City of Austin
2004 Golden-cheeked Warbler
Dendroica chrysoparia and
Black-Capped Vireo *Vireo atricapilla*
Monitoring Program

Balcones Canyonlands Preserve Annual Report
Fiscal Year 2003-04



Photo: John Ingram



Photo: TPWD

The City of Austin
Water Utility
Wildland Conservation Division
Balcones Canyonlands Preserve Program

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The City of Austin

2004 Golden-cheeked Warbler and Black-capped Vireo Monitoring Program

Balcones Canyonlands Preserve

This report summarizes the results of the City of Austin's 2004 golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapilla*) endangered species monitoring program. The 2004 field season was the seventh year of endangered species monitoring on the City of Austin's Balcones Canyonlands Preserve properties.

I. GOLDEN-CHEEKED WARBLER MONITORING

INTRODUCTION

Background

The golden-cheeked warbler (GCWA) is a neotropical migrant passerine that breeds only in central Texas where suitable oak-juniper (*Quercus spp.-Juniperus Ashei*) habitat occurs (Ladd and Gass 1995). Due to accelerating loss of breeding habitat over the past several decades, this species was listed as federally endangered by the U.S. Fish and Wildlife Service in 1990 (USFWS 1990). The Balcones Canyonlands Preserve (BCP) was established in 1996 in part to mitigate for continuing loss of golden-cheeked warbler breeding habitat in western Travis County and to aide in the species' local recovery (BCP 1998). The Balcones Canyonlands Preserve is managed by a number of private and public entities, including the City of Austin. The City of Austin manages 13,035 acres of the BCP.

Objectives

Stated management goal of the Balcones Canyonlands Preserve (1998) for the golden-cheeked warbler is

> . . . to maintain and, if possible, increase the population of golden-cheeked warblers in the BCP. The focus of management should be to produce rates of occupancy, fecundity, and survivorship … that equal or exceed those recommended in the *Golden-cheeked Warbler Population and Habitat Viability Assessment Report* [1996 USFWS].

To facilitate species' survival and recovery, the golden-cheeked warbler population within the BCP, as well as the Balcones Canyonlands National Wildlife Refuge (BCNWR), is

monitored through a standardized, region-wide program. Population and productivity trends are tracked on a series of 100-acre plots located throughout the BCP and BCNWR. The City of Austin collects data on territory density, territory location, pairing success, breeding success, and productivity. The City of Austin also conducts territory enumerations over a large area of the BCP to ascertain distribution and to estimate overall territory numbers.

METHODS

Study Sites

In field season 2004, golden-cheeked warblers were territory mapped on six 100-acre "prime" study plots established on six different preserve tracts: Emma Long, Barton Creek, Ivanhoe, Forest Ridge, 3M/St. Edwards, and Bohls Hollow. "Prime" plots are defined as those with >75% excellent golden-cheeked warbler habitat, i.e. habitat with >70% canopy cover (BCP 1998). Enumerations were conducted on 12 city-managed Preserve tracts, totaling 8,335 acres. Surveys were conducted by City of Austin biologists and trained volunteers. (See Appendix A for a summary of acreages, surveyors and survey effort for each tract.)

Site Description

The topography and vegetation of the surveyed tracts are typical of the eastern edge of the Edwards Plateau. Steep, wooded canyons and riparian corridors dissect drier upland savannahs. Most streams are intermittent, though a few have a permanent water source, such as a perennial spring. The predominant vegetation association is oak-juniper.

It is thought that woodlands in western Travis County were logged in the late 1800s and early 1900s and are currently in various stages of recovery (Keddy-Hector 1996). After clearing, much of the topsoil was lost due to chaining and subsequent goat and cattle overgrazing. On some steep slopes, this soil loss has greatly reduced the revegetation potential. Current and past overbrowsing by white-tailed deer (*Odocoileus virginianus*) has reduced understory floral diversity and species abundance. A distinct browse line is visible on the majority of Preserve tracts. Conspicuously absent in the study area are saplings of deciduous trees, such as oaks (*Quercus* spp.), escarpment black cherry (*Prunus serotina serotina*), rusty black-haw (*Viburnun rufidulum*), cedar elm (*Ulmus crassifolia*), Texas ash (*Fraxinus texensis*) and Texas mulberry (*Morus microphylla*).

In woodlands and forests, the canopy is dominated by Texas oak (*Quercus texana*), Ashe juniper (*Juniperus ashei*), plateau live oak (*Quercus fusiformis*), escarpment black cherry, Texas ash (*Fraxinus texensis*), and cedar elm (*Ulmus crassifolia*). Common understory

species include Ashe juniper, Carolina buckthorn (*Rhamnus caroliniana*), yaupon holly (*Ilex vomitoria*), red buckeye (*Aesculus pavia pavia*), white shin oak (*Quercus sinuata* var. *breviloba*), Mexican buckeye (*Ungnadia speciosa*), Lindheimer silk-tassel (*Garrya Lindheimeri*) and elbow bush (*Forestiera pubescens*). Descriptions of individual prime plots can be found in Abbruzzese and Koehler (2003), as well as in Tier III Land Management Plans for each property (BCP 1998).

Region-wide Monitoring Program: 100-acre Study Plots

Territory mapping was conducted on permanent 100-acre study plots. This monitoring program and the data collection protocol is described in detail in the Balcones Canyonlands Preserve Land Managers Handbook, Chapter VIII: Monitoring of the Golden-cheeked Warbler (BCP 1998); the City of Austin Golden-cheeked Warbler and Black-capped Vireo Monitoring Program (Abbruzzese and Koehler 2003); and Appendix B of this document.

Analysis of Territory Density. Number of territories on 100-acre plots were calculated and presented in three ways: 1) as a low estimate (only full territories were counted); 2) as a high estimate (both full and edge territories were counted as 1.00); and 3) using Verner's (1995) method (each territory that straddles the boundary of the plot was counted as 0.5 territories, avoiding the upward bias inherent in the IBCC's (1970) methodology). Territory density is given as number of territories (using Verner's counting method) per 100 hectares. These procedures were also followed during the six previous survey years for the 100-acre study plots.

Analysis of Pairing Status and Productivity. Productivity and mated status were estimated only for "full" territories, i.e., those that fell entirely within plot boundaries. Males were determined to be paired if they were observed associating with a female, observed tending young, or a nest was located for that male. The pairing success rate is the number of males determined to have paired with a female divided by the number of full territories.

A territory was considered to have bred successfully if the male or female was observed tending one or more nestling or fledgling. The breeding success rate is the number of territories determined to have produced at least one young divided by the number of full territories. Productivity was calculated in two ways. First, the highest number of nestlings or fledglings observed for each brood were summed and divided by the number of pairs that successfully bred. Second, the total number of nestlings or fledglings produced per brood was divided by the total number of full territories

Fecundity was estimated by dividing the total number of fledglings produced by 0.50 (based on studies indicating a 1:1 ratio of male and female offspring for this species

(Anders 2000)) and then dividing by the number of full territories. This gives an estimate of the number of male or female fledglings per singing male.

Enumerations

Territory enumeration is a count of all singing males in a given area and provides data on distribution and an estimate of territory numbers. Enumeration of territories required 3-4 visits per study area during good weather conditions (USFWS 1994). Incidental sightings of females and fledglings, parasitism, and predators were noted and mapped during enumerations. Analysis of pairing and breeding success was not conducted.

RESULTS AND DISCUSSION

100-acre Study Plots

Territory Densities and Locations. Average GCWA territory number for the six prime study plots in 2004 was 13.5 territories per 100 acres (range 6.5–21.0), based on Verner's (1995) counting method (Table 1). Average GCWA territory density is 33.4 territories per 100 hectares. This territory density is slightly lower than in 2003 (34.1 territories/100ha), but still higher than all other years in which the plots were surveyed (1998 through 2002; see Appendix C). Figures 1-6 depict GCWA territory locations for the 100-acre plots. Maps depict territory locations relative to topography and to other territories and are not meant to represent actual territorial boundaries.

The highest territory density occurred on the Ivanhoe plot with 51.9 territories per 100 hectares; while the lowest territory density was observed at the Barton Creek plot, with only 16.1 territories per 100 hectares. The Bohls plot had the second lowest density: 19.8 territories per 100 hectares.

Table 1. Golden-cheeked warbler territory number and territory density (per 100ha) for six 100-acre prime study plots on the City of Austin's Balcones Canyonlands Preserve tracts, field season 2004, Travis County, Texas. See Methods section for calculations.

Prime Plot Name	No. of Full Territories	No. of Full and Edge Territories	No. of Full Territories + (0.5 x Edge Territories)	Territory Density (100ha)
Barton Creek	3	10	6.5	16.1
Emma Long	11	22	16.5	40.8
Ivanhoe	12	30	21.0	51.9
St. Eds/3M	6	17	11.5	28.4
Forest Ridge	13	22	17.5	43.2
Bohls Hollow	5	11	8.0	19.8
Average			13.5	33.4

Although statistical trend analysis was not conducted, warbler territory density has been increasing more or less steadily since 1998 (see Appendix C). This may or may not reflect in an increase in the local GCWA population. Changes in observed densities may be related to differences in observer abilities. Another possibility is that increasing destruction of warbler habitat throughout western Travis County may be forcing warblers to move to protected areas, such that no net increase in the GCWA population is occurring in Travis county.

Table 2 provides a comparison of GCWA territory density surveys conducted by various programs during breeding seasons 2002 through 2004. The table includes results from three managing partners of the BCP: City of Austin, Travis County and LCRA; and from the Ft. Hood Endangered Species Research Program in Bell and Coryell Counties. For 2002 and 2003, numbers were rounded.

Table 2. Comparison of GCWA territory mapping results on prime plots (see Appendix B) of three BCP land managers and results from the Fort Hood Endangered Species Research Program, field seasons 2002-20004 (Abbruzzese and Koehler 2002, 2003; Loomis 2002; Pavlos 2003; Peak 2003; Pekins 2002; Travis County 2002, 2003). Average territory density is given per 100 hectares. Total hectares sampled in each study are given in parentheses.

		GCWA Territory Density/100 HA		
Survey	County	2002	2003	2004
City of Austin BCP	Travis	29(243)	34(243)	33(243)
Travis County BCP	Travis	28(40)	35(81)	
LCRA BCP	Travis	12(40)	13(40)	
Ft. Hood E. S. Research	Bell, Coryell	25(788)	21(788)	

Both Travis County and the City of Austin conducted their surveys using the same protocol, surveying a total of 60 hours for each 100-acre plot. Travis County conducted surveys on one prime plot in 2002 and on two prime plots in 2003. The 2002 and 2003 LCRA data are from the Wheless 100-acre prime plot that was surveyed a total of circa 20 hours each year. At Ft. Hood, surveyors visited their research plots every five days from March to mid-June, a slightly greater effort than that of the City of Austin and Travis County. The Ft. Hood report did not include a quantitative description of habitat types and quality of habitat within the study areas. Differences in average territory densities may reflect differences in surveyor effort, ability, degree of habitat fragmentation, and habitat quality, among other untested covariates.

Pairing Success, Brood Success, and Productivity. Average pairing rate for full territories was 66% (Table 3). The highest pairing rate occurred on Barton Creek, where one female was observed for each full territory. The lowest pairing rate was observed on Forest Ridge (only 54% of territories had females).

Table 3. Golden-cheeked warbler pairing rate; breeding success rate; and productivity per successful pair and full territory. Observations recorded on six 100-acre prime plots during field season 2004 on the City of Austin's Balcones Canyonlands Preserve, Travis County, Texas. All data is calculated using observations of full territories only. See methods for calculations.*

Prime Plot Name	No.of Territories w/ Female	Pairing Rate	Number of Territories producing >1 young	Breeding Success Rate	Productivity per Successful Territory	Productivity per Full Territory
Barton Creek	3	1.00	2	0.66	1.50	1.00
Emma Long	9	0.82	5	0.46	2.60	1.18
Ivanhoe	7	0.58	4	0.33	3.00	1.00
St. Eds/3M	4	0.66	3	0.50	2.00	1.00
Forest Ridge	7	0.54	7	0.54	3.00	1.62
Bohls Hollow	3	0.60	--	--	--	--
Average		0.66		0.47	2.62	1.22

"--" = No data recorded.

The Barton Creek plot also had the highest breeding success: 66% of full territories produced at least one young (Table 3). Only 33% of full territories produced at least one young on Ivanhoe, the lowest breeding success rate. Data for Bohls was not collected. Average breeding success rate for full territories was 47%, excluding the Bohls plot. Because females and fledglins are difficult to detect, pairing and productivity data represent minimum estimates.

A total of 55 fledglings were observed in 21 broods, yielding an average productivity of 2.62 fledglings per successful pair and 1.22 fledglings per full territory. No second broods were confirmed. Fecundity was 0.61 male fledglings per singing male. This figure is lower than the fecundity estimate of 0.75 male fledglings per SY (=second year) male and 1.08

* In the results table for surveys conducted from 1998 to 2003 given in Appendix C, the number of full territories producing > 1 fledgling is stated as "brood number." Productivity per Successful Territory in this report is the same as "Number of Fledglings per Successful Pair" in Appendix C; Productivity per Full Territory here is the same as "Number of Fledglings per Territory."

male fledglings per ASY (=after second year) male used in a model to estimate the probability of extinction in 100 years (see the *1996 GCWA Population and Habitat Viability Assessment* (USFWS 1996)).

Enumerations

A total of 252 singing GCWA males were detected during enumeration surveys on 8,335 acres of BCP lands. Of these, 36 were observed with females. Twenty-three fledglings were recorded. Figures 7 through 19 illustrate warbler distribution on these properties. Because tracts were not surveyed systematically and varying survey effort was expended on each, results between tracts are not comparable. Surveyors attempted to sort out individual warblers to increase the accuracy of the count. However, significantly less time was spent on these tracts per acre than on the 100-acre plots (see Appendix A). Results represent rough estimates of numbers of singing males only.

Incidental Observations

Incidental observations include one warbler nest located on the Ivanhoe study plot and two nests detected during enumerations. The nest on Ivanhoe was situated in an Ashe juniper circa 25 feet above ground. Both parents were bringing food to the nest, but the contents of the nest could not be determined. Fledglings were not observed for this pair on subsequent visits, and thus, nest fate remains unknown. Of the two nest discovered on enumerations, one was in an Ashe juniper on the Park West tract. On 15 April 2004, a male was seen feeding the female on the nest. A subsequent visit on 10 May revealed that the pair had fledged at least three young. The other nest was located on the Franklin tract in a cedar elm on 15 May. A female was seen sitting on the nest, agitated by the observers' approach. Follow-up visits yielded no evidence of young for this territory.

Brown-headed cowbird (*Molothus ater*) parasitism was observed on the Bohls plot. On 19 May, a male and female warbler were seen feeding one brown-headed cowbird fledgling approximately 50 feet from the plot boundary. No GCWA fledglings were observed at this time. Cowbird trapping was not conducted in conjunction with warbler management in 2004.

American crows (*Corvus brachyrhynchos*) and blue jays (*Cyanocitta cristata*) were observed in GCWA breeding habitat. Changes in warbler behavior were detected upon their approach. Common grackles (*Quiscalus quiscula)* were often seen flying in large, noisy flocks in breeding habitat on Forest Ridge, Jester and Ivanhoe, although the warblers did not appear to respond to them.

Several other potential nest predators were observed in survey areas, including western scrub jay (*Aphelocoma coerulescens*), great-tailed grackle (*Quiscalus mexicanus*), ringtail (*Bassiriscus astutus*), fox squirrel (*Sciurus niger*) and red imported fire ant (*Solenopsis invicta*). Many of these predators thrive in urban and edge habitats (Wilcove 1985).

II. BLACK-CAPPED VIREO MONITORING PROGRAM

INTRODUCTION

Background

Like the golden-cheeked warbler, the black-capped vireo (BCVI) is a neotropical migrant that has suffered population declines in the past several decades. Major threats to species' survival include habitat loss, habitat fragmentation, and parasitism by brown-headed cowbirds (*Molothus ater*). The black-capped vireo was listed by the U.S. Fish and Wildlife Service as federally endangered in 1987 (USFWS 1991). Currently, this species breeds only in portions of central Texas, southern Oklahoma, and Coahuila, Mexico. The Balcones Canyonlands Preserve was established in 1996 to mitigate for loss of BCVI habitat as development continues in western Travis County and to aide BCVI recovery. The black-capped vireo has been known to occur on several City of Austin-managed BCP properties in the past 15-20 years. The best-studied vireo colony occurred at the Black-capped Vireo Research Area. The colony declined steadily from a high of 32 pairs in 1987 to just one pair in 1997 (DLS 1988, Abbruzzese 1998). Other records for the past ten years include sightings of BCVI on Forest Ridge and Park West, and a small colony at Cortana.

Objectives

The Balcones Canyonlands Conservation Plan requires setting aside a total of 2,000 acres of potential black-capped vireo habitat in western Travis County within the BCP. The BCVI management plan (BCP 1998) calls for protection and enhancement of the black-capped vireo population on the Preserve. In conjunction with the Balcones Canyonlands National Wildlife Refuge, the BCP should support a viable breeding population, as outlined in the BCVI Recovery Plan (USFWS 1991).

To monitor population trends of black-capped vireos on City of Austin-managed BCP properties, BCVI are surveyed every year using territory mapping methods. In addition, nest searches are conducted to monitor cowbird parasitism, and productivity data is also gathered. As of the 2003 field season, the only known breeding population of BCVI on City-managed BCP tracts was on the Cortana tract. Vireos also occur on the River Place Mitigation tract adjacent to Cortana, which is privately managed.

Approximately 76 acres of an upland portion of the Cortana tract was manipulated in the winter of 1995 to restore vireo habitat. Juniper-oak woodland was cleared using mechanical disturbance methods (hand clearing and hydroaxing). Restoration was also conducted on approximately 38 acres of the River Place Mitigation tract. Since 2000, both the City of Austin and SWCA INC. have observed vireos in the two restored areas. In 2002, three

males defended territories there (Abbruzzese 2002), and in 2003, five territorial males were detected in this same area (Abbruzzese and Koehler 2003).

METHODS

Sites and Survey Effort

In field season 2004, black-capped vireos were surveyed on the Cortana restoration area (76 acres). Observations of vireos on the River Place Mitigation tract (38 acres) were also mapped, if detected. Data were collected on black-capped vireo territory number, territory location, pairing, breeding success, parasitism, and productivity using territory mapping (Bibbey 1995) and nest searching. The restoration areas were surveyed from 5 April to 28 July for a total of 49 survey hours. The study site was visited at least once per week. Other tracts where vireos have occurred in the recent past were surveyed for golden-cheeked warblers in 2004. Vireos were noted and mapped if detected during these surveys.

Data Collection and Analysis

All locations of males, females, fledglings and nests were recorded on Digital Orthophoto Quarter Quads at a scale of 1:2000. Nest searching was conducted and nests were periodically checked to monitor brood number and check for cowbird eggs, which were then removed from the nest if found. Pairing status and number of fledglings produced per pair were determined for each territory. Pairing success, breeding success and productivity were calculated for all territories using the same criteria and formulas as for golden-cheeked warblers (see Methods section, p. 6 above). Playback tapes of BCVI songs and shrads were used to elicit responses. A wooden cowbird trap was maintained on Cortana during most of the breeding season (April through June).

RESULTS AND DISCUSSION

Three male black-capped vireos were observed defending territories on the restored portion of the Cortana tract (see Figure 20). No vireos were detected this season using the River Place Mitigation tract. Based on plumage characteristics (as described in Pyle 1997), all three males were ASY birds. All males were observed associating with females (pairing success = 100%), and all pairs nested at least once.

Six nests were located on the Cortana restoration area. Two nests were found for the first male, three nests for the second male, and one nest for the third male. Nest stages, contents, and final outcome of nests are presented in Table 4. Only two of the six nests produced

nestlings and no nests produced fledglings. No fledglings were observed in the restoration area at any time. The breeding success rate was 66% and productivity was 2.50 young produced per territory. However, fecundity was 0.00 due to the fact that no nestlings reached the fledgling stage during the entire season.

Fate of nests was not directly observed. Potential predators include a number of species of snakes, as well as ringtails, raccoons, scrub jays, and crows. Both mockingbirds (*Mimus polyglottus*) and common grackles were seen harassing male #1 throughout the season, perhaps forcing the abandonment of at least one nest. Three western diamondback rattlesnakes (*Crotalus atrox*) were encountered during the season, one situated just below male #2's first nest. Although an unlikely predator of the nest, the rattlesnake's presence may have affected the vireos behavior, perhaps inducing him to abandon the nest. Red imported fire ants were not seen in any nests and mounds were not abundant in the restoration area. Given the small number of nests sampled, it is difficult to compare these results with other nest monitoring studies of black-capped vireos. No cowbirds were observed in the breeding area during the field season, and no cowbird eggs were found in the six nests. However, the cowbird trap did capture 7 cowbirds: 3 females and 4 males.

One SY male vireo was detected on 27 June at the Vireo Research Area. He appeared to defend a territory on top of the highest hill. No female or fledglings were observed. Five subsequent visits throughout July failed to relocate the male. His status remains unclear. Vireos were not detected on any other tract surveyed in field season 2004 (see Appendix A for a complete list of surveyed City of Austin BCP tracts.)

Table 4. Nest attempts for three territorial BCVI males. Nesting stage, dates, contents of nest and final outcome is given for each nest.

Male	Nest attempt	Substrate	Date found	Stage* found	Contents on first day found	Date of check before last	Contents	Date of last check	Contents on last check	Nest Fate**
#1	1	*Q. buckleyi*	5/23/04	B	0	6/4/04	1 white egg	6/7/04	0, 1 egg cracked on ground	A or D
	2	*Rhus lan-ceolata*	7/2/04	N	3 nestlings 4 days old			7/704	0	D
#2	1	*Diosporys texana*	4/6/04	D or A	0			4/6/04	0	D or A
	2	*Q. fusiformis*	6/4/04	I	3 white eggs			6/10/04	0	D
	3	*Q. buckleyi*	7/2/04	B	0	7/13/04	4 eggs	7/21/04	0, 1 egg on ground, nest ripped	D
#3	1	*Quercus sinuata*	4/20/04	Between B and L	0	5/13/04	4 nestlings 4 days old	5/16/04	0	D

* Nest Stages: B=Building; L=Laying; I=Incubating; N=Nestling
** Nest Fate: D=Depredated; A=Abandoned

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IV. APPENDICES

APPENDIX A

Summary of BCP tracts surveyed for GCWA by the City of Austin, field season 2004, Travis County, Texas. Tract acreage, surveyor(s) and total survey effort given in hours is shown.

Tract	Acreage Surveyed	Surveyor(s)	Survey Hours
100-acre prime plots			
Emma Long	100	H. Becker	60
Forest Ridge	100	H. Becker	60
Ivanhoe	100	M. Sanders	60
Barton Creek	100	J. Chenoweth	60
3M/St. Edwards	100	J. Davis	60
Bohls	100	J. Lindsay	60
Enumerations			
3M/St. Eds/Kruger	360	J. Davis	47.5
Bohls	450	J. Lindsay, K. O'Connor	44 22
Commons Ford	115	E. Fair	11
Cortana	1752	K. O'Connor	32
Double J and T	1729	C. Davis, J. Davis	27 33
Emma Long Park	950	H. Becker	22
Franklin	151	M. Sanders	4
Hanks	88	M. Sanders	14
Jester	294	M. Sanders J. Davis	21 21
Lime Creek	494	J. Davis	25.5
Long Canyon/Park West/Vireo Preserve	1132	J. Chenoweth	83.5
Reicher Ranch	820	J. Lindsay	90
Totals	**8,935**		**857**

APPENDIX B

100-acre Study Plot Protocol

I. Protocol from Management Handbook, Chapter VII: Golden-cheeked Warbler Management:

Plot selection: random as possible, based on habitat rather than warbler density

Plot shape: square as possible

Plot characteristics:

Prime sites: minimum 75-80% excellent warbler habitat w/ >70% canopy cover.

Transitional sites: currently has zero to a few warbler territories and has potential to develop into excellent habitat in next 30 years

II. Standardization of methods:

Season for territory mapping: March 25-May 25 (after this, observations should not be used for territory data, only productivity); **productivity data** can still be gathered after May 25

Start time: ½ hour after sunrise

Weather: rough guidelines: temp>55°; wind<15mph; none to light precipitation

Visits during season:

Prime sites: 10x

Transitional: 3x: Transitional sites only need to be surveyed every other year. Productivity data not gathered.

Hours per visit: Six hours per visit

Mapping methods: territory mapping roughly following IBCC (1970) guidelines (except calculation of edge territories); breeding territories are differentiated using observations of bird behavior, location, counter-singing, and sequential movements rather than using "clusters" (see Bibbey et al 1992)

Playback tapes: No playback tapes

Data Analysis:

- ***territory density***: # of territories per 100 acres
- ***calculation of edge territories****:* each territory that straddles the plot boundary counts as a half territory (0.5 territories) (see Verner 1995)
- ***territory size***: NOT doing territory size estimates based on research by Anders (2000).

- ***productivity measures (see Anders 2000)***: these will only be calculated for full territories ONLY:

  1) ***pairing success***: Pairing success of male warblers determined by observing one or more of the following conditions: a territorial male associating with a female; the nest of a territorial male; and/or a male tending ≥1 fledgling. Pairing success rate = number of territories determined to have pairing success / total number of full territories

  2) ***breeding success***: Breeding success rate = number of territories that successfully fledged at least one young / total number of full territories

  3) ***estimated brood size***: average brood size per successful pair (based on "breeding success"

  4) ***productivity*** = sum of the highest number of fledglings recorded at any one time for each full territory / total number of full territories

Citations

Anders, A.D. 2000. Demography of golden-cheeked warblers on Fort Hood, Texas in 2000: productivity, age structure, territory density, and adult return rates. *In* Endangered species monitoring and management at Fort Hood, Texas: 2000 annual report. Fort Hood Project, The Nature Conservancy of Texas, Fort Hood, Texas.

Bibbey, C. J., N.D. Burges, and D.A. Hill. 1992. Bird Census Techniques. Academic Press. San Diego, California. 257pp.

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Verner, J. 1985. Assessment of counting techniques. Current Ornithology. 2:247-302.

APPENDIX C

A summary of golden-cheeked warbler territory number and territory density (per 100 HA) for six 100-acre prime study plots on the City of Austin's BCP tracts, field seasons 1998--2004, Travis County, Texas. See Methods section for calculations.

Plot Name	No. of Full Territories[1]	No. of Full and Edge Territories[2]	No. of Full Territories + 50% of edge Teritories[3]	No. of Territories per 100HA
Barton Creek				
1998	2	8	5.0	12.5
1999	6	12	9.0	22.5
2000	5	9	7.0	17.5
2001	3	7	5.0	12.5
2002	2	8	5.0	12.5
2003	2	9	5.5	13.8
2004	3	10	6.5	16.1
Emma Long				
1998	6	11	8.5	21.3
1999	7	12	9.5	23.8
2000	12	21	16.5	41.3
2001	15	23	18.5	46.3
2002	18	22	20.0	50.0
2003	14	19	16.5	41.3
2004	11	22	16.5	40.8
Ivanhoe				
1998	7	13	10.0	25.0
1999	8	17	12.5	31.3
2000	7	19	13.0	32.5
2001	2	14	8.0	20.0
2002	9	22	15.5	38.8
2003	13	30	21.5	53.8
2004	12	30	21.0	51.9
St. Eds/3M				
1998	6	12	9.0	22.5
1999	7	15	11.0	27.5
2000	7	17	12.0	30.0
2001	3	8	6.0	15.0
2002	9	16	12.5	31.3
2003	8	16	12.5	31.3
2004	6	17	11.5	28.4
Forest Ridge				
1998	7	14	10.5	26.3
1999	11	17	14.0	35.0
2000	7	14	10.5	26.3
2001	8	14	11.0	27.5
2002	11	15	13.0	32.5
2003	9	16	12.5	31.3
2004	13	22	17.5	43.2
Bohls Hollow				
1998	3	6	4.0	10.0
1999	1	4	4.0	10.0
2000	1	5	3.0	7.5
2001	4	8	6.0	15.0
2002	4	7	5.5	13.8
2003	4	9	6.5	16.3
2004	5	11	8.0	19.8
TOTALS				**Average**
1998	31	64	47	19.6
1999	40	77	60	25.0
2000	39	85	62	25.9
2001	35	74	54.5	22.7
2002	53	88	70.5	29.4
2003	50	99	74	34.1
2004	50	112	81	33.4

APPENDIX D

A summary of golden-cheeked warbler pairing success and productivity for six 100-acre prime study plots on the City of Austin's Balcones Canyonlands Preserve tracts, field seasons 1998--2004, Travis County, Texas. See Methods section for calculations.

Plot Name	Females Observed (inferred)	Number of Fledgling Groups	Number of Fledglings Per Successful Pair	Number of Fledglings per Territory
Prime Plots				
Barton Creek				
1998	1(1)	1	2	1.3
1999	3(6)	6	2.2	2.2
2000	4(4)	2	1.5	.6
2001	0(3)	2	2.5	1.67
2002	2(2)	1	2	1
2003	2(2)	2	1.5	1.5
Emma Long				
1998	3(6)	6	2.3	1.3
1999	3(6)	6	2.3	2.0
2000	5(5)	2	2	.33
2001	10(10)	9	1.78	1.06
2002	12(12)	7	1.7	.66
2003	9(10)	7	2.4	1.21
Ivanhoe				
1998	2(3)	3	2.7	1.3
1999	3(4)	4	2.8	1.3
2000	1(1)	1	3	.43
2001	2(2)	2	3	3
2002	6(6)	5	3	1.7
2003	8(9)	9	2.7	1.8
St. Eds/3M				
1998	5(5)	2	2.5	0.8
1999	4(5)	3	1.7	0.7
2000	1(3)	2	2.5	.71
2001	0(0)	0	0	0
2002	1(2)	1	1	.1
2003	2(3)	2	1.5	.43
Forest Ridge				
1998	4(4)	3	2.3	1.1
1999	5(7)	6	2.7	1.5
2000	6(6)	5	2.8	2.0
2001	7(7)	4	2.5	1.25
2002	7(9)	5	2.6	1.2
2003	6(7)	6	2.3	1.6
Bohls Hollow				
1998	0	0	0	0
1999	0	0	0	0
2000	3	0	0	0
2001	2(3)	1	3	.75
2002	3(3)	1	3	.75
2003	3(3)	0	0	0
TOTALS				
1998	15(19)	15	1.97	.97
1999	18(28)	25	1.95	1.3
2000	17(19)	12	1.97	.68
2001	21(25)	18	2.13	1.3
2002	31(34)	20	2.38	1.3
2003	30(34)	26	1.74	1.09

V. FIGURES

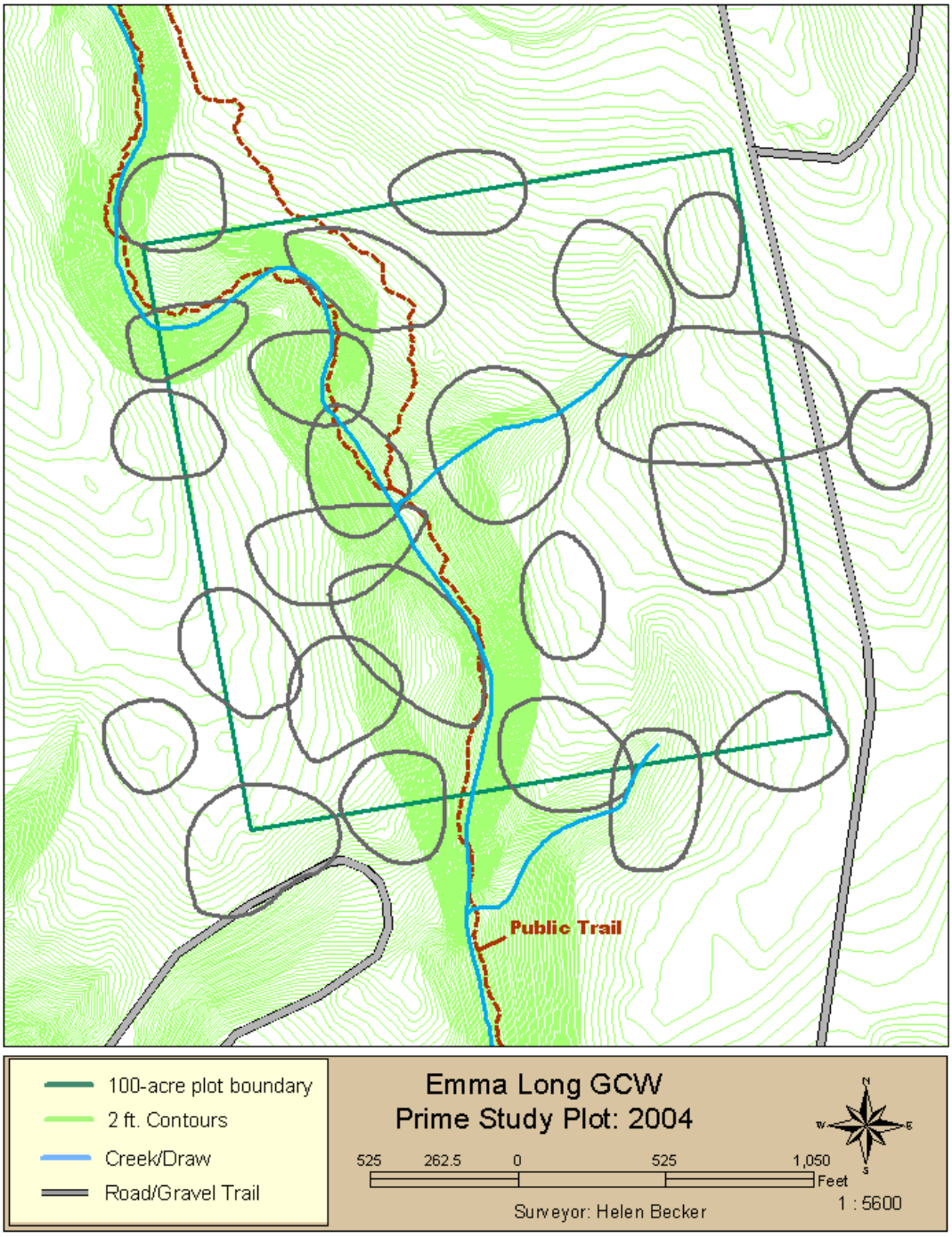

Figure 1. Locations of golden-cheeked warbler territories at Emma Long Metropolitan Park 100-acre prime study plot, field season 2004. Polygons enclose observations of individual territorial warblers and are not meant to represent actual territorial boundaries.

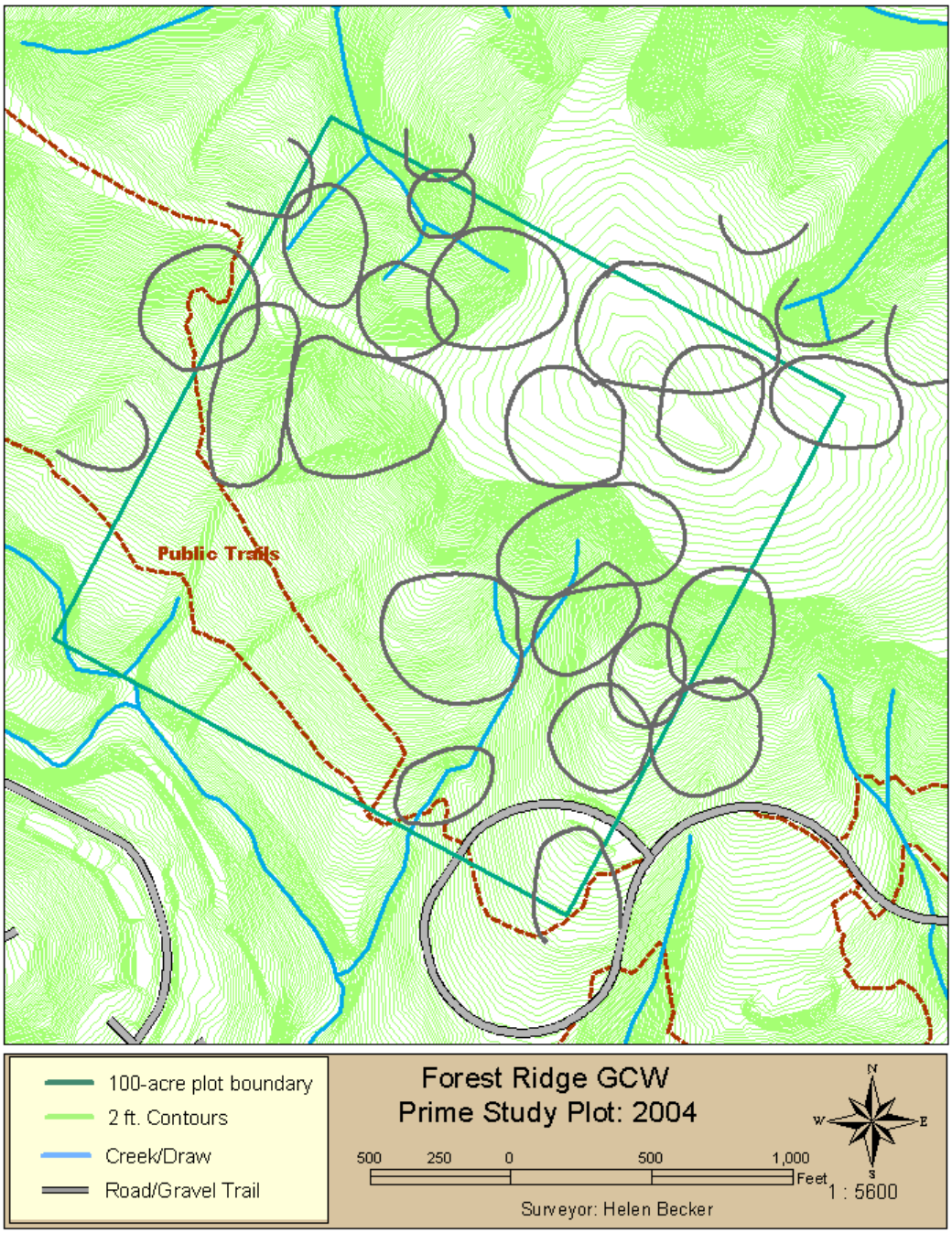

Figure 2. Locations of golden-cheeked warbler territories at Forest Ridge 100-acre prime study plot, field season 2004. Polygons enclose observations of individual territorial warblers and are not meant to represent actual territorial boundaries.

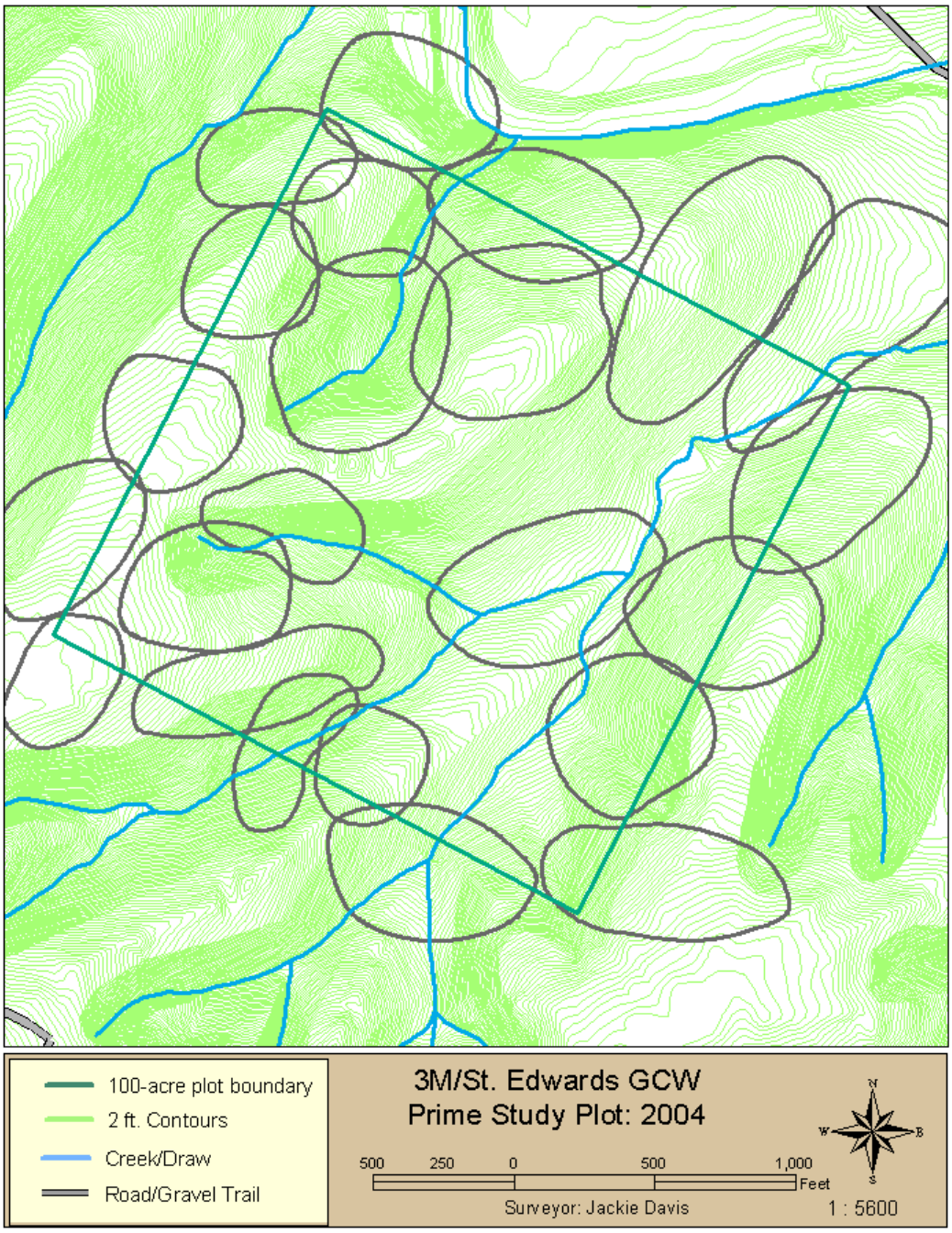

Figure 3. Locations of golden-cheeked warbler territories at 3M/St. Edwards 100-acre prime study plot, field season 2004. Polygons enclose observations of individual territorial warblers and are not meant to represent actual territorial boundaries.

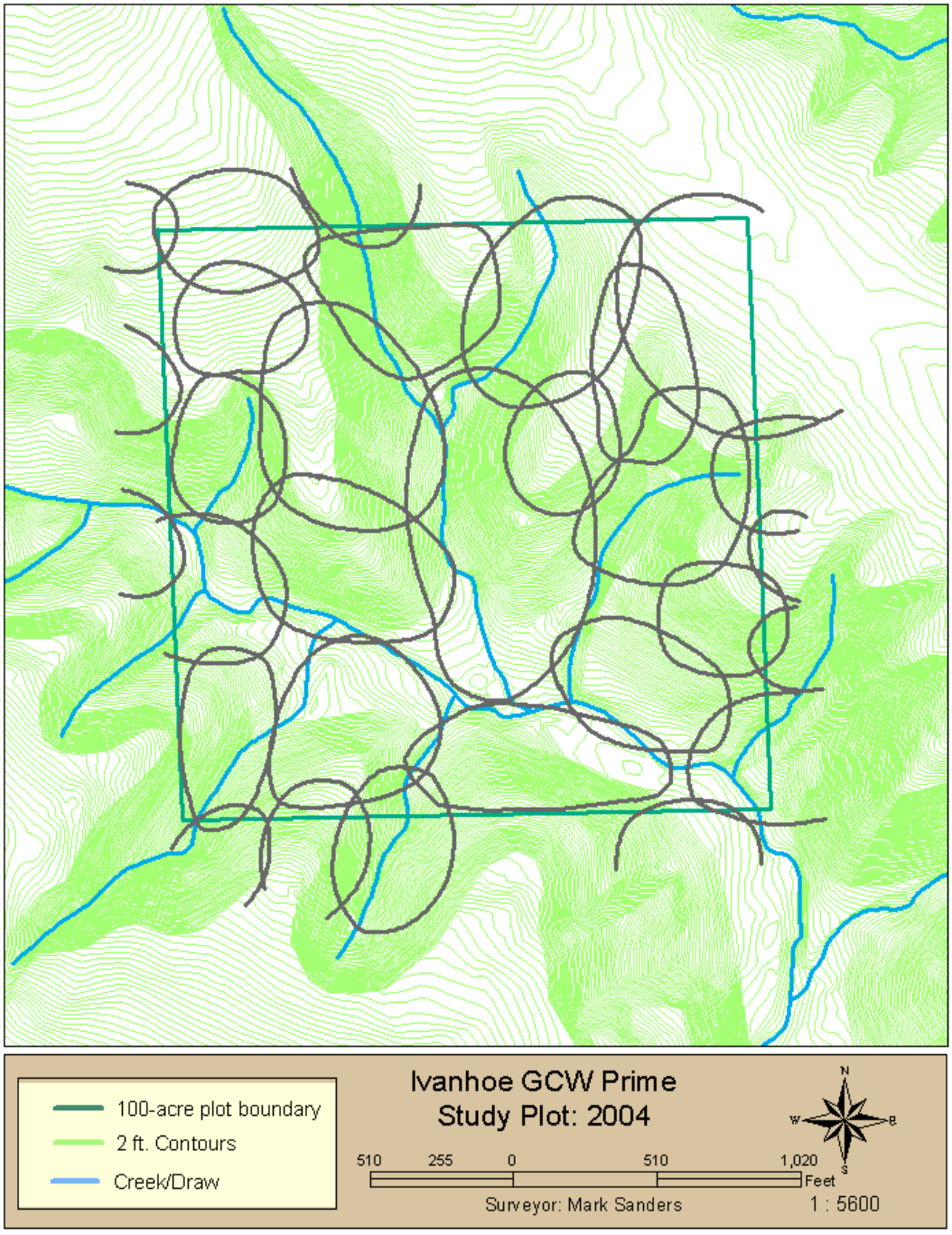

Figure 4. Locations of golden-cheeked warbler territories at Ivanhoe100-acre prime study plot, field season 2004. Polygons enclose observations of individual territorial warblers and are not meant to represent actual territorial boundaries.

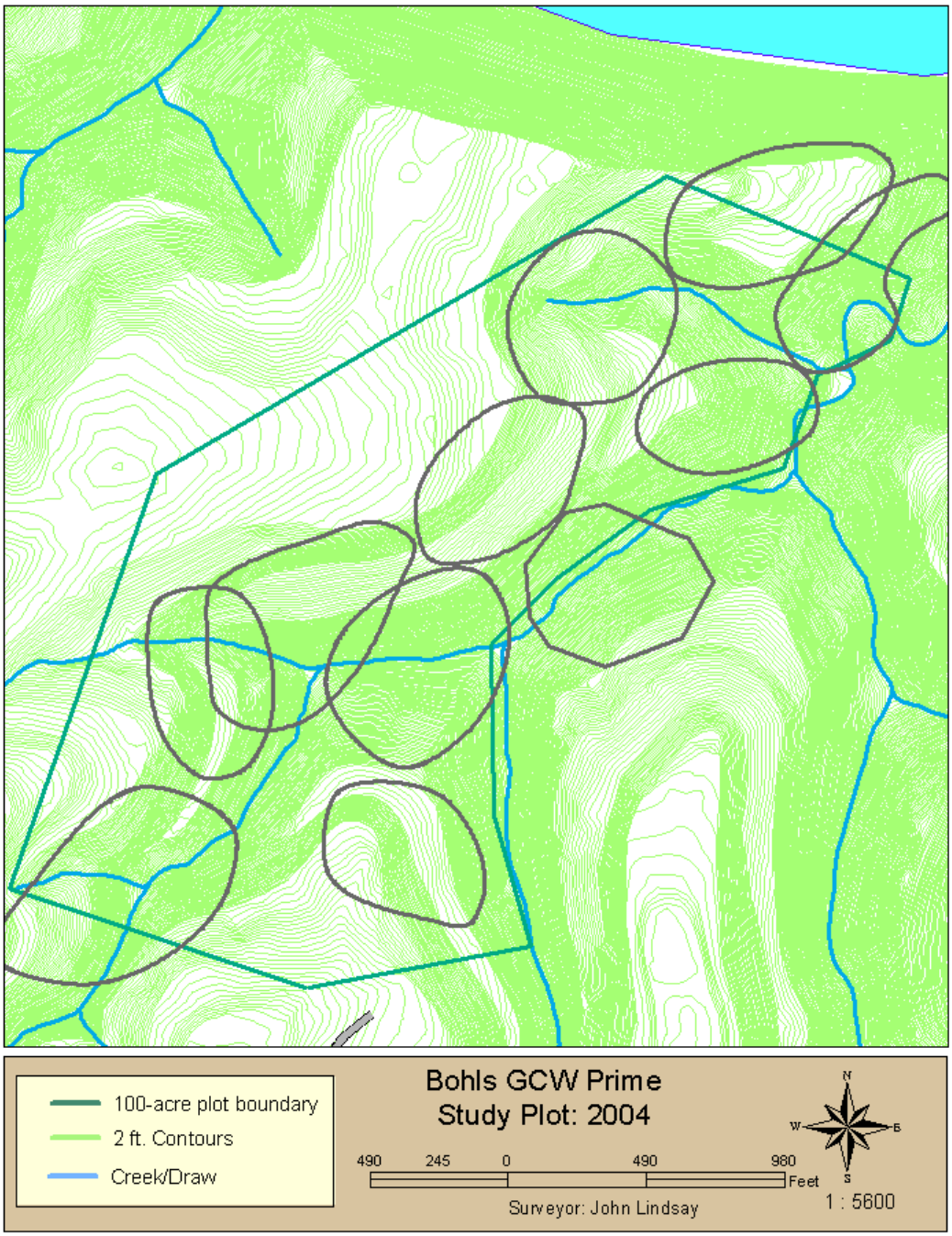

Figure 5. Locations of golden-cheeked warbler territories at Bohls Hollow 100-acre prime study plot, field season 2004. Polygons enclose observations of individual territorial warblers and are not meant to represent actual territorial boundaries.

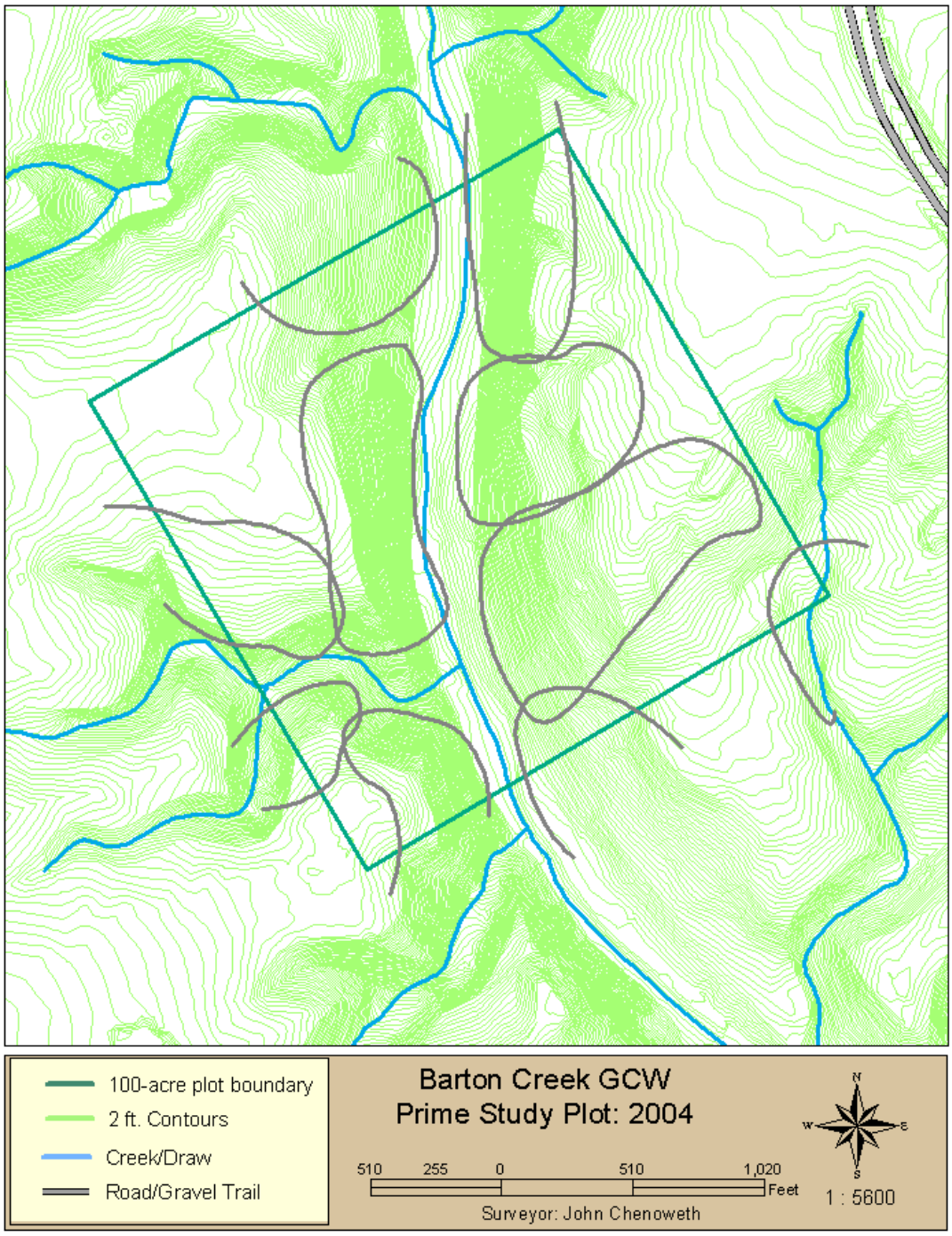

Figure 6. Locations of golden-cheeked warbler territories at Barton Creek Preserve 100-acre prime study plot, field season 2004. Polygons enclose observations of individual territorial warblers and are not meant to represent actual territorial boundaries.

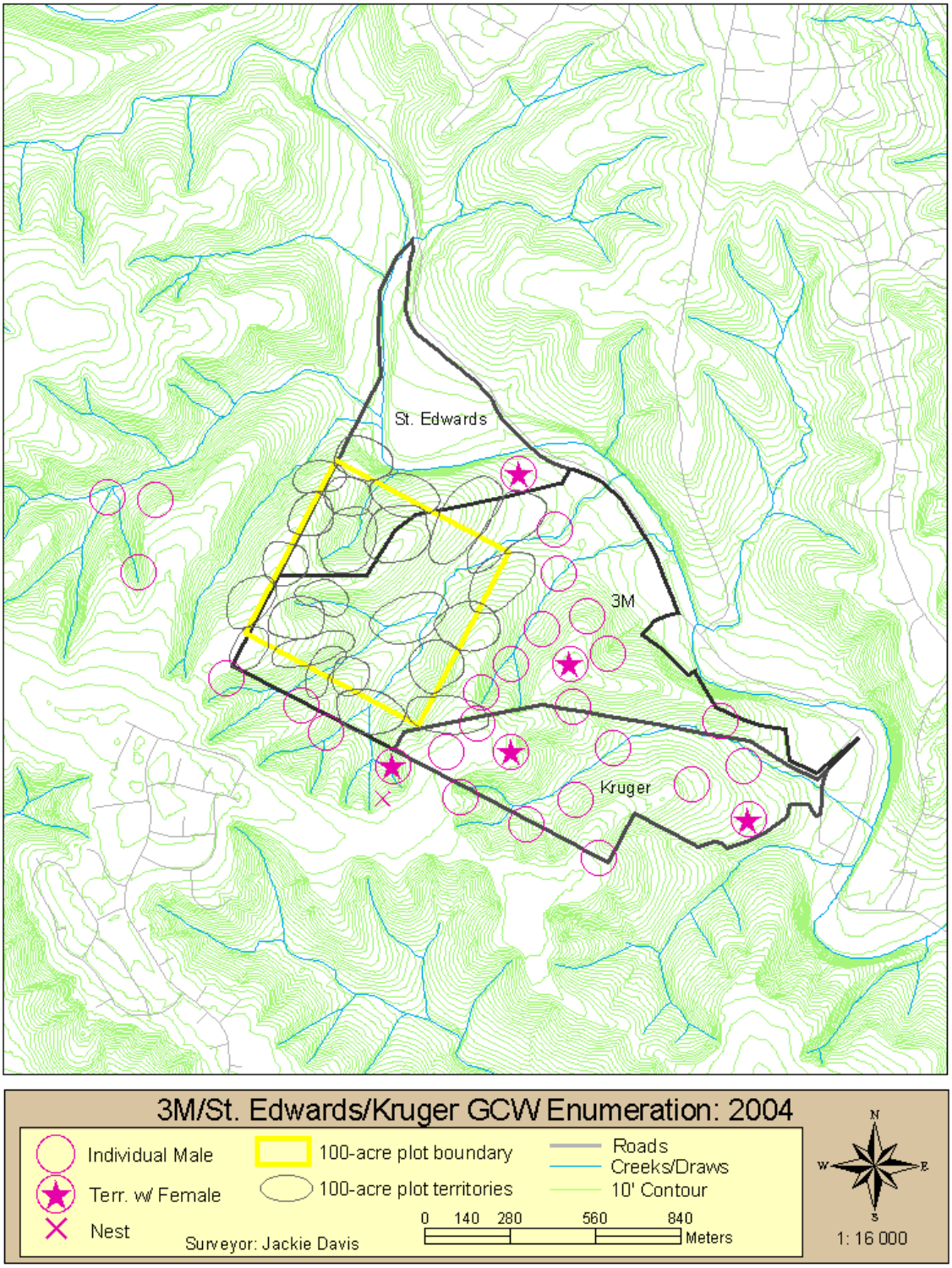
St. Edwards
3M
Kruger
3M/St. Edwards/Kruger GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Nest
100-acre plot boundary
100-acre plot territories
Roads
Creeks/Draws
10' Contour
0 140 280 560 840
Meters
Surveyor: Jackie Davis
N
W
E
S
1: 16 000

Figure 7

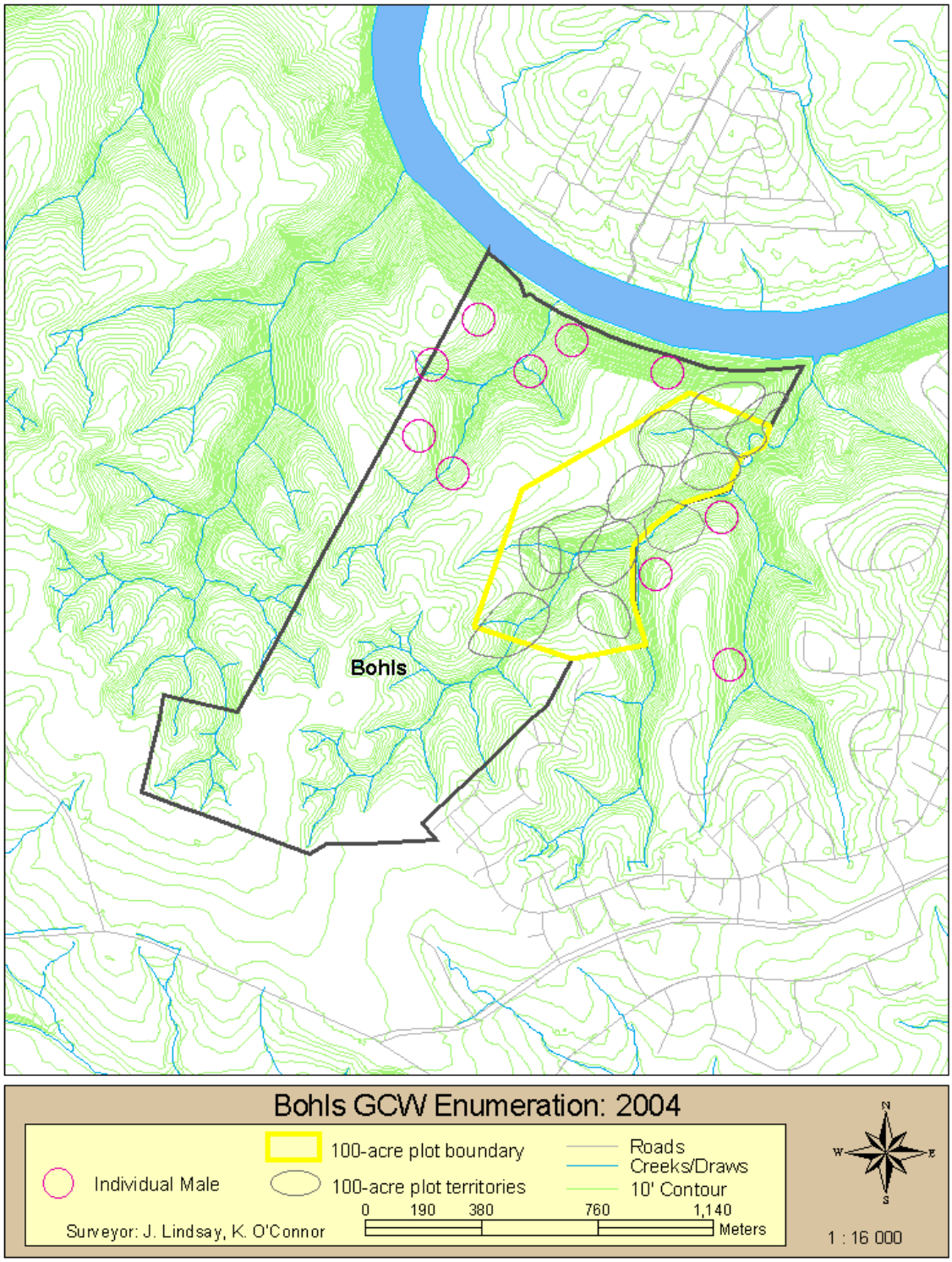
Bohls
Bohls GCW Enumeration: 2004
100-acre plot boundary
Individual Male
100-acre plot territories
Roads
Creeks/Draws
10' Contour
0 190 380 760 1,140
Meters
Surveyor: J. Lindsay, K. O'Connor
N
W
E
S
1 : 16 000

Figure 8

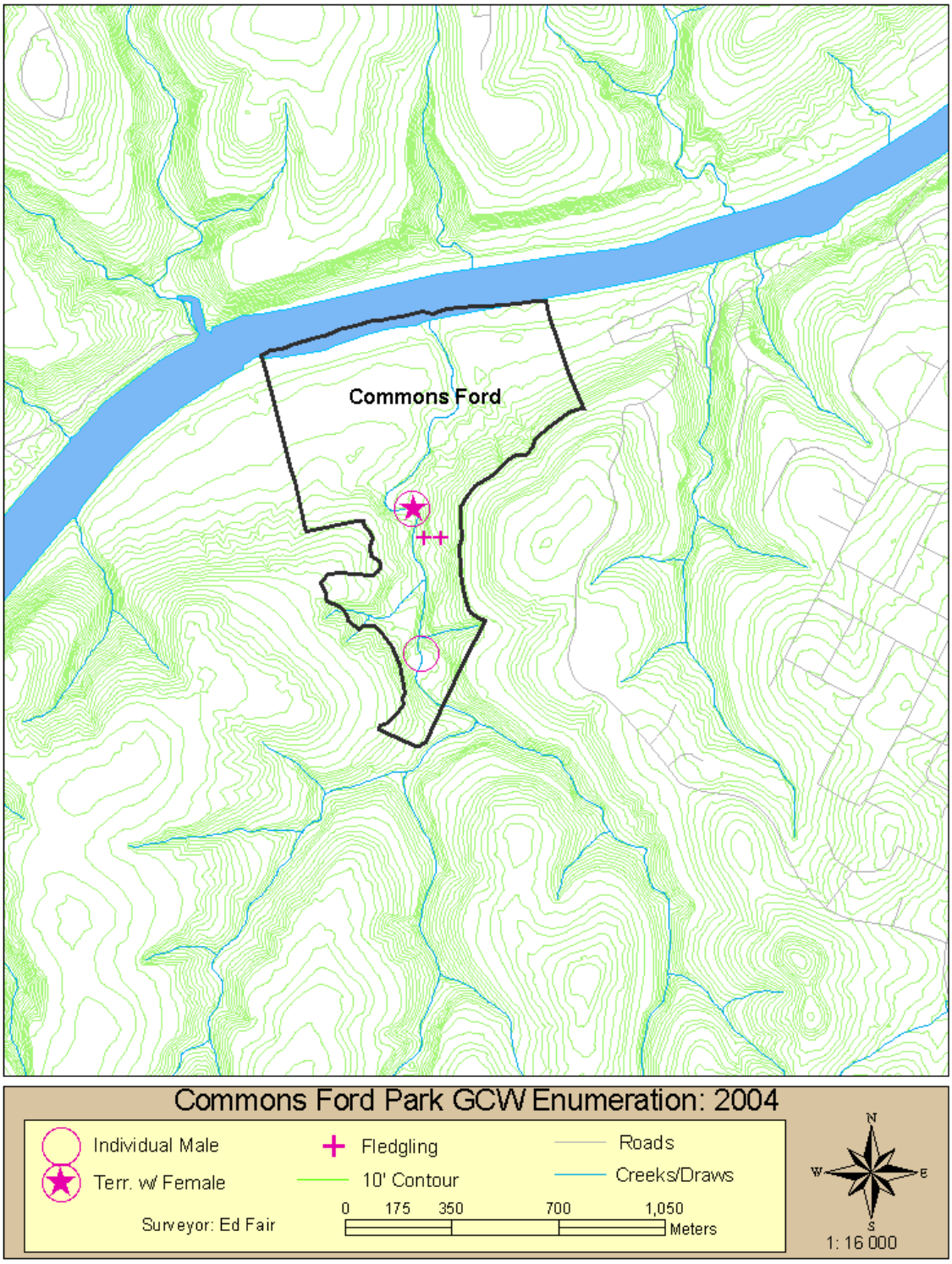
Commons Ford
Commons Ford Park GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Surveyor: Ed Fair
Fledgling
10' Contour
0 175 350 700 1,050
Meters
Roads
Creeks/Draws
N
W
E
S
1: 16 000

Figure 9

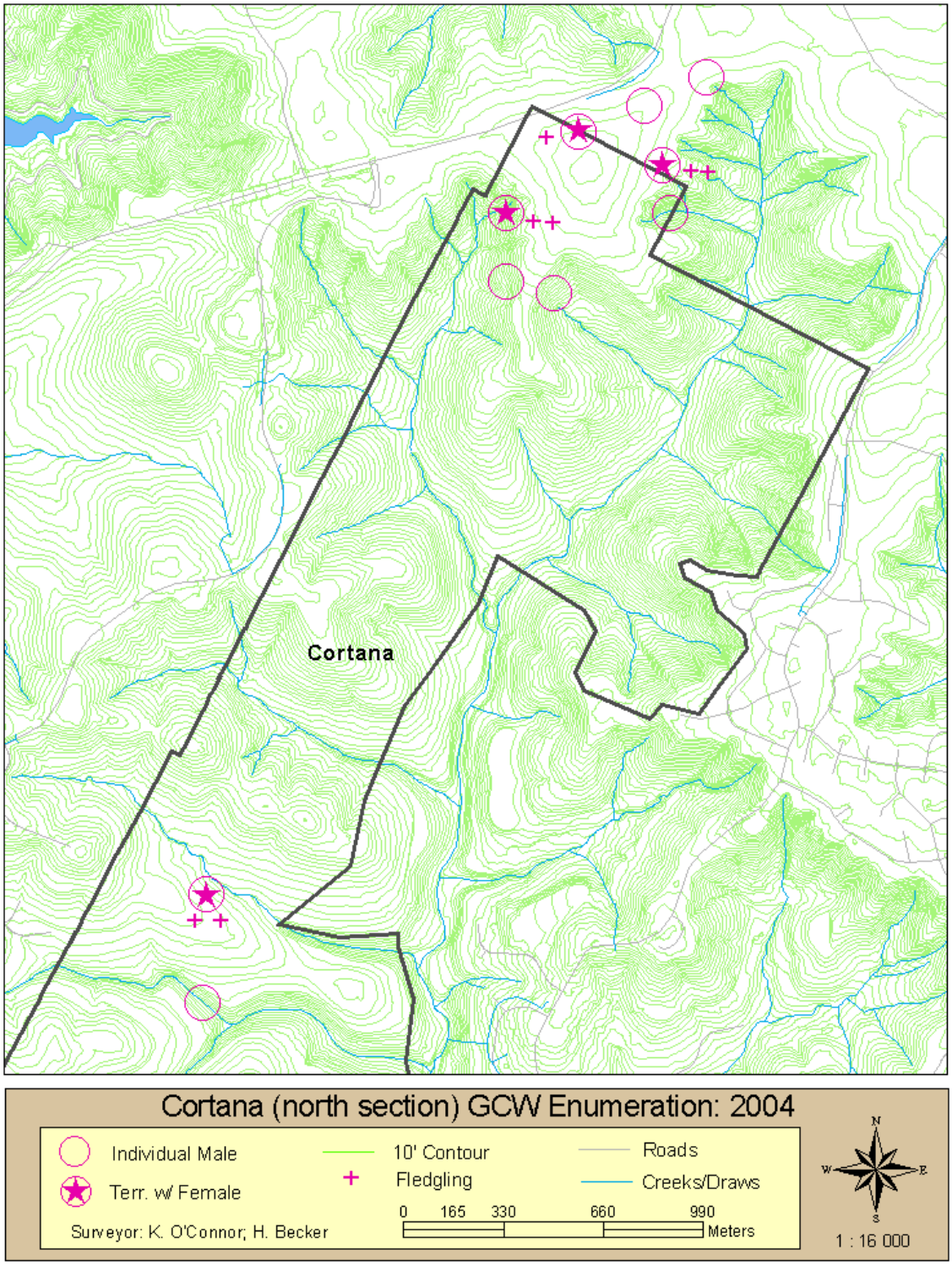
Cortana
Cortana (north section) GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Surveyor: K. O'Connor; H. Becker
10' Contour
Fledgling
Roads
Creeks/Draws
0 165 330 660 990
Meters
N
W
E
S
1 : 16 000

Figure 10

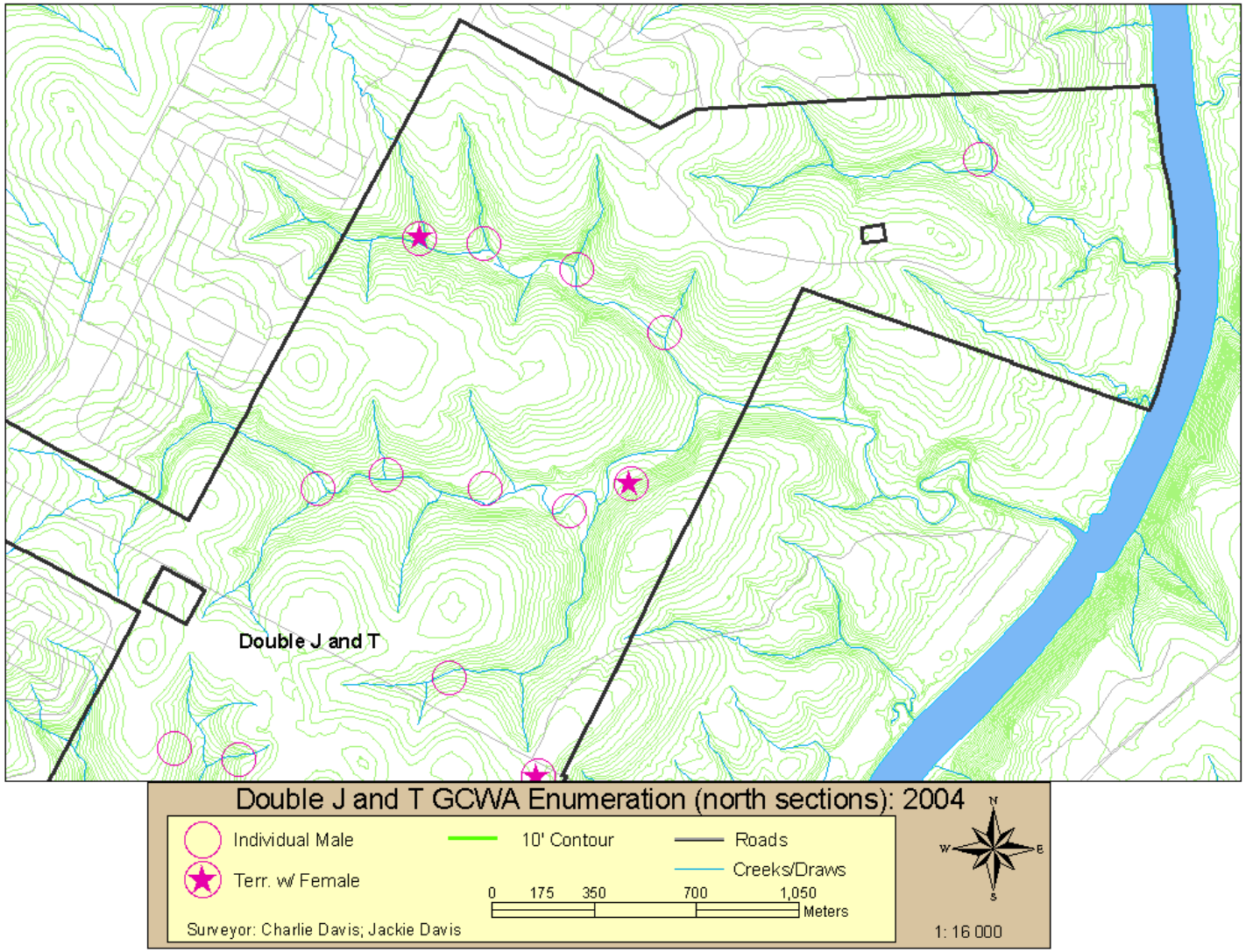
Double J and T
Double J and T GCWA Enumeration (north sections): 2004
Individual Male
Terr. w/ Female
10' Contour
Roads
Creeks/Draws
0 175 350 700 1,050
Meters
Surveyor: Charlie Davis; Jackie Davis
N
W
E
S
1: 16 000

Figure 11

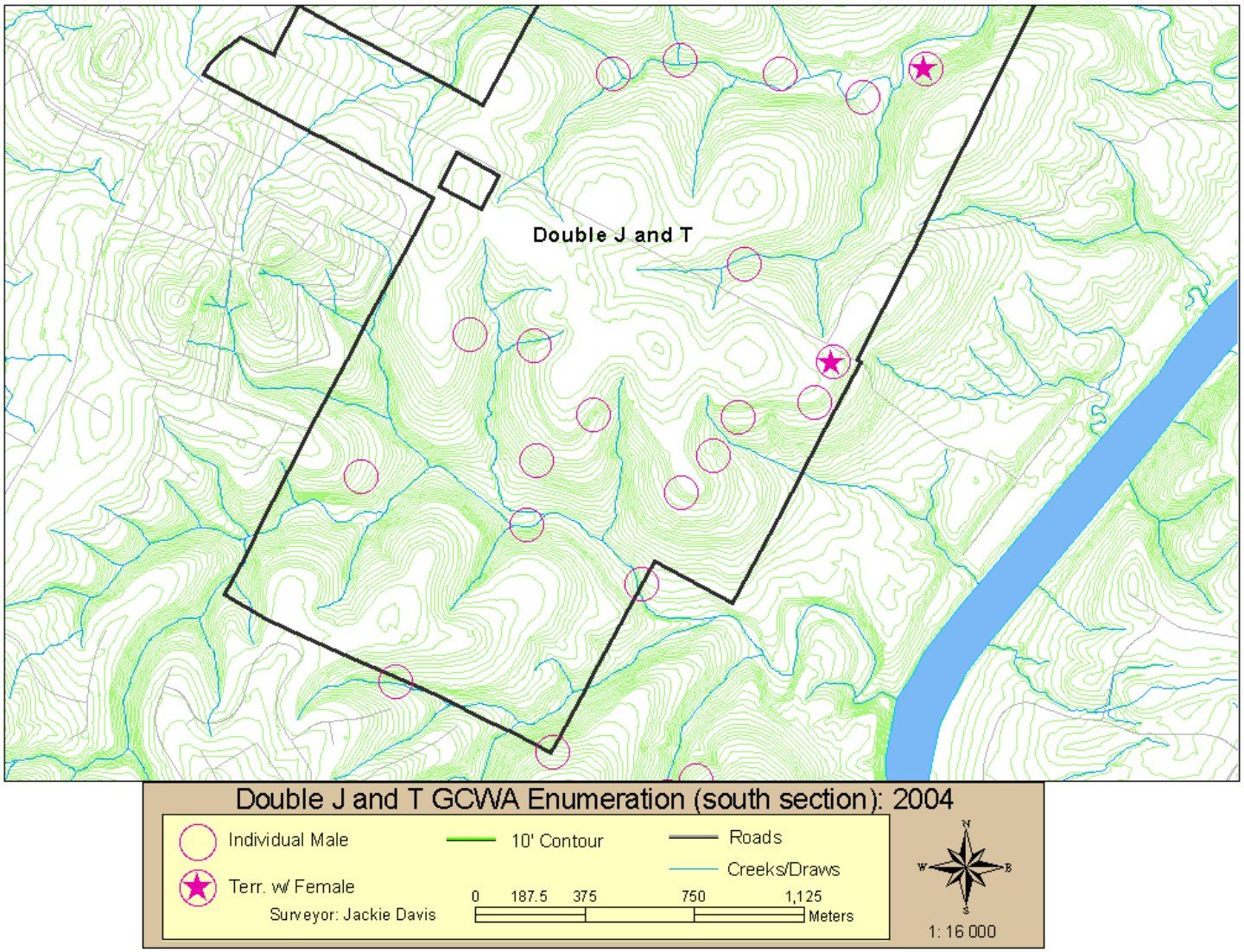
Double J and T
Double J and T GCWA Enumeration (south section): 2004
Individual Male
Terr. w/ Female
Surveyor: Jackie Davis
10' Contour
Roads
Creeks/Draws
0 187.5 375 750 1,125
Meters
1: 16 000

Figure 12

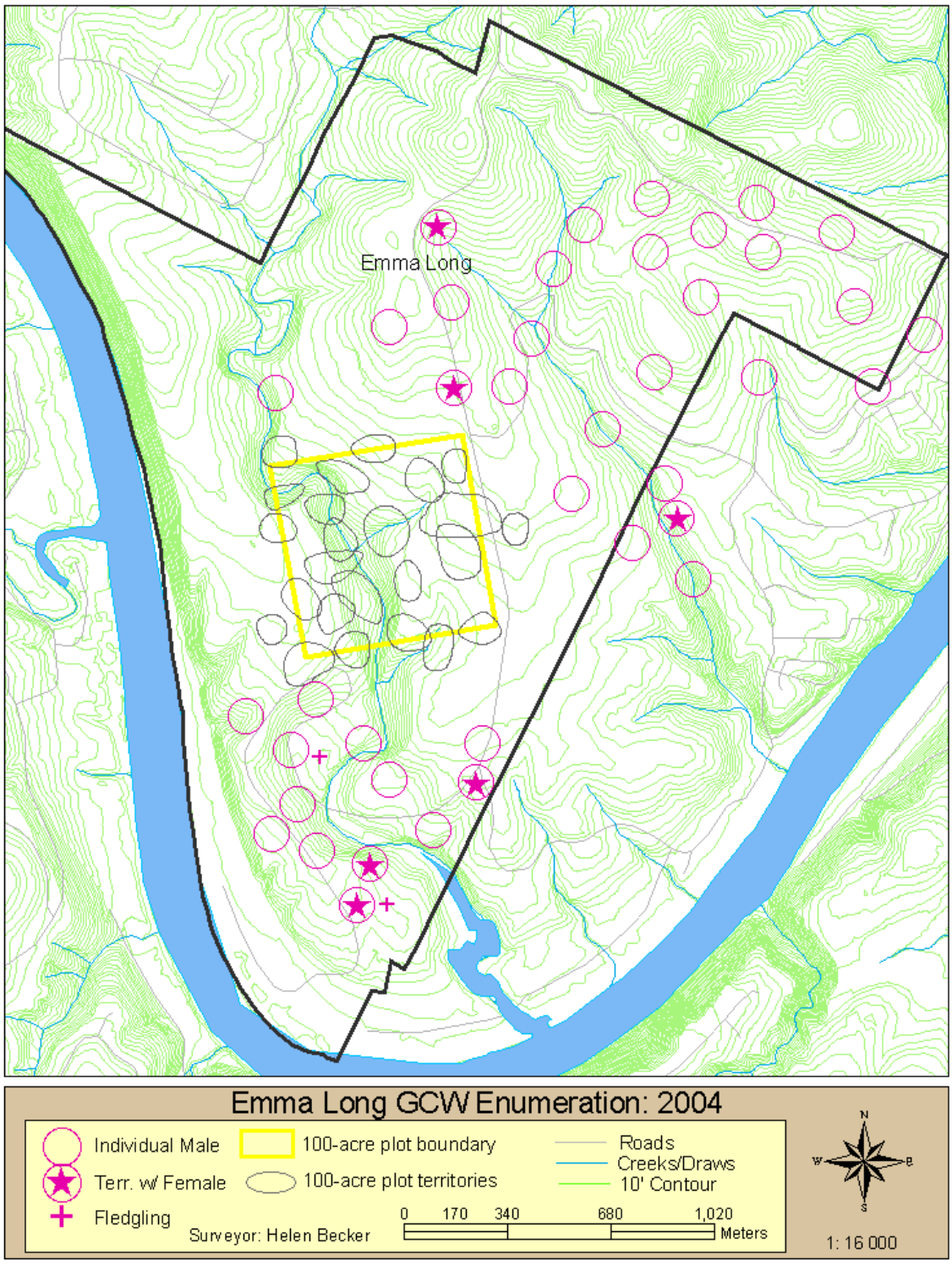
Emma Long
Emma Long GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Fledgling
100-acre plot boundary
100-acre plot territories
Roads
Creeks/Draws
10' Contour
Surveyor: Helen Becker
0 170 340 680 1,020
Meters
N
W
E
S
1: 16 000

Figure 13

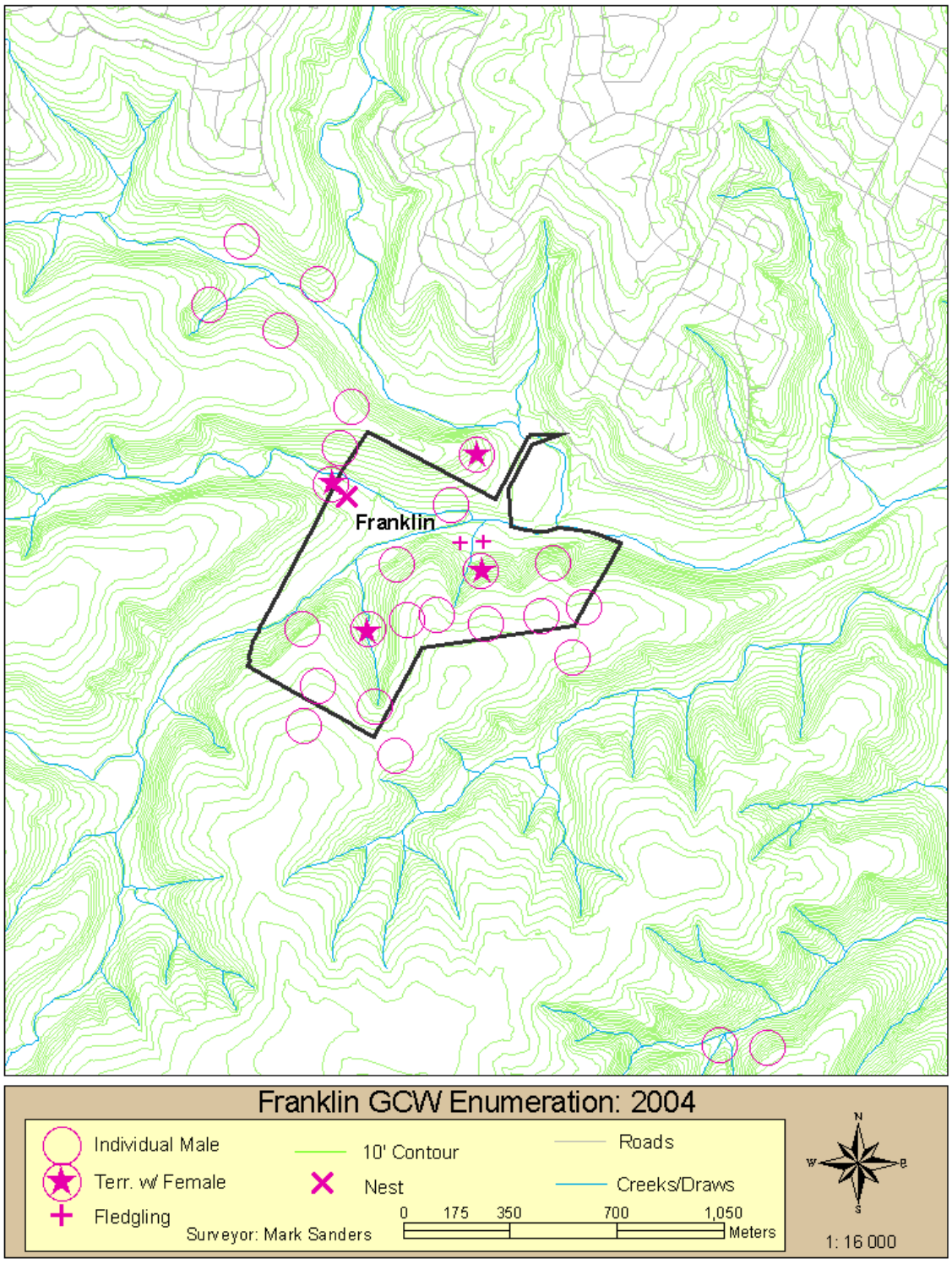
Franklin
Franklin GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Fledgling
10' Contour
Nest
Roads
Creeks/Draws
0 175 350 700 1,050
Meters
Surveyor: Mark Sanders
N
W
E
S
1: 16 000

Figure 14

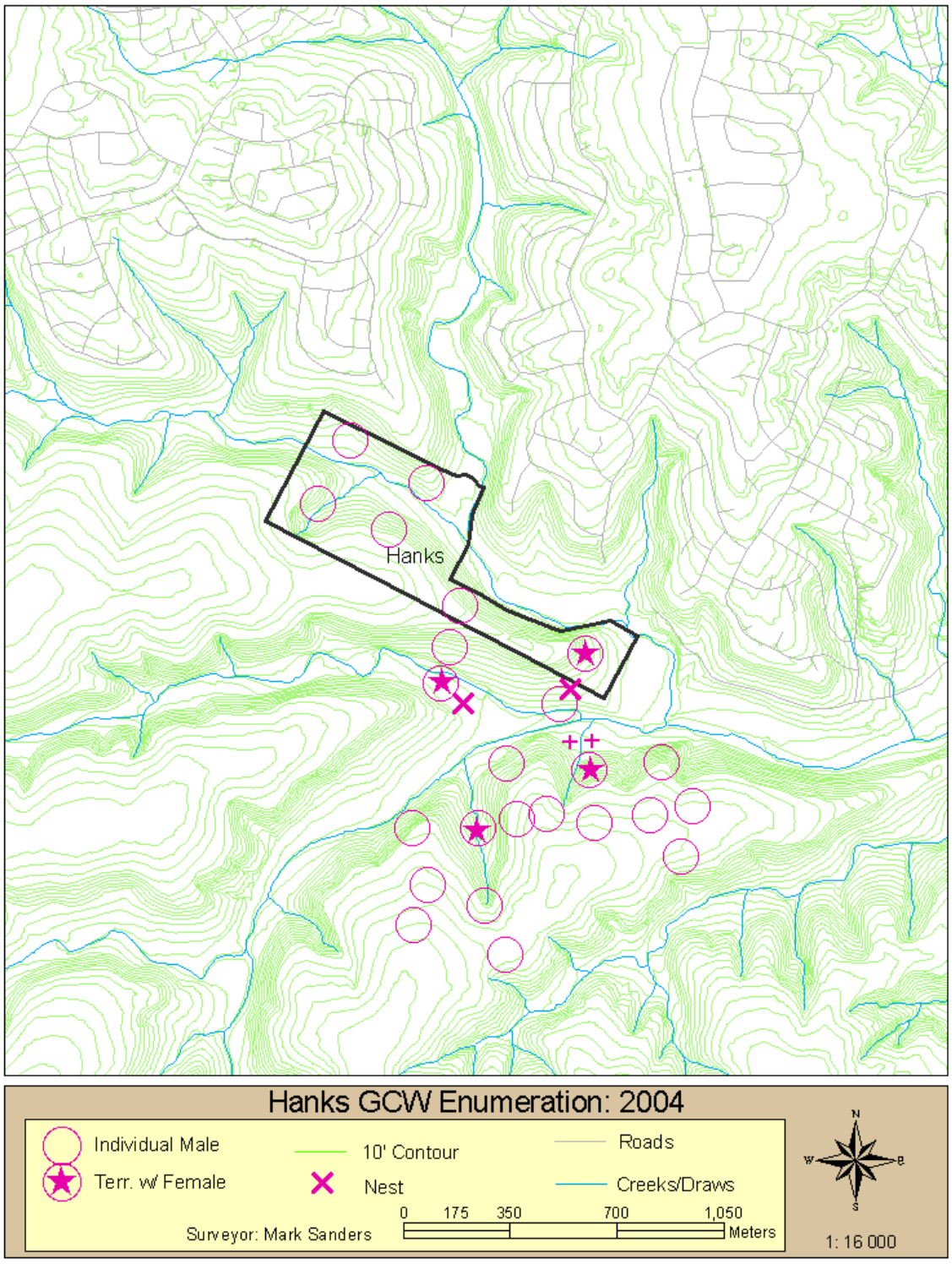
Hanks
Hanks GCW Enumeration: 2004
Individual Male
Terr. w/ Female
10' Contour
Nest
Roads
Creeks/Draws
0 175 350 700 1,050
Meters
Surveyor: Mark Sanders
N
W
E
S
1: 16 000

Figure 15

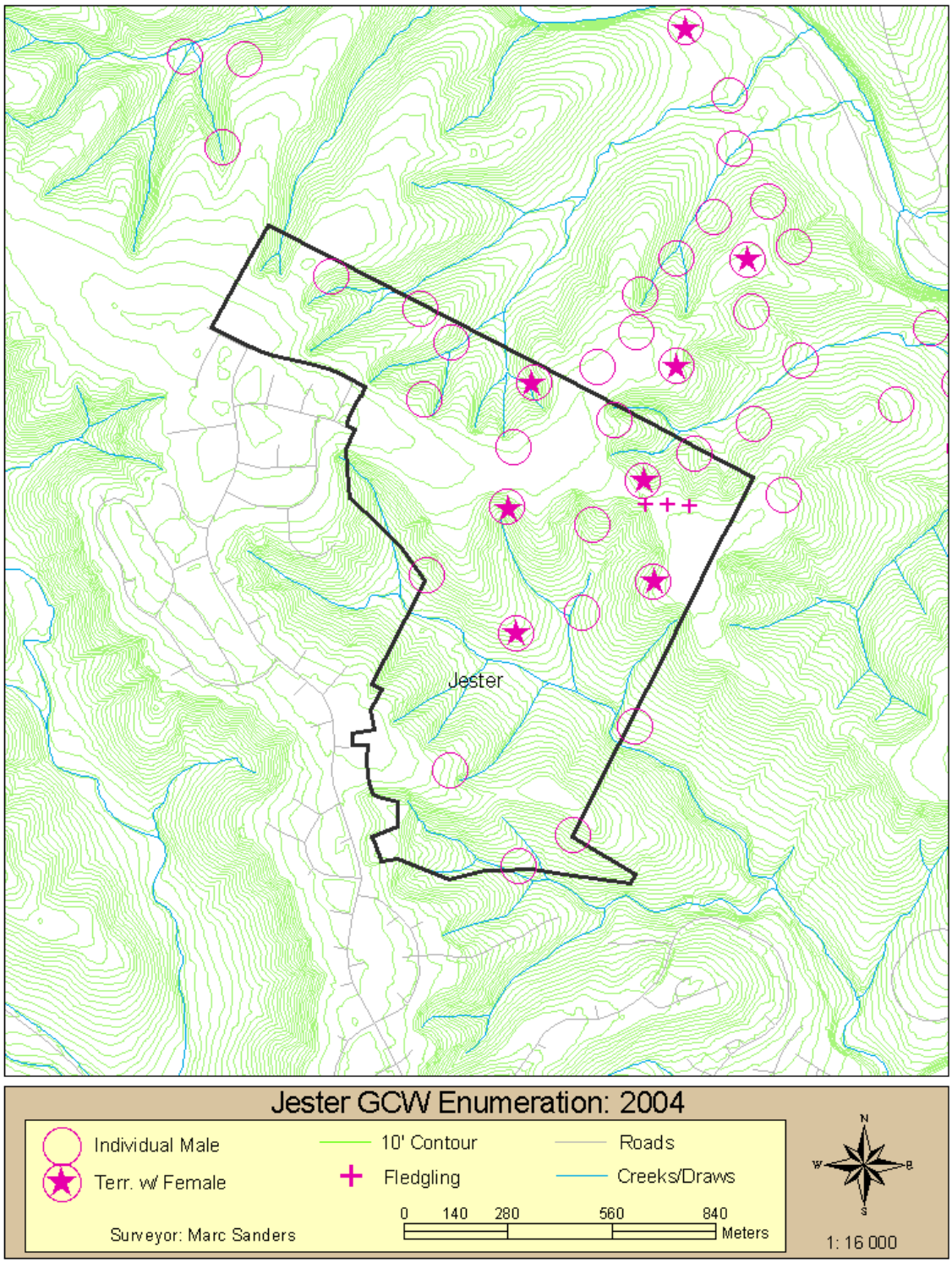
Jester
Jester GCW Enumeration: 2004
Individual Male
Terr. w/ Female
10' Contour
Fledgling
Roads
Creeks/Draws
0 140 280 560 840
Meters
Surveyor: Marc Sanders
N
W
E
S
1: 16 000

Figure 16

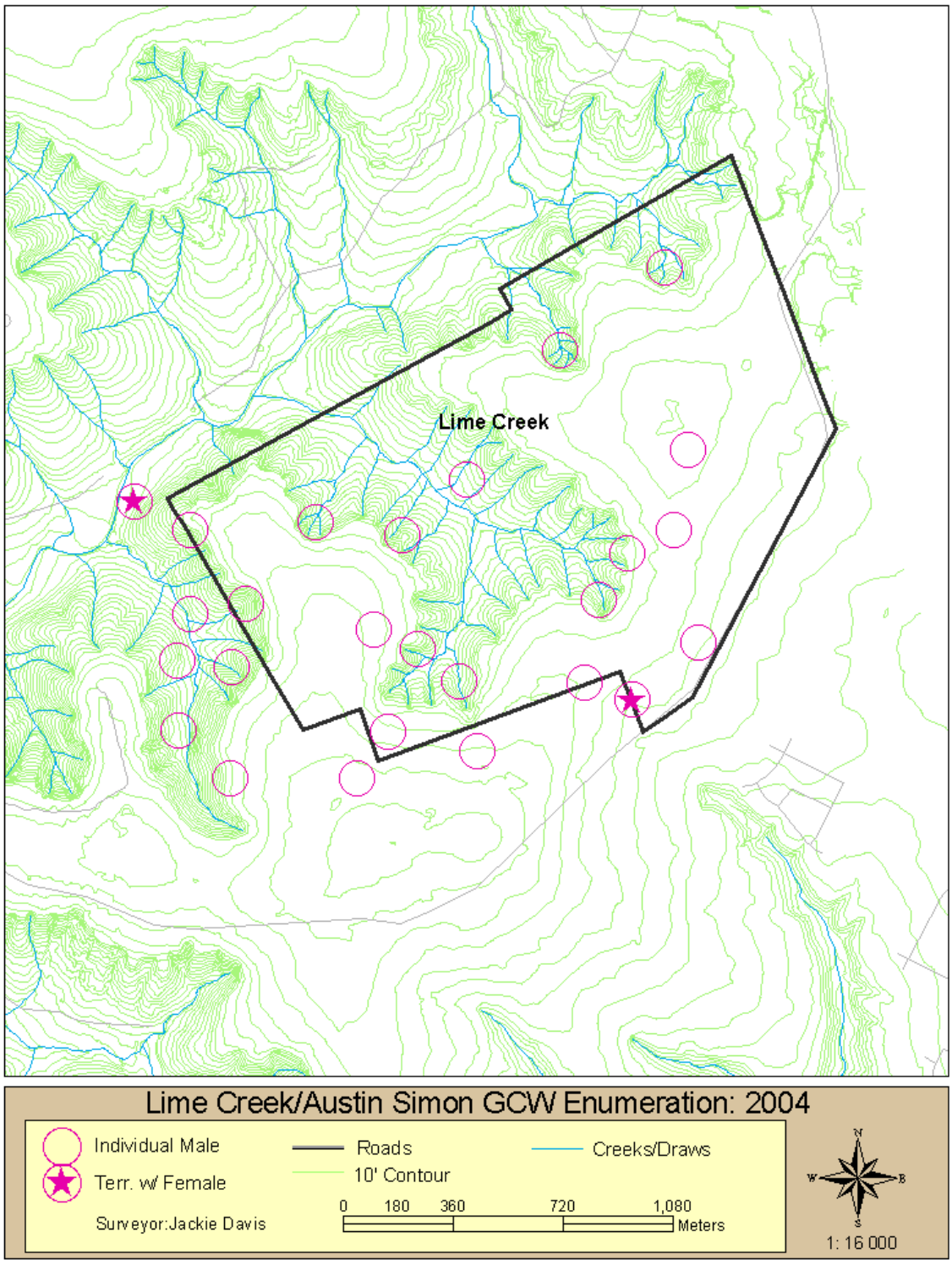
Lime Creek
Lime Creek/Austin Simon GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Surveyor:Jackie Davis
Roads
10' Contour
Creeks/Draws
0 180 360 720 1,080
Meters
N
W
E
S
1: 16 000

Figure 17

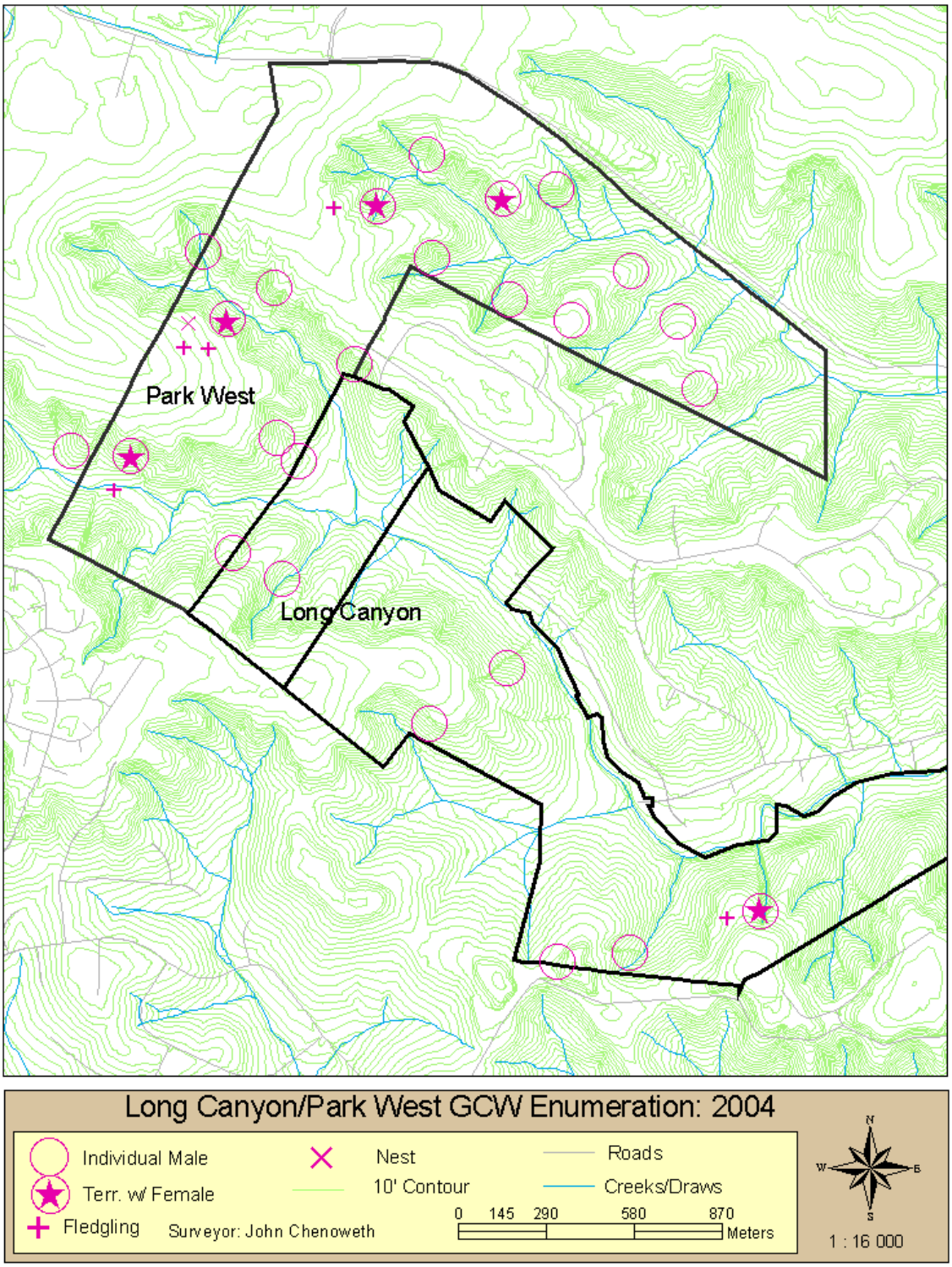
Park West
Long Canyon
Long Canyon/Park West GCW Enumeration: 2004
Individual Male
Terr. w/ Female
Fledgling
Surveyor: John Chenoweth
Nest
10' Contour
Roads
Creeks/Draws
0 145 290 580 870
Meters
N
W
E
S
1 : 16 000

Figure 18

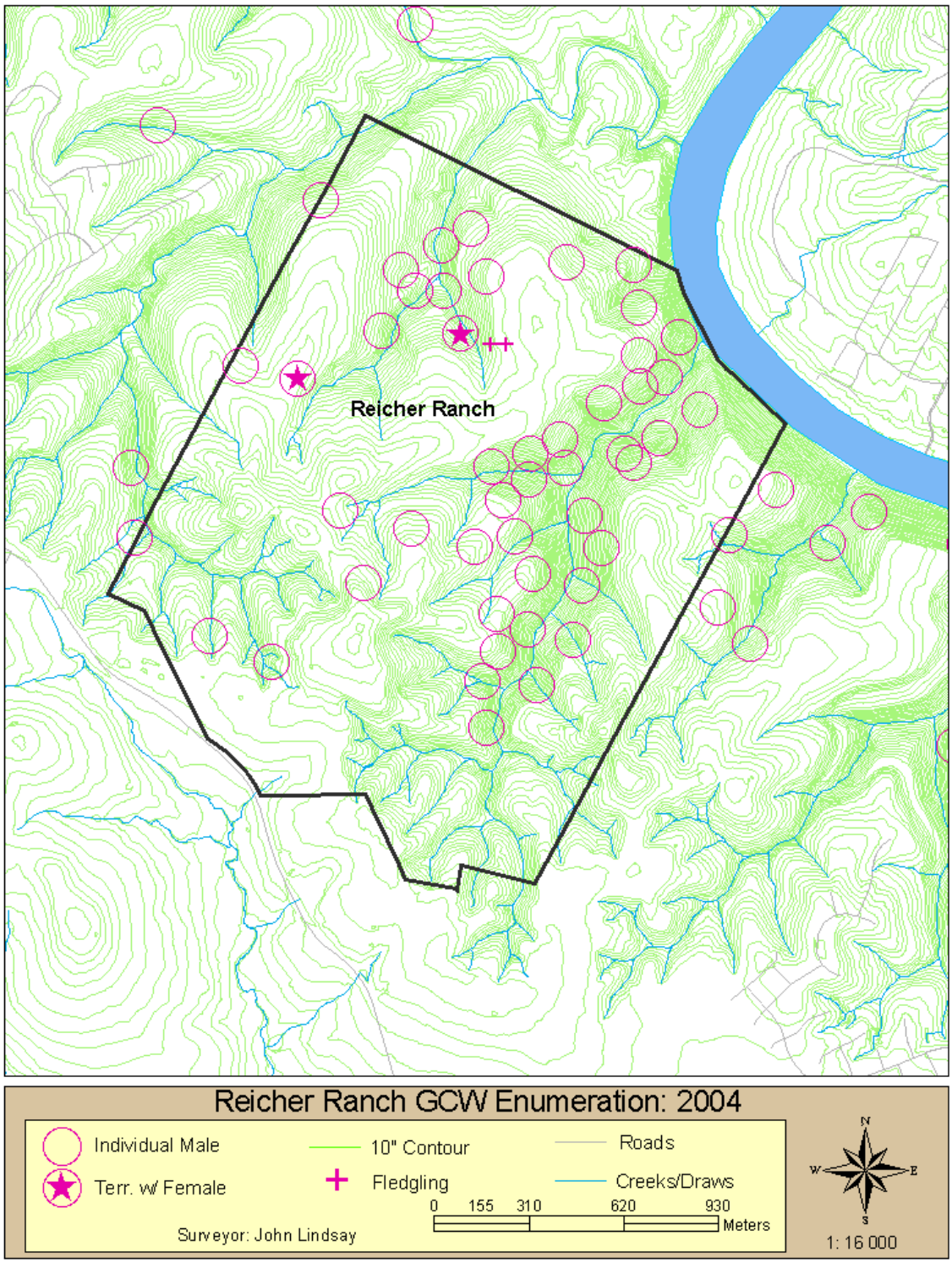
Reicher Ranch
Reicher Ranch GCW Enumeration: 2004
Individual Male
Terr. w/ Female
10" Contour
Fledgling
Roads
Creeks/Draws
0 155 310 620 930
Meters
Surveyor: John Lindsay
N
W
E
S
1: 16 000

Figure 19

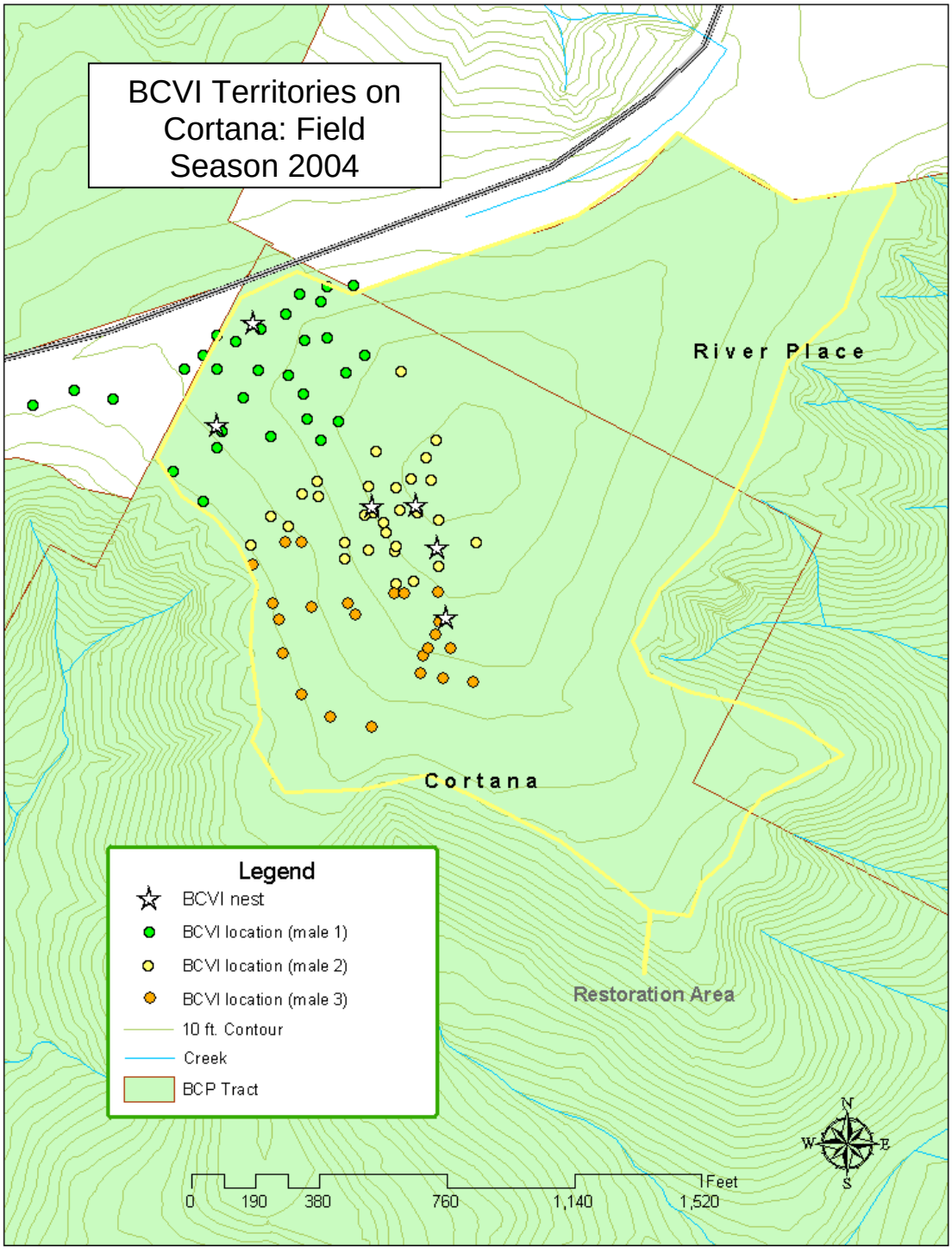
BCVI Territories on Cortana: Field Season 2004
River Place
Cortana
Restoration Area
Legend
BCVI nest
BCVI location (male 1)
BCVI location (male 2)
BCVI location (male 3)
10 ft. Contour
Creek
BCP Tract
N
W
E
S
0
190
380
760
1,140
1,520
Feet

Figure 20