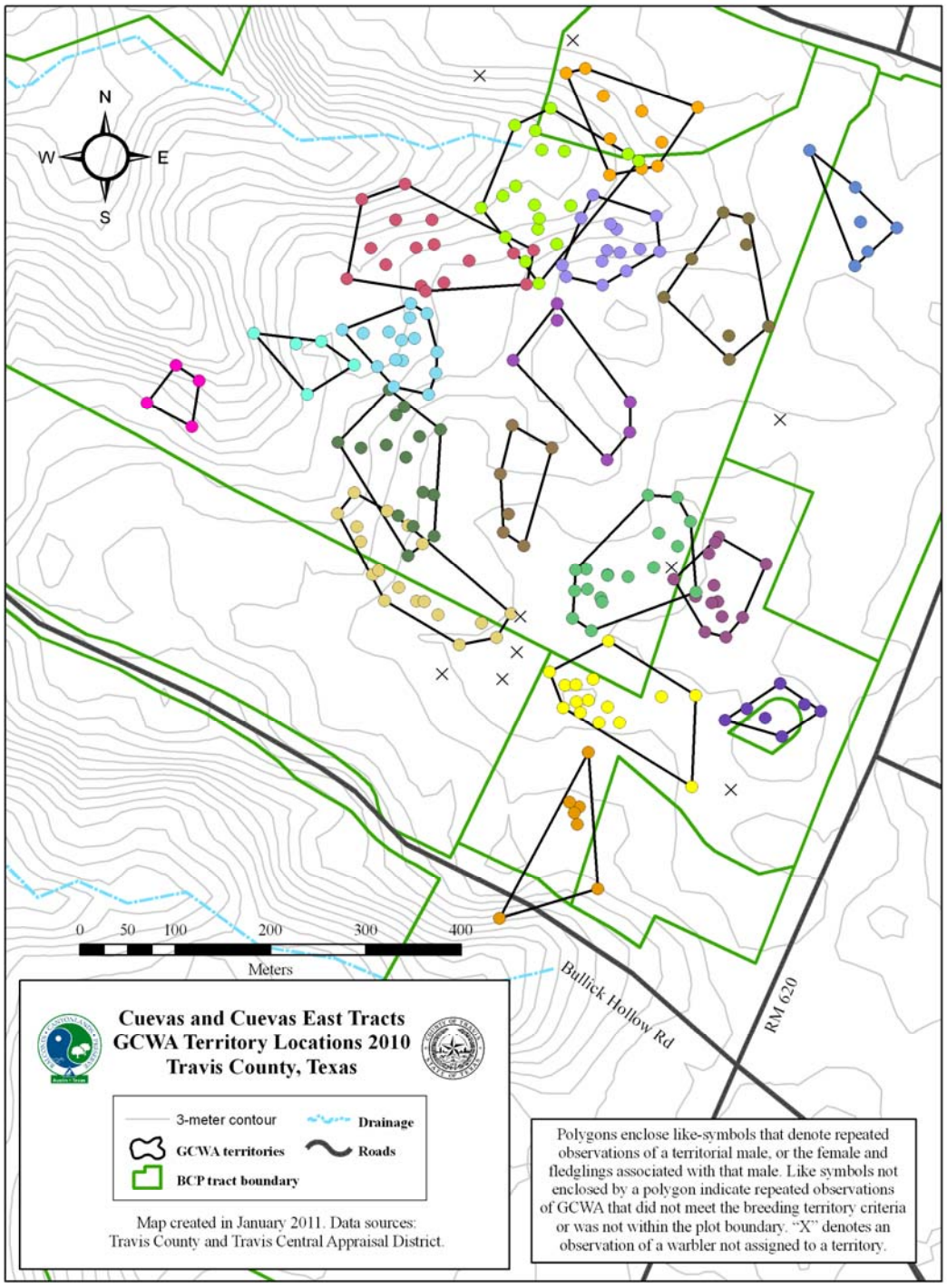

Figure 3. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Cuevas and Cuevas East tracts within the Balcones Canyonlands Preserve in western Travis County, Texas.

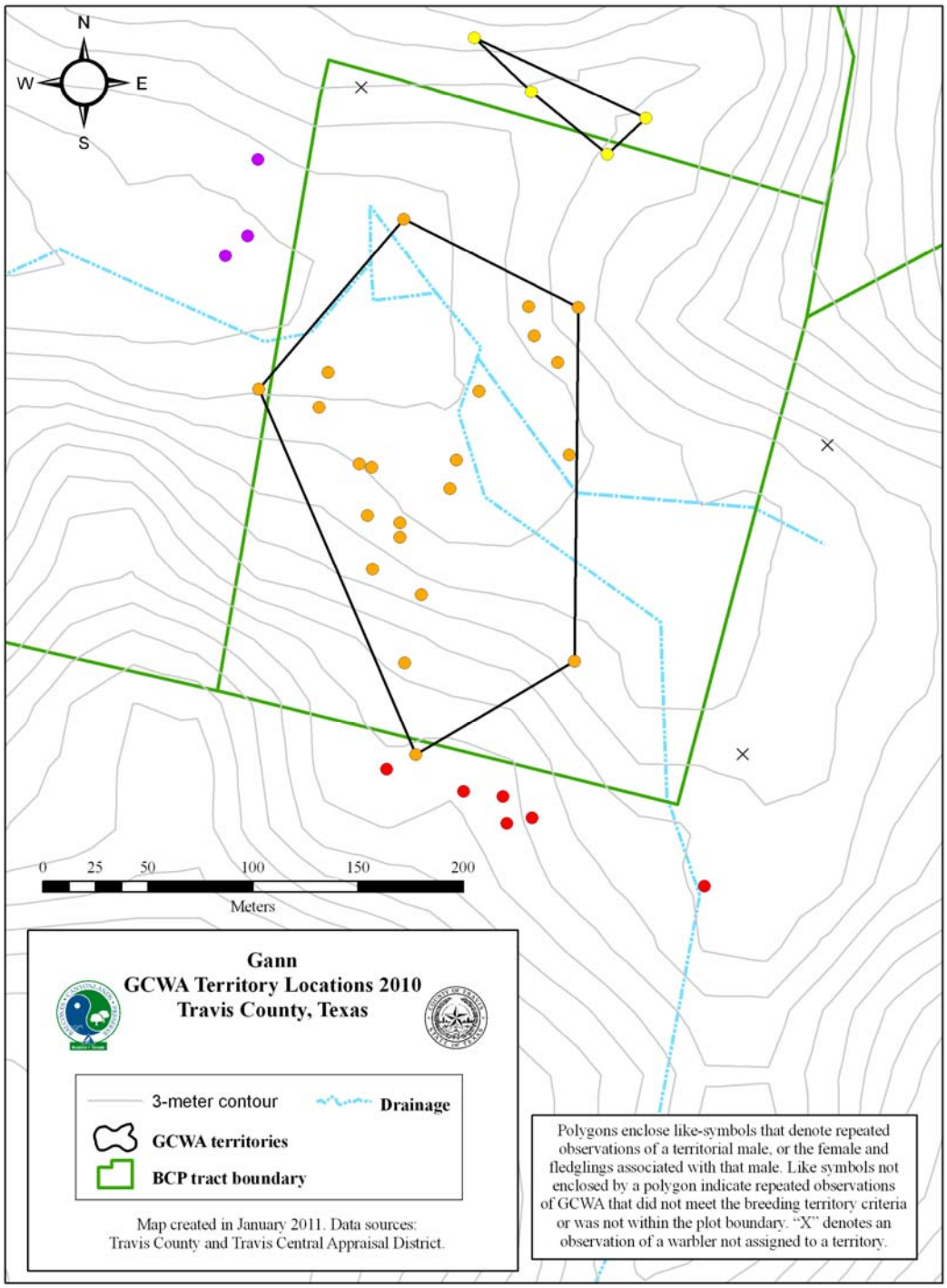

Figure 4. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Gann tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

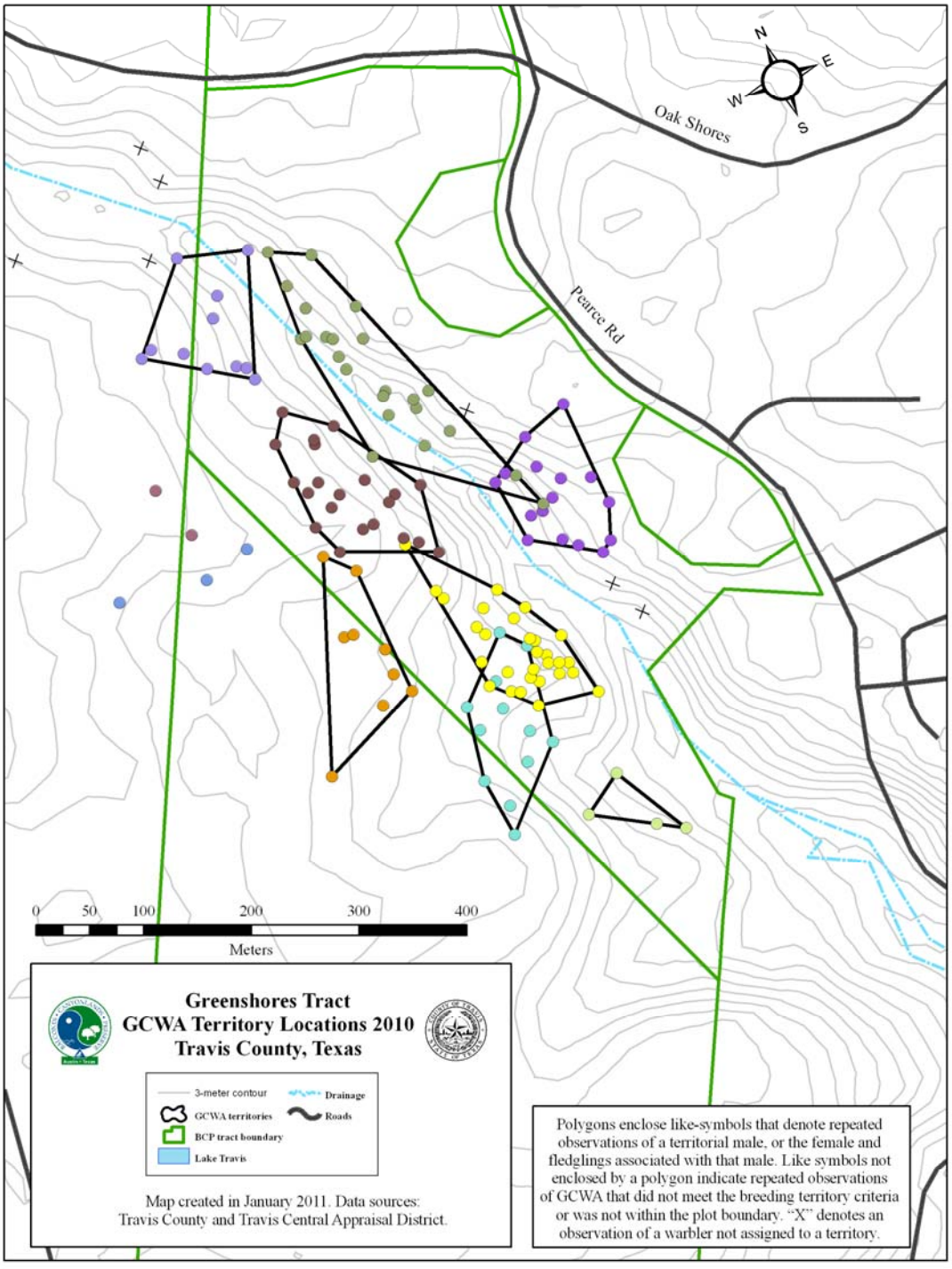

Figure 5. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Greenshores tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

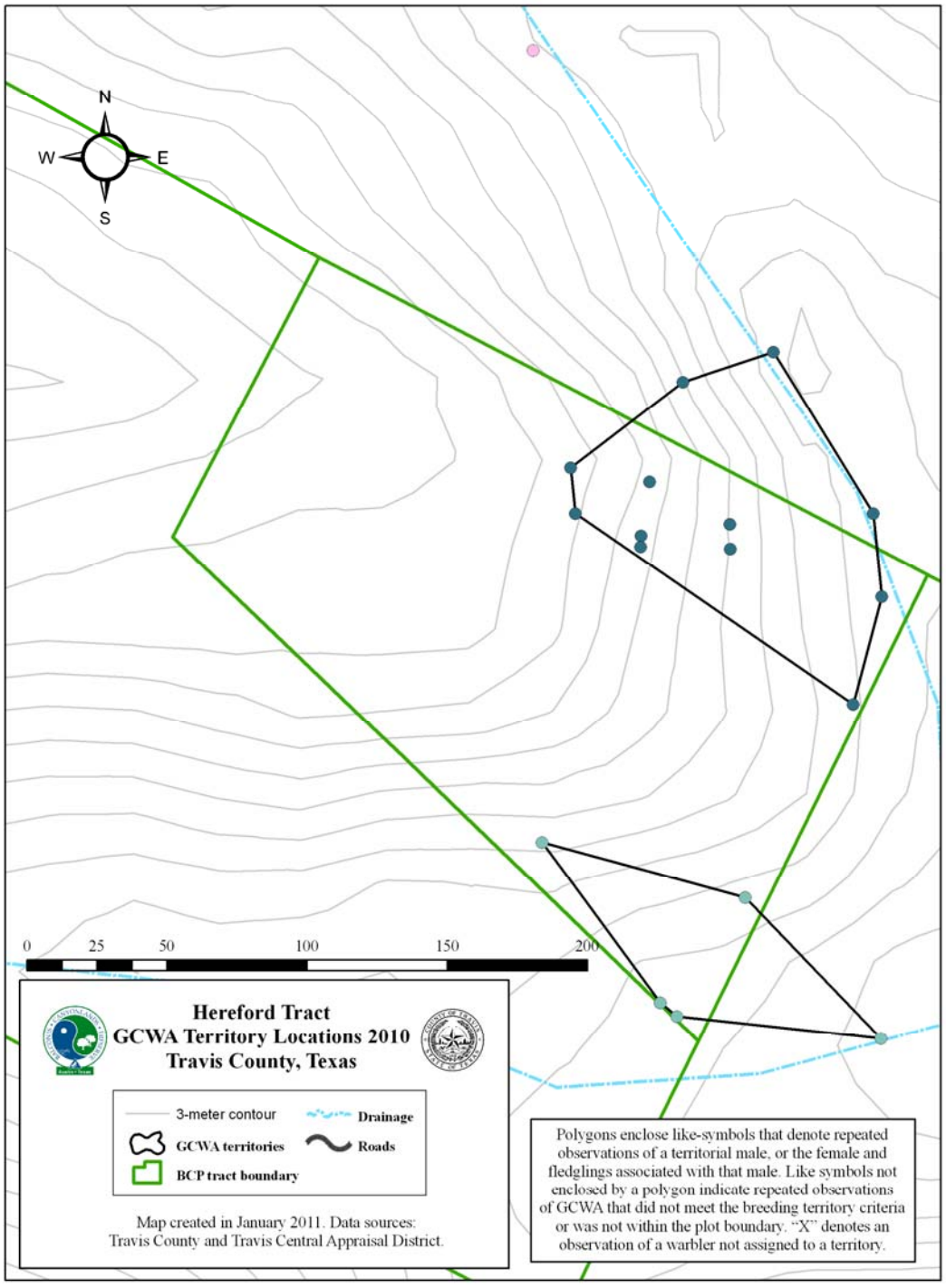

Figure 6. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Hereford tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

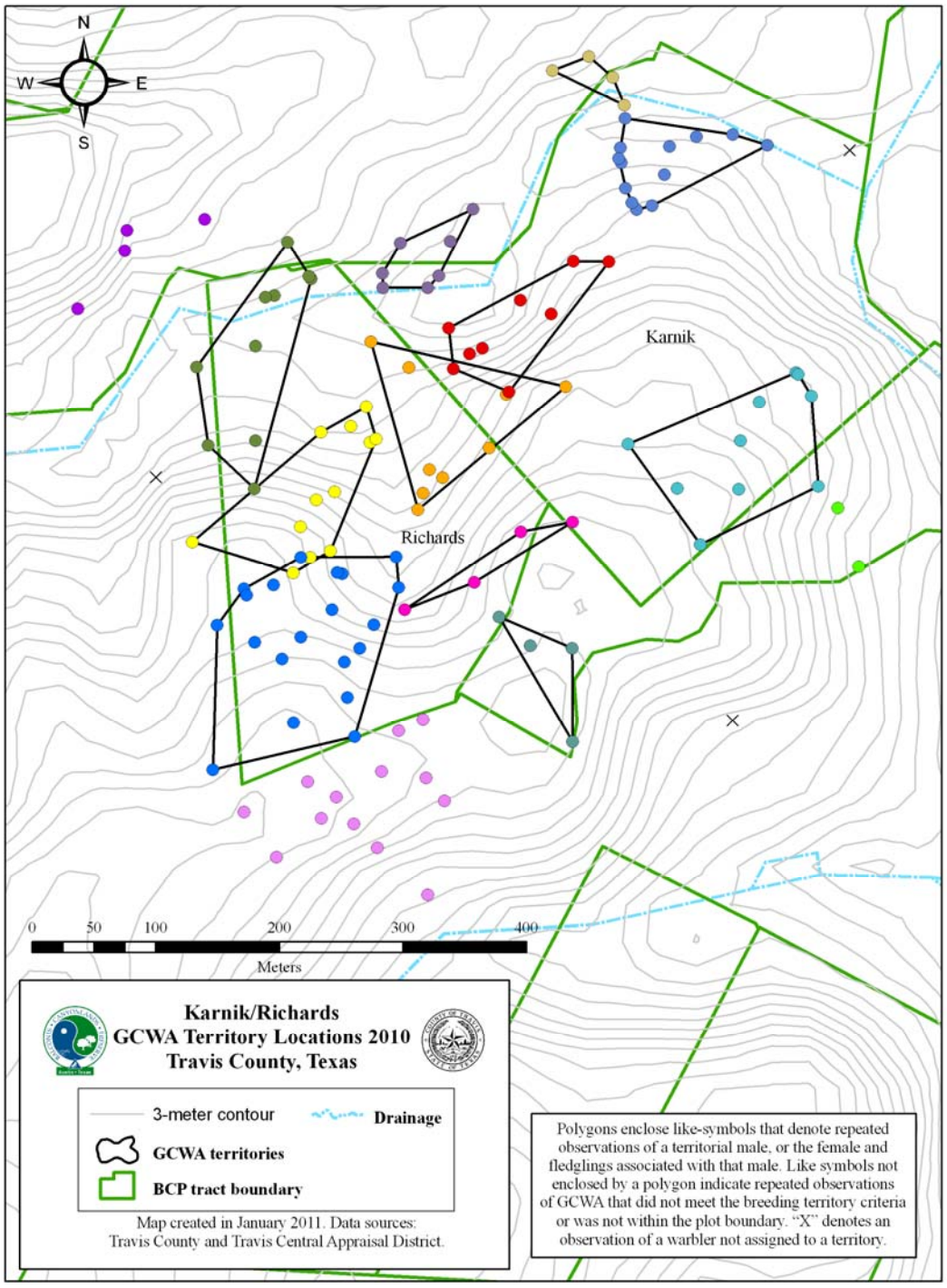

Figure 7. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Karnik and Richards tracts within the Balcones Canyonlands Preserve in western Travis County, Texas.

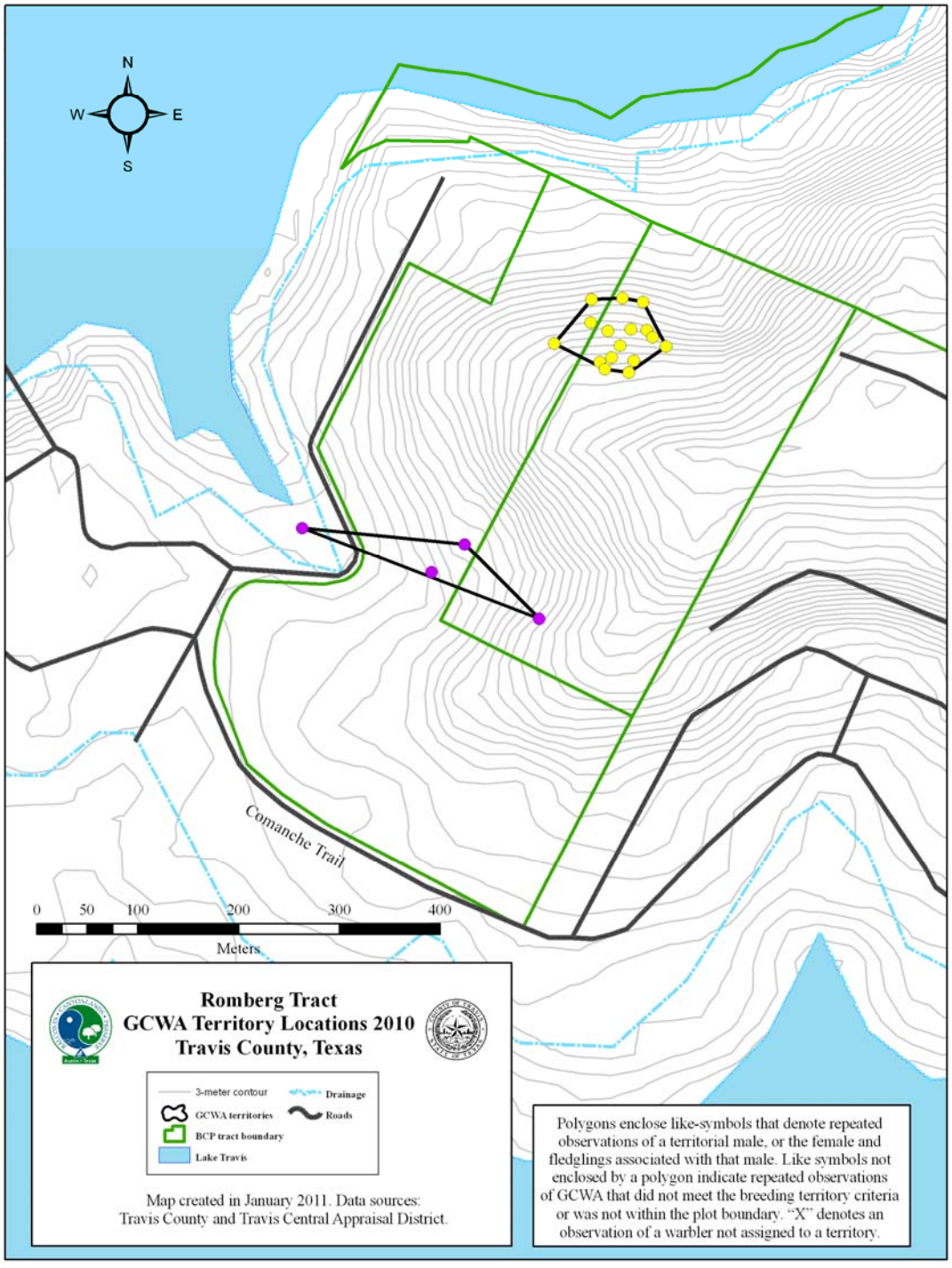

Figure 8. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Romberg tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

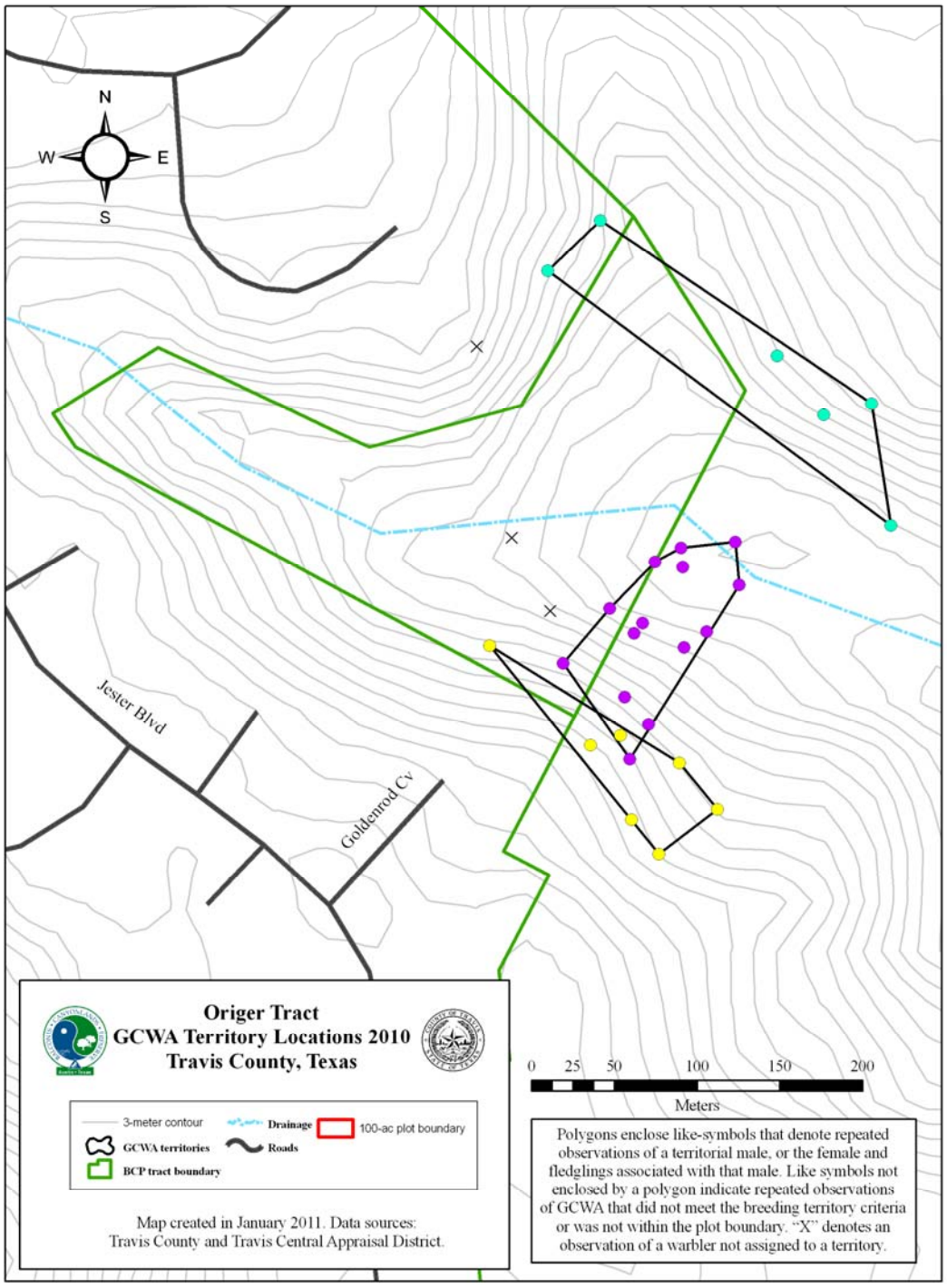

Figure 9. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Origer tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

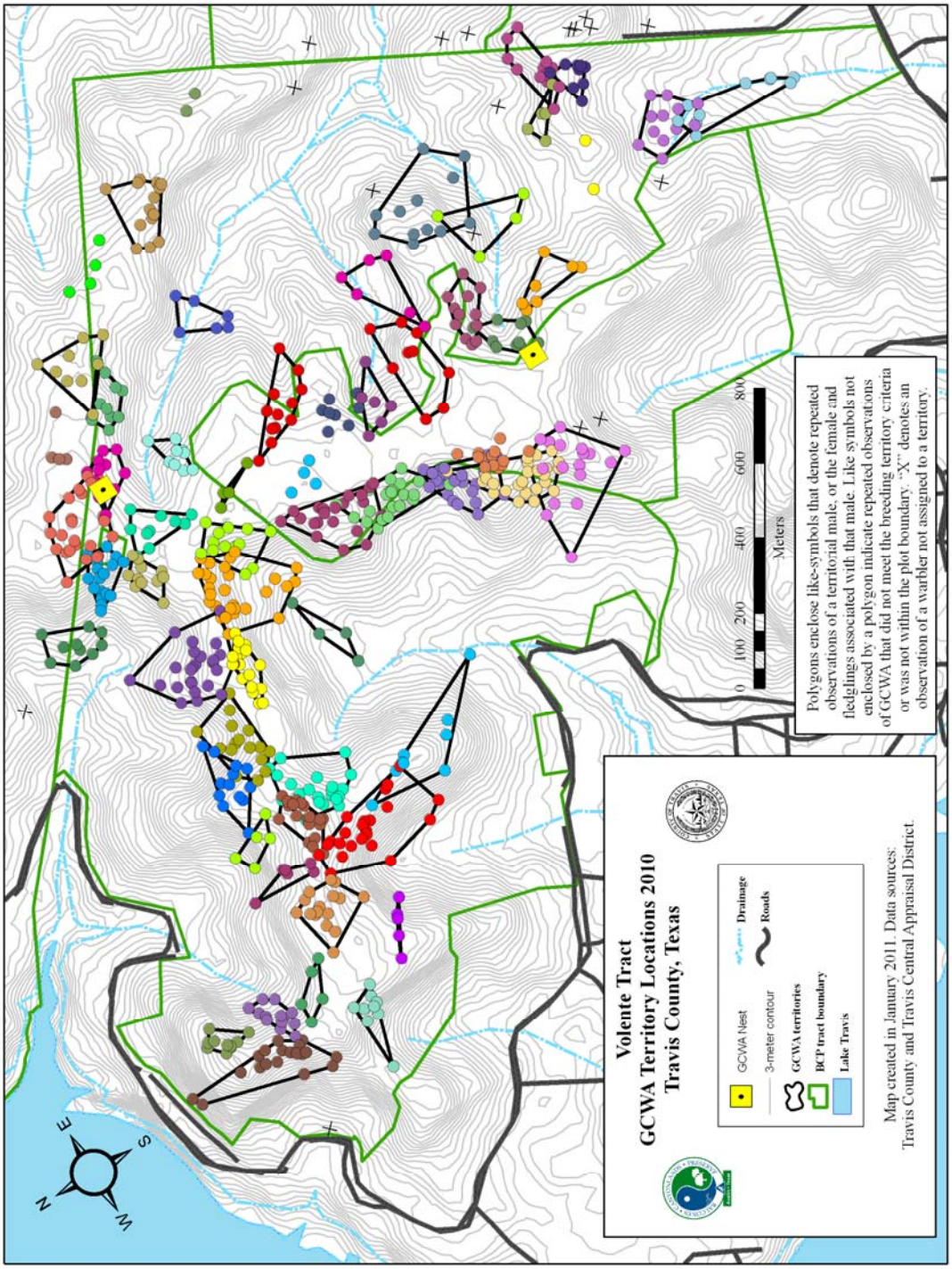

Figure 10. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Volente tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

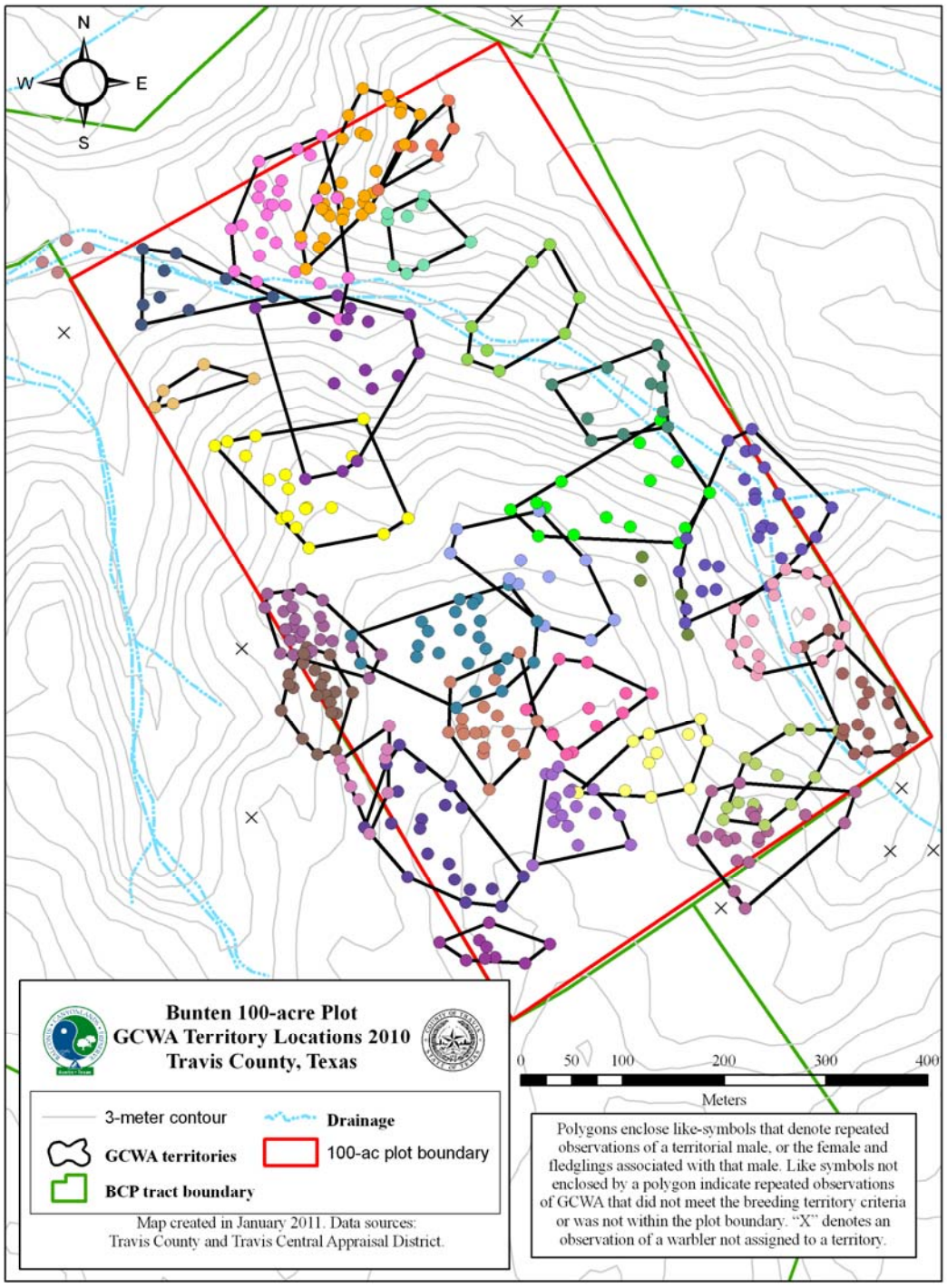

Figure 11. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Bunten prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.



Figure 12. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Canyon Vista prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

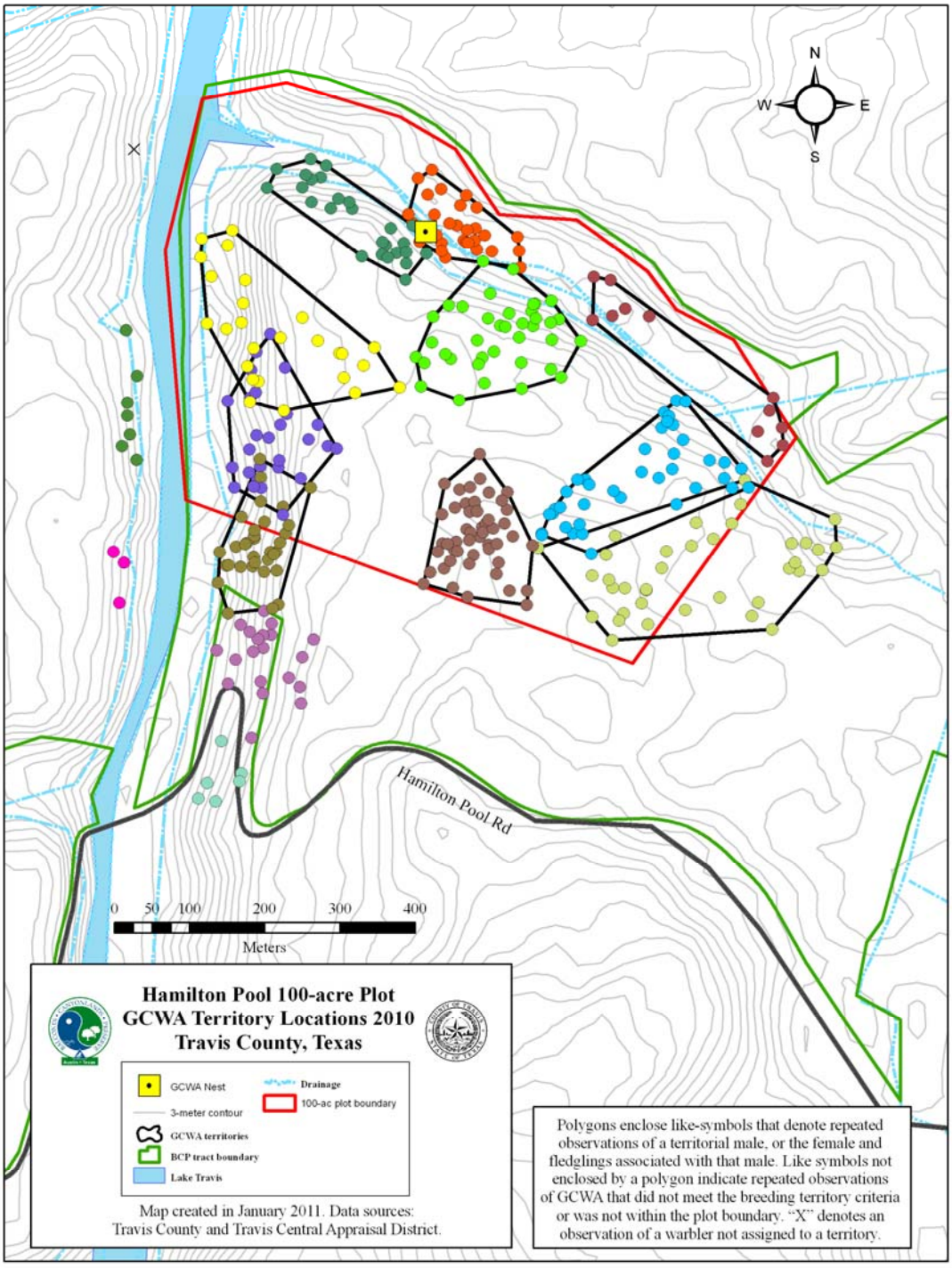

Figure 13. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Hamilton Pool Preserve prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

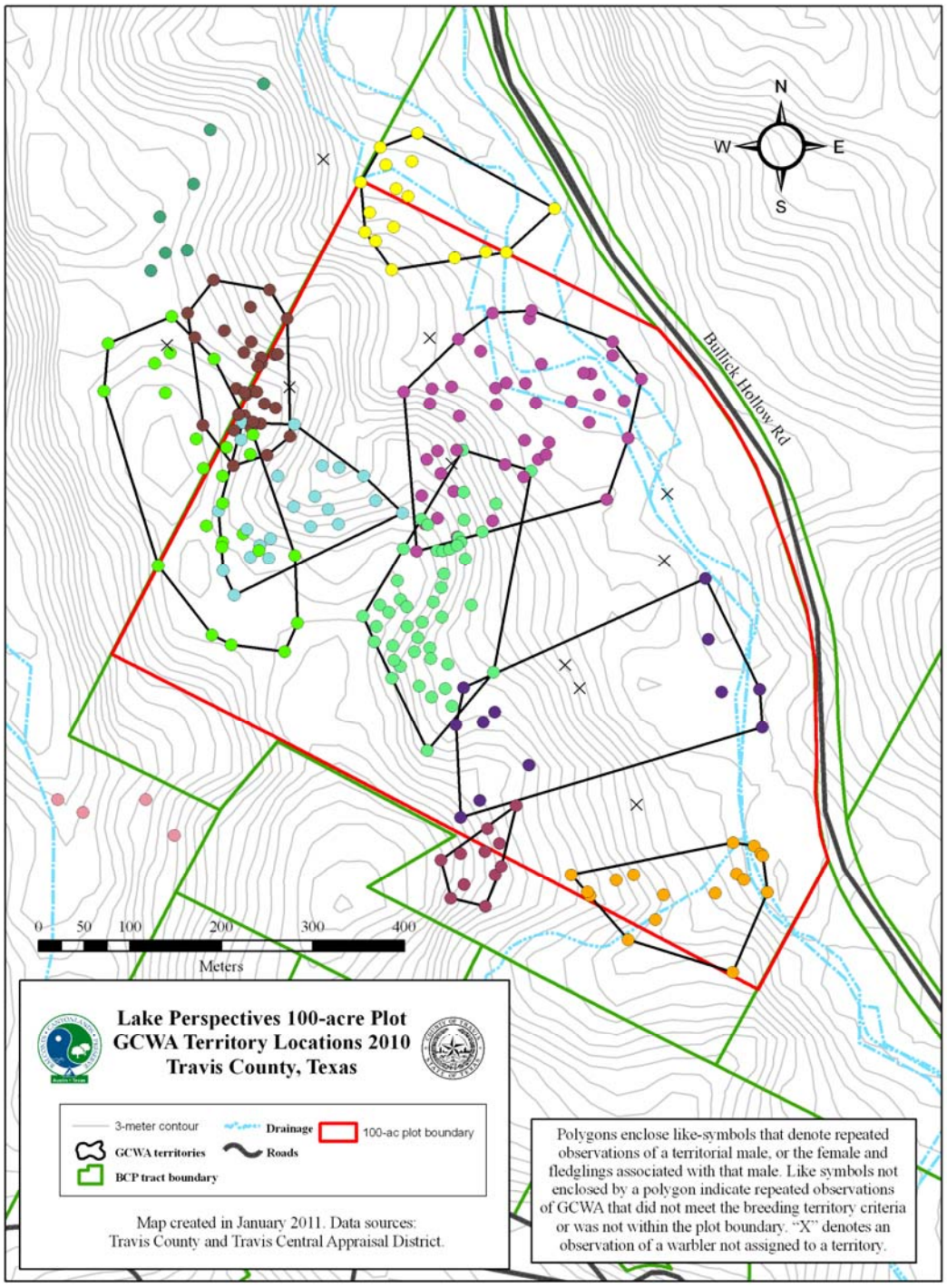

Figure 14. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Lake Perspectives prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

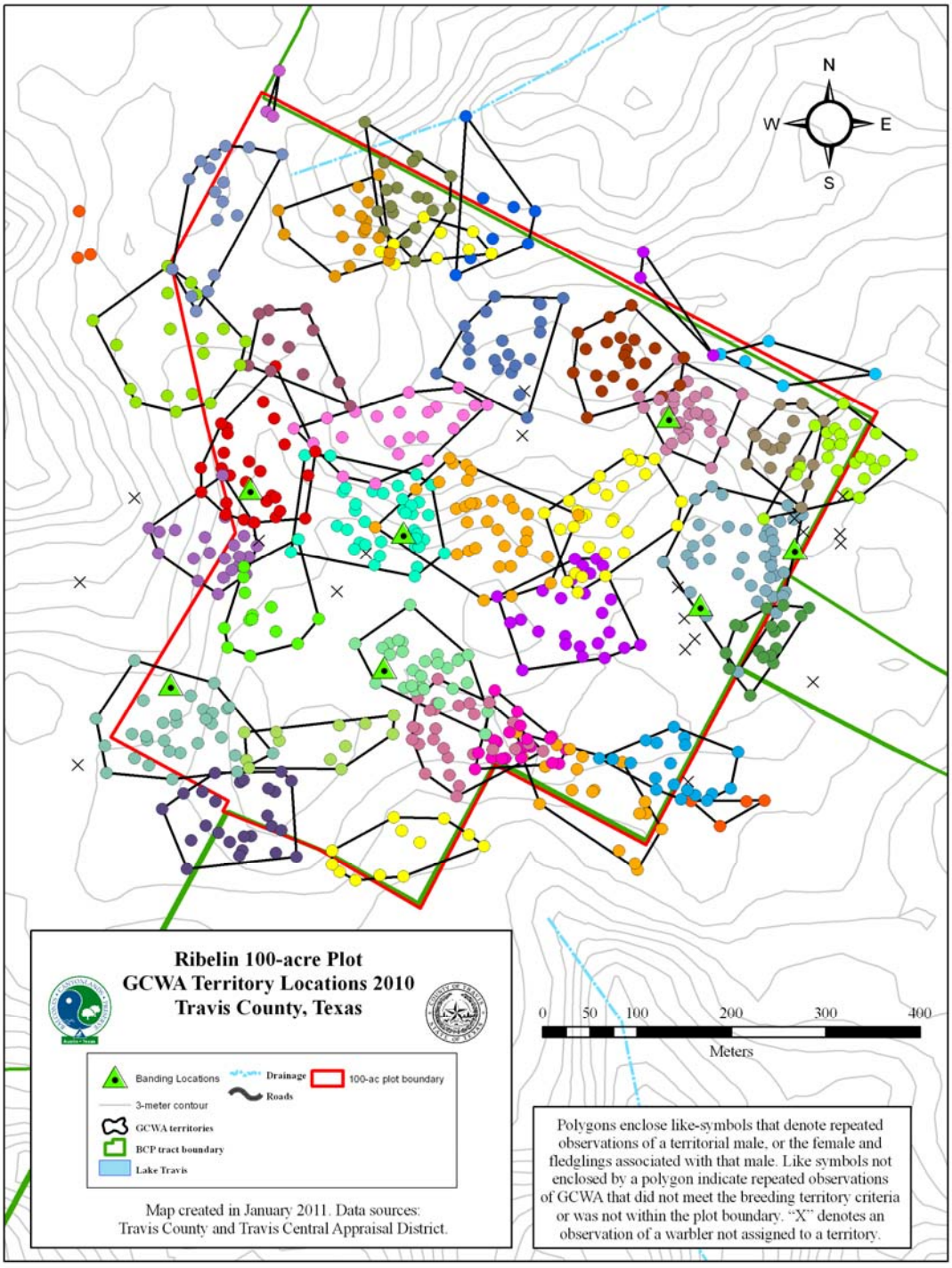

Figure 15. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Ribelin prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

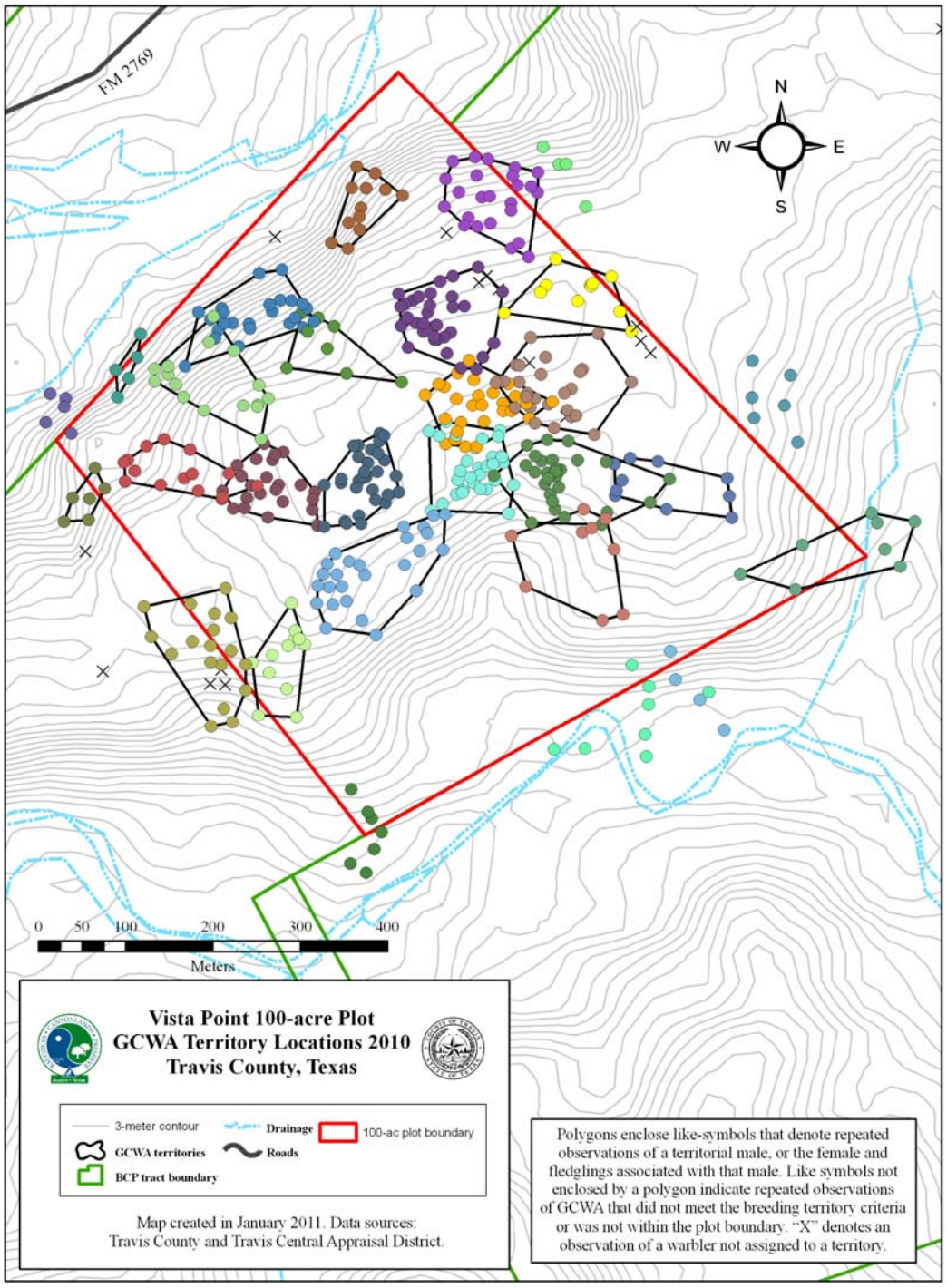

Figure 16. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Vista Point prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

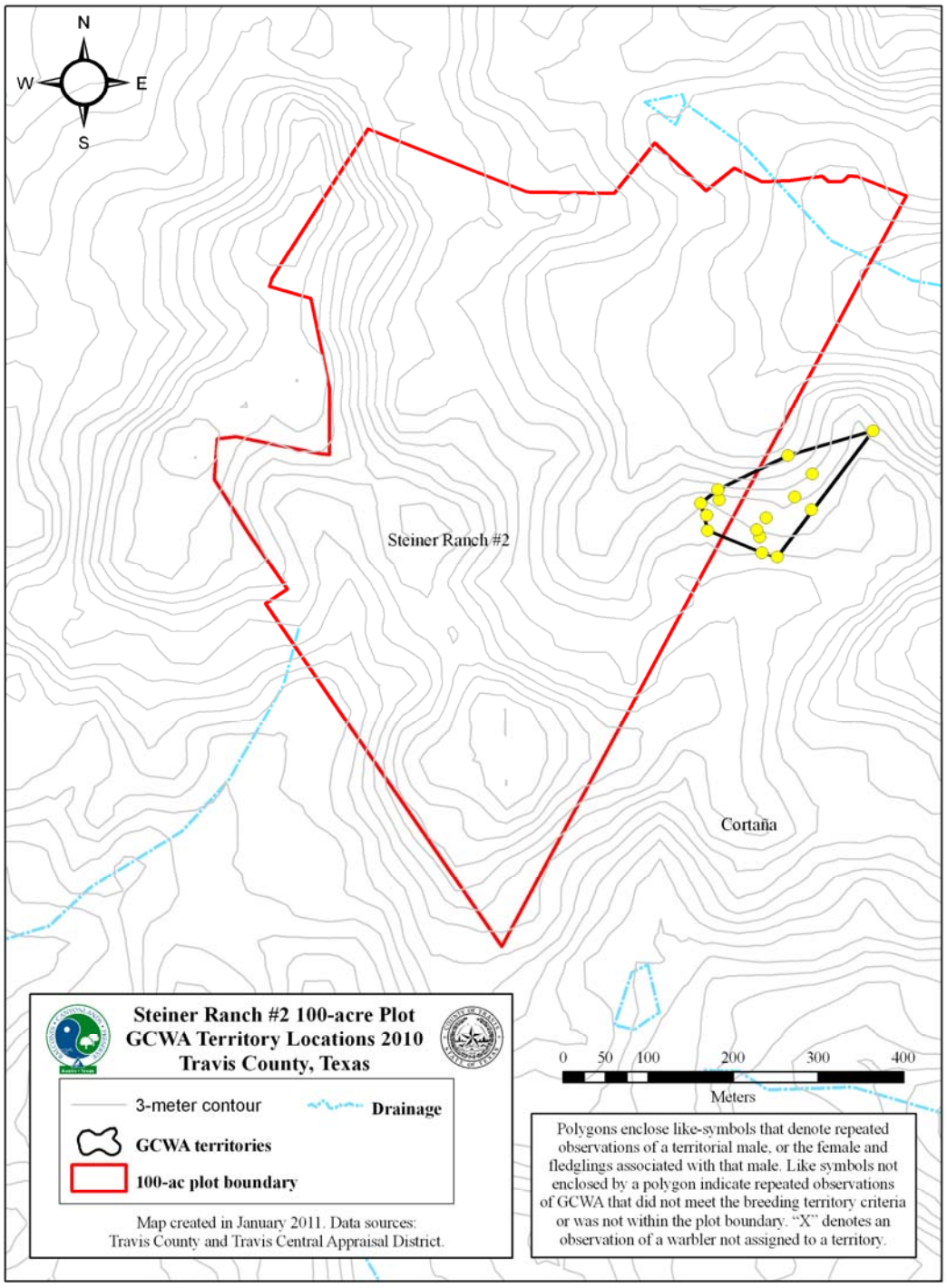

Figure 17. 2010 Golden-cheeked Warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Steiner Ranch #2 transitional 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

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	Average
Bunten		45	52	56	65	64	58	52	56	**56**
Canyon Vista							40	32	41	**38**
Hamilton Pool	16	19	20	17	22	21	20	28	21	**20**
Lake Perspectives	28	25	26	24	33	35	33	27	16	**27**
Ribelin					50	57	51	46	62	**53**
Vista Point								53	46	**50**
Average	**22**	**30**	**33**	**32**	**43**	**44**	**40**	**40**	**40**	

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	**Average**
Pair Success	0.8	0.83	0.86	1	0.38	1	0.71	0.63	0.86	**0.78**
Breeding Success	0.4	0.67	0.43	1	0.25	0.57	0.57	0.5	0.29	**0.55**
Estimated Brood Size	1.5	2	1.66	1.8	1.5	1.86	1.6	1.8	0.67	**1.72**
Productivity	0.6	1.33	0.71	1.8	0.38	1.86	1.14	1.13	0.57	**1.12**

Lake Perspectives	2002	2003	2004	2005	2006	2007	2008	2009	2010	**Average**
Pair Success	0.88	1	0.75	0.71	0.55	0.8	0.64	0.38	1.00	**0.71**
Breeding Success	0.75	0.86	0.5	0.71	0.18	0.7	0.36	0.13	0.75	**0.52**
Estimated Brood Size	1.83	2.16	2.25	2.2	0.33	1.88	1.43	0.66	1.00	**1.59**
Productivity	1.38	1.86	1.13	1.57	0.18	1.5	0.91	0.25	1.00	**1.1**

Bunten	2003	2004	2005	2006	2007	2008	2009	2010	**Average**
Pair Success	0.92	1	0.73	0.73	0.95	0.95	0.76	0.72	**0.86**
Breeding Success	0.75	0.8	0.67	0.68	0.89	0.58	0.24	0.39	**0.66**
Estimated Brood Size	1.89	2.5	2.8	1.75	1.55	1.33	0.85	1.31	**1.81**
Productivity	1.42	2	1.86	1.27	1.47	1.21	0.65	0.94	**1.41**

Ribelin	2006	2007	2008	2009	2010	**Average**
Pair Success	1	0.86	0.66	1	0.82	**0.88**
Breeding Success	0.93	0.86	0.6	0.92	0.41	**0.83**
Estimated Brood Size	2.14	2.33	1.8	1.83	1.50	**2.03**
Productivity	2.14	2	1.2	1.83	1.24	**1.79**

Canyon Vista	2008	2009	2010	**Average**
Pair Success	0.57	0.8	0.77	**0.69**
Breeding Success	0.36	0.5	0.38	**0.43**
Estimated Brood Size	1	1.25	0.90	**1.13**
Productivity	0.57	1	0.69	**0.79**

Vista Point	2009	2010	**Average**
Pair Success	0.88	0.87	**0.87**
Breeding Success	0.41	0.73	**0.57**
Estimated Brood Size	0.87	2.00	**1.44**
Productivity	0.77	1.73	**1.25**

Exhibit C

Information on Golden-cheeked Warblers banded on the Ribelin Plot in 2010. Easting and northing coordinates are given in UTM 14N projection NAD 83 datum.

Date Banded	Color Combination	Easting	Northing	Sex	Age
3/26/2010	MV/SI:PI/MV	613706	3364173	M	ASY
3/26/2010	OR/SI:OR/RD	613479	3364158	M	ASY
3/26/2010	NB/SI:BK/DB	613566	3364365	M	ASY
3/30/2010	GR/SI:OR/YE	614043	3364235	M	SY
3/30/2010	BK/RD:MV/SI	614144	3364294	M	ASY
3/30/2010	OR/WH:OR/SI	614012	3364436	M	ASY
3/30/2010	BK/SI:DG/GR	613728	3364316	M	SY

Exhibit D

USGS National Wildlife Health Center Diagnostic Services Case Update for Golden-cheeked Warblers, June 8, 2010.

NATIONAL WILDLIFE HEALTH CENTER

6006 Schroeder Road
Madison, Wisconsin 53711-6223
608-270-2400 (FAX 608-270-2415)

DIAGNOSTIC SERVICES CASE UPDATE

CASE: **23067** **EPIZOO:** 6/8/2010

FINDINGS TO DATE

Submitter:
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P.O. Box 1088
Austin, TX 78767

Date Submitted: 5/27/2010

Specimen description/identification/Location:

ACC	SPECIES	SPECIMEN TYPE	BAND NUMBER	SUBMITTER's ID	COUNTY	STATE
001	Warbler, Golden-cheeked	CARCASS	2620-61311	OR/SI:OR/RD	Travis	TX
002	Warbler, Golden-cheeked	CARCASS	2620-61355	BL/MV:GR/SI	Travis	TX

Comment:

The two adult warblers submitted from Balcones Canyonlands Preserve were necropsied 5/27/10. Both birds were adult males. Accession001 was in fair body condition and Acc002 was in excellent body condition. The precise cause of death of warbler 001 was not evident at necropsy. There was evidence of trauma around the eyes, ears and dorsum of the head in a pattern suggestive of cohort fighting and trauma. The cause of death in warbler 002 appeared to be from cardiac tamponade (mechanical compression of heart resulting from blood/fluid building up in the space between the heart muscle and sac covering the heart). We are performing routine cultures and tests including those for West Nile Virus and Avian influenza. The GI tract and tail feathers will be shipped after a final diagnosis has been made. - CLW

If you have questions regarding this case, contact:

LeAnn White

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Diagnostic findings may not be used for publication without the pathologist's knowledge and consent.