FINAL REPORT

SECTION 6

ENDANGERED SPECIES ACT

FEDERAL AID PROJECT E-1

POPULATION AND NESTING ECOLOGY OF THE BLACK-CAPPED VIREO (VIREO ATRICAPILLUS) IN OKLAHOMA

APRIL 1, 1986 thru MARCH 31, 1989

FINAL PERFORMANCE REPORT

State of Oklahoma   Project Number E-1-3

Project Type: Endangered Species.

Project Title: Population and nesting ecology of the Black-capped Vireo (Vireo atricapillus) in Oklahoma.

Project period: April 1, 1986 - March 31, 1989.

Project objectives: 1) to monitor the use of breeding sites where Black-capped Vireos (Vireo atricapillus) had been found since 1985. This includes searches in and around these breeding sites to attempt to locate peripheral birds or nearby groups of vireos;

2) to enhance reproduction of the Black-capped Vireos at breeding localities by removal of Brown-headed Cowbirds (Molothrus ater) at the primary vireo breeding sites, and/or by direct interference with cowbird nest parasitism (through removal of cowbird eggs and young from vireo nests) at all vireo breeding sites;

3) to obtain an estimate of vireo breeding activity and production, and to monitor (and interfere with) the impact of cowbirds on this production of vireos;

4) to obtain an estimate of pair success accomplished by evaluating the number of offspring produced by all pairs of adult Black-capped Vireos (or as many pairs as feasible) found during May of each year;

5) to obtain an estimate of mortality as determined through return of banded vireos (continuation beyond 1988 will be necessary to complete this objective);

6) to re-survey those areas of cross-timbers surveyed in 1985, and establish some form of protection for vireos from Brown-headed Cowbird nest parasitism at sites where vireos are located;

7) to assess some physiognomic and floristic features of habitats containing Black-capped Vireos. These data can be used in a preliminary evaluation of those features of the habitat which are important to vireos.

8) to provide an assessment of potential Black-capped Vireo breeding areas in west-central Oklahoma through use of LANDSAT imagery.

9.) to assist Wichita Mountains National Wildlife Refuge (NWR) personnel in developing a management plan for the Black-capped Vireo on the Refuge as needed.

INTRODUCTION

The Black-capped Vireo (Vireo atricapillus) formerly nested in scrub-oak habitats from south-central Kansas through central Oklahoma and central Texas to central Coahuila, and possibly Nuevo Leon and Tamaulipas in Mexico (Graber 1961, American Ornithologists' Union 1983). However, it has not been reported in Kansas since 1953 (Tordoff 1956, Graber 1961), and is gravely endangered in Oklahoma (Grzybowski et al. 1986, Grzybowski 1987, Ratzlaff, 1987). An extensive survey of the former breeding range in Oklahoma during 1984 and 1985 disclosed only about 30 males in three generalized areas (Grzybowski et al. 1986). Furthermore, the Black-capped Vireo appears to be disappearing in a random pattern throughout its range in Texas (Marshall et al. 1985).

A number of factors may be acting in the decline of the vireo, but one is undoubtedly making a significant impact--namely, nest parasitism by Brown-headed Cowbirds (Molothrus ater). Nest parasitism was documented at 90-100% for a number of sites in both Oklahoma and Texas (Grzybowski 1985b). Since no vireos are produced from Black-capped Vireo nests parasitized by cowbirds (Graber 1957, Grzybowski 1985b, Grzybowski et al. 1986), such impacts are clearly implicated in the severe decline of the vireo in Oklahoma. Thus, some form of cowbird control is important in Oklahoma.

Another factor possibly influencing vireo populations is the nature of their habitat. Breeding vireos use habitats restricted to areas with scrub-oak growth of irregular height and distribution, but with spaces between the small thickets and clumps, and with vegetation cover to ground level (Graber 1961). This type of vegetational configuration is successional, or maintained in edaphic settings such as can occur in rocky gullies, edges of ravines and on eroded slopes; thus it can be quite localized. However, the actual features of this successional habitat have yet to be clearly identified.

With the very low numbers of Black-capped Vireos in Oklahoma, some monitoring of breeding adults, and an estimate of how well reproduction matches mortality is needed to establish the reproductive potential of the remaining vireo population. These data are also be necessary to assess changes in the population status of the vireos, and in establishing the level of effort and level of success of the management options employed.

METHODS

During 1985 an extensive survey was conducted to locate Black-capped Vireos in Oklahoma (Grzybowski 1985a). The survey focused on areas of cross-timbers in west-central and central Oklahoma considered primary areas of the vireo's former range in Major, Dewey, Blaine, Canadian, Caddo, Grady, Cleveland, Comanche and Murray counties (see Graber 1957, Grzybowski et al. 1986).

This was an extension of searches conducted in 1984. The coverages of these surveys are depicted in Figure 1a and b. Some areas missed in the 1985 survey were searched in 1986 (Fig. 1b).

Another extensive survey, similar to that conducted during 1985 (Grzybowski 1985a), was undertaken in 1987. The area covered by this survey is shown on Figure 2 (see also Grzybowski 1988b). Completion of this 1987 survey was accomplished during 1988 for parts of the Wichita Mountains. The survey focused on the northwestern portion of the Wichita Mountains National Wildlife Refuge (NWR), and one of the adjacent ranches. Specific stops are shown on Figure 3.

Observers travelled in the survey area and systematically stopped and listened for vireos at sites with suitable amounts of scrubby woody vegetation (see Grzybowski 1985a). Taped recordings of vireo songs were used to help elicit responses of male vireos. Each specific locality was marked on a United States Geological Survey (USGS) topographic map (either 7 1/2′ or 15′), or on a county map. The primary survey was conducted from 25 April through 21 May 1987. Supplemental survey work was performed from 8-14 May 1986, and from 28 April through 21 May 1988.

Graber (1961) described primary Black-capped Vireo habitat as being "wooly,′ i.e., heterogeneous in vegetation heights with some spacing between trees, and with cover to ground level. This habitat was demonstrated to all observers conducting survey work during a preliminary session with the principle investigator each year.

For each of the areas which appeared particularly suitable for Black-capped Vireos, and a sample of the rest, the length of the stop was at least ten minutes. However, to facilitate checking as many specific locations as possible, observers were encouraged to make briefer stops at even marginal appearing areas. Because male vireos are vocal through much of the day, the likelihood of detecting them during even the briefer stops is high. Many are actually detected without the aid of tape recordings, or respond to it quickly (pers. obs.). The length of the stop (long or short) was symbolized on all maps; longer stops by a solid circle, and shorter stops by an "X." All stop localities were transferred onto county or Refuge maps (see Grzybowski 1988a and Figure 3).

In addition, a thorough survey of Fort Sill Military Reservation (MR) was also conducted under a separate contract (see Tazik and Grzybowski 1988). Areas with potential vireo habitat on Fort Sill were identified (much by helicopter overflight), and all areas containing potential habitat were searched. The specific areas surveyed and the location of the vireos found are provided in the Appendix.

Localities where vireos had already been located during surveys and in previous years (Grzybowski 1985a, 1988b) were revisited each year, and vireo territories in these areas mapped. These included the Blaine County locality in the upper reaches of Salt Creek (north of Watonga), the sites in extreme southwestern

Canadian County and immediately adjacent Caddo County, and sites in the Wichita Mountains (including the Wichita Mountains NWR and Fort Sill MR; see Grzybowski 1985a, and 1988b for list and description of specific localities). Peripheral searches were conducted around these areas as well to locate any potential satellite groups or expansion.

At each of the breeding localities monitored, the number of adults was carefully determined, and their territories mapped. The observations for each visit to a male vireo territory were recorded. Males were located and followed to determine if they were mated, to locate females (if present), and to assess reproductive activity (nests or young). Since males are involved in every step of the breeding process (including incubation, nest-building, and care of nestlings and fledglings; Graber 1961, pers. obs.), determinations of mated and nesting status, and pair success were established by following activities of male vireos at intervals throughout the nesting season. Care of fledglings by males may continue for up to 40+ days after the young leave the nest (Graber 1961). Thus, it was possible to establish whether or not each pair fledged young, even if every nesting attempt was not discovered, with a reasonable monitoring schedule of the males.

However, limits of time and personnel restricted the number of vireos monitored in the Wichita Mountains to a subset of the total. More birds were located than expected. In addition, some birds were in very remote areas of the Refuge.

Visits of all sites monitored were made throughout the potential nesting period (as long as active birds were present) from 19 April through 20 September 1986 (mostly from mid-April to mid-July), 11 April through 5 August 1987, and 21 April through 5 August 1988. All pairs unsuccessful in fledging young through June, but still active on their territories, were re-checked in mid-July (to establish their potential nesting success).

Cowbird-removal traps (USDI 1973), were constructed, assembled and maintained for various periods at the Methodist Canyon Camp Site, Canadian County, and in the Wichita Mountains NWR., Comanche County. These traps were used to attract and remove cowbirds from the vireo breeding sites. A trap at Methodist Canyon was operated during May and June 1986, and April and May 1987. In the Wichita Mountains, two traps were operated in Greenleaf Canyon during 1986. In 1987, the number of traps was increased to four; three in Greenleaf Canyon and one at the head of Wild Horse Canyon. Two additional traps were added in 1988; one just east of Mount Lauramac, and one in the unnamed canyon just north of Greenleaf Canyon at a place locally known as Soldier Dam. During mid-June, the easternmost trap in Greenleaf Canyon was moved to Winter Valley, a grazing pasture west of the main vireo "colony," as an experimental measure to enhance removal of cowbirds, and reduce the pool of available cowbirds which could penetrate the main vireo "colony." Decoy cowbirds for the traps were initially captured with mist nets in Norman, Oklahoma.

In addition, interference of cowbird nest parasitism was conducted through the location and removal of cowbird eggs from active vireo nests, and also the removal of young cowbird nestlings or fledglings, when discovered. Where only one or two pairs of vireos were located in an area, these were the only mechanisms of interfering with cowbird nest parasitism that were employed.

Attempts were made to capture and color-band a sample of adult Black-capped Vireos located during the study. Mist nets, in conjunction with tape recordings of vireo songs and wooden decoy models of male Black-capped Vireos, were used in attempts to capture males. Attempts at capturing females focused on placing mist nets in lanes of travel near active nests, or at times when females were traveling with the males; however, caution was used in all cases to avoid undue disturbance or harassment of both males and females. Nets were placed at some distance from the nests, and attempts for females were made only when the nests were known to be at a late enough stage where abandonment was not a concern. A policy of priority for vireo reproductive success over color-banding was employed.

During 1986 and 1987, banding of young was considered on the ninth or tenth day in the nest (one to two days before anticipated fledging), and after fledging. In 1988, this policy was changed to banding young at normal fledging time, and not returning them into the nest. While this limited opportunities for the banding of the young, these precautions were taken to avoid potential investigator-enhanced predation of young in nests.

A unique combination of color and aluminum leg-bands was used for each adult male or female captured. Thus, specific individuals can be identified in subsequent years without recapture. However, all young in a given year were banded with the same color and aluminum leg-band combination unique only for that year; these combinations were not used for any of the adults.

All captured adult birds were photographed and aged (in most cases) by the condition of their primary coverts. Because juveniles of many passerines have an incomplete pre-basic molt (into first-winter feather) where they retain their juvenile primaries, rectrices and primary coverts into the following breeding season, differences in tone and wear between these retained juvenile feathers and feathers of adults have potential to be used in aging (Humphrey and Parkes 1959). However, aging was limited to distinguishing between birds in their first breeding season (designated here and throughout as SY [meaning in second calendar year of life] in parallel with use by U.S. Fish and Wildlife Service Bird Banding Lab) and those older designated ASY (=after second calendar year of life). In Black-capped Vireos, the differences in plumage wear are best expressed in the primary coverts which are browner, more worn and with buff edgings in SY birds rather than blackish with greenish-yellow edgings in ASY individuals (Grzybowski 1988a).

Male Black-capped Vireos undergo delayed plumage maturation, a phenomenon where the SY male (in his first breeding season) takes on a plumage similar to that of the female (see Selander 1972, Rohwer et al. 1980, Lyon and Montgomerie 1986). SY males show essentially gray napes, with gray cornering into the superoposterior border of the white "spectacles." However, other male vireos, of uncertain age, but considered here as gray-ASY (after second calendar year in age) may show varying but lesser amounts of gray up the nape. The average age of these gray ASY males may be TY (or in their third calendar year or second breeding season), though this has not been well established (Grzybowski 1988a). Use of gray in aging is discussed in Grzybowski (1988a) and is validated by brown (rather than blackish) and worn condition of primary coverts with tan (rather than greenish-yellow) edgings in SY males captured and banded.

To improve the efficiency of the cowbird traps, data were also collected concerning the behavior of cowbirds in and around these traps during 1988. An individual monitored the traps during morning hours recording (1) the behaviors of cowbirds in the traps, (2) any observations of cowbirds flying over, perched nearby, and/or approaching the traps, and the response of cowbirds in the traps to any cowbirds outside the traps. These data were collected on about 7 days from 26 April to 8 June 1988.

In addition, 10-minute spot counts of cowbirds were made at various locations in and around the main vireo colony during 1988 to assess the general distribution of cowbirds. Time of the single observer spread among several tasks limited the ability to replicate samples, and evaluate all sources of potential variation in these counts. However, they still provided a means of assessing how cowbirds were distributed relative to the main vireo colony, the effectiveness of the traps, and the potential sources of cowbirds penetrating the main vireo breeding colony.

Data for evaluation of vireo habitat were obtained though two methods. The first (used in 1986) was an application and modification of the random-pairs method (Cottam and Curtis 1949, 1955, and 1956), where woody shrubs or clumps of vegetation were used as the discrete entities. The random pairs were taken at 30 m intervals along transects through scrubland vegetation. Various dimensions of these clumps were also measured, including height and circumference of foliage at various height intervals, as well as subjective determinations of foliage density. The species of woody vegetation were recorded. In addition, the cover types and their heights at five meter intervals along the transects used in the random-pairs approach were also documented.

Each random pair was assigned as being in a vireo territory, or not being in a vireo territory. Transects were established at all sites where vireos were located; scrubland sites without vireos were also used to extend the control sample for comparison. Analysis was based on this assignment of random pairs to vireo or non-vireo territories. Summary statistics and statistical analyses were accomplished using SAS (SAS Institute Inc. 1985). Differences in percentages of occurrence between samples for various class categories were compared with those for confidence limits of percentages given in Rohlf and Sokal (1969) to determine statistical significance.

The second approach to evaluating habitat was an application and modification of a plot-method using one-tenth acre circles developed by James and Shugart (1970). Within these circles, this method essentially measures (1) the numbers of each species of woody plants with diameters at waist height of greater than 7.6 cm in a series of diameter classes, (2) the number of stems of each species intercepted by a rod 1.52 m long passed horizontally through the vegetation at a height of 1 m along two orthogonal diameters, and (3) cover types at 20 points spaced 2 m apart, and also taken along two orthogonal diameters. From these data, relative densities, basal areas and relative dominances for each species can be calculated, along with an area measure of stem counts, and percentages of the the various cover types.

In addition to these measures, and the variables so derived, other habitat data were also collected. These included the heights of all the tree species with diameters greater than 7.6 cm. Also, a rod was passed vertically through the vegetation at 20 points 2 m apart along two orthogonal diameters, and counts made of the number of decimeter intervals within larger height class intervals containing various types of vegetation (recorded to species for woody plants). Cover types over two orthogonal diameters 1 m high were also recorded within each circle.

Vireo territories to be evaluated were drawn from a hat containing identification tags for all territories. Sixteen territories were selected including nine on the Wichita Mountains N.W.R., Comanche County, five on the adjacent Fort Sill M.R., Comanche County, and one each at the Methodist Camp site, Canadian County and the Scott site, Cadddo County. In addition, 13 equivalent non-vireo areas with scrubland vegetation were also sampled for comparison, 11 in the Wichita Mountains, and one each near the Methodist Camp site and Scott site. Habitats clearly unacceptable for vireos (such as grasslands or cedar brakes) were avoided.

Seven circles were established in a grid oriented by the cardinal directions in each vireo territory measured. An equivalent number of circles were used to characterize the habitat in areas not occupied by vireos as well. The circles were separated by a distance equal to the diameter of a circle. To randomize the starting point for any area or territory, the initial circle was determined by pacing a predetermined distance in a predetermined direction from the initial entry point into a territory, or from some point in a scubby area not occupied by vireos. In a few cases, only five or six circles could so fit in a vireo territory. However, James and Shugart (1970) indicate that four or five circles can adequately characterize a sampling area.

The data from this Oklahoma study are here combined with that from two other regions, Fort Hood, Texas and Kerr County, Texas, to help elucidate various points. In addition, those territories occupied by SY or ASY males are also identified.

Analysis involved first a multivariate summary technique--Principal Components Analysis (PCA)--which simply shows the relationships between points (here vireo territories or non-vireo areas) in multivariate space determined by axes orthogonal to each other, and hierarchically representing the decreasing amounts of variation in the data. Its primary advantage is that it makes no assumptions about the individual data points.

Next, a Discriminant Function Analysis (DFA) was performed to attempt to identify that combination of variables most capable of separating groups; in this case, vireo territories (hereafter VIREO) from areas not occupied by vireos (hereafter NON-VIREO). Canonical Variates Analysis (CAN), a DFA with more than two groups, was performed in analyses where data were grouped as NON-VIREO, ASY-VIREO and SY-VIREO. The advantage of these approaches is that they search for axes upon which groups are most separated. However, it suffers from the disadvantage for ecological data in that it assumes that all groups are correctly classified. Quite possibly, NON-VIREO may be so because of factors other than its suitability for vireos, including isolation or low populations levels. Conversely, VIREO may be occupied because of proximity to other VIREO, rather than intrinsic habitat characteristics themselves. Thus, results need to be interpreted with caution.

These analysis procedures were employed on various subsets of the data including (1) all VIREO and NON-VIREO from all regions, (2) only VIREO from all regions, (3) VIREO and NON-VIREO for the Oklahoma subset only, and (4) SY-VIREO, ASY-VIREO, and NON-VIREO also for the Oklahoma subset. Because floristic differences occurred between regions (for example in the specific species of oaks) which could clearly weight axes in PCA and DFA along species gradients, woody species were grouped into life-form categories to include oaks, junipers, deciduous non-oaks, and vines.

RESULTS AND DISCUSSION:

SURVEYS:

Table 1 summarizes the approximate number of "stops" made in each county during various surveys for the Black-capped Vireo from 1984 through 1987. The locations of specific stops for these surveys are presented in Grzybowski (1985a, 1988b). While specific stops are given, the numbers generated are still an approximation, as some stops documented by the observers and very near each other were combined and counted as one for this summary. The areas covered by these surveys are delimited in Figures 1 and 2.

No vireos were detected in the supplemental survey accomplished during 1986. Of the 737 localities surveyed in 1987, Black-capped Vireos were found at 16. During 1988, approximately 274 stops were made in the supplemental survey covering the northwestern portion of the Wichita Mountains NWR and an adjacent private ranch (Figure 3). Black-capped Vireos were noted at eight of these stops, two shared in common with the 1987 survey. However, vireos may not have been present at all of these sites during 1987.

In addition, a detailed survey of Fort Sill MR was conducted under a separate contract. The areas covered on Fort Sill are given in the Appendix (from Tazik and Grzybowski 1988). Since much of this area was covered by foot, only paths of travel were recorded, rather than stops. Three areas with what would be an equivalent of 5-6 stops contained Black-capped Vireos (Tazik and Grzybowski 1988).

All total during 1987 and 1988, Black-capped Vireos were located at 27-28 stops, though a few may not have been occupied during 1987. However, when localities within 1 mile of each other were combined, these 27-28 specific stops reduced to 13 sites with vireos--one each in Blaine, Canadian and Caddo counties, and ten in the Wichita Mountains (including one large "colony").

Although the 1987 survey systematically covered potential vireo habitat in counties of west-central and central Oklahoma virtually section-line road by section-line road, vireos were still found in only the same three general areas as noted in 1985--(1) gypsum canyons in the upper reaches of Salt Creek (north of Watonga) in Blaine County, (2) extreme southwestern Canadian County and immediately adjacent Caddo County, and (3) in the Wichita Mountains--including the Wichita Mountains NWR, adjacent areas of Fort Sill MR, and one, also adjacent, private ranch. The Wichita Mountains NWR contained the bulk of the sightings. Vireos were found at only one locality in Caddo County, once believed to be a stronghold for the species. None were noted in a block of cross-timbers habitat in eastern Dewey County, adjacent Major County, or in almost all of Blaine County, another area believed to have maintained vireo populations as recently as the 1950's, and possibly the 1960's (Graber 1961, Grzybowski et al. 1986).

If substantially more vireos were present in 1985 outside of the core areas than were actually being detected, then it would be expected that some random detections of new areas with vireos outside the already known core areas would have occurred with the 1987 survey. However, this was not the case. Thus, it is likely that the Black-capped Vireo (1) is confined to these three core areas; (2) that the size of the core areas is closely related to between season dispersal distances; (3) that these three areas are genetically isolated from each other; and (4) that the Oklahoma population(s) is(are) isolated from those in Texas.

The numbers of Black-capped Vireos located during 1988 is given in Table 2 along with those located in 1985, 1986 and 1987.

Maps showing all of the territories each year are given in Figures 4-12. While only about 30 males were located during 1985 and 1986, this number was doubled to between 60-64 males in 1987, and then increased by yet another 75% to 102-118 males in 1988. The total number of adult vireos detected in Oklahoma during 1988 was 172-199. Almost all of these (156-183; 91-92%) were in the Wichita Mountains. This percentage of vireos in the Wichita Mountains has increased each year (54-56% in 1985, 61-63% in 1986, and 88-87% in 1987).

During 1985, only 35-39 adult vireos were located. Because mated status was not determined for many of the males, and a few observers identified sites only as containing vireos, the value generated was suspected as conservative. In 1986, 44-51 adult vireos were located. The number of males was approximately the same in 1986 as in 1985, even though vireos were not found at five localities (one not searched) where they were present during 1985. Thus, the increase in numbers was probably the result of better effort in mapping territories at specific sites. In addition, the mated status of each male was assessed resulting in a larger number of females detected (7 in 1985 compared to 18-20 in 1988). Because vireos disappeared at a number of sites, it was implied that a slight decline in vireo population probably occurred between 1985 and 1986.

During 1987, however, 102-106 adult Black-capped Vireos were noted in Oklahoma, including 60-64 males and 42 females. All 42 females were mated. This total count is higher than the numbers detected in 1986 (44-51 adults--26-31 males and 18-20 females) by a factor of about 2. Almost all of the increase in 1987, came from the detection of substantially more vireos in an expanded single area of the Wichita Mountains NWR--the Greenleaf Canyon area--an area where vireos had already been detected in 1985 and 1986. At this site, vireos were found just over almost every hill and ridge from where they had been noted in earlier years (see Figure 11b and c). The new territories were in areas not visited in 1986, with one exception. This area in and around Greenleaf Canyon accounted for 83% of all vireos detected in Oklahoma in 1987.

While these numbers implied an increase in population size since the previous survey in 1985, it appears more probable that the increase was due to improved detection by better and experienced observers. While male vireos can be relatively conspicuous to the experienced, some level of skills in survey work apparently enhances the ability to note and detect vireos. This may be a significant factor with increasing distance, as better general bird-song identification ability may be necessary to sort the song of the vireo from other species as distance increases.

During 1986, vireo territories were mapped primarily in a strip of Greenleaf Canyon on slopes near and on *Cedar Mountain* and Mount Marcy (Figure 11b). Other areas were searched on the Refuge and on Fort Sill MR, but much of this was done by essentially inexperienced observers. The North Mountain

Wilderness Area of the Refuge was not checked, and no vireos were located at three other localities where they were noted during 1985. Only one of these areas (Elk Mountain) was visited by the principle investigator.

Because much of the Wichita Mountains needs to be covered by foot, and the terrain is rugged, it is not very convenient to be as close to every patch of habitat as is possible on the numerous section line roads in much of west-central Oklahoma. Thus, the ability of observers to sort and identify bird songs at a distance becomes important.

An experienced and well-trained observer was employed during 1987. He had considerable experience in survey work of passerines, is an interested and experienced birder, and had worked with the Black-capped Vireos in Texas the previous season. This, perhaps, emphasizes the importance of attracting such skills in hiring field technicians.

Considering this, it was even more surprising to find even more Black-capped Vireos in the Wichita Mountains during 1988, again, by a factor of almost 2, from 90-92 adults (54-56 males and 36 females) in 1987, to 156-183 adults (94-110 males and 62-73 females) in 1988. Some of this was likely an effect of cowbird trapping which increased production of young vireos. The ratio of SY (first-year) males increased from 1987 to 1988 (see below), supporting this effect.

Some of the increase in numbers was due to completion of the 1987 survey in areas not searched or only partially searched. These areas included:

(1) North Mountain Wilderness Area. While only four males were found here during 1987 in one survey day by the principle investigator, eight males and one female were located there in 1988 (with four man-days of effort by two field assistants). Because the territories were not mapped, nor mated status determined, it is likely that more vireos were present.

(2) Fort Sill MR. Increased coverage during 1988 resulted in the discovery of ten males and 7-8 females compared to three males and one female found during part of one day's search in 1987.

(3) A hollow just north of Cedar Mountain contained 13-15 males and at least five females. Only two males and two females were found at the entrance to this hollow in 1987. However, in 1987, the field assistant traveled only part way into this hollow, quit because of wind and time of day, and did not return.

(4) Mount Lauramac. An unmated male was located in an area north of the main peak not searched in 1987.

(5) Private ranch adjacent the Refuge. A single unmated male was located.

In composite, these account for only 34-36 of the additional 71-89 adults detected in the Wichita Mountains during 1988. An additional 2-3 adults were noted in the Charon Gardens Wilderness Area. Conversely, no vireos were noted in an area of Wild Horse Canyon containing five territories in 1987.

However, the territories on both Cedar Mountain and Mount Marcy (and ridges to the east) were more packed during 1988 than 1987 (Figure 11c and d). An area of the Cedar Mountain containing 15 male territories in 1987 contained 27-31 territories in 1988. Similarly, the Mount Marcy cluster of territories numbering 18 in 1987 held 24-26 territories during 1988 (see Figure 11d).

Some of the increase in packing between years may have been due to an increase in reproductive success in 1987. Ten SY males were noted in these areas in 1988 compared to five in 1987 (including two in Wild Horse Canyon).

In addition, an influx of some birds settling in this main colony in their second or subsequent breeding season may have occurred. One bird, banded as an SY male during 1986, was the second of three males sequentially occupying a territory, and was recaptured in 1988 only about 0.25 mi. from his original capture site. Furthermore, a mated male banded on Fort Sill and noted there through mid-June was recaptured in the Mount Marcy cluster of territories in early July. Both of these observations implicate that this main colony may act as a "sink" in which unsettled vireos may establish breeding territories in subsequent years. The lower return rate of birds banded in small satellite groups compared to larger colonies in Texas (Grzybowski 1988b) also supports this possibility.

Some of this increase in numbers between years is undoubtedly due to birds which escaped detection in 1987. At least two males banded in 1986, plus two others with aluminum bands but no color bands (possibly banded in 1986 or 1987 and losing their color bands) escaping detection in 1987, were discovered in 1988.

Banding efforts have been conservative to avoid negative effects on reproductive success, and thus many of the males are unbanded. The terrain is rugged, with scattered large boulders, and enough patches of impenetrable scrubby oaks so that individual birds can be temporarily lost during a monitoring bout. With conservative interpretations of singing neighbor males, and interruptions of monitoring causing the observer to unwittingly switch between neighboring birds, the total number of males could have been underestimated in 1987.

Compounding this is the problem of vireos at this site being tape-shy, and perhaps quieter, probably because of excessive use by one of the less skilled field assistants hired during 1986. Supporting this interpretation are the following observations. One male banded in 1986 has been extremely shy during both 1987 and 1988. Though singing regularly, he has been very difficult to physically observe. In 1987, his color bands were first determined in mid-June, when he was netted with one of his young.

He has been equally difficult to observe in 1988. In addition, two pairs were detected by the principle investigator between other territories in late June 1987 when they were noted traveling with young. They had escaped detection earlier, probably because they were thought to be the same bird as one of their neighbors, and their territories were considered parts of other territories. Even others without young could have escaped detection similarly.

Furthermore, even though the number of territories being located in 1988 seemed excessive as they were being mapped out, a check by the principle investigator in mid-June discovered two new birds among them. One vireo, originally banded in 1986 (no color bands), and using the same territory as in 1986, escaped detection in 1987 even though in an area frequently visited. An aluminum banded bird, probably the same, was noted in late April on this territory by an independent group of researchers taping vireo vocalizations. The other bird, also banded, was noted with young fledged about two weeks, thus also actually present for a substantially longer period than when first detected. Other birds in this area also respond poorly to tapes and capture attempts even though the use of tapes has been very conservative since 1986.

While these observations could refute the claim made that male vireos are readily detected, this type of situation has not occurred on other sites studied in Oklahoma or Texas, except Lost Maples State Natural Area, Bandera County, Texas, a popular birding location, where birders have frequently used tapes (until recently). Vireos at this site were similarly difficult to observe, and to net, though territories have been counted and mapped there (Grzybowski 1988a).

Outside the Wichita Mountains, the numbers of males has decreased slightly from 12-13 in 1985, 10-12 in 1986, 6-8 in 1987, to 8 in 1988. The number of females was not accurately assessed during 1985. In 1986 through 1988, however, the mated status of all males outside the Wichita Mountains was determined and the number of females found to range from 6 in 1987 to 8 in 1988. The prospects that this group of vireos in Oklahoma can maintain viable populations is dismal (but see below).

Surprising were observations of an unmated female at the Blaine County site. All available males were mated. No more than one lone female was observed per visit. On two visits, a female was observed away from the established territories. On 10 June 1988, however, a female was noted at the upper end of one of the vireo territories near an abandoned vireo nest. Later, a female, likely the same, was encountered in the adjacent vireo territory. The male left his mate with whom he was traveling at the time, and approached the intruding female, bill-pointing and swaying his head. However, he was soon interrupted as his mate attacked the intruding female who departed. Later, an unmated female, likely the same, was banded near another pair's nest (containing eggs).

Thus to summarize, much of the increase in the number of males detected in 1988 has come from increased coverage and better detection in the Wichita Mountains. However, some is likely the effect of removal of cowbirds at the vireo breeding sites, and the resultant increase in vireo reproductive success.

BANDING RESULTS TO DATE

Tables 3 and 4 summarize the numbers of Black-capped Vireos banded since 1984, and the detection of returning birds in subsequent years. Returning males are identified individually on territory maps (Figures 4-12). Although attempts at banding have been conservative, the number of birds with bands at the end of the season (including returns banded in other years) has increased steadily from three in 1984, six in 1985, 25 in 1986, 49 in 1987 to 73 in 1988. In 1988, 31 males, 13 females and 12 young were banded.

Some adjustments in banding from previous reports have been made on the Tables, and include as returns among the 1986 banded birds for the Wichita Mountains, birds not detected in 1987, but located in 1988. Although the individual identity of two birds banded only with aluminum bands is uncertain, they were considered part of the 1986 sample, as most of the 1986 sample was not color-banded, while all were color-banded in 1987.

The sample of banded birds is still small. Eight of 17 (47%) males with bands in 1986 were known to survive in 1987. Only one of seven (14%) females banded (or with bands) in 1986 were detected in 1987. Of 30 males with bands in 1987, 17 (57%) returned in 1988. None of the six females with bands in 1987 were detected in 1988, and none of the 17 young birds banded in Oklahoma since 1985 have been detected in subsequent years. This latter is surprising given the substantial increase in the number of birds found in the Wichita Mountains during 1988. One male originally banded in 1984 at Methodist Canyon returned again in 1988.

Combining years and samples across sites, one-year detected return for males in Oklahoma was 28 of 51 (56%); and two of 15 (13%) for females. For the main colony in the Wichita Mountains, one-year detected return for males is 20 of 34 (59%); for females, one of six (17%). In the small remaining groups in Blaine, Caddo and Canadian counties, these values are eight of 17 (47%) for males, and one of nine (11%) for females. These are below the 63% (71 of 113) return for males in the main Texas colonies, but similar to the 49% (31 of 63) return in peripheral and smaller satellite areas in Texas (Grzybowski 1989). For females, the return in Oklahoma is surprisingly low, and is hopefully a problem of detection or a peculiarity of this sample. Because most of the vireos are monitored, it is unlikely that dispersal off the study areas could explain all of this low return, though females are known to have lower site fidelity (Nolan 1978, Grzybowski 1988a). The return for females in Texas is 44% in the main colonies and 11% (only 1 of 9) in the smaller satellite groupings (Grzybowski 1989).

The two-year detected return is eight of 18 (44%) for males, and zero of eight (0%) for females. However, for males in the Wichita Mountains colony, the two-year return is seven of nine (78%). Only one of nine (11%) outside the Wichita Mountains returned two-years after initial banding. This bird, very black-capped when originally banded in 1984, and was in at least his sixth breeding season in 1988, probably in his seventh.

Ten of 11 males in the Wichita Mountains returned to virtually the same territory space occupied in a preceding year (Figure 11). Only two of these had shifts where there territory in one year only slightly overlapped their territory in a preceding year (see Figure 11b-d). One was a bird banded in its first breeding season, and mentioned above. However, the exception, male J in Figure 11b-d, moved from a territory on Panther Creek, where he was mated in 1986, to one of the easternmost of the main grouping south of Graham Flat in 1987 (see Figure 11c), a distance of almost three miles. He was unmated in 1987. In 1988, he moved again to a territory somewhat isolated from the rest and 1.5 miles from his territory in 1987 (see Figure 11d).

Outside the Wichita Mountains, four of five males returned to the same territory as in a previous year (see figures 4-7). The fifth returning male (Male B in Figure 6a-e) was originally banded in 1984 at the Methodist Canyon Camp site where he returned in the 1985 and 1986. However, in 1987, he was located about 1 mile south of his previous locality. In 1988, he returned to the area of his previous territories in 1984, 1985, and 1986.

Such dispersal of male B may be explained by the difficulty males have in attracting mates, and their wandering to establish territories near other males and enhance the chance of successfully attracting a female. This did not occur for male J, as he was unmated in 1987. However, only one pair was present at the traditional Methodist Canyon Camp site in 1987, and these birds arrived some time after April 20. In 1986, male B was already present on April 18. If he arrived early in 1987, was alone, and could not attract a female, he may have wandered until locating a female, or established his territory near another male and then successfully attracted a female. The mated male in the adjacent territory (see Figure 6d), present there in May and June, moved from his locality to the traditional site in July (territory designated by dashed lines in Figure 6d) where he has observed traveling loosely in company of an unbanded female, not his mate from earlier in the season. This unbanded female may have been the mate of male B earlier in the season, also unbanded.

Of two returning females, one in the Wichita Mountains was found about 1 mile from her original banding location. The second female returned to the same territory and same mate (at least for part of the season) at the Methodist Camp site.

A gray-naped male (probable SY) located at the Salt Creek site on 3 May 1987 was observed singing as he moved about 1/2 mile down the canyon. Although not observed specifically, he may have been the holder of the territory briefly established on the south slope of the main channel of Salt Creek (see Figure 4c). These observations of between and within season dispersal may indicate that females may be limiting and/or difficult to locate or attract, and that males may apply a between season dispersal strategy to enhance their chances of attracting a mate. However, this strategy may also hamper the ability to detect returning males, and would lower the estimate of survival so derived.

In Blaine County, two males and two females located during 1986 were banded. None of these returned. One other male detected there was unbanded, and four young were produced in 1986. The unbanded gray-naped male noted in 1987 may have been one of these young. The second male may have been the third and unbanded male known in 1986. It is also possible that both females noted in 1987 were among the young produced in 1986.

In 1988, the only male banded in 1987 returned. A partly gray-naped, but unbanded, male may have been the same bird as the gray-naped male noted in 1987. However, even assuming that the two females present in 1987 returned in 1988, two more males and three more females were noted in 1988 than 1987. One territory was likely occupied in 1987 and went undetected, as an old nest from 1987 was found in this territory in 1988. Quite possibly, the others were also present, as their location were not visited by the principle investigator. Of those adults banded in 1988, all were ASY (i.e., ASY=After second calendar year), indicating that they were adults in 1987. Yet, this area of canyons may contain still undetected vireos, as access is difficult, and all of the survey needs to be done on foot.

At Methodist Canyon, several unbanded males were known in 1986. These may account for the initially unbanded males noted in 1987. Both females noted in 1986 were banded, and no young were produced. Thus, the two females noted in 1987 were undetected or produced from nesting(s) not detected in 1986. In 1988, both males detected were already banded. However, again, both females were unbanded, though at least one, possibly two females were unbanded at the end of the 1987 season.

In addition, the male found at Scott in 1987 was initially unbanded, and was not detected in 1986 either. The male detected at Scott in 1986 was banded. Because vireos could not be located on several visits to the Scott site in May 1987, it is also possible that the territory at Scott was sequentially occupied by several males. In 1988, two males (one banded in 1987) and one female were noted. However, this was the suspected number present in 1987.

In summary, most vireos detected outside the Wichita Mountains can be accounted for by birds noted in previous years. Thus, it is likely that these small groups of vireos represent most of the birds present, though the Blaine County site will hopefully prove the exception. In the Wichita Mountains, more birds may still be present in the North Mountain Wilderness Area than have yet been discovered, and the increased production of young (see below) may foster expansion. Encouraging is the observation that half of the 10 males found on Fort Sill were first-year males, an indication of an expanding, or at least productive population.

AGE DETERMINATION

The amount of gray in the napes was used as a field character in aging male Black-capped Vireos. SY males have a significant amount of gray on the nape and hind-crown. This amount of gray is known to decrease with age (see Grzybowski 1988a). Using an Oklahoma bird as an example, one male originally banded as an SY male in 1986 had extensive gray in the crown at the time of capture, even to the point of almost reaching the white spectacles. He was recaptured in 1988 (his third potential breeding season) with an entirely black crown.

Because the condition of the primary coverts is likely to be a better indicator of SY age than the amount of gray in the cap, it is useful to note that a few individuals with browner and worn primary coverts were in blacker cap plumage classes. This may indicate that some of the blacker capped Black-capped Vireos are also SY males. Conversely, a few individuals with extensive gray in the nape and crown possessed primary coverts of ASY birds. Thus, using cap color as an indicator of age class (SY or ASY) is not infallible, but the number of errors is as likely in one direction as the other, so as to make it a reasonable index with adequate sample size. Among the 30 males banded or recaptured in Oklahoma during 1988, discrepancies between field and photographic determinations of age occurred in three cases. In all three cases, birds with extensive gray in the cap possessed ASY primary coverts. However, opposite examples were noted for a few birds in Texas (Grzybowski, unpubl. data)

Table 5 gives the ratios of SY, gray-ASY, and black-ASY males (most aged by the amount of gray in cap) broken out by region and year (1987 or 1988). Significant to note is that only one SY male of 21 (5%) yearly sightings was discovered since 1986 in Oklahoma outside the Wichita Mountains. Of 12 females banded outside the Wichita Mountains since 1984, 6 were aged. However, all of these were aged ASY; none were aged as SY. This implicates very poor recruitment, thus very poor production, and is a sign of a deteriorating population. In contrast, the percent of SY males in the Wichita Mountains was 19% in 1987, and improved to 24% in 1988. Also encouraging, 4 of 12 (33%) females banded in the Wichita Mountains during 1988 were aged SY by primary coverts. This may be due in large part to increased production enhanced by reduced cowbird parasitism.

BREEDING BIOLOGY

During 1988, about 65 of 82 (79% using median values) males were mated in Oklahoma (where mated status could be determined). This is an improvement over 1987, when 42 of 57 (74%) males were mated. Of about 28 males (26-31) located in 1986, 19 (18-20) were mated (68%). Using males where mated status could be determined, 67% (2 of 3) were mated in 1984, and 60% (6 of 10) were mated in 1985. Combining samples from 1985 to 1988, the estimate of mated males in Oklahoma is 74% (134 of 180). This is very similar to that noted in Texas (73%; Grzybowski (1988a)). Assuming unmated females unable to locate mates are also present (see Nolan 1978, Harris 1984, Grzybowski 1986), these data imply that the effective size of the population (those actually breeding) may be less than 75% of the total population. If, however, the sex ratio is actually skewed in favor of the males, and all, or near all females are mated, then about 85% of the population is breeding.

Plumage class did appear to have an influence on various dimensions of breeding success. In the Wichita Mountains, the SY male plumage class showed lower mating success compared to the gray-ASY and black-ASY males; 26% (6 of 23), 97% (32 of 33), and 86% (44 of 51), respectively. During 1988, the portion of SY males at Fort Sill fared better (2 of 5 mated; 40%) than in the main colony in Greenleaf Canyon (3 of 11 mated; 27%). Only 1 of 8 (13%) SY males at the main colony were mated in 1987. These results compare similarly to those obtained for SY and ASY males in "colony" and satellite groups in Texas (see Grzybowski 1988b).

Outside the Wichita Mountains, it was uncertain if the one SY male observed was mated. The individual observed was unmated in early May, but may have been the mate of a pair which was later noted nearby. However, this pair disappeared by the end of May. The single gray-ASY male was mated, and 16 of the 19 (84%) black-ASY males were mated.

The significance of delayed plumage maturation for vireos is likely related to a limiting resource. Competition for this resource takes place among males. The mobile patterns of territory occupancy and dispersal between seasons observed in Texas may be responsible for the lower detected return of banded birds in the satellite groups (Grzybowski 1988b). From a management perspective, these plumage characteristics may be useful is assessing recruitment of birds into the population, and represent an index of population status.

Of the 61 to 70 pairs monitored during 1988, 28 (about 43%) fledged young vireos (Table 6). The total count of fledglings noted was 67-83. Two to four were produced in Blaine County, all assisted by the removal of cowbird eggs from active vireo nests. Between 6-9 young were fledged on Fort Sill MR, two assisted by removal of a cowbird egg from a nest. In areas not protected by cowbird trapping, 14-15 pair produced 8-13 young, or about 0.71 young/pair/year. However, subtracting those assisted by removal of cowbird eggs from vireo nests, only 4-7 young were produced, or about 0.36 young/pair/year unassisted by human interference.

In the main colony site (in the Wichita Mountains) where cowbird traps were maintained, 47-55 pair produced 62-73 vireo young, and two cowbird young. A cowbird egg was removed from one successful nesting producing 2 young vireos. Four additional young were fledged from a nest, but could not be later located. These were not included. They may have succumbed in a local hail storm about three days after fledging. Using median values of 51 pair and 67 young, production was about 1.31 vireo young/pair/year. This is the highest production observed in the three years of this study!

Of the 42 pairs located in 1987, 15 fledged young vireos, and 2 fledged cowbirds (Table 6). The total count of fledglings which were physically observed was about 39. All but one of these young was produced in the Wichita Mountains (including the Fort Sill MR). One additional nest fledged 3 young, but these young could not be located a few days later, and the pair were rebuilding a new nest soon after.

Pair success (those fledging at least one young vireo) was 36% in 1987 (compared to 43% in 1988 and 25-28% in 1986). However, cowbird eggs were removed from two of five successful nests at sites without cowbird removal, and two of ten successful nests at sites with cowbird removal during 1987. Thus, of 11 pairs monitored during 1987 at sites with no cowbird removal, 3 pair (27%) produced 5-7 vireo young, or 0.55 young/pair/year unassisted by human interference. Of 31 pairs monitored at sites with cowbird removal, 8 (26%) produced 18-23 vireo young (unassisted by removal of cowbird eggs), or about 0.65 young/pair/year. Cowbird trapping by itself, thus, had only minor impact on nesting success in 1987. In fact, parasitism of vireo nestings was 58% (11 of 19) with no cowbird removal, and 48% (13 of 27) with cowbird removal. Implications are discussed in the section below. However, if we include the successful nestings where cowbird eggs were removed, production with human interference elevates to 0.96 young/pair in 1987, or almost twice that without interference.

Of the 18-20 pairs located during 1986, only five (25-28%) fledged young vireos. The total count of fledglings which were physically observed was 14-17, though the count of young may have been as high as 20 if all successful nestings actually produced four young. Four fledged young were observed only for one of the Blaine County pairs. Thus, outside the Wichita Mountains, 7 pair produced only 4 young (or 0.57 young/pair/year). This would have been zero with no human interference. All other vireo young observed were produced within two miles of Cedar Mountain, Wichita Mountains NWR. Three additional pairs fledged young cowbirds; two of these cowbirds were collected, but the vireos of these pairs did not renest.

Pair success (those fledging at least one young vireo) was 25-28% during 1986. However, only one pair clearly would have fledged vireo young without human interference; cowbird eggs were removed from two of the nests producing young, and the remaining two broods (of the five) were within the area of influence of functional cowbird traps. Thus, it is possible that human interference quintupled natural production of Black-capped Vireos in Oklahoma during 1986.

COWBIRD REMOVAL AND NEST PARASITISM

The number of cowbirds trapped per week during 1988 for each of the traps is given in Table 7. In general, it was calculated as the difference in the number of cowbirds in the trap at the end of the period minus the number added and the number in the trap at the beginning of the period. Negative numbers were sometimes generated for some of the weekly periods when more birds were lost than were removed. A summary of the number of birds captured per trap from 1986 to 1988 is provided in Table 8.

About 67% (51 of 76; using median values) of the adult female vireos located in Oklahoma during 1988 were within the potential influence zones of cowbird traps. At the six traps in the Wichita Mountains, 165 males, 130 females and 88 juveniles were captured, or retained until the end of the breeding season. This compares with 102 males, 65 females and 16 juveniles removed by 4 traps in 1987, and 53 males, 8 females and 16 juveniles removed by two traps in 1986. Because trapping was initiated several weeks earlier in 1988 and 1987 than in 1986, most vireos in the trap areas first initiated breeding during the period of the traps' greatest potential influences.

Documented parasitism rates in areas with cowbird removal were 50% in 1986 (2 of 4 nestings), 48% in 1987 (13 of 27 nestings) and 24% (10 of 41 nestings) in 1988. This compares to 92% (12 of 13 nestings), 58% (11 of 19 nestings) and 81% (13 of 16 nestings), respectively for areas with no cowbird trapping.

Capture rates have waned with time during 1987 (Grzybowski 1988b), after initial success. To some extent, the reduction in capture rate reflects on the significant removal of cowbirds. In fact, almost all vireo nestings located in the trap influence areas were unparasitized during this period in 1987, and few cowbirds were seen--though they were common in nearby areas--creating a positive initial effect. It was not until late May, that the number of parasitized nests increased.

Capture rates for females in 1986 seemed marginally low (Grzybowski 1987), though capture rates for males continued through the operation of traps. Recorded nest parasitism (though for a small sample) was 2 of 4 nestings, which seemed marginally acceptable.

The 1987 season may have been anomalous. Data from past seasons show 94% of vireo nests parasitized with no cowbird removal, but only 29% with cowbird removal (Grzybowski 1986). However, combining the 1987 data with that of previous years, the situation looked both better and worse for the vireo; better in that a lower percentage of vireo nests in unprotected areas were being parasitized (26 of 35 nests, or 74%); worse in that 15 of 34 vireo nests, or 44% were parasitized in areas with cowbird traps.

Given some of these problems, more effort was directed at the effectiveness of cowbird trapping in 1988. During 1988, two of four traps initiated in April again showed a peak, then decline in capture within the first two weeks of trap operation. The two others remained reasonably functional for almost a month.

In mid-late May, two more traps were established along the north east side of the main vireo colony. The one closer to the main colony was only modestly successful through late June. This may have been due to the general reduction of cowbirds in the area already, and/or to birds being intercepted by the second new trap further east which was very successful.

In mid-June, one of the traps in Greenleaf Canyon was moved to Winter Valley, a pasture west of the main vireo colony where spot counts of cowbirds (see below) were high. Though its effectiveness in enhancing vireo production at this time of the season was probably limited, it was instructive to see a substantial increase in the capture of females at his trap.

Substantially more males were captured than females in 1986, though capture of females was much improved in 1987 and 1988. However, in 1988, 37 of the 130 (28%) females were captured in the Winter Valley pasture away from the main vireo colony. Thus, placement of traps in these feeding areas may be a useful technique for reducing the pool of female cowbirds available to penetrate the main vireo colony.

Trapping was hampered in all years by a number of factors, but their overall impact was minor, and a number of steps were taken to minimize the problems. Again, some local predators appeared to quickly recognize the presence of cowbirds in the traps. Raccoons (<u>Procyon lotor</u>) presented some problems at three of the cowbird traps, though the impact was limited by providing small brush pile roosts within the cage away from the walls, and preventing cowbirds from roosting in the small outer gathering cage. Aprons of chicken wire around the bases of the traps appeared to be effective in preventing potential mammal predators from tunneling into the trap.

In addition, some of the cowbirds seemed to learn the actual trap entrance, and effectively used the trap as a hotel. However, this was believed to be reduced in 1987 and 1988 by rotating individuals into traps. Most females that were captured were either removed, or their primaries clipped substantially in 1987, hindering flight. This level of clipping was not done in 1988. However, the tips of the primaries were clipped in 1988 when capture rates declined to allow recognition of new birds, and removal of the older birds sequentially, so that fewer birds became familiar with the traps.

One of the minor problems encountered in 1987 was buffalo rubbing on the cages, and actually shifting the cages up to one meter out of their original position. Because the ground around the trap was not perfectly flat, this shifting created some openings from which cowbirds escaped on occasion. Anecdotally, a female cowbird with well-clipped primaries and capable of limited flight which escaped from such circumstance re-entered another cowbird trap about two miles away. However, no buffalo seriously damaged any trap.

To further evaluate the effectiveness of trapping, observations were made on the behavior of birds in the trap and of birds approaching the traps. Of 20 cases where cowbirds were observed perched near or on the trap, capture occurred in only 5. When birds did enter the traps, the cowbirds in the trap flew up to their perch and/or were still in four cases. Males in the trap were displaying in the fifth case from their perch. Of 14 cases where cowbirds near or on the traps did not enter, the birds in the trap had no response in six, displayed in six, flew to the perch in one, and were restless in the last case. The low number of captures for these observation may have been caused by the presence of the observer. Though at some distance from the trap, he could have been visible. Collins et al. (1988) comment that humans near the traps deterred cowbirds from entering the traps in their studies.

Figure 13 shows the locations of the cowbird traps, the territories where cowbird parasitism was documented, territories where vireo young were produced, and values for a series of spot counts conducted while traps were in operation (except Winter Valley). Four of the ten cases of parasitism occurred in adjacent territories just over the saddle east of Mount Marcy. Two of the cases of parasitism occurred in the only two territories in Panther Creek. These appear to be in marginal areas of influence for the cowbird traps. Although a trap is near the latter territories in Panther Creek, it was one of the least effective. Also, cowbirds may simply be entering this zone from feeding areas where they were abundant in Winter Valley. A trap was placed late in the season.

Cowbird counts appear depressed in the actual vireo colony. However, the cowbird counts increased along the entire perimeter of the main vireo colony which was sampled. It is easy to imagine how individual cowbirds can infiltrate along the edges of the vireo colony. The nests parasitized in adjacent territories may have been parasitized by a single female cowbird which may have penetrated from the southeast where no cowbird traps were placed. It will be be useful to further evaluate this situation, and trap cowbirds in areas of concentration away from the main colony to depress the number of cowbirds along the perimeter of the main vireo colony.

HABITAT ANALYSIS

An initial analysis of the habitat using the random-pairs approach is given in Grzybowski (1987). An advantage of the random-pairs method is that it is plotless and lets one sample large areas of habitat relatively quickly. This approach, however, proved somewhat problematic in scrubby habitats, as the individual bushes were not always discrete entities, and often coalesced into clumps of vegetation with irregular shapes. A determination on the extent of individual clumps was often a subjective assessment which could vary substantially between individuals.

Nonetheless, some of these data were useful, particularly in the frequencies of woody plants encountered (Table 9). The total frequencies of occurrences for all samples were compared with the frequencies of occurrences in vireo territories only. The primary difference is the significant ($P<0.01$) under-representation of juniper (Juniperus virginianus) in the sample from within vireo territories. This is compensated by small increases in a number of other deciduous species including oaks (Quercus spp.), sumacs (Rhus spp.), Netleaf Hackberry (Celtis reticulata) and Western Soapberry (Sapindus drummondii). A similar result in abundance of junipers was obtained from comparisons in Texas (see Grzybowski 1986). In addition, while junipers made up 12% and 28% of the woody clumps at the Kerr WMA and Davenport Ranch/Wild Basin sites in Texas, they accounted for only 2% and 10%, respectively, of the actual nesting sites used by vireos (Grzybowski 1986). Thus, it would appear that junipers are not a dimension of vireo habitat which is particularly important to vireos, and that other deciduous woody plants can substitute for each other.

Because of the problems in identifying discrete bushes or clumps of vegetation, an alternate method of vegetation analysis using one-tenth acre circles (James and Shugart 1970 with modifications) was employed in 1987 and 1988. All variables measured or derived from these methods and any transformations required before inclusion in analysis, along with abbreviations used in this report are listed in Table 10.

PCA plots on the first two principal components (PC) axes for all "territories" (VIREO and NON-VIREO) in all regions and for just VIREO in all regions are depicted in Figures 14 and 15, respectively. A strong regional bias in the distribution of points is observed along PCI, with "territories" from Fort Hood, Texas occurring at low values, those mostly from the Wichita Mountains at intermediate values, and those from Kerr County, Texas at higher values. Some mixing of points from the Wichita Mountains and Kerr County can be noted. PCI in Figure 14 is primarily an axes of decreasing juniper (high loadings for DENSJ, BAJUN, RDJUN, J3SUM; see Table 11) and increasing oak (RDOAK and BAOAK), but also becoming more open (increasing PERCOPEN and decreasing TOTSUM). Similar loadings are found for PCI in Figure 15 (see Table 12). Although sites in Kerr County and Fort Hood are both on the Edward's Plateau, and more closely related floristicaly, the points for the Wichita Mountains show physiognomic characteristics intermediate between them.

The PCA plot of "territories" in the Wichita Mountains (Figure 16) does not show any special pattern between NON-VIREO, ASY-VIREO and SY-VIREO. PCI is an axis of essentially increasing juniper (high loadings for JUNA, JUNB, JUNC, DENSJ, BAJUN, RDJUN, NSTEMSJ, JASUM, JBSUM, JCSUM, JDSUM, J3SUM, and PERCJUNI; see Table 13), and decreasing oak (DENSO, RDOAK), the opposite of previous plots, but also increasing variation between circles (as seen by high loadings for VARJUN, J1SD, JDSD, and J3SD).

Much of the variation for the Wichita Mountains PCA plot is created by outliers for upper values of PCI. These points are, in fact, those "territories" measured outside the Wichita Mountains at the Methodist Camp and Scott sites which contain substantially more junipers. These outliers, and the data from Fort Hood, indicate that vireos are capable of tolerating the presence of more junipers. However, the plot for Fort Hood "territories" also shows VIREO to be in areas containing fewer junipers, and higher densities of deciduous vegetation in the 1.0-3.0 m height range (unpubl. data).

The higher amounts of junipers in "territories" outside the Wichita Moutains may indicate deteriorating habitat conditions. Much of west-central Oklahoma is visibly overgrown with junipers, and this condition may also be a factor contributing to the decline of vireos in this region. While more vireo habitat still appears to exist than is being occupied, it may be fractured and isolated to the point of possibly having limited value in sustaining viable vireo populations.

DFA and CAN were used to assess variables important in separating groups. The variables, when in combination, important in separating groups are shown in Table 14 for the DFA using VIREO and NON-VIREO for groups, and in Table 15 for the CAN using SY-VIREO, ASY-VIREO, and NON-VIREO as the groups. Both entered DASUM (a relative measure of deciduous vegetation density in the 0-0.5 m height class), MHEIGHT (mean height of woody vegetation), and GRASSCOV (percent grass cover), in steps 1, 2, and 3, respectively, of their procedures. Mean values for DASUM and GRASSCOV were higher for VIREO than NON-VIREO; that of MHEIGHT was lower in VIREO.

The DFA correctly classified 94% of the VIREO, and 92% of the NON-VIREO. One NON-VIREO on Arapaho Point, Fort Sill was misclassified by the discriminant variables, and another, also on Arapaho Point was barely classified correctly as NON-VIREO. The VIREO incorrectly classified as NON-VIREO was also on Fort Sill near Mt. Sherman.

In the CAN, 75% of the ASY-VIREO, 50% of the SY-VIREO, and 85% of the NON-VIREO were correctly classified. Both of the Arapaho Point NON-VIREO mentioned above were classified as ASY-VIREO, and were clearly intermediate between the groups. Only one SY-VIREO and one ASY-VIREO were incorrectly classified as NON-VIREO by the procedure. Other misclassified SY-VIREO and ASY-VIREO were switched between these groups.

Because both techniques use a step-wise procedure, looking for the next variable capable of adding the most to discriminating between groups given the preceding variable(s), it is useful to look at the initial F-values of all variables. For the DFA, the F-value of DASUM was 9.35. Other variables with high initial F-values were TOTSD (S.D. of the number of all decimeter intervals with vegetation) with an F-value of 8.01, and DCSUM (number of decimeter intervals between 1.0-2.0 m with deciduous vegetation; F-value of 7.08). Thus deciduous vegetation below 2 m and total variation in vegetation contacts between circles appeared to be correlated, and related to the level of separation between VIREO and NON-VIREO areas. All of these variables had higher mean values in VIREO. These variables had the highest F-values to enter in the CAN, as well.

Because SY-males may occupy less suitable areas than ASY-males, the points for their territories were extracted from the analysis, and a DFA performed for the ASY-VIREO and the NON-VIREO alone. Interestingly, the variables extracted were similar, but TOTSD, and DBSUM were removed in steps 1 and 2 (see Table 16), respectively, instead of DASUM, and ahead of MHEIGHT. Again, the relative densities of deciduous vegetation in the lower height intervals and TOTSD had the highest initial F-values to enter (DASUM, DBSUM, DCSUM and TOTSD with initial F-values of 9.53, 4.86, 7.64, and 9.83, respectively; $\underline{P}<0.05$), implicating the importance of these vegetational dimensions in vireo habitat. Perhaps indicating some intermediate nature of the habitat on Arapaho Point, a third NON-VIREO here was the only misclassified "territory. in this analysis"

On Fort Hood, where junipers were more abundant, variables related to junipers figured importantly in the discrimination between VIREO and NON-VIREO. However, DDSUM (relative density of deciduous vegetation in the 2.0-3.0 m height class) was the first variable removed in step 1 of the DFA. DCSUM (the same in the 1.0-2.0 m height class) also had a high initial F-value (unpubl. data). VIREO were in areas with higher values for DCSUM and DDSUM, a lower percent of tall juniper cover, but a higher number of juniper stems. Quite possibly, these territories are being invaded by junipers, and will not be as suitable in the future as the percent of tall juniper cover increases.

For Kerr County, Texas, the best results were obtained for the DFA between ASY-VIREO and NON-VIREO where 100% of the "territories" were correctly classified. This region has the fewest junipers (Figures 14 and 15). ASY-VIREO were in less open habitats with fewer forbs, and a higher basal areas of oak than NON-VIREO (unpubl. data).

Across the spectrum of regions, Black-capped Vireos territories appear to be in portions of the gradient favoring the middle. They avoided junipers at Fort Hood and more open areas at the Kerr WMA, and selected onto variables in the habitat favoring higher relative density of deciduous vegetation in the 0.0-2.0 m range in Oklahoma (the 1.0-3.0 m range on Fort Hood).

SIGNIFICANT DEVIATIONS

LANDSAT imagery under objective 8 was not completed.

SUMMARY

An extensive survey for Black-capped Vireos (Vireo atricapillus) was conducted in central and west-central Oklahoma during 1987, and supplemented by additional survey work in 1988. The area searched was similar to that surveyed during 1984 and 1985 (see Grzybowski 1985a), and supplemented in 1986.

Although a large area was searched in 1987 and 1988, vireos were located at only about 27-28 specific stops. All these stops were at or near the same general areas identified in the 1985 survey (see Grzybowski 1985a). However, when localities within 1 mile of each other were combined, these 27-28 specific stops reduced to 13 sites with vireos--one each in Blaine, Canadian and Caddo counties, and ten in the Wichita Mountains (including one large "colony").

At eight of these localities during 1987, 102-106 adult Black-capped Vireos were located, including 60-64 males and 42 females; the 42 active pairs produced 34-43 young. About 172-199 adults--102-118 males and 70-81 females--were located in 1988. A single "colony" which focused primarily on four sections in the Greenleaf Canyon area of the Wichita Mountains NWR accounted for 83% of all adult vireos detected in 1987, and about 75% in 1988. This single area produced all but 3-4 of the 34-43 young located in 1987, and 62-73 of the 70-86 young detected in 1988. However, the entire colony could not be monitored in 1988.

The numbers of vireos declined from that detected in 1986 outside the Wichita Mountains. However, many more were detected in the Wichita Mountains, almost entirely around the already known Greenleaf Canyon locality. Much of this is likely attributable to more intensive effort, better coverage, and better detection by more experienced individuals in 1987 and 1988.

Some banding was accomplished as part of the study. One-year detected return in Oklahoma was 28 of 51 (56%) for males, and two of 15 (13%) for females. For the main colony subsample in the Wichita Mountains NWR, it is only slightly higher (20 of 34, or 59% for males, and one of six, or 17% for females). In the small groups outside the Wichita Mountains, the one-year detected return was eight of 17 (47%) males and one of nine (11%) females. These values are generally lower than returns documented in Texas (see Grzybowski 1988a), particularly for females. None of the 17 young banded in Oklahoma since 1985 have been detected in subsequent years.

Most Black-capped Vireos in their first breeding season (symbolized here and throughout as SY males) can be distinguished from older males (here designated as ASY) by having extensive gray on nape and usually at least the hind-crown. Only one SY male was noted in 21 yearly sightings of males outside the Wichita Mountains since 1986. No SY females were noted in a sample of six which were aged when captured (by condition of primary coverts). These observations, and the low number of birds located implicates a deteriorating population outside the Wichita Mountains.

In the Wichita Mountains, however, 19% (8 of 42) of the males were aged SY in 1987, and 21 of 88 (24%) in 1988. The increase between years for males is encouraging, as it implies an increase in production and recruitment from the previous year.

In a combined sample (from 1984 to 1988), 74% (about 134 of 180) of adult male Black-capped Vireos were mated. Age did appear to have an effect on mated status. In the Wichita Mountains during 1987 and 1988, six of 23 (26%) SY males were mated compared to 32 of 33 (97%) gray-ASY males (ASY males with partial gray napes) and 44 of 51 (86%) black-ASY males. The portion of SY males mated at Fort Sill MR fared better than the total sample; two of five (40%) were mated.

The percent of vireo pairs fledging at least one young ranged from 25-28% in 1986 to 43% in 1988. Removal of cowbird eggs from active vireo nests was responsible for three of four successful nestings outside of the Wichita Mountains. Pair success unassisted by human interference (removal of cowbird eggs or cowbird trapping) was 0, 0.55, and 0.36 young/pair in 1986, 1987, and 1988, respectively. With cowbird trapping and egg removal, pair success was 0.91, 0.96, and 1.31 young/pair during 1986, 1987, and 1988, respectively. While pair success with trapping alone would only have been 0.65 young/pair in 1987, a greater effort in maintaining the effectiveness of the cowbird traps in 1988 doubled this effect to its total observed value of 1.31 in 1988 (62-73 vireo young produced by 47-55 pair).

Parasitism of vireo nests with no cowbird removal during 1986 was 92% (12 of 13 nestings) compared to 58% (11 of 19) in 1987, and 81% (13 of 16) in 1988. All three unparasitized nests found during 1988 away from cowbird trapping areas were on Fort Sill MR. Interestingly, there is no cattle grazing on this installation.

With cowbird removal, two of four nestings (50%) discovered during 1986 were parasitized; 13 of 27 (48%) in 1987 and ten of 41 (24%) in 1988. The sample for 1986 is too small to warrant comment. In 1987, parasitism was low at the beginning of the season, then increased as the cowbird traps appeared to become less effective. In 1988, more effort was put into maintaining the effectiveness of the cowbird traps, with resultant success in lower parasitism, and higher vireo production.

Four traps were operated in the Wichita Mountains during 1987, compared to two in 1986. During 1988, six traps removed (or retained) 165 male, 130 female and 88 juvenile cowbirds. One of these traps was moved in mid-season to a cowbird congregating area. During 1987, 102 male, 65 female and 16 juvenile cowbirds were removed, compared to 53 males, eight females and 16 juveniles captured in 1986.

Spot counts of cowbirds were made in and around the main vireo colony during 1988 to assess their distribution, and sources of cowbirds potentially invading the vireo colony. A significant afternoon feeding area was located immediately to the west of the vireo colony. A trap moved to this location in mid-June had substantially greater success in capturing cowbirds, particularly females. These spot counts also demonstrated that cowbird numbers were reduced in most of the main vireo colony, but that cowbirds were available for penetration from very near in almost any direction.

To date, these studies demonstrate that cowbird control must be continued, should focus in the Wichita Mountains where over 90% of the vireos were located, and should be initiated in mid-April. In addition, the movement and dispersal patterns of cowbirds in areas of the Wichita Mountains Wildlife Refuge surrounding the main grouping of vireos should be assessed to help guide effective placement of cowbird trapping efforts, and to help develop and consider possible specific alternative cowbird removal measures. Some additional effort should be expended in investigating the nature of vireos in the North Mountain Wilderness Area, as information for this area is still incomplete. Current monitoring and banding of vireos also needs to be continued.

Two approaches were used in measuring dimensions of vireo habitat, one using a random-pairs technique, and the second sampling one-tenth acre circles. Because of the coalescing nature of the the scrub vegetation, the clumps were often not discrete units, making the random-pairs approach problematic. However, this technique did demonstrate that junipers (Juniperus virginianus) were under-represented in vireo territories compared to non-vireo areas.

Principal components analysis (PCA), discriminant function analysis (DFA) and Canonical Variates Analysis (CAN) were performed using variables measured or derived from measurements in five to seven one-tenth acre circles taken in vireo territories (VIREO) or equivalent areas unoccupied by vireos (NON-VIREO). For comparison and clarification of patterns in the results of these analyses, data from three regions were included: Fort Hood, Texas, Kerr County, Texas, and Oklahoma (mostly the Wichita Mountains region).

A strong regional bias was found by the PCA analyses which represented a gradient in the abundance of junipers from higher values on Fort Hood to intermediate values in the Wichita Mountains, to low values in Kerr County. Each region maintained a slightly different pattern in the variable matrices. However, Black-capped Vireos appeared to avoid higher densities of junipers at Fort Hood and more open areas at the Kerr WMA, and selected onto variables in the habitat favoring higher relative density of deciduous vegetation (primarily oaks) in the 0.0-2.0 m range in Oklahoma (the 1.0-3.0 m range on Fort Hood). In addition, vireo territories occurred where the variation in the relative density measures of woody vegetation between circles in a territory were highest.

These analyses confirm the subjective assessments that important dimensions of vireo habitat are the absence or reduction of junipers, the presence of deciduous vegetation to or near ground level, and an iregular or patchy character to the habitat allowing for this lower deciduous vegetation on perimeters of individual scrubs and clumps.

RECOMMENDATIONS

1.) The decline of the Black-capped Vireo in Oklahoma is clearly linked to nest parasitism by Brown-headed Cowbirds. This parasitism is still a significant factor, and management activities which interfere with this parasitism should continue. This includes trapping, and removal of cowbird eggs and young from vireo nests. As a first concern, cowbird trapping should be continued at the primary breeding sites which now include only those areas in and around Greenleaf Canyon, Wichita Mountains NWR. A configuration of traps which could be most effective should be used. At other nesting sites with only one or two pairs of vireos, it is probably less labor intensive, though less effective to monitor breeding activity, locate nests, and remove cowbird eggs or young. However, this latter option does require special skills in locating vireo nests.

2.) Given that over 90% of the known vireos in Oklahoma occurred in the Wichita Mountains, some effort should continue to be expended to learn more specific movement, feeding and dispersal patterns of cowbirds in and around this area.

3.) Although already moderately successful, it would be useful to improve or develop methods which increase the efficiency of cowbird removal, and its efficiency in enhancing reproductive success in vireos. This includes the construction and operation of more cowbird traps in and around the vireo breeding localities in the Wichita Mountains.

4.) To be effective, an individual should be responsible for cowbird traps full-time. About ten to 15 traps can be managed by a single individual with no other responsibilities. With additional data collection, the number of traps manageable reduces to 7-10.

5.) Trapping of cowbirds might be considered at the Blaine County site, though location of the territories and access will make this difficult. Although the number of known vireos is small, and the risk of failure is high, cowbird trapping may be the only method with any potential of preventing this group from going to extinction.

6.) Some additional survey work should be continued in the North Mountain Wilderness Area of the Wichita Mountains NWR to more clearly establish the status of this sub-group, and in the canyons around the currently known breeding locality in Blaine County, to attempt to locate and enhance the reproductive success of as many Black-capped Vireos as possible.

7.) Monitoring of known sites should continue on an annual basis to log the history of use by vireos at these sites. An effort should be made to count all vireos present, to assess the probable age class of the males and to locate females. These data can be used in answering questions on whether vireo populations are changing, in addressing what dimensions of the populations are changing, and in directing management activities.

8.) Nesting activity and productivity should also continue to be monitored. This should include a late season survey of pair success. These data can be used to assess status of the population, and effectiveness of cowbird trapping; also to enhance interference with cowbird nest parasitism.

9.) Banding attempts should continue for all adults and as many young as possible to assess turnover, dispersal and local movements (both within and between seasons) in the population. This is a long-term recommendation. However, care should be taken so as not to unduly disturb the vireos and interfere with breeding success.

10.) Additional personnel are needed to monitor vireos in the Wichita Mountains. A single individual can only effectively monitor 40-60 pairs. This monitoring should continue until the effectiveness of the trapping is clearly established.

11.) An analysis of west-central Oklahoma using LANDSAT imagery, not accomplished under this study because scenes useful for this analysis were not available, may still be useful in extracting the amounts of potential habitat still present which match characteristics of currently occupied areas, and to identify new areas still unknown which may have potential for vireos.

12.) The results of the habitat analysis generally confirmed subjective assessments. The next most profitable course of research would entail behavioral observations linking use with various habitat features. Only a small amount of behavioral data has been collected thus far.

13.) Because vireos use successional habitats often created and/or maintained by burning or some level of disturbance, some work should go into developing management plans for prescribed burning or other management approaches to create or enhance current or potential vireo habitat, and/or delay succession from going beyond points suitable for vireos.

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FIGURE CAPTIONS

FIGURE 1. Locations of areas surveyed for Black-capped Vireos in Oklahoma during (a) 1984 and (b) 1985. Supplementary survey work in 1986 also depicted.

FIGURE 2. Locations of areas surveyed for Black-capped Vireos in Oklahoma during 1987. Supplementary survey work in 1988 also depicted.

FIGURE 3. Specific locations searched for the presence of Black-capped Vireos in the Wichita Mountains National Wildlife Refuge and an adjacent private ranch during 1988. "X"s indicate sites surveyed by simply listening for vireos for less than ten minutes. Solid circles represent sites where the observer spent at least ten minutes, and recorded all species noted. Solid circles enclosed by circles are sites of the above where vireos were located. See text for specific information on numbers of vireos observed. Area searched in 1987 is delimited by dashed lines. The area of the main vireo colony is also specified.

FIGURE 4. Locations of Black-capped Vireo territories near Southard, Blaine County, Oklahoma during (a) 1985, (b) 1986, (c) 1987, and (d) 1988. Letters within territories identify banded vireos present more than one year. Dashed lines within an enclosed solid line indicate uncertain number of territories (1 or 2). Observations of non-territorial males not included.

FIGURE 5. Locations of Black-capped Vireo territories at Niles (0.5 mi.N) in southwestern Canadian County, Oklahoma during (a) 1985 and (b) 1986.

FIGURE 6. Locations of Black-capped Vireo territories in extreme southwestern Canadian County (mostly Methodist Canyon Camp site), Oklahoma during (a) 1984, (b) 1985, (c) 1986, (d) 1987, and (e) 1988. Territories enclosed by dashed lines were not established until late in the season, and/or were of birds known or possibly originating from territories already identified. Other symbols as in Figure 4.

FIGURE 7. Locations of Black-capped Vireo territory near Scott, Caddo County, Oklahoma during (a) 1985, (b) 1986, (c) 1987, and (d) 1988. Symbol designations as in Figure 4.

FIGURE 8. Location of a Black-capped Vireo territory just outside the northwest border of the Wichita Mountains NWR, Comanche County, Oklahoma during 1988.

FIGURE 9. Locations of Black-capped Vireo territories in the Charon Gardens Wilderness Area (including Elk Mountain) of the Wichita Mountains NWR, Comanche County, Oklahoma during (a) 1985, and (b) 1988.

FIGURE 10. Locations of Black-capped Vireo territories in the North Mountain Wilderness Area area of the Wichita Mountains NWR, Comanche County, Oklahoma during (a)

1985, (b) 1987, and (c) 1988. Symbol designations as in Figure 4.

FIGURE 11. Locations of Black-capped Vireo territories in the Greenleaf Canyon area of the Wichita Mountains NWR, Comanche County, Oklahoma during (a) 1985, (b) 1986, (c) 1987, and (d) 1988. Symbol designations as in Figures 4 and 6.

FIGURE 12. Locations of Black-capped Vireo territories in the Arapaho Point and Mount Sherman areas of Fort Sill MR, Comanche County, Oklahoma during (a) 1985, (b) 1987, and (c) 1988. Symbol designations as in Figure 4.

FIGURE 13. Locations of spot counts of Brown-headed Cowbirds in and around the main colony of Black-capped Vireos in the Greenleaf Canyon are of the Wichita Mountains NWR, Comanche County, Oklahoma. Numbers indicate the number of cowbirds counted at that location. Letters in vireo territories represent the following statuses: C=cowbird fledged; P=nest in territory parasitized by cowbirds; U=unmated; V=vireo young produced. Solid squares represent locations of cowbird traps. Territories with no letter symbols represent mated pairs which produced no young. Vireo territories above the dashed line were not monitored.

FIGURE 14. Plot of all vireo territories and non-vireo areas from Fort Hood, Texas (H), Kerr County, Texas (K), and southwestern Oklahoma, primarily the Wichita Mountains (W) with respect to the first two principal components axes (PCI and PCII) using variables identified in Table 10. See text and Table 11 for variable loading on PCI and PCII.

FIGURE 15. Plot of all vireo territories from Fort Hood, Texas (H), Kerr County, Texas (K), and southwestern Oklahoma, primarily the Wichita Mountains (W) with respect to the first two principal components axes (PCI and PCII) using variables identified in Table 10. See text and Table 12 for variable loadingd on PCI and PCII.

FIGURE 16. Plot of all vireo territories and non-vireo areas from southwestern Oklahoma, primarily the Wichita Mountains (W) with respect to the first two principal components axes (PCI and PCII) using variables identified in Table 10. See text and Table 11 for variable loading on PCI and PCII.

FIGURE 1

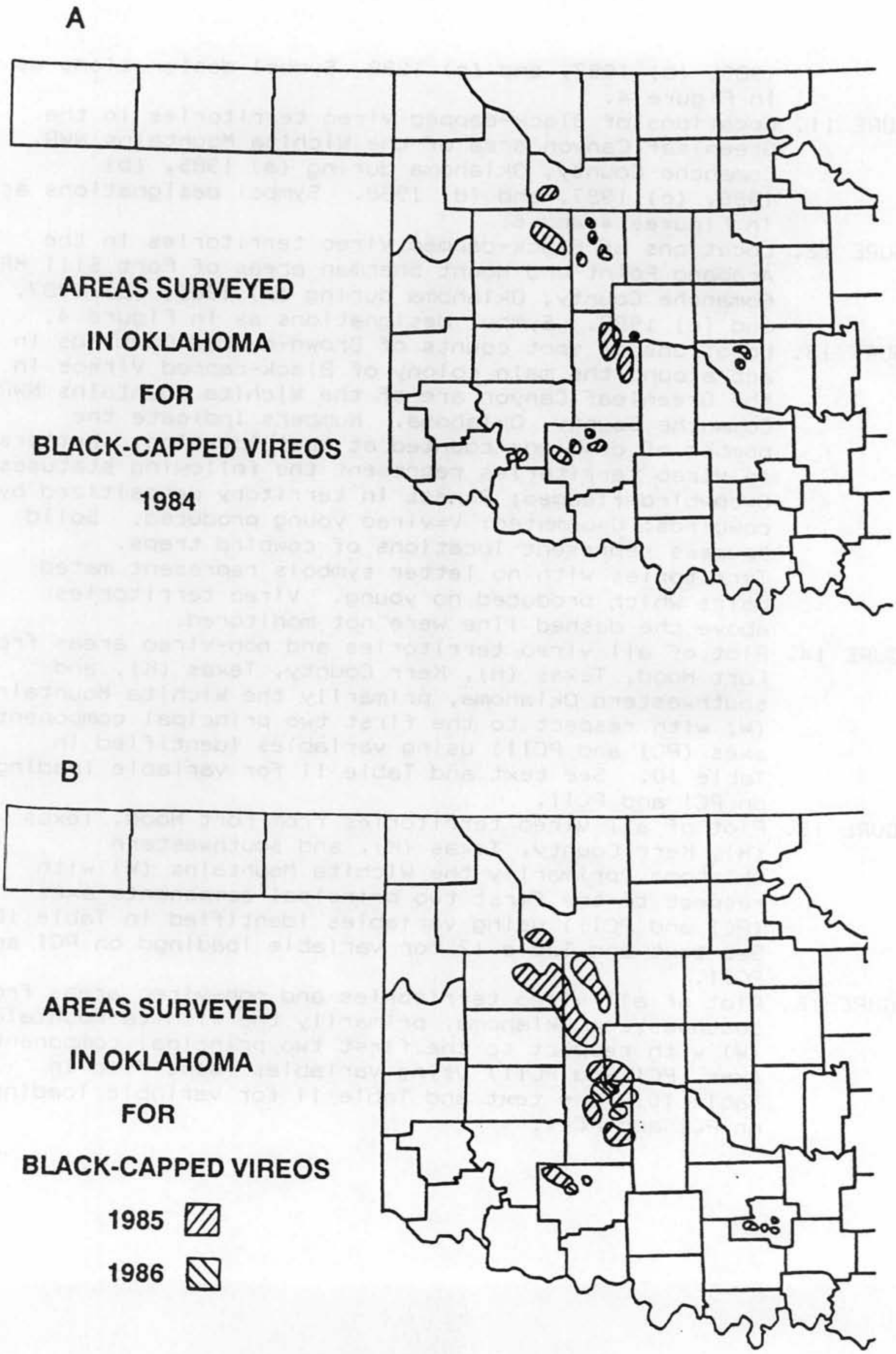
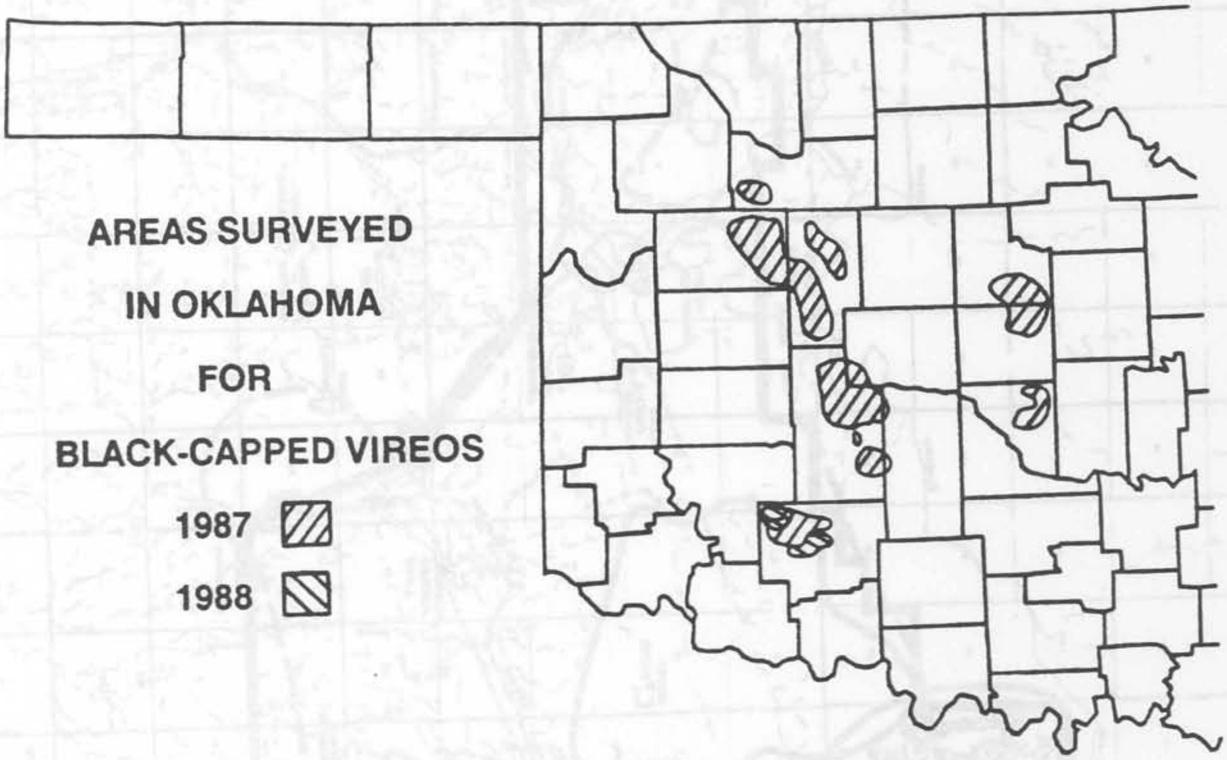

A
AREAS SURVEYED
IN OKLAHOMA
FOR
BLACK-CAPPED VIREOS
1984
B
AREAS SURVEYED
IN OKLAHOMA
FOR
BLACK-CAPPED VIREOS
1985
1986

FIGURE 2


AREAS SURVEYED
IN OKLAHOMA
FOR
BLACK-CAPPED VIREOS
1987
1988

WICHITA MOUNTAINS WILDLIFE REFUGE

COMANCHE COUNTY, OKLAHOMA

FIGURE 3

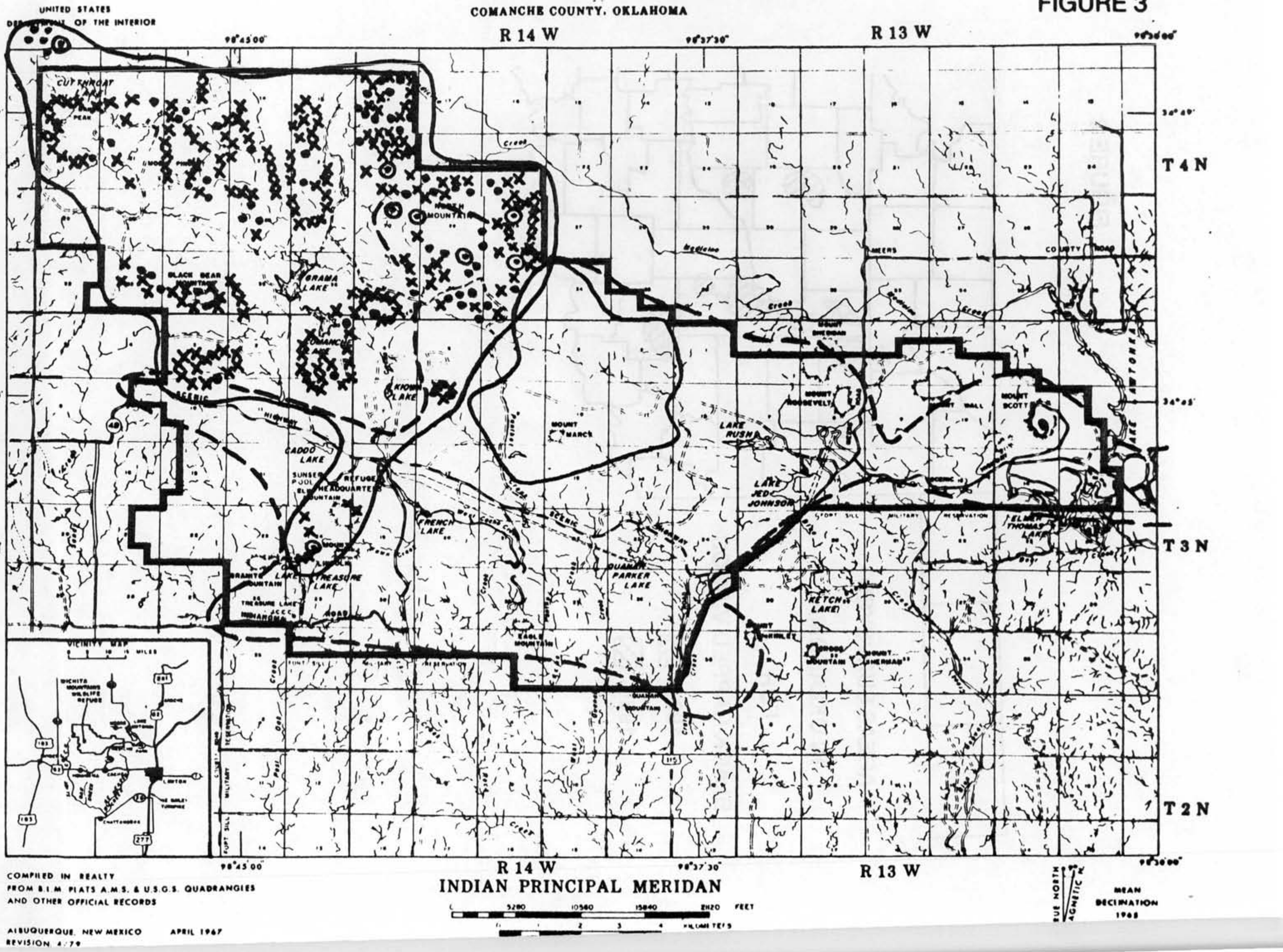


FIGURE 4

BLACK-CAPPED VIREO TERRITORIES

Near SOUTHARD, BLAINE COUNTY, OK

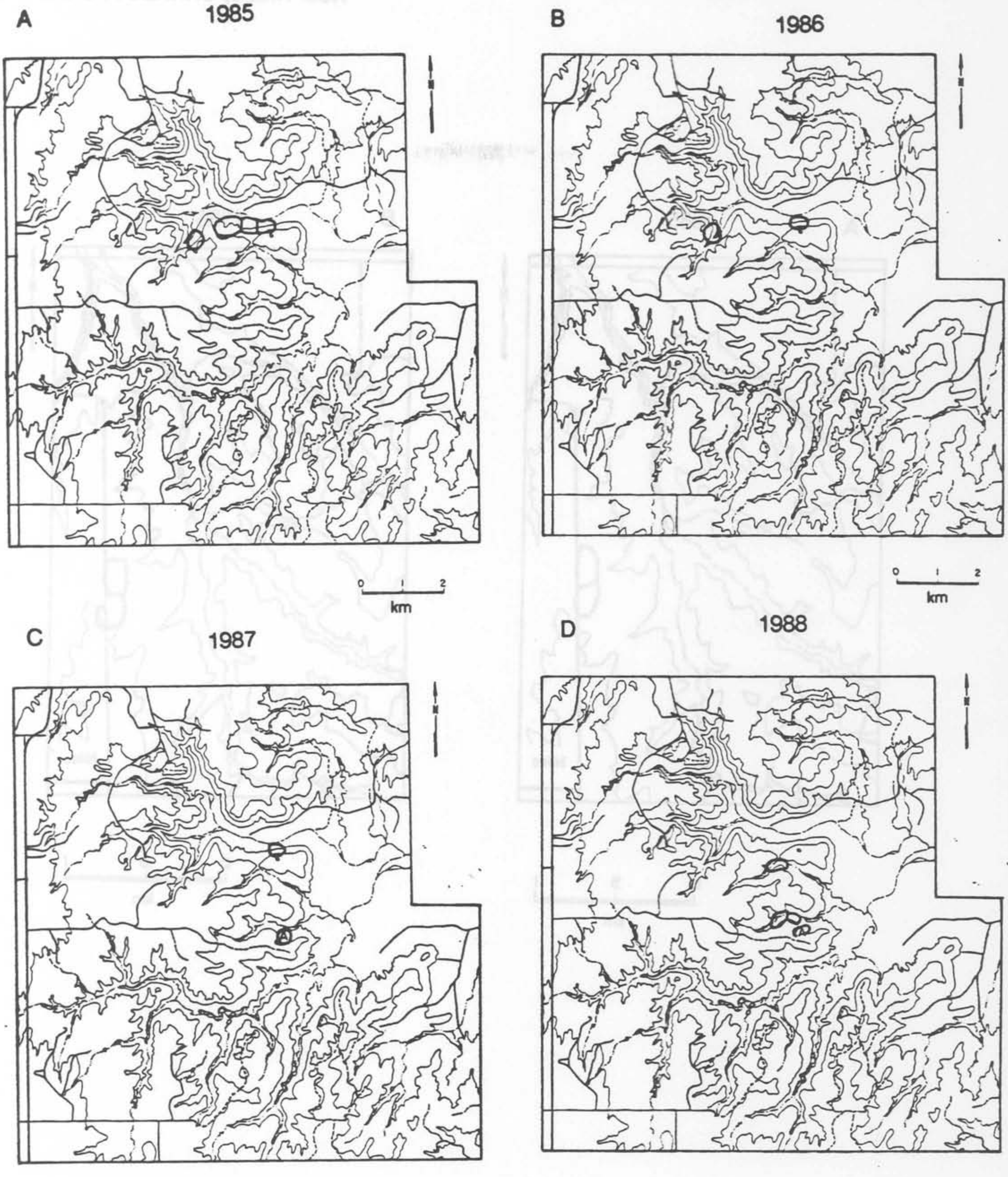
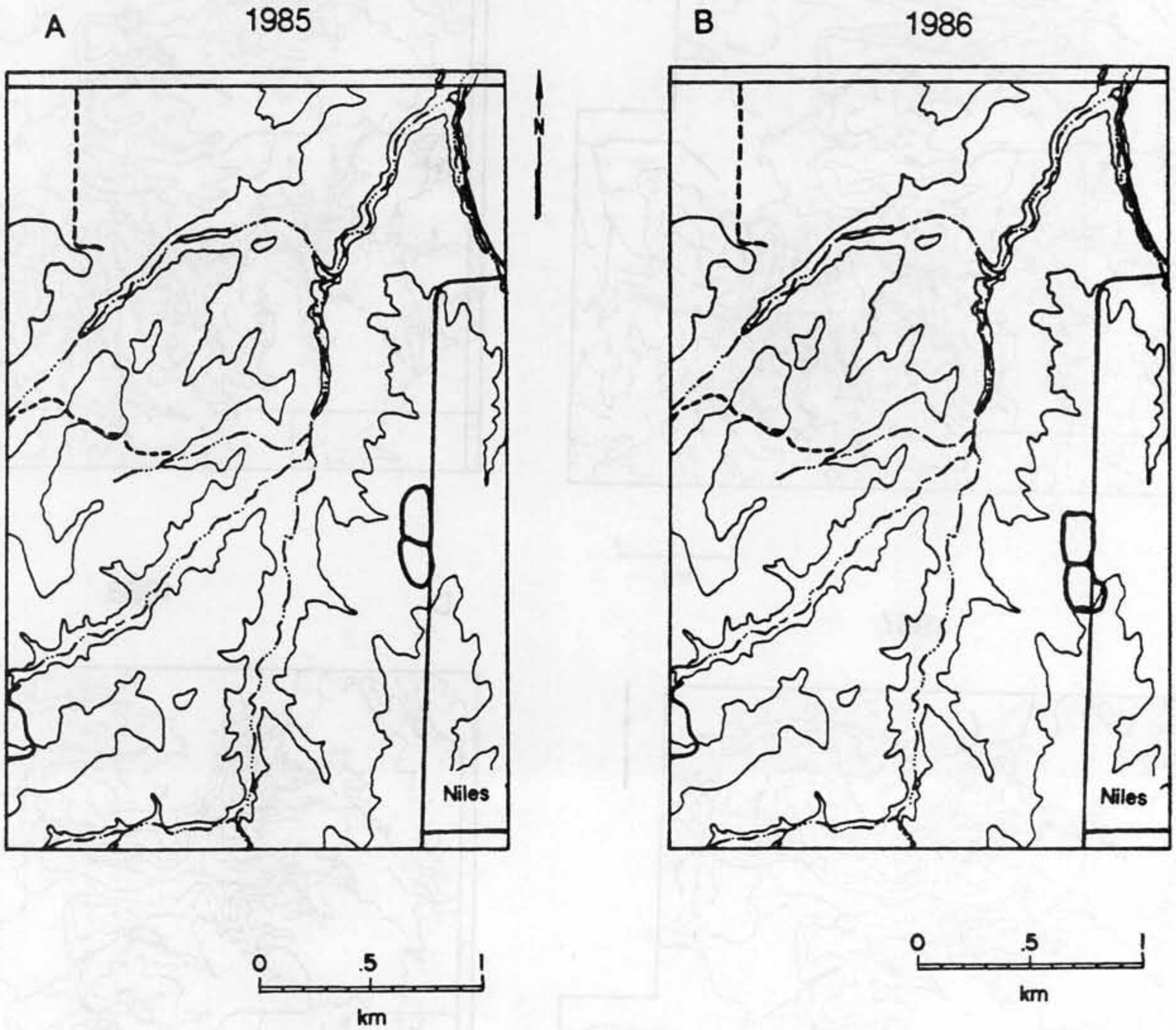


FIGURE 5

BLACK-CAPPED VIREO TERRITORIES

Near NILES, CANADIAN COUNTY, OK



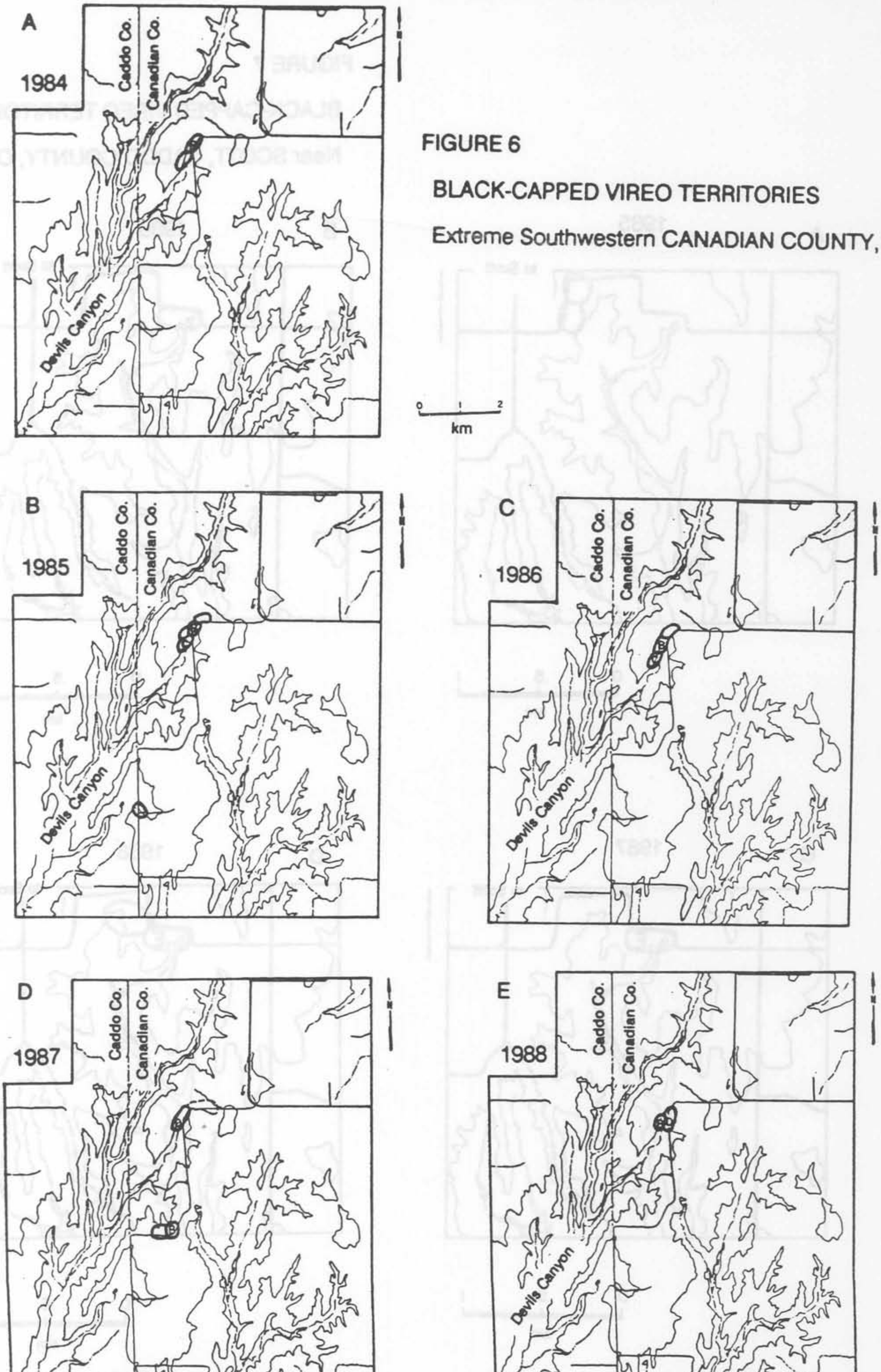


FIGURE 6

BLACK-CAPPED VIREO TERRITORIES

Extreme Southwestern CANADIAN COUNTY, OK

FIGURE 7

BLACK-CAPPED VIREO TERRITORIES

Near SCOTT, CADDO COUNTY, OK

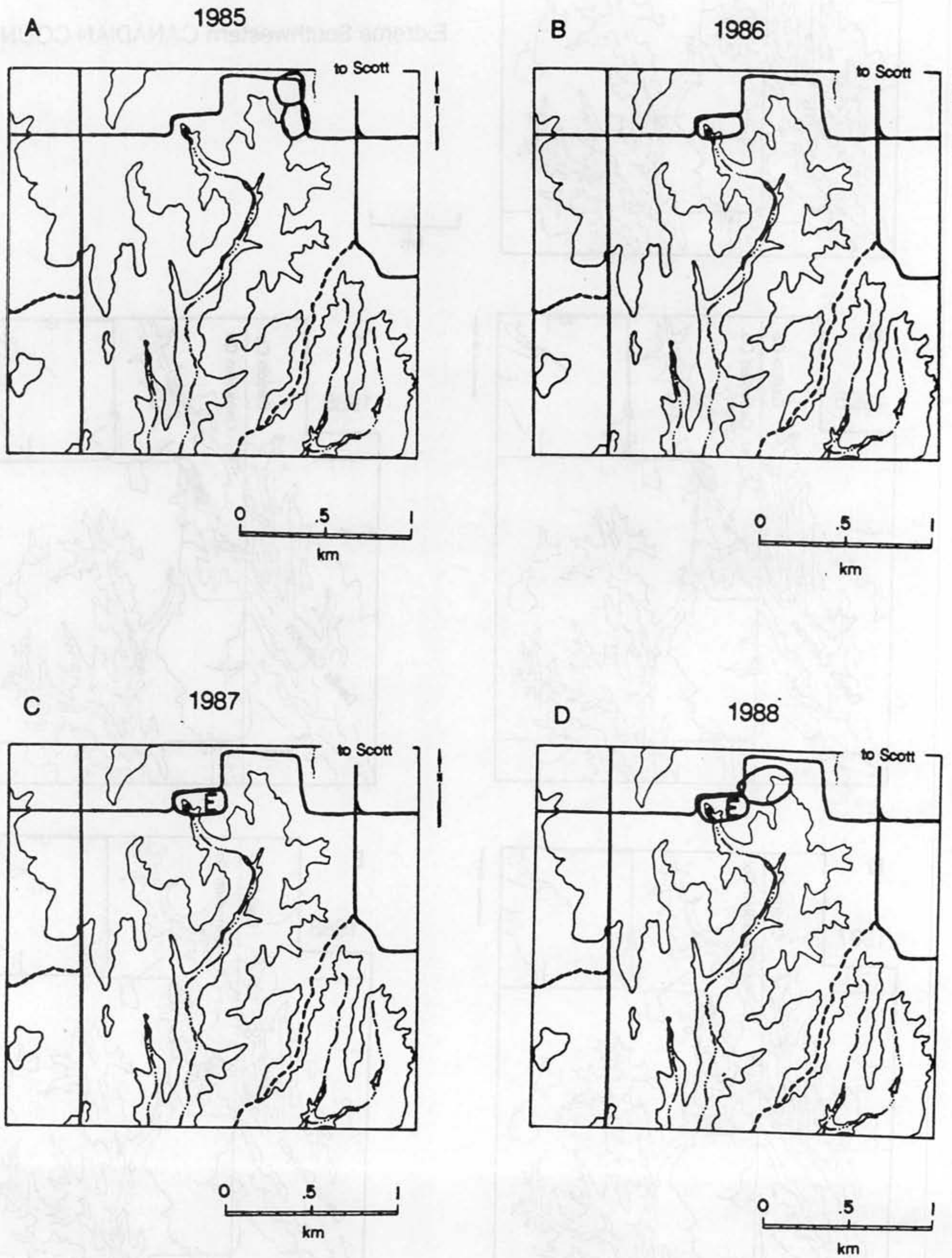
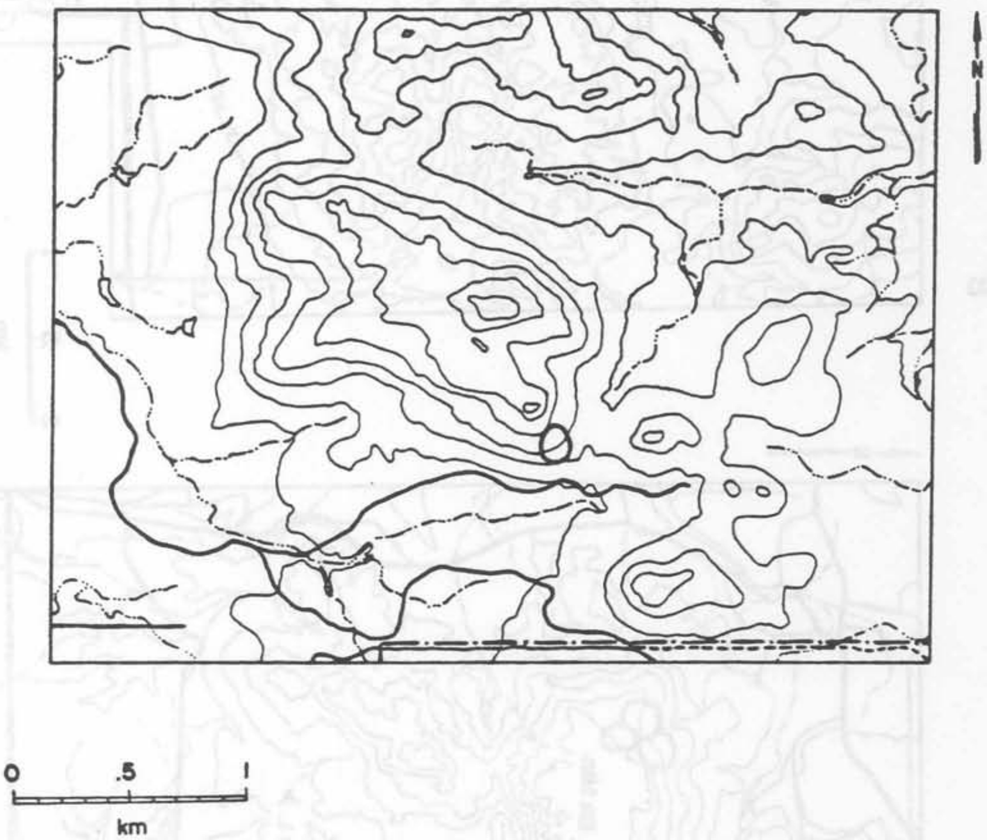


FIGURE 8

BLACK-CAPPED VIREO TERRITORIES

HALEY RANCH, COMANCHE COUNTY, OK

1988



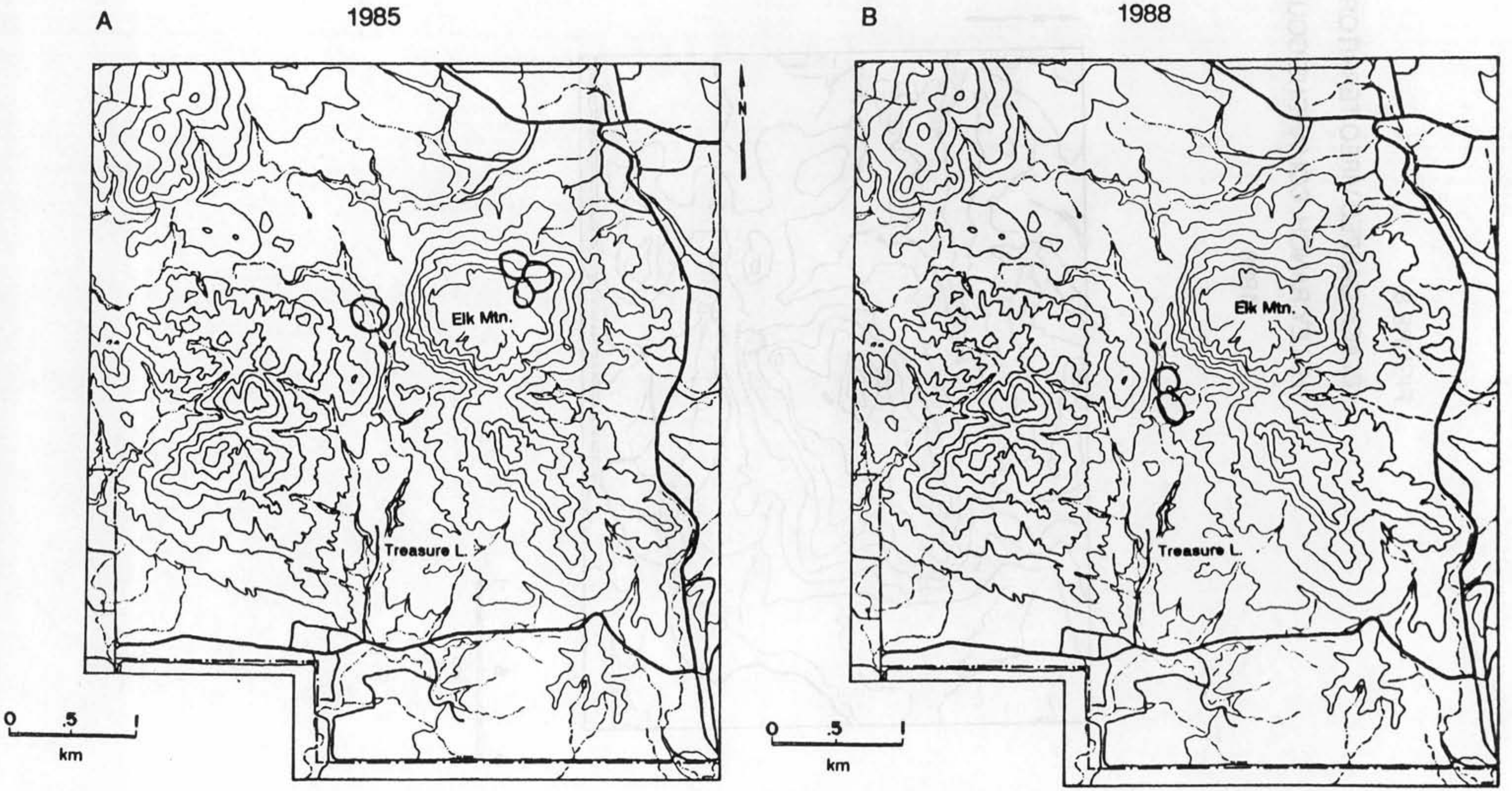


FIGURE 9

BLACK-CAPPED VIREO TERRITORIES

CHARON GARDENS WILDERNESS AREA

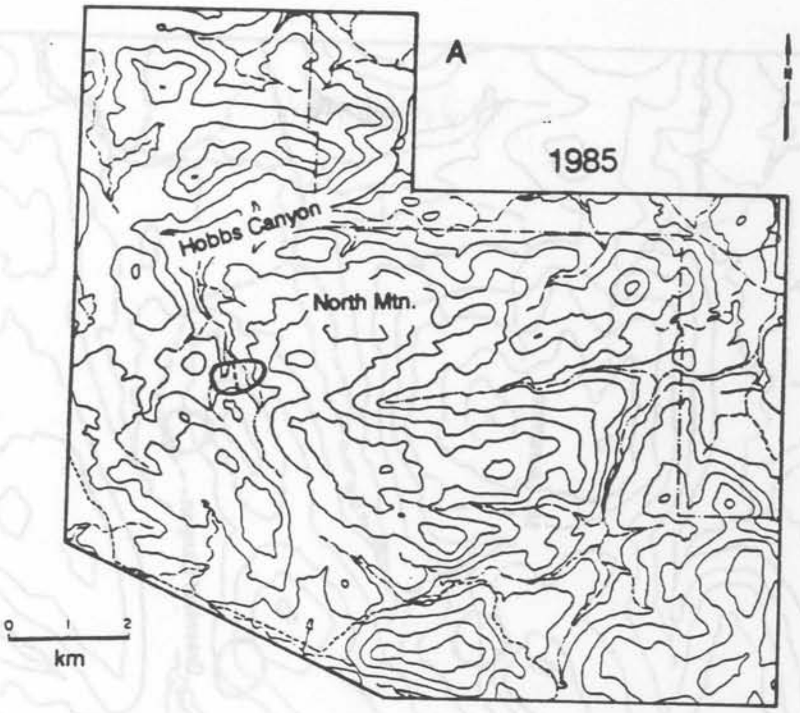
WICHITA MOUNTAINS NWR, COMANCHE COUNTY, OK

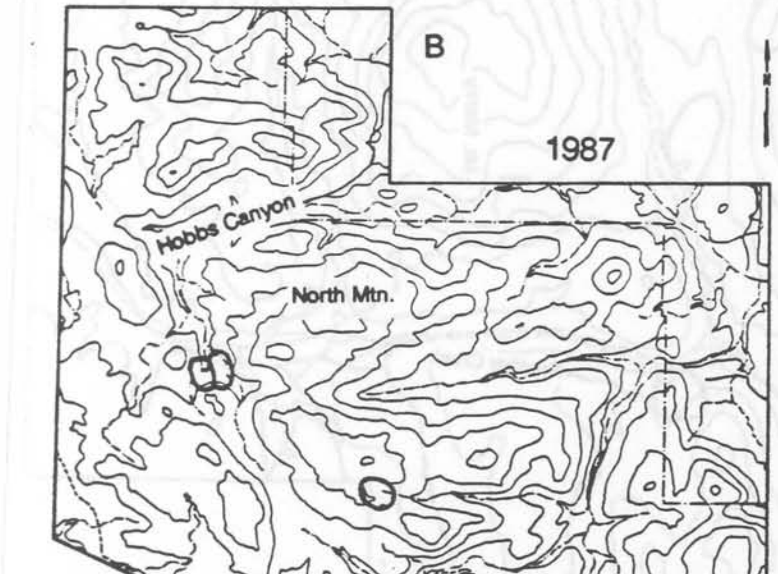
FIGURE 10

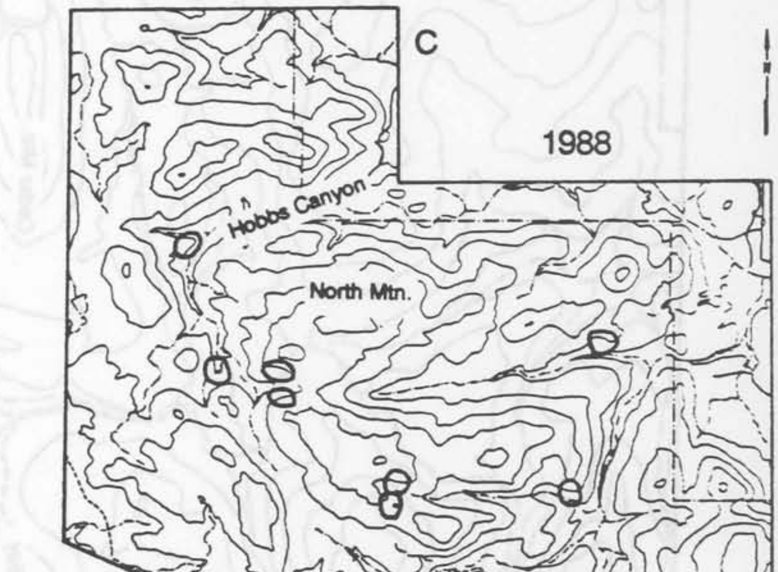
BLACK-CAPPED VIREO TERRITORIES

NORTH MOUNTAIN WILDERNESS AREA

WICHITA MOUNTAINS NWR, COMANCHE COUNTY, OK







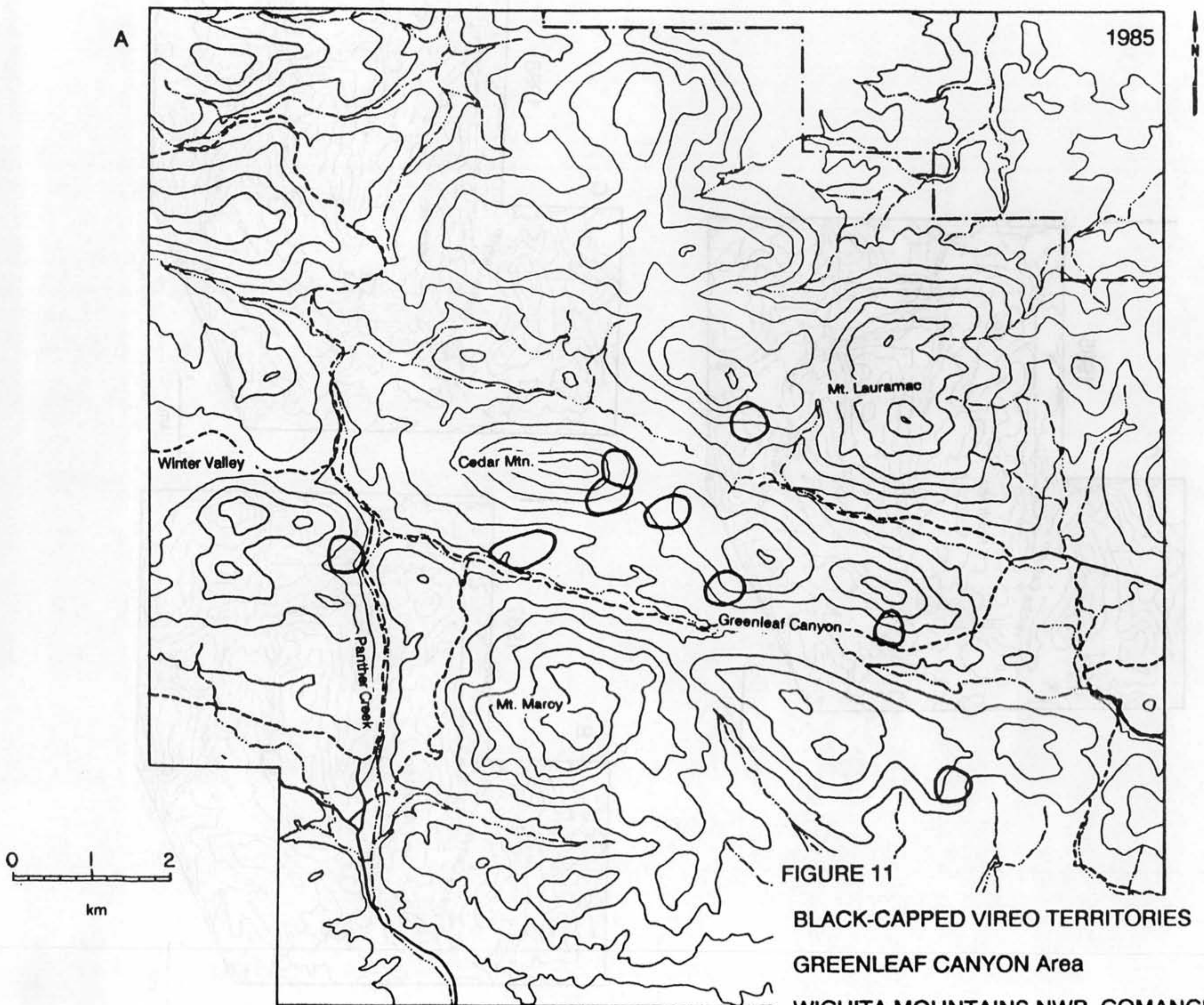


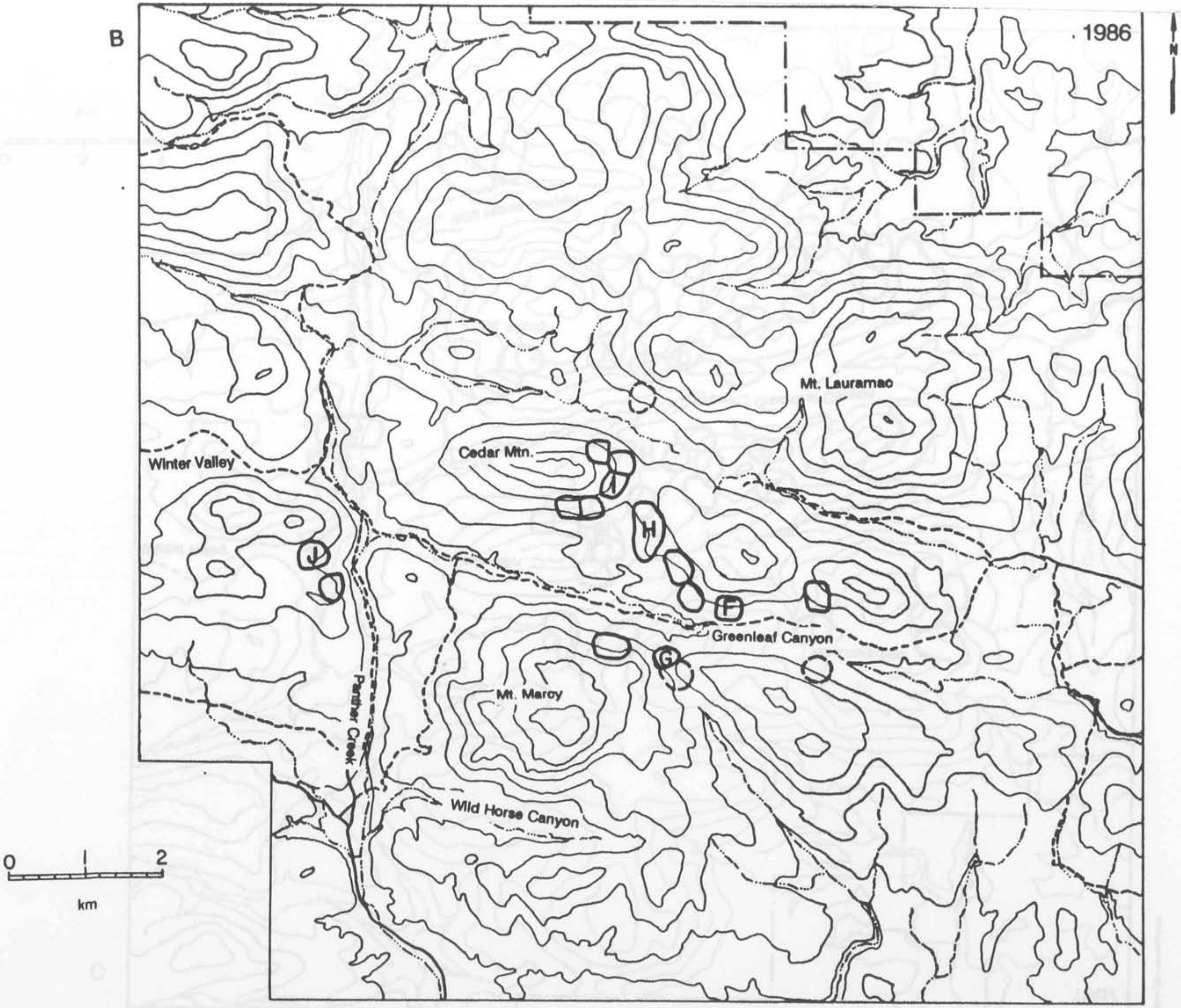
FIGURE 11

BLACK-CAPPED VIREO TERRITORIES

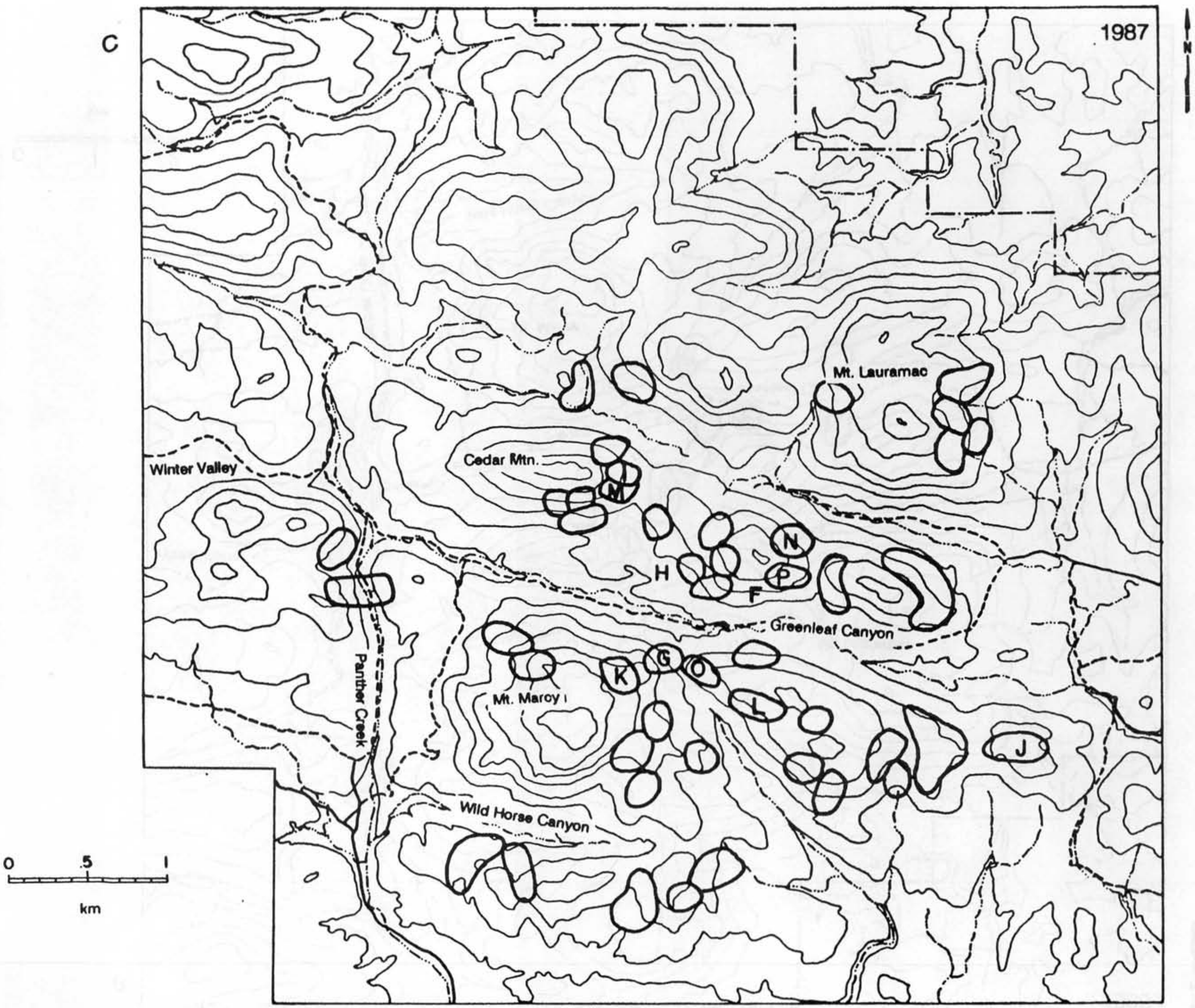
GREENLEAF CANYON Area

WICHITA MOUNTAINS NWR, COMANCHE COUNTY, OK

B


1986
N
Mt. Lauramac
Cedar Mtn.
Winter Valley
H
F
G
J
Greenleaf Canyon
Mt. Marcy
Panther Creek
Wild Horse Canyon
0
1
2
km

C



1987
N
Mt. Lauramac
Cedar Mtn.
Winter Valley
M
N
H
P
F
Greenleaf Canyon
G
K
O
L
J
Mt. Marcy
Panther Creek
Wild Horse Canyon
0
.5
1
km

D

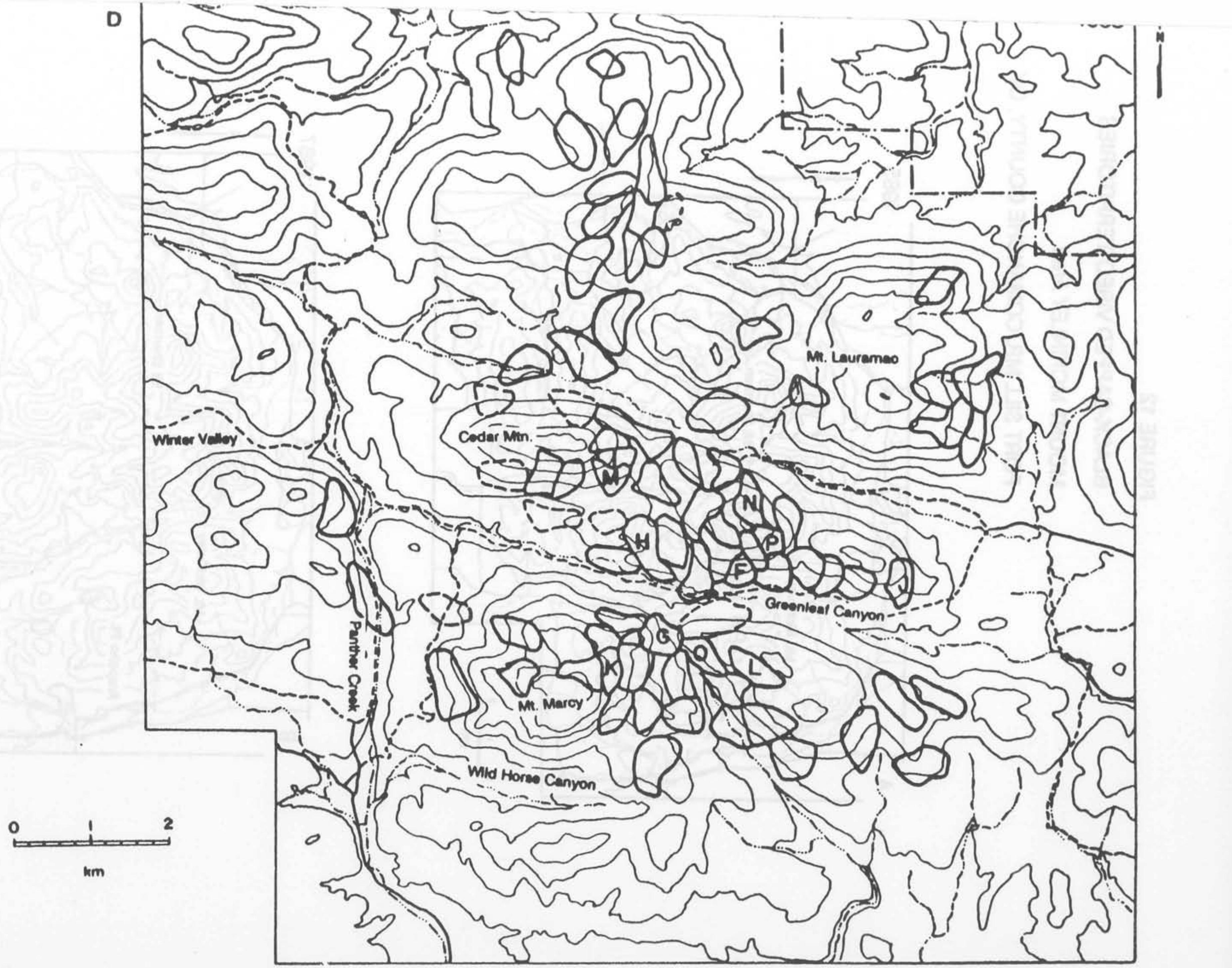
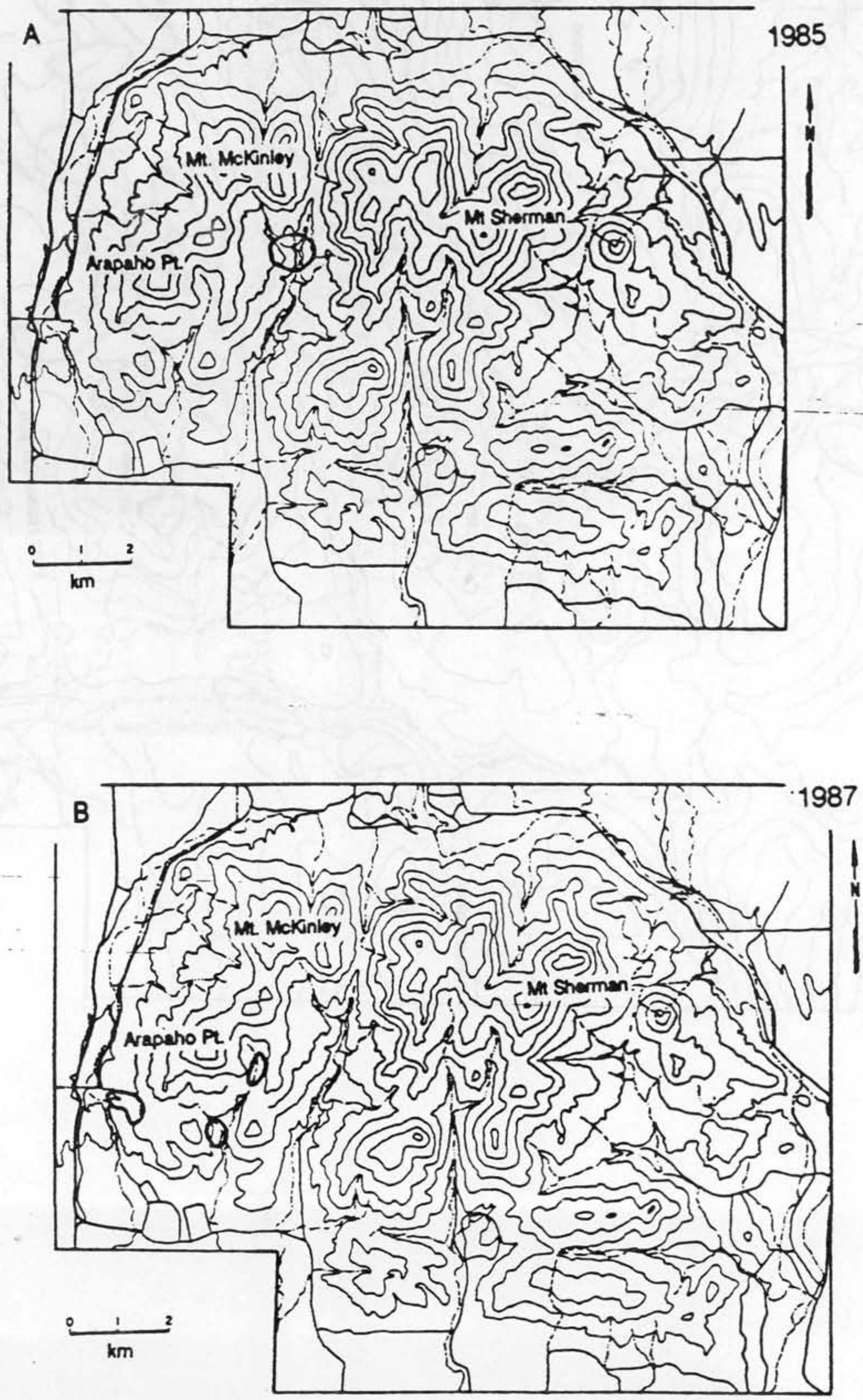

N
Mt. Lauramao
Cedar Mtn.
Winter Valley
Greenleaf Canyon
Mt. Marcy
Wild Horse Canyon
Panther Creek
M
N
H
P
F
G
O
K
L
0
1
2
km

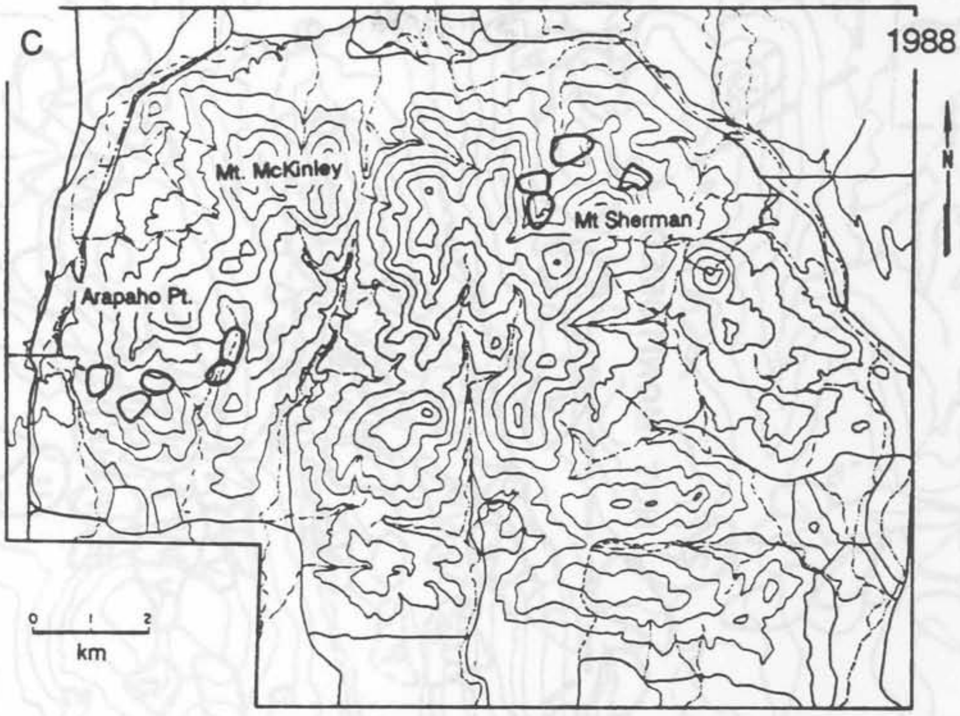
FIGURE 12

BLACK-CAPPED VIREO TERRITORIES

MOUNT MCKINLEY Area

FORT SILL MR, COMANCHE COUNTY, OK





C
1988
Mt. McKinley
Mt Sherman
Arapaho Pt.
N
0 1 2
km

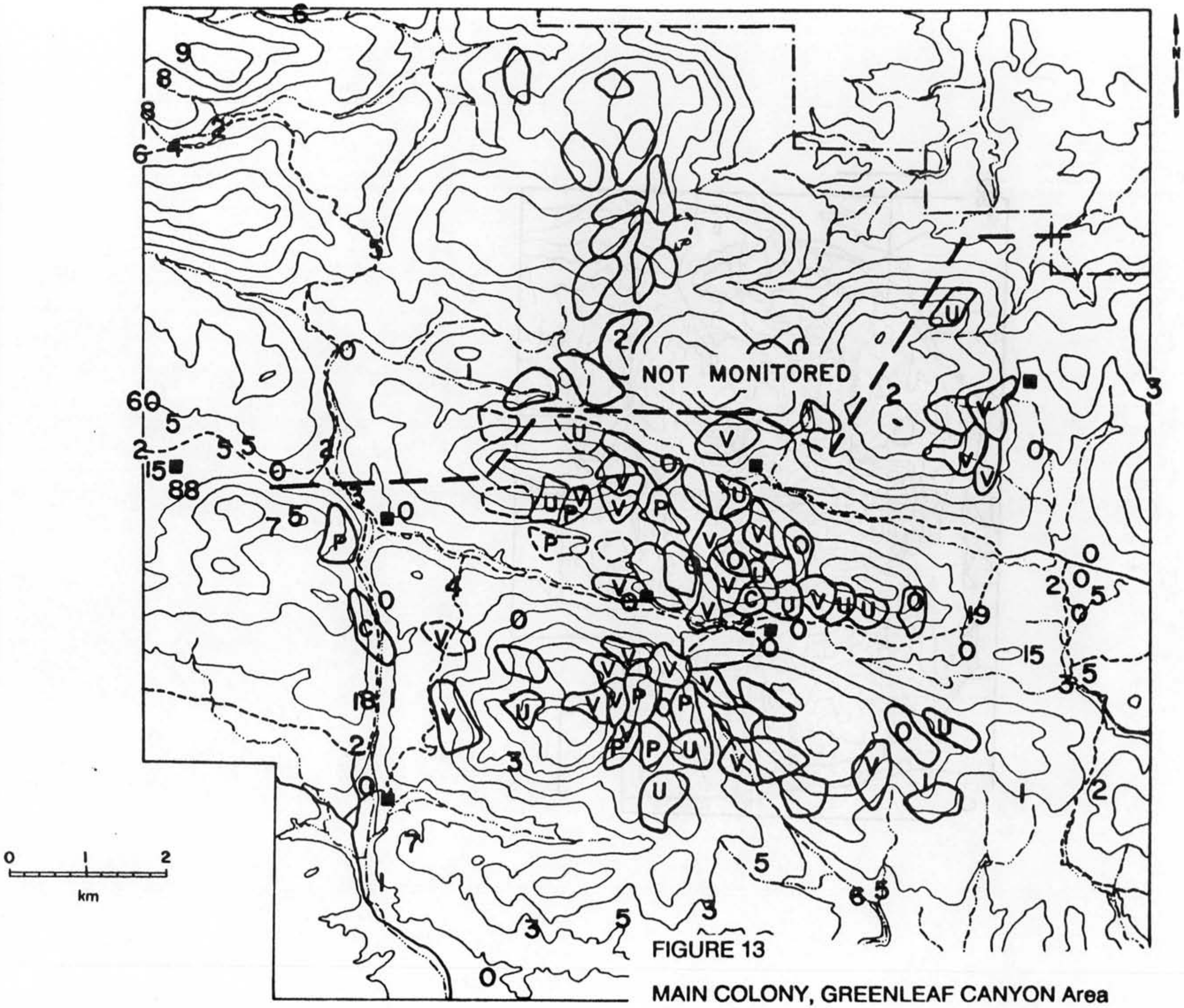


FIGURE 13

MAIN COLONY, GREENLEAF CANYON Area

FIGURE 14

PRINCIPAL COMPONENT PLOTS, ALL TERRITORIES, REGIONS IDENTIFIED

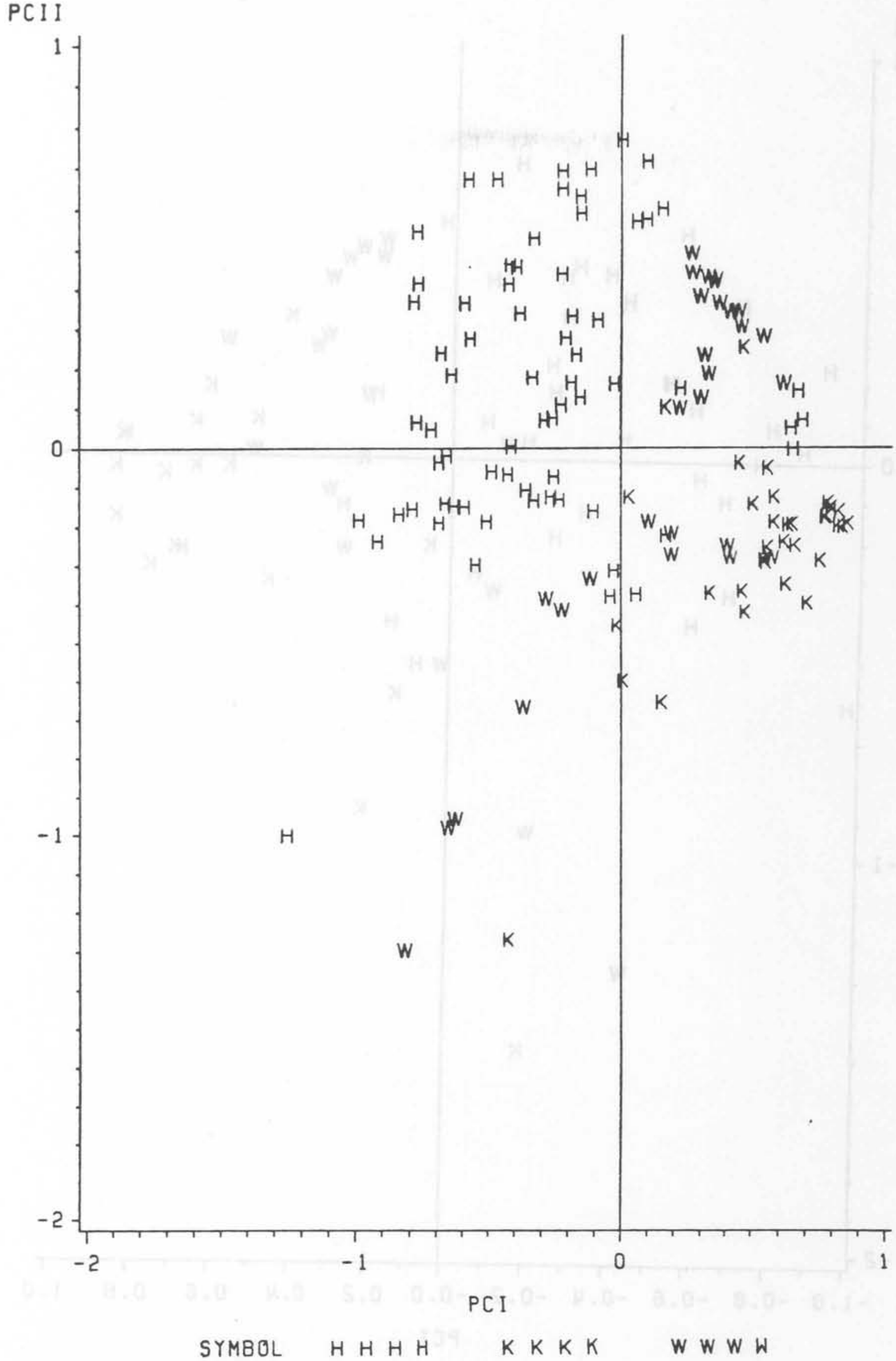


FIGURE 15

PRINCIPAL COMPONENT PLOTS, VIREOS ONLY, REGIONS IDENTIFIED

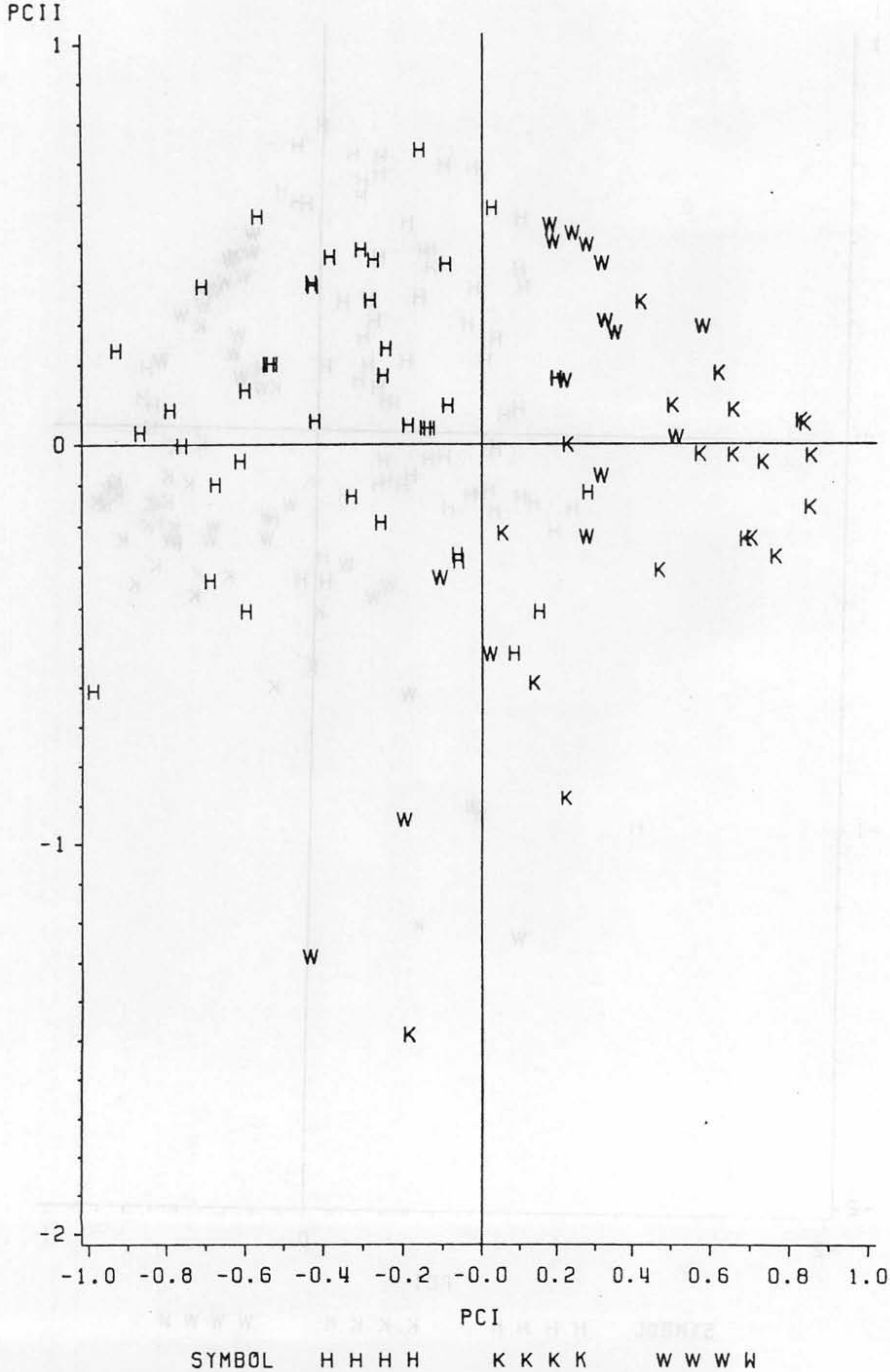


FIGURE 16

PRINCIPAL COMPONENT PLOTS, WICHITA MOUNTAINS, VIREOS IDENTIFIED

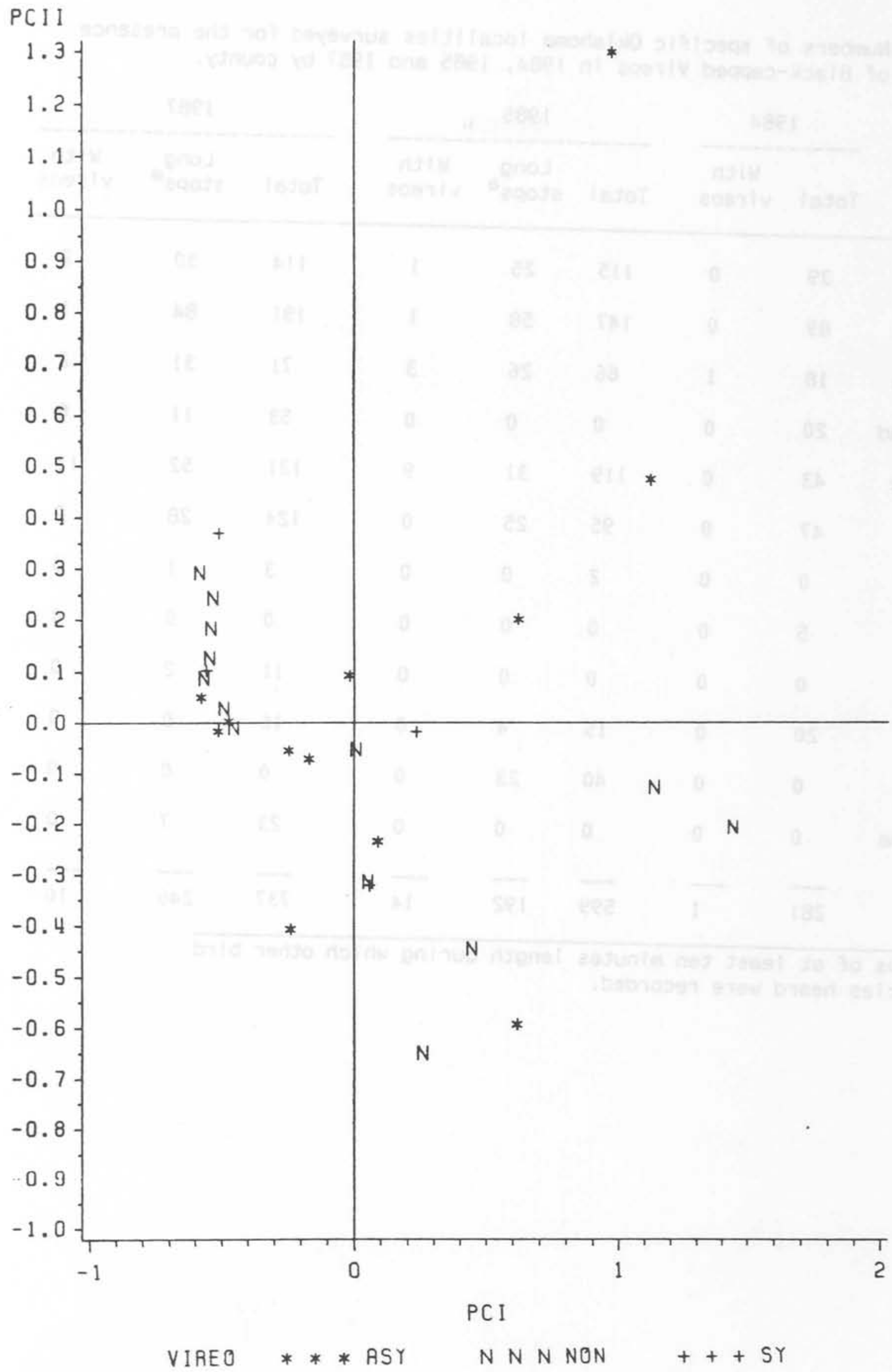


TABLE 1. Numbers of specific Oklahoma localities surveyed for the presence of Black-capped Vireos in 1984, 1985 and 1987 by county.

	1984		1985			1987		
County	Total	With vireos	Total	Long stops[a]	With vireos	Total	Long stops[a]	With vireos
Blaine	39	0	115	25	1	114	30	2
Caddo	89	0	147	58	1	191	84	1
Canadian	18	1	66	26	3	71	31	2
Cleveland	20	0	0	0	0	53	11	0
Comanche	43	0	119	31	9	131	52	11
Dewey	47	0	95	25	0	124	28	0
Grady	0	0	2	0	0	3	1	0
Kiowa	5	0	0	0	0	0	0	0
Logan	0	0	0	0	0	11	2	0
Major	20	0	15	4	0	16	0	0
Murray	0	0	40	23	0	0	0	0
Oklahoma	0	0	0	0	0	23	7	0
	281	1	599	192	14	737	246	16

[a] - stops of at least ten minutes length during which other bird species heard were recorded.

TABLE 2. Numbers of adult Black-capped Vireos located in Oklahoma during 1985, 1986, 1987, and 1988 and numbers of young produced.

County/ Locality	1985			1986			1987					
	M	F	Yg	M	F	Yg	M	F	Yg	M	F	Yg
Blaine/ Salt Creek	3-4	0	0	3	2	4	2-3	2	0?	4	5	2-4
Canadian/ Caddo Co. line	1	1	0	0	0	0	0	0	0	0	0	0
Methodist Camp	4	3	10-11	4-5	2	0	3	3	1	2	2	0
Miles	2	0	0	2	2	0	0	0	0	0	0	0
Caddo/ Scott	2	0	0	1-2	1	0	1-2	1	0	2	1	0
Comanche[a]/ Haley Ranch	?	?	?	?	?	?	?	?	?	1	0	0
North Mountain Wildern. Area[b]	2	?	?	?	?	?	4	?	?	8	1+	?
Greenleaf Canyon and area[c] (monitored)	9-11	1	0	16-19	11-13	10-13	47-49	35	31-39[d]	58-69	47-55	63-73[d]
(not monitored)	-	-	-	-	-	-	-	-	-	16-20	6+-8+	?
Elk Mountain	3	2	0	0	0	0	0	0	0	0	0	0
Charons Garden	1	0	0	0	0	0	0	0	0	1-2	1	?
Fort Sill MR	1-2	0	0	0	0	0	3	1	2-3	10	7-8	6-9
TOTALS	28-32	7	10-11	26-31	18-20	14-17	60-64	42	34-43	102-118	70-81	70-86
Total adults	35-39			44-51			102-106			172-199		

[a] - all sites in the Wichita Mountains, including the Haley Ranch, the Wichita Mountains NWR, and Fort Sill MR.

[b] - includes Hobbs Canyon, North Mountain and Moko Mountain sites from Grzybowski (1988).

[c] - includes Cedar Mtn. and Mt. Marcy and ridges to the east, and Mt Lauramac; also the Panther Creek, Lower Greenleaf Canyon and Section 14 sites from Grzybowski (1987).

[d] - does not include 3 young and 4 young which disappeared soon after fledging in 1987 and 1988 respectively. See text.

TABLE 3. Numbers of Black-capped Vireos banded at Methodist Canyon Camp, Canadian County, Oklahoma from 1984 through 1986, and numbers detected in subsequent years.

Locality	Year 1st banded	Number banded and returning[a]														
		1984			1985			1986			1987			1988		
		M	F	Y	M	F	Y	M	F	Y	M	F	Y	M	F	Y[b]
Methodist Canyon,	1984	2	1	0	1	0	-	1	-	-	1	-	-	1	-	-
	1985				1	1	3	1	1	0	0	0	-	-	-	-
	1986							1	1	0	0	0	-	-	-	-
	1987										2	2	0	1	0	-
TOTALS WITH BANDS/YEAR		2	1	0	2	1	3	3	2	0	3	2	0	2	0	0

a - M=male; F=female; Y=young.

a - second and subsequent row values indicate numbers of individuals from preceding row values returning and detected.

TABLE 4. Numbers of Black-capped Vireos banded at various localities in Oklahoma other than the Methodist Canyon Camp during 1986 and 1987, and numbers detected in subsequent years.

Locality	Year 1st banded	Number banded and returning[a] 1986			1987			1988		
		M	F	Y	M	F	Y	M	F	Y[b]
Salt Creek, Blaine Co.	1986	2	2	0	0	0	–	–	–	–
	1987				1	0	0	1	–	–
	1988							2	2	1
Niles, Canadian Co.	1986	2	1	0	0	0	–	–	–	–
Scott, Caddo Co.	1986	1	0	0	0	–	0	–	–	–
	1987				1	0	0	1	–	–
Wichita Mtns. NWR Comanche Co.	1986	9[c]	2	1	7	1	0	7	0	–
	1987				18	3	13[d]	6	0	0
	1988							21	10	10
Fort Sill MR Comanche Co.	1988							8	1	1
TOTAL WITH BANDS/YEAR		14[c]	5	1	23	4	13[d]	46	13	12
		20			44			71		

[a] - second and subsequent row values indicate numbers of individuals from preceding row values returning and detected.
[b] - M=male; F=female; Y=young.
[c] - one individual which succumbed in capture was not counted.
[d] - two nestlings banded which did not fledge were not counted.

TABLE 5. Numbers of first-year (SY) males, males in at least their second breeding season with significant gray in nape (gray-ASY), and males with solid, or predominantly black napes (black-ASY) given by region and year. Only males where determinations were made are counted.

Region	year	SY	gray-ASY	black-ASY
Outside Wichita Mountains[a]	1986	-	-	8
	1987	1	-	5
	1988	-	1	6
Wichita Mountains[b]	1987	8	11	23
	1988	21	29	38

a - includes sites in Blaine, Caddo and Canadian counties.
b - includes birds observed on Fort Sill MR in 1988.

TABLE 6. Nesting success and parasitism of Black-capped Vireo nests in Oklahoma during 1986, 1987, and 1988 with and without cowbird trapping.

County	Total Nestings discovered	Nestings with full clutches: paras./unparas.		unsucc.	Number succ./yg. produced: Vireo	Cowbird
		***** 1986 *****				
Without cowbird trapping						
Blaine	2	2	0	0	1[a] / 4	1 / 1[b]
Caddo	2	2	0	1	0 / 0	1 / 1[b]
Canadian	3	2	0	3	0 / 0	0 / 0
Comanche	7	6	1	4	2[a] / 4-7	1 / 1
Subtotal	14	12	1	8	3[a] / 8-11	3 / 3
With cowbird trapping						
Canadian	2	2	0	0	0 / 0	0 / 0
Comanche	2	0	2	2	2 / 6	0 / 0
Subtotal	4	2	2	2	2 / 6	0 / 0
		***** 1987 *****				
Without cowbird trapping						
Blaine	4	1	2	3	0 / 0	0 / 0
Caddo	2	1	0	0	0 / 0	1 / 1
Canadian	4	3	1	3	1 / 1	0 / 0
Comanche	15	6	5	7	4 / 10-13[c]	0 / 0
Subtotal	24	11	8	13	5 / 11-14[c]	1 / 1
With cowbird trapping						
Comanche	34	13	14	16	10 / 23-29[c]	1 / 1
		***** 1988 *****				
Without cowbird trapping						
Blaine	8	7	0	5	2[a] / 2-4	0 / 0
Caddo	1	1	0	1	0 / 0	0 / 0
Canadian	2	2	0	2	0 / 0	0 / 0
Comanche	9	3	3	2	3 / 6-9[d]	0 / 0
Subtotal	20	13	3	15	5 / 8-13	0 / 0
With cowbird trapping						
Comanche	51	10	31	26	23[d] / 62-73	2 / 2[e]

[a] - cowbird eggs removed from all nests.
[b] - cowbird fledgling captured and removed.
[c] - includes 2 nests fledging 5-6 young from which cowbirds eggs were removed.
[d] - includes 1 nest fledging 2 young from which a cowbird egg was removed.
[e] - one cowbird fledgling collected.

TABLE 7. Results of cowbird trapping in the Wichita Mountains NWR, Comanche County, Oklahoma during 1988.

	Greenleaf Canyon									Wild Horse Canyon			Soldier Dam			Mount Lauramac			Winter Valley		
	Trap 1			Trap 2			Trap 3														
Trapping began	22 April			23 April			23 April			29 April			19 May			1 June			22 June		
Trapping ended	20 June			25 July			25 July			25 July			25 July			25 July			25 July		
Days operational	60			94			94			95			68			55			34		
	Brown-headed Cowbirds captured																				
Dates	M	F	Y	M	F	Y	M	F	Y	M	F	Y	M	F	Y	M	F	Y	M	F	Y
17 - 23 April	4	3	0	6	2	0	0	0	0	0	0	0									
24 - 30 April	6	6	0	9	7	0	12	10	0	8	5	0									
1 - 7 May	5	4	0	2	4	0	0	-1	0	4	2	0									
8 - 14 May	7	2	0	0	3	0	1	0	0	4	1	0									
15 - 21 May	-5	0	0	3	0	0	5	0	0	6	0	0	0	3	0						
22 - 28 May	-1	0	0	1	1	0	-2	-1	0	0	0	0	1	0	0						
29 May - 4 Jun	0	1	0	-1	-1	0	5	0	0	1	0	0	5	3	0	9	2	0			
5 - 11 Jun	3	0	0	1	0	0	1	-1	0	0	0	0	3	-1	0	12	3	1			
12 - 18 Jun	1	-1	0	0	1	2	-2	-1	0	3	0	1	3	0	3	5	0	0			
19 - 25 Jun	0	0	0	3	3	2	-4	0	3	-2	0	3	2	2	5	2	0	5	9	3	0
26 Jun - 2 Jul				1	5	2	-1	3	3	1	5	5	1	2	3	7	10	4	6	15	3
3 - 9 Jul				1	1	-1	-2	-1	0	0	2	8	-1	4	3	12	0	5	10	10	6
10 - 16 Jul				0	0	6	-1	0	-1	0	0	1	-1	2	1	1	0	-2	0	7	16
17 - 23 Jul				2	-1	0	0	0	0	0	0	0	0	0	0	0	0	3	-2	0	-1
24 - 30 Jul				-2	0	-1	-1	0	0	-1	1	-1	0	0	0	0	-1	0	0	0	2
TOTALS	20	15	0	26	25	10	11	8	5	24	16	17	13	15	15	48	14	15	23	37	26
Totals by site	35			61			24			57			43			77			86		
Cowbirds/day	0.58			0.65			0.26			0.65			0.63			1.40			2.53		
	1.31 cowbirds/day																				

TABLE 8. Summary of cowbird trapping at the Methodist Canyon Camp site, Canadian County, and in the Wichita Mountains NWR, Comanche County, Oklahoma from 1986 to 1988 (see Grzybowski 1987, 1988b).

	Methodist Camp	Greenleaf Canyon	Wild Horse Canyon	Soldier Dam	Mount Lauramac	Winter Valley
TRAP OPERATION						
1986						
Trapping began	4 May	10 May				
Trapping ended	28 June	28 June				
Trap No.(if >1)		1 2				
Days operational	55	49 43				
1987						
Trapping began	18 April	19 April	14 May			
Trapping ended	10 May	25 July	25 July			
Trap No. (if >1)		1 2 3				
Days operational	23	98 98 95	73			
1988						
Trapping began		22 April	29 April	19 May	1 June	22 June
Trapping ended		25 July	25 July	25 July	25 July	25 July
Trap No. (if >1)		1 2 3				
Days operational		60 94 94	95	68	55	34
TRAP CAPTURE	M F Y	M F Y	M F Y	M F Y	M F Y	M F Y
1986						
TOTAL cowbirds captured	-4 0 0	53 8 16				
Totals by site	-4	77				
Cowbirds/day	-0.07	1.59				
1987						
TOTAL cowbirds captured	2 2 0	81 56 8	21 9 8			
Totals by site	4	145	38			
Cowbirds/day	0.17	1.46	0.52			
1988						
TOTAL cowbirds captured		57 48 15	24 16 17	13 15 15	48 14 15	23 37 26
Totals by site		120	57	43	77	86
Cowbirds/day		1.31	0.65	0.63	1.40	2.53

TABLE 9. Plant species associated with territories of Black-capped Vireos in Oklahoma. Only species with frequencies greater than 1% of the entire sample in vireo territories are included. Species are listed in alphabetical order.

Species	Total freq. (%)	Freq. (%) in Vireo territories
<u>Bumelia lanuginosa</u>	5 (0.4%)	3 (1.0%)
<u>Celtis occidentalis</u>	18 (1.5%)	0 (0.0%)
<u>Celtis reticulata</u>	31 (2.6%)	14 (4.9%)
<u>Cercis canadensis</u>	4 (0.3%)	3 (1.0%)
<u>Juniperus virginianus</u>	442 (36.7%)	74 (25.9%)**
<u>Quercus marilandica</u>	371 (30.8%)	92 (32.2%)
<u>Quercus stellata</u>	83 (6.9%)	32 (11.2%)*
Other <u>Quercus</u> spp.	65 (5.4%)	7 (2.4%)
<u>Rhus aromatica</u>	25 (2.1%)	12 (4.2%)
<u>Rhus glabra</u>	85 (7.0%)	27 (9.4%)
Other <u>Rhus</u> spp.	22 (1.9%)	3 (1.0%)
<u>Sapindus drummondii</u>	7 (0.6%)	7 (2.4%)
	1158 (96.2%)	274 (95.6%)

* - significantly different (P<0.05) from total frequency.
** - highly significantly different (P<.01) from total frequency.

TABLE 10. Habitat variables measured or derived from measurements taken on one-tenth acre circles, units, and transformations performed before inclusion in analyses, along with abbreviations for these variables used in the text. Standard Deviations (S.D.) taken for circle values.

Variable Description	Unit or Transformation	Abbreviation
No. oaks in dbh class 1 (7.5-15 cm.)	/hectare	OAKA
No. oaks in dbh class 2 (>15-38 cm.)	/hectare	OAKB
No. oaks in dbh class 3 (>38 cm.)	/hectare	OAKC
No. non-oaks in dbh class 1	/hectare	NONA
No. non-oaks in dbh classes 2 and	/hectare	NONB
No. junipers in dbh class 1	/hectare	JUNA
No. junipers in dbh class 2	/hectare	JUNB
No. junipers in dbh class 3	/hectare	JUNC
Relative density of oaks	arcsine	DENSO
Relative density of non-oaks	arcsine	DENSN
Relative density of junipers	arcsine	DENSJ
Basal area of oaks	(cm^2/hectare)	BAOAK
Basal area of non-oaks	(cm^2/hectare)	BANON
Basal area of junipers	(cm^2/hectare)	BAJUN
S.D. of basal area for oaks		VAROAK
S.D. of basal area for non-oaks		VARNON
S.D. of basal area for junipers		VARJUN
Relative dominance of oaks	arcsine	RDOAK
Relative dominance of non-oaks	arcsine	RDNON
Relative dominance of junipers	arcsine	RDJUN
Average height of all trees	meters	MHEIGHT
No. of oak stems at height of 1 m	/hectare	NSTEMSO
No. of non-oak stems at height of 1 m	/hectare	NSTEMSN
No. of juniper stems at height of 1 m	/hectare	NSTEMSJ
No. of vine stems at height of 1 m	/hectare	NSTEMSV
(taken for 20 points 2 m apart along two orthogonal diameters)		
% cover of woody plants	arcsine	WOODYCOV
% cover of forb	arcsine	FORBCOV
% cover of grass	arcsine	GRASSCOV
% cover of rock	arcsine	ROCKCOV
% cover of cactus	arcsine	CACTCOV

Table 10. (cont.)

Variable Description	Unit or Transformation	Abbre- viation
(taken for 20 points 2 m apart along two orthogonal diameters)		
No. of dm of deciduous trees in 0-0.5 m	/circle	DASUM
No. of dm of junipers in 0-0.5 m	/circle	JASUM
No. of dm of forbs in 0-0.5 m	/circle	FASUM
No. of dm of grass in 0-0.5 m	/circle	GASUM
No. of dm of deciduous trees in >0.5-1.0 m	/circle	DBSUM
No. of dm of junipers in >0.5-1.0 m	/circle	JBSUM
No. of dm of forbs in >0.5-1.0 m	/circle	FBSUM
No. of dm of grass in >0.5-1.0 m	/circle	GBSUM
No. of dm of deciduous trees in >1.0-2.0 m	/circle	DCSUM
No. of dm of junipers in >1.0-2.0 m	/circle	JCSUM
No. of dm of forbs in >1.0-2.0 m	/circle	FCSUM
No. of dm of grass in >1.0-2.0 m	/circle	GCSUM
No. of dm of deciduous trees in >2.0-3.0 m	/circle	DDSUM
No. of dm of junipers in >2.0-3.0 m	/circle	JDDUM
No. of dm of deciduous trees above 3.0 m	/circle	D3SUM
No. of dm of junipers above 3.0 m	/circle	J3SUM
Total	/circle	TOTSUM
S.D. of deciduous in 0-2.0 m		DISD
S.D. of junipers in 0-2.0 m		JISD
S.D. of deciduous in >2.0-3.0 m		DDSD
S.D. of junipers in >2.0-3.0 m		JDSD
S.D. of deciduous above 3.0 m		D3SD
S.D. of junipers above 3.0 m		JDSD
S.D. of total		TOTSD
(% of 2 orthogonal diagonal lines 10 m long at height of 1 m)		
% deciduous cover	arcsine	PERCDECI
% juniper cover	arcsine	PERCJUNI
% open	arcsine	PERCOPEN
% cover with 1 plant	arcsine	PERC1
% cover with 2 overlapping plants	arcsine	PERC2
% cover with 3 or more plants	arcsine	PERC3
No. of changes from open to cover	/circle	NOCHANGE

TABLE 11. Principal component loadings for all 131 vireo territories and non-vireo areas from Fort Hood, Texas, Kerr County, Texas, and southwestern Oklahoma. Variable abbreviations as in Table 10.

Variable	Component I	II	III
OAKA	0.110	-0.423	0.726
OAKB	0.122	-0.496	0.600
OAKC	0.187	-0.258	0.407
NONA	-0.373	-0.163	-0.273
NONB	0.025	-0.191	-0.076
JUNA	-0.747	-0.309	-0.088
JUNB	-0.642	-0.471	0.041
JUNC	-0.238	-0.532	0.000
DENSO	0.683	0.090	0.517
DENSN	-0.213	0.024	-0.422
DENSJ	-0.771	-0.042	-0.289
VAROAK	0.283	-0.553	0.569
VARNON	-0.104	-0.207	-0.084
VARJUN	-0.509	-0.604	0.018
BAOAK	0.218	-0.556	0.715
BANON	-0.310	-0.250	-0.254
BAJUN	-0.743	-0.538	-0.014
RDOAK	0.704	0.118	0.479
RDNON	-0.156	0.084	-0.352
RDJUN	-0.777	-0.106	-0.288
MHEIGHT	-0.603	0.530	-0.178
NSTEMSO	-0.179	0.439	0.470
NSTEMSJ	-0.662	-0.338	-0.141
NSTEMSV	-0.360	0.271	0.100
NSTEMSN	-0.444	0.459	0.001
WOODYCOV	-0.677	0.583	0.071
FORBCOV	0.476	-0.141	-0.497
GRASSCOV	0.712	-0.414	0.041
ROCKCOV	0.237	0.113	0.164
CACTCOV	-0.129	-0.211	-0.198
JASUM	-0.649	-0.350	-0.147
DASUM	-0.429	0.720	-0.101
FASUM	0.484	-0.230	-0.399
GASUM	0.665	-0.538	0.117
JBSUM	-0.691	-0.409	-0.071
DBSUM	-0.389	0.801	0.117
FBSUM	-0.014	-0.238	-0.071
GBSUM	0.365	-0.444	0.136
JCSUM	-0.663	-0.533	0.010
DCSUM	-0.374	0.589	0.445
FCSUM	-0.036	-0.152	-0.019
GCSUM	-0.048	-0.093	-0.023

Table II. (cont.)

Variable	Component I	II	III
JDSUM	-0.692	-0.547	-0.039
DDSUM	-0.437	0.394	0.527
J3SUM	-0.752	-0.334	-0.125
D3SUM	-0.596	0.082	0.293
TOTSUM	-0.807	-0.078	0.314
D1SD	-0.194	0.140	0.104
DDSD	-0.222	-0.016	0.421
D3SD	0.196	-0.538	0.414
J1SD	-0.620	-0.375	0.008
JDSD	-0.599	-0.561	0.093
J3SD	-0.182	-0.667	0.204
TOTSD	-0.235	-0.246	0.083
PERCDECI	-0.328	0.575	0.568
PERCJUNI	-0.611	-0.537	-0.043
PERCOPEN	0.825	-0.192	-0.438
PERC1	-0.732	0.215	0.475
PERC2	-0.824	0.110	0.215
PERC3	-0.618	0.049	0.068
NOCHANGE	-0.599	0.580	0.126

TABLE 12. Principal component loadings for 74 vireo territories from Fort Hood, Texas, Kerr County, Texas, and southwestern Oklahoma. Variable abbreviations as in Table 10.

Variable	Component I	II	III
OAKA	0.421	-0.112	0.722
OAKB	0.347	-0.258	0.611
OAKC	0.249	-0.109	0.453
NONA	-0.067	-0.417	-0.300
NONB	0.239	-0.242	-0.171
JUNA	-0.623	-0.474	0.030
JUNB	-0.510	-0.502	0.183
JUNC	-0.123	-0.643	0.064
DENSO	0.666	0.403	0.431
DENSN	-0.001	-0.231	-0.616
DENSJ	-0.777	-0.279	-0.176
VAROAK	0.537	-0.270	0.620
VARNON	0.152	-0.291	-0.123
VARJUN	-0.351	-0.726	0.113
BAOAK	0.525	-0.268	0.715
BANON	0.079	-0.437	-0.272
BAJUN	-0.564	-0.693	0.122
RDOAK	0.687	0.397	0.404
RDNON	0.018	-0.169	-0.577
RDJUN	-0.770	-0.312	-0.179
MHEIGHT	-0.707	0.413	-0.214
NSTEMSO	-0.207	0.503	0.261
NSTEMSJ	-0.579	-0.641	-0.048
NSTEMSV	-0.421	0.172	0.002
NSTEMSN	-0.614	0.274	-0.079
WOODYCOV	-0.724	0.485	0.021
FORBCOV	0.316	-0.294	-0.371
GRASSCOV	0.827	-0.172	-0.014
ROCKCOV	0.164	-0.011	0.075
CACTCOV	-0.123	-0.405	-0.133
JASUM	-0.465	-0.533	-0.044
DASUM	-0.647	0.526	-0.089
FASUM	0.293	-0.414	-0.220
GASUM	0.821	-0.349	0.076
JBSUM	-0.416	-0.588	0.061
DBSUM	-0.625	0.630	0.015
FBSUM	0.064	-0.442	0.032
GBSUM	0.517	-0.339	0.071
JCSUM	-0.369	-0.690	0.191
DCSUM	-0.551	0.499	0.286
FCSUM	0.002	-0.221	0.134
GCSUM	-0.009	-0.189	-0.041

Table 12. (cont.)

Variable	Component I	II	III
JDSUM	-0.442	-0.748	0.116
DDSUM	-0.653	0.318	0.276
J3SUM	-0.623	-0.426	0.011
D3SUM	-0.511	0.151	0.262
TOTSUM	-0.729	-0.087	0.353
DISD	-0.151	0.138	0.077
DDSD	-0.196	-0.027	0.335
D3SD	0.405	-0.360	0.392
JISD	-0.338	-0.452	0.126
JDSD	-0.348	-0.666	0.248
J3SD	0.037	-0.710	0.199
TOTSD	-0.130	-0.339	0.201
PERCDECI	-0.446	0.559	0.394
PERCJUNI	-0.350	-0.611	0.084
PERCOPEN	0.797	-0.140	-0.406
PERC1	-0.695	0.182	0.417
PERC2	-0.734	0.021	0.260
PERC3	-0.488	0.122	0.127
NOCHANGE	-0.746	0.405	0.030

TABLE 13. Principal component loadings for 29 vireo territories or non-vireo areas in the Wichita Mountains, Canadian and Caddo counties, Oklahoma. Variable abbreviations as in Table 10.

Variable	Component I	II	III
OAKA	0.585	-0.668	0.198
OAKB	0.662	-0.594	0.052
OAKC	0.110	-0.371	0.158
NONA	0.484	0.652	-0.405
NONB	0.260	0.155	-0.848
JUNA	0.894	0.082	0.147
JUNB	0.792	0.010	0.140
JUNC	0.804	0.384	-0.102
DENSO	-0.905	-0.271	0.098
DENSN	0.405	0.592	-0.556
DENSJ	0.844	0.434	0.079
VAROAK	0.534	-0.584	0.007
VARNON	0.275	0.161	-0.844
VARJUN	0.906	0.147	-0.144
BAOAK	0.589	-0.670	0.057
BANON	0.458	0.352	-0.727
BAJUN	0.967	0.117	-0.007
RDOAK	-0.928	-0.248	0.104
RDNON	0.299	0.302	-0.808
RDJUN	0.855	0.460	0.032
MHEIGHT	-0.725	0.254	-0.078
NSTEMSO	-0.268	-0.528	0.256
NSTEMSJ	0.857	0.270	0.114
NSTEMSV	0.321	-0.190	-0.806
NSTEMSN	0.138	0.049	-0.775
WOODYCOV	-0.458	0.176	-0.334
FORBCOV	-0.192	0.479	0.520
GRASSCOV	-0.130	0.262	0.508
ROCKCOV	-0.527	-0.008	-0.645
CACTCOV	0.455	0.722	0.110
JASUM	0.735	0.148	0.235
DASUM	-0.417	0.200	-0.433
FASUM	0.154	0.249	0.551
GASUM	0.419	0.070	0.539
JBSUM	0.771	0.171	0.241
DBSUM	-0.642	0.218	-0.245
FBSUM	0.352	-0.088	0.245
GBSUM	0.594	0.290	0.230
JCSUM	0.861	0.128	0.136
DCSUM	-0.172	-0.137	-0.060
FCSUM	0.235	0.328	0.145
GCSUM	0.356	0.704	0.086

Table 13. (cont.)

Variable	Component I	II	III
JDSUM	0.926	0.096	0.074
DDSUM	0.206	-0.546	-0.011
J3SUM	0.786	-0.105	0.075
D3SUM	0.391	-0.608	-0.297
TOTSUM	0.871	-0.128	0.171
D1SD	0.227	-0.023	0.178
DDSD	0.424	-0.217	0.208
D3SD	0.727	-0.564	-0.088
J1SD	0.779	-0.158	0.029
JDSD	0.881	-0.109	-0.107
J3SD	0.857	-0.148	-0.074
TOTSD	0.347	0.004	0.100
PERCDECI	-0.251	-0.603	-0.391
PERCJUNI	0.801	-0.195	0.016
PERCOPEN	-0.537	0.608	0.367
PERC1	0.439	-0.617	-0.362
PERC2	0.519	-0.433	-0.299
PERC3	0.599	-0.075	0.083
NOCHANGE	-0.330	0.004	-0.065

TABLE 14. Statistics for stepwise discriminant function analysis of vireo territories (VIREO) and non-vireo areas (NON-VIREO) in southwestern Oklahoma, primarily the Wichita Mountains. Variable abbreviations as in Table 10.

Variable	F-value to enter	Order of Entry	Coefficient[a]	Classification function VIREO	NON-VIREO
DASUM	9.355	1	0.568	4.969	3.243
MHEIGHT	10.996	2	-0.225	-1.598	-0.916
GRASSCOV	11.731	3	4.919	52.860	37.911
TOTSD	5.447	4	0.049	0.488	0.340
Constant			-7.475	-43.828	-21.588

[a] - Coefficient for canonical variable, which in the two group case is equivalent to the discriminant funstion between the two groups.

TABLE 15. Statistics for stepwise canonical variate analysis of ASY-male vireo territories (ASY-VIREO), SY-male vireo territories (SY-VIREO) and non-vireo areas (NON-VIREO) in southwestern Oklahoma, primarily the Wichita Mountains. Variable abbreviations as in Table 10.

Variable	F-value to enter	Order of Entry	Coefficients[a]		Classification function ASY-VIREO	SY-VIREO	NON-VIREO
DASUM	4.953	1	0.601	-0.021	4.432	4.100	2.783
MHEIGHT	7.509	2	-0.275	-0.034	-1.691	-1.492	-0.930
GRASSCOV	5.997	3	3.750	-4.504	37.478	40.180	27.931
Constant			-5.756	2.876	-30.384	-29.860	-15.136

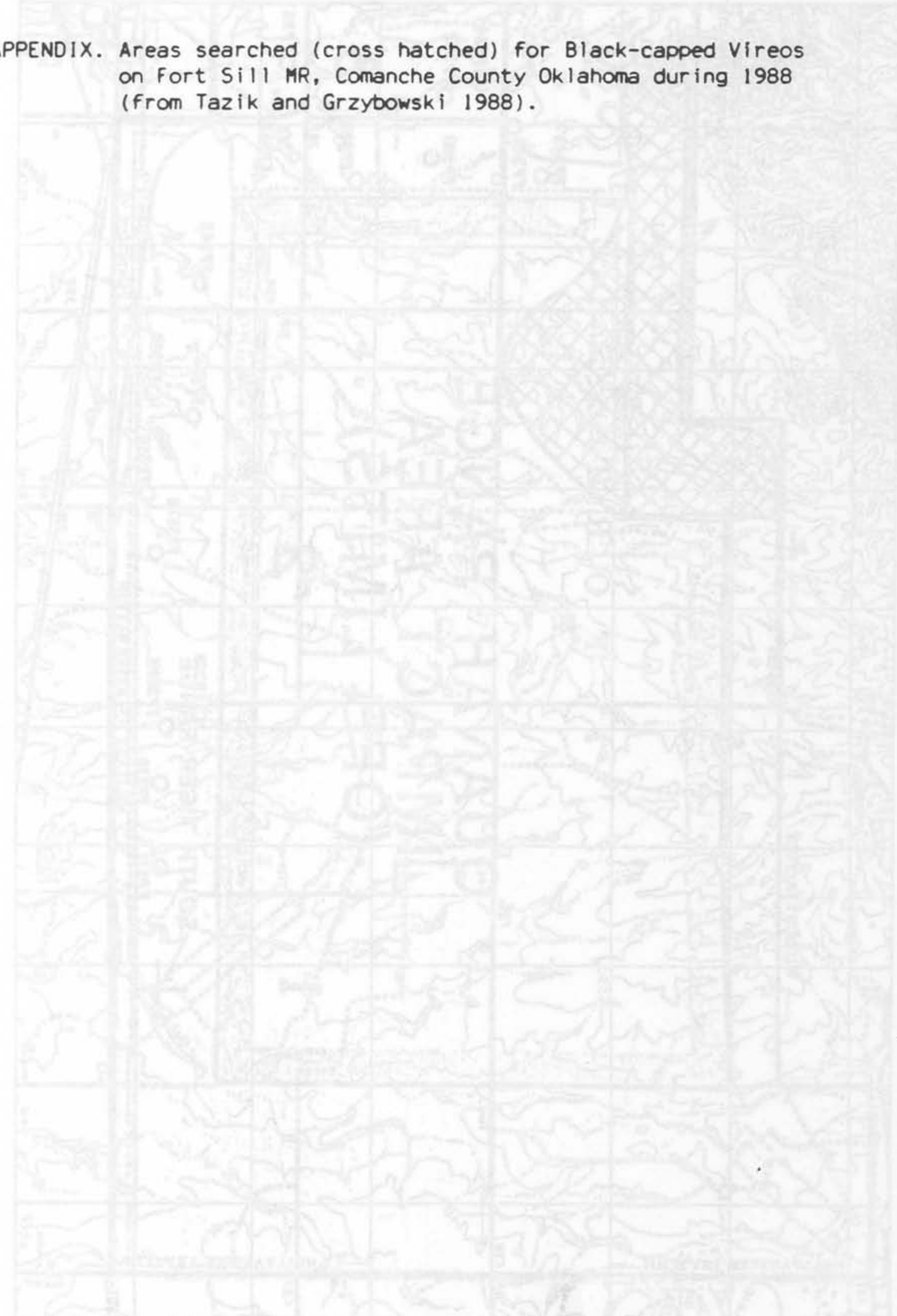
[a] - Coefficient for canonical variable, which in the two group case is equivalent to the discriminant funstion between the two groups.

TABLE 16. Statistics for stepwise discriminant function analysis of ASY-male vireo territories (ASY-VIREO) and non-vireo areas (NON-VIREO) in southwestern Oklahoma, primarily the Wichita Mountains. Variable abbreviations as in Table 10.

Variable	F-value to enter	Order of Entry	Coefficient[a]	Classification function	
				ASY-VIREO	NON-VIREO
TOTSD	9.832	1	0.112	0.702	0.298
DBSUM	7.356	2	0.298	1.748	0.674
MHEIGHT	9.871	3	-0.284	-1.242	-0.218
DISD	6.334	4	-0.099	-0.430	-0.073
DENSN	4.316	5	8.316	51.964	21.992
Constant			-4.152	-21.277	-6.053

a - Coefficient for canonical variable, which in the two group case is equivalent to the discriminant funstion between the two groups.

APPENDIX. Areas searched (cross hatched) for Black-capped Vireos on Fort Sill MR, Comanche County Oklahoma during 1988 (from Tazik and Grzybowski 1988).



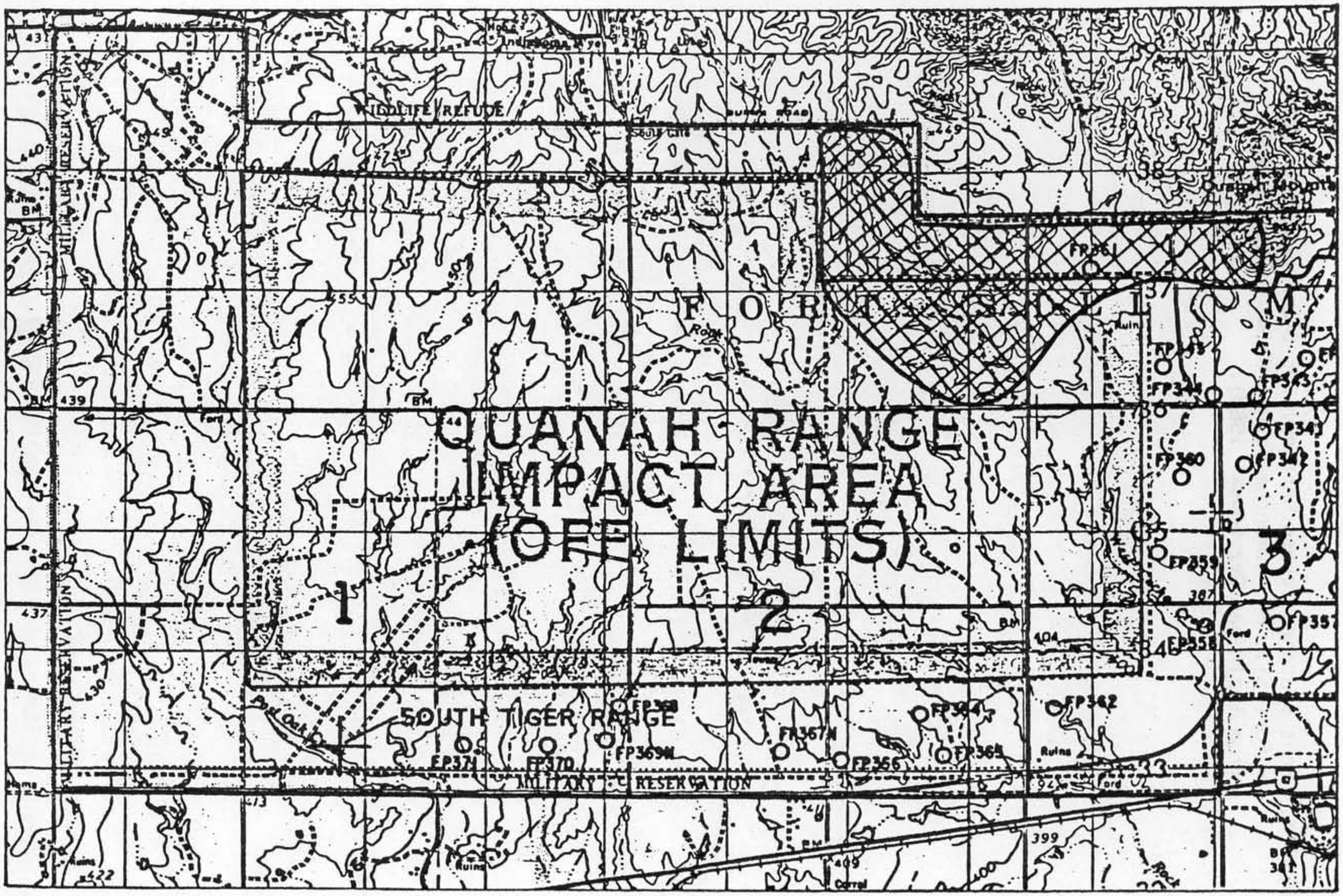


Figure 1a. Black-capped Vireo Search Areas on Ft. Sill - - Quannah Range

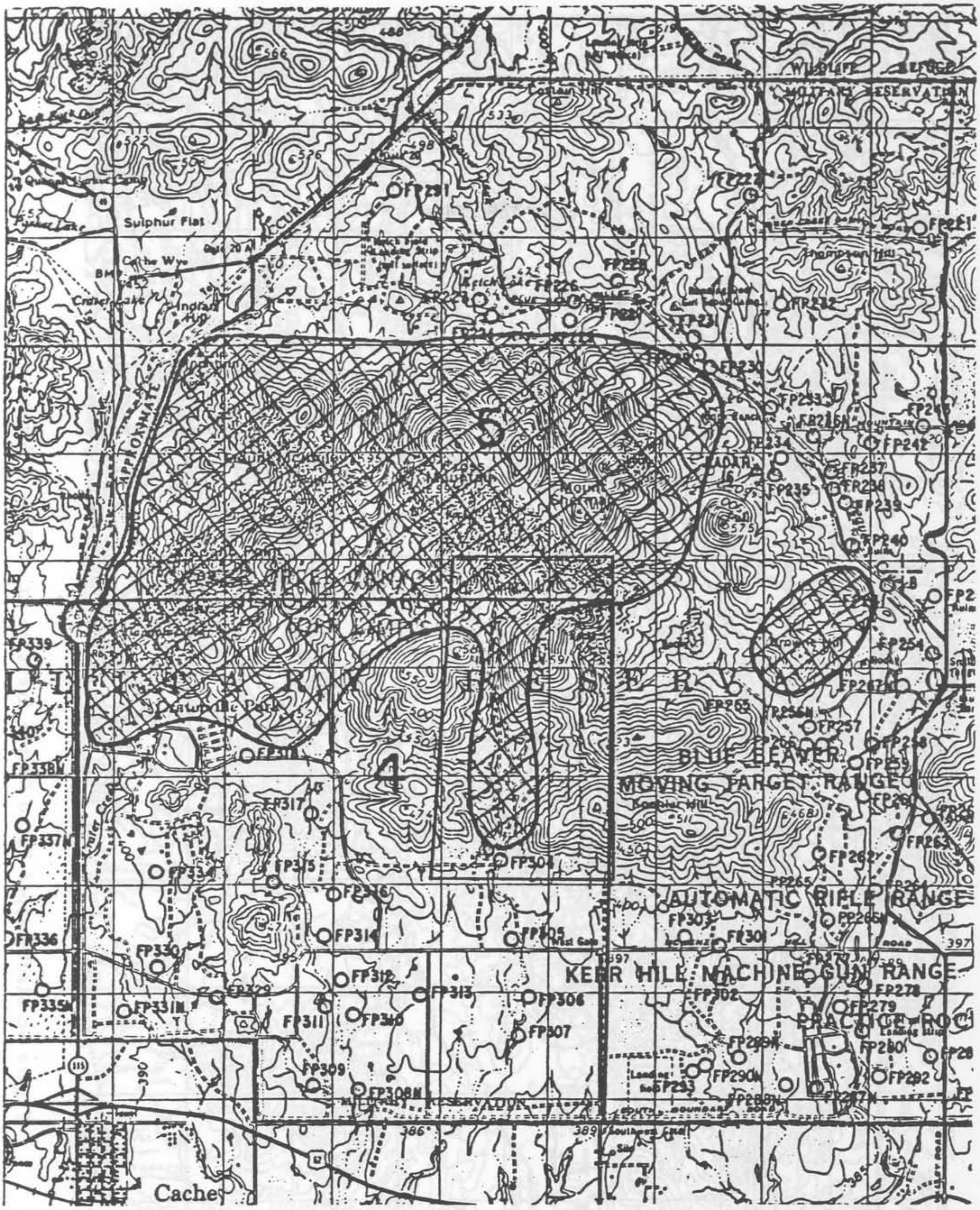


Figure 1b Black-capped Vireo Search Areas on Ft. Sill - - North West.

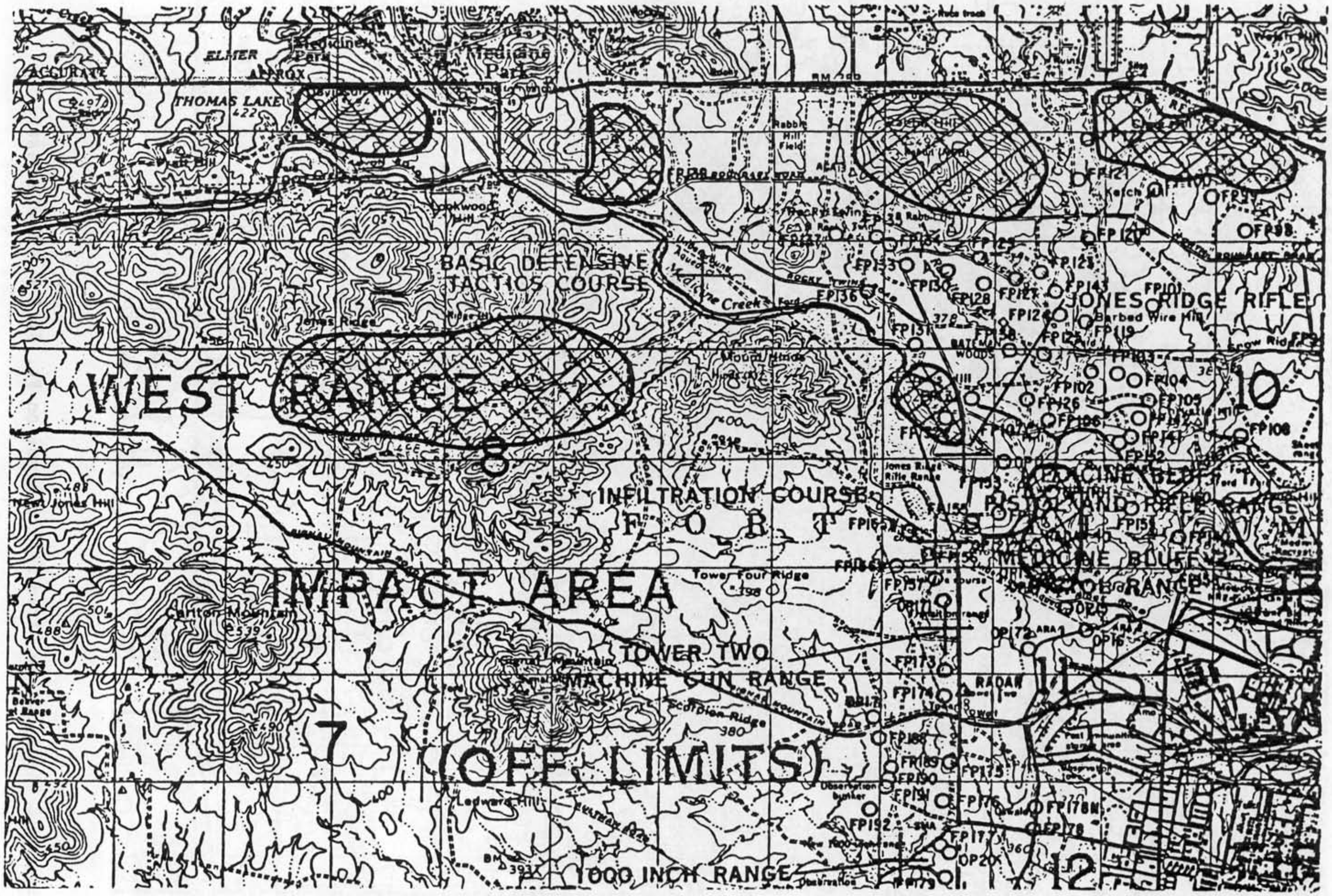


Figure 1c. Black-capped Vireo Search Areas on Ft. Sill - - North