Monitoring of the golden-cheeked warbler (*Dendroica chrysoparia)* In western Travis County, Texas: 2006 Field Season



Photo: The Nature Conservancy, Ft. Hood, 1998

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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 terrestrial species, commonly known as neotropical migrants, breed in North America, and then migrate south to 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, but not limited to, 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*), a neotropical migrant, as federally endangered as a result of loss and fragmentation of habitat due to suburban development, reservoir construction, and agricultural use (U.S. Fish and Wildlife Service 1990, Ladd and Gass 1999). The golden-cheeked warbler breeds only in Travis County and 24 other counties 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 golden-cheeked warbler breeding habitat. In 1996, the Balcones Canyonlands Conservation Plan was approved by the USFWS to mitigate for the loss of habitat due to development and to facilitate the local recovery of the warbler and seven other endangered species (Balcones Canyonlands Preserve 1999). A minimum of 30,428 acres of endangered species habitat in western Travis County will be set aside as a preserve. This preserve system, the Balcones Canyonlands Preserve (BCP), is managed and owned by various governmental and private entities, including Travis County. Travis County actively manages 3,970 acres within the BCP as well as an additional 819 acres at Steiner Ranch. Steiner Ranch has not yet been included in the acreage requirement set by the USFWS since it is located outside the original preserve acquisition boundary.

In 1996, Travis County began monitoring the golden-cheeked warbler on the BCP and other county-managed properties, and surveys have since been conducted annually with an emphasis on newly acquired preserve property (Travis County Natural Resources 1996; 1997; 1998; 1999; 2000; 2001; 2002; 2003; 2004; 2005). In 2006, Travis County Natural Resources monitored golden-cheeked warblers on fourteen BCP tracts covering 1,909 acres

(ac) (773 hectares (ha)) (**Figure 1; Table 1**). Territory mapping of entire preserve tracts was conducted on Franzetti, Grandview Hills-South, Greenshores, Toops, Vista Point, Steiner Ranch J-Canyon (Tract 1), King, Attwood, and Blake (hereafter KAB). On each tract, data were collected on four bird population parameters: male abundance, species distribution, territory density, and territory location (see methods section for an explanation of survey methodology). Also, presence/absence surveys for the warbler were conducted on the Hereford (newly acquired in 2006), Romberg, and Medway tracts. Medway was slated for transitional 100-acre plot surveys in 2006, however due to lack of adequate staff time, only presence/absence data was collected within the boundaries of the established 100-acre plot. Golden-cheeked warbler presence/absence surveys were also conducted on four county parks: Cypress Creek, Sandy Creek, Selma Hughes and the Pogue Springs Preserve component of the Southwest Metropolitan Park.

In addition to these surveys, territory and productivity data were collected on four annually monitored, permanent 100-acre (40.4 ha) study plots at Bunten, Hamilton Pool Preserve (hereafter Hamilton Pool), Lake Perspectives, and Ribelin. Ribelin was surveyed for the first time as a prime habitat 100-acre study plot during the 2006 survey season. On these plots, data were collected on territory density and location, pairing success, breeding success, and productivity.

METHODS

STUDY SITES

The Jollyville Unit (1,926 ac/780 ha) is located in northwest Travis County (**Figure 1**) in the Cypress Creek macrosite (Balcones Canyonlands Preserve 1999), and it includes, but is not limited to, the tracts of Vista Point, Bunten, Grandview Hills-South, and Lake Perspectives. Also within the Cypress Creek macrosite is the Cypress Creek Unit (473 ac/191.5 ha), which includes Toops, Beck, and KAB. The road FM 2769 divides the Jollyville Unit and Cypress Creek Unit. Steiner Ranch Preserve (819 ac/332 ha) is located off RM 620 (**Figure 1**) in the North Lake Austin macrosite (Balcones Canyonlands Preserve 1999). Detailed physical descriptions of these units within the BCP can be found in the Jollyville Unit, Romberg, and Steiner Ranch Land Management Plans (Balcones Canyonlands Preserve 1999).

The Romberg tract (40 ac/16 ha) is located within the Cypress Creek macrosite **(Figure 1)**. Romberg resides near the north shore of Lake Travis, is southeast of the LCRA MacGregor BCP tract, and just north of Travis County's Bob Wentz at Windy Point Park. The land is

relatively flat in the southern portion, with steep north-, west-, and south-facing slopes in the northern section of the property. Two small canyons form intermittent creeks, which join about halfway down the west-facing slope and continues on to the lake. Another small canyon lies near the eastern boundary of the tract (Carr 1996). The tract is underlain by Glen Rose limestone with outcrops of the Walnut formation in the higher elevations (Soil Conservation Service 1974). The evergreen woodland, which covers most of the tract, is dominated by Ashe juniper. Along with juniper, live oak (*Quercus virginiana*) occurs in the lower elevations and Texas oak (*Quercus texana*) in the ravines and on north-facing slopes. There are also a few cedar elm (*Ulmus crassifolia*) and hackberry (*Celtis spp*). In the more mesic areas, there are also a number of species of shrubs, ferns, and sages. In the drier, rockier soils, grassy openings occur between clumps of juniper. These areas are dominated by seep muhly (*Muhlenbergia reverchonii*), tall grama (*Bouteloua pectinata*), and little bluestem (*Schizachyrium scoparium*) (Carr 1996).

The Hereford (10 ac/ 4 ha), Greenshores (52 ac/21 ha) and Franzetti (58 ac/24 ha) tracts are located in the North Lake Austin macrosite (**Figure 1**). Greenshores is located near the Oak Shores and Pearce Roads off of City Park Road, south of RM 2222 while the Hereford and Franzetti tracts are located directly off of City Park Road. 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. Franzetti is a long linear tract comprised of oak-juniper woodland, a creek, canyons and plateaus. The 10-acre Hereford tract consists of sloped oak-juniper woodland.

The Ribelin tract is located within the Bull Creek macrosite and on the Jollyville Plateau (**Figure 1**). This 319-acre tract is located off of RM 2222 and McNeil Drive, which is the primary access point. 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 cattle and livestock ranching.

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)

(**Figure 1**) (Balcones Canyonlands Preserve 1999). River and creek terrain supports mixed, evergreen-deciduous woodland dominated by *J. ashei, Quercus texana*, and *Ulmus crassifolia* (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 1999).

Medway Ranch tract is located in the South Lake Austin macrosite (**Figure 1**). This 344-acre tract is located between Lake Austin on the east and RM 620 on the west, located on Pecan Drive and Murfin Road. A major drainage as well as two smaller drainages flows through the tract toward Lake Austin. Due to historic clearing for ranch land uses, much of the tract has semi-open savannahs with post oaks (*Quercus stellata*) and little habitat for the warbler except for along the drainages, which provides the best habitat for the golden-cheeked warbler. The transitional 100-acre plot captures most of the best warbler habitat within its boundaries.

Pogue Springs Preserve (hereafter, PSP) is located within the newly acquired Southwest Metropolitan Park and managed by Travis County Parks. Southwest Metropolitan Park is comprised of 4 tracts, totaling approximately 1500 acres (607 ha). The PSP tract comprises 500 acres (202 ha) and is currently not part of the BCP system. 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 of the PSP generally are comprised of Brackett and Volente series (Soil Conservation Service 1974). PSP 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, Texas oak, cedar elm, 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, 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 have high plant diversity in the number and type of species of plants present.

Cypress Creek Park (37 ac/15 ha) is a Travis County-managed park located off of Bullick Hollow Road and FM 2769. It is comprised of gently sloping western topography that falls into Lake Travis. Soils are primarily in the Volente series (Soil Conservation Service 1974).

Vegetation is compromised of mainly live oak, ashe juniper, black willow *(Salix nigra*), and sycamore (*Platanus occidentalis*) trees with an understory of yaupon (*Ilex vomitoria*), sumac (*Rhus spp*), and American beautyberry. It is a highly used recreational spot with many areas that are kept mowed for public use.

Travis County's Sandy Creek Park (25 ac/10 ha) is located off of Lime Creek Road north of the Village of Volente. Vegetation consists of an oak and ashe juniper woodland mix on the slopes and a semi-open grassland on the upper terraces. Soils are primarily found in the Tarrant series (Soil Conservation Service 1974).

Selma Hughes (5 ac/2 ha) is a Travis County-managed park situated off of Quinlan Park Road near Lake Austin and Steiner Ranch development. It's topography is southern facing and drains into Lake Austin. The vegetation is comprised of mainly semi-open grasslands with a mix of oak and juniper woodlands. Soils are primarily found in the Hardemen Series (Soil Conservation Service 1974).

TRACT TERRITORY MAPPING

Data Collection

Territory mapping of golden-cheeked warblers was conducted from 12 March to 22 June 2006 on the following Travis County preserve tracts: Franzetti, Grandview Hills-South, Greenshores, KAB, Steiner Ranch J-Canyon, Toops, and Vista Point (**Figure 1**). 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 was also noted. Avian locations were later recorded in an ArcView 3.2 (ESRI, Inc., Redlands, California) database using the NAD 1983 Texas State Plane Coordinate System. Spatial and demographic data were also entered into the database via an ArcView 3.2 script.

All potential warbler habitat at each site was surveyed repeatedly throughout the breeding season. Total survey hours varied according to tract size and terrain (**Table 1**). Due to limitations inherent to territory mapping methods including, but not limited to, 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 1992). Field observations (e.g., bird behavior, phenology) and general knowledge of the species (e.g., territory size, habitat requirements) were also relied upon to help differentiate individual males and delineate their territories. Any male that could be differentiated from surrounding males was given a unique number for further tracking. Females or fledglings associating with a unique male were given the same unique 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 onto the hard-copy digital orthophoto maps. All observations of brown-headed cowbirds (*Molothrus ater*) and any signs of nest parasitism were also noted. During the rare observed occurrence, brown-headed cowbird fledglings were to be safely dispatched if being tended by a warbler.

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 of acres and hectares for a tract.

100-ACRE PRIME PLOT

Data collection

Establishment of 100-acre permanent plots allows standardized, long-term monitoring of golden-cheeked warblers and statistical analyses of pair and breeding success and productivity, which is required by the USFWS Habitat Conservation Plan (1996). In 2006, territory mapping was conducted on four 100-acre permanent plots on the following preserves: Bunten, Lake Perspectives, Hamilton Pool, and Ribelin, all of which are classified as "prime" sites, i.e., more than 75% of the plot contains excellent warbler habitat (Balcones Canyonlands Preserve 1999). The 100-acre plots were surveyed following the same procedure as the abovementioned territory mapping with some exceptions. Territory mapping was conducted between 27 March and 22 June 2006. 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. The study plots were visited a total of ten times distributed evenly throughout the season, with each survey totaling six hours. No playback tapes were used to elicit warbler responses or systematic nest searching undertaken. However, incidental observations of any warbler nests were noted and mapped onto the hard-copy digital orthophoto maps. Two or three 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 1999).

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 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 was 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 for 100-acre prime plots, the tract territory mapping methodology was utilized. Territory density is calculated as the number of modified territories per 100 acres, and then, for easier interpretation, is calculated per 100 hectares (247.1 acres).

To calculate pairing 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. Pairing success rate was calculated as the number of males 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 was 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

PRESENCE/ABSENCE SURVEY

Presence/absence surveys were conducted on Hereford, Medway, and Romberg preserve tracts and on Travis County's Cypress Creek Park, Sandy Creek Park and Pogue Springs Preserve (SW Metro Park). Presence/absence surveys followed U.S. Fish and Wildlife Service minimum procedures for golden-cheeked warbler and black-capped vireo presence/absence surveys (USFWS 1994).

RESULTS AND DISCUSSION

During field season 2006, golden-cheeked surveys were conducted between 12 March and 22 June on 1,909 acres, and the total amount of time-spent surveying was 591.5 hours (**Table 1**). A total of 3,319 observations of warblers were recorded on the surveyed properties. This total includes observations of 3,051 males, 57 females, and 211 pairs of warblers. These observations include multiple detections of the same individual.

Table 1. List of Travis County Balcones Canyonlands Preserve (BCP) tracts surveyed for golden-cheeked warblers (*Dendroica chrysoparia*) during the 2006 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	3/27 - 6/22/06	60
Hamilton Pool	100	3/30 - 6/16/06	60
Lake Perspectives	100	3/30 - 6/07/06	60
Ribelin	100	4/03 - 6/16/06	60
Total	**400**	**3/27 - 6/22/06**	**240**
Territory Mapping			
Franzetti	58	3/12 - 6/11/06	13.5
Grandview Hills-South	145	3/21 - 5/30/06	31.5
Greenshores	52	3/25 - 6/22/05	12
KAB	128	3/21 - 6/03/06	45
Steiner Ranch J-Canyon	317	3/31 - 06/06/06	47.5
Toops	170	3/30 - 6/06/06	31.5
Vista Point	490	3/21 - 6/07/06	151
Total	**1360**	**3/12 - 6/22/06**	**332**
Presence/Absence			
Hereford	10	4/15, 4/23, 6/10/06	3.5
Medway	100	4/30 - 6/04/06	14.5
Romberg	39	4/02/06	1.5
Total	**149**	**4/02 - 6/10/06**	**19.5**
Overall Total	**1,909**	**3/12 - 6/22/06**	**591.5**

TRACT TERRITORY MAPPING

Overall, 1,360 acres were mapped for golden-cheeked warbler territories for 332 hours during the 2006 field season (**Table 1**). The tracts surveyed were Franzetti, Grandview Hills-South, Greenshores, KAB, Steiner Ranch J-Canyon, Toops, and Vista Point. The total abundance of golden-cheeked warbler males on all tracts surveyed was 171. Abundance was greatest on the Vista Point tract (80) and KAB (6) had the least abundance (**Table 2**). The Vista Point tract also had the greatest number of modified territories (52.5) and the greatest territory density overall (0.52/ac; 0.27/ha) (**Table 2**). Grandview Hills-South (0.10/ac; 0.25/ha) had next greatest density, while Greenshores (0.06/ac; 0.15/ha) and Toops (0.06/ac; 0.15/ha) had similar territory densities. Franzetti (0.05/ac; 0.13/ha), KAB (0.02/ac; 0.06/ha), and Steiner Ranch J-Canyon (0.02/ac; 0.06/ha) had the lowest territory densities (**Table 2**).

Table 2. Results of the golden-cheeked warbler (*Dendroica chrysoparia*) territory mapping on Travis County-managed Balcones Canyonlands Preserve tracts surveyed during the 2006 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 (ac)	Abundance	No. of Full Territories	No. of Full & Edge Territories	Modified Number of Territories[a]	Territory Density (ac)[b]	Territory Density (ha)[b]
Franzetti (58)	12	1	5	3	0.05	0.13
Grandview Hills-South (145)	23	11	15	13	0.10	0.25
Greenshores (52)	11	3	4	3.5	0.06	0.15
KAB (128)	6	0	6	3	0.02	0.06
Steiner Ranch J-Canyon (317)	17	6	10	8	0.02	0.06
Toops (170)	22	7	14	10.5	0.06	0.15
Vista Point (490)	80	47	58	52.5	0.52	0.27

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

Figures 2 through 8 illustrate territory distribution and abundance for each of the properties surveyed. 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.

Additional observations

Warbler nests were not systematically searched for during the territory mapping surveys, however two nests were located during the 2006 field season. Both nests were found on the Vista Point tract in Ashe juniper trees. Subsequent visits found that the nestlings had fledged in one of the two nests.

Construction noise on the Steiner Ranch tract hindered surveyors' ability to accurately listen and map for warblers. Most of the surveyed tracts have a substantial feral hog issue, which is being addressed through hog trapping by approved local trappers. No other issues were observed or recorded during tract territory mapping.

100-ACRE PRIME PLOTS

Territory Density

In the 2006 field season on the 100-acre prime plots, an average of 17.25 territories were established per 100 acres or an average of 41 territories per 100 hectares (**Table 3**). Thirty-nine males were detected during the 100-acre plot surveys on Bunten, 33 males at Ribelin, and 16 and 19 males were detected on the Hamilton Pool and Lake Perspectives study plots, respectively (**Table 3**). The Bunten 100-acre plot had 26.5 modified territories, which was greater than the number of modified territories on Ribelin (20), Lake Perspectives (13.5), or Hamilton Pool (9) (**Table 3**). On the Bunten study plot, 22 territories fell entirely within plot boundaries and nine were edge territories. Within the Ribelin plot, 14 territories were contained in the boundaries and 12 were considered edge territories. Eleven territories were located entirely within the study plot boundary on Lake Perspectives, with five additional territories straddling the boundary. Finally, at Hamilton Pool, eight out of 10 territories fell entirely within the boundary of the study plot.

Based on Verner's (1985) method for calculating territory number, territory density was highest at Bunten with 65 territories per 100 hectares (one male per 1.5 ha). Ribelin had the second highest territory density of 50 territories per 100 hectares or, in other words, one male per two hectares. Territory density at Lake Perspectives was less than Bunten and Ribelin (27 territories per 100 hectares or one male per 3.7 ha), but Hamilton Pool had the least number of territories overall (22 territories per 100 ha or one male per 4.6 ha) (**Table 3**).

Table 3. Results of the 2006 golden-cheeked warbler (*Dendroica chrysoparia*) territory mapping on Bunten, Lake Perspectives, Hamilton Pool, and Ribelin 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 per 100 hectares.

Study Plot	Abundance	No. of full territories	No. of full and edge territories	Modified number of territories[a]	Territory density per 100ha[b]
Bunten	39	22	31	26.5	65
Hamilton Pool	16	8	10	9	22
Lake Perspectives	19	11	16	13.5	27
Ribelin	33	14	26	20	50
Average				**17.25**	**41**

[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 9 through 12 illustrate territory distribution and abundance for each of the 100-acre prime study plots surveyed. 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.

Differences in territory density between prime plots may be attributed to site-specific characteristics, although other, untested covariates may have affected densities (e.g., age structure of the local population, inter-specific competition). Although both Bunten and Lake Perspectives contain excellent warbler habitat, there are differences between plots with regard to the ratios of excellent to marginal habitat, as well as, the amount of edge on the plot boundaries (See Campbell 1995 for descriptions of *excellent* and *marginal* warbler habitat). Both Ribelin and Bunten study plots comprise excellent warbler habitat. Lake Perspectives, on the other hand, contains areas of marginal and excellent warbler habitat. Perhaps more importantly, however, Bunten and Ribelin study plots are situated entirely within a much larger block of continuous excellent warbler habitat, while Lake Perspectives is bounded to the east by Bullick Hollow Road and the center of the plot is comprised mostly of grasslands with intermittent large hardwood trees which generally is considered unsuitable for breeding golden-cheeked warblers. 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).

Hamilton Pool study plot had the lowest warbler territory density. Only half of the study plot contains excellent warbler habitat; the remaining percent is marginal to poor breeding habitat. In 1996, Hamilton Pool was designated a prime plot in the Balcones Canyonlands Preserve Handbook (Balcones Canyonlands Preserve 1999) 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 handbook. However, since the Hamilton Pool study plot is officially designated as a prime plot, it will continue to be surveyed and analyzed as prime for the sake of consistency.

Pairing Success, Breeding Success, and Productivity

For all four 100-acre study plots, the average pairing success was 67%. The highest pairing rate (100 %) occurred at Ribelin with one female or at least one observed fledgling for every full territory. At Bunten, 73% of all males were determined to have paired with females, at Lake Perspectives, 55% of all males were paired, and 38% of males paired with females at Hamilton Pool (**Table 4**).

The breeding success rate for all three plots ranged from 0.18 to 1.00 with an average of 51% of pairs successfully raising a brood; Ribelin had fledglings in 93% of the full territories on the plot. A total of 63 fledglings were observed in 32 broods across all four 100-acre study plots. Each successfully paired territory averaged 1.39 fledglings (range: 0.18 to 2.14), while each full territory averaged 1.03 fledglings (range: 0.33 to 2.14) (**Table 4**).

Appendix A includes productivity data for the past five years for Bunten, Hamilton Pool, and Lake Perspectives. Since surveys on Ribelin's 100-acre plot began in the 2006 field season, it is not included but may be seen in Table 4.

Table 4. Golden-cheeked warbler pairing success rate; breeding success rate; and productivity per successful pair and full territory for the four Travis County 100-acre prime plots, Bunten, Hamilton Pool, Lake Perspectives, and Ribelin. Data collected during the 2006 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 rate	Breeding success rate	Productivity per successful pair	Productivity per full territory
Bunten	22	16	15	0.73	0.68	1.75	1.27
Hamilton Pool	8	3	2	0.38	0.25	1.50	0.38
Lake Perspectives	11	6	2	0.55	0.18	0.18	0.33
Ribelin	14	14	13	1.00	0.93	2.14	2.14
Average				**0.67**	**0.51**	**1.39**	**1.03**

Additional observations

One nest was discovered during surveys on the Bunten 100-acre plot on 26 April 2006. The nest was located in a mature Ashe juniper, and the brood was successful. Two nests were also discovered during surveys at Ribelin. Both nests were located in cedar elms (*Ulmus crassifolia*). One nest was deemed successful, however, staff was unable to ascertain the other nest's success. No viable nests were found on the Lake Perspectives study plot, however an intact, fresh-looking nest was discovered on the ground. No eggs, fragments, or evidence of fledglings were discovered in the immediate area. Branch tips from hardwoods in the area were noted on the ground and may have been evidence of a severe localized weather event.

Surveyors had some difficulty-detecting warblers during surveys at Lake Perspectives due to construction noise from a ridge to the south and also due to heavy traffic along Bullick Hollow Road.

PRESENCE/ABSENCE SURVEYS

During the 2006 field season, 149 acres were surveyed for the presence of golden-cheeked warblers on the Hereford, Medway, and Romberg preserve tracts (**Table 1**). Seven golden-cheeked warbler detections (3 males and 4 pairs) were recorded on the Hereford tract during three visits. Also, four fledglings were observed on Hereford's 10-acre tract (**Figure 13**).

Medway was set-up as a transitional habitat 100-acre permanent plot prior to the survey season in the spring of 2006. Due to staff limitations, the recommended 3-six hour surveys were not completed in a timely manner. The six observations are included in this report as presence/absence data. Five males, one female, and no fledglings were observed between 30 April and 4 June 2006 (**Table 1; Figure14**). Medway will be surveyed again during the 2007 survey season as a 100-acre plot. The Romberg tract was surveyed for 1.5 hours on 2 April 2006, and one golden-cheeked warbler detection was made within the tract boundaries (**Table1; Figure 15**). Three other observations were recorded outside the tract boundaries to the northeast.

Four Travis County parks were visited to determine the presence of golden-cheeked warblers. Cypress Creek, Sandy Creek, and Selma Hughes Park were surveyed during the 2006 field season, but no warblers were detected. The Pogue Springs Preserve, a component of the newly acquired Southwest Metropolitan Park complex, was surveyed between 13 April and 8 June 2006, and 27 observations of warblers were recorded (**Figure 16**). Twenty-four observations were of males only, and the remaining three were pairs. Two fledglings were also noted during the surveys. Travis County parks will be continually surveyed for the presence of warblers in the future to assess the viability of populations in recreational areas and assist with future management techniques in parks.

Brown-headed Cowbird Parasitism

A female golden-cheeked warbler was observed feeding a juvenile cowbird on the Toops tract on 10 May 2006. For a summary of brown-headed cowbird parasitism for 2006 see the "2006 Summary of Wildlife Management Activities on Travis County Tracts of the BCP" (Travis County Natural Resources 2006).

RECOMMENDATIONS

- Natural Resources staff will continue to make cowbird trapping at Hamilton Pool Preserve a high priority. The success of cowbird trapping may be critical to golden-cheeked warbler survival on Hamilton Pool Preserve. Cowbird parasitism affects not only golden-cheeked warblers but also other neotropical migrant species for which Hamilton Pool provides habitat, such as northern parula (*Parula americana*), black-and-white warbler (*Mniotilta varia*), and painted bunting (*Passarina ciris*).

- Abundance of cowbirds presents a similar problem for both golden-cheeked warblers and other migrant songbirds on Steiner Ranch Preserve. Although productivity data have not been gathered systematically at Steiner Ranch, it is probable that warbler productivity rates are very low, as they were at Hamilton Pool Preserve in 2002 prior to effective cowbird trapping. Cowbird trapping is problematic at Steiner Ranch due to accessibility, as well as its distance from other trap locations and preserves.

- It is also recommended that Travis County Natural Resources continue to add additional 100-acre study plots. Staff intends to add another transitional and prime 100-acre plot by the beginning of survey season in 2009. Because they provide systematic data to measure population and productivity trends, 100-acre study plots are critical to the BCP golden-cheeked warbler-monitoring program. The accuracy of the monitoring program increases with the number of plots surveyed.

- After field season 2006, there will be five years of data for Hamilton Pool and Lake Perspectives and four years of data for Bunten (see Appendix A). Travis County staff are in the process of submitting requests for proposals to perform appropriate statistical analyses on the data sets.

- Habitat enhancement will be performed in areas with a high density of juniper saplings to encourage hardwood regeneration. Golden-cheeked warbler monitoring will continue in areas restored for black-capped vireo habitat to evaluate their response to management activities. Vireo Ridge on the Jollyville Unit of the Travis County BCP will be surveyed during the 2007 season, which will allow increased opportunities to record warbler activity in the vireo restoration areas.

- Any golden-cheeked warbler nests that are discovered during surveys will undergo nest substrate/vegetation surveys to collect important data about nest selection sites versus habitat availability. Vegetation surveys will be conducted after the breeding season is completed to avoid negatively impacting breeding or nestling success.

- Natural Resources staff is exploring the possibility of implementing a golden-cheeked warbler color-banding program on either the Hamilton Pool or Lake Perspectives 100-acre prime plot. Color-bands will supplement and enhance the productivity and distribution data as well as provide information about site-recruitment and fidelity.

DATA MANAGEMENT

Information regarding data sets compiled for field season 2006 is provided below. All data sets are currently stored in the Travis County Natural Resources office, 1010 Lavaca Street, Austin, Texas.

Excel Files:

allgcwa_2006.xls
Bunten_2006.xls
Franzetti-2005.xls
Gvh_s_2006.xls
Greenshores_2006.xls
Hereford_2006.xls
HP_2006.xls
KAB_2006.xls
LP_2006.xls
Medway_2006.xls
Pogue_2006.xls
Ribelin_2006.xls
Romberg_2006.xls
Steinerjcyn_2006.xls
Toops_2006.xls
VP_2006.xls

Description: Golden-cheeked warbler Excel database locations for 2006 field season
Software: Microsoft Windows NT, Excel 2000
Noostie Field Office Archive Location: Q:\Park_NR\NatRes\Common\Gcwa\GCWA 2006\2006 GCWA Excel files

ArcView Shapefiles:

all_2006_gcwa_data.shp
all_bunten.shp
all_franzetti.shp
greenshores_all.shp
all_gvhs.shp
all_hereford.shp
all_hp.shp
all_kab.shp
all_steinerj.shp
all_toops.shp
all_vp.shp
all_romberg.shp
all_ribelin.shp
all_pogue.shp
all_medway.shp
all_lp.shp

Description: Golden-cheeked warbler geospatial files for 2006 field season
Software: ArcView 3.2 and ArcGIS 9.1
Nootsie Field Office Archive Location:
Q:\Park_NR\NatRes\Common\Gcwa\GCWA2006\2006 GCWA Shapefiles\GCWA Data

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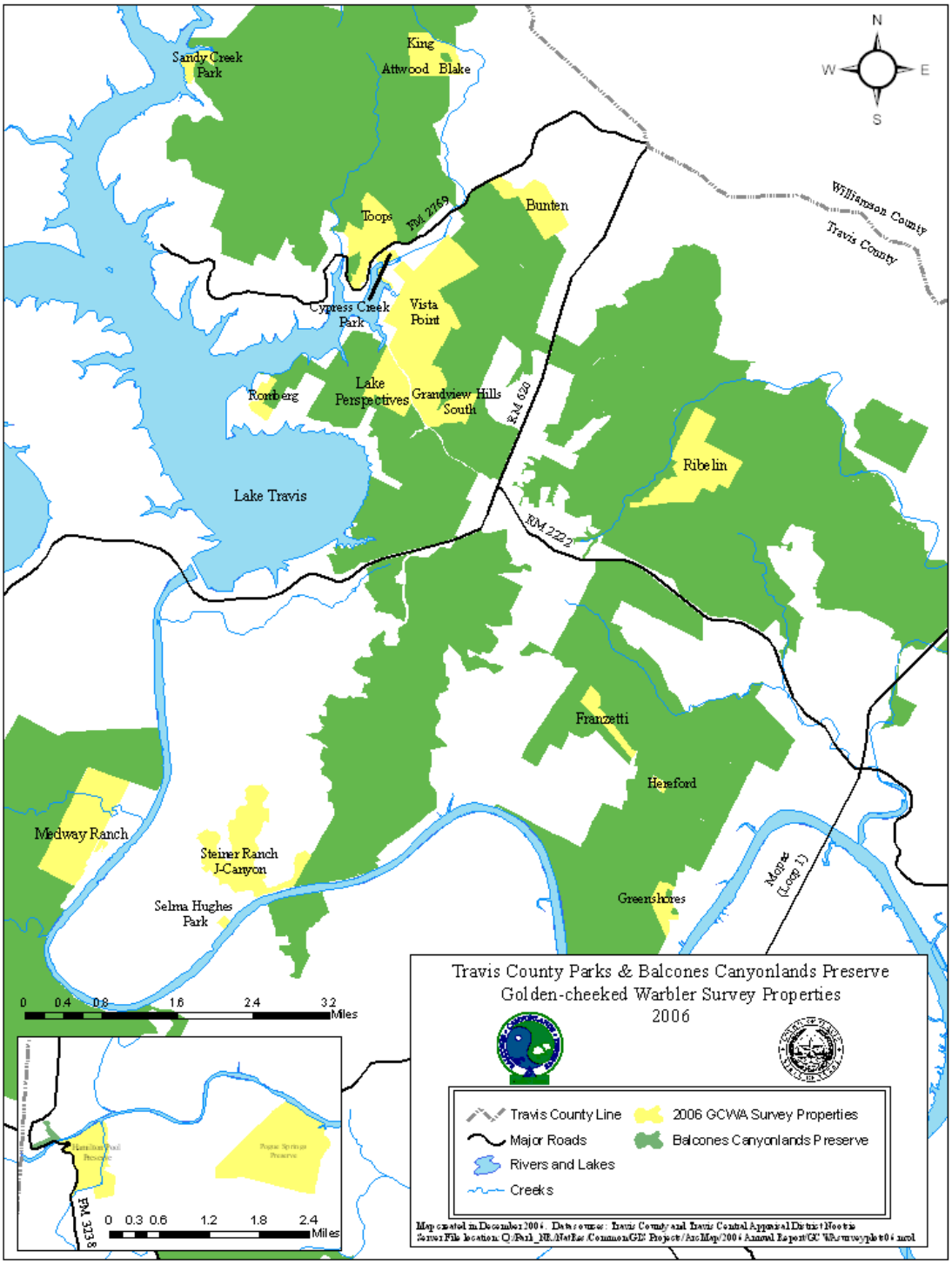

Figure 1. Location of Travis County-managed Parks and Balcones Canyonlands Preserve tracts surveyed for golden-cheeked warblers (*Dendroica chrysoparia*) in 2006.

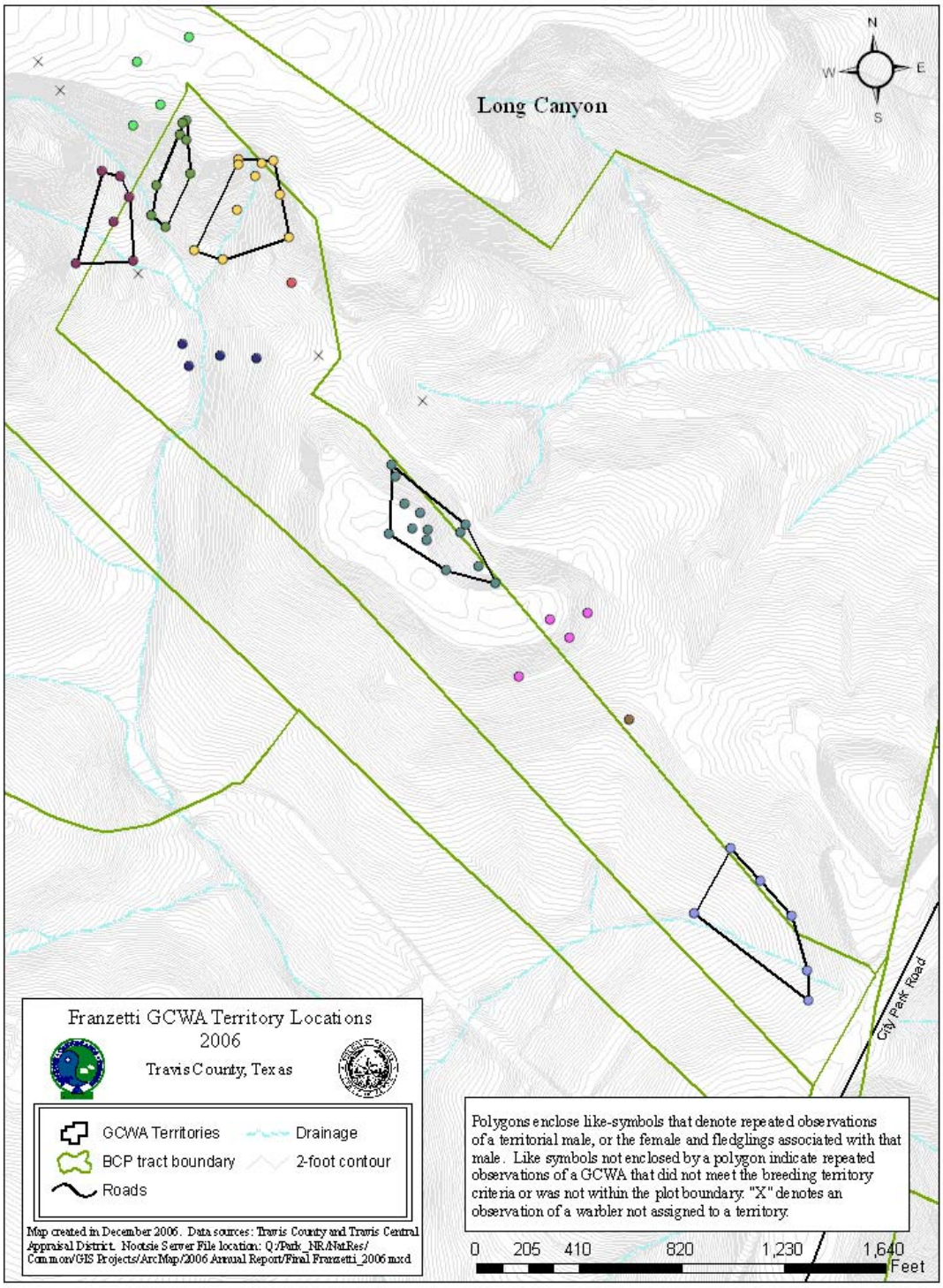

Figure 2. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Franzetti tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

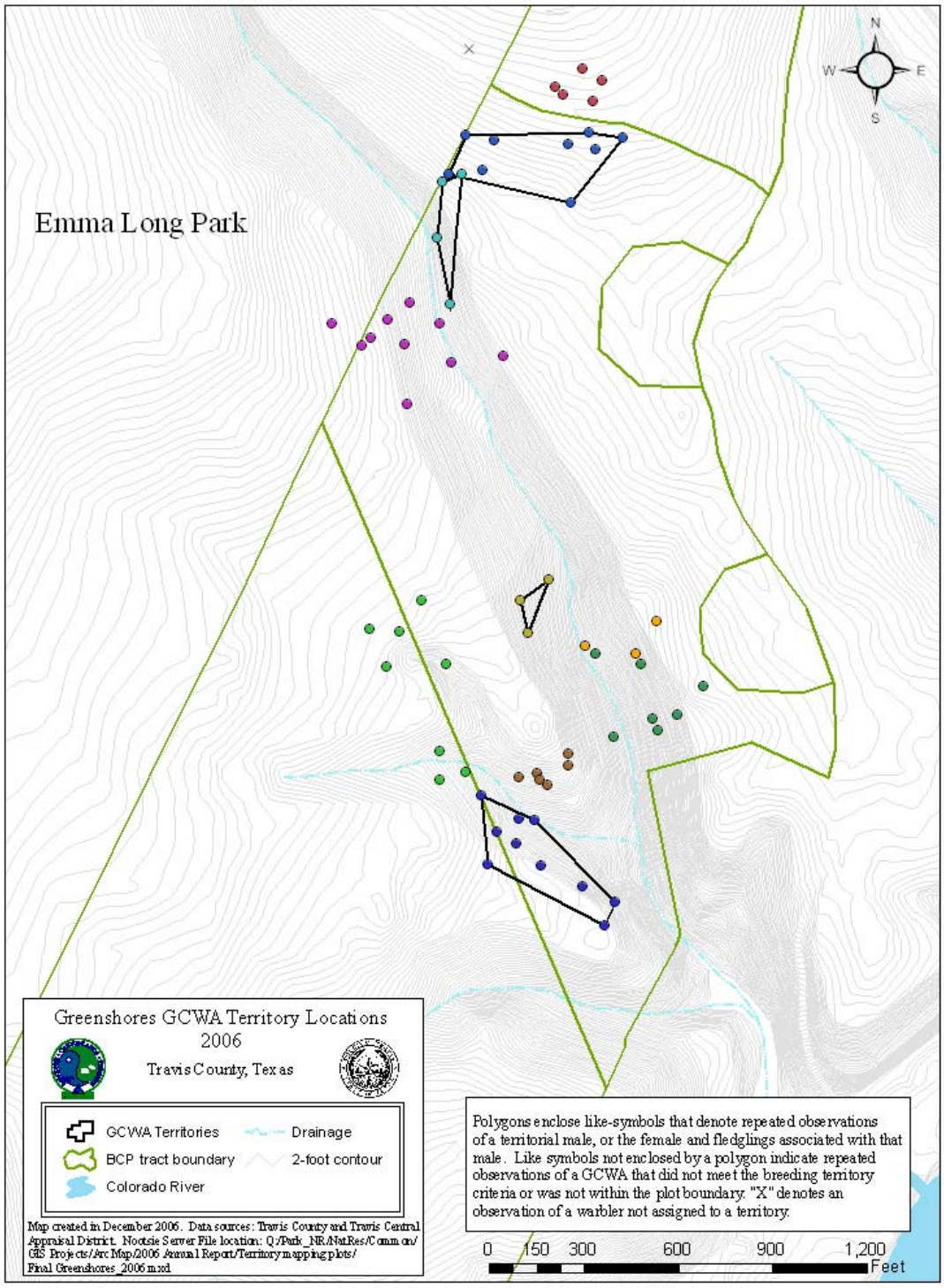

Figure 3. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Greenshores tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

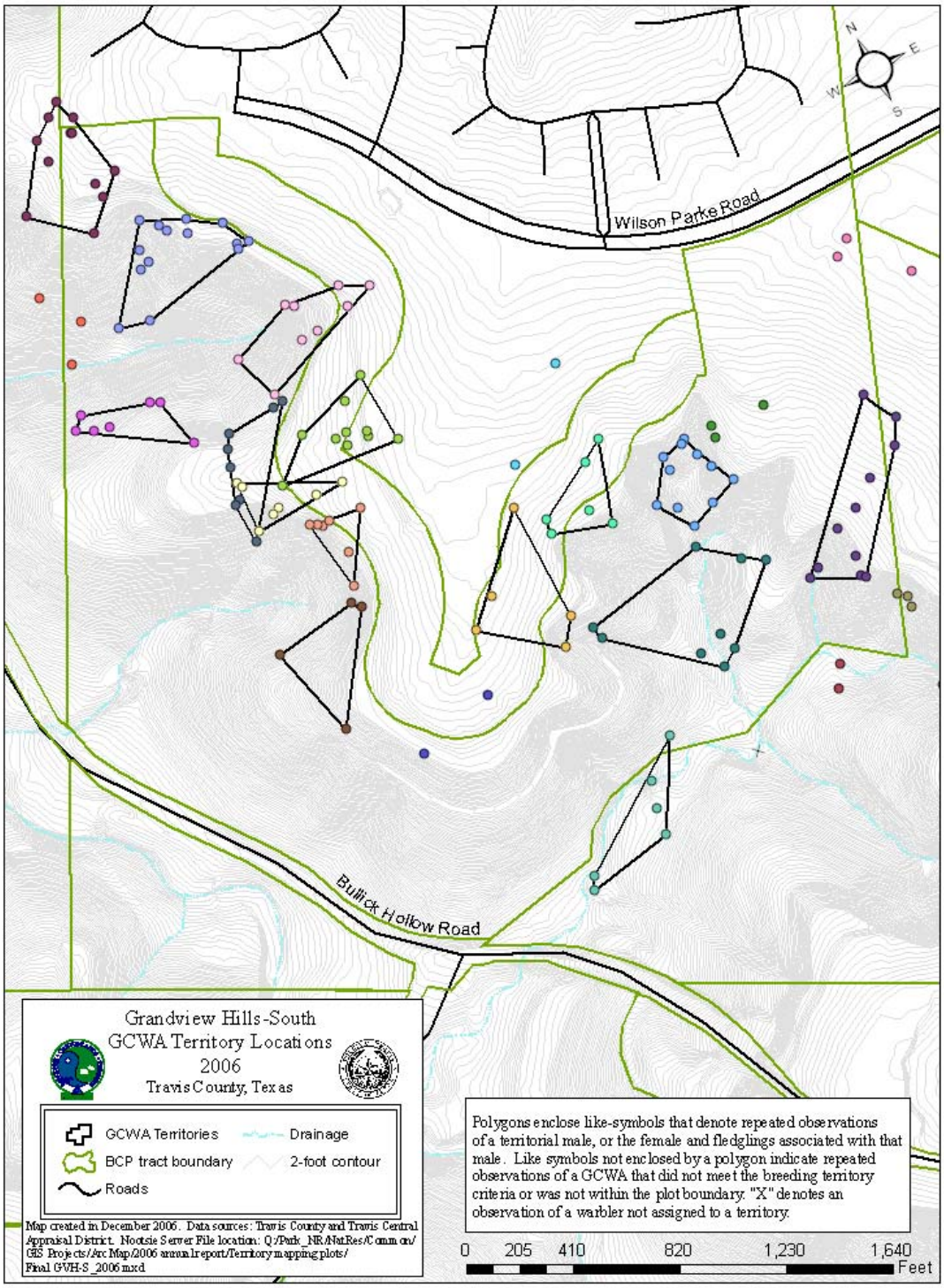

Figure 4. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Grandview Hills-South tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

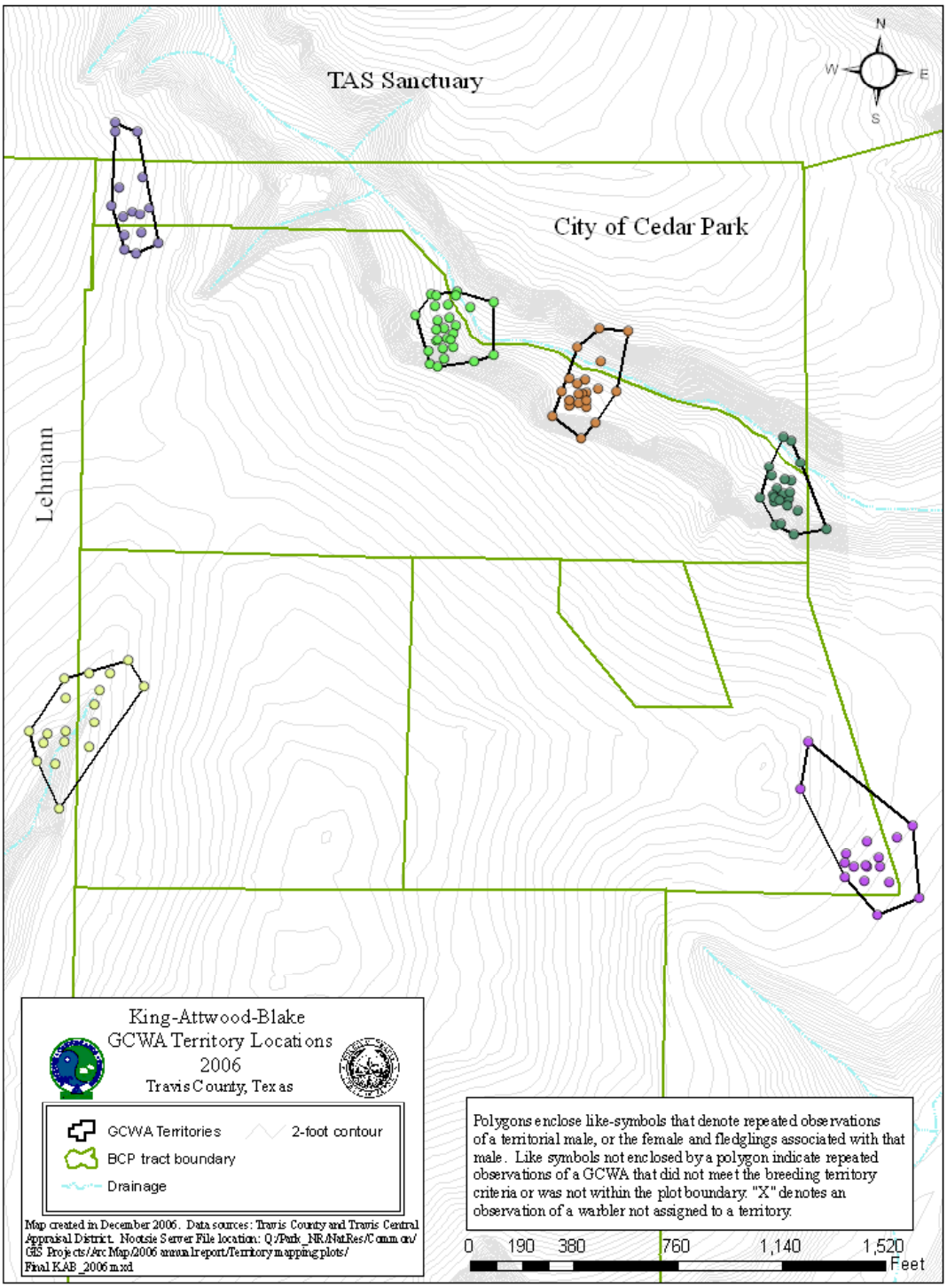

Figure 5. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the King, Attwood, and Blake tracts within the Balcones Canyonlands Preserve in western Travis County, Texas.

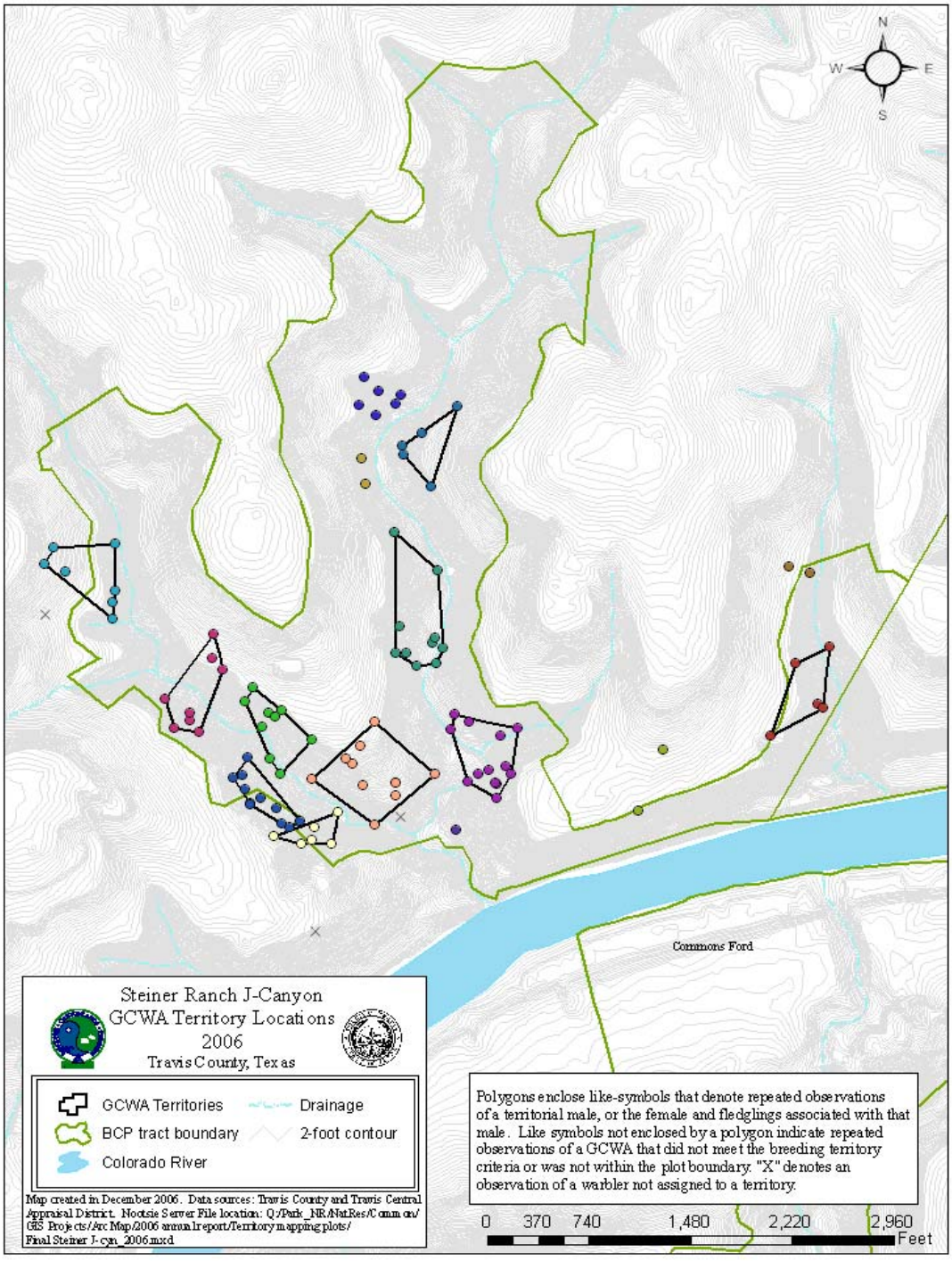

Figure 6. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Steiner Ranch J-Canyon tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

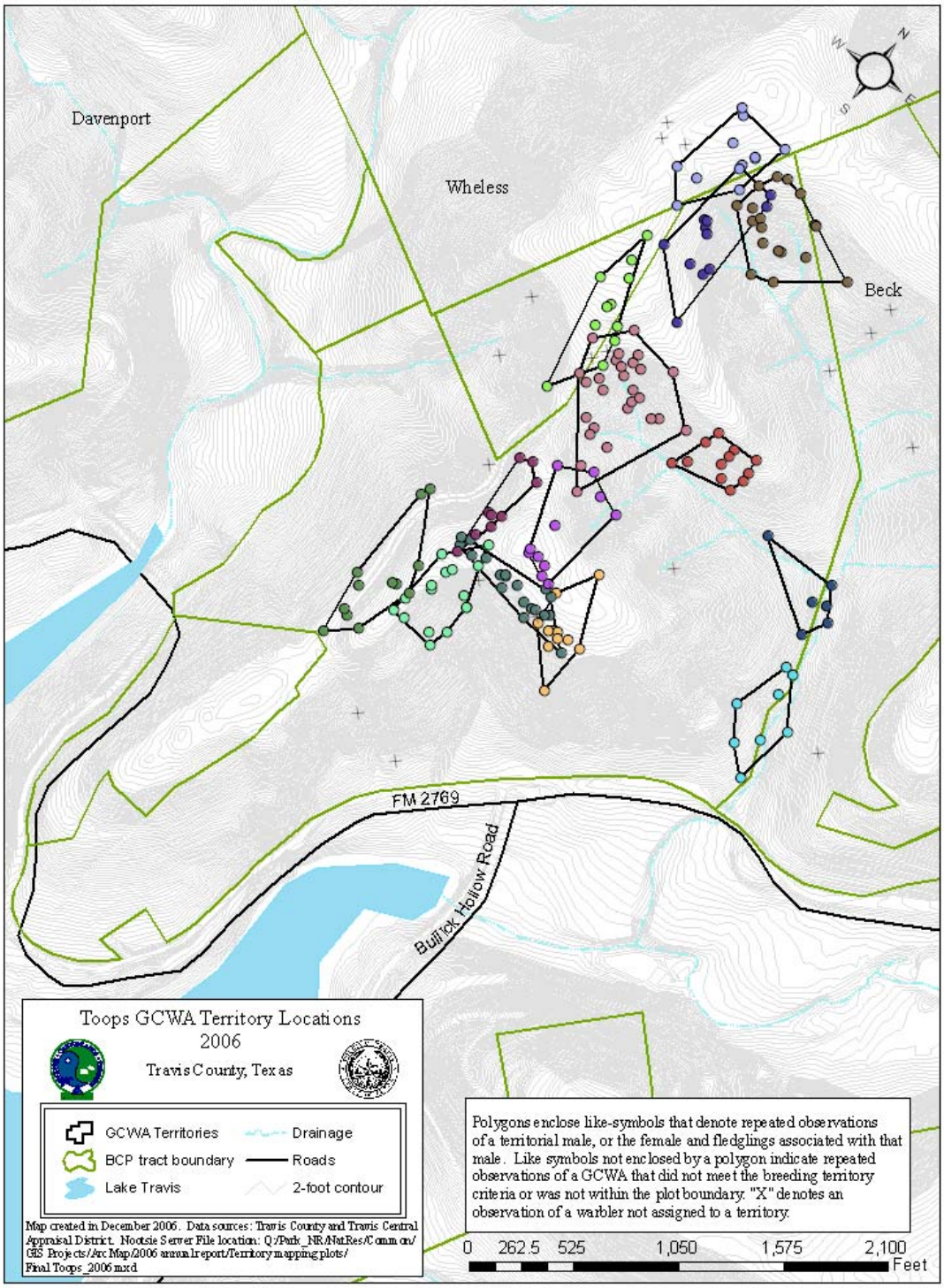

Figure 7. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Toops tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

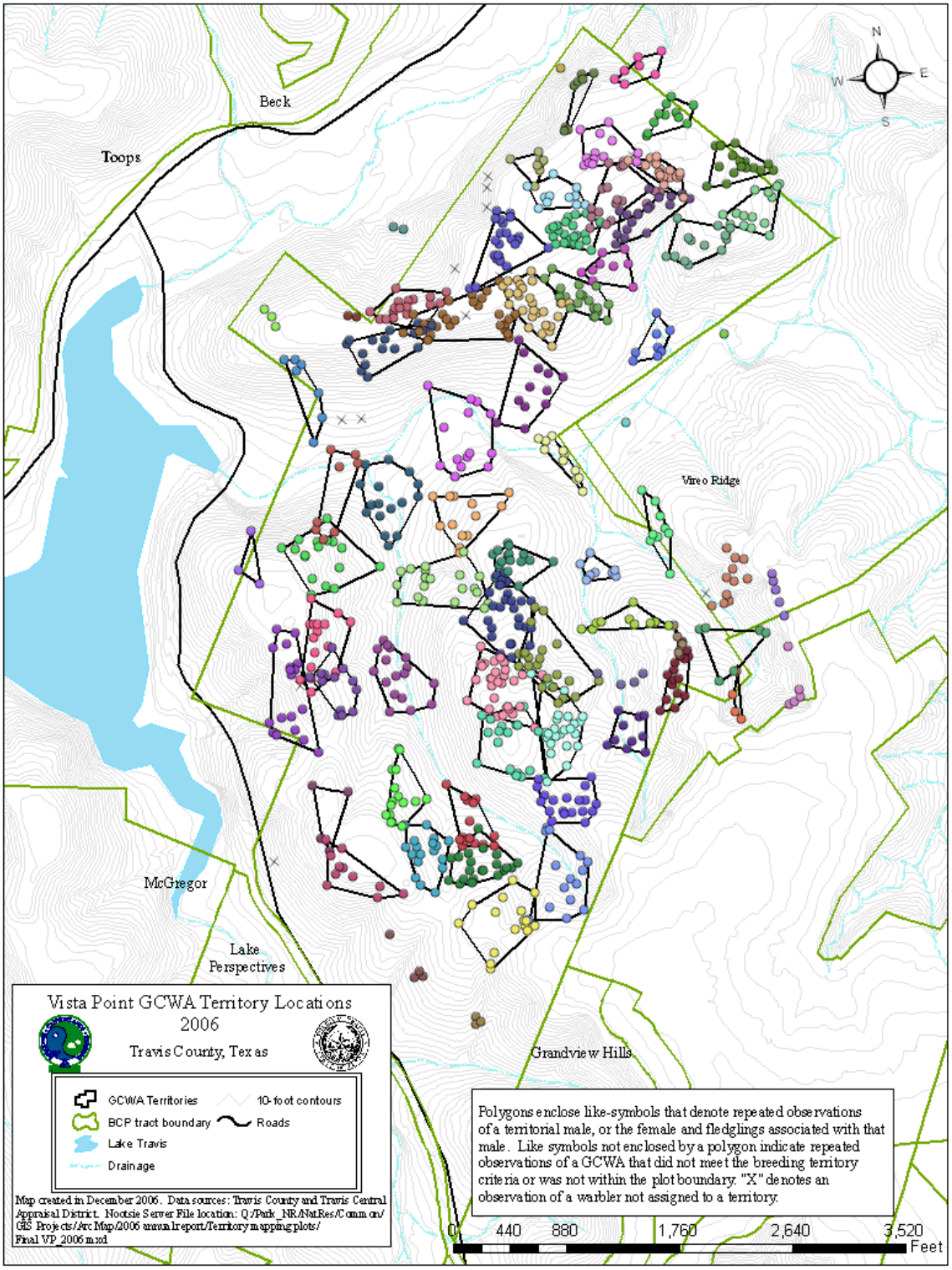

Figure 8. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Vista Point tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

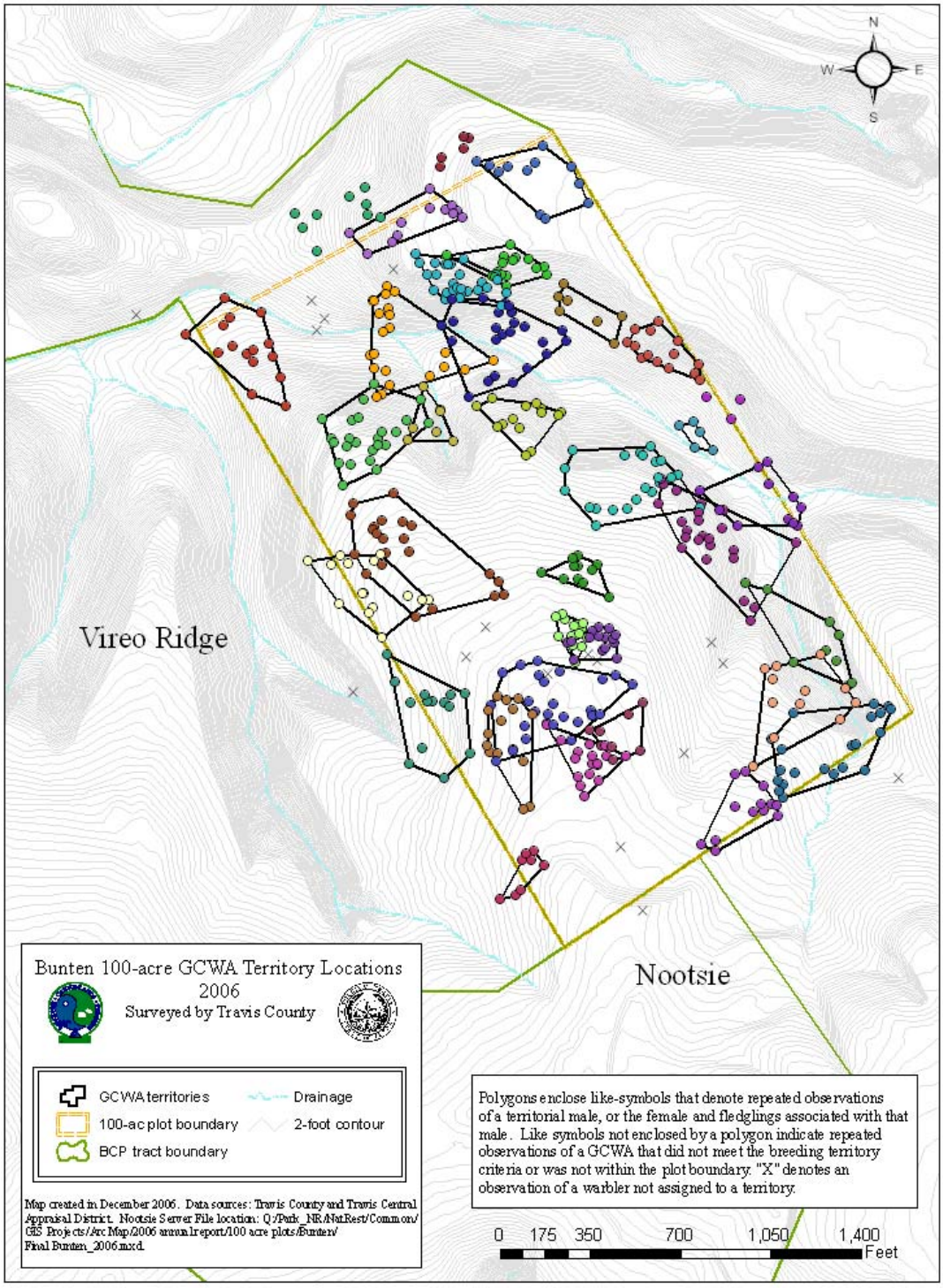

Figure 9. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Bunten 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

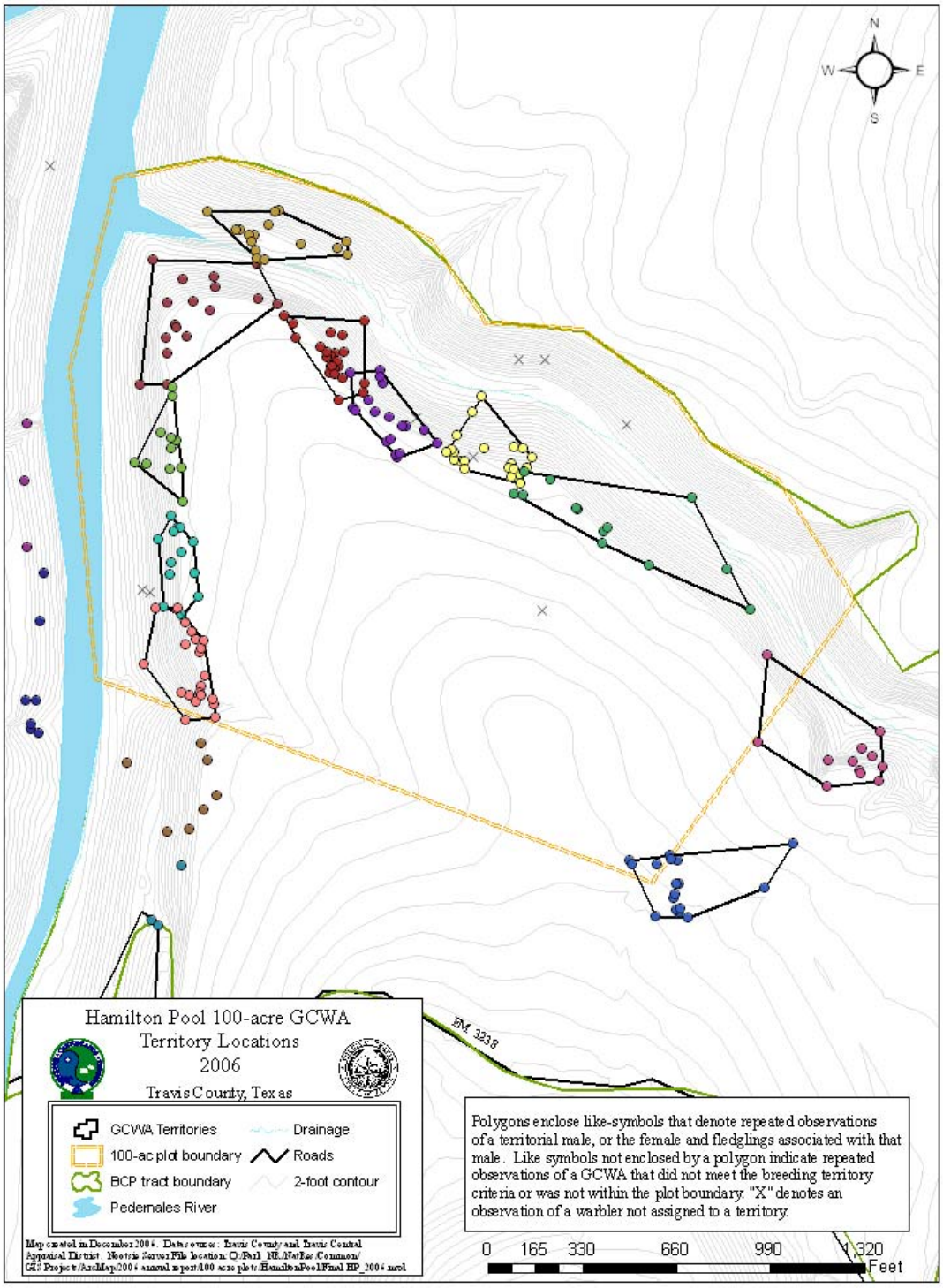

Figure 10. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Hamilton Pool 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

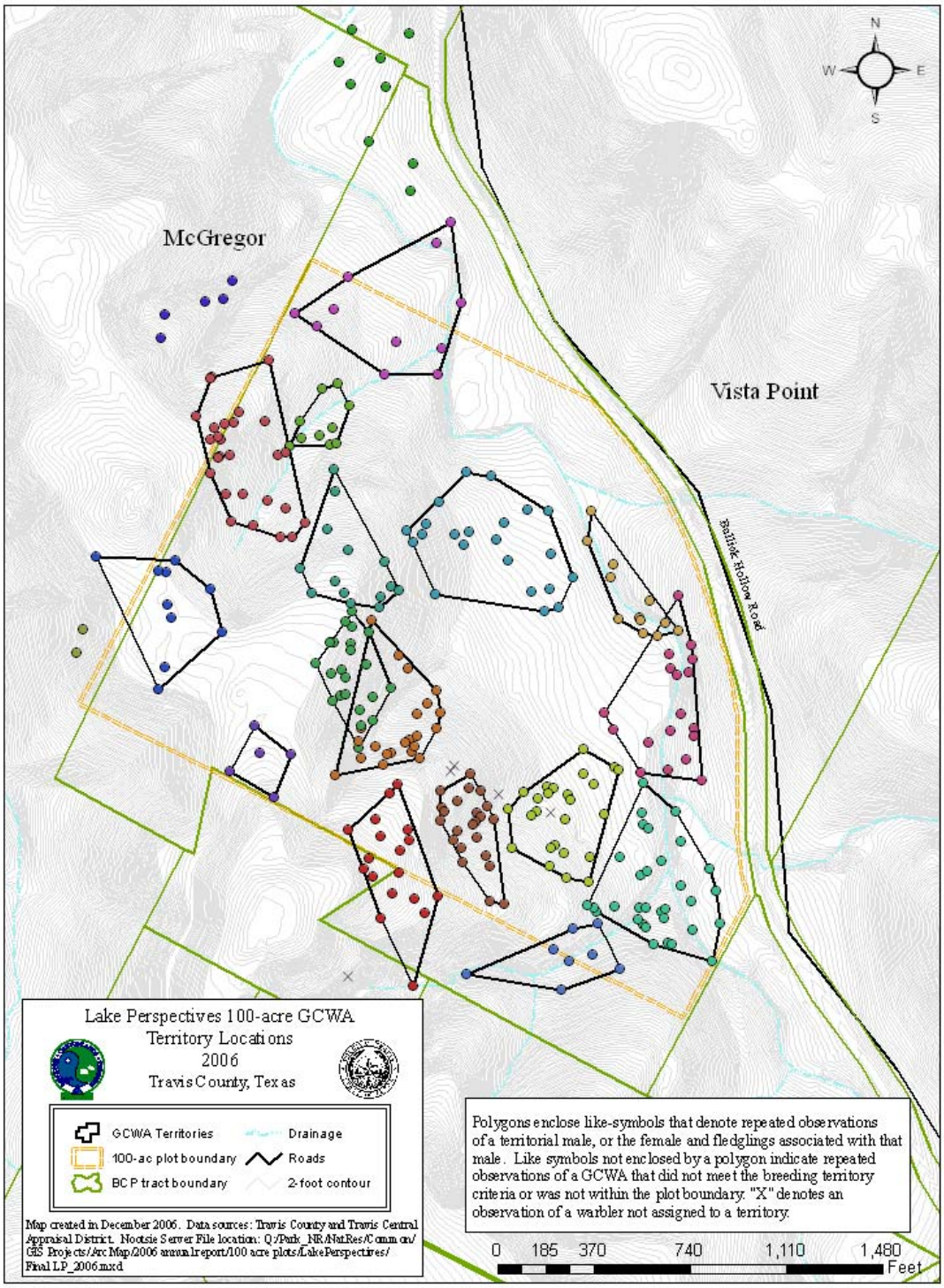

Figure 11. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Lake Perspectives 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

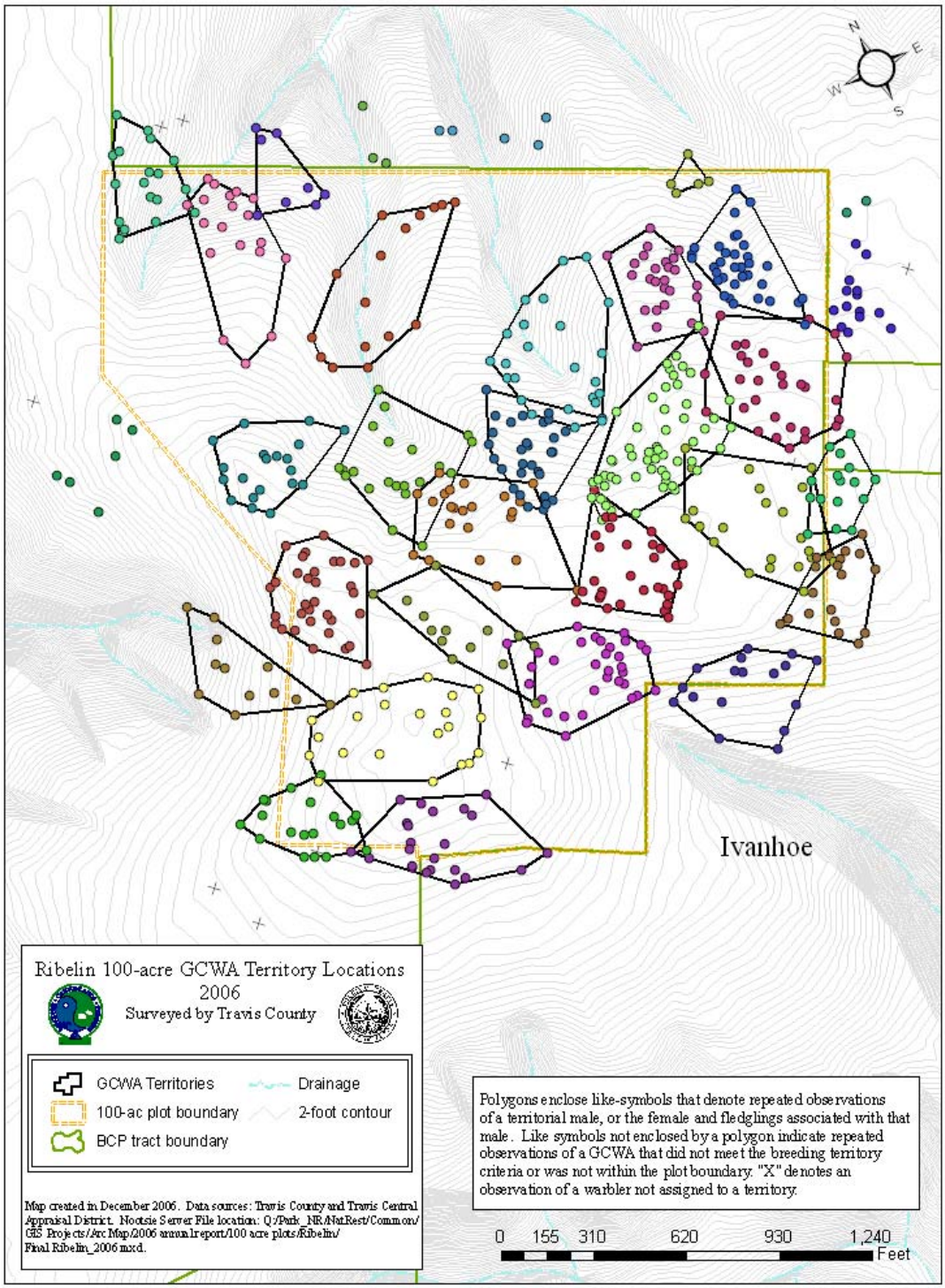

Figure 12. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Ribelin 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

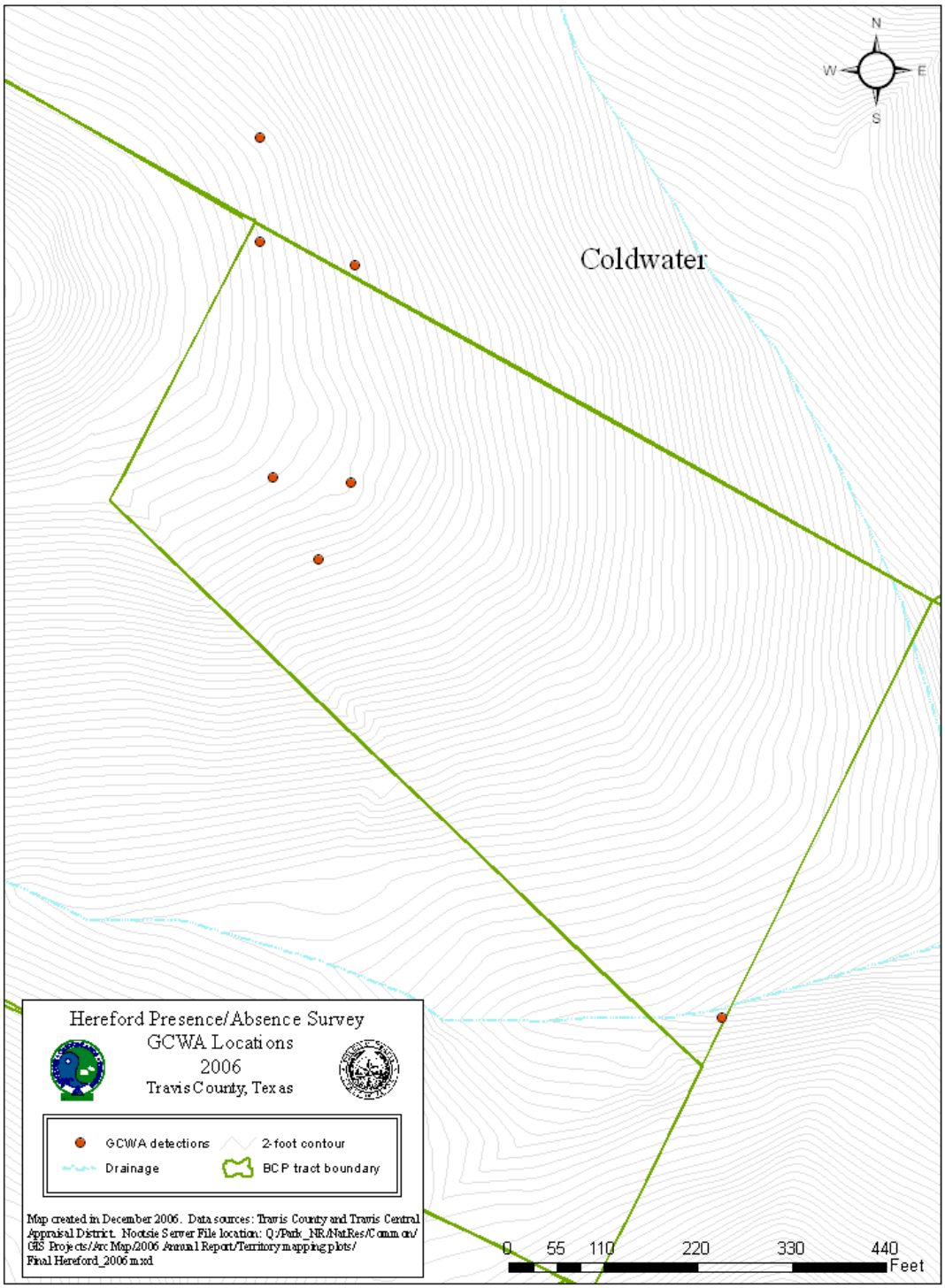

Figure 13. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) detections during presence/absence surveys on the Hereford tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

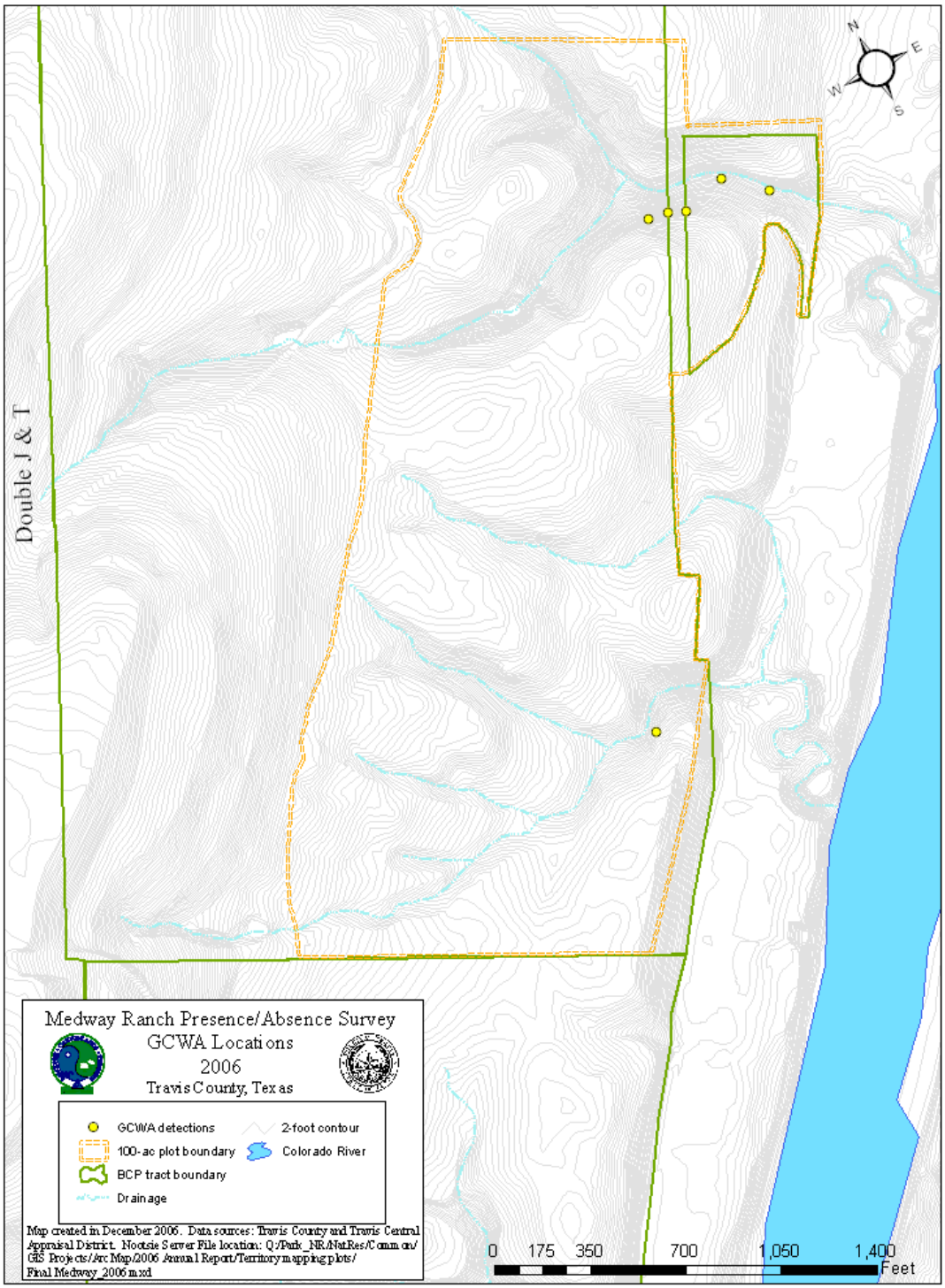

Figure 14. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) detections during presence/absence surveys on the Medway tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

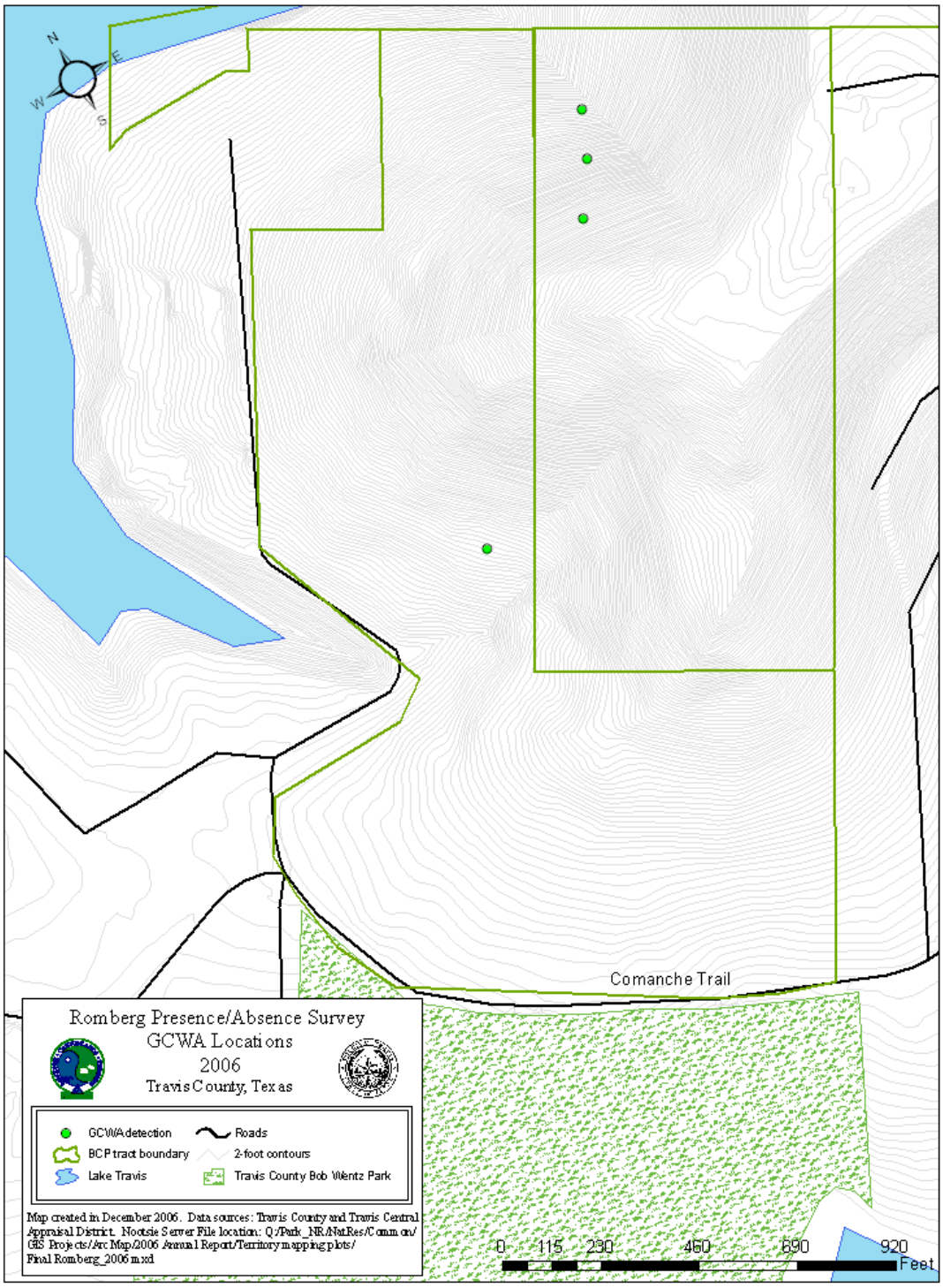

Figure 15. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) detections during presence/absence surveys on the Romberg tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

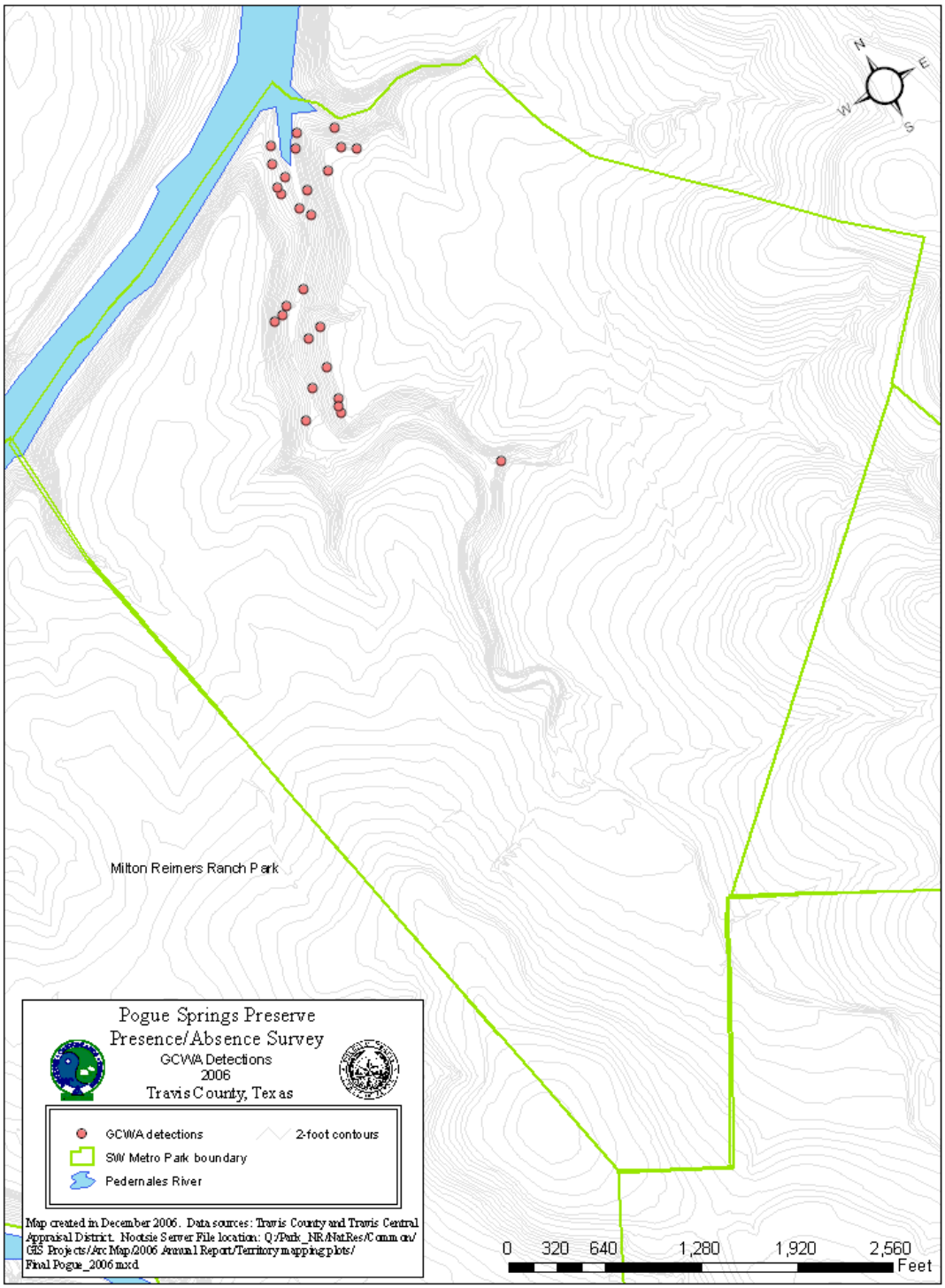

Figure 16. 2006 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) detections during presence/absence surveys on the Pogue Springs Preserve within the Southwestern Metropolitan Park in western Travis County, Texas.

Appendix A

Past Productivity Data for Travis County 100-acre golden-cheeked warbler study plots*

Hamilton Pool	2002	2003	2004	2005	2006	**Average**
Pair Success	0.80	0.83	0.86	1.00	0.38	**0.77**
Breeding Success	0.40	0.67	0.43	1.00	0.25	**0.55**
Estimated Brood Size	1.50	2.00	1.66	1.80	1.50	**1.69**
Productivity	0.60	1.33	0.71	1.80	0.38	**0.96**

Lake Perspectives	2002	2003	2004	2005	2006	**Average**
Pair Success	0.88	1.00	0.75	0.71	0.55	**0.78**
Breeding Success	0.75	0.86	0.50	0.71	0.18	**0.60**
Estimated Brood Size	1.83	2.16	2.25	2.20	0.33	**1.75**
Productivity	1.38	1.86	1.13	1.57	0.18	**1.35**

Bunten	2003	2004	2005	2006	**Average**
Pair Success	0.92	1.00	0.73	0.73	**0.85**
Breeding Success	0.75	0.80	0.67	0.68	**0.73**
Estimated Brood Size	1.89	2.50	2.80	1.75	**2.24**
Productivity	1.42	2.00	1.86	1.27	**1.64**

* 2006 was the first year Ribelin was included as a prime 100-acre study plot, therefore data is not included here, but it can be viewed in Table 4 of the document.

**Data presented in this appendix are different from values listed in past reports due to previous calculation errors.