Monitoring of the golden-cheeked warbler (*Dendroica chrysoparia)* In western Travis County, Texas: 2008 Field Season



Photo: The Nature Conservancy, Ft. Hood, 1998

Travis County
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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 habitat loss and fragmentation 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 (a Habitat Conservation Plan) was approved by the USFWS and a 10(a)1(b) permit issued 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 2007). 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 currently manages 4,611 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.

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; 2006; 2007). In 2008, Travis County Natural Resources monitored golden-cheeked warblers on ten BCP tracts covering

1,107 acres (ac) (448 hectares (ha)) (**Figure 2; Table 1**). Territory mapping of entire preserve tracts was conducted on Concordia (newly acquired in 2007), Greenshores, and Snowden (newly acquired in 2007). Surveys were conducted on 151 acres of the total 175 acres of Grandview Hills-North (this includes the Grandview Hills Section 8 tract) due to access difficulties. The unsurveyed portion will be added to the Vista Point tract surveys in the future. 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). Golden-cheeked warbler surveys were also conducted on two county parks: Tom Hughes and the Pogue Springs Preserve component of the Southwest Metropolitan Park. Hicks and Company surveyed additional portions of Ribelin and Pace Bend Park during the 2008 survey season. Please refer to the appropriate technical memoranda in Appendices K and O of the 2008 Balcones Canyonlands Conservation Plan Annual Report for further information about these surveys.

In addition to these surveys, territory and productivity data were collected on five annually monitored, permanent prime habitat 100-acre (40.4 ha) study plots at Bunten, Canyon Vista, Hamilton Pool Preserve (hereafter Hamilton Pool), Lake Perspectives, and Ribelin tracts. Canyon Vista was surveyed for the first time as a prime habitat 100-acre study plot during the 2008 survey season. Also, surveys were done on Steiner Ranch #2, which has a permanent, transitional habitat 100-acre study plot within its boundaries, and it will be visited every other year. On these plots, data were collected on territory density and location, pairing success, breeding success, and productivity.

METHODS

STUDY SITES

The Jollyville Unit (2,037 ac/825 ha) is located in northwest Travis County in the Cypress Creek macrosite (Balcones Canyonlands Preserve 1999) (**Figure 1**), and includes, but is not limited to, the tracts of Bunten, Grandview Hills-North, Lake Perspectives, and Snowden (**Figure 2**). Steiner Ranch Preserve (819 ac/332 ha) is located off RM 620 (**Figure 1 & 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 Greenshores (52 ac/21 ha) tract is located in the North Lake Austin macrosite (**Figure 1 & 2**). Greenshores is located near the Oak Shores and Pearce Roads off of City Park Road

and 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 that give way to a steep, mesic canyon.

The Ribelin tract is located within the Bull Creek macrosite (**Figure 1 & 2**). 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.

The Concordia Preserve (hereafter Concordia) tract is located within the Bull Creek macrosite (**Figure 1 & 2**). This 250-acre (101 ha) conservation easement is managed in conjunction with Concordia Lutheran University. The tract is located to the east of RM 620 and Concordia University Drive. Concordia is adjacent to City of Austin's Canyon Creek, Lanier and WTP4 BCP tracts, residential and commercial areas, and the Concordia University campus. Two extensive canyons bisect this tract, which contain a number of springs and perennial to intermittent creeks. The uplands consist of mostly closed canopy oak-juniper woodlands and large open grass areas. The canyon areas support mature mesic hardwood species in the overstory and a diverse array of shrubs and forbs in the understory. Primary soils on this tract are found in the Tarrant and Volente series (Soil Conservation Service 1974). Previous human use of this tract is evident throughout in the form of trails, pond impoundment, roads, and ranch fencing.

The 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. 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 while Tarrant series soils occur on steep slopes and in canyons (Soil Conservation Service 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 large tracts of privately owned land are found along the southern boundary.

Hamilton Pool (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 & 2**) (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 2007).

Pogue Springs Preserve (hereafter, PSP) is located within the 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 nor is it open to the general public. 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.

Tom Hughes Park (15 ac/6.1 ha) is located on the south shore of Lake Travis (**Figure 2**). At this park, vegetation is typical of western Travis County with hilly to steep topography dominated by oak-juniper woodlands. All Travis County parks experience year-round recreational use.

TRACT TERRITORY MAPPING

Data Collection

Territory mapping of golden-cheeked warblers was conducted from 24 March to 27 May 2008 on the following Travis County preserve tracts: Concordia, Grandview Hills-North, Greenshores, and Snowden (**Figure 2**). Territory mapping also occurred on Pogue Springs Preserve. 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 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, 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 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

onto the hard-copy digital orthophoto maps. All observations of brown-headed cowbirds (*Molothrus ater*) and any signs of nest parasitism were also noted. Brown-headed cowbird fledglings were to be safely dispatched if observed 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 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 2008, territory mapping was conducted on five 100-acre permanent plots on the following preserves: Bunten, Canyon, Vista, Hamilton Pool, Lake Perspectives, 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 2007). The 100-acre plot methodology was also used on a plot established on the Steiner Ranch #2 tract. 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 as the abovementioned territory mapping with some exceptions. Territory mapping was conducted between 24 March and 12 June 2008 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. The 100-acre prime study plots were visited a total of 60 hours distributed evenly throughout the season. During the 100-acre transitional plot surveys, the site is visited for a total of 30 hours. Also, the transitional 100-acre plots will only be surveyed on alternate years and not every year like the prime plots. 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 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 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 plots, the tract territory mapping methodology was utilized (see aforementioned section). 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 Travis County's Tom Hughes Park. Presence/absence surveys followed U.S. Fish and Wildlife Service minimum procedures for golden-cheeked warbler presence/absence surveys (USFWS 1994).

RESULTS AND DISCUSSION

During field season 2008, all golden-cheeked warbler surveys were conducted between 24 March and 12 June on 1,107 acres, and the total amount of time-spent surveying was 441 hours (**Table 1**). Additionally, Tom Hughes Park was visited five times throughout the survey season, and Pogue Springs Preserve surveys were conducted between 25 March and 26 May 2008 for a total of 22 hours.

Table 1. List of Travis County Balcones Canyonlands Preserve (BCP) tracts surveyed for golden-cheeked warblers (*Dendroica chrysoparia*) during the 2008 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 - 5/29/08	60
Canyon Vista	100	3/27 – 5/28/08	60
Hamilton Pool	100	3/24 - 6/11/08	60
Lake Perspectives	100	4/02 - 6/11/08	60
Ribelin	100	3/25 - 6/12/08	60
Total	**500**	**3/24 - 6/12/08**	**300**
100-acre transitional plot			
Steiner Ranch #2	100	3/28 - 6/11/08	18
Total	**100**	**3/28 - 6/11/08**	**18**
Territory Mapping			
Concordia	250	3/25 - 5/27/08	57
Grandview Hills-North	151	3/26 - 5/22/08	32
Greenshores	52	3/24 - 5/12/08	18
Snowden	54	3/26 - 5/27/08	16
Total	**507**	**3/24 - 5/27/08**	**123**
Overall Total	**1107**	**3/24 - 6/12/08**	**441**

TRACT TERRITORY MAPPING

Overall, 507 acres were mapped for golden-cheeked warbler territories for 123 hours during the 2008 field season (**Table 1**). The tracts surveyed were Concordia, Grandview Hills-North, Greenshores, and Snowden. The total abundance of golden-cheeked warbler males on all tracts surveyed was 66. Abundance was greatest on the Concordia tract (33), and

Snowden (9) had the least abundance (**Table 2**). The Concordia tract also had the greatest number of modified territories (18), however Greenshores had the greatest territory density overall (0.12/ac; 0.29/ha) (**Table 2**). Snowden (0.05/ac; 0.11/ha) and Grandview Hills-North (0.03/ac; 0.08/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 2008 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]
Concordia (250)	33	13	23	18	0.07	0.18
Grandview Hills-North (152)	14	3	7	5	0.03	0.08
Greenshores (52)	10	4	8	6	0.12	0.29
Snowden (54)	9	2	3	2.5	0.05	0.11

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

Figures 3 through 6 illustrate territory distribution and abundance for each of the BCP 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.

During the golden-cheeked warbler surveys on Pogue Springs, two males were detected in the northern part of the canyon that feeds into the Pedernales River (**Figure 12**). One of the males was seen with a female and three fledglings. Territory density per hectare was 0.009 for the 202 ha parcel.

Additional observations

Warbler nests were not systematically searched for during the territory mapping surveys, and no nests were located during the 2008 field season on Concordia, Grandview Hills-North, Greenshores, or Snowden. Construction noise from the Concordia University site to the west of the Concordia tract impacted detectability of warblers during surveys. Most of the surveyed tracts have a substantial feral hog issue, which is being addressed through hog

trapping by approved local trappers. Strong winds, warmer than normal temperatures, and below average rainfall from March to June may have impacted detectability of singing males.

100-ACRE PRIME PLOTS

Territory Density

In the 2008 field season on the 100-acre prime plots, an average of 16.8 modified territories were established per 100 acres or an average of 44 territories per 100 hectares (**Table 3**). Thirty-five males were detected during the 100-acre plot surveys on Bunten, 32 males at Ribelin, 27 males at Canyon Vista, and 22 and 11 males were detected on the Lake Perspectives and Hamilton Pool study plots, respectively (**Table 3**). The Bunten 100-acre plot had 23.5 modified territories, which was greater than the number of modified territories on Ribelin (20.5), Canyon Vista (18), Lake Perspectives (13.5), or Hamilton Pool (8.5) (**Table 3**). On the Bunten study plot, 19 territories fell entirely within plot boundaries and 9 were edge territories. Within the Ribelin plot, 15 territories were contained in the boundaries and 11 were considered edge territories. There were 14 full territories within the 100-acre plot on Canyon Vista, while eight were determined to be 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, seven 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 58 territories per 100 hectares (one male per 1.7 ha). Ribelin had the second highest territory density of 51 territories per 100 hectares or, in other words, one male per 1.96 hectares. Canyon Vista had a moderate territory density with 1 male per 2.5 ha. Territory density at Lake Perspectives was less than Bunten, Ribelin, and Canyon Vista (33 territories per 100 hectares or one male per 3.0 ha), but Hamilton Pool had the least number of territories overall (21 territories per 100 ha or one male per 4.8 ha) (**Table 3**).

Appendix A includes territory density data for the past seven years for Hamilton Pool and Lake Perspectives, six years for Bunten, and three years for Ribelin. Since surveys on Canyon Vista's 100-acre plot began in the 2008 field season, only this year's data are presented.

Table 3. Results of the 2008 golden-cheeked warbler (*Dendroica chrysoparia*) territory mapping on Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives, and Ribelin 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 per 100 hectares.

100-acre Prime Study Plot	Abundance	No. of full territories	No. of full and edge territories	Modified number of territories[a]	Territory density per 100ha[b]
Bunten	35	19	28	23.5	58
Canyon Vista	27	14	22	18	40
Hamilton Pool	11	7	10	8.5	21
Lake Perspectives	22	11	16	13.5	33
Ribelin	32	15	26	20.5	51
Average				**16.8**	**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 7 through 11 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, residential development to the south, and the center of the plot is comprised mostly of grasslands with intermittent large hardwood trees. This habitat type is generally considered unsuitable for breeding golden-cheeked warblers. Canyon Vista represents a tract that has moderately excellent habitat, but is almost completely surrounded by residential development. This may explain the mid-range territory density numbers

presented in Table 3. 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. Individual males will utilize the uplands, which contain less than optimal habitat. However, 2008 was the first year that multiple males established territories in the uplands of Hamilton Pool, which may be an indication that the habitat is improving over time. In 1996, Hamilton Pool was designated a prime plot in the Balcones Canyonlands Preserve Handbook (Balcones Canyonlands Preserve 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 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 five 100-acre prime plots, the average pairing success was 71%. The highest pairing rate (95 %) occurred at Bunten with one female or at least one observed fledgling for every full territory. At Hamilton Pool, 71% of all males were determined to have paired with females, at Ribelin, 66% of all males were paired, 64% of males paired with females at Lake Perspectives, and only 57% of the full territories at Canyon Vista were successfully paired (**Table 4**).

The breeding success rate for all four plots ranged from 0.36 to 0.60 with an average of 49% of pairs successfully raising a brood; Ribelin had fledglings in 60% of the full territories on the plot. Each successfully paired territory averaged 1.43 fledglings (range: 1.00 to 1.80), while each full territory averaged 1.00 fledgling (range: 0.57 to 1.21) (**Table 4**). With the varying rates of success, no clear pattern emerges from the productivity data other than Canyon Vista had lower values overall. A total of 57 fledglings were observed in 33 broods across all five 100-acre study plots.

Appendix B includes productivity data for the past seven years for Hamilton Pool and Lake Perspectives, six years for Bunten, and three years for Ribelin. Since surveys on Canyon Vista's 100-acre plot began in the 2008 field season, its data is only presented in Table 4.

Table 4. Golden-cheeked warbler pairing success rate; breeding success rate; and productivity per successful pair and full territory for the five Travis County prime habitat 100-acre prime plots, Bunten, Canyon Vista, Hamilton Pool, Lake Perspectives, and Ribelin. Data collected during the 2008 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	19	18	11	0.95	0.58	1.33	1.21
Canyon Vista	14	8	5	0.57	0.36	1.00	0.57
Hamilton Pool	7	5	4	0.71	0.57	1.60	1.14
Lake Perspectives	11	7	4	0.64	0.36	1.43	0.91
Ribelin	15	10	9	0.66	0.60	1.80	1.20
Average				**0.71**	**0.49**	**1.43**	**1.00**

100-ACRE TRANSITIONAL PLOT

A 100-acre plot on the Steiner Ranch #2 tract in the North Lake Austin Unit was surveyed between 28 March and 11 June 2008 for a total of 18 survey hours. No golden-cheeked warblers were detected during the surveys. Ideally, the marginal habitat within this 100-acre plot will transition into habitat that can eventually support warblers.

Additional observations

The first golden-cheeked warbler was detected on Travis County BCP property on 05 March 2008. Nests were discovered on every 100-acre prime plot this survey season except Ribelin. On Bunten, two nests were discovered on 24 April 2008, one in an Ashe juniper and the other in a mature shin oak (*Quercus sinuata*). Success for either nest was not determined and, incidentally, fledglings were never detected for either of these territories. Two nests (9 and 24 April 2008) were also found at Hamilton Pool, both in live oak (*Quercus fusiformis*). Fledglings were detected for each of these nests. One nest was discovered during surveys on the Lake Perspectives 100-acre plot on 28 May 2008, and the nest was located in a mature Ashe juniper. It was never determined if this nest attempt was successful. Three fledglings were associated with the nest found on Canyon Vista on 25 April 2008. The nest was located in an Ashe juniper.

The golden-cheeked warbler breeding season of 2008 experienced a drier than normal trend that began in September of 2007. By September 2008, central Texas was designated as undergoing extreme drought intensity. This designation was in stark contrast to weather patterns from the spring and summer of 2007, which was one of the wettest and coolest on record. A number of cold fronts moved through the area in March and April, but unusually warm temperatures occurred between the cold fronts. May and June are usually the wettest months of the year, but they were very dry in 2008. This dryness was also intensified by stronger than usual winds. Also, June 2008 was warmest on record at Camp Mabry, the closest weather monitoring station to Travis County BCP ("Weather Events").

PRESENCE/ABSENCE SURVEYS

One Travis County Park was visited to determine the presence of golden-cheeked warblers. Tom Hughes Park was visited April 17, May 7, 21, 28, and June 3, 2008 with no success in detecting a warbler. Some Travis County parks will be surveyed, on a rotational basis, 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

No brown-headed cowbird parasitism was documented during any of the surveys throughout the 2008 field season. For a summary of brown-headed cowbird trapping for 2008 see the "2008 Summary of Wildlife Management Activities on Travis County Tracts of the BCP" (Travis County Natural Resources 2008).

RECOMMENDATIONS

- Natural Resources staff should 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 due to cowbird parasitism, 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. However, staff will evaluate the possibility of adding a cowbird trap to this area.

- It is also recommended that Travis County Natural Resources continue to add additional 100-acre study plots. Staff intends to add one prime 100-acre plot in survey season 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 2008, there will be seven years of 100-acre plot data for Hamilton Pool and Lake Perspectives, six years of data for Bunten, and three years for Ribelin (see Appendix B). Travis County staff needs to perform basic statistical tests within each plot to elucidate between year differences in abundance and productivity. After sufficient data is collected for each 100-acre, Travis County should consider contracting a statistician to perform more complex statistical analyses on the data sets.

- Golden-cheeked warbler habitat enhancement needs to be performed in areas with a high density of juniper saplings to encourage hardwood regeneration.

- Golden-cheeked warbler monitoring should be continued on Travis County BCP tracts with ongoing vireo restoration projects to evaluate the response of warblers to vireo management activities.

- Any golden-cheeked warbler nests that are discovered during surveys need to 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.

- There is a dearth of information about the ecology of the golden-cheeked warbler, therefore Natural Resources staff is interested in providing opportunities to university researchers that want to implement a golden-cheeked warbler banding program on Travis County-managed BCP tracts. Color-bands can supplement and enhance the productivity and distribution data of the warbler as well as provide information about site-recruitment and fidelity within the BCP and range wide. Staff should continue to network with universities that may be interested in the BCP for research opportunities.

DATA MANAGEMENT

Information regarding data sets compiled for field season 2008 is provided below. All data sets are currently stored on the server at the Travis County BCP Field Office 9512 RM 620 North, Austin, Texas.

ArcGIS 9.2 shapefiles:

all_2008GCWA_data.shp
all_bunten_2008.shp
all_canyonvista_2008.shp
all_concordia_2008.shp
all_greenshores_2008.shp
all_gvhn_2008.shp
all_hp_2008.shp
all_lp_2008.shp
all_poguesprings_2008.shp
all_renegaderidge_2008.shp
all_ribelin_2008.shp
all_snowden_2008.shp

Description: Golden-cheeked warbler geospatial files for 2008 field season
Software: ArcGIS 9.2
Nootsie Field Office Archive Location: Q:\Park_NR\NatRes\Common\Gcwa\GCWA 2008\2008 GCWA shapefiles\GCWA Data - 2008

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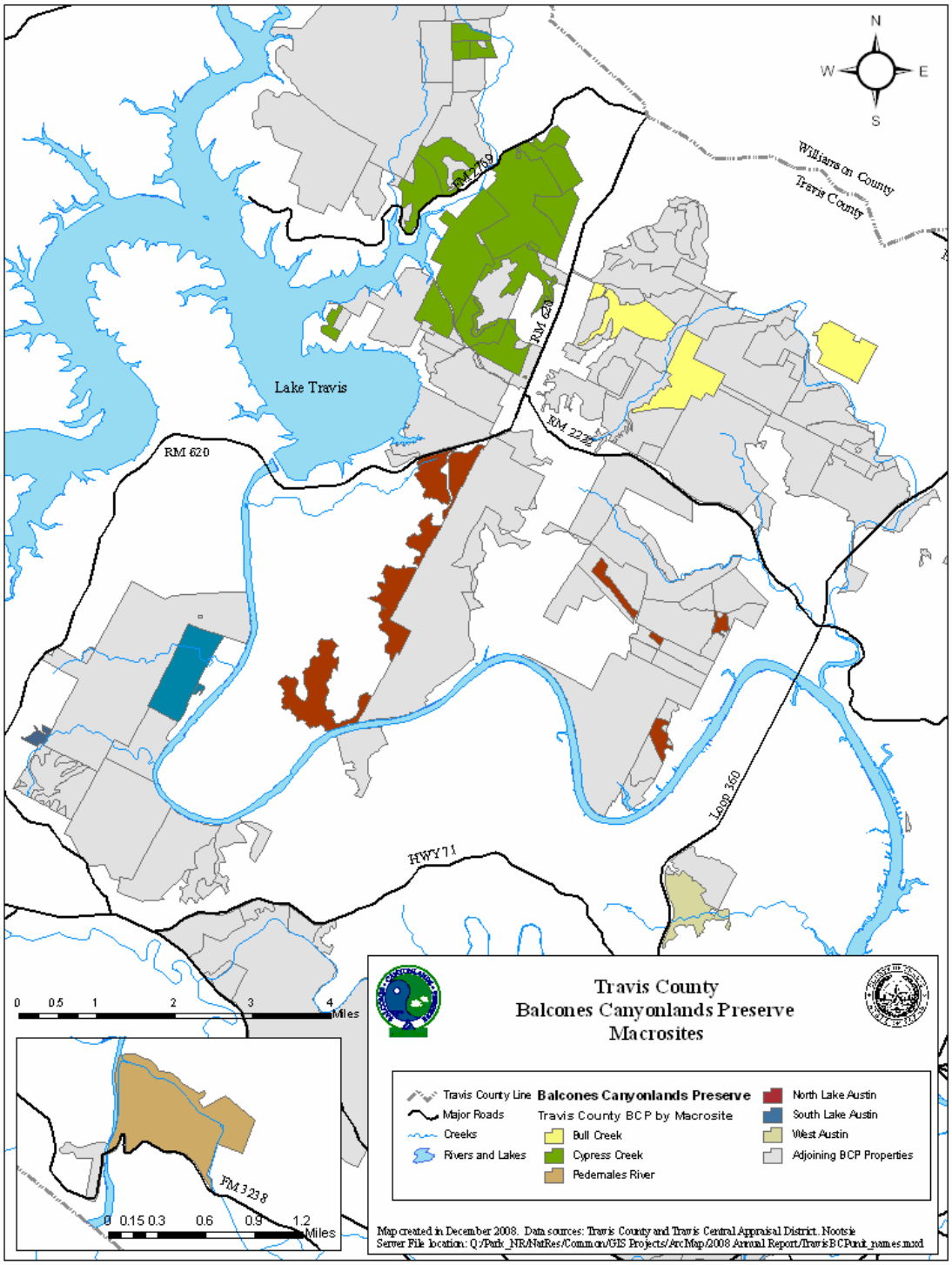


Figure 1. Location of Travis County Balcones Canyonlands Preserve properties by macrosite throughout western Travis County, Texas.

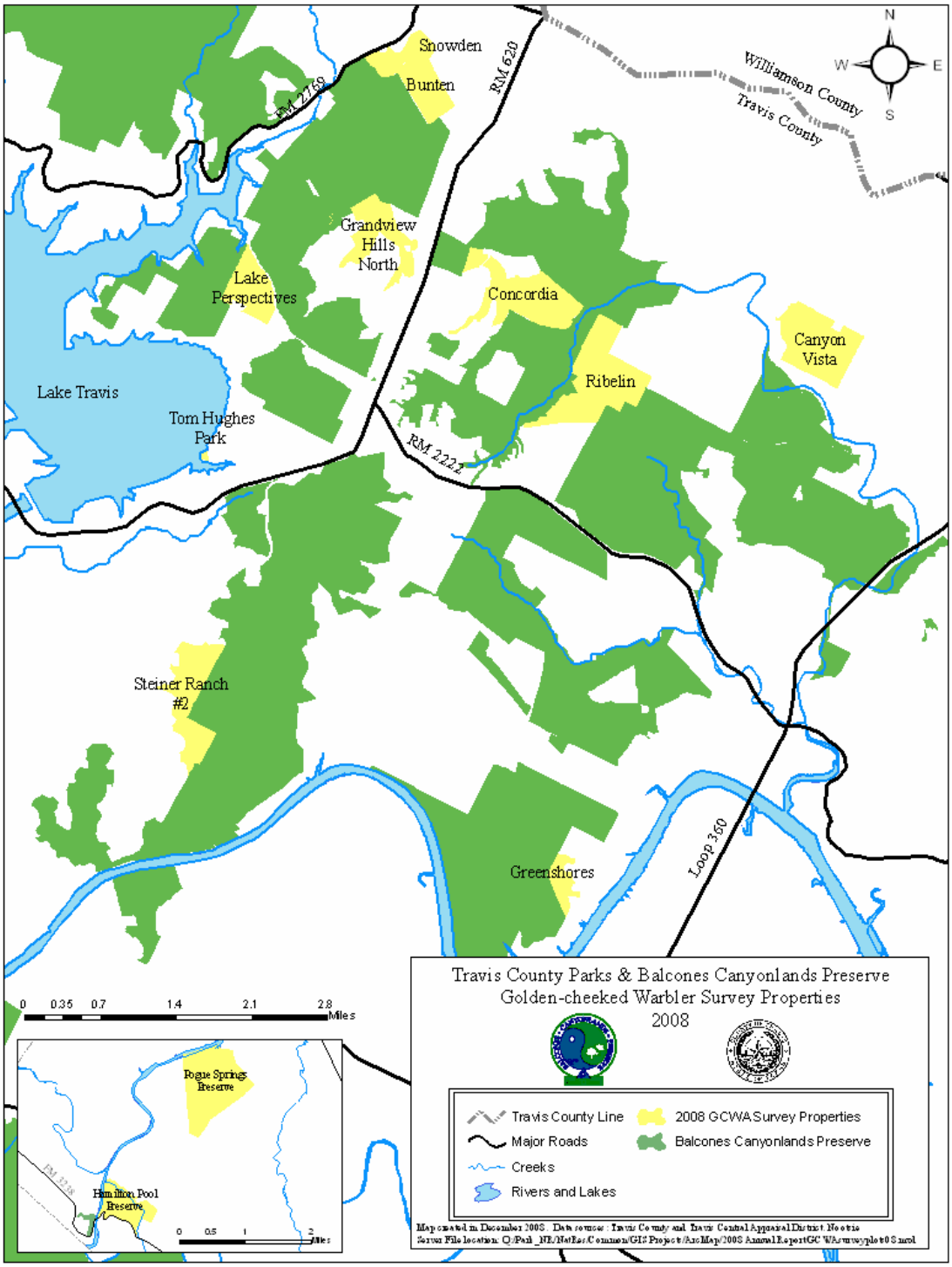


Figure 2. Location of Travis County-managed Parks and Balcones Canyonlands Preserve tracts surveyed for golden-cheeked warblers (*Dendroica chrysoparia*) in 2008.

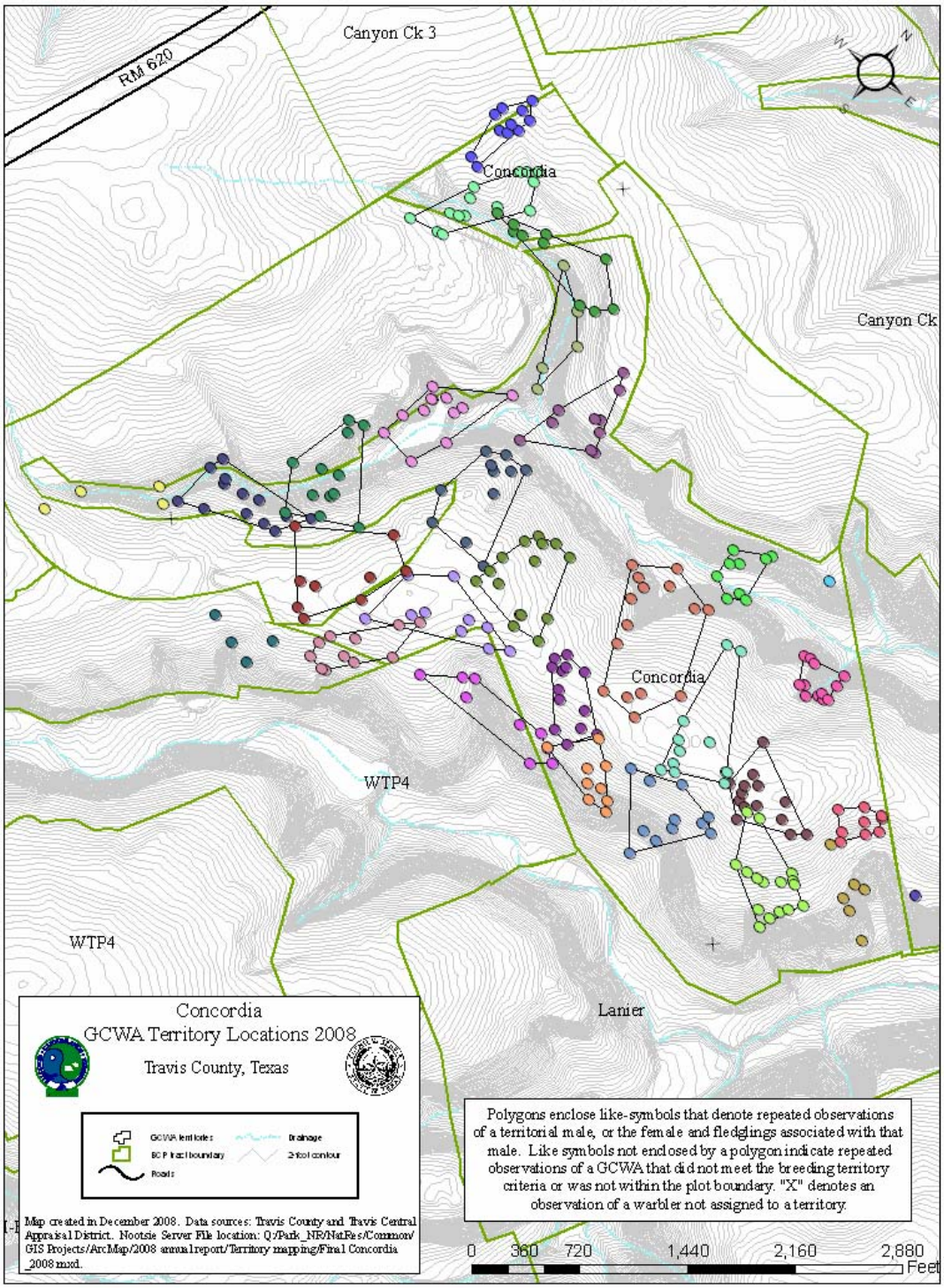


Figure 3. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Concordia tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

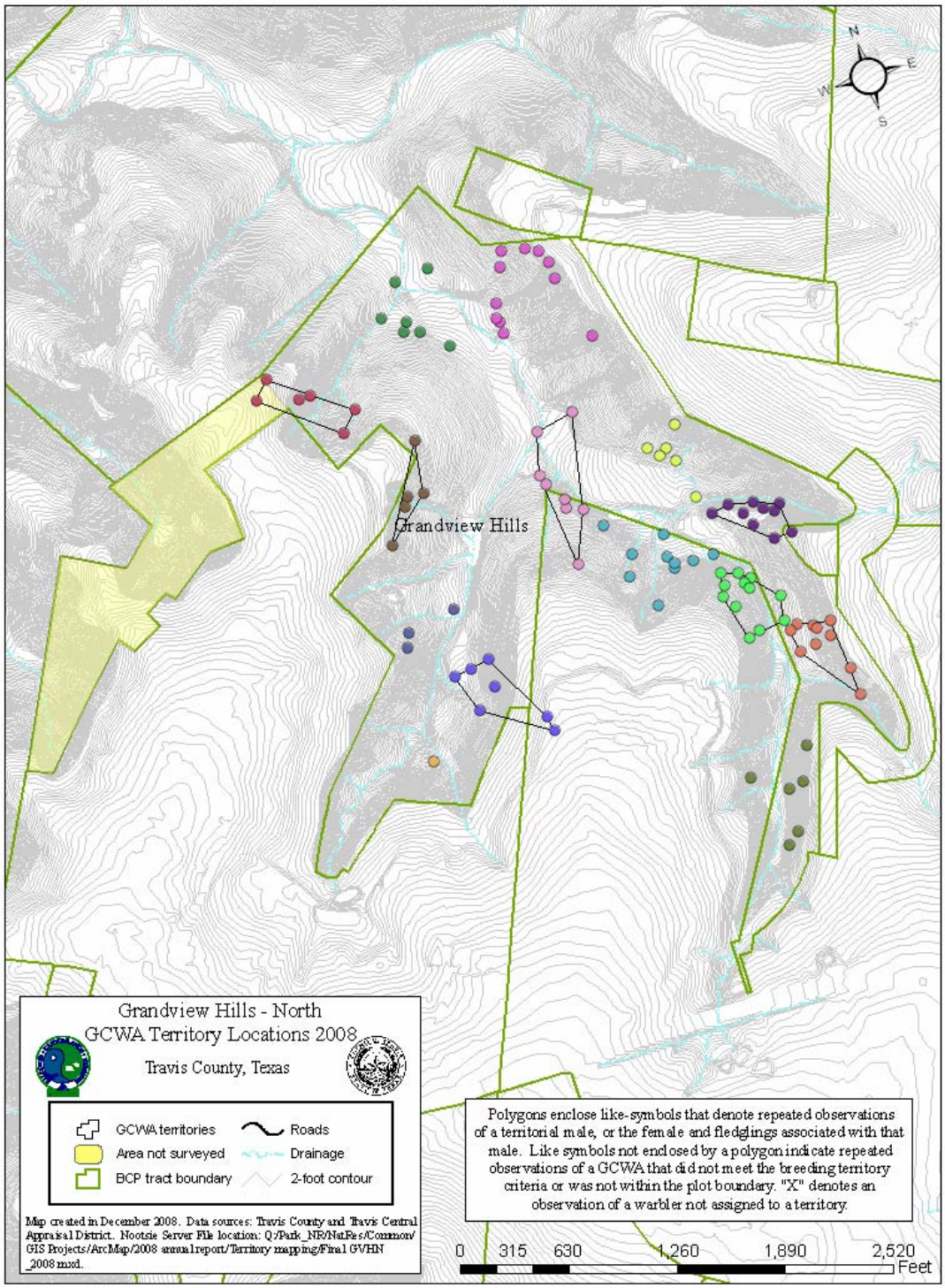


Figure 4. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Grandview Hills-North tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

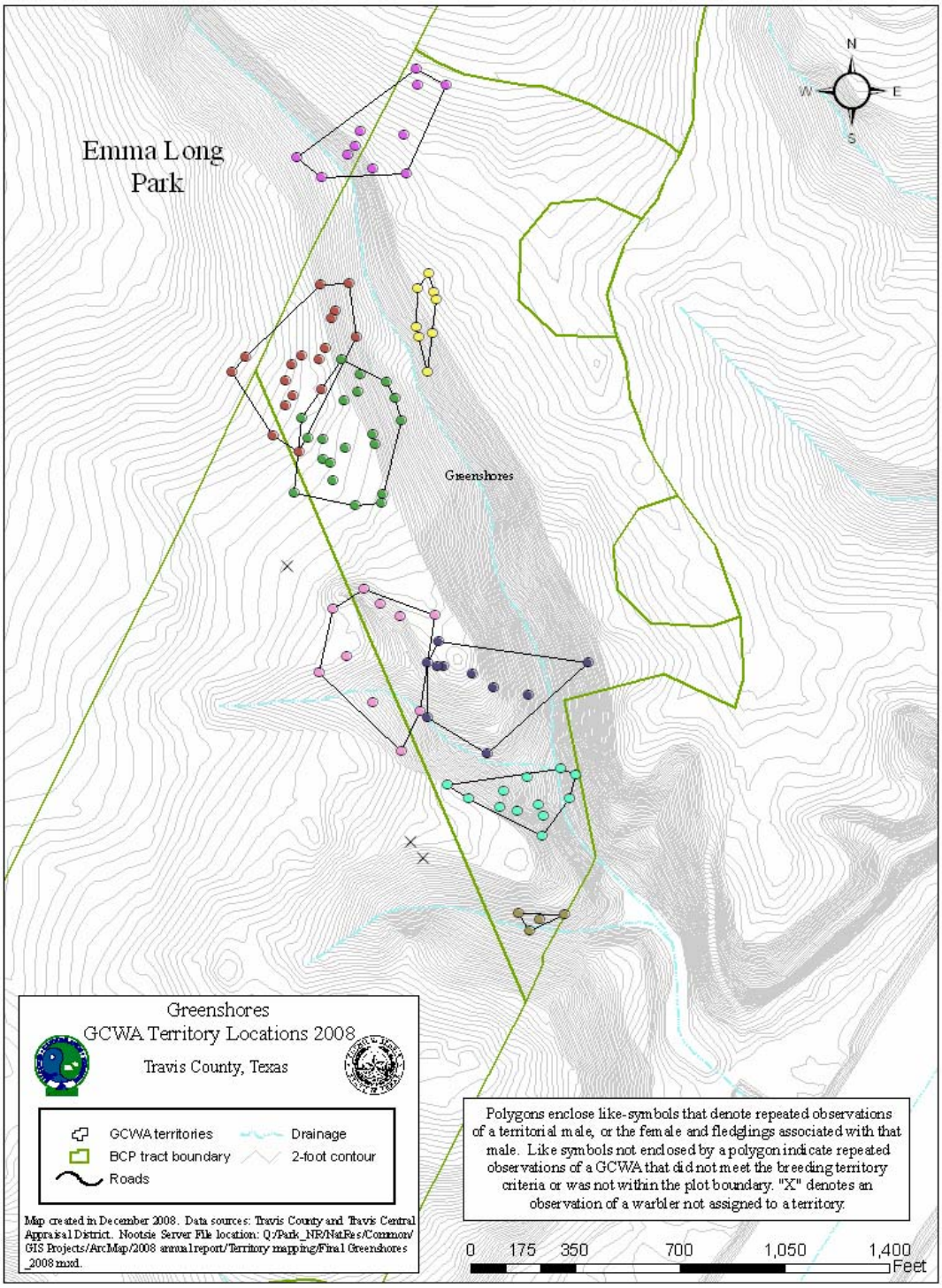


Figure 5. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Greenshores tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

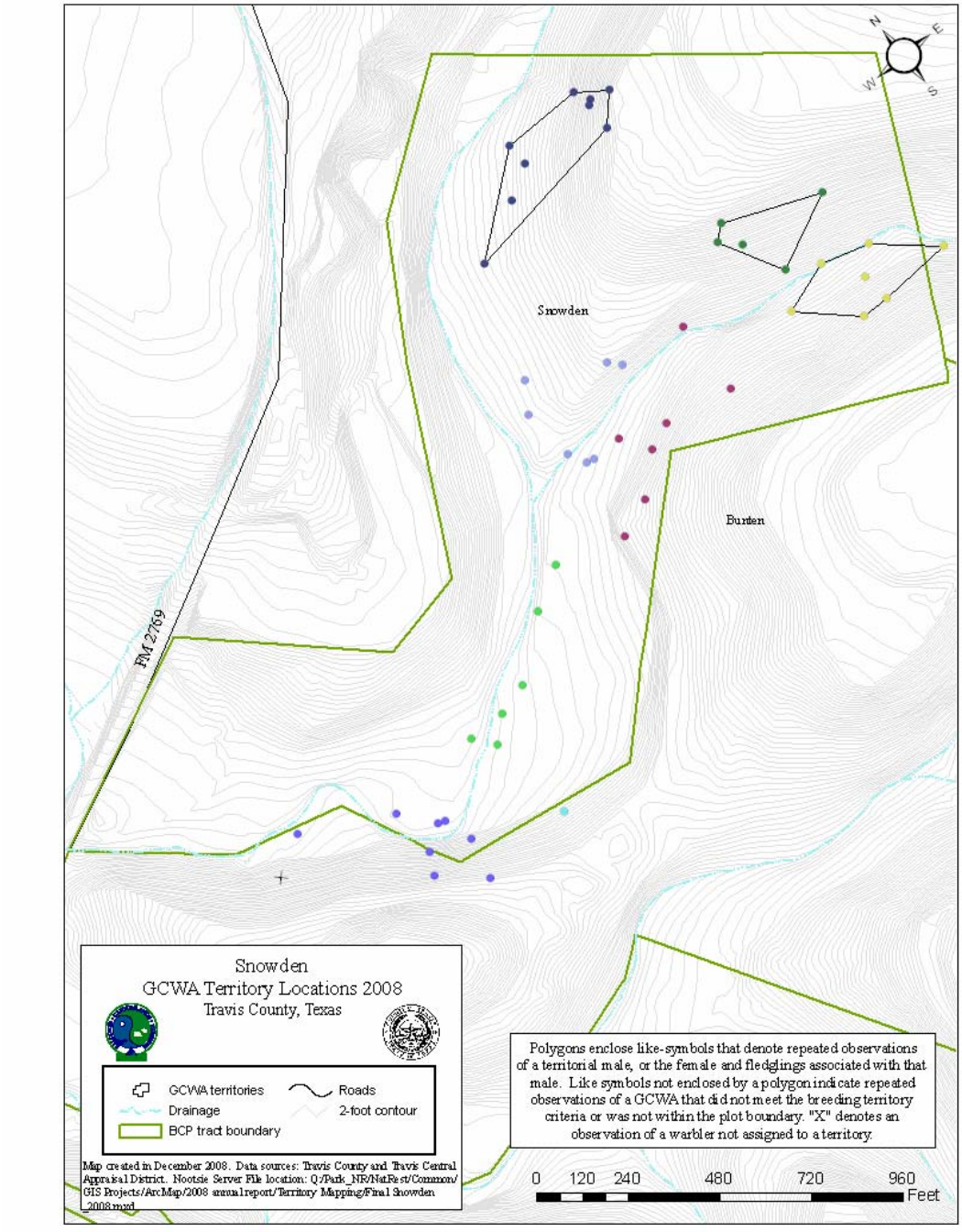


Figure 6. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Snowden tract within the Balcones Canyonlands Preserve in western Travis County, Texas.

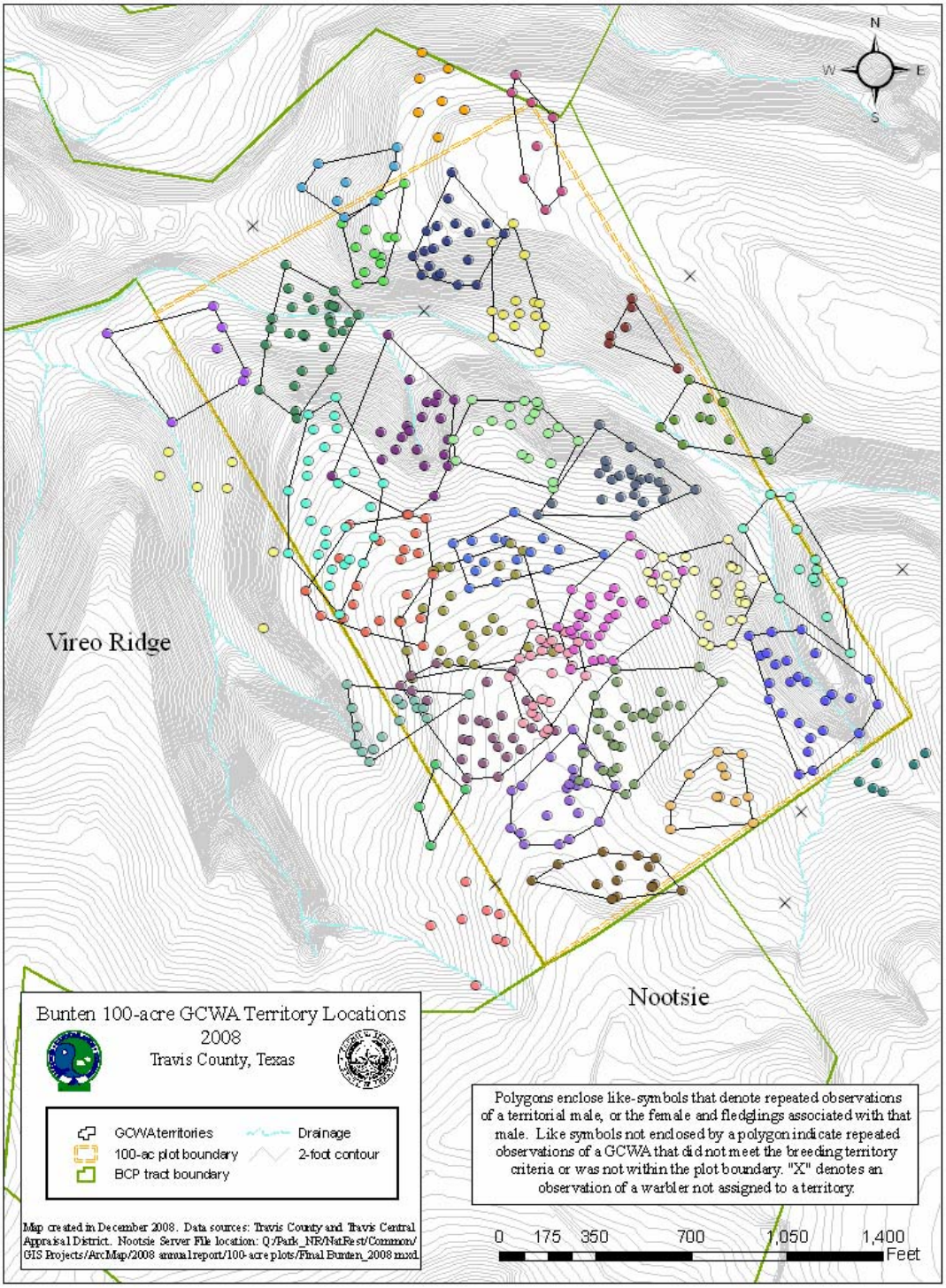


Figure 7. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Bunten prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

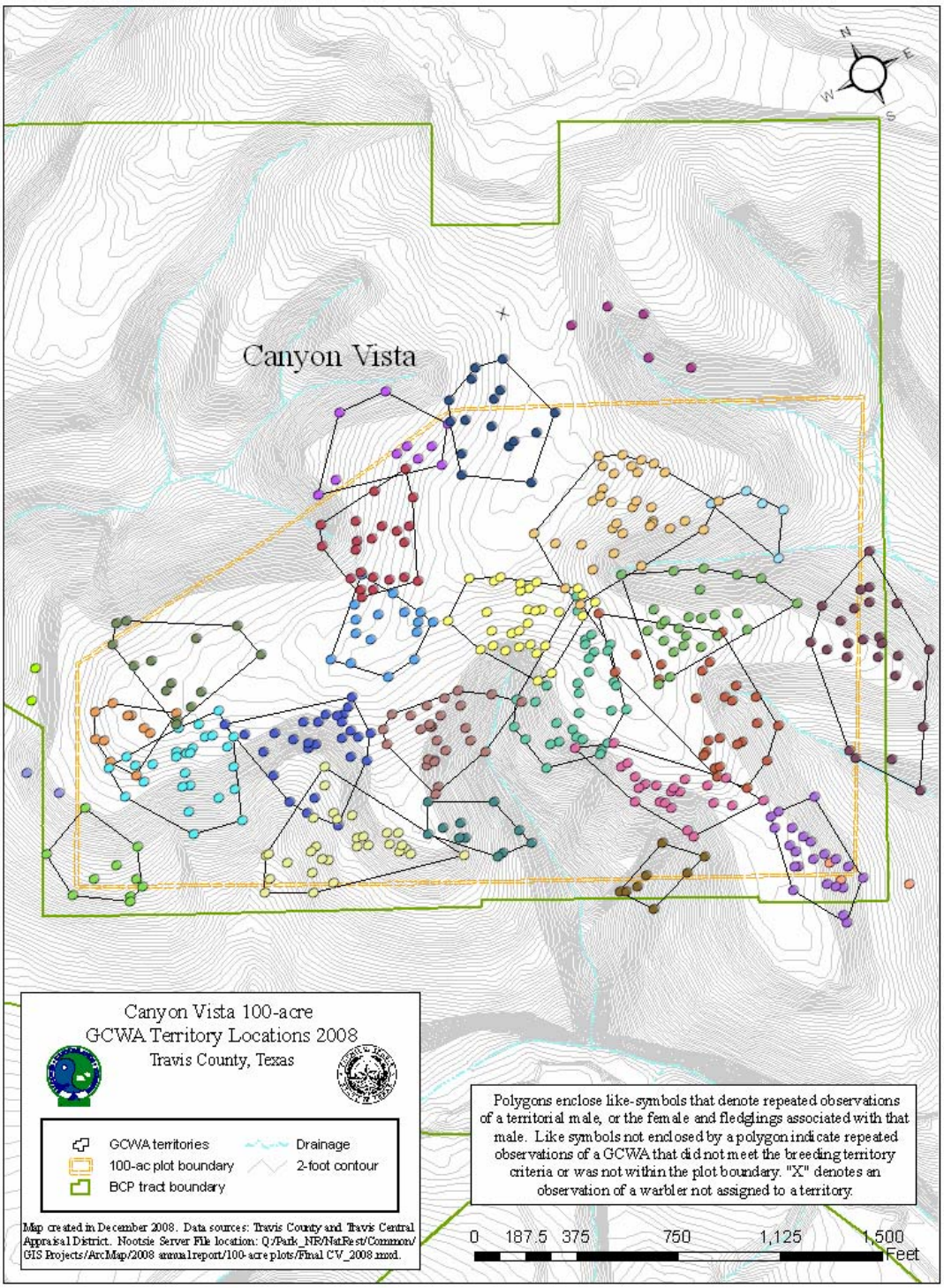


Figure 8. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Canyon Vista prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

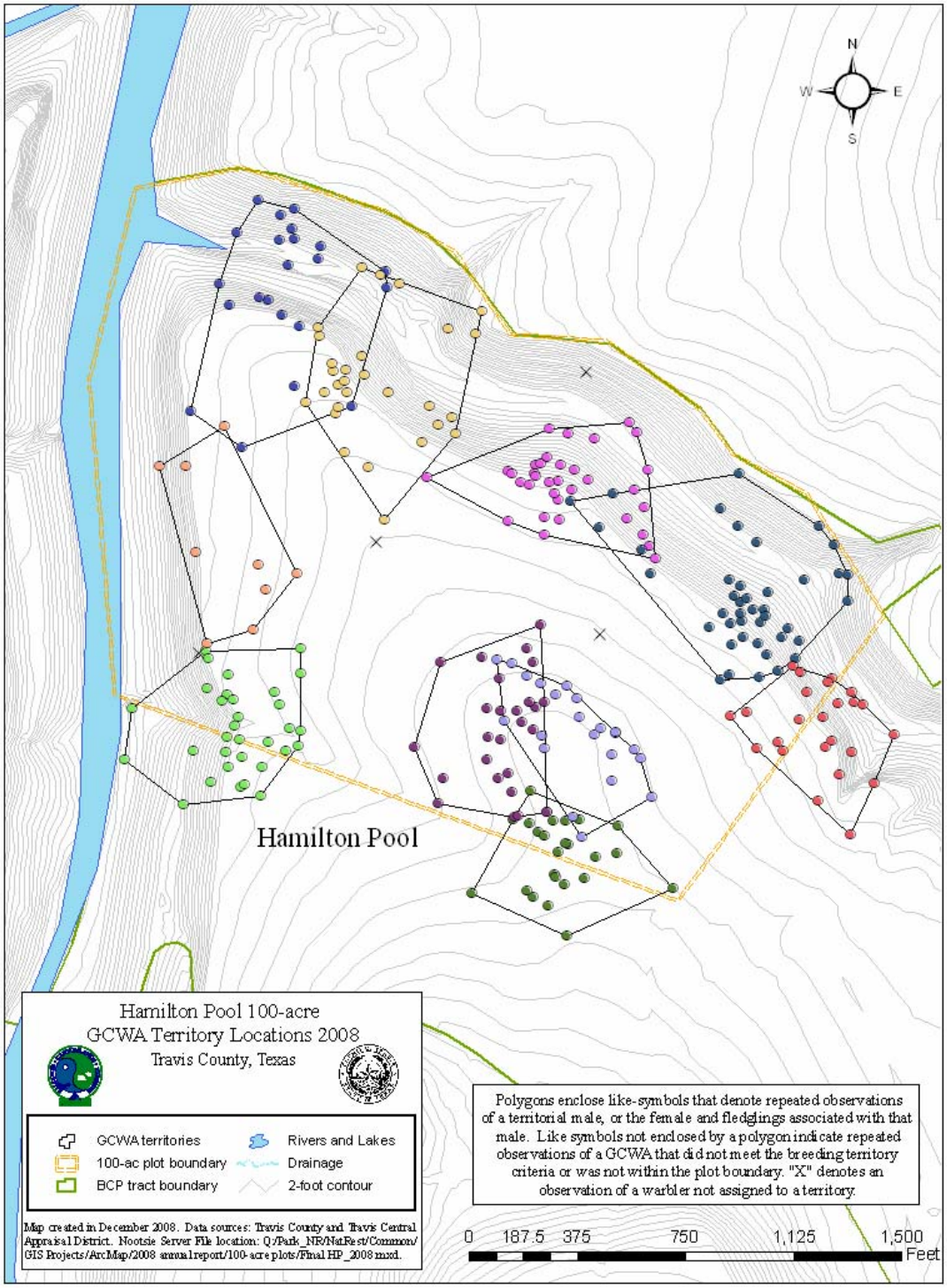


Figure 9. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Hamilton Pool prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

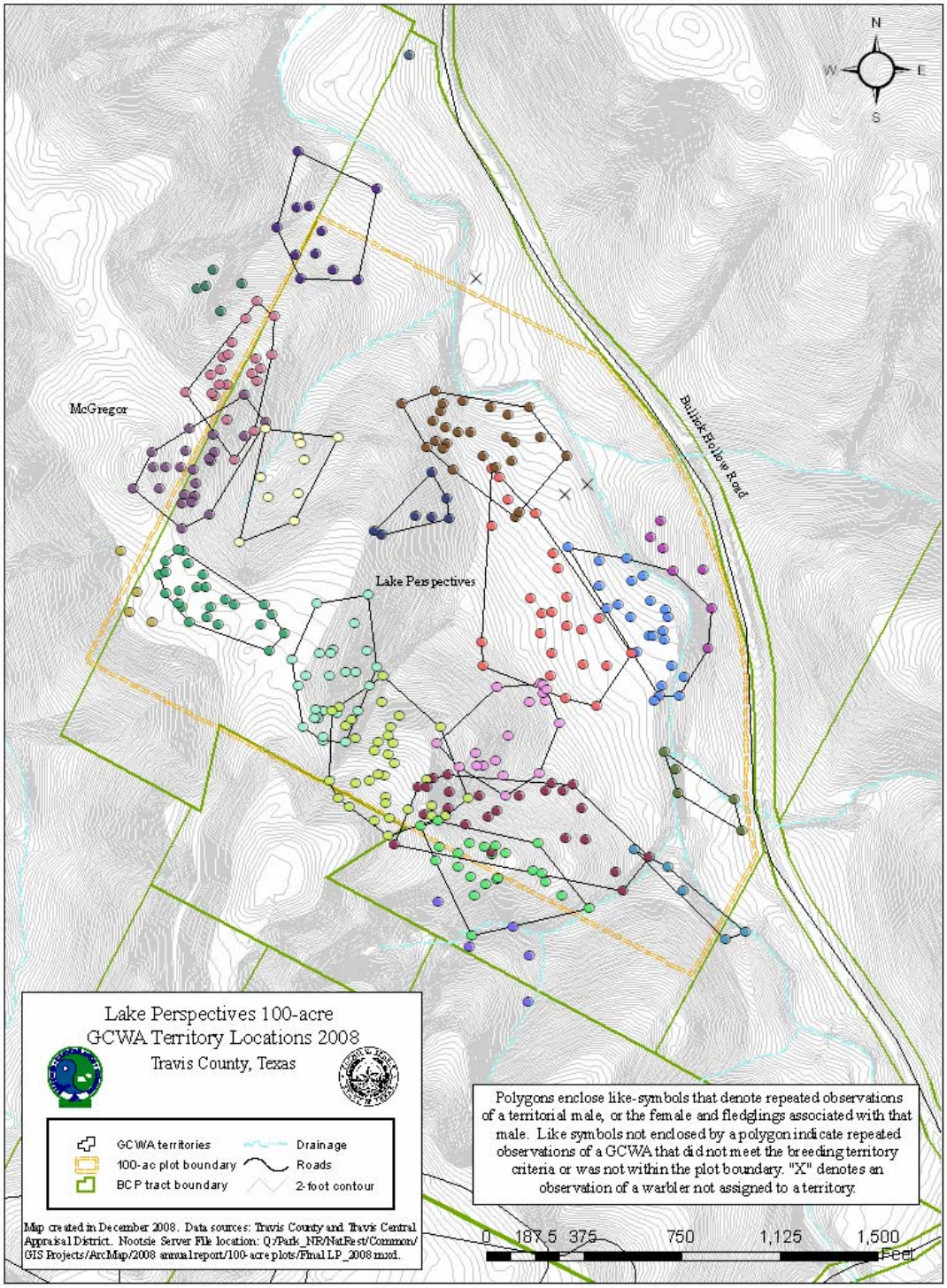


Figure 10. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Lake Perspectives prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

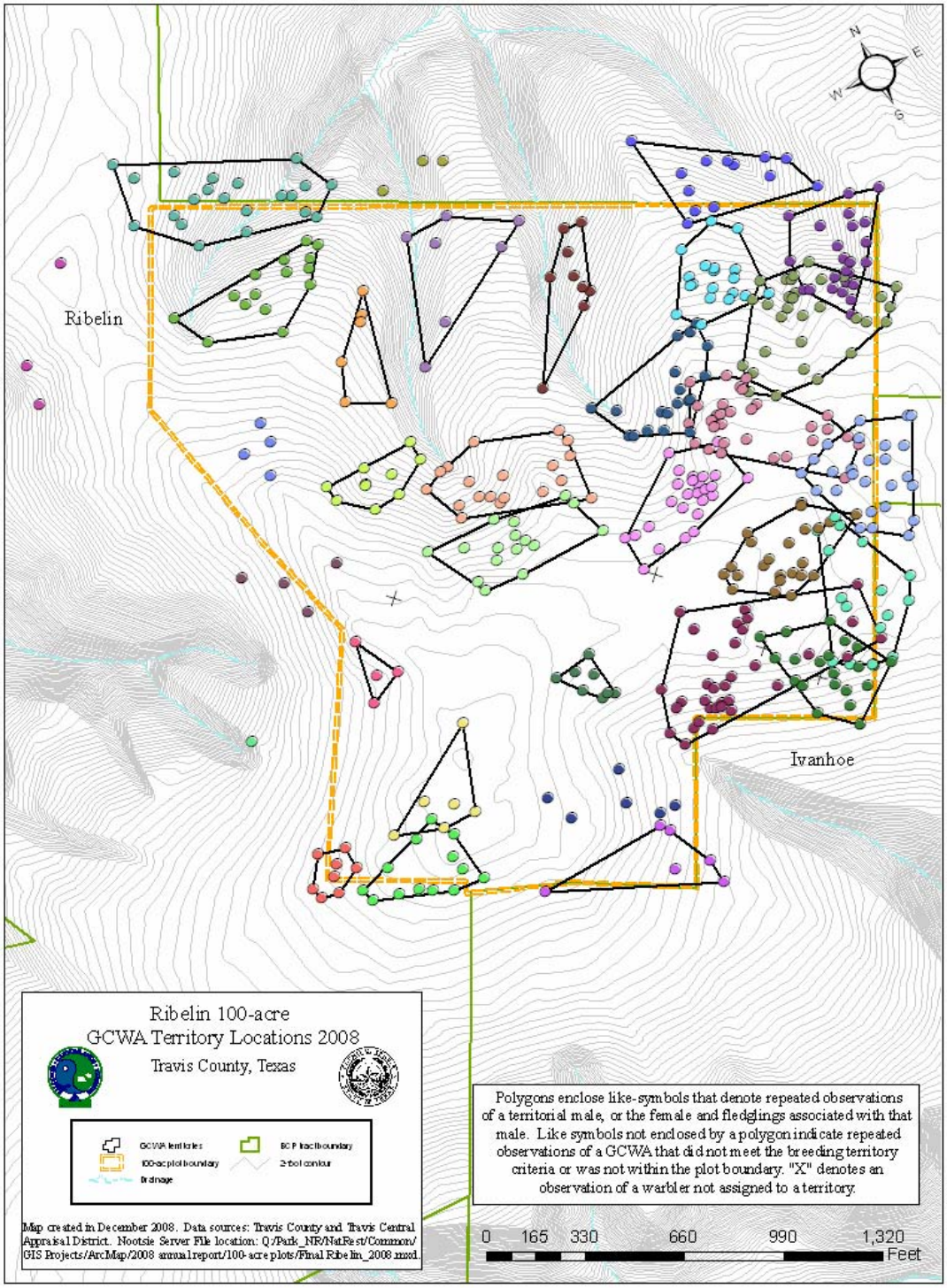


Figure 11. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Ribelin prime 100-acre study plot within the Balcones Canyonlands Preserve in western Travis County, Texas.

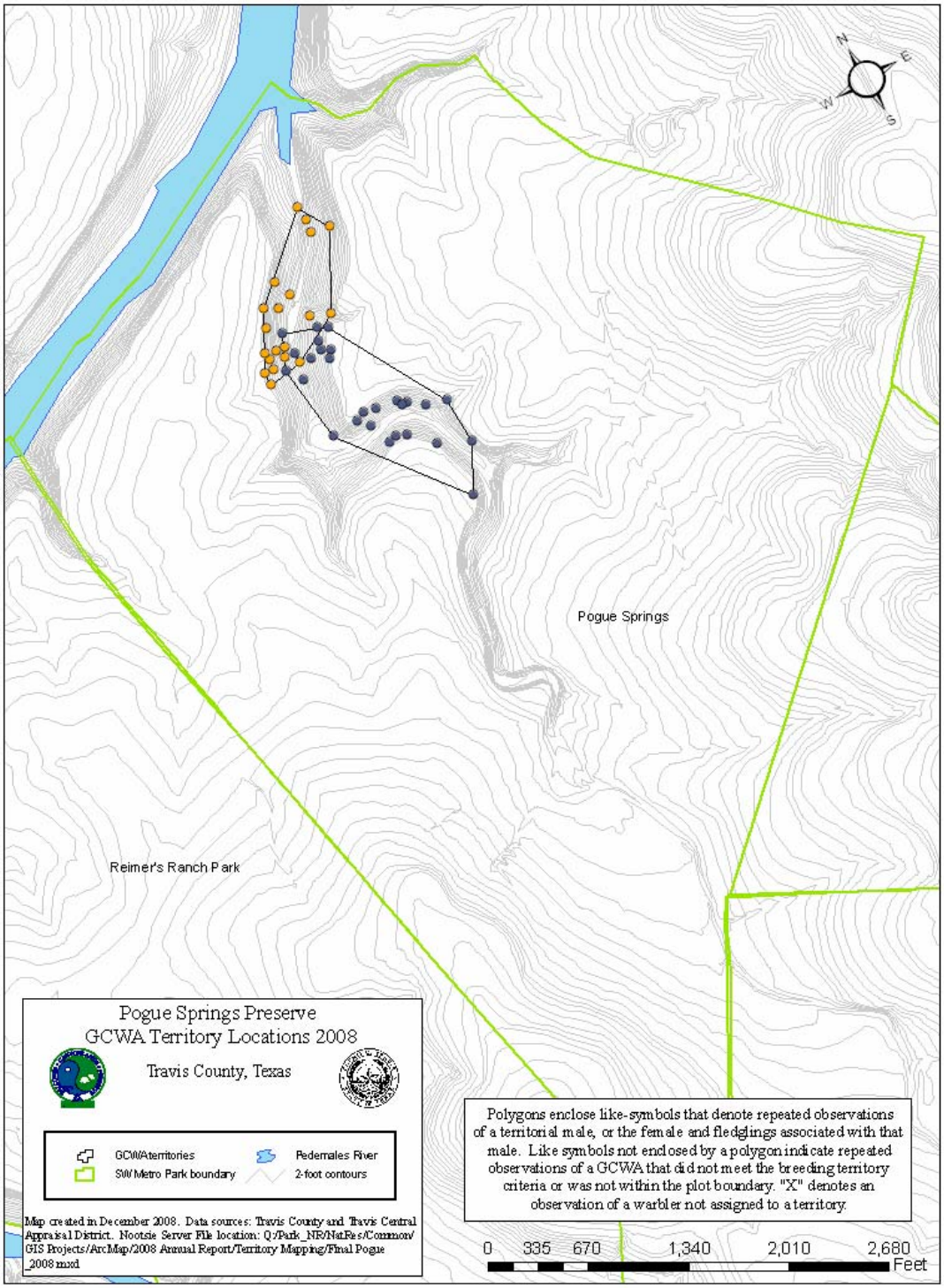


Figure 12. 2008 golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) territory locations on the Pogue Springs Preserve component of Southwest Metropolitan Park within the Travis County park system, Texas.

Appendix A

Past territory density per 100 hectares of golden-cheeked warblers
on the four Travis County prime 100-acre plots

	2002	2003	2004	2005	2006	2007	2008	Average
Bunten		45	52	56	65	64	58	**57**
Canyon Vista							40	**40**
Hamilton Pool	16	19	20	17	22	21	20	**19**
Lake Perspectives	28	25	26	24	33	35	33	**29**
Ribelin					50	57	51	**53**
Average	**22**	**30**	**33**	**32**	**41**	**44**	**40**	

Appendix 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	**Average**
Pair Success	0.80	0.83	0.86	1.00	0.38	1.00	0.71	**0.80**
Breeding Success	0.40	0.67	0.43	1.00	0.25	0.57	0.57	**0.56**
Estimated Brood Size	1.50	2.00	1.66	1.80	1.50	1.86	1.60	**1.70**
Productivity	0.60	1.33	0.71	1.80	0.38	1.86	1.14	**1.12**

Lake Perspectives	2002	2003	2004	2005	2006	2007	2008	**Average**
Pair Success	0.88	1.00	0.75	0.71	0.55	0.80	0.64	**0.76**
Breeding Success	0.75	0.86	0.50	0.71	0.18	0.70	0.36	**0.58**
Estimated Brood Size	1.83	2.16	2.25	2.20	0.33	1.88	1.43	**1.73**
Productivity	1.38	1.86	1.13	1.57	0.18	1.50	0.91	**1.22**

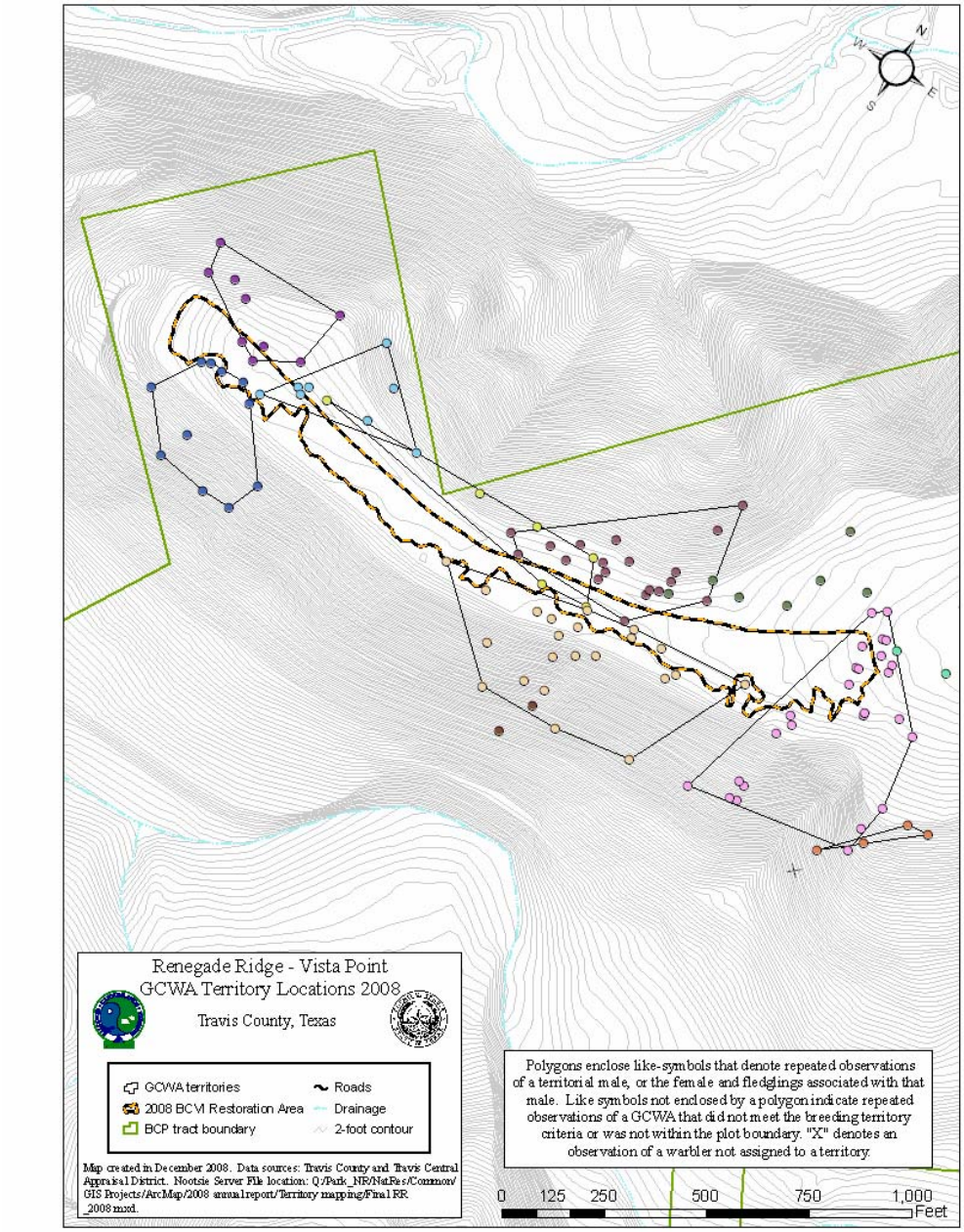
Bunten	2003	2004	2005	2006	2007	2008	**Average**
Pair Success	0.92	1.00	0.73	0.73	0.95	0.95	**0.88**
Breeding Success	0.75	0.80	0.67	0.68	0.89	0.58	**0.73**
Estimated Brood Size	1.89	2.50	2.80	1.75	1.55	1.33	**1.97**
Productivity	1.42	2.00	1.86	1.27	1.47	1.21	**1.54**

Ribelin	2006	2007	2008	**Average**
Pair Success	1.00	0.86	0.66	**0.84**
Breeding Success	0.93	0.86	0.60	**0.80**
Estimated Brood Size	2.14	2.33	1.80	**2.09**
Productivity	2.14	2.00	1.20	**1.78**

* 2008 was the first year Canyon Vista was included as a prime 100-acre study plot, therefore data is not included here, but it can be viewed in Table 3 & 4 of the document.

Appendix C

Additional golden-cheeked warbler observations for the 2008 survey season



Renegade Ridge, a portion of Vista Point tract, was surveyed five times during the 2008 spring survey season. Survey effort concentrated on an area of the ridge manipulated for black-capped vireo habitat restoration. Eleven golden-cheeked warbler males were detected, and there were eight full territories in this area.