HABITAT OCCUPANCY BY THE BLACK-CAPPED VIREO (*VIREO ATRICAPILLUS*) FOLLOWING PRESCRIBED BURNS AT KERR WILDLIFE MANAGEMENT AREA

THESIS

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By

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The Black-capped Vireo (*Vireo atricapillus*), a small, migratory passerine, was listed as a federal endangered species in November 1987. This status resulted from a sustained decline in abundance and loss of populations throughout its geographic range. One of the management guidelines in the Black-capped Vireo Recovery Plan is the use of prescribed fire to create and maintain habitat. Fire is used for the reduction and removal of Ashe juniper (*Juniperus Ashei*) and to promote low growth in deciduous shrubs for Black-capped Vireo nesting. My study examined the occupancy of pastures by Black-capped Vireos following prescribed burns at the Kerr Wildlife Management Area in the Edwards Plateau of Texas. Population (singing males) and burn records for 1986-2003 were analyzed to determine the relationship between fire regimes applied on pastures and population responses by Black-capped Vireos. My results showed that 52.6% of the prescribed burns resulted in population increases within the same year as the burn and

92.1% within 2 years post-burn. The overall population trend showed a 20-fold increase in singing males. A trend analysis indicated that 81% of the increase in the number of singing males can be attributed to the prescribed burn regime. An ANOVA showed differences in burn frequencies did not generate the increase in Black-capped Vireo pasture densities. Based on the documented increases within each pasture, however, prescribed fire is recommended as an important management tool to maintain the random interspersion of shrubby, deciduous vegetation, which the Black-capped Vireo selects for breeding territory.

INTRODUCTION

Background on the Black-capped Vireo

The Black-capped Vireo (hereafter BCV or vireo), *Vireo atricapillus*, is a small, migratory passerine that historically occupied a geographic range extending from central Kansas south through central Oklahoma and Texas and into Mexico (Fig. 1). This species winters on the west coast of Mexico and returns to northern Mexico and the south-central United States to breed and nest in spring and summer. The BCV is now extirpated from Kansas but remains in Oklahoma and Texas (USFWS 1991). In Oklahoma, the species is restricted to 3, disjunct populations with the largest situated in the Wichita Mountains (Hamilton 1990). The vireo's abundance has declined also in Texas where it occupies habitat in the Lampasas Cut Plains, Edwards Plateau and southeastern Trans-Pecos regions (Campbell 1995) (Fig. 2). The primary breeding habitat in Texas occurs in the Lampasas Cut Plains and Edwards Plateau. The BCV was listed as a federal endangered species in November 1987 because of a sustained decline in abundance and loss of populations throughout the geographic range from the 1950s through the 1970s (Ratzlaff 1987).

The characteristic habitat of the BCV contains a random interspersion of shrubby vegetation of various woody species on moderate to rough topography. Territorial males require 2 - 4 ha of habitat. Relatively large, continuous areas of shrubby vegetation with limited edge effect provide optimum habitat (Graber 1961). Preferred habitat for

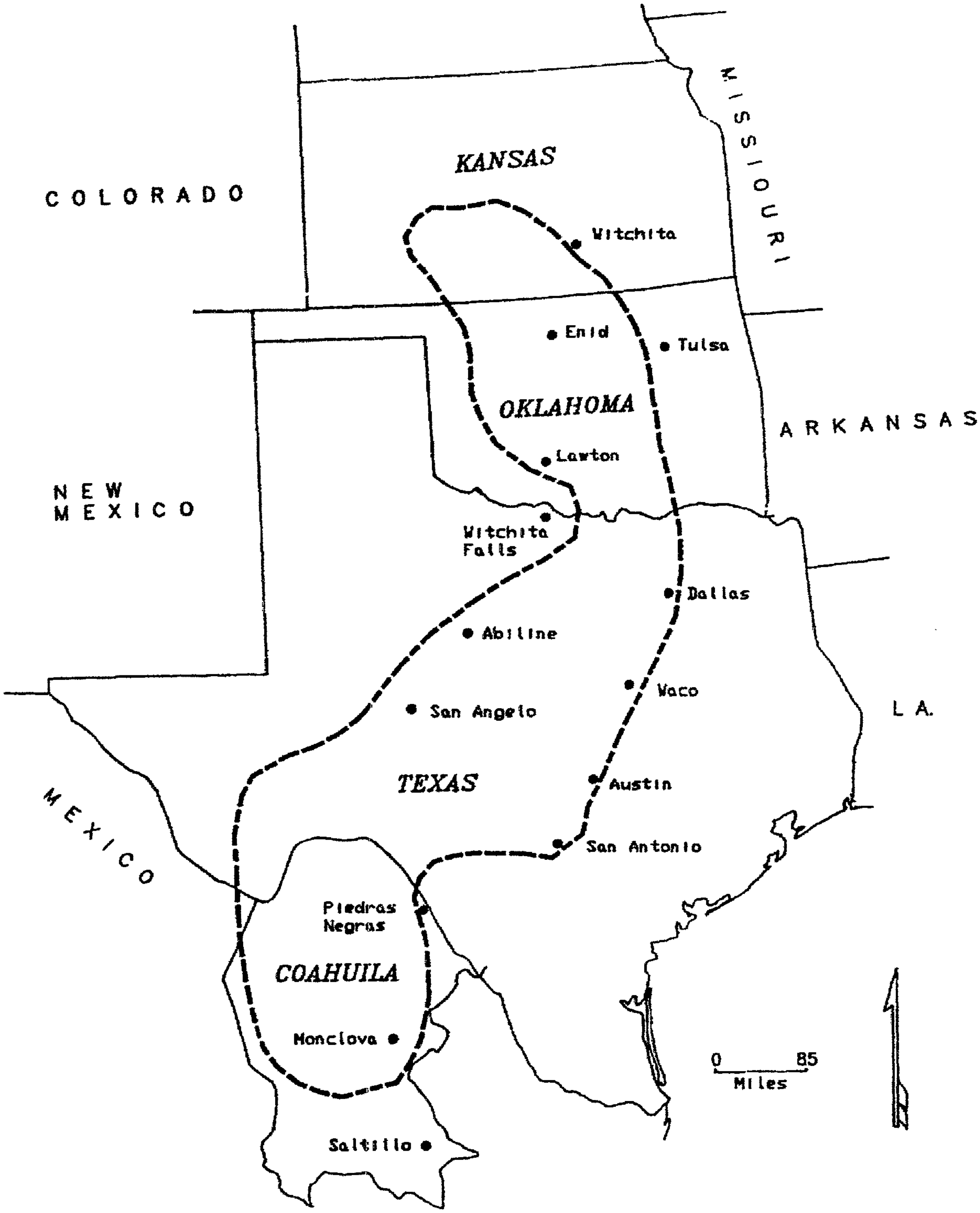


Figure 1: Historical breeding range of the Black-capped Vireo. Reprinted from the BCV Recovery Plan (USFWS 1991) and based on information from Graber (1961).

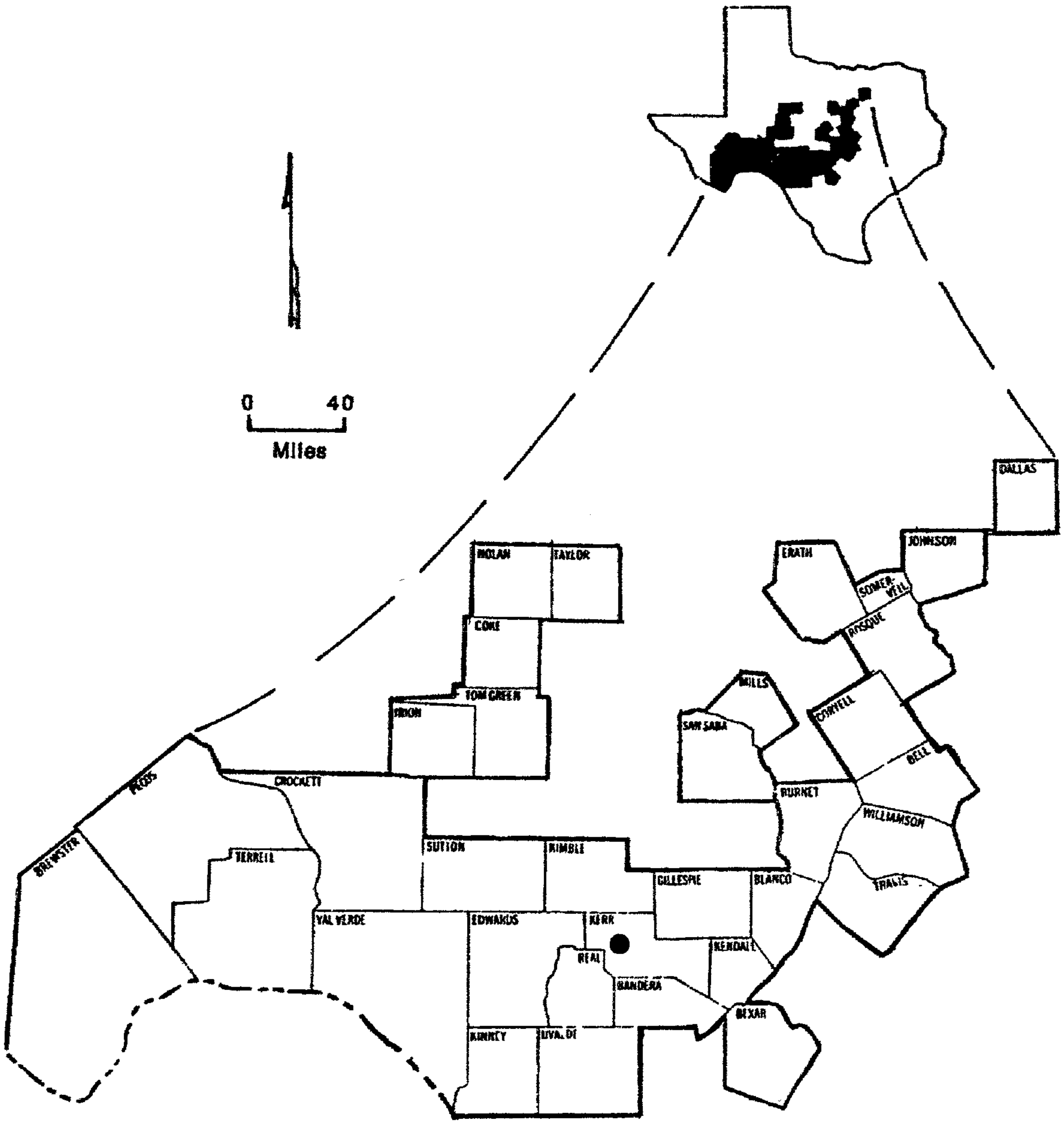


Figure 2: Counties in Texas with Black-capped Vireo populations. The study area location, Kerr Wildlife Management Area, is indicated within Kerr County. Reprinted from the BCV Recovery Plan (USFWS 1991) and Sexton (1990).

nesting consists of low-growing shrubs about 3 m in height with lateral branches extending out at ground level for concealment of nests. Excessive amounts of Ashe juniper (*Juniperus ashei*) is undesirable (USFWS 1991).

The decline in abundance and distribution of the BCV can be attributed directly to habitat loss. Several factors contributed to the loss of BCV habitat. The suppression of fire on rangeland and overgrazing as ranching emerged as the dominant land use in the late 1800s led to successional changes in the growth form of vegetation from a low shrub-grassland community to a more advanced seral stage of large shrubs and early trees. Because of these factors, nesting habitat for the species diminished (USFWS 1991). Graber (1961) recognized the importance of fire in maintaining BCV habitat and documented the species occupancy on burn sites. She advocated that the burning practiced by the Plains Indians probably aided in the dispersal of this species.

Nest parasitism by the brown-headed cowbird (*Molothrus ater*) is responsible for compounding population losses of the BCV (USFWS 1991). Grzybowski (1991) documented an average parasitism rate of 77% over a 3 year period at the Kerr Wildlife Management Area (KWMA) in the 1980s. With successful trapping and removal of *M. ater*, the parasitism rate on BCV nests dropped to 18%. It is widely accepted that any management plan to aid the abundance and distribution of the BCV must include removal of cowbirds.

The Use of Prescribed Fire in Black-capped Vireo Habitat Management

The successional changes resulting in habitat loss for the BCV occurred at the landscape level. The restoration of BCV habitat to a lower seral stage of the plant community can be achieved economically through prescribed fires. Graber (1961) found that a prescribed burn resulted in deciduous growth at the proper height for BCV nest concealment within 3 years. At Fort Hood, Texas, appropriate growth of foliage for nesting habitat occurred within 3-5 years following a burn and remained so for as long as 30 years (Tazik et al. 1993). Vegetational parameters suggested for BCVs are woody cover of 30 to 60% with Ashe juniper less than 10% where deciduous growth is abundant (USFWS 1996). Grzybowski et al. (1994) suggested that hot prescribed burns would probably be most effective in reaching this goal, although cool burns were also recommended as an important tool to inhibit succession.

Management guidelines for prescribed burns in BCV habitat were thoroughly reviewed at a BCV Population and Habitat Viability Assessment (PHVA) workshop held in Austin in 1995. At this workshop, fire suppression was named as a cause of loss of BCV nesting habitat. Scientists participating in this workshop outlined the benefits of prescribed burns with an interval of 4 to 10 years generally considered desirable to limit Ashe juniper invasion and allow regrowth of broad-leaved shrubs. It was also noted that burns should be monitored to identify the appropriate frequency of application at various locations across vireo summer range (USFWS 1996). This was considered important from the standpoint that managing for the maximum amount of BCV habitat available in any one nesting season is a primary goal. To achieve this, it became necessary to understand the timing between a burn and the reoccupancy of the burned site.

The BCV recovery plan stated that the issue of occupancy following a burn had not been thoroughly documented and would likely differ throughout the species' range. In the Wichita Mountains, BCVs reinhabitated burn sites 2 years following a burn (USFWS 1991). O'Neal et al. (1996) conducted a study on effects of cool burns on BCV habitat between 1993 - 1995 at KWMA and documented an increase in the number of post-burn territories. One pasture had a decrease in the number of territories in the second year following the burn. In addition, another pasture showed a decrease in territories in the year following the burn before rebounding. These data suggested that further study of the burn time and reoccupancy was warranted. Koloszar and Horne (2000) evaluated the effects of fire on vegetative growth at Fort Hood and used a model to predict BCV reoccupancy in burned areas. The model predicted 72% of the area would have appropriate BCV habitat within 3 years postburn.

KWMA was purchased by the state of Texas in 1950. At that time, Ashe juniper was the dominant woody species. As a result, it was speculated that "the presence of BCVs was highly unlikely" at the time of purchase (Armstrong, personal communication; TPWD 2002). KWMA began conducting prescribed burns to control juniper in 1979. Since then, pastures have been burned on an as needed basis (Armstrong, personal communication). As a result, the woody plant composition that now exists at KWMA is conducive to habitation by the BCV.

The objectives of my study were to determine the time of post-burn reoccupancy of burned pastures at KWMA by BCVs and examine the effect of time intervals between burns for pastures. My findings will be used to determine the effectiveness of fire as a

BCV habitat management tool and assist in developing effective burn schedules and practices for both KWMA and other areas with BCV territories.

Based on accounts of reoccupancy post-burn at Fort Hood and the Wichita Mountains National Wildlife Refuge, I expected pastures would be fully recolonized by BCVs within 2-3 years post-burn (Grzybowski 1991, Tazik et al. 1993, Koloszar et al. 2000). It is possible that a pasture may show a decline in numbers post-burn (O'Neal 1996). It is not expected, however, for this decline to be permanent or to show a decreasing, pre-burn population over time.

The BCV PHVA workshop panel (1995) recommended that burn frequency within BCV habitat be studied. In addition, members of this workshop recommended a 4-10 year interval for burns based on time needed for Ashe juniper to re-invade an area and for the deciduous foliage required for nesting to develop. My study examined variation in population numbers from year to year and in relation to frequency of burns. Analysis of the records at KWMA and data compiled is expected to produce a pattern of re-occupancy following burns which can be utilized as a tool for BCV habitat production and management.

STUDY AREA

Historically, the KWMA was a grassland. Encroachment by man and livestock, however, caused a succession towards a shrubland with encroachment by Ashe juniper, known in central Texas as cedar brakes (Armstrong, personal communication). KWMA was purchased by the Texas Parks and Wildlife Department in 1950 for White-tailed deer (*Odocoileus virginianus*) management and research. Located in Kerr County (Fig. 2) near Hunt, Texas, KWMA consists of 2,628 hectares (6,493 acres) at the head of the North Fork of the Guadalupe River in the Edwards Plateau. Geology underlain by limestone is characteristic (TPWD 1998). The elevation is at about 609.6 meters (2,000 feet). Rainfall is moderate with an average of 76.2 centimeters (30 inches) per year (O'Neal et al. 1996).

Primary woody vegetation consists of various oak species, including live oak (*Quercus virginiana*), white shin oak (*Q. durandii*), Texas oak (*Q.buckleyi*), and Ashe juniper (TPWD 1998). The shin oak is utilized as an indicator species for ecosystem health. Texas redbud (*Cercis canadensis*) and flameleaf sumac (*Rhus copallina*) have become a more common motte component in pastures treated with prescribed burns. Forbs in this landscape are common but vary with rainfall (Armstrong, personal communication). Grasses include Texas wintergrass (*Stipa leucotricha*), little bluestem (*Schizachyrium scoparium*), and big bluestem (*Adropogon geradii*) (O'Neal et al. 1996).

Historically, fauna consisted of bison, antelope, prairie chickens, bears, and wolves. Today, white-tailed deer and cattle graze KWMA. There are 191 avian species documented. The BCV is only one of the endangered avian species on the property. The Golden-cheeked Warbler (*Dendroica chrysoparia*) is also an inhabitant (Armstrong, personal communication). The brown-headed cowbird parasitizes the nests of both species.

KWMA managers realized through research that deer were more successful in oak pastures than in cedar brakes because Ashe juniper is comparatively low in protein. In 1972, however, Ashe juniper continued to re-establish despite previous attempts to control it. In addition, the expense of removal procedures increased. As a result, in 1979 the KWMA discontinued fire suppression. A routine of prescribed burns was established to manage Ashe juniper. In addition, a policy of management for oak and other browse leaf growth versus one of fruit / acorn production was established. These practices had the effect of producing conditions conducive to habitation by the BCV (Armstrong, personal communication).

KWMA consists of 33 pastures (Figs. 3 and 4). Smaller pastures, Plots 1 – 10, are used for studies involving white-tailed deer, exotics, sheep, goats, and lyme disease. Spring, Spring Trap and Redwine pastures are not treated with fire but are left as cedar brakes for habitation by the golden-cheeked warbler. The pastures containing BCV habitat are East, Middle and West Bobcat, East and West Buck, North and South Doe, East and West Fawn, East and West Love, Middle Trap, North and South Owl, Rabbit Trap, River, North, Middle and South Rock, East and West Turkey and West Trap.

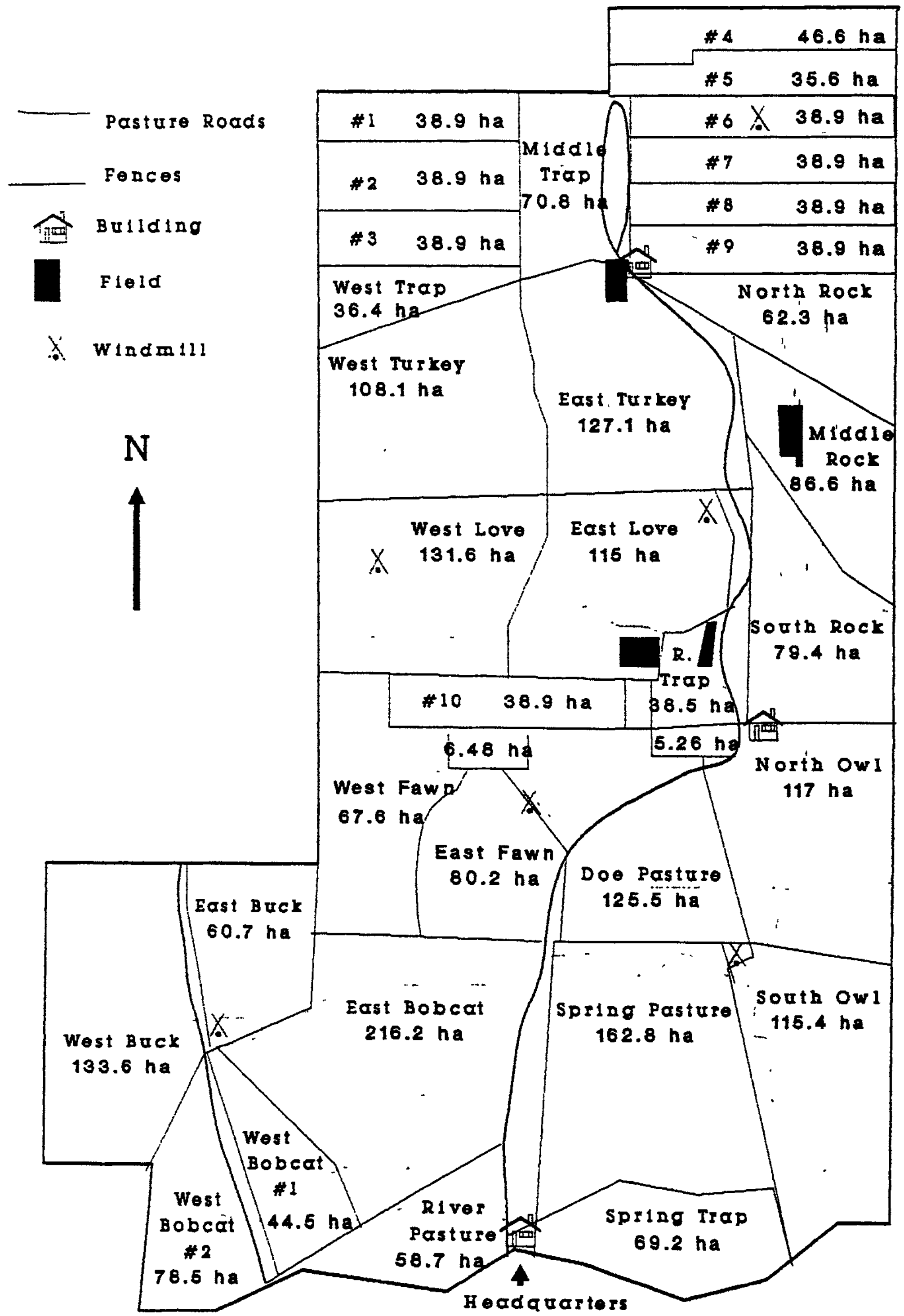


Figure 3: Map of the pastures at Kerr Wildlife Management Area, including names and pasture sizes in hectares.

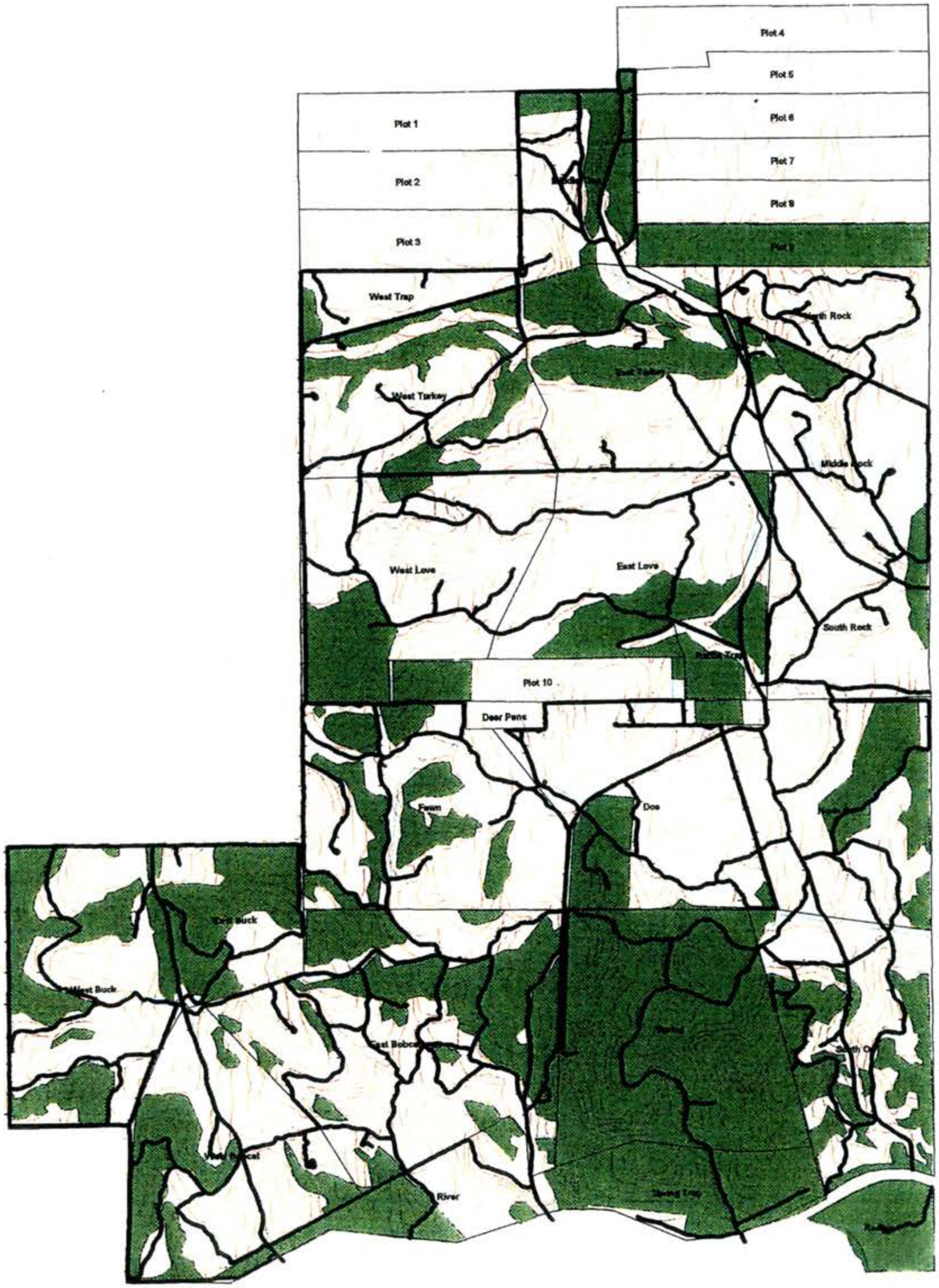


Figure 4: Map of the pastures at Kerr Wildlife Management Area, showing topography, roads and areas occupied by Ashe juniper (colored in green). Provided by Bill Armstrong from the GIS database at KWMA.

METHODS AND MATERIALS

KWMA Management Practices: Prescribed Burns

The primary method used for burning pastures at the KWMA has been headfires. Headfires are high-intensity fires that move quickly with the direction of the wind. They reach high temperatures and as a result, are an effective means of Ashe juniper removal and control. Headfires also tend to increase grass production by setting back the plant community to an earlier successional stage (Baccus, personal communication; Bidwell 1990). Fine fuel loads have varied through the years. Burns were not conducted at the Area in 1985, 1990, or 2001 because of drought conditions. Today, about 20% (324-405 ha or 800 – 1,000 acres) of KWMA is burned annually using cool season / winter burns in January and February (Armstrong, personal communication).

KWMA Management Practices: Black-capped Vireo Surveys

During BCV surveys at KWMA, about 20 individuals are teamed and assigned to pastures to conduct counts over a 1 week period. Pasture counts are conducted to estimate the number of singing males. Males are assumed to have a mate, but females are not included in counts. Data are compiled by 1 to 3 individuals walking point count transect lines in a particular pasture. Transects are selected according to topography and past BCV presence. Surveyors stop every 300 m along the line to listen and count birds.

One surveyor has past experience on a specific line. If inexperienced surveyors are involved, they accompany an experienced individual. Additional survey data are collected by skilled individuals in portions of pastures with BCVs but having no transect line. Following data collection by transect and individual surveys, pasture information is analyzed to determine if the present year's distribution of BCV occurrence conforms with the previous year's distribution. If a gap in the distribution is found, a skilled surveyor goes back to the site to collect post- survey data and determine the presence or absence of BCVs. A pasture count for the year is the sum of BCV numbers from transect, individual surveys and post- survey data (Armstrong, personal communication).

Data Acquisition

This study was conducted using burn data and BCV population records for KWMA as well as early population records for KMWA kept by J. Grzybowski. Several pastures are burned each year. Burn data was maintained in a computer database at KWMA. These data (Appendix A) and burn dates were organized in graphs with BCV survey data for the same pasture.

Population and distribution data for BCVs were also examined. Numerical BCV survey data has been maintained in a computer database at KWMA since 1997. Survey data for individual pastures prior to 1997 had to be researched in archived files at KWMA. Upon finding individual pasture maps from each year's survey, beginning with 1986, I counted BCV observation points and compiled individual timelines showing BCV numbers for pastures being examined (Appendix B). These same numbers were used to create line graphs showing population trends for each pasture along with burn dates. In 1992, a partial survey was conducted and individual pasture count data were unavailable.

Maps showing locations of the BCVs within each pasture were obtained from the database for 1998 and 2003. For 1986 to 1997 and 1999 to 2002 the only maps available were those kept in the files at KWMA. These were the same individual pasture maps I examined for survey data for years prior to 1997, and the same maps taken into the field by surveyors during surveys. I compiled these individual pasture maps into 1 comprehensive map of KWMA for each year, and relying on fence lines and topography to place a point for each BCV observation (Appendix C). These show locations of individual BCVs and illustrate their overall avoidance of cedar brakes.

Data on pasture sizes and number of hectares cleared of Ashe juniper were obtained from the GIS database at KWMA (Appendix D). These data were used to calculate a more accurate BCV population density per pasture.

Data Analysis

A total of 12 line graphs, 1 for each pasture, was prepared to examine the population trend following a prescribed burn (Figs. 6-17). The graphs show numbers of singing males per year and indicate each year a pasture was burned. Only 12 of the pastures were studied. Plots 1-10 that are used for many different experimental studies were not examined because of the different treatments these pastures receive. In addition, pastures maintained as cedar brakes for golden-cheeked warblers were not examined.

The number of male BCVs and hectares cleared of Ashe juniper were used to calculate a BCV crude and ecological densities for each pasture. The crude density was calculated as number of singing male BCVs per total pasture hectares. The ecological density was calculated as number of singing male BCVs per pasture hectares cleared of Ashe juniper. A bar graph compared crude and ecological densities of pastures. It is understood, however, that no 2 pastures were identical in vegetational composition, topography, and as a result, overall habitat quality. To account for this, Bill Armstrong, KWMA Assistant Director and Wildlife Biologist, ranked each pasture on a scale of 1-10 based on quality of habitat. I have included these results in a bar graph and scatter-plot, comparing his rankings, based on experience, with those of the density for each pasture.

To explore a casual factor of increasing singing males in burned pastures, I conducted a trend analysis using singing male densities for pastures 1, 2 and 3 years post-burn (Appendix E). Densities were compared relative to the prescribed burn regime of 1986 – 2003. In the data set for 1 year post-burn, 1994 was an outlier. This year had an unusually high density of singing males compared to other years. Density for singing males in 1994 did not fit the model and no clear explanation is apparent other than an inadvertent error in data collection.

An Analysis of Variance (ANOVA) was conducted to determine if a relationship existed between the number of male BCVs in a pasture and frequency of burn for a pasture. In this analysis, categories for data consisted of intervals in years between burns. The four categories were the following: 1-3, 4 -6, 7-9 and 10-13 year burn frequency. Data within each group consisted of male BCV densities from the 12 study pastures. If multiple data sets for a particular pasture fell within the same burn frequency group, the most recent was used. This procedure produced a total of 23 data sets. BCV densities rather than male BCV count numbers were used to account for the differences in pasture sizes (Appendix D). In addition, since BCVs avoid nesting in cedar brakes, ecological densities were used instead of crude densities. The 23 individual data sets within the ANOVA were calculated with the following formula: density of males per pasture / density for the total area. The variance between groups (Sb^2) and variance within groups (Sw^2) were then calculated and a F value found with $dfB = 3$ and $dfW = 19$ and assuming a P value of $>.05$ (Appendix F).

RESULTS

In 1986, prior to its listing as an endangered species, only 27 BCV males were documented at KWMA. Census data on the BCVs was collected and complied by J. Grzybowski from 1986 until 1991. Beginning in 1992, BCV surveys were conducted each spring in April or May. In 2003, 445 singing males were counted at KWMA (Armstrong, personal communication). Survey trends illustrate an increase in the population at KWMA (Fig. 5)

Examination of BCV survey data and burn data showed each pasture was re-occupied within the same year of the prescribed fire. In addition, the populations within each pasture increased in BCVs in post-burn years. Many pastures had an increase in BCVs the year of the burn and most showed an increase within 1 – 2 years post-burn. A few declines were noted, but they were temporary and the pasture was fully re-colonized within 2 years post-burn. Decreases in BCVs did not result in pre-burn numbers. It should be noted that most pastures had been burned at some point in time prior to BCV surveys being conducted. These were primarily preliminary burns that were only the beginning of the Ashe juniper clearing process (Armstrong, personal communication).

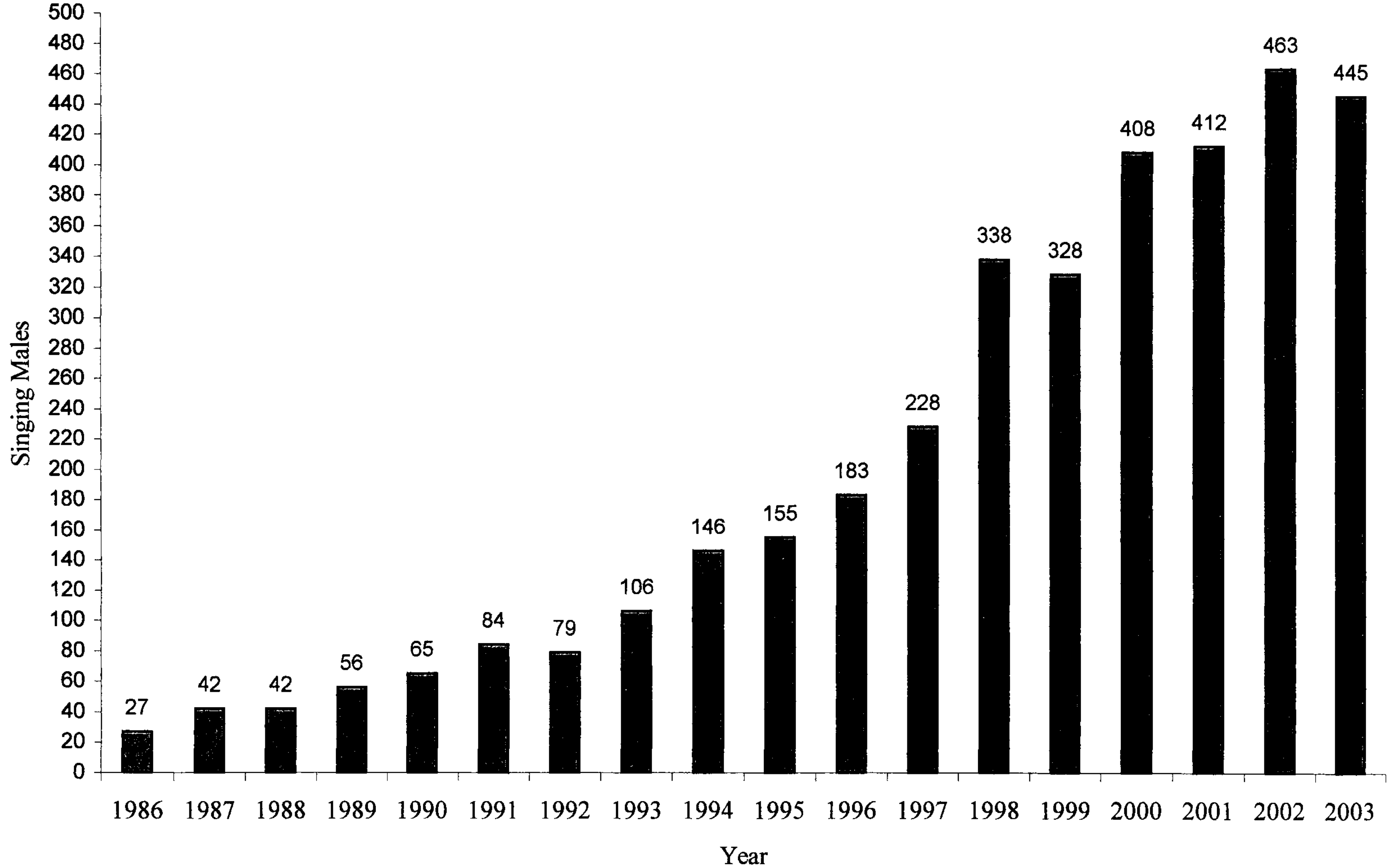


Figure 5: The Black-capped Vireo Population Trend at Kerr Wildlife Management Area

Bobcat Pasture

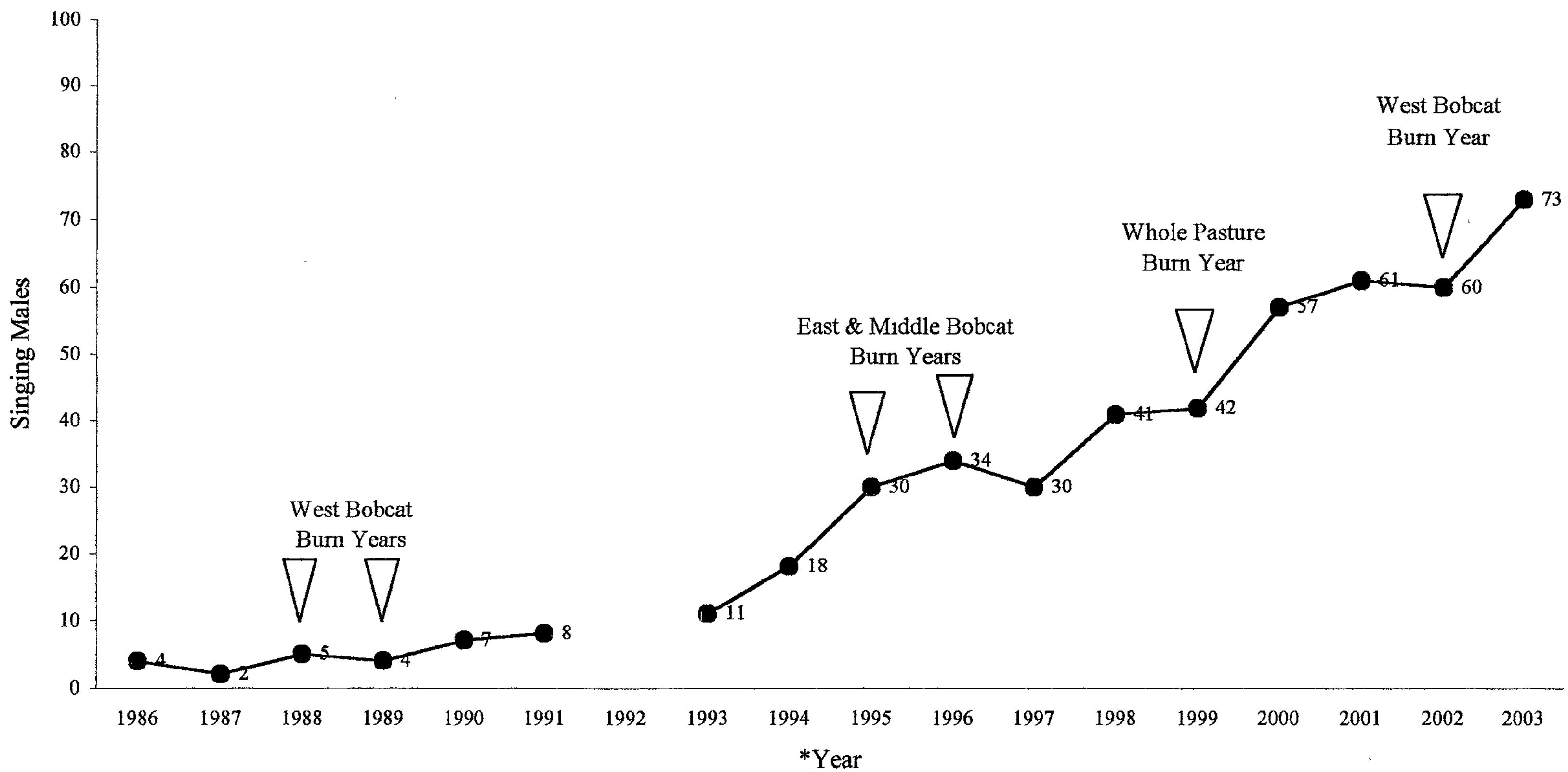
Bobcat has been burned 6 times since BCV surveys began (Fig. 6). Population trends were stable during the early burn years and began to increase in 1993. East Bobcat was burned in 1995 and Middle Bobcat in 1996. BCV numbers increased during these years. A slight decrease in number occurred in 1997, but the increase continued within 2 years post-burn. All of Bobcat pasture was burned in 1999. The following year's survey showed an increase of 15 males in the pasture. West Bobcat was burned in 2002, and the population remained stable this year. Singing male BCVs in Bobcat pasture increased from 4 in 1986 to 73 in 2003, an 18 fold increase.

Buck Pasture

Buck has been burned 3 times since BCV surveys began (Fig. 7). A burn in West Buck in 1989 resulted in a decline of 2 vireos in the year of the burn. Within 2 years post-burn, the population trend showed an increase. East Buck was burned in 1995. Numbers of male BCVs increased this year and nearly doubled within 2 years post-burn. A total pasture burn was conducted in 1999, resulting in an increase both the year of the burn and 3 years post-burn. Singing male BCVs in Buck pasture increased from 1 in 1986 to 40 in 2003, a 40 fold increase.

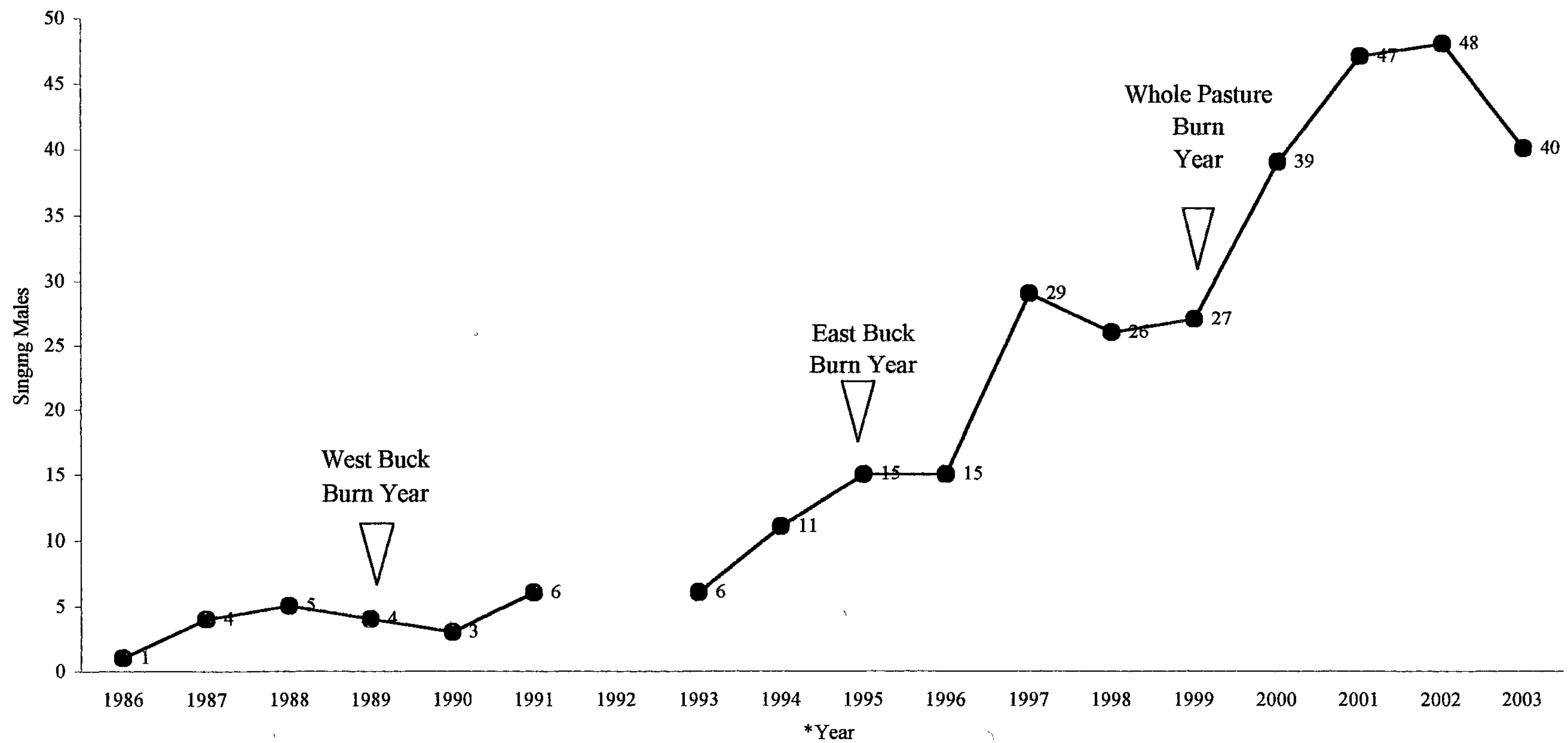
Doe Pasture

Doe has been burned 4 times since BCV surveys began (Fig. 8). The first burn in 1986 occurred with no vireos present. Four BCVs occupied the pasture 1 year post-burn, and the population trend increased up to the burn of North Doe in 1994. Numbers of



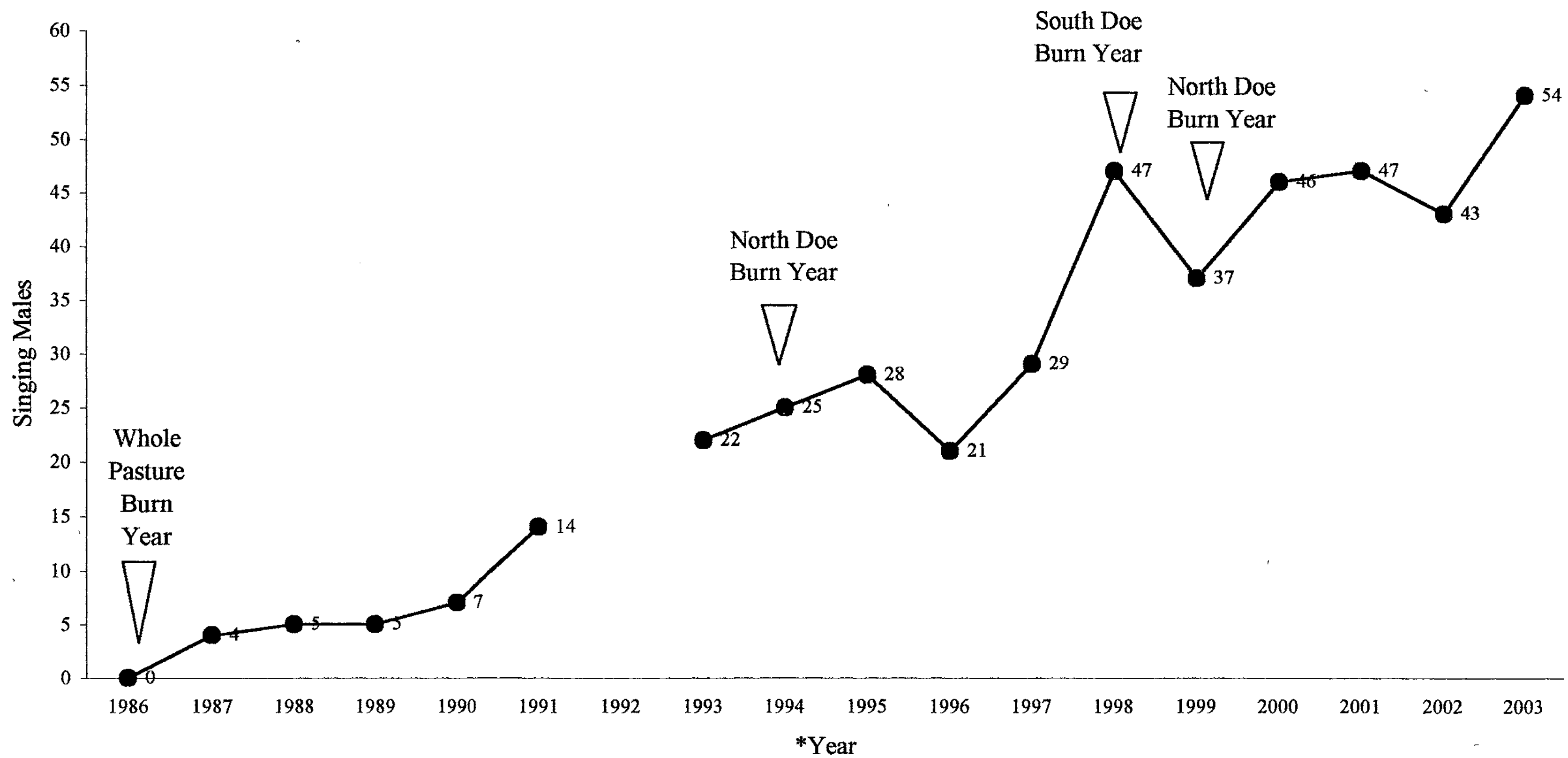
Burn prior to Area annual census occurred in 1982.
*1992 data unavailable.

Figure 6: BCV Population at Bobcat Pastures



Burn prior to Area annual census occurred in 1983.
*1992 data unavailable.

Figure 7: BCV Population at Buck Pastures



Burns prior to Area annual census occurred in 1980 and 1981.
*1992 data unavailable.

Figure 8: BCV Population at Doe Pasture

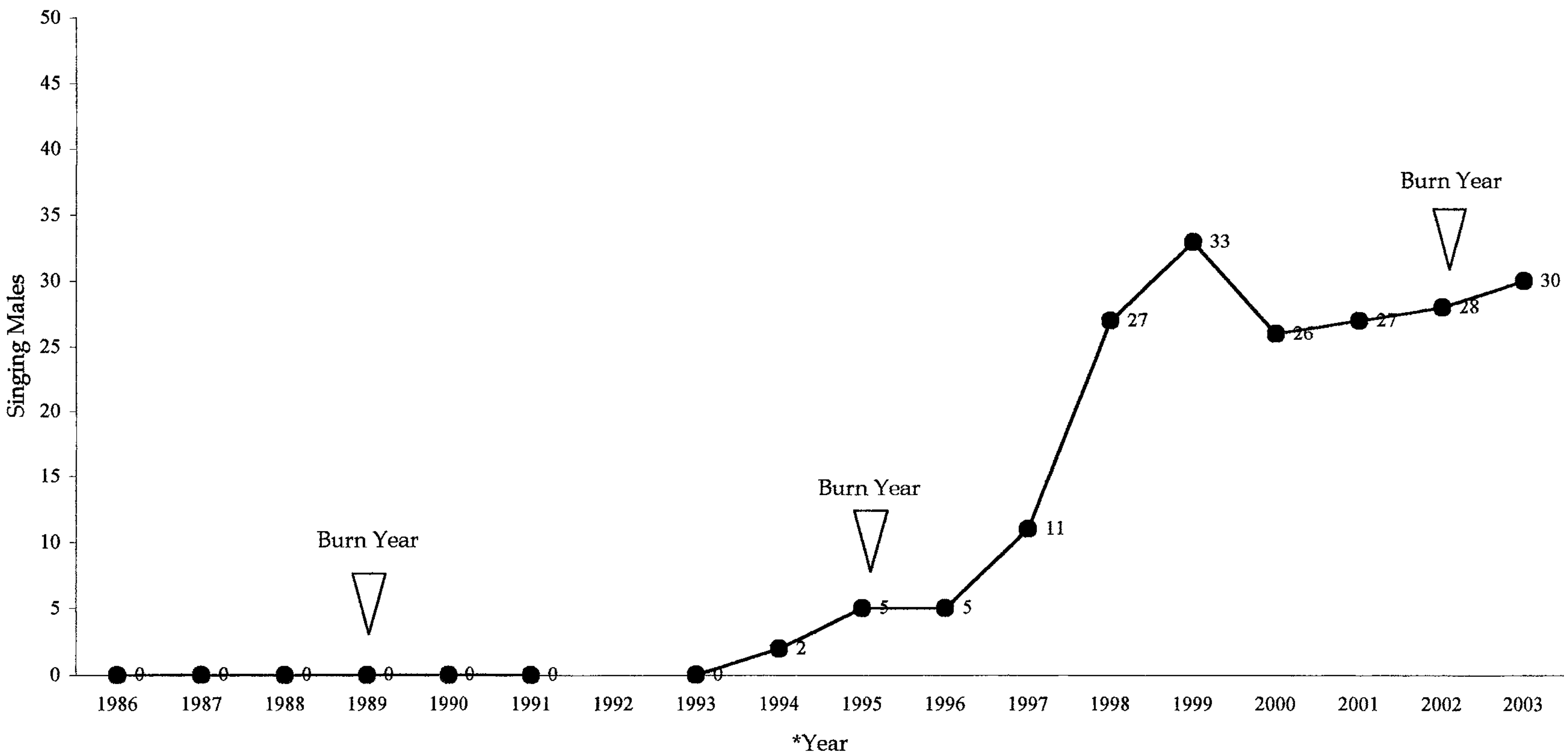
males increased the same year of this burn and the following year with a slight decrease 2 years post-burn. The population in Doe increased from 29 to 47 BCVs the same year as the 1998 burn in South Doe. The population decreased the year of the next burn in North Doe in 1999 but still stayed above the count from the previous burn year. The pasture was fully recovered within 1 year post-burn. Male numbers in Doe have increased since this last burn. Singing male BCVs in Doe pasture increased from 0 in 1986 to 54 in 2003, a 54 fold increase.

Fawn Pasture

Fawn has been burned 3 times since BCV surveys began (Fig. 9). There were no BCVs before or after the first burn. The first males were counted in 1994, 5 years post-burn. The following year in 1995, a burn was conducted. The population increased slightly the year of the burn and began to increase dramatically within two years post-burn. Fawn was treated again in 2002. The pasture exhibited relative stability with a slight increase following this burn. Singing male BCVs in Fawn pasture increased from 0 in 1986-1993 to 30 in 2003, a 30 fold increase.

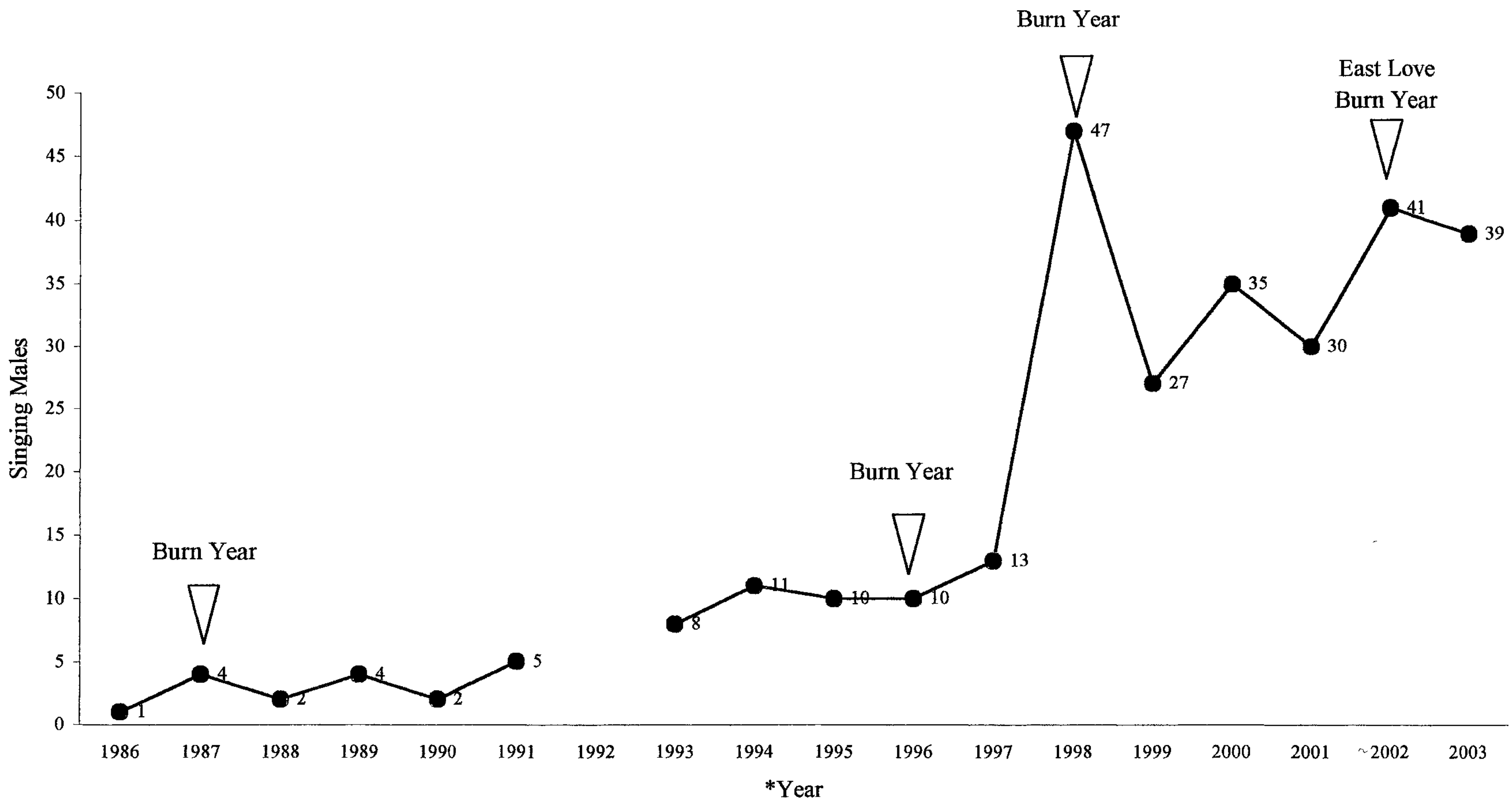
Love Pasture

Love has been burned 4 times since BCV surveys began. After the first burn in 1987, the BCV population increased from 1 to 4 post-burn (Fig. 10). In subsequent years, the population fluctuated slightly, but maintained an increasing trend. Another burn was conducted in 1996. The population remained stable with this burn. The next burn in 1998 resulted in a substantial increase from 13 BCVs the year before to 47 the



Burns prior to Area census occurred in 1979, 1980 and 1984.
*1992 data unavailable.

Figure 9: BCV Population at Fawn Pastures



Burn prior to area census occurred in 1982.
*1992 data unavailable.

Figure 10: BCV Population at Love Pastures

year of the burn. A decline in the population occurred the following year, the population fluctuated and did not regain the number of males in 1998. Singing male BCVs in Love pasture increased from 1 in 1986 to 39 in 2003, a 39 fold increase.

Middle Trap Pasture

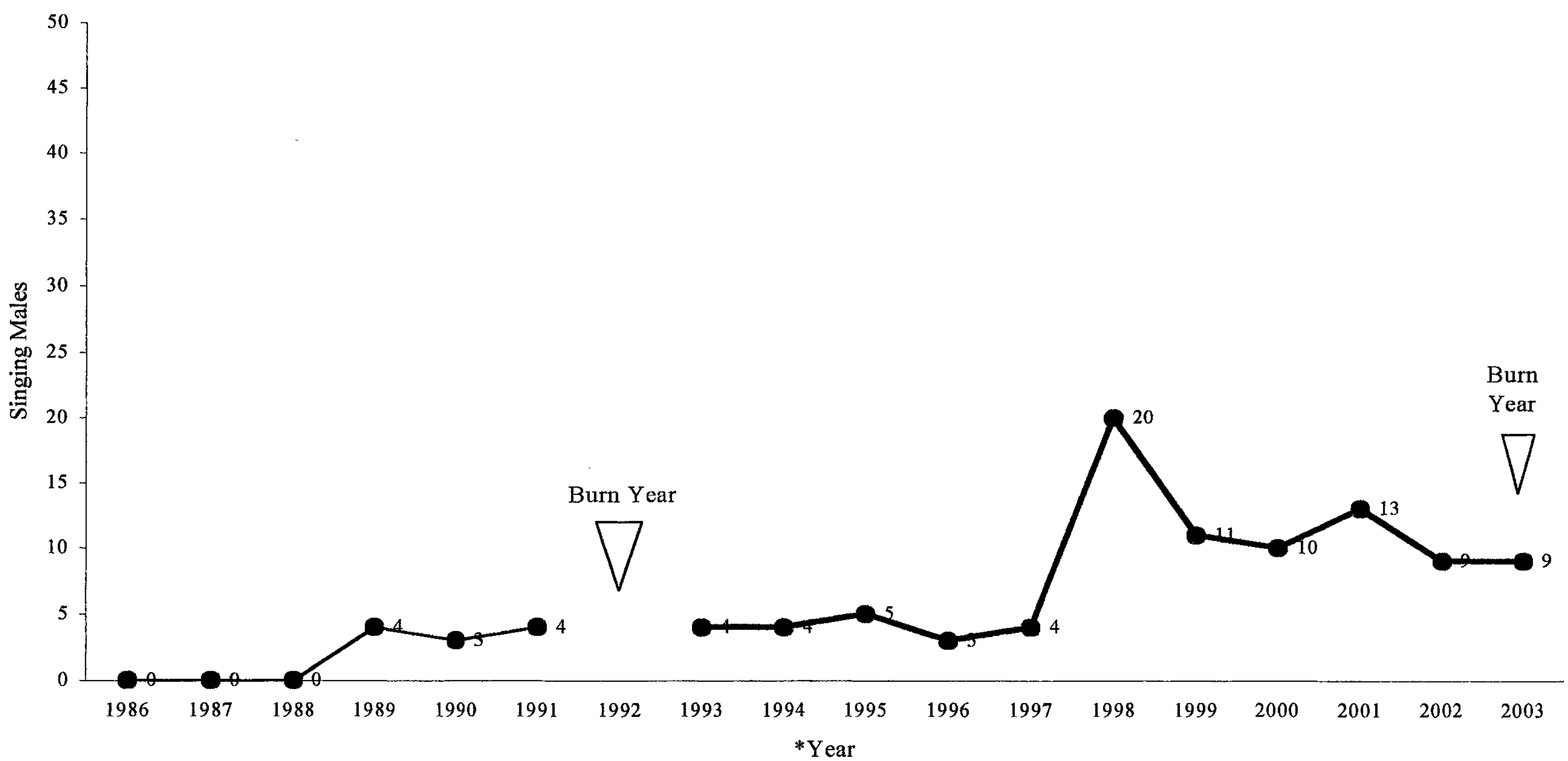
Middle Trap has only been burned 2 burned twice since BCV surveys began. The first was in 1992, the year for which individual pasture survey data is unavailable. The population trend for Middle Trap was low but stable before an increase in 1998 (Fig. 11). The trend declined but stabilized again, leading up to a burn in 2003. Singing male BCVs in Middle Trap pasture increased from 0 in 1986-1989 to 9 in 2003, a 9 fold increase.

Owl Pasture

Owl pasture has been burned 3 times since BCV surveys began (Fig. 12). The first year after the burn in 1986, no vireos were counted in surveys until 1989. The population began to increase prior to 1992 but remained unstable despite increasing for 2 years post-burn. After the burn in 1997, the population trend was upward. Singing male BCVs in Owl pasture increased from 1 in 1986 to 31 in 2003, a 31 fold increase.

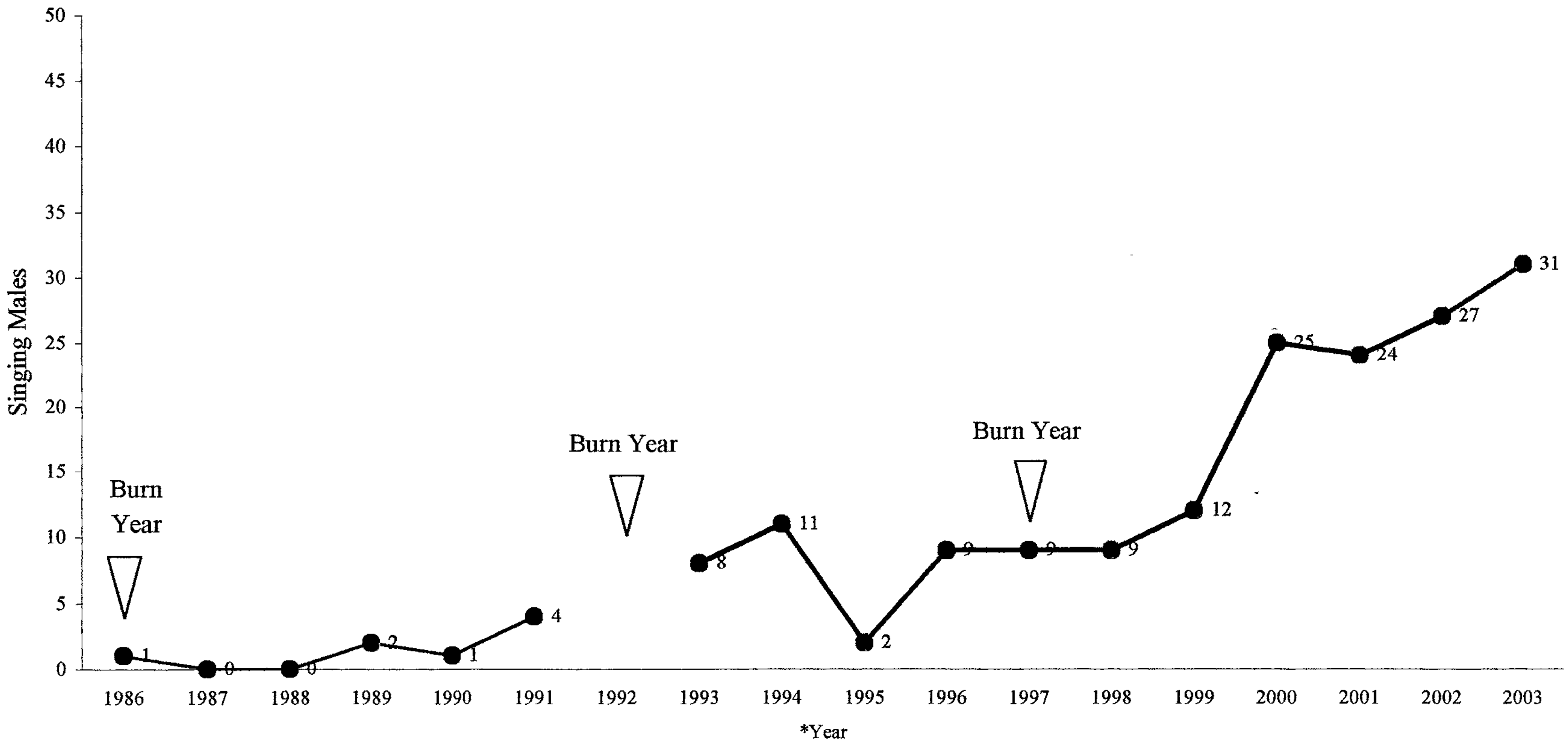
Rabbit Trap Pasture

Although this pasture was burned twice, there was little response by BCVs in this pasture (Fig. 13).



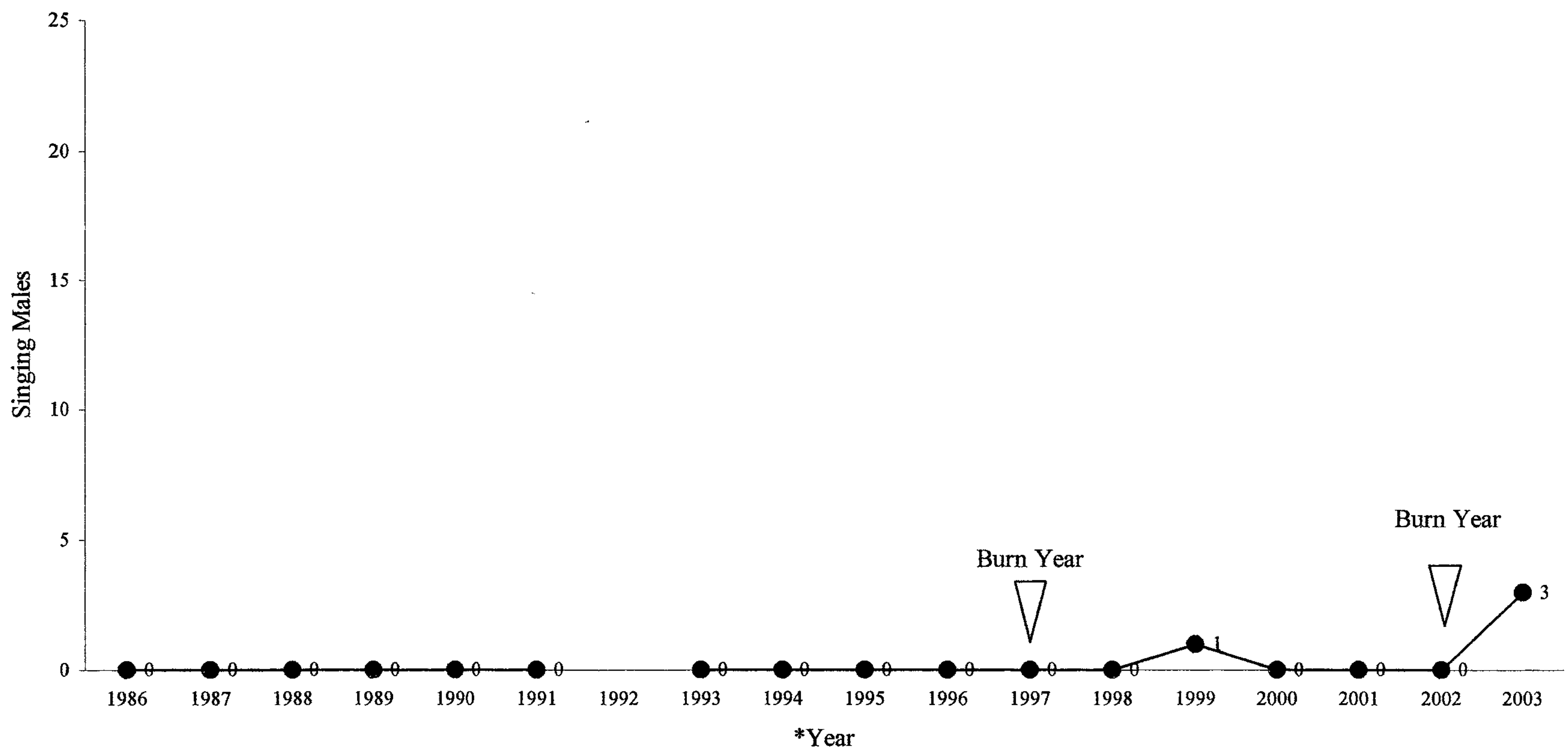
Burn prior to Area annual census occurred in 1983.
*1992 data unavailable.

Figure 11: BCV Population at Middle Trap Pasture



Burns prior to Area annual census occurred in 1980 and 1981.
*1992 data unavailable.

Figure 12: BCV Population at Owl Pastures



Burns prior to Area annual census occurred in 1982 and 1984.
*1992 data unavailable.

Figure 13: BCV Population at Rabbit Trap Pasture

River Pasture

Although River pasture was burned twice, there was little response by BCVs in this pasture (Fig. 14).

Rock Pasture

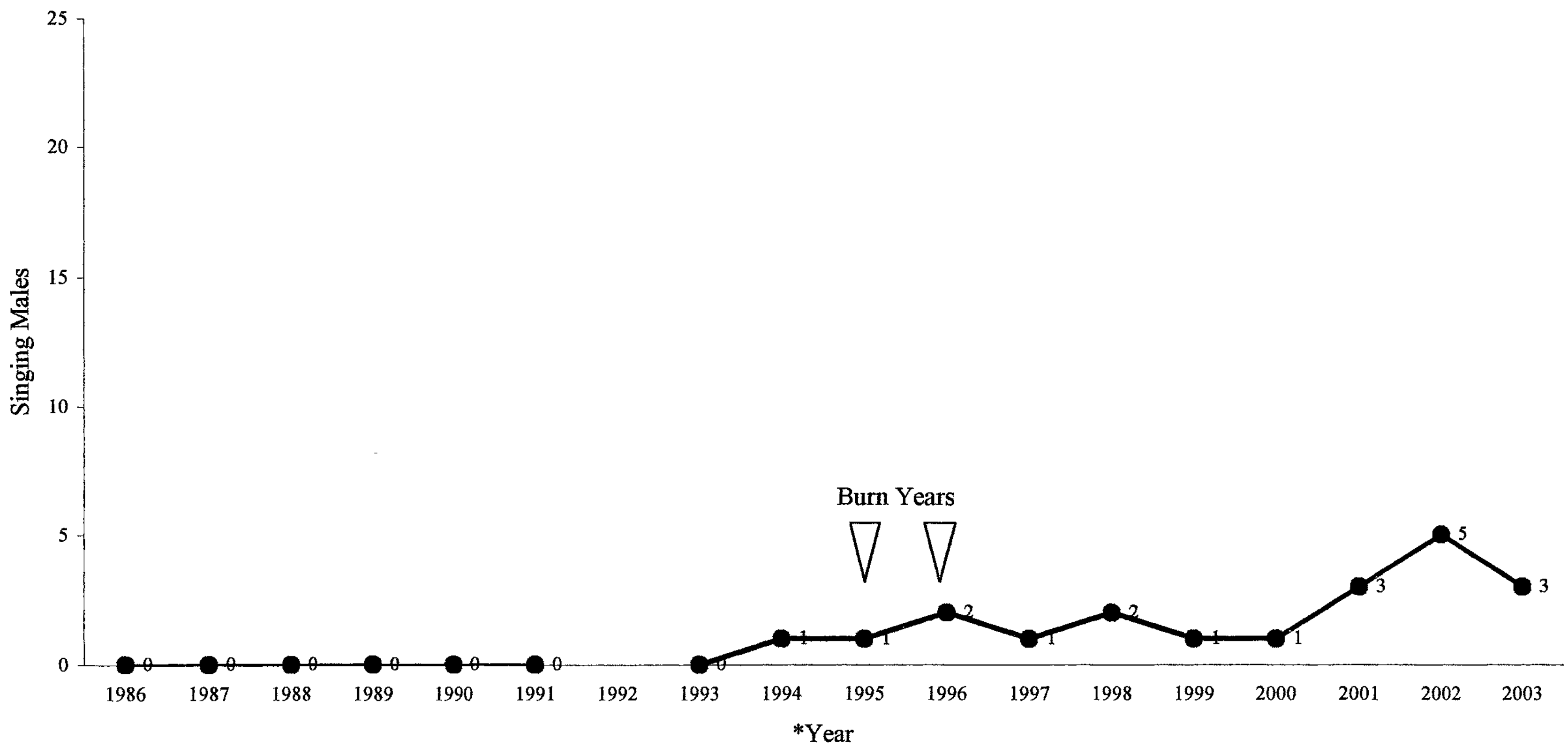
Rock pasture has been burned 5 times since BCV surveys began in 1986 (Fig. 15). The number of males showed an increase until 2002. All or part of Rock was burned for 4 consecutive years, leading to the highest number of males 5 years post-burn. A total burn of Rock in 2003 resulted in a 32% decline of males. Singing male BCVs increased from 19 in 1986 to a high of 109 in 2002, a 6 fold increase.

Turkey Pasture

Turkey has been burned 3 times since BCV surveys began in 1986 (Fig. 16). The BCV assemblage remained low in this pasture until 2 years after the first burn in 1993. The pasture was burned again in 1998. The BCV population then declined before in 2002, a burn year. Singing male BCVs in Turkey pasture increased from 0 in 1986 to 26 in 2003, a 26 fold increase.

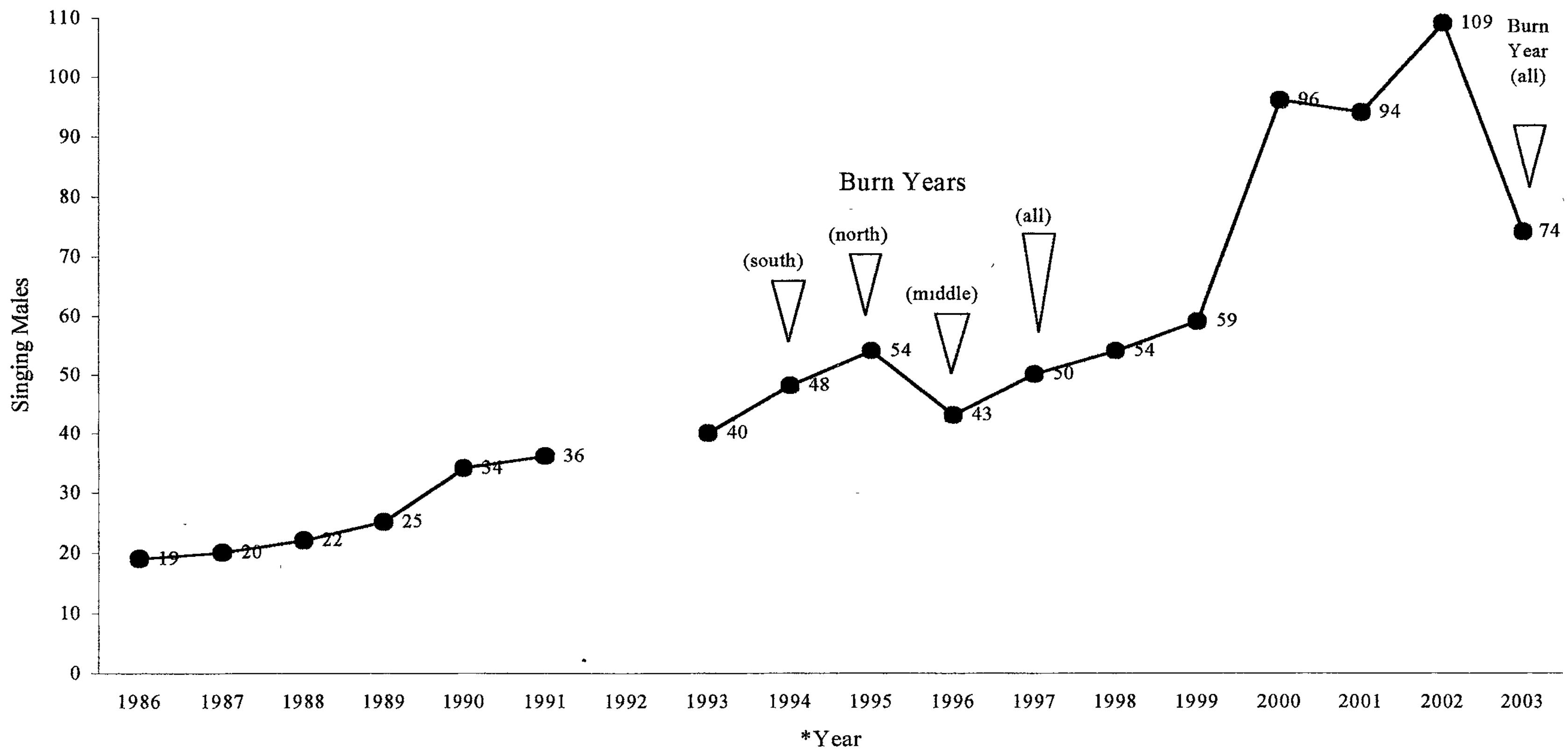
West Trap Pasture

West Trap has been burned twice since BCV surveys began in 1986 (Fig. 17). There was a variable response within this pasture. Singing male BCVs in West Trap increased from 0 in 1986-1996 to a net of 7 in 2003.



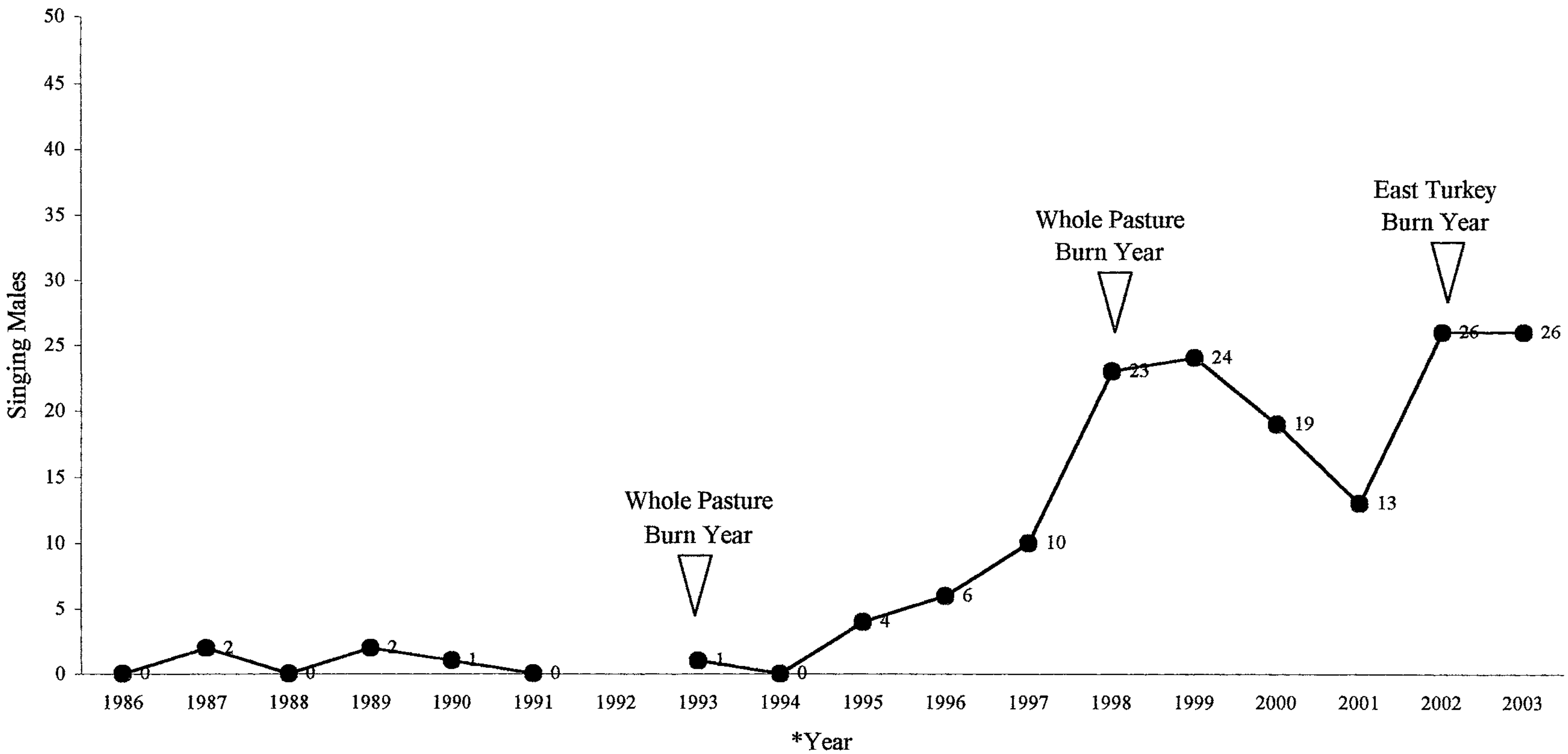
Burns prior to Area annual census occurred in 1980 and 1982.
*1992 data unavailable.

Figure 14: BCV Population at River Pasture



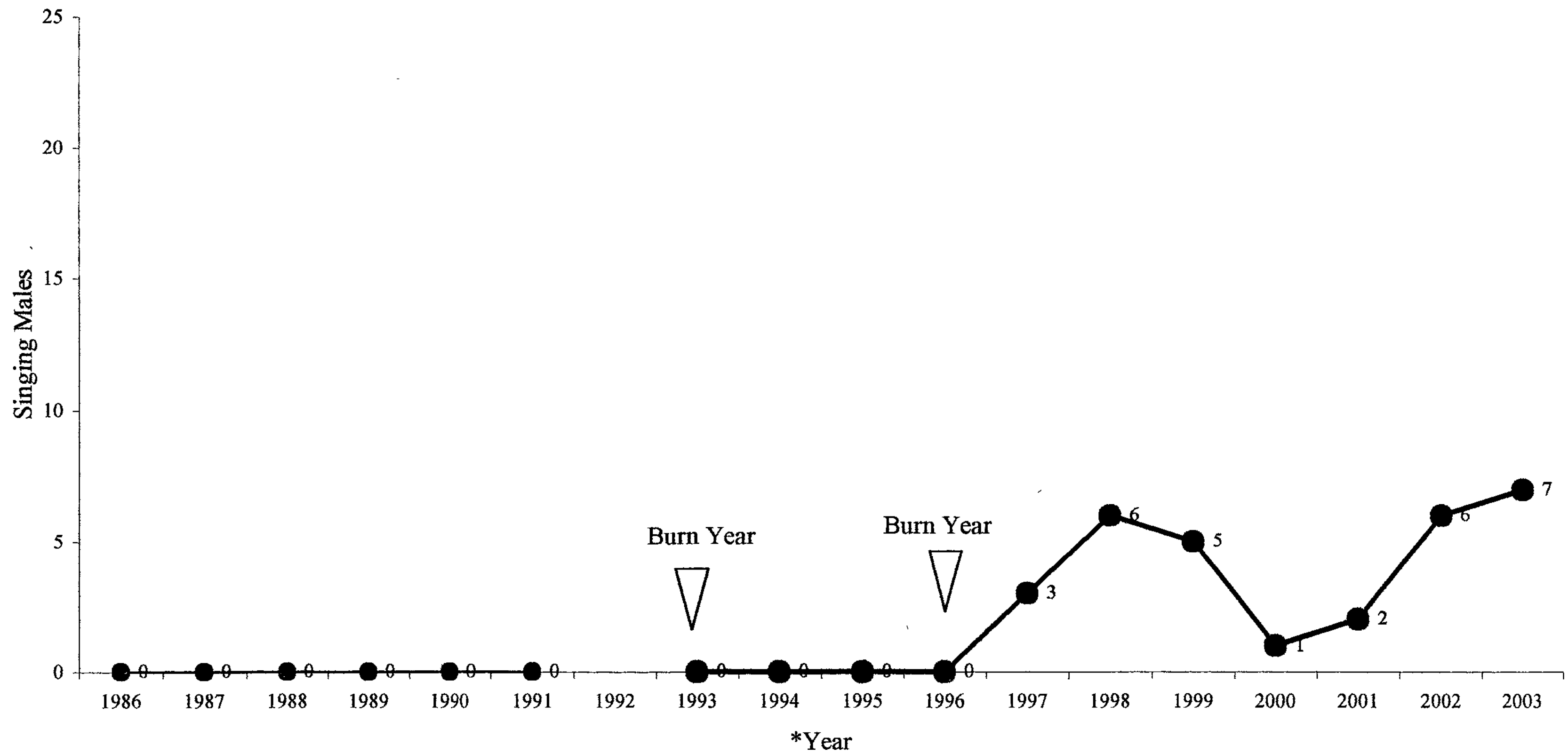
Burn prior to Area annual census occurred in 1984.
*1992 data unavailable.

Figure 15: BCV Population at Rock Pastures



Burn prior to Area annual census occurred in 1983.
*1992 data unavailable.

Figure 16: BCV Population at Turkey Pastures



Burns prior to Area annual census occurred in 1981, 1982 and 1983.
*1992 data unavailable.

Figure 16: BCV Population at West Trap Pasture

Figures 18 – 19 utilize pasture densities as a tool for analysis. Figure 18 illustrates the BCV density for each pasture versus the percent of that pasture that is cleared of Ashe juniper. Rock is 92.6% cleared and has the highest density of BCVs. Buck is only 56.7% cleared but has the second highest density. West Trap is 94.4% cleared but has one of the lower densities. Results on this graph appear to be mixed, but must be examined by taking pasture vegetational composition into account.

In order to account for differences in pasture habitat quality due to vegetation, topography, etc., Bill Armstrong, KWMA Assistant Director and Wildlife Biologist, was asked to rank habitat quality based on his experience working on the Area. The rankings occurred on a scale of 1-10 with 1 being the lowest quality of habitat for BCVs. Mr. Armstrong was not aware of calculated densities prior to his questioning. These pasture rankings were compared to the BCV density within each pasture in Figure 19. Pastures receiving the highest habitat quality rankings also consistently had the highest densities.

The relationship of the burning regime at KWMA and change in density of singing males was further explored through a trend analysis (Fig. 20 – 22). This analysis showed a substantial increase in singing males at KWMA concurrent with the burning regime used from 1986 through 2003. The model for 1 year post-burn indicated that 81% of the increase in the number of singing males might be attributed to the burn regime. The other 19% would be attributed to management factors such as cowbird control, deer herd management, grazing schedules for domestic livestock or some other factor. The model for 2 years post-burn indicated that 78% of the increase in the number of singing males might be attributed to the burn regime. The model for 3 years post-burn indicated that 67% of the increase in singing males might be attributed to the burn regime.

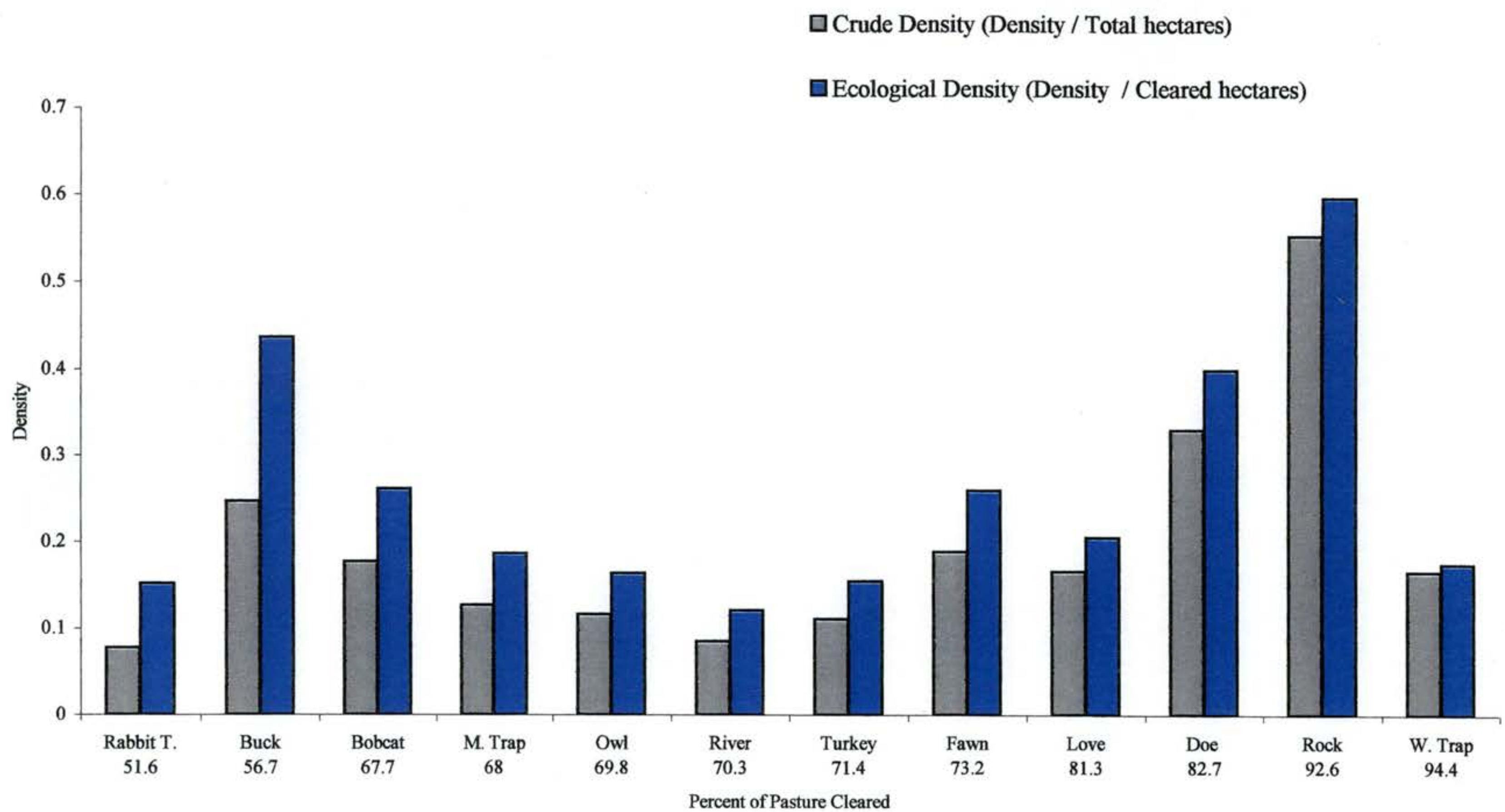
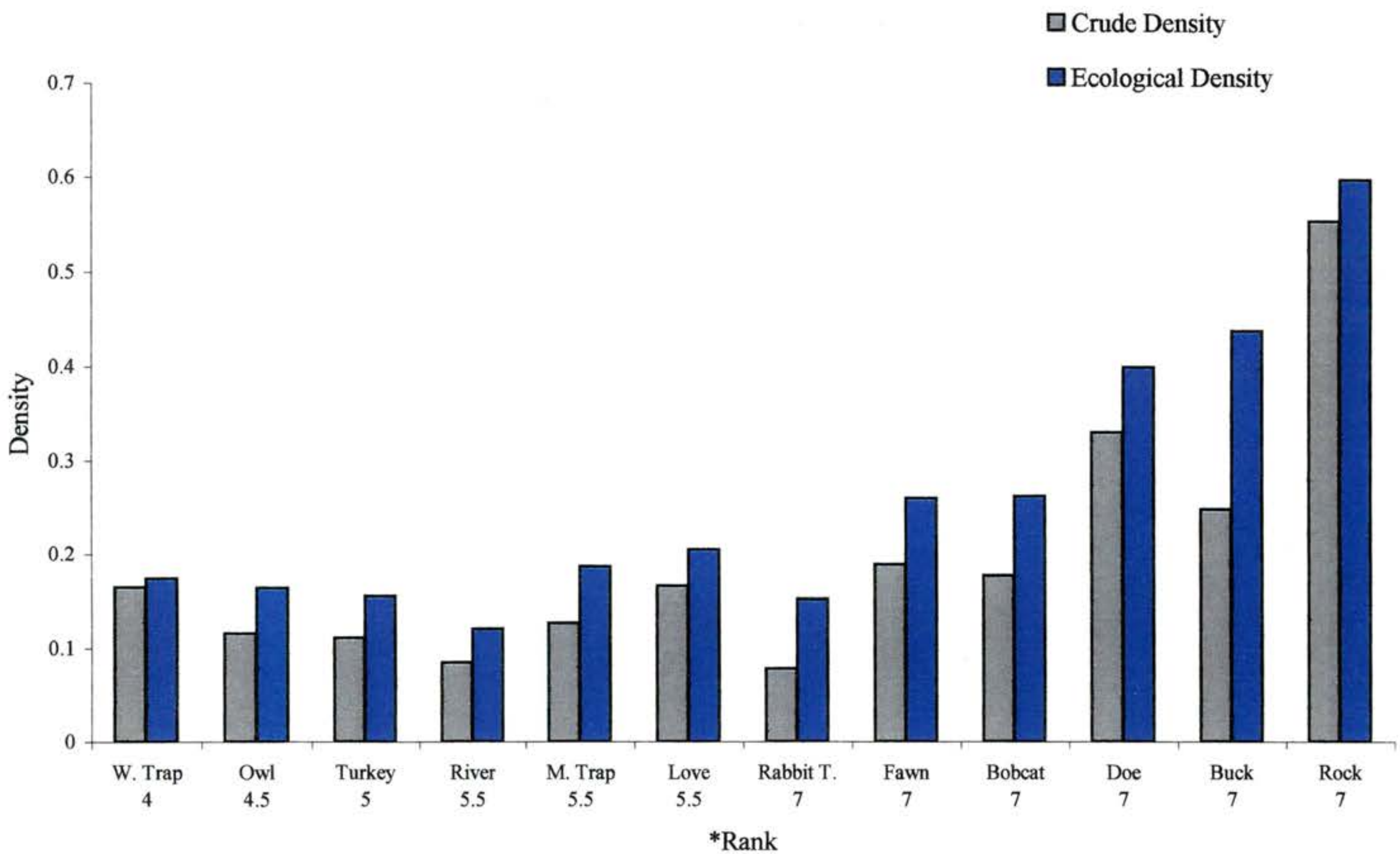
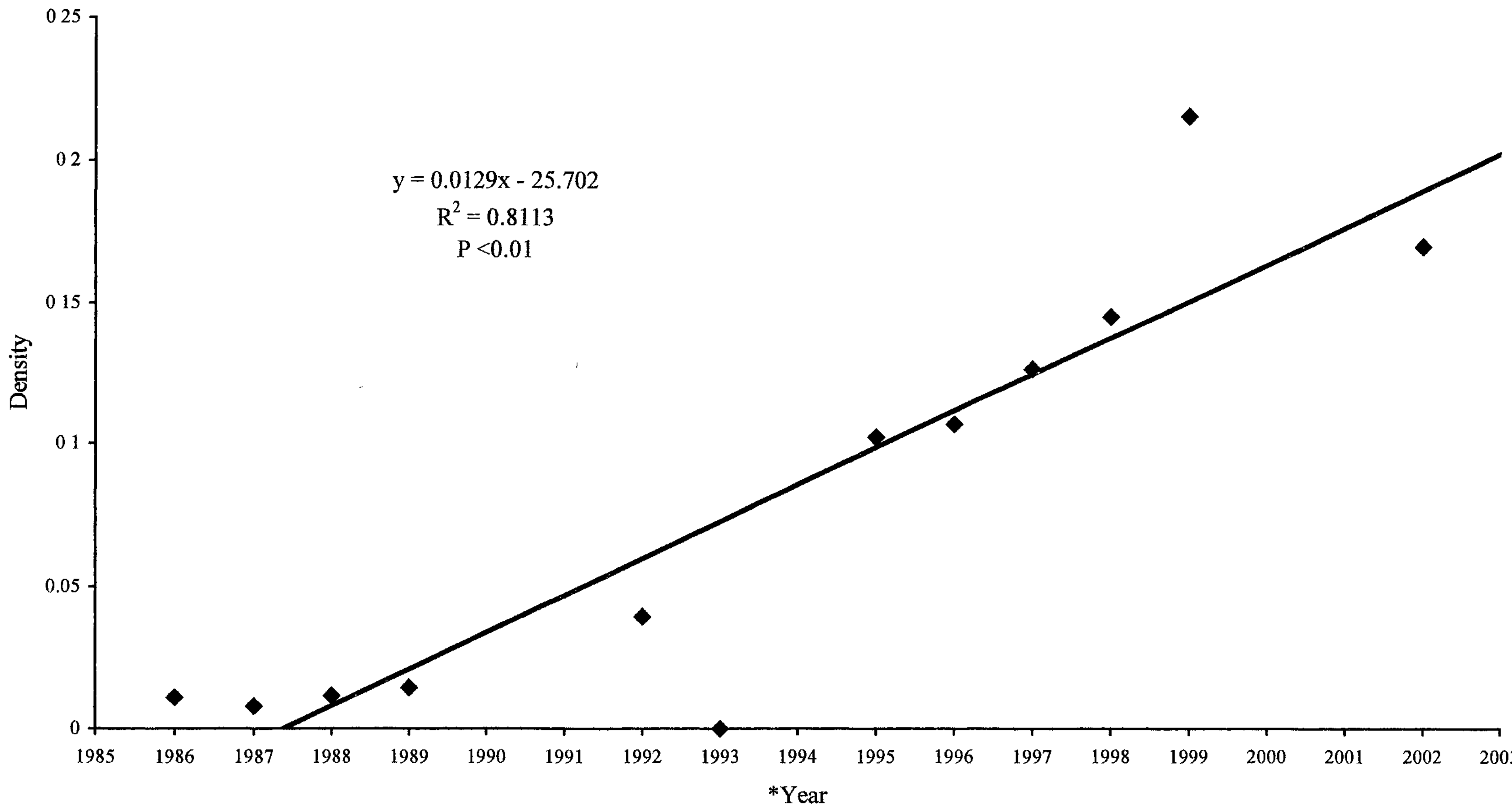


Figure 18: BCV Density vs. Pasture hectares



*per Bill Armstrong of KWMA

Figure 19: BCV Population Density vs. Rank of Habitat Quality within Pasture



*1994 was excluded as an outlier.

Figure 20: Trend Analysis of Male BCV Density 1 year post-burn at KWMA

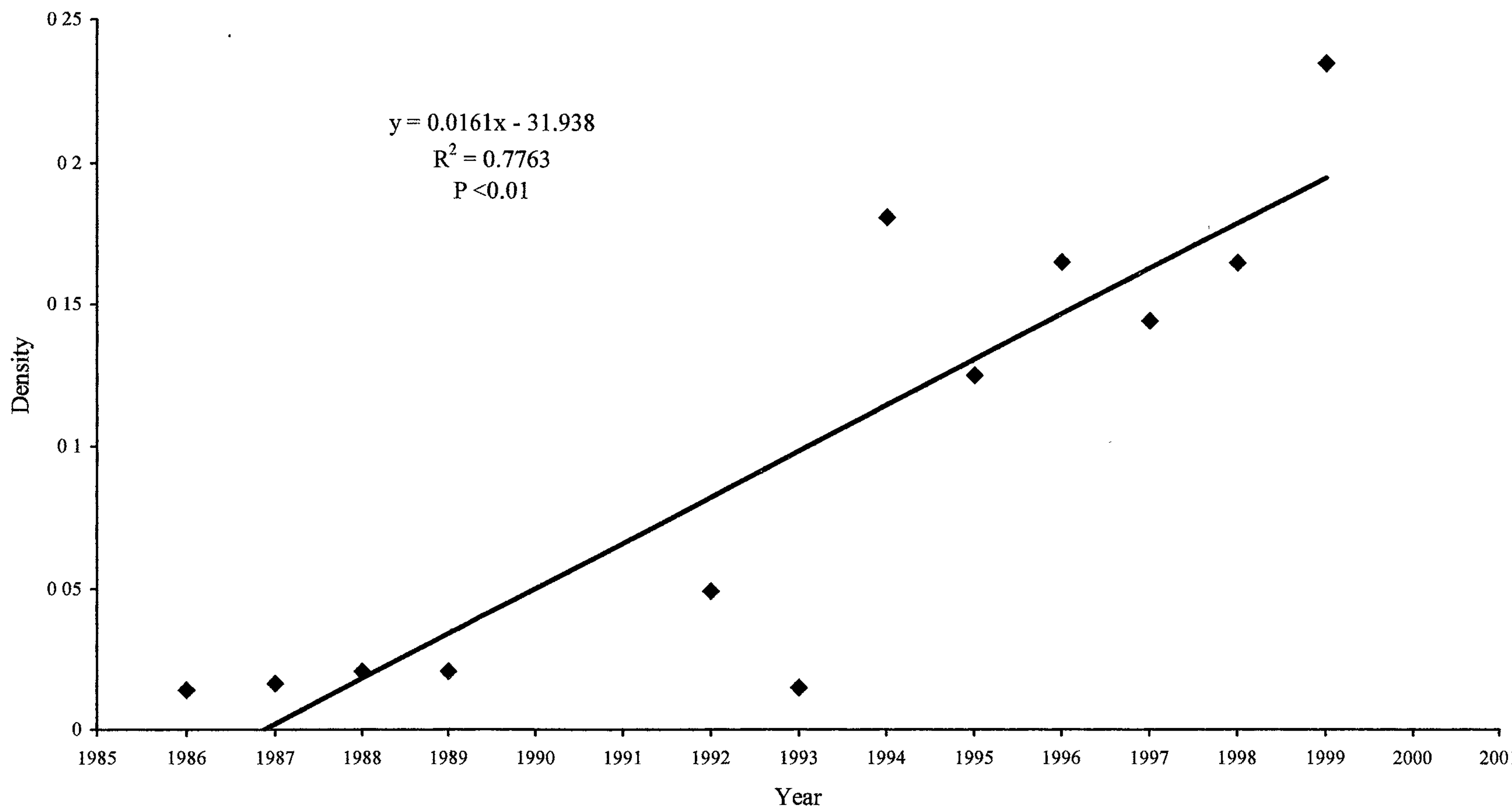


Figure 21: Trend Analysis of Male BCV Density 2 years post-burn at KWMA

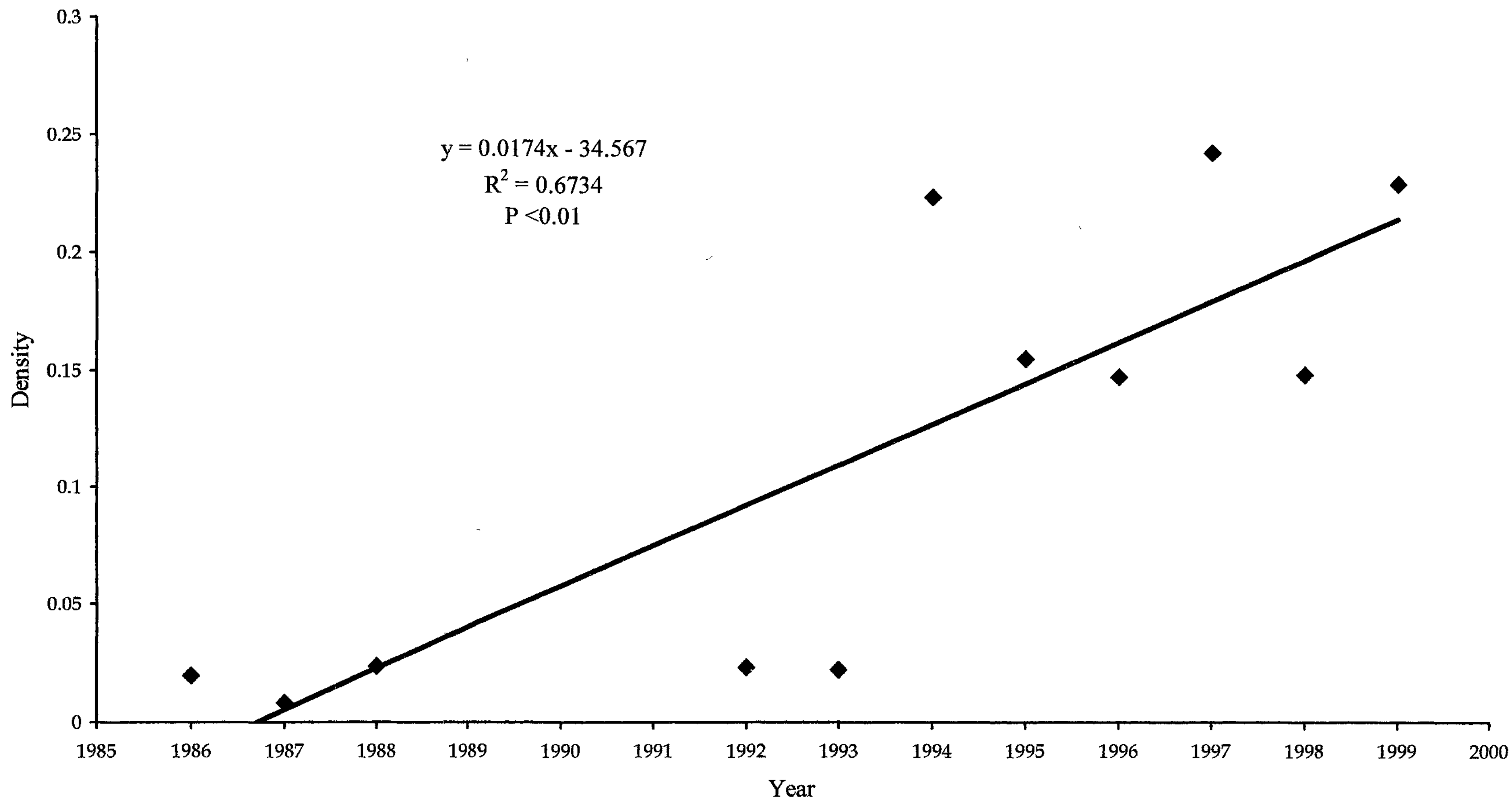


Figure 22: Trend Analysis of Male BCV Density 3 years post-burn at KWMA

An ANOVA was conducted in order to examine any correlations between bird densities within a pasture and frequency of burns. Twenty-three densities were utilized as data sets, $n = 23$, within 4 burn frequency categories, $k = 4$ (Appendix F). The variance between groups (Sb^2) was .94289. The variance within groups (Sw^2) was .4977. An F value was calculated (Sb^2 / Sw^2) at 1.894. Degrees of freedom were dfB = 3 and dfW = 19, resulting in a P value of .1649.

DISCUSSION

The primary objective of this study was to determine if a relationship existed between prescribed fires and the BCV population trend at KWMA. Results showed that the application of cool season fires as prescribed at KWMA had a positive impact on the BCV population at KWMA. The Area population trend showed an increase from 27 singing male BCVs in 1986 to 445 in 2003. Thirty-nine prescribed burns have been applied to the pastures I examined at KWMA since BCV surveys began in 1986. Of these, 21 (53.8%) resulted in an increase in BCV numbers within the pasture the same year as the burn. By "same year," it is meant that a burn occurred between January and March and the population response was measured by a survey conducted in April – May. A total of 15 (38.5%) of the 39 burns studied remained stable the year of the burn and increased within 1-2 years post-burn. As a result, 92.1% of the pastures studied were occupied within 2 years post-burn and accompanied by increases in the overall population trend.

Howard et al. (1959) stated "numbers of all animals increased immediately after (a) fire." The overall increase in the BCV population at KWMA corresponds with what has been found in other areas of the BCV range where habitat was maintained through prescribed fire. Graber (1961) found BCVs so often on post-burn sites that she was convinced the burning probably aided in the dispersal of the species. Grzybowski et al. (1994) supported Graber's findings that many BCV territories were in areas treated with fire. The USFWS (1991) recovery plan for the BCV stated "the largest population groupings in the Wichita Mountains, Fort Hood Military Reservation (MR), Kerr WMA, and Austin (vicinity) occur in areas recovering from significant burning." O'Neal et al. (1996) documented that the number of territories increased in all but 1 pasture following prescribed burns on KWMA. In 1996 a series of crown fires occurred at Fort Hood. Fort Hood has the largest BCV population under single management. The effects of these fires were studied in subsequent years. It was found that more BCVs occurred on burn sites than on non-burn sites. In addition, twice the number of BCVs were counted on these burn sites vs. other areas (Cimprich 2002). The Wichita Mountains NWR Manager, Sam Waldstein (personal communication), stated that there are a minimum of 902 BCV pairs at the 23,877 ha (59,000 acre) refuge and about 400 pairs on neighboring Fort Sill. This is from an increase of 27 total birds in 1986. He also stated that it is normal for BCVs to occur on burn sites the same year as the burn.

Most of the historic range and habitat (Fig. 1) of the BCV was grassland. The BCV, however, selected sites within this ecosystem that had a distinctive patchy structure (Campbell 1995). Historically, the BCV occurred in primarily oak or sumac mottes within this ecosystem and more commonly on the slopes, ravines and canyonlands that dotted the range. This eroded topography supported trees at the appropriate height for BCV nesting longer than trees in open habitat because of the shallow soils. Deciduous growth in these locations has the heterogeneous appearance preferred by the BCV (Graber 1961, Grzybowski et al. 1994). Campbell (1995) stated that although many variables in the BCV's habitat, including vegetation, soil, temperature and rainfall, vary throughout its range in Texas, the overall look is similar.

It is most likely this look, or the physical structure of the vegetation, the BCVs are responding to when they occupy an area following a burn. Graber (1961), Grzybowski et al. (1994), and the BCV USFWS recovery plan (1991) all recommend burning to reduce the numbers and density of Ashe juniper and increase the growth of deciduous shrubs at the height required for BCV nesting. The thin bark and flammable leaves of Ashe juniper make it very susceptible to fire. Oak and sumac, however, may be top-killed but re-sprout vigorously (Wright 1982). The application of fire on species of *Quercus* and *Rhus* stimulate shrubs to sprout at the base, thus providing areas of dense foliage at the low level required by vireos (Campbell 1995). In a study of post-burn response to vegetation in the Edwards Plateau of Texas, Stone (1984) documented fire temperatures under tree canopies at temperatures of 73 to 102 degrees Celsius. Temperatures in open grassland areas, however, only reached 64 degrees Celsius. The higher temperatures under tree canopies resulted from higher fuel quantities. Many deciduous species, especially oaks, are known to be nurse plants for less desirable species, such as Ashe juniper. The increased temperatures under these canopies aids in the removal of the juniper (Stone 1984). An effect of this removal is a more open appearance compared to those of cedar brakes in surrounding areas. This attracts the BCV to establish territories at burned sites.

A decline in numbers of males occurred for 3 (7.9%) of the burns. One of these occurred in Doe pasture and 2 in Rock. The decline in Doe Pasture in 1999 was 10 birds. The numbers increased again 1 year post-burn to within 1 bird of pre-burn numbers. Subsequent years showed an overall increasing population trend. The first decline in Rock Pasture in 1996 was 11 birds. As in Doe, these numbers increased again 1 year post-burn and reached pre-burn numbers within 2 years post-burn. Subsequent years showed an increasing population trend until the 2003 burn when numbers dropped from 109 to 74 BCVs. A careful census during 2004 surveys will need to be taken in order to determine future trend for Rock pasture.

It is unknown why there were declines following 3 burns at KWMA. Reasons are probably related to other variables occurring in that year and are most likely site-specific. It is possible in 2 of the 3 cases that burns occurred too close in sequence and while the habitat was still in a recovery stage from the previous burn. The year with a substantial population decline for Doe Pasture occurred in 1999 when the northern portion of the pasture was burned. The southern portion of this same pasture had been burned just the year before and had a substantial increase from 29 to 47 BCVs the year of the burn. The first decline in a burn year in Rock Pasture occurred in 1996 with a decrease from 54 to 43 BCVs. Parts of this pasture had already been burned in the 2 previous years. This does not explain, however, why the numbers increased again just 1 year later when the entire pasture was burned again. The decline in Rock Pasture in 2003 from 109 to 74 BCVs following a prescribed burn is also difficult to explain. It is possible that by this point in time, the pasture had become saturated and the vireos were dispersing to other nearby territories. Surveys will need to be conducted and studied in future years to understand this change in the population trend at Rock Pasture.

In order to further explore these 3 post-burn decreases, I examined carrying capacities and the possibility of territory compression as a stress factor in the pastures at the Area. An approximate carrying capacity in terms of number of territories was calculated for each pasture, assuming each male would establish a territory of 4 hectares

(9.88 acres) and would not establish a territory in areas not cleared of Ashe juniper (Appendix G). These numbers were compared to the maximum number of singing males documented in each pasture in any one year. Most of these occurred in 2002 or 2003. It was discovered that in 6 of the 12 pastures, there is a strong possibility that territory compression is occurring. These 6 pastures include the following: Bobcat, Buck, Doe, Fawn, Middle Trap and Rock. This may explain some of the declines in pastures post-burn. Assuming a territory size of 4 hectares per male, Doe should carry about 57 BCV territories. In 2003, however, there were 73. Rock pasture, which had 2 declines post-burn, should carry about 53 BCV territories. In 2002, 109 singing males were documented in this pasture. Perhaps this explains the significant decline in this pasture one year later to 74 singing males. The look of the vegetational composition following burns may be attracting more vireos than the habitat can actually hold. Females may prefer other, less crowded territory sites and males may be unsuccessful attracting mates, causing them to disperse the following year. This data also suggests that males may be compressing their territories out of lack of other suitable territory sites in their range.

It is because of these differences in suitable habitat quality that I asked Bill Armstrong of KWMA to rank the study pastures. When I examined the BCV density versus pasture hectares, I noticed variable results. The highest density of singing male BCVs did not consistently occur in the pastures with the highest percentage of Ashe juniper cleared. When densities were compared to overall habitat quality, however, a strong correlation existed. It was shown that pastures with higher densities were also the same ones ranked more highly as to quality of habitat by Bill Armstrong. By "quality of habitat," the overall vegetational composition was taken into account. These results occurred because a pasture cleared of juniper does not necessarily have good BCV habitat. Rock and West Trap, for example, are similar in percent cleared. Rock, however, is mostly deciduous oak mottes and West Trap has mesquite and live oak trees. Buck pasture's percentage cleared is low in comparison, but has large areas of shin oak mottes which are highly preferred by the BCV.

Since comparing density numbers to the percentage of a pasture cleared of Ashe juniper was not a conclusive means of establishing a link between the prescribed burn regime and the population of the Area, I found it necessary to conduct further trend analysis. The compiled data for numbers of singing males at the Area indicated an interesting and continuous trend of increase. In addition, individual pasture examination showed clear increases in their populations as burns were conducted throughout the years. All pastures surveyed annually for BCVs were a part of the overall burning regime applied for Ashe juniper control. The burning regime for a given pasture was based on the management need in a specific year; thus the sequence of burns was not consistent. However, even though the burn pattern was not consistent, the trend of increase in singing males is not in dispute. To better understand the cause of this trend, I compared the change in density of singing males with the area burned by year. The analysis which examined a change in densities 1 year post-burn indicated that 81% of the increase in the number of singing males might be attributed to the burn regime. The other 19% would be attributed to other management factors, consisting of cowbird control and deer herd and cattle grazing management. The percentage dropped to 78% for 2 years post burn and 67% for 3 years post-burn. I believe this may be explained by the decrease in sample size that occurs as the years post-burn increases.

Another objective of this study was to examine intervals between burns within the pastures at KWMA. Campbell (1995) and the BCV PHVA workshop of 1995 both recommended further study of this aspect of BCV habitat management. This need becomes more apparent as a review of the literature and discussions with habitat managers also suggest different burn intervals. Campbell (1995) suggested a burn interval of 4 - 7 years and PHVA (1995) workshop participants suggested an interval of 4 – 10 years. Yancy (1982) determined the effects of fire on Ashe juniper in the Edwards Plateau, and recommended frequent fires in a 4-5 year burn interval to control large bole diameter junipers. Wright (1982) stated that following removal of large junipers, subsequent fires should occur within 10-15 years. The Wichita Mountains NWR Manager stated that they try to conduct burns on a 12 year interval cycle (Waldstein, personal communication). Tazik et al. (1993) reported that BCV habitat on Fort Hood does not become suitable for full re-occupation until 3-5 years after a burn but will remain so for up to 20-30 years post-burn. He also documented BCVs with territories at sites that were 5-30 years post-burn and recommended a 25 year burn cycle with 5 year intervals between each individual site burn.

It is because of these discrepancies and / or differences of opinion on burn frequency that I examined the intervals at KWMA. The ANOVA I conducted based on 4 burn frequency categories had a P value = .1649. The percentage of error is greater than 16% if one were to assume burn frequency had an impact on BCV densities at KWMA. As a result, it must be concluded that with the data available and in the amount of time that KWMA has been conducting burns and surveying for BCVs, the frequency of prescribed burns does not generate an increase in BCV pasture densities. This supports the findings of Tazik et al. (1993) that a burn site may be suitable for as long as 20-30 years. The study pastures at KWMA have not been allowed to rest between burns for greater than 13 years. These findings also make sense when compared to historical accounts and records from 1849 of natural burns in the Edwards Plateau region of Texas, documented as occurring in 20 – 30 year intervals. If there is an ideal burn frequency for BCV habitat, it remains to be discovered through further study and under controlled and deliberate burn intervals. At this time, it appears that the BCV simply responds to the more open and heterogeneous appearance of habitat that results following a burn.

When KWMA was purchased in 1950, it was essentially a large cedar brake with the exception of a few small clearings. Manual cutting to remove Ashe juniper was difficult and expensive to conduct. When fire suppression was discontinued in 1979, the use of prescribed burns altered the composition of Ashe juniper in pastures and created an environment conducive to habitation by the BCVs. Controlled grazing and cowbird control also influenced the increase in BCV numbers.

It is recommended that fire continued to be used to increase BCV numbers throughout its range. In the Edwards Plateau region of Texas, it is recommended that further study of burn intervals be conducted. Needs of a particular pasture in regards to fire are probably site-specific. Current burn schedules are probably most effective if conducted on an as needed basis per pasture and taking into account yearly rainfall, pasture vegetational composition and encroachment rates of Ashe juniper.

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APPENDIX A

Kerr Wildlife Management Area Burn Records Data

KWMA Burn Records Data

Year	Pasture	ha	Burn Date	Humidity	Wind Speed	Direction	Comments
1954	Turkey/Love						Wildfire
1971	Turkey/Love/Rock	414.4	25963				Wildfire
1979	Fawn	18.6	2/26/79	40-60%	10-12 mph	SSW	
1980	Fawn	6.1	2/4/80	85%	15-20 mph		
1980	Fawn	17.0	2/6/80	40-45%	10-15 mph		
1980	Fawn	2.0	2/6/80	40%	10-15 mph		
1980	Fawn	42.9	2/6/80	33-35%	10-15 mph		
1980	Fawn	8.1	2/13/80	51-80%	10-15 mph	SSW	Spotty
1980	Plot 10	28.7	2/26/80	40-57%	5-10 mph	S	
1980	Doe/Doe Trap	38.9	2/26/80	20-60%	5-10 mph	SE	Ext. Hot
1980	Owl	6.9	2/26/80	35-37%	5-8 mph	S	
1980	River	8.1	2/27/80	50-60%	5-10 mph	SW	
1980	Owl	20.2	3/10/80	45-50%	5-10 mph	SW	Spotty
1980	Owl	32.4	3/11/80	60%		SSE	Poor
1981	Doe	70.0	1/28/81	29-30%	<5 mph	SW	
1981	West Trap	34.4	2/19/81	35-44%	<3 mph	WNW	Poor, No wind
1981	Owl	44.5	2/24/81	24-35%	5-10 mph	WSW	Poor
1981	Love/Brush piles		2/24/81	38%	5-10 mph	WSW	
1982	West Trap	34.4	2/10/82	42-48%	10-32 mph	SSW	
1982	Love/Plot 10/R. Trap	248.9	2/1/82	42-48%	10-32 mph	SSW	
1982	Bobcat/River/S. Trap	365.4	3/2/82	46-50%			
1982	Bobcat/River/S. Trap	365.4	3/3/82	18-44%			
1983	Turkey	168.0	1/10/83	11-43%	<5 mph	S	West Good
1983	Buck	110.1	2/22/83	44-47%			Cool
1983	Spring Trap	6.5	3/1/83				
1983	Middle Trap	48.2	1/11/83	43%	5-10 mph		Poor
1983	Plot 7	38.9	1/11/83	36%	5-10 mph		
1983	West Trap	34.4	1/12/83	33-43%			Good
1984	Bobcat/River	103.2	3/27/84	<15%	28-43 mph	W	Wildfire
1984	Fawn	108.1	1/5/84	32-83%	3-7 mph		
1984	Rabbit Trap	19.8	1/12/84	40-50%	5-15 mph	S	Demo.
1984	Rock	211.3	1/26/84	18-35%	3-7 mph		Hot
1985	No Burns Conducted						

Year	Pasture	ha	Burn Date	Humidity	Wind Speed	Direction	Comments
1986	North Doe	38.0	1/23/86	45-50%	5 mph	S	
1986	South Doe	70.0	1/28/86	40-50%	5-10 mph	S	Good
1986	North Owl	87.0	1/28/86	38-60%	5-10 mph	S	
1986	South Owl	77.7	2/24/86	21-30%	5 mph	ESE	
1986	Plot 3	38.9	2/24/86	28%	<5 mph	NNE	
1987	Love	220.2	2/9/87	25-45%	3-5 mph	SE	
1988	West Bobcat	42.1	1/27/88	32-44%	3-5 mph		Hot
1989	Doe	2.0	1/30/89	31%	5-10 mph	SSW	Firelane
1989	Plot 8	13.0	1/30/89	37%	5-10 mph	SSW	West 1/3
1989	Fawn	108.1	1/31/89	23-35%			
1989	West Buck	88.2	3/8/89	17-44%	3-5 mph	NE	
1989	West Bobcat	20.2	3/8/89	17-44%	3-5 mph	NE	
1989	West Bobcat	30.4	3/9/89	27-54%	<5 mph	W	
1990	No Burns Conducted						
1991	Plots 4,5,6,7 & 8	194.3	2/20/91	27-45%	<5 mph	NE	
1992	Middle Trap	48.2	1/31/92	31-37%	5 mph	N	
1992	North Owl	87.0	2/18/92	18-36%	5-10 mph	NW	
1992	South Owl	77.7	2/19/92	14-25%	5 mph	SE	
1993	Turkey	168.0	1/21/93	25-30%	5 mph	N	
1993	West Trap	34.4	1/21/93	25-30%	5 mph	N	
1993	Plot 10	28.7	1/22/93	30-55%	5-10 mph	SW	
1994	South Rock	76.9	2/16/94	35-45%	3-7 mph	SW	
1994	North Doe	36.4	3/10/94	41-49%	10 mph	NW	
1995	North Rock	62.3	1/31/95	20-31%	10 mph	SW	
1995	Plot 1	38.9	2/1/95	17-45%	5 mph	NW	
1995	Fawn	108.1	2/6/95	50-55%	5-15 mph	SW	
1995	East Buck	21.9	2/20/95	19-30%	10 mph	NE	
1995	Doe Trap	1.6	2/20/95	23%	10 mph	NE	
1995	River	41.3	2/21/95	24-40%	5-10 mph	E	
1995	Middle Bobcat	20.2	2/21/95	24-40%	5-10 mph	E	
1996	Middle Rock	74.1	1/10/96	31-45%	5 mph	SE	Hot
1996	West Trap	34.4	1/9/96	29-40%	5 mph	N	Good
1996	East Bobcat	139.2	2/9/96	27-56%	<5 mph	S	Good
1996	River	41.3	2/9/96	27-56%	<5 mph	S	Good

Year	Pasture	ha	Burn Date	Humidity	Wind Speed	Direction	Comments
1996	Middle Bobcat	42.9	2/9/96	27-56%	<5 mph	S	Good
1996	Love	200.3	1/26/93	20-34%	5 mph	N	
1997	Owl	164.7	1/29/97	8-20%	5-10 mph	S	Good
1997	Plot 2	38.9	1/30/97	28-15%	calm		
1997	Plot 3	38.9	1/30/97	12-15%	calm		
1997	Rabbit Trap	19.8	3/6/97	20-30%	calm		
1997	South Rock	12.1	3/6/97	20-30%	calm		
1997	Spring Trap	6.5	3/6/97	20-30%	calm		
1998	South Doe	70.0	2/3/98	31-34%	5-10 mph	E	
1998	Plot 6	8.1	2/3/98	31%	5-10 mph	E	
1998	Turkey	168.0	2/20/98	25%	5-10 mph	SE	
1998	Love	180.1	2/20/98	25%	5-10 mph	SE	
1998	South Love		3/11/98	18-20%	10-15 mph	W	
1998	Plot 10	18.6	3/11/98	18-20%	10-15 mph	W	
1999	North Doe	30.4	2/4/99				
1999	West Buck	133.5	2/19/99	25-30%	5-10 mph	SE	
1999	North/West Bobcat	182.0	2/19/99	25-30%	5-10 mph	SE	
1999	Buck		2/23/99	15%	5-10 mph	SE	Cleanup
2000	Plot 6	18.2	2/9/00	12%	5-10 mph	SE	
2001	No Burns Conducted						No Burns
2002	Fawn	147.7	1/8/02	31-34%	1-5 mph	SSE	Poor
2002	West Bobcat	26.3	1/15/02	24-26%	14-20 mph	SSE	Good
2002	East Turkey	56.7	2/11/02	14-27%	calm		Good
2002	East Love	57.5	2/12/02	17-18%	5-11 mph	SSW	Good
2002	Rabbit	19.8	2/12/02	17-18	5-11mph	SSW	Good
2003	Middle Trap	48.2					
2003	Rock	228.3					

APPENDIX B

Black-capped Vireo Census Data for Study Pastures

Black-capped Vireo Census Data: Bobcat Pastures

Year	# of Birds
1986	4
1987	2
1988	5
1989	4
1990	7
1991	8
1992	
1993	11
1994	18
1995	30
1996	34
1997	30
1998	41
1999	42
2000	57
2001	61
2002	60
2003	73

1992 data unavailable.

Black-capped Vireo Census Data: Buck Pastures

Year	**# of Birds**
1986	1
1987	4
1988	5
1989	4
1990	3
1991	6
1992	
1993	6
1994	11
1995	15
1996	15
1997	29
1998	26
1999	27
2000	39
2001	47
2002	48
2003	40

1992 data unavailable.

Black-capped Vireo Census Data: Doe Pasture

Year	# of Birds
1986	0
1987	4
1988	5
1989	5
1990	7
1991	14
1992	
1993	22
1994	25
1995	28
1996	21
1997	29
1998	47
1999	37
2000	46
2001	47
2002	43
2003	54

1992 data unavailable.

Black-capped Vireo Census Data: Fawn Pastures

Year	**# of Birds**
1986	0
1987	0
1988	0
1989	0
1990	0
1991	0
1992	
1993	0
1994	2
1995	5
1996	5
1997	11
1998	27
1999	33
2000	26
2001	27
2002	28
2003	30

1992 data unavailable.

Black-capped Vireo Census Data: Love Pastures

Year	# of Birds
1986	1
1987	4
1988	2
1989	4
1990	2
1991	5
1992	
1993	8
1994	11
1995	10
1996	10
1997	13
1998	47
1999	27
2000	35
2001	30
2002	41
2003	39

1992 data unavailable.

Black-capped Vireo Census Data: Middle Trap Pasture

Year	**# of Birds**
1986	0
1987	0
1988	0
1989	4
1990	3
1991	4
1992	
1993	4
1994	4
1995	5
1996	3
1997	4
1998	20
1999	11
2000	10
2001	13
2002	9
2003	9

1992 data unavailable.

Black-capped Vireo Census Data: Owl Pastures

Year	# of Birds
1986	1
1987	0
1988	0
1989	2
1990	1
1991	4
1992	
1993	8
1994	11
1995	2
1996	9
1997	9
1998	9
1999	12
2000	25
2001	24
2002	27
2003	31

1992 data unavailable.

Black-capped Vireo Census Data: Rabbit Trap Pasture

Year	# of Birds
1986	0
1987	0
1988	0
1989	0
1990	0
1991	0
1992	
1993	0
1994	0
1995	0
1996	0
1997	0
1998	0
1999	1
2000	0
2001	0
2002	0
2003	3

1992 data unavailable.

Black-capped Vireo Census Data: River Pasture

Year	# of Birds
1986	0
1987	0
1988	0
1989	0
1990	0
1991	0
1992	
1993	0
1994	1
1995	1
1996	2
1997	1
1998	2
1999	1
2000	1
2001	3
2002	5
2003	3

1992 data unavailable.

Black-capped Vireo Census Data: Rock Pastures

Year	**# of Birds**
1986	19
1987	20
1988	22
1989	25
1990	34
1991	36
1992	
1993	40
1994	48
1995	54
1996	43
1997	50
1998	54
1999	59
2000	96
2001	94
2002	109
2003	74

1992 data unavailable.

Black-capped Vireo Census Data: Turkey Pastures

Year	**# of Birds**
1986	0
1987	2
1988	0
1989	2
1990	1
1991	0
1992	
1993	1
1994	0
1995	4
1996	6
1997	10
1998	23
1999	24
2000	19
2001	13
2002	26
2003	26

1992 data unavailable.

Black-capped Vireo Census Data: West Trap Pasture

Year	# of Birds
1986	0
1987	0
1988	0
1989	0
1990	0
1991	0
1992	
1993	0
1994	0
1995	0
1996	0
1997	3
1998	6
1999	5
2000	1
2001	2
2002	6
2003	7

1992 data unavailable.

APPENDIX C

Compiled Yearly Maps of Black-capped Vireo Census Observation Points

Figure 23: 1986 Black-capped Vireo Census Observation Points

Figure 24: 1987 Black-capped Vireo Observation Points

Figure 25: 1988 Black-capped Vireo Census Observation Points

Figure 26: 1989 Black-capped Vireo Census Observation Points

Figure 27: 1990 Black-capped Vireo Census Observation Points

Figure 28: 1991 Black-capped Vireo Census Observation Points

Figure 29: 1993 Black-capped Vireo Census Observation Points

Figure 30: 1994 Black-capped Vireo Census Observation Points

Figure 31: 1995 Black-capped Vireo Census Observation Points

Figure 32: 1996 Black-capped Vireo Census Observation Points

Figure 33: 1997 Black-capped Vireo Census Observation Points

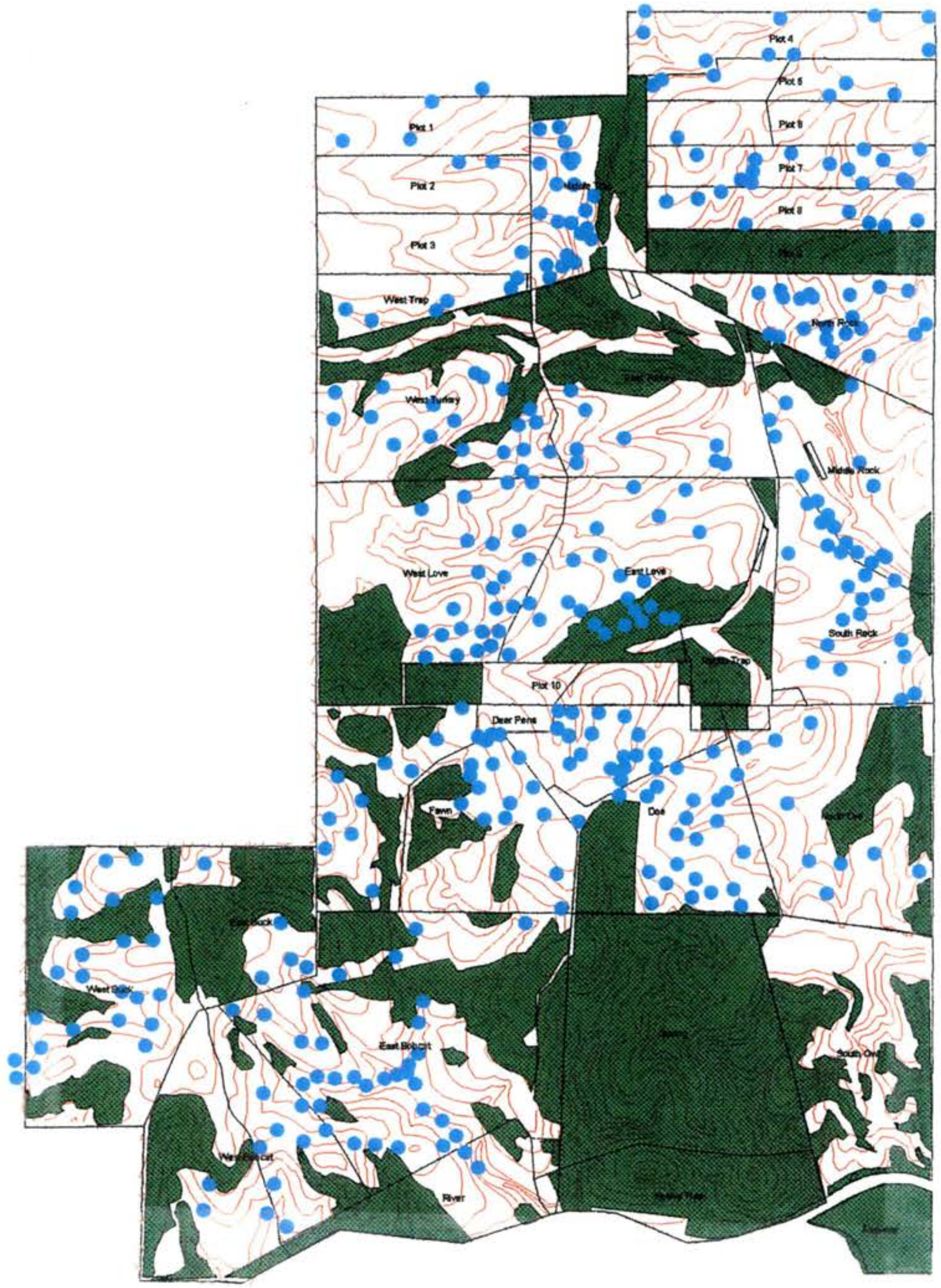

***Figure 34:** 1998 Black-capped Vireo Census Observation Points

*Map obtained from KWMA BCV GIS Database, created with ArcView GIS software

Figure 35: 1999 Black-capped Vireo Census Observation Points

Figure 36: 2000 Black-capped Vireo Census Observation Points

Figure 37: 2001 Black-capped Vireo Census Observation Points

Figure 38: 2002 Black-capped Vireo Census Observation Points

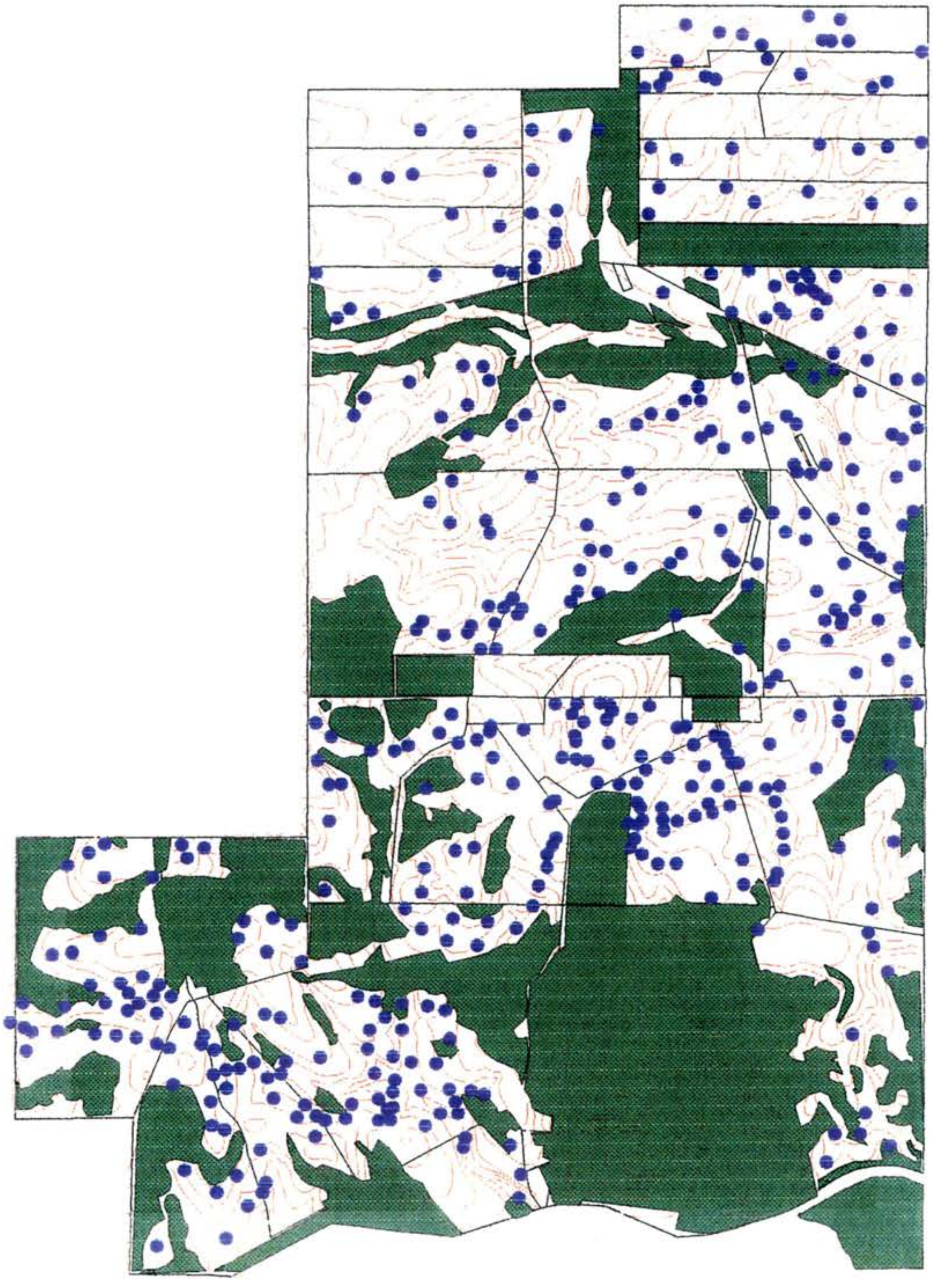

***Figure 39:** 2003 Black-capped Vireo Census Observation Points

*Map obtained from KWMA BCV GIS Database, created with ArcView GIS software

APPENDIX D

Sizes of Study Pastures

Sizes of Study Pastures

Pasture	East (ha)	Middle (ha)	West (ha)	North (ha)	South (ha)	Total ha	Cleared ha
Bobcat	216.2	44.5	78.5			339.2	229.5
Buck	60.7		133.6			194.3	110.1
Doe						125.5	106.4
Fawn	80.2		67.6			147.8	108.1
Love	115		131.6			246.6	200.3
Middle Trap						70.8	48.2
Owl				117	115.4	232.4	164.7
Rabbit Trap						38.5	19.8
River						58.7	41.3
Rock		86.6		62.3	79.4	228.3	211.3
Turkey	127.1		108.1			235.2	167.9
West Trap						36.4	34.4

APPENDIX E

Trend Analysis Data

Trend Analysis Data for 1 year Post-burn

Burn Year	Pasture(s)	Pop. # 1 yr. Post-burn	Hectares	Density
1986	Doe & Owl	4	357.9	0.01118
1987	Love	2	246.6	0.00811
1988	Bobcat	4	339.2	0.01179
1989	Bobcat, Buck & Fawn	10	681.3	0.01468
1990				
1991				
1992	M. Trap & Owl	12	303.2	0.03958
1993	Turkey & W. Trap	0	271.6	0
1994	Doe & Rock	82	353.8	
1995	Bobcat, Buck, Fawn, River & Rock	99	968.3	0.10224
1996	Bobcat, Love, River, Rock & W. Trap	97	909.2	0.10669
1997	Owl, R. Trap & Rock	63	499.2	0.1262
1998	Doe, Love & Turkey	88	607.3	0.1449
1999	Bocat, Buck & Doe	142	659	0.21548
2000				
2001				
2002	Bobcat, Fawn, Love, R. Trap & Turkey	171	1007.3	0.16976
2003	M. Trap & Rock			

Trend Analysis Data for 2 years Post-burn

Burn Year	Pasture(s)	Pop. # 2 yr. Post-burn	Hectares	Density
1986	Doe & Owl	5	357.9	0.01397
1987	Love	4	246.6	0.01622
1988	Bobcat	7	339.2	0.02064
1989	Bobcat, Buck & Fawn	14	681.3	0.02055
1990				
1991				
1992	M. Trap & Owl	15	303.2	0.04947
1993	Turkey & W. Trap	4	271.6	0.01473
1994	Doe & Rock	64	353.8	0.18089
1995	Bobcat, Buck, Fawn, River & Rock	121	968.3	0.12496
1996	Bobcat, Love, River, Rock & W. Trap	150	909.2	0.16498
1997	Owl, R. Trap & Rock	72	499.2	0.14423
1998	Doe, Love & Turkey	100	607.3	0.16466
1999	Bocat, Buck & Doe	155	659	0.2352
2000				
2001				
2002	Bobcat, Fawn, Love, R. Trap & Turkey		1007.3	
2003	M. Trap & Rock			

Trend Analysis Data for 3 years Post-burn

Burn Year	Pasture(s)	Pop. # 3 yr. Post-burn	Hectares	Density
1986	Doe & Owl	7	357.9	0.01956
1987	Love	2	246.6	0.00811
1988	Bobcat	8	339.2	0.02358
1989	Bobcat, Buck & Fawn		681.3	
1990				
1991				
1992	M. Trap & Owl	7	303.2	0.02309
1993	Turkey & W. Trap	6	271.6	0.02209
1994	Doe & Rock	79	353.8	0.22329
1995	Bobcat, Buck, Fawn, River & Rock	150	968.3	0.15491
1996	Bobcat, Love, River, Rock & W. Trap	134	909.2	0.14738
1997	Owl, R. Trap & Rock	121	499.2	0.24239
1998	Doe, Love & Turkey	90	607.3	0.1482
1999	Bocat, Buck & Doe	151	659	0.22914
2000				
2001				
2002	Bobcat, Fawn, Love, R. Trap & Turkey		1007.3	
2003	M. Trap & Rock			

APPENDIX F

ANOVA Data

ANOVA DATA

Pasture	Burn Frequency: 1-3 years	4-6 years	7-9 years	10-13 years	Years for Density Data Points
	Pasture Density for Burn Year				
Fawn		0.086	0.807		1995 & 2002
Doe		1.529	2.509		1999 & 1994
Owl		0.348			1997
River	0.378			0.223	1996 & 1995
West Trap	0			0	1996 & 1993
Turkey		0.483		0.082	2002 & 1993
Love		0.638			2002
Buck		1.077			1999
Middle Trap			1.515	0.606	1992 & 2003
Rabbit Trap	0	0		0	1984, 2002 & 1997
Rock	1.5	1.089		2.38	1997, 2003 & 1995
Bobcat	0.707		1.166		2002 & 1996
sum =	**2.585**	**5.25**	**5.997**	**3.291**	
n =	5	8	4	6	
mean (x) =	0.517	0.65625	1.499	0.5485	**Grand Mean = .7444**
					Variance between (Sb^2) = .94289
variance (s^2) =	0.3891	0.2867	0.5367	0.8566	**Variance within (Sw^2) = .4977**

$F = (Sb^2) / (Sw^2) = 1.894$

k = 4

n = 23

(dfB = 3, dfW = 19)

P **0.164883553**

Note: Densities calculated in order to account for population trend over time and differences in pasture sizes.

Formula: Density for pasture / Density for total area

APPENDIX G

Carrying Capacity and Territory Compression Analysis Data

Carrying Capacity and Territory Compression Analysis Data

Pasture	Cleared ha	*Carrying Capacity	Highest BCV #	Year
Bobcat	229.5	57.38	73	2003
Buck	110.1	27.5	48	2002
Doe	106.4	26.6	54	2003
Fawn	108.1	27.03	33	1999
Love	200.3	50.08	47	1998
Middle Trap	48.2	12.05	20	1998
Owl	164.7	41.18	31	2003
Rabbit Trap	19.8	4.95	3	2003
River	41.3	10.33	5	2002
Rock	211.3	52.83	109	2002
Turkey	167.9	41.98	26	2002-2003
West Trap	34.4	8.6	7	2003

*based on 4 ha territory size

VITA

Deirdra Dufault was born in Frederick, Maryland, on December 20, 1974, the daughter of Linda Ann Dufault and Douglas Reginald Dufault. After completing her work at MacArthur High School, Lawton, Oklahoma, in 1992, she entered Oklahoma State University. She transferred to Tarleton State University in Stephenville, Texas, as a Presidential Honors Program Scholar in 1993. She received the degree of Bachelor of Science in Biology from Tarleton State University in May 1996. She began her career as a science teacher in a private school in San Antonio, Texas, in August 1996. In May 1999, she earned her Texas teaching certificate in Secondary Biology through Texas A&M International University in Laredo while teaching in the Laredo Independent School District. Since August 1999, she has been employed as a science teacher and department head at OakRun School in the New Braunfels Independent School District. In June 2000, she entered the Graduate College of Texas State University-San Marcos.

This thesis was typed by Deirdra Dufault.