Species Status Assessment Report

for the Black-capped vireo (*Vireo atricapilla*)

Prepared by the Arlington, Texas Ecological Services Field Office
U.S. Fish and Wildlife Service

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Black-capped vireo singing on territory at Big Bend National Park. *Photo by Eric M. Wood.*

EXECUTIVE SUMMARY

This Species Status Assessment reports the results of the comprehensive status review for the black-capped vireo (*Vireo atricapilla*) and provides a thorough account of the species' overall viability. The black-capped vireo is a small, insectivorous songbird that breeds and nests in Oklahoma, Texas, and northern Mexico, and winters along Mexico's western coast (Figure ES-1). The species was listed as endangered under the Endangered Species Act in 1987.

In conducting this status assessment, we first considered what the black-capped vireo needs to ensure viability. We consider viability for the black-capped vireo as the ability to avoid extinction over the short term (up to 30 years) and persist over the long term (30 to 50 years). We next evaluated whether the identified needs of the black-capped vireo are currently available and the repercussions to the species when its needs are missing or diminished. We then consider known threats that cause the species to lack what it needs historically and in its current condition. Finally, considering the information reviewed, we evaluate the current status and future viability of the species in terms of resiliency, redundancy, and representation. Resiliency is the ability of the species to withstand stochastic events and, in the case of the black-capped vireo, is best measured by vireo abundance within known populations or localities. Redundancy is the ability of a species to withstand catastrophic events by spreading risk and can be measured through the duplication and distribution of populations across the breeding range of the black-capped vireo. Representation is the ability of a species to adapt to changing environmental conditions and can be measured by the breadth of genetic diversity within and among populations and the ecological diversity of populations across the species' range.

Our evaluation indicates the primary threats to the species continue to be habitat loss through land use conversion, grazing and browsing by livestock and native and exotic ungulates, and vegetational succession, and brown-headed cowbird parasitism; however, most threats have decreased in magnitude or are adequately managed. As such, we consider the black-capped vireo a conservation-reliant species; meaning it is likely that conservation actions, in the form of habitat and cowbird management, are needed for persistence of breeding populations in a large portion of its range.

The wintering area for the black-capped vireo occurs entirely in Mexico, and is spread across nine states along its western Pacific coast. Wintering habitat loss is a concern, however, much of the existing habitat areas are buffered from degradation due to limited accessibility, and it does not appear to be a limiting factor based on studies of return rates on banded vireos, which long term data show is within the range of other songbirds. There are no known threats to vireos during migration.

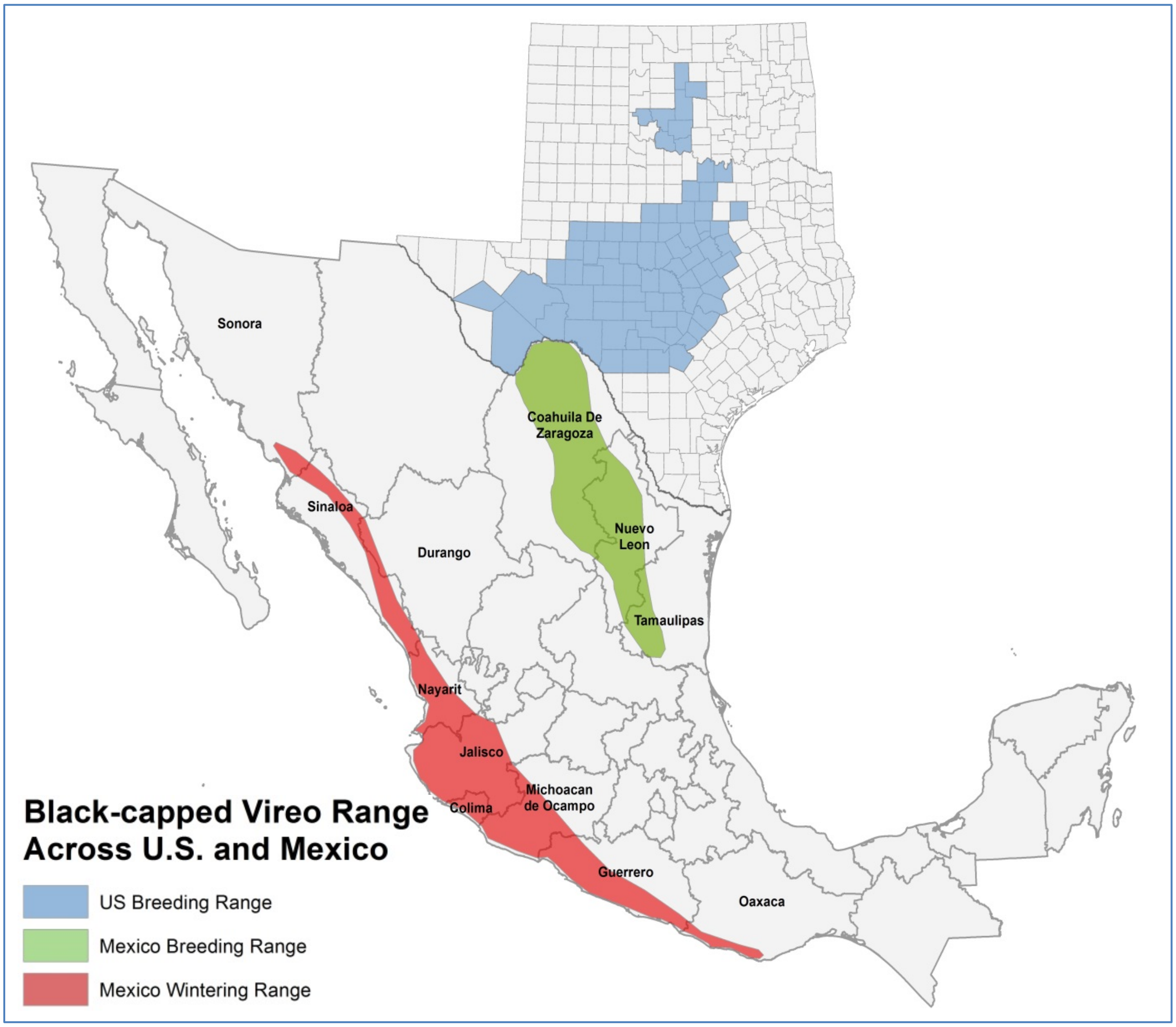

Figure ES-1. Known breeding and wintering range of the black-capped vireo.

There are no rangewide population or habitat estimates for the black-capped vireo. The best available information on the abundance and distribution of the species comes from reported surveys across the range, and population estimates from well-surveyed properties. The known population of the black-capped vireo in the breeding range from 2009 to 2014 was documented at 5,244 adult males. Compared to information used for the previous status review (2000 to 2005), there was a 17.5 percent increase in the known population (Table ES-1). At the time of listing in 1987, only 350 black-capped vireos were known within the breeding range.

Forty percent of the known population occurs on Fort Hood and Fort Sill Military Installations, Wichita Mountains Wildlife Refuge and Kerr Wildlife Management Area, compared to 64 percent from 2000 to 2005. Because these populations have remained stable or increased, the difference in the percentage indicates an increase in the reported abundance and distribution, particularly on private lands. These localities, and the Devils River Conservation Easement locality, are known to have substantial breeding populations. From 2013 to 2014, it was estimated that over 14,000 male vireos occurred on these five properties.

Table ES-1. Known black-capped vireo population numbers and distribution from specific timeframes.

Timeframe	Known Population	Distribution
1987	350 birds	4 Oklahoma Counties 21 Texas Counties 1 Mexico State
1996	1,803 birds	3 Oklahoma Counties 40 Texas Counties Mexico - unknown
2000-2005	4,464 males	3 Oklahoma Counties 38 Texas Counties 3 Mexico States
2009-2014	5,244 males	5 Oklahoma Counties 40 Texas Counties 3 Mexico States

We estimate that vireo localities with suitable breeding habitat to support 30 or more adult male vireos (a manageable locality) can be maintained through vegetation and cowbird management, and habitat that supports 100 or more adult male vireos (a likely resilient locality) is buffered from stochastic events, although some management is still necessary. Current conditions of populations indicate there are 20 manageable and 14 likely resilient localities across the breeding range. We assessed the likelihood of persistence of these localities over the short and long term under two scenarios: 1) current management actions continue, and 2) management actions are reduced or discontinued.

We then used the information on persistence of current localities to forecast redundancy over the short and long term. Three scenarios of future conditions were evaluated (Figure ES-2).

Scenario 1. Existing number of known localities. This scenario forecasts the persistence of existing localities through the long term and represents the worst case under continued management and decreased management conditions. The black-capped vireo's viability is characterized by losses of redundancy in the short and long term, mostly occurring under decreased management conditions. However, under all situations redundancy is expected to remain above the level reported from 2000 to 2005.

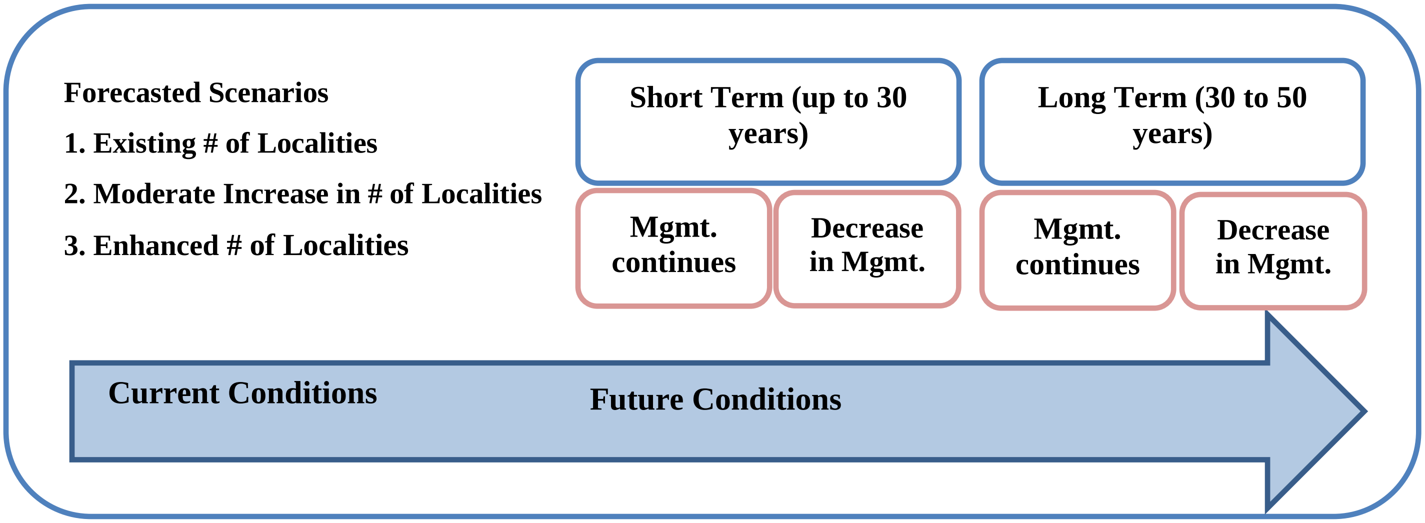

Figure ES-2. Graphic representation of scenarios forecasted over short and long term and under managed and decreased management conditions.

Scenario 2. Moderate increase in number of localities from restoration and survey effort. A moderate case scenario, which includes an estimated increase in redundancy in the short and long term. Viability of the black-capped vireo is characterized by slight increases in redundancy under all continued management conditions, and a loss of redundancy under long term decreased management.

Scenario 3. Enhanced number of localities from restoration and survey effort. The best case scenario under continued management or decreased management. Viability of the vireo is characterized by increases in redundancy under all conditions except for long term decreased management, where the level remains the same as the current conditions.

We evaluated several studies with respect to representation in the black-capped vireo, mostly involving genetic diversity. Although there is discrepancy between studies, there is evidence that adequate gene flow exists across known breeding populations. Additionally, there is a diversity of habitat types utilized within the breeding and wintering ranges. For these reasons, the black-capped vireo appears to have adequate representation both genetically and ecologically.

A general summary of the black-capped vireo's needs, stressors, and current and future conditions is shown in Figure ES-2. It is important to recognize areas of uncertainty associated with this assessment. This includes the abundance and amount of suitable breeding habitat needed that represent manageable and likely resilient localities and the extent of redundant localities needed to provide for adequate redundancy and representation. There is also limited documentation in the estimation of historical population size, population structuring due to restrictions in gene flow, and the extent of the species historical range. We base our assumptions in these areas on the best available information, which is presented in this assessment.

BLACK-CAPPED VIREO NEEDS

INDIVIDUAL NEEDS

Breeding

Suitable habitat patch of:

- At least 3.7 acres of shrublands with between 35-55% shrub cover, largely deciduous shrubs, and with few junipers.
- Nest and foraging shrub mottes with deciduous foliage from 0-10 feet.

Migration:

- Airspace for movement and woody vegetation for feeding and sheltering

Wintering:

- Woody vegetation, generally 2 to 10 feet in height for feeding and sheltering.

POPULATION NEEDS

Breeding

Populations or localities:

- Manageable localities: suitable breeding habitat to support at least 30 adult males.
- Likely resilient localities: suitable breeding habitat to support ≥100 adult males.
- Brown-headed cowbird parasitism rate <40%.

Migration:

- Sufficient airspace and stopover sites of woody vegetation.

Wintering:

- Arid/semi-arid scrub and secondary growth habitat for feeding and sheltering

SPECIES (rangewide) NEEDS

Breeding

Suitable habitat to support:

- Manageable (≥30 males) and likely resilient localities (≥100 males) distributed throughout the range to allow gene flow and dispersal.
- Brown-headed cowbird parasitism rate low enough to allow sufficient productivity on average across the range.

Migration:

- Sufficient airspace and stopover sites of woody vegetation.

Wintering:

- Sufficient and sustainable arid/semi-arid scrub and secondary growth habitat along the Pacific slope of western Mexico.

Current Condition of the Black-capped vireo

Individual Conditions:

- Existing habitat conditions are present at managed lands in the U.S. Mexico breeding habitat shows high densities of breeding males.
- Wintering and migratory habitat are assumed sufficient.

Population Conditions:

- There are five large managed locations with an estimated 14,418 adult males in 2013 - 2014. Four of the five have active cowbird management.
- Migratory conditions are present along the predicted migration route.
- Wintering is known to occur in 7 Mexican states.

Rangewide Conditions:

- There are 14 likely resilient breeding localities, nine on managed lands.
- An additional 20 localities with ≥ 30 males; 10 on managed lands.
- Wintering and migratory habitat is not known to be a limiting factor.

Primary Causes and Effects (Threats) to Black-capped vireo

Main Stressors:

- Breeding habitat loss.
- Parasitism by brown-headed cowbird.

Main Sources:

Breeding habitat loss:

- Land use conversion
- Grazing/browsing by livestock and native and exotic ungulates
- Vegetational succession (due to fire suppression) in the eastern portion of the range.

Parasitism:

- Establishment of domestic livestock
- Anthropogenic habitat modification; habitat fragmentation – increased edge density
- Parasitism is more important to breeding populations in the eastern portion of the U.S. range, including Oklahoma.

Future Condition (Viability) of the Black-capped vireo

Forecasted Scenarios

- Scenario 1: Existing number of localities. Worst case, viability characterized by losses of resiliency and redundancy in the short and long term, mostly occurring under decreased management conditions, but still above the level reported from 2000 to 2005.
- Scenario 2: Moderate increase in number of localities. The moderate case with the expectation of increased redundancy in the short and long term. Viability is characterized by slight increases in resiliency and redundancy under all increased management conditions, and a loss of redundancy under long term decreased management.
- Scenario 3: Enhanced number of localities. Best case, under continued management and decreased management conditions. Viability is characterized by increases in resiliency and redundancy under all conditions except long term decreased management, where levels remain the same as current conditions.

Figure ES-2. Summary of Black-capped Vireo Needs, Stressors, and Current and Future Conditions.

ACKNOWLEDGEMENTS

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James J. Giocomo
Michael A. Patten
M. Clay Green
David A. Cimprich
C. Craig Farquhar
Matthew Fullerton

TABLE OF CONTENTS

CHAPTER 1– INTRODUCTION

The black-capped vireo (*Vireo atricapilla*) is a small, insect-eating, migratory songbird that breeds and nests in Oklahoma, Texas, and northern Mexico, and winters along Mexico's western coastal states. The species was listed as endangered on October 6, 1987 (52 FR 37420–37423) without critical habitat under the Endangered Species Act (Act). In 2007, a 5-year review of the black-capped vireo's status under the Act recommended the species be downlisted to threatened status (USFWS 2007, entire). However, a proposed rule to downlist the species was not published due to higher priority listing actions. Since that time, the U.S. Fish and Wildlife Service (Service) has developed the Species Status Assessment (SSA) framework to review a species' biology and evaluate its biological status. This evaluation will determine if the black-capped vireo has the resources and conditions necessary for long term viability. The Service will subsequently use this information to make a determination of the species' status with respect to the Act. The SSA framework is a comprehensive review intended to be easily updated as new information becomes available and to support all decisions and activities under the Act, such as listing rules, recovery plans, and 5-year reviews.

This SSA Report for the black-capped vireo provides the biological support for the determination of the status of the species under the Act. While the SSA Report does not result in a determination of the appropriate status of the species, the determination will be made by the Service following review of the SSA and all relevant laws, regulations, and policies. The determination of the species' status will be announced in the *Federal Register*. This SSA Report is a biological review of the black-capped vireo based on the best available scientific and commercial information.

For the purpose of this assessment, we define **viability** as the ability of a species to avoid extinction over the short term (up to 30 years) and persist over the long term (30 to 50 years). The 30-year timeframe is used to reflect available information evaluated since the first status assessment of the species reported in 1985, and this assessment using information through 2015, or roughly 30 years. The long term timeframe is used to reflect specific climate change models relevant to the black-capped vireo and its habitat. This time period is informative for forecasting the viability of the species. Using the SSA framework, we consider what the species needs to maintain viability by characterizing the status of the species in terms of its **resiliency**, **redundancy**, and **representation**.

- **Resiliency** is defined as the ability of the species to withstand stochastic events. We can measure resiliency based on metrics of population health, for example, birth versus death rates, and population size. Healthy populations are more resilient and better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

- **Redundancy** is defined as the ability of a species to withstand catastrophic events. Redundancy is about spreading the risk and can be measured through the duplication and distribution of resilient populations across the range of the species. The greater the number of resilient populations a species has distributed over a larger landscape, the higher the probability it can withstand catastrophic events.

- **Representation** is defined as the ability of a species to adapt to changing environmental conditions. Representation can be measured through the breadth of genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment.

The current and future biological status of the black-capped vireo is assessed under a range of conditions in order to consider the species' resiliency, redundancy, and representation. This SSA Report provides a thorough assessment of the biology of the black-capped vireo and evaluates demographic risks, stressors and known threats, and limiting factors with respect to its viability and risk of extinction. A stressor is a process or event with negative impact on the species. In this SSA, the term threat is used to describe stressors and their sources previously identified in past assessments (*i.e.*, the original listing rule and 2007 5-year review). Herein, we compile biological data and a description of past, present, and likely future stressors facing the black-capped vireo.

CHAPTER 2 – SPECIES BIOLOGY AND LIFE HISTORY

In this chapter, we provide basic biological information about the black-capped vireo, including its morphological description, taxonomic history and relationships, habitat types, and reproductive and other life history traits. We then outline the resource needs of individuals and populations of vireos. These resources are primarily used to determine the health and resiliency of the vireo. Finally, we consider the rangewide needs of the species with regard to its historical range.

2.1 Description

The black-capped vireo is one of the smallest vireos, weighing 9 to 10 grams (0.32 to 0.35 ounces) and measuring 11 to 12 centimeters (4.3 to 4.7 inches) in length (USFWS 1991, p. 2) when mature. It is sexually dichromatic (sexes have different colorations)(USFWS 1991, p. 2) and unique among vireos in having delayed plumage maturation in first-year males (Rohwer *et al.* 1980, p.404). Adult males are olive-green on the back, mostly white below with flanks of faint greenish-yellow (Campbell 2003, p. 29). The bill is black and the head is mostly black with prominent white spectacles extending to the lores, but interrupted over the eye (Oberholser 1974, pp. 700–701; USFWS 1991, p. 2; Grzybowski 1995, p. 2; Figure 1). The iris is brownish-red to red, wings and tail dark olive to blackish, and tertiary and secondary coverts with yellowish wing-bars (Oberholser 1974, pp. 700–701; USFWS 1991, p. 2). Some males show gray rather than black on the lower portions of the nape. The plumage of mature females is duller than males, with the head having a medium to dark gray head (Campbell 2003, p. 29). First breeding season males (second calendar year) have a gray nape and posterior crown (USFWS 1991, p. 2).

2.2 Taxonomy

The black-capped vireo was originally described by Woodhouse (1852) from a specimen taken in Val Verde County, Texas in 1851 (Sexton and Tomer 1990, p. 4). Its most closely related congener is believed to be the dwarf vireo (*Vireo nelsoni*), which occurs in Mexico and is very similar in size and plumage color, with the exception of its greenish gray cap (Grzybowski 1995, p. 2; USFWS 1991, p.2), and potentially the slaty vireo (*Vireo brevipennis*)(Slager *et al.* 2014, p. 98; Vázquez-Miranda *et al.* 2015, p. 6). The species taxonomy is currently accepted as described in David and Gosselin (2002, p.33):

Class: Aves
Order: Passeriformes
Family: Vireonidae
Species: *Vireo atricapilla*, Woodhouse, 1852.

Figure 1. Male black-capped vireo. *Photo by Gil Eckrich.*

2.3 Habitat Types

Habitat utilized by the black-capped vireo generally consists of three types that are associated with basic life history needs: breeding/nesting, wintering, and migration/staging.   Each habitat type is briefly described below.

2.3.1 Breeding/Nesting Habitat

The historical breeding range of the black-capped vireo extended from Kansas south to northern Mexico. Breeding season records of black-capped vireo are known from Coahuila, Nuevo León, Tamaulipas, and San Luis Potosí, Mexico, which is likely the extent of the breeding range in that country (Farquhar and Gonzalez 2005, p. 25).   In general, black-capped vireo breeding habitat is categorized as shrublands and open woodlands. Specifically, vireos utilize low scrubby growth, mostly comprised of deciduous vegetation, of irregular height and distribution, having foliage cover to ground level and with spaces between shrub/tree mottes (Grzybowski 1995, p. 4; Figure 2). Open area, or spaces between shrub mottes and trees consists of bare ground, rock, grasses

Figure 2. Typical black-capped vireo habitat at Fort Hood, Texas. *Photo by Scott Summers.*

and forbs (Marshall *et al.* 1985, p. 15). The presence of taller trees within preferred shrubby habitat are tolerated, and are often used as song perches, provided they conform to or do not disrupt the general shrubland/thicket configuration (Grzybowski 1985, p. 27). Within the breeding range (Figure 3), there is variation in the vegetational components that comprise breeding and nesting habitat, although within the United States (U.S.) range, habitat can be described as having 1) greater deciduous foliage density in the 0–3 meters (m)(0–10 feet (ft)) height classes, 2) fewer juniper species, 3) less-open habitats, and 4) greater heterogeneity in density of woody vegetation (especially deciduous)(Grzybowski *et al.* 1994, p. 534). Based on Grzybowski *et al.* (1994, p. 541), woody shrub cover of 35 to 55 percent is preferred by vireos. The conditions that provide shrubland habitat are primarily determined by climate, soil, and topography (Graber 1961, p. 315). In portions of the species' range, habitats are often described as early successional (*e.g.*, Campbell 2003, p. 30) or dependent on periodic disturbance (*e.g.*, wild or prescribed fire) to maintain suitable conditions (Bailey 2005, pp. 2–3).

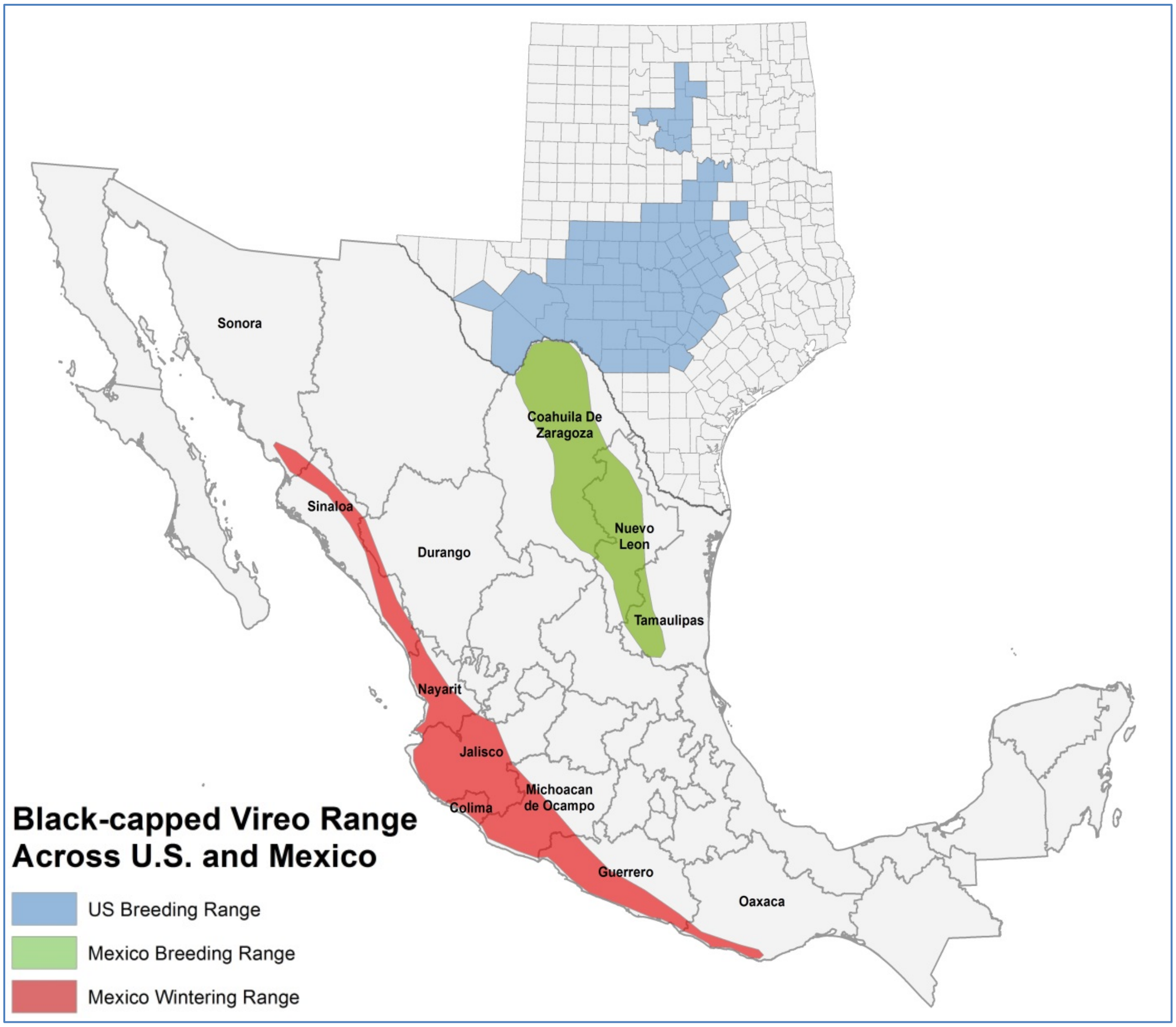

Figure 3. Known breeding and wintering range of the black-capped vireo.
Ranges are generalized from known locations.

In Mexico, the known breeding range generally occurs along the lowlands and canyons interspersed among the Sierra Madre Oriental region (Figure 3). While the general habitat patch characteristics of low (<3 m, 10 ft) growing foliage prominent in the U.S. portion of the breeding range apply, a distinction in the Mexican range is the lack of open areas between shrub mottes at some breeding sites (Benson and Benson 1990, p. 779; Farquhar and Gonzalez 2005, p. 10). Early descriptions of habitat in the state of Coahuila were described by Graber (1961, pp. 315–318). Common woody shrubs at Sierra Padilla, Coahuila, where black-capped vireos were abundant are listed in Table 1. In the Sierra Madera of Coahuila, vireos were only found on dry, limestone hillsides with thick "mats" of vegetation similar to Sierra Padilla, but lacked *Cercis* sp. and were dominated by *Quercus undulata* and *Rhus virens* (Graber 1961, p. 318). Two distinct categories were described by Farquhar and Gonzalez (2005, pp. 11–15) as dense low stature (<3 m, 10 ft) thornscrub in hilly regions of northeast Nuevo León and scrub oak woodlands and thornscrub along the bases and slopes of the Sierra Madre Occidental and along drainages of canyons in northern Coahuila. Dominant vegetation was recorded at sites in Nuevo León and Coahuila where black-capped vireos were detected (Table 1). Benson and Benson (1990, p. 777) censused a portion of northern Coahuila and described the area where vireos occurred as dominated by live and deciduous oaks that formed a montane low forest as described by Muller (1947). The area occupied by vireos occurred in an elevated, dissected, limestone plateau described as a desert scrub at the base of the mountains. In addition to the oaks (*Quercus* spp.) that often formed dense thickets, walnuts (*Juglans* spp.) and elms (*Ulmus* spp.) were common as well as both pinyon (*Pinus edulis*) and Ponderosa (*P. ponderosa*) pines (Benson and Benson 1990, p. 777).

In Oklahoma, the breeding range occurs in the central portion of the state that includes the Cross Timbers, Central Great Plains and Central Irregular Plains ecoregions (Woods *et al.* 2005, entire). Habitat used by the black-capped vireo for breeding is dominated by blackjack oak (*Q. marilandica*), post oak (*Q. stellata*) and eastern red cedar (*J. virginiana*)(Graber 1961, p. 316; Grzybowski *et al.* 1994, p. 540). However, a small population in the northern portion of the species' range lacked oaks in the past (USFWS 1991, p. 21). Eastern red cedar is known to be an invader in the historically grassland and oak woodland dominated areas due to natural wildfire suppression (Woods *et al.* 2005, entire). Graber (1961, p. 318) found *Celtis reticulata, Opuntia sp., R. glabra, Symphoricarpos orbiculatus*, and *Aesculus glabra* to be common where vireos occurred in Caddo County.

Black-capped vireo populations in Texas are well studied due to its large share of the breeding range and the preponderance of the known population occurring in the state. Breeding habitat in Texas is believed to occur in 69 counties extending from the Red River in north Central Texas, along the Balcones Escarpment, across the Edwards Plateau and westward into the Trans-Pecos ecoregion. Vegetation composition is variable across the state, but the general requirement of woody vegetation structure remains the same.

Table 1. Tree/shrub vegetation common in black-capped vireo habitat across the breeding range.

Location	**Plant species (common name)**	**Latin name**
Sierra Padilla and Sierra Madera, Coahuila, Mexico (Graber 1961, p. 318)	guajillo	*Acacia berlandieri*
	wavyleaf oak	*Quescus undulata*
	redbud	*Cercis* sp.
	Texas sotol	*Dasylirion texanum*
	yucca	*Yucca* sp.
	evergreen sumac	*Rhus virens*
	mimosa	*Mimosa* sp.

	Chisos red oak	*Quercus gravesii*
	gray oak	*Quercus grisea*
	pine	*Pinus* sp.
Northern Coahuila, Mexico (Farquhar and Gonzalez 2005, p. 13)	Texas sotol	*Dasylirion texanum*
	catclaw acacia	*Acacia roemeriana*
	little leaf ash	*Fraxinus greggi*
	chittamwood	*Bumelia lanuginosa*
	evergreen sumac	*Rhus virens*
	one-seed juniper	*Juniperus monosperma*
	Chisos red oak	*Quercus gravesii*
	gray oak	*Quercus grisea*
	lacey oak	*Quercus laceyi*
Nuevo León, Mexico (Farquhar and Gonzalez 2005, pp. 12–13)	netleaf forestiera	*Forestiera reticulata*
	evergreen sumac	*Rhus virens*
	lechuguilla	*Agave lechuguilla*
	slender grama	*Bouteloua repens*
	Texas sotol	*Dasylirion texanum*
	Texas persimmon	*Diospyros texana*
	kidneywood	*Eysenhardtia polystachya*
	one-seed juniper	*Juniperus monosperma*
	gumhead	*Gymnosperma glutinossum*
	Gregg lead tree	*Leucaena greggi*
	Texas live oak	*Quercus fusiformis*
	no common name	*Quercus invaginata*
	little leaf ash	*Fraxinus greggi*
	mountain laurel	*Sophora secundiflora*
	slimleaf rosewood	*Vauquelinia corymbosa*
Oklahoma (Graber 1961, p. 316)	blackjack oak	*Quercus marilandica*
	post oak	*Quercus stellata*
	eastern red cedar	*Juniperus virginiana*
Caddo County, Oklahoma (Graber 1961, p. 318)	hackberry	*Celtis reticulata*
	cactus	*Opuntia sp.*
	smooth sumac	*Rhus glabra*
	coralberry	*Symphoricarpos orbiculatus*
	Ohio buckeye	*Aesculus glabra*
Central Texas (Edwards Plateau and Cross Timbers and Prairies; Campbell 2003, p. 29)	Texas red oak	*Quercus buckleyi*
	shin oak	*Quercus sinuata* var. *breviloba*
	live oak	*Quercus fusiformis*

	lacey oak	*Quercus laceyi*
	Texas persimmon	*Diospyros texana*
	mountain laurel	*Sophora secundiflora*
	evergreen sumac	*Rhus virens*
	skunkbush	*Rhus trilobata*
	flameleaf sumac	*Rhus lanceolata*
	eastern redbud	*Cercis canadensis*
	Mexican buckeye	*Ungnadia speciosa*
	elbowbush	*Forestiera pubescens*
	agarita	*Berberis trifoliolata*
West Texas (Trans-Pecos; Campbell 2003, p. 29)	sandpaper oak	*Quercus pungens* var. *pungens*
	vasey oak	*Quercus pungens* var. *vaseyana*
	Texas kidneywood	*Eysenhardtia texana*
	Texas walnut	*Juglans microcarpa*
	Texas persimmon	*Diospyros texana*
	lotebush	*Ziziphus obtusifolia*
	Brasil	*Condalia hookeri*
	wafer ash	*Ptelea trifoliate*
	mountain laurel	*Sophora secundiflora*
	cenizo	*Leucophyllum frutescens*
	whitebrush	*Aloysia gratissima*
	guajillo	*Acacia berlandieri*

In general, black-capped vireo habitat in Texas can be found on limestone soils of the Edwards Plateau, Cross Timbers and Prairies and eastern Trans-Pecos ecoregions, and on igneous soils in the Chisos Mountains (Campbell 2003, p. 29). In the western Edwards Plateau and Trans-Pecos regions, vireo habitat is often associated with canyon bottoms and slopes, which support shrub vegetation (Campbell 2003, p.29). Dominant/common trees and shrubs in these regions are listed in Table 1. Ashe juniper (*J. ashei*) is widespread in central Texas, and is often a component of black-capped vireo habitat. However, it appears to be only tolerated by vireos and sites with less Ashe juniper as a component of shrub cover are more likely to be occupied by breeding vireos (Grzybowski *et al.* 1994, p. 519; Juarez 2004, pp. 56–57; Bailey and Thompson 2007, p. 834). Grzybowski *et al.* (1994, p. 541) suggested juniper cover of <10 percent and not exceed one-fourth of deciduous cover within occupied habitat.

Black-capped vireos may also be found using additional habitat types as part of a territory or for nesting in Texas. Such observed habitats include deciduous and oak-juniper woodlands (Pope *et al.* 2013a, p. 995) and the locally named “donut habitat” from Fort Hood Military Installation (Noa *et al.* 2007, p. 1043). Woodlands typically contain taller trees and more canopy cover than shrubland habitat, with deciduous woodlands used by vireos typically found along drainages (Pope *et al.* 2013a, p. 995). Fort Hood donut habitat is comprised of multiple “donuts,” which are defined as areas of scrubby vegetation <2 m (6.6 ft) in height (predominately oaks) that surround a larger tree or group of trees and is usually surrounded by grass or bare ground (Noa *et al.* 2007, p. 1043).

2.3.2 Winter (non-breeding) Habitat

The non-breeding winter range of the black-capped vireo is confined to western Mexico (Figure 3). It is patchily distributed along the Pacific slopes of the Sierra Madre Occidental from southern Sonora through Sinaloa, Durango, Nayarit, Jalisco, Colima, Michoacán, Guerrero, and Oaxaca, Mexico (Wilkins *et al.* 2006, p. 10; Powell 2013, p. 34). The majority of records occur in Sinaloa and Nayarit, which was described as the center of the wintering grounds by Graber (1961, p. 314). More recent information indicates the larger proportion of the winter range may also include Jalisco and Colima (Wilkins *et al.* 2006, p. 11). Data also suggest that the northern states within the wintering range (from Sinaloa to Colima) contain the majority of the wintering population (Powell 2013, p. 34).

Habitat types used by black-capped vireo in the non-breeding winter range are poorly known. However, the wintering habitat requirements consist of a wider range of vegetation types than that of the breeding grounds (Graber 1961, p. 319; Vega Rivera *et al.* 2010, p. 102). Two habitats, an arid scrub 0.6 to 3.0 m (2 to 10 ft) in height from Sinaloa and a more diverse, mesic cut-over second growth habitat from Nayarit, were described by Graber (1961, p. 319). Both habitats contained low-growing deciduous vegetation (Graber 1961, pp. 319–320). Winter habitat described by Howell and Webb (1995 p. 617) consisted of either arid to semi-arid scrub (especially where oaks are present) or humid, brushy, secondary growth and forest edge. Research has supported Graber (1961) and Howell and Webb (1995) by finding vireos selected habitat with significantly less canopy cover, denser shrubs and steeper slopes than random habitat points (Powell 2013, p. 90). Vireos have also been found preferring south-facing slopes in the winter range (Powell 2013, p. 91). A variety of other habitat types have also been used, including shade coffee plantations, fruit and vegetable plantations, thorn forest, riparian forest, pine-oak forest and deciduous forest (Wilkins *et al.* 2006, p. 19; Vega Rivera *et al.* 2010, p. 102). Wintering vireos are generally found at altitudes from sea level to 1,462 m (4,798 ft) above sea level (asl), with a mean altitude of 585 ± 100 m asl (1,919 ± 328 ft asl)(n=56, Wilkins *et al.* 2006, p. 19).

2.3.3 Migration

Little is known about the habits of black-capped vireos during migration. Migration is believed to be mainly nocturnal (Grzybowski 1995, p. 3). Vireos arrive on the breeding grounds in Texas from mid-March to mid-April and mid- to late April in Oklahoma (Grzybowski 1995, p. 3; Campbell 2003, p. 31). Adult males generally arrive 1 to 2 weeks earlier than females (Graber 1961, p. 322). Fall migration begins in July, but most occurs in August and September (Grzybowski 1995, p. 3; Campbell 2003, p. 31). Young birds migrate first (by late August), followed by adult females (most by early September), and then adult males (Graber 1961, p. 333). Information on the migratory route(s) to and from the breeding grounds is lacking. Due to a lack of records from Sonora, Mexico, Moore (1938, p. 25) suggested a route across the tableland through Chihuahua, Mexico, east of the Sierra Madre Occidental and through the canyons of southwestern Chihuahua and Durango. This route would be the most direct connection of the breeding and wintering grounds. Graber (1961, p. 315) agreed with the possibility of this route, though did not find evidence of suitable habitat existing in the region.

Marshall *et al.* (1985, p. 4) suggested there was no evidence for a straight line migration route between the breeding and wintering grounds, but instead a fall migration would circumvent the Central Plateau and follow the Sierra Madre Oriental. Further evidence of such a route was confirmed by the extension of the breeding range in Mexico (Farquhar and Gonzalez 2005, entire). Breeding vireos documented in Nuevo León and Tamaulipas give additional support for a southerly, central Mexican migratory route (Farquhar and Gonzalez 2005, p. 22; Figure 4).

At Fort Hood, data indicate hatch-year vireos may depend on non-breeding habitat prior to fall migration (Dittmar *et al.* 2014, entire). Juvenile vireos (independent of parental care) equipped with radio transmitters were more often found in riparian habitat than other habitats (Dittmar *et al.* 2014, entire).

2.4 Breeding Range

Historically, the black-capped vireo breeding range extended from south-central Kansas through Oklahoma and Texas and south to central Coahuila, Mexico (Grzybowski 1995, pp. 1–2). Scant records and one specimen have been documented, albeit as an accidental summer resident, in southeastern Nebraska (Graber 1961, p. 313). Its historical prevalence in Kansas is unknown, although the state is the northern extent of known breeding records and both male and female specimens were taken as far back as 1885 (Tordoff 1956, p. 342). Recent molecular analysis suggests a historically limited or non-existent range in Kansas (Vázquez-Miranda 2015, p. 7). It has not been reported from Kansas since 1953 (Grzybowski 1985, p. 5).

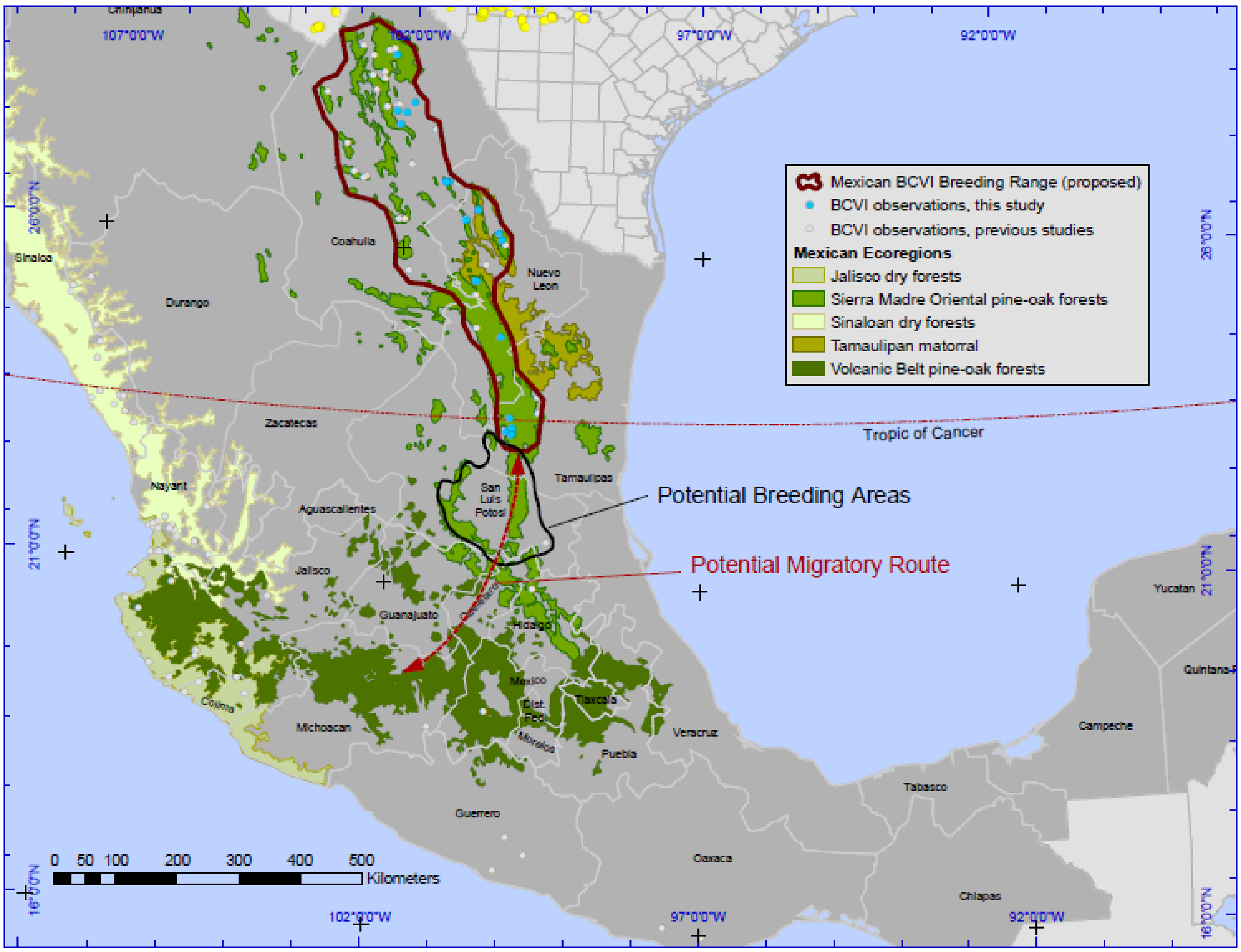

Figure 4. Breeding areas and potential migratory route of black-capped vireo in Mexico. From Farquhar and Gonzalez (2005, p. 24); used with permission.

At the time of Graber's (1961) seminal work on the species, breeding vireos were known in Oklahoma from Caddo, Dewey and Major Counties, with observations also occurring in Blaine, Canadian, Beaver, Cleveland and Payne Counties (p. 314). A thorough search failed to find birds in Comanche (where it now thrives) and Murray Counties (Graber 1961, p. 314). Modeling using genetic samples from black-capped vireos shows a much more restricted range up to 120,000 years ago relative to the present range, although the estimated population may have been significantly larger (Vázquez-Miranda *et al.* 2015, pp. 7–8).

Wilkins' *et al.* (2006, pp. 26–28) compiled records of the black-capped vireo across its range and developed a potential distribution of the species (Figure 5). Their analysis included a comparison of data on confirmed records by county in the U.S. from 1990 to 1996 to records known from 2000 to 2005. From 1990 to 1996, the vireo was confirmed present in three Oklahoma counties and 40 Texas counties. From 2000 to 2005, Wilkins *et al.* (2006, p. 93) confirmed vireo records from three Oklahoma counties and 38 Texas counties. It was suggested that the vireo no longer occurs in Kansas (Wilkins *et al.* 2006, p. 9).

Prior to 2003, the black-capped vireo's southern-most confirmed breeding range was in central Coahuila, Mexico (Wilkins *et al.* 2006, p. 10). Since then, confirmed breeding has been documented in Nuevo León and Tamaulipas, extending the known breeding range 520 km (323 mi) southeast from the previous southernmost record near Ocampo, Coahuila (González-Rojas *et al.* 2014, p. 151).

Since Wilkins *et al.* (2006), the Service has compiled valid records of the species within the U.S. portion of its range. From 2009 to 2014, the vireo has been confirmed in five Oklahoma counties and 40 counties in Texas (USFWS unpublished). During development of the 2007 5-year review, the range of the black-capped vireo in the U.S. was delineated based on Wilkins *et al.* (2006), using cumulative occurrence data, by county, which was much larger than the known range at the time and included locations where black-capped vireo had not been recorded in more than twenty years. In this assessment, the current range of the black-capped vireo is used (USFWS 2015), rather than the range used in the 2007 5-year review. Additionally, the Recovery Units defined in USFWS (2013, p. 33) are used in this assessment, which also differs from the 2007 5-year review. A comparison of the known U.S. distribution by county (modified from Wilkins *et al.* 2006) is presented in Table 2 and shown in Figure 5. Since the 2007 5-year review, 10 counties in the U.S. with previous occurrence of black-capped vireos have not been confirmed, and 14 counties not identified in the previous review have been confirmed occupied by black-capped vireos.

McFarland *et al.* 2013 (entire) conducted a comprehensive survey in 2009 of 57 counties in Texas, which detected 460 black-capped vireos at 4,056 points (11 percent)(Figure 6). The surveys include the first detection of black-capped vireos in Pecos County in over 30 years.

Additional records have recently been reported far outside both the current and historical ranges. In 2004, a black-capped vireo was confirmed from a migrant trap in Roosevelt County, New Mexico. In 2009 and 2010, a singing male on territory was found in the Guadalupe Mountains in southeastern New Mexico (USFWS, unpublished). There is very little additional information on vireo occurrence in New Mexico; thus, its status in that state is unknown. There is speculation among some experts that the possibility of expansion into New Mexico is possible. At least two aberrant records are known from Canada, including an immature male caught in a mist-net in British Columbia in 2008 (Brown 2008, p. 8).

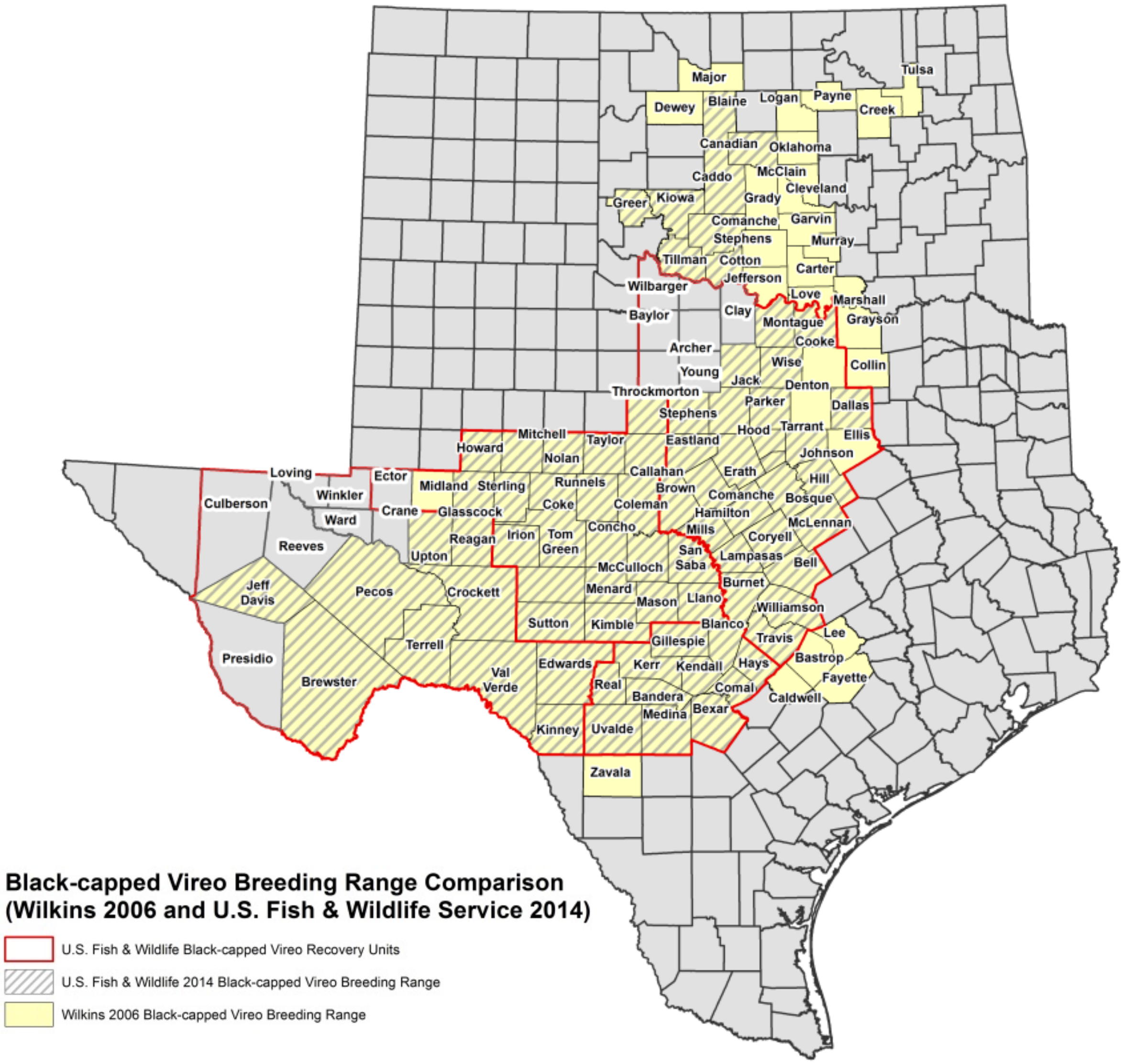

Figure 5. Comparison of black-capped vireo breeding range as outlined by Wilkins *et al.* (2006) and USFWS (2014).

Table 2. Counties within the U.S. with confirmed presence of the black-capped vireo during three time intervals: 1996, 2000-2005 (Wilkins *et al.* 2006) and 2009 to 2014. Green cells indicate a county previously not confirmed from Wilkins *et al*. 2006 (14 total) and red cells indicate a county not confirmed since last 5-year review (10 total).

State	County	USFWS 1996	Wilkins *et al.* 2006	USFWS 2009–2014
Oklahoma	**Blaine**	confirmed	confirmed	confirmed
	Canadian			confirmed
	Cleveland	confirmed	confirmed	
	Comanche	confirmed	confirmed	confirmed
	Greer			confirmed

	Kiowa			confirmed
Texas	**Bandera**	confirmed	confirmed	confirmed
	Bell	confirmed	confirmed	confirmed
	Bexar	confirmed	confirmed	confirmed
	Blanco	confirmed	confirmed	
	Bosque	confirmed	confirmed	
	Brewster	confirmed	confirmed	confirmed
	Burnet	confirmed	confirmed	confirmed
	Callahan		confirmed	
	Coke	confirmed	confirmed	
	Coleman		confirmed	confirmed
	Concho		confirmed	confirmed
	Coryell	confirmed	confirmed	confirmed
	Crockett	confirmed	confirmed	confirmed
	Dallas		confirmed	
	Eastland			confirmed
	Edwards	confirmed	confirmed	confirmed
	Erath	confirmed	confirmed	confirmed
	Gillespie	confirmed		confirmed
	Hamilton	confirmed	confirmed	
	Hays	confirmed		confirmed
	Irion	confirmed		
	Jack			confirmed
	Kendall	confirmed		confirmed
	Kerr	confirmed	confirmed	confirmed
	Kimble	confirmed	confirmed	confirmed
	Kinney	confirmed	confirmed	confirmed
	Lampasas	confirmed		confirmed
	Llano			confirmed
	Mason	confirmed	confirmed	confirmed
	McCulloch		confirmed	confirmed
	Medina		confirmed	
	Menard		confirmed	confirmed
	Mills	confirmed		confirmed
	Montague		confirmed	
	Nolan	confirmed	confirmed	confirmed
	Palo Pinto	confirmed	confirmed	confirmed
	Pecos	confirmed		confirmed
	Real	confirmed	confirmed	confirmed
	Runnels	confirmed	confirmed	confirmed
	San Saba	confirmed	confirmed	confirmed

Schleicher			confirmed
Somervell	confirmed	confirmed	confirmed
Stephens	confirmed		
Sterling	confirmed		
Sutton	confirmed	confirmed	confirmed
Taylor	confirmed	confirmed	confirmed
Terrell	confirmed	confirmed	confirmed
Tom Green	confirmed	confirmed	
Travis	confirmed	confirmed	confirmed
Uvalde	confirmed		confirmed
Val Verde	confirmed	confirmed	confirmed
Williamson	confirmed	confirmed	confirmed
Number of Counties	43	41	45

2.5 Winter (non-breeding) Range

Black-capped vireos are known to winter during the non-breeding season along Mexico's western edge from the foothills of the Sierra Madre Occidental to the coast (Graber 1961, p. 314) and extending from Sonora to Oaxaca (Wilkins *et al.* 2006, p. 10). Very few studies have concentrated on the winter range, but those few have evaluated the Mexican states of Sonora, Sinaloa, Durango, Nayarit, Jalisco, Colima, Michoacán, Mexico, Guerrero, and Oaxaca (Wilkins *et al.* 2006, p. 10). Specimens exist from each state with the exception of Sonora. Most wintering birds are thought to occur in the northern most portion of this range, from southern Sinaloa to Colima (Graber 1957, p. 314; Powell 2013, pp. 145–146). Modeling efforts have predicted wintering areas to be spread across 103,000 to 141,000 km^2 (39,769 to 54,440 mi^2) and extend further than previous records have identified, including the states of Guerrero and Chiapas (Vega Rivera *et al.* 2010, p. 101; Powell 2013, pp. 34–38).

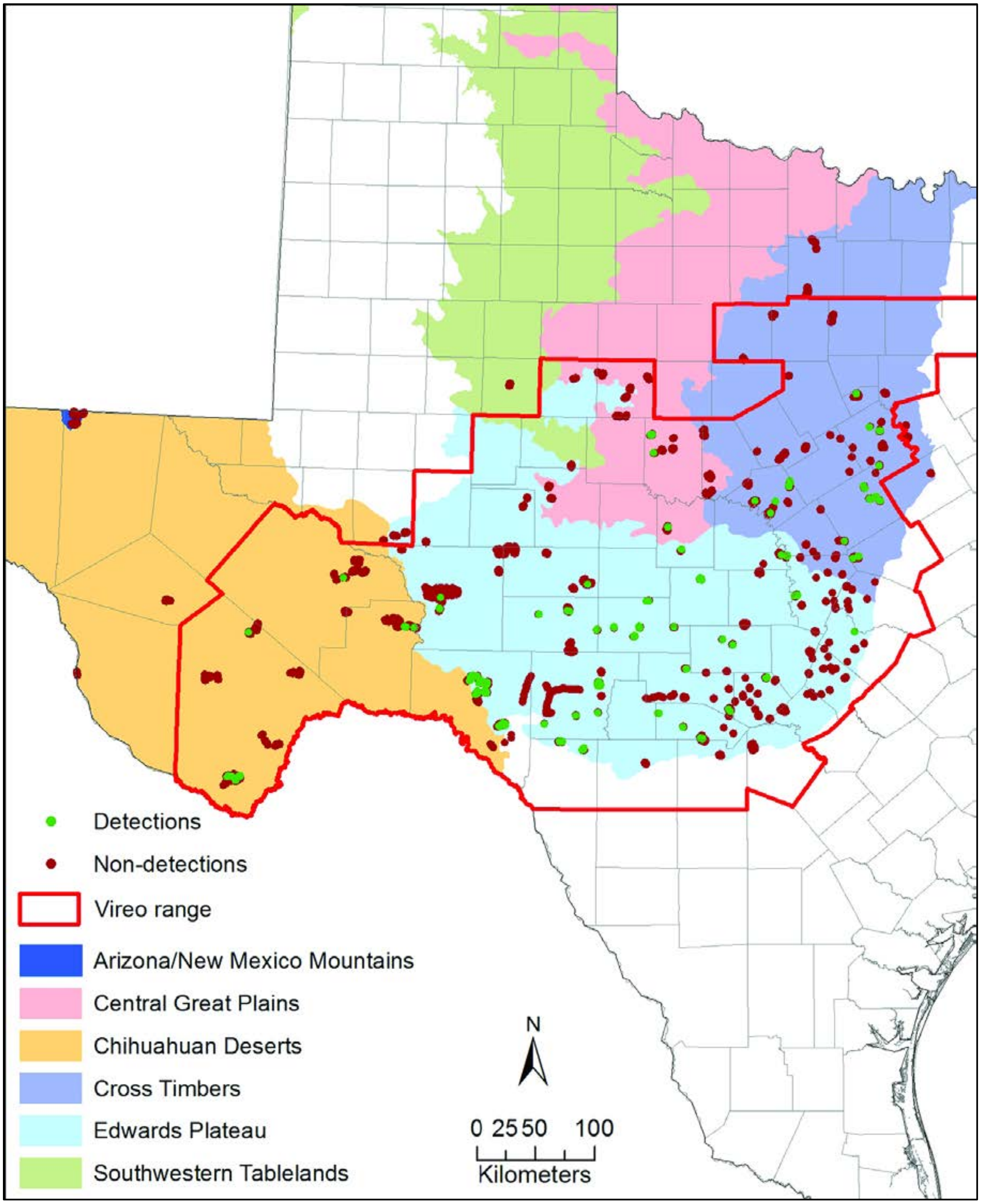

Figure 6. Results from McFarland *et al.* (2013) black-capped vireo surveys. Sampling occurred in 57 counties in 8 different ecoregions across the range. Area outlined in red indicates the vireo's breeding range in Texas as suggested for revision by the Population and Habitat Viability Assessment Report (USFWS 1996). Used with permission.

No information is known about territoriality or individual spacing on the wintering grounds (Grzybowski 1995, p. 10). Graber (1957, p. 319) described vegetation conditions of non-breeding habitat in Nayarit and Sinaloa as more generalized than the breeding range. Sinaloa habitat utilized by wintering black-capped vireos include arid scrub 0.6 to 3 m (2 to 10 ft) in height, while the habitat in Nayarit was mesic, cut-over secondary growth with a more diverse woody structure (Graber 1957, p. 319). Marshall *et al.* (1985, p. 17) indicated the wintering black-capped vireos documented in their survey of the same states were at higher elevations than mentioned in Graber (1957), but noted the later timeframe (December) of that study. There is evidence that differential migration exists between genders and young birds. Powell (2013, p. 39) found a greater proportion of males in the northern latitudes of the winter range and females and juveniles in southern latitudes. This type of segregation in birds is often explained as 1) dominant individuals occupying optimal habitat, which forces subordinates into less optimal areas (Ketterson and Nolan 1976, pp. 687–688), and 2) advantage in intrasexual competition by choosing wintering areas closer to the breeding grounds (Myers 1981, p. 1532). Considering the accepted migration route following the Sierra Madre Oriental, gender segregation along the southern portion of the wintering range would require a much longer distance and earlier departure period for spring migration for the males to arrive before females on the breeding grounds.

2.6 Territoriality

Male black-capped vireos usually arrive before females in breeding areas and establish territories that range from 1.0 to 1.9 hectares (ha)(2.5 to 4.6 acres (ac); mean = 1.5 ha (3.7 ac), Graber 1961, p. 323) but have been recorded up to 4.1 ha (10.1 ac; Tazik 1991, p. 32). On Fort Hood, territory size ranged from 2.9 ha (7.2 ac) in 1987 to 4.1 ha (10.1 ac) in 1989 (mean = 3.6 ha (8.9 ac)) and appears to have varied inversely with population density (Tazik 1991, p. 113). Black-capped vireo territories often occur in clusters or groupings within a habitat patch (USFWS 1991, p. 17). Males defend a territory primarily through song along the boundaries, but also by threats (using posture) and chases that occasionally result in physical contact (Grzybowski 1995, p. 9). Males sing daily (most intensely in the mornings) during the entire breeding season, though frequency diminishes in July and August (Grzybowski 1995, p. 7). Males are unlikely to move far from an established territory (Graber 1961, p. 322). Trespassing of non-vocalizing first-year males is tolerated by territorial males in mid-to late season. Females do not chase male intruders, but have been observed attacking and chasing other female intruders into their mate's territory (Grzybowski 1995, p. 9). Black-capped vireo territories have been known to overlap those of Bell's (*V. bellii*), white-eyed (*V. griseus*), gray (*V. vicinior*), yellow-throated (*V. flavifrons*), red-eyed (*V. olivaceus*) and Hutton's (*V. huttoni*) vireos (Graber 1961, p. 316; Grzybowski 1995, p. 10; D. Cimprich, pers. comm.). Agonistic encounters with congeners with overlapping territories are rare (Grzybowski 1995, p. 10).

2.7 Pair Bond/Courtship

Pair formation occurs immediately upon arrival of female black-capped vireos (Graber 1961, p. 323). Courtship largely consists of song and display (Graber 1961, p. 323), but the exact sequence of pair formation behavior is not known (Grzybowski 1995, p. 10). Some courtship flights have been observed, largely pursuit of the female by a male (Graber 1961, p. 323), as well as wing spreading, quivering and posturing by the male (Grzybowski 1995, p. 10). Pairs often remain mated throughout the breeding season (Grzybowski 1995, p. 10; Graber 1961, p. 323), although some females change mates within and between seasons (Grzybowski 1995, p. 10). There are genetic data suggesting extra-pair copulations may occur (Athrey *et al.* 2012b, p. 4362), but further study on this topic is needed.

Pairing success (males obtaining a mate) varies and has been reported from 69 percent (USFWS 1991, p. 18) to 99 percent (Cimprich and Heimbuch 2013, p. 16). At Fort Hood, mating success for males was 93.8 percent over a two-year study (Tazik 1991, p. 74).

2.8 Nest construction, Egg-laying, and Hatching

Nest sites are selected by vireo pairs together; previous nest sites are often repeatedly used (Graber 1961, p. 324). Both the male and female will construct the nest, although the male's effort is more limited and at least in instances when the male is caring for a first brood, the entire nest has been constructed by the female alone (Graber 1961, p. 324). The nest is a small, pendant cup, ranging from 5.8 to 6.2 cm (2.3 to 2.4 in) wide and 3.7 to 3.9 cm (1.5 to 1.5 in) in depth (Graber 1961, p. 324) that is hung from a terminal or sub-terminal horizontal branch, approximately 0.5 to 2.0 m (1.6 to 6.6 ft) above the ground (Grzybowski 1995, p. 12). The nest site is usually a shrub within shrub mottes, with leafy vegetation extending to the ground (Grzybowski 1995, p. 12). Deciduous shrubs are preferred, particularly dominant oaks in more mesic areas. Graber (1961, p. 324) observed 73 percent of nests (n=70) in blackjack oak in Oklahoma. In central Texas, Texas red oak (*Q. buckleyi*) and shin oak were used for nest sites (> 50 percent of all nests, n= 358) in greater proportion than available shrubs, and Ashe juniper (third most used for nest sites) was used less than the proportion available (Bailey and Thompson 2007, p. 833). Unpaired males may build nest platforms in order to attract females (USFWS 1991, p. 17; Grzybowski 1995, p. 12). Multiple nesting attempts (nests that contain an egg or nestling) may occur after prior nest failure, with as many as seven being recording by a single territorial male (Walker 2014, p. 17).

Egg-laying generally begins in late April and reaches its peak during May in Texas and June in Oklahoma (Graber 1961, p. 325). In the western portion of the breeding range, incubation may begin earlier than in other parts of the range (Smith *et al.* 2012a, p. 283). The initial clutch consists normally of four eggs, later season clutches with 3 or 4 eggs (Graber 1961, p. 326;

Grzybowski 1995, p. 13). One egg is usually laid per day (USFWS 1991, p. 17) and on consecutive days (Graber 1961, p. 325). Both male and female incubate the eggs; however females spend more time at the nest, especially during the nestling stage (Pope *et al.* 2013b, p. 5). Incubation of eggs ranges from 14 to 19 days, but normally 15 to 16 days (Graber 1961, p. 326; USFWS 1991, p. 18). Eggs hatch over a two-day period (Graber 1961, p. 327) and chicks are born naked and blind (USFWS 1991, p. 18; Figure 7). Females may successfully rear two broods in a single season, but it is estimated that it occurs in less than 10 percent of populations (Grzybowski 1995, p. 18).

Figure 7. Female black-capped vireo feeding nestlings. *Photo by Gil Eckrich.*

2.9 Survival, Growth, and Longevity

Nest monitoring at Fort Hood indicated the egg-laying stage has the lowest daily survival rate compared to incubation and nestling stages (Cimprich and Heimbuch 2013, p. 19), the lowest rates occurring in nests initiated late in the breeding season (Bailey 2005, p. 52). The nestling stage ranges from 9 to 12 days, but is normally 11 days (USFWS 1991, p. 18). Few studies exist of daily survival of young during the nesting period; however, monitoring at Fort Hood of the approximate 28-day nesting period from 2003 to 2013 ranged from about 18 to 44 percent (Cimprich and Heimbuch 2013, p. 23). Both male and female feed young, but the majority of food items is provided by the male (Grzybowski 1995, p. 14). Chicks open their eyes at five days and gain about a gram per day until weighing between 7 and 8 grams (Graber 1961, p 327). The young are well-feathered by day 10 and begin to leave the nest on the 11th or 12th day (Graber 1961, pp. 327–328). Both adults attend the fledglings and feed them together or singly, or split the brood between them (Grzybowski 1995, p. 14). By day 25 after fledging, the young can forage for themselves and are more independent, although they are generally still attended by the adults; complete independence generally occurs between 35 and 45 days after fledging (Grzybowski 1995, p. 17). At Fort Hood, juvenile black-capped vireos often utilize riparian areas, presumably for food and cover, after becoming independent of parental care (Dittmar *et al.* 2014, entire).

The majority of males (75 to 99 percent) greater than one-year old find mates during the breeding season, compared to 20 to 60 percent of 1st year males (Grzybowski 1995, p. 17). Estimates of average annual survival of adult vireos have been based on return rates from banded birds. There is a wide range of survival estimates based on this methodology. At Kerr WMA in Texas annual survival of males was estimated between 0.55 and 0.75 (Grzybowski 1991, p. 37). An annual survival rate of 0.57 has been used for two population viability analyses for the species (USFWS 1995, p. 15; Parysow and Tazik 2002, p. 221). Over a 10-year period at Fort Hood (1997 to 2009), survival rates for black-capped vireos ranged from 0.36 to 0.60 (n=912; Kostecke and Cimprich 2008, p. 254). Female survival is not well known, but is presumed to be lower than males because sex ratios favor males (Grzybowski 1995, p. 18). Estimates of juvenile survival are also not well established, but have been estimated at 0.43 for the purposes of population viability analyses (USFWS 1995, p. 15). Grzybowski (2005, entire) predicts that juvenile survival may be greater than 2/3 that of adults. Black-capped vireos have been documented to live up to 12 years based on banding information (Cimprich *et al.* 2010, p. 43).

2.10 Dispersal

Adult breeding vireos show strong site fidelity to territories between breeding seasons, especially in larger populations (USFWS 1991, p. 19). Mean dispersal distances measured from banded birds at Fort Hood were 0.21 and 0.19 km (0.13 and 0.12 mi) for males and 0.14 and 0.41 km (0.09 and 0.25 mi) for females in 2000 and 2001, respectively (DeBoer and Kolozar 2001, entire). Long dispersal distances have been recorded up to 12.8 km (8 mi) for males and 10 km (6.2 mi) for a female (USFWS 1991, p. 19). Natal dispersal, the movement from hatch site to breeding site, is known to be much greater, generally from 21 to 30 km (13 to 19 mi)(Grzybowski 1995, p. 18; Cimprich *et al.* 2009, p. 46). The longest dispersal distance of a banded nestling re-sighted as a breeding adult was 78 km (48.5 mi)(Cimprich *et al.* 2009, entire). Evidence exists that female-biased dispersal occurs in black-capped vireos (Athrey *et al.* 2012b, entire). Restricted dispersal in males may influence local genetic diversity in populations where females contribute more to dispersal (Athrey *et al.* 2012b, p. 4367).

2.11 Individual Needs

This section considers the needs of individual black-capped vireos through the three general phases of its life history – breeding, migration, and wintering. The consideration of the sub-adult stages (egg, nestling, fledgling, and hatch-year/juvenile) will be described within the relevant phases and based on the availability of information. The needs of individuals during migration and wintering are discussed under Species Rangewide Needs (Section 2.13).

2.11.1 Breeding

Individual male and female black-capped vireos require suitable breeding habitat with which to establish a territory, construct a nest in suitable substrate, and forage for food for themselves and their offspring. Territories consist of shrub mottes covering 35 to 55 percent of the area and interspersed among grasses, forbs, rocks, and soil. Specific vegetation components within territories vary within the breeding range of the species. Within the U.S. portion of the range, territories would likely have 1) greater deciduous foliage density in the 0–3 m (0–10 ft) height classes, 2) fewer juniper species, 3) less-open habitats, and 4) greater heterogeneity in density of woody vegetation (especially oaks)(Grzybowski *et al.* 1994, p. 534). Vegetation within such territories would supply materials needed to construct nests at preferred sites. Based on the average territory size, a single mated pair may need a minimum of 1.5 ha (3.7 ac) for a single successful breeding season.

2.11.2 Feeding Habits and Diet

Adult and fledgling black-capped vireos forage for insects within their preferred habitat mostly by gleaning them from vegetation (Graber 1961, p. 332; Grzybowski 1995, p. 5; Houston 2008, p. 23). Males tend to forage higher (>2 m; 6.6 ft) in vegetation strata than females in breeding habitats (Grzybowski 1995, p. 5; Houston 2008, p. 17). The need for increased structural heterogeneity in vegetation, including vertical strata above 3 m (10 ft) may be important for foraging, especially for males and juveniles (Houston 2008, p. 26).

The diet of black-capped vireos consists mainly of arthropods, and of those mostly Lepidoptera (butterflies and moths) larvae (Graber 1961, p. 332). They will also supplement the diet with plant matter, mainly seeds (Graber 1961, p. 332; Grzybowski 1995, p. 5). Most foraging in Texas occurs in deciduous vegetation, largely live oak, as well as shin oak, and Texas red oak (Houston 2008, p. 16; Morgan 2012, p. 41). When available, considerable foraging may also occur in Ashe juniper trees (Morgan 2012, p. 41).

2.11.3 Nesting Substrate

In Texas and Oklahoma, the most frequently used shrubs for nest sites are blackjack oak, shin oak, Texas red oak, live oak, redbud, sugarberry (*Celtis laevigata*), evergreen sumac and Texas persimmon (Graber 1961, p. 324; Grzybowski 1995, p. 12). At Fort Hood Military Reservation, the most common shrub used for nesting was Texas red oak, followed by shin oak and Ashe juniper, although Ashe juniper was used less than the proportion available, suggesting it is not favored as a nest site (Bailey and Thompson 2007, p. 833). In habitat patches, dense woody cover is avoided for nest sites (Bailey and Thompson 2007, p. 833). Vireos prefer increased vegetation cover below 2 m (6.6 ft) within a 5-m (16.4-ft) radius of nests (Bailey and Thompson 2007, p. 834).

On Fort Hood, vireos were 283 percent more likely to nest in deciduous substrates, such as oaks, than in juniper (Bailey and Thompson 2007, p. 834). Bailey (2005, p. 13) located 358 black-capped vireo nests found in 16 different deciduous shrubs and Ashe juniper. Although Ashe juniper appears to be avoided in habitat patches (Grzybowski *et al.* 1994, p. 538) and as nesting substrate, daily nest survival rate for nests in juniper and deciduous shrubs are similar (Bailey 2005, p. 56).

For nest sites, spatial heterogeneity in woody vegetation is important to black-capped vireos (Bailey 2005, p. 14; Grzybowski 1994, p. 541). Dense foliage of shrubs extending from the ground to >2 m (6.6 ft) is important for nest concealment from the elements and predators (Grzybowski 1994, p. 539).

Nest survival is greatest for nests initiated early in the breeding season. This may be attributed to cooler temperatures that limit rat snake foraging (Bailey 2005, p. 50; Sperry *et al.* 2008, p. 82). Second broods and re-nesting attempts due to initial nest failure are more likely to fail as rat snake predation increases in warmer temperatures (Bailey 2005, p. 53).

2.12 Population Needs

A population consists of a group of individuals of a species that interbreed with other members of the same population. Populations need a minimum number of individuals to maintain viability and persist over time. For the black-capped vireo, populations are best identified on the breeding grounds where limitations of suitable habitat continuity and natural adult dispersal, allow a distinct geographical separation of groups of individuals. The needs of populations during migration and wintering are discussed under Species Rangewide Needs (Section 2.13).

2.12.1 Habitat Patch Requirements

Black-capped vireos spend mid-March to mid-September on suitable breeding areas in Texas, south central Oklahoma and northeastern Mexico. The majority of this time is spent within the habitat patch, which is shrublands, mostly deciduous shrubs less than 3 m (10 ft) tall and with foliage extending to the ground, patchily distributed with shrub canopy coverage between 35 to 55 percent. Within habitat patches, black-capped vireos appear to prefer nesting areas with greater edge density (Bailey and Thompson 2007, p. 832). Fine scale habitat heterogeneity in woody cover appears to be preferred by black-capped vireos, which may provide advantages in nest concealment from predators (Bailey 2005, pp. 14–15).

Few estimates exist of the minimum patch size requirements to sustain black-capped vireos. Tazik (1991, p. 33) estimated a reasonable number of vireos for management may be 10 to 20 territories occurring on 40 to 80 ha (99 to 198 ac) and 50 to 100 ha (123 to 247 ac) and include buffer areas. At Fort Hood, habitat patches have included an area of only 0.02 ha (0.50 ac)(Bailey and Thompson 2007, p. 829). However, Graber (1961, p. 316) suggested a minimum patch of 4 to 5 ha (10–12 ac) based on the smallest group (five males and three females) observed. Based on available information and analysis of extant populations, USFWS (2013, p. 20) has recommended areas of at least 100 ha (247 ac) of occupied breeding habitat for long term management of black-capped vireo populations. Areas with 100 ha (247 ac) of breeding habitat are expected to support at least 30 adult males, with adequate management.

For this assessment, we define two population types, manageable and likely resilient. As discussed above, a population or locality with at least 30 adult males may be sustained through management of stressors. We define a "manageable population or locality" as breeding habitat supporting a minimum of 30 adult males. Management of such localities consists largely of vegetation management (mostly in the eastern portion of the range) and cowbird management. Vegetation management, such as prescribed fire, often leaves breeding habitat unsuitable for one to three years. As a conservative measure to allow for fluctuating availability of habitat due to management, we define a "likely resilient population or locality" as breeding habitat supporting greater than 100 adult males, which is more than three times the size of a manageable locality. Likely resilient populations or localities may still require habitat and/or cowbird management; however, they are more suited to withstand stochastic events.

2.12.2 Brood Parasitism

Black-capped vireo reproductive success is almost always negatively affected by brood parasitism. Brood parasitism is a breeding strategy employed by various species of birds and insects involving a "brood parasite" (Payne 1977, p. 1) laying their eggs in the nest of other species which become the "host" (Figure 8). There are at least 85 species of birds considered brood parasites (May and Robinson 1985, p. 475), three of which, the brown-headed (*Molothrus ater*), bronzed (*M. aeneus*), and shiny cowbirds (*M. bonariensis*) occur in the U.S. (Wilkins *et al.* 2006, p. 68). The most widespread of these is the brown-headed cowbird, which exploits more than 200 different host species (Mayfield 1965, entire) and has been implicated in the decline of several North American passerine species, including the black-capped vireo (Ortega *et al.* 2005, p. 6). Host species that do not have an effective defense against parasitism (*e.g.*, by deserting the nest or removing the cowbird egg), will then raise the cowbird chick(s) as their own (Peer *et al.* 2005, entire). Female brown-headed cowbirds often remove or puncture the host's eggs prior to laying her own eggs (Payne 1977, p 5). The young cowbirds generally hatch quickly and grow rapidly, often receiving the majority of food supplied by the foster parents, which often raise fewer or none of their own offspring (Peer *et al.* 2005, pp. 85–86).

Figure 8. Black-capped vireo nest parasitized by brown-headed cowbird (large spotted egg). *Photo by Scott Summers.*

Brood parasitism by brown-headed cowbirds is known to greatly inhibit reproductive success in black-capped vireos (*e.g.*, Kostecke *et al.* 2005; Campomizzi *et al.* 2013; Wilsey *et al.* 2014).

Black-capped vireos may be more susceptible to brood parasitism than sympatric songbirds due to late nest initiation during the breeding season (Campomizzi *et al.* 2013, p. 716). A common response to nest parasitism is desertion by host species, resulting in nest failure (Tazik and Cornelius 1993, p. 43). Studies at Fort Hood, Texas determined the percentage of black-capped vireo nests parasitized by cowbirds (= parasitism rate) was greater than 90 percent prior to the initiation of cowbird control (Kostecke *et al.* 2005, p. 29). Because nest success for a parasitized site is substantially reduced, populations decline under high parasitism rates (Kostecke *et al.* 2005, p. 32; Wilsey *et al.* 2014, p. 568).

Although brood parasitism is a natural factor in the life history of the black-capped vireo, anthropogenic events have increased the rate of parasitism within populations across its range (see Chapter 3, Section 3.5). Several studies have provided estimates of parasitism rates that black-capped vireo populations could sustain without decline. Tazik and Cornelius (1993, p. 49) estimated parasitism limits to maintain a stable population at Fort Hood to be between 16–38 percent. Population modeling at several populations in Texas indicated a parasitism rate of up to 30 percent could be tolerated by black-capped vireos while maintaining a stable population (Smith *et al.* 2013, p. 3). Wilsey *et al.* (2014) developed several modeling scenarios at Fort Hood providing additional consideration for managing cowbird populations for black-capped vireo sustainability. Maximum sustainable parasitism rates ranged from 9–16 percent under low population growth rates to 49–60 percent under the high growth rate scenario (Wilsey *et al.* 2014, p. 561). Further analysis concluded that a sustained parasitism rate as low as 45 percent at Fort Hood could cause their population to fall below their target size in just 25 years (Wilsey *et al.* 2014, p. 569).

The variation on estimates of maximum sustainable parasitism rates (9–60 percent) is dependent on other factors, including population size, fecundity rate, and other landscape factors. Information on population demographics should be collected in order to determine the stability of the population and determine management goals, such as an acceptable rate of cowbird parasitism. Based on available information, a general estimated parasitism rate for management purposes should be less than 40 percent.

2.12.3 Productivity

Nest predation is the most important factor in bird mortality (Ricklefs 1969, p. 38; Martin 1993, p. 523). The primary cause of nest failure among black-capped vireos at Fort Hood is nest predation (Cimprich and Cimprich 2014, p. 17). Recruitment of individuals into the population relies upon the ability of breeding black-capped vireos to successfully raise young.

Population viability analysis (PVA) is a quantitative tool used to evaluate a species' population response to various life history parameters (Beardmore *et al.* 1996, p 13). The use of PVA relies on several assumptions and some degree of uncertainty (reviewed in Parysow and Tazik 2002) and its practical use may be limited.

Annual female fecundity (young produced/adult female/year) has been estimated using PVAs to be from 2.5 to 3.5 to avoid extinction scenarios or meet stable population goals (Parysow and Tazik 2002, pp. 222–223; USFWS 1996, p. 20). Growth rate estimation has included an annual female fecundity of 2.4 to maintain a stable population (USFWS 1991, p. 24). Few locations monitor productivity as a measure of population viability across the species' range. Fort Hood monitors productivity as the number of fledglings produced per territory in long term study sites. Under cowbird management and low parasitism, black-capped vireo abundance has substantially increased, with an average productivity of 1.98 fledglings per territory (Cimprich and Cimprich 2014, pp. 18–19), which suggests an acceptable rate to provide for an increasing population.

2.13 Species Rangewide Needs

2.13.1 Recovery Plan

The Recovery Plan for the black-capped vireo was completed in 1991 (USFWS 1991, entire). The prospect of complete recovery of the species was indeterminable and, therefore, an interim objective of downlisting to threatened status was used to develop recovery criteria (USFWS 1991, p. 36). The four criteria of the Recovery Plan are: 1) all existing populations are protected and maintained, 2) at least one viable breeding population exists in each of the following six locations: Oklahoma, Mexico and four of six Texas regions, 3) sufficient and sustainable area and habitat on the winter range exists to support the breeding populations outlined in (1) and (2), and 4) all of the above have been maintained for at least five consecutive years and available data indicate that they will continue to be maintained.

At that time, a viable population was estimated to be at least 500 pairs through PVA. The Recovery Plan was intended to protect and enhance the known populations (at that time), while evaluating the possibility of recovery and developing the necessary delisting criteria if recovery is found to be feasible. The population rangewide was unknown, but the Oklahoma population was thought to be less than 300 birds. During the 2007 5-year review of the status of the species, it was determined that the 1991 Recovery Plan was outdated and did not reflect the best available information on the biology of the species and its needs (USFWS 2007, p. 5). The Recovery Plan has not been updated, with the exception of redefined and reduced Recovery Units in Texas to four (Oklahoma and Mexico remain separate units) to reflect the changes in the known distribution of the species and potential availability of habitat (USFWS 2013, p. 23, Figure 9).

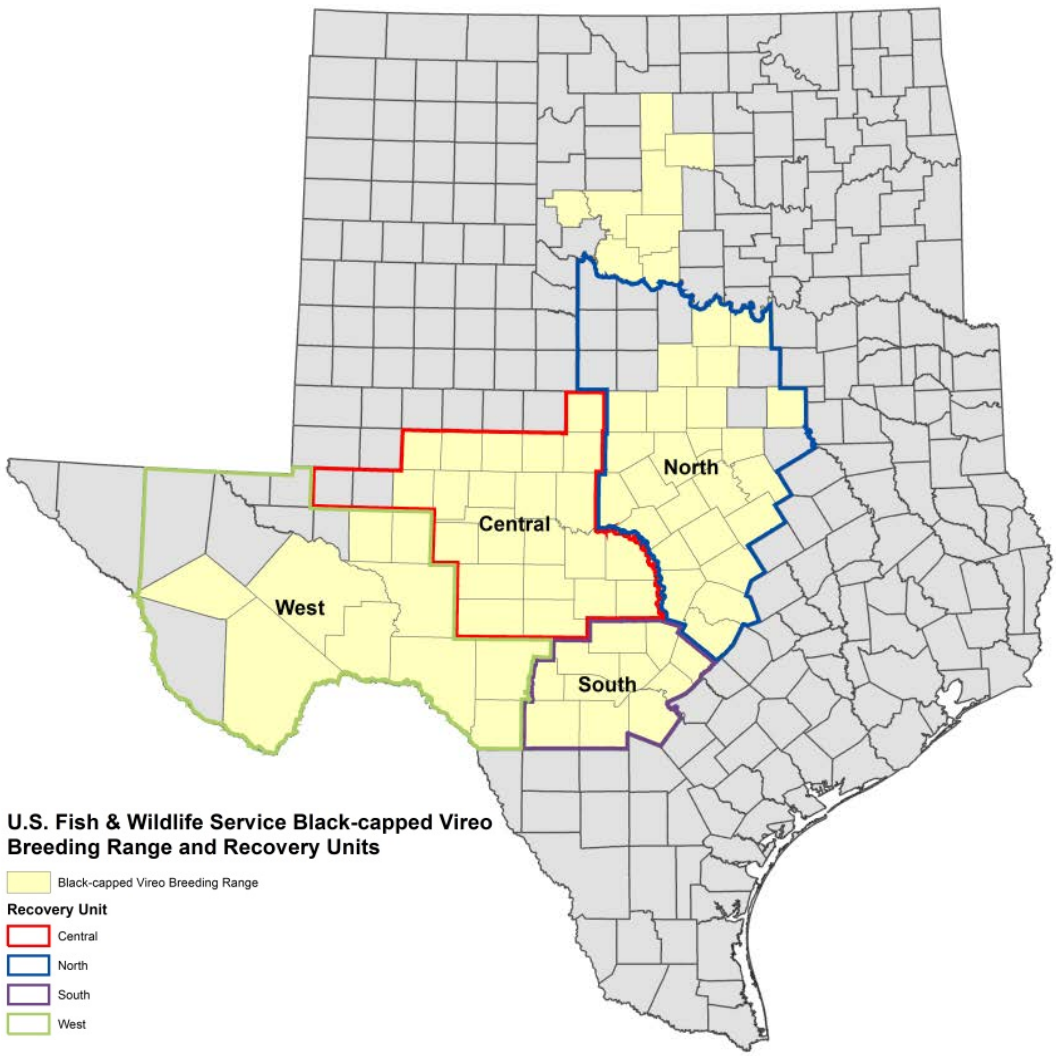

Figure 9. Current black-capped vireo range in the U.S. showing Texas Recovery Units.

2.13.2 Breeding

In determining the needs of the species within its breeding range, available information is limited due to the majority of the area in private ownership. In Texas and Oklahoma, about 95 percent of lands are under private ownership or management. The exception is the robust data set collected from the vireo population at Fort Hood over the past 20 years. Current information suggests black-capped vireos cluster in habitat patches and are locally more abundant in the western portion of the range (McFarland *et al.* 2013, p. 55). Clustering of black-capped vireos may be the result of conspecific attraction (Ward and Schlossberg 2004, p. 523), where males select suitable habitat, in part, by the presence of other males. The early successional nature of the vireo's habitat in the eastern portion of its range, dictates a patchy distribution, especially in that part of Texas. In the west and south, breeding populations do not appear to be tied to mid-seral stages of succession. Rather, the distribution in those regions is more closely tied to edaphic, topographic and geographic features. Clustering and conspecific attraction may further explain small populations scattered through its range, and lend support for populations of 20–30 pairs for long term management (Tazik 1991, p. 33; USFWS 2013).

In Mexico, the breeding range was thought to be restricted to the state of Coahuila (USFWS 1991, p. 51). By the time the 2007 5-year review was prepared, new information confirmed the species occurring in a much larger area including the states of Tamaulipas and Nuevo León (Wilkins *et al.* 2006, p. 10). Surveys conducted in 2012 and 2013 in the Mexican breeding range continue to show robust populations (>285 males) across the three states (Morrison *et al.* 2014, p. 16). Additionally, the most current information on black-capped vireos in certain locations in Mexico have indicated densities of breeding vireos up to six times as large as typically determined in the U.S. portion of the range (Farquhar and Gonzalez 2005, pp. 4–5 ; Wilkins *et al.* 2006, p. 28; Morrison *et al.* 2014, p. 16). Dense populations recorded by Farquhar and Gonzalez (2005) may corroborate high population estimates by Benson and Benson (1991, entire), who predicted over 7,000 adult males for a portion of Coahuila.

For the purposes of identifying breeding range needs of the species, information necessary to evaluate redundancy and representation are available only for the U.S. portion of the range. For redundancy, both likely resilient (>100 males) and manageable (>30 males) populations or localities should be distributed throughout the known breeding range. Such localities should be within proximity to allow gene flow, support dispersal, and provide protection from catastrophic events.

2.13.3 Migration and Winter Range

Information on use of habitat during migration is sparse. In general, black-capped vireos require airspace for movement and woody vegetation for stopovers extending from the northernmost portion of the breeding grounds, to the extent of the known wintering grounds.

The winter range of the black-capped vireo occurs entirely on the slopes of Mexico's Pacific coast. Arid and semi-arid scrub and secondary growth habitat, generally 0.6 to 3.0 m (2 to 10 ft) in height, is needed for feeding and sheltering.

2.13.4 Genetic Needs

The evolutionary history and genetic diversity of the black-capped vireo has been the subject of several studies (*e.g.*, Barr *et al.* 2008, Zink *et al.* 2010, Athrey *et al.* 2012a). Because endangered species are likely restricted in distribution and population size and were presumably more abundant and widespread historically, there is interest in studying the implications of their plight on the current population's genetic structure. This interest is particularly strong with regard to the black-capped vireo, having a fairly restricted breeding range both historically and currently, and due to the ephemeral nature of its habitat in portions of its range, which exists as a patchy mosaic on the landscape and is often lost to vegetational succession over the short term (10 to 25 years). Additionally, there is concern that declining and isolated populations of endangered species may lose genetic diversity, suffer from inbreeding depression and genetic drift, or exhibit high genetic differentiation between populations (Hedrick and Miller 1992, p. 39; Fazio *et al.* 2004, p. 377). The maintenance of genetic variation (heterozygosity) within populations is also important. For the black-capped vireo, gene flow may be restricted between the extant large populations due to their geographic separation, but not enough to alter population structure (Zink *et al*. 2010, p. 801).

Wilkins *et al.* (2006, p. 96) determined the majority of the known population in the breeding range occurred on four properties in the U.S. from 2000 to 2005. Two of these properties (Wichita Mountains Wildlife Refuge and Fort Sill Military Reservation) are adjacent and function as a single population in Oklahoma and are approximately 362 kilometers (km)(225 miles (mi)) from the nearest large (>100 pairs of birds) population (Fort Hood Military Reservation) in Texas. The fourth property occurs in Texas on Kerr Wildlife Management Area (WMA), approximately 184 km (114 mi) from Fort Hood.   In recent years, the Service has identified another large population on the order of the previous four described in Wilkins *et al.* (2006). This population occurs in Val Verde County, Texas, about 130 km (81 mi) from the next closest large population (Kerr WMA). Due to the lack of evidence that dispersal occurs between these populations, studies using three types of genetic data have sought to determine the extent, if any, of genetic differentiation between apparently isolated populations. These studies are summarized below.

Fazio *et al.* (2004) attempted to evaluate heterozygosity and genetic structure using allozymes from samples collected in 1992 at four sites in the U.S. range of the black-capped vireo. Genetic variation was found to be high within the populations, contrary to the expectation that isolated populations would likely lose genetic information over time (Fazio *et al.* 2004, pp. 379–380). Significant variation was found among the four populations greater than commonly reported for other birds. However, the results were skewed by high values at two loci suggesting the influence of natural selection, rather than limited gene flow among populations, potentially biasing the results (Fazio *et al.* 2004, p. 381; Barr *et al.* 2008, p. 3629). More recently, two studies, one using microsatellites the other mitochondrial DNA, produced contradictory findings.

Barr *et al.* (2008) used microsatellites from nuclear DNA collected at 10 sites in Texas and two in Oklahoma. They interpreted their results to indicate significant population differentiation throughout the black-capped vireo's range and that gene flow is limited between populations separated by >60 km (37 mi)(Barr *et al.* 2008, pp. 3634–3635). The second study used mitochondrial DNA from specimens collected in Oklahoma, Texas, and three states in Mexico (Zink *et al.* 2010, p.127). They concluded that there was no evidence of genetic structure or barriers to gene flow among populations (Zink *et al.* 2010 pp. 801–802). This study also reinterpreted the findings in Barr *et al.* (2008) to suggest that differentiation between populations was not evident (Zink *et al.* 2010, p. 802).

Microsatellite DNA was also used in Athrey *et al.* (2012a, entire) to examine population structure and genetic diversity in historical samples from Texas and Oklahoma collected from 1899 to 1915 for comparison to samples collected between 2004 and 2008. They found that the amount of differentiation among the sampled contemporary populations has increased and genetic diversity has decreased compared to historical populations (Athrey *et al.* 2012a, p. 548). The higher genetic richness in historical compared to recent samples was suggested as evidence of a historical bottleneck (population contraction) estimated to have occurred between 1930 and 1940 (Athrey *et al.* 2012a, pp. 547–548). While there appears to be evidence both for and against genetic structuring in the isolated populations of black-capped vireos (Barr *et al.* 2011, p. 793; Zink *et al.* 2011, p. 795), a more recent study provides further evidence that structure due to lack of gene flow across known populations from a lack of gene flow does not exist, but that genetic richness has declined (Vázquez-Miranda *et al.* 2015, p. 9).

2.14 Summary of Needs

The black-capped vireo is a taxonomically distinct songbird listed as endangered under the Act in 1987. Its historical breeding range has receded in the northern portion, where it no longer occurs in Kansas and is limited to south central Oklahoma, however, the known range has expanded substantially in Mexico. The black-capped vireo’s winter range is limited to Mexico’s western coastal states. Its general shrubland breeding habitat is patchily distributed across its range which is known to occur in Texas, Oklahoma and 3 states in Mexico. The needs of the black-capped vireo are summarized below.

Individuals

Suitable breeding habitat patch of:

- At least 1.5 hectares (3.7 acres) of shrublands with between 35–55 percent shrub cover, largely deciduous shrubs, often oaks in mesic areas, and with a low proportion of junipers.
- Nest and foraging shrubs mottes with deciduous foliage from 0–3 m (0 to 10 ft).

Migration and Wintering:

- Airspace for movement and woody vegetation for feeding and sheltering during migration

- Winter habitat consisting of woody vegetation, generally 0.6 to 3 m (2 to 10 ft) in height for feeding and sheltering.

Populations

Suitable breeding habitat:

- Manageable populations (or localities): breeding habitat supporting at least 30 adult males.
- Likely resilient populations (or localities): breeding habitat supporting ≥100 adult males.
- Brown-headed cowbird parasitism rate <40 percent.

Migration and Wintering:

- Sufficient airspace and stopover sites of woody vegetation for migration.
- Wintering areas of arid/semi-arid scrub and secondary growth habitat for feeding and sheltering.

Rangewide

Suitable breeding habitat to support:

- Manageable populations or localities (≥30 adult males) and likely resilient populations or localities (≥100 adult males) distributed throughout the range to allow gene flow and dispersal.
- Brown-headed cowbird parasitism rate low enough to allow sufficient black-capped vireo productivity on average across the range.

Migration and Wintering

- Sufficient airspace and stopover sites of woody vegetation throughout the migratory range.
- Sufficient and sustainable arid/semi-arid scrub and secondary growth habitat along the Pacific slope of western Mexico.

CHAPTER 3 – CAUSES AND EFFECTS

In this chapter we evaluate the past, current, and future stressors that affect the long term viability of black-capped vireos. The most important stressors identified are related to breeding habitat loss and brood parasitism by brown-headed cowbirds (*Molothrus ater*). The sources of habitat loss are primarily related to land use change, grazing and browsing by domestic and wild herbivores, and vegetational succession (52 FR, pp. 37421–37422, October 6, 1987). In addition, we also review climate change as an additional factor potentially affecting the species.

In 2007, the Service published a 5-year review of the black-capped vireo (USFWS 2007, entire) based largely on the status report *Population Status and Threat Analysis for the Black-capped Vireo* (Wilkins *et al.* 2006). A brief summary of the results of the 5-year review are provided, followed by updated information and analysis of each stressor. For the current analysis, the existing range of the black-capped vireo is used (USFWS 2015). The current range is more contracted than the range used in the 2007 status review, which included U.S. counties with limited historical occurrence records (see Appendix A for comparison).

This analysis concentrates on stressors to the species and their associated sources (combined, these are the "causes"). Each of the causes is examined for its historical, current, and potential future effects on the black-capped vireo. It should be noted that current and potential future effects, along with current distribution and abundance, determine present viability and, therefore, vulnerability to extinction. Information about historical causes and effects is included to assist the interpretation of population trends and to inform our assessment of the future responses by the black-capped vireo to ongoing and future vulnerabilities to extinction. The relationship between historical causes and effects, and population persistence also provides insights that may help to project future responses to vulnerability.

3.1 Mexican Breeding Range

At the time of listing, there were no known threats to the black-capped vireo within its Mexican breeding range. Similarly, threats to vireos in Mexico were not identified in the 2007 5-year review. However, the lack of information was evident and available population information revealed that the known breeding population in Mexico represented only 4 percent of the total known population at the time (USFWS 2007, p. 11). The needs of individuals and populations in Mexico appear to be similar to western portion of the U.S., where habitat occurs largely in a mature stage and brown-headed cowbird parasitism is relatively low. Additionally, evidence suggests that nest predation, the primary cause of nest failure, is substantially lower in portions of Mexico (Morrison *et al.* 2014, p. 18) compared to the U.S.

3.2 Land Use Change and Conversion

3.2.1 Assumptions

The extent of available breeding habitat for the black-capped vireo is unknown. Estimating available habitat using remotely-sensed data on a rangewide scale is limited, due to the need to detect the necessary shrub foliage used for nest concealment. As an indirect metric, the 5-year review (USFWS 2007, p. 14) evaluated U.S. Department of Agriculture (USDA) Agricultural Census data for trends in land use. Agricultural census data are collected from landowners reporting various land use details, including acreages of land categories. Of the categories reported, "rangeland" best fits areas that would support black-capped vireo habitat. Essentially, within the range of the species, black-capped vireo habitat is likely reported as rangeland, although not all rangeland would contain suitable black-capped vireo habitat (Wilkins *et al.* 2006, p. 33). These data are not directly comparable to available habitat; that is, reported rangeland area is not reported vireo habitat area. However, in the absence of rangewide habitat suitability information, assessing the trends in reported land use change is helpful in understanding trends affecting the species Land use change in this context is the conversion of rangeland into conditions unsuitable for black-capped vireos.

3.2.2 Trends in Reported Land Use

Changes in land use, for example native rangeland to cropland, can negatively affect the black-capped vireo when breeding habitat is present. Black-capped vireos specialize in shrubland habitats of woody tree and shrub mottes with foliage extending to the ground, and patchily distributed and separated by grasses, forbs and rock (Campbell 2003, p. 30). Territories are often located on steep slopes where the shallow soils slow succession and the microclimate perpetuates the clumping of vegetation suitable for black-capped vireo habitat (Graber 1961, p. 315). However, under mesic conditions, black-capped vireo habitat is early to mid-successional in nature, maintained by disturbance (*e.g.*, fire), and typically changes through succession into closed-canopy hardwood forest unsuitable for breeding black-capped vireo (Wilkins *et al.* 2006, p. 20). When breeding habitats are lost, black-capped vireo individuals can no longer reproduce in that area and populations are displaced. Individuals must then seek out available suitable habitat which may already be occupied by black-capped vireos, which often return to the same nesting site across breeding seasons. The availability of breeding habitat for the black-capped vireo is a primary factor in the viability of the species rangewide.

Wilkins *et al.* (2006, pp. 34–35) stated that change in land use across the black-capped vireo breeding range in Oklahoma had remained relatively stable due to a 4.5 percent increase in rangeland. Land use data for this period in Texas revealed an 8.6 percent decrease in rangeland. Decreases in reported rangeland in Texas from 1992 to 2002 are illustrated in Figure 10. The correlation between ownership size distribution and wildlife habitat fragmentation is not fully understood, but data suggested that the division of large farm and ranch ownerships >809 ha (2,000 ac) into smaller tracts may change the landscape unfavorably for many species of wildlife, including the black-capped vireo (Wilkins *et al.* 2006, p. 34).

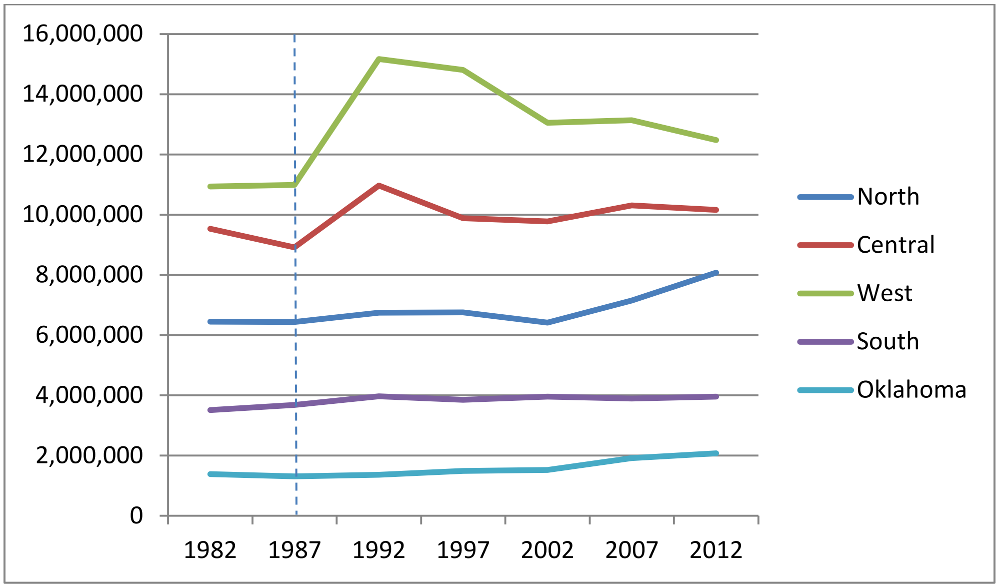

Figure 10. Total rangeland acres by year (excluding those withheld to avoid disclosing data for individual farms) by Recovery Unit in the U.S. Dashed line shows year in which black-capped vireo was listed (1987).

As in the 2007 analysis, there are no direct measures of the amounts and distribution of suitable habitat for black-capped vireo; therefore, it is not possible to conduct a trend analysis for available breeding habitat. However, statistics from the USDA Census of Agriculture from 1987 to 2002 were used by Wilkins *et al.* (2006, pp. 33–34) to evaluate changes in land use (Figure 11). Since 2002, these statistics have been updated for approximate acres of rangeland per county in each state. Statistics on rangeland acres are included as "pastureland and rangeland other than cropland and woodland pastured," and are referred to hereafter as "rangeland" for the purposes of analysis of habitat availability (USDA 2002a, 2002b, 2012a, and 2012b). Between 2002 and 2012 (most recent data available), reported rangeland increased 35.9 percent in Oklahoma and 4.4 percent in Texas (Table 3, Figure 10). Since 1987, an increase of 17.3 percent in total rangeland was reported across the U.S. black-capped vireo breeding range (Table 3, Figure 11 and 12, Appendix B).

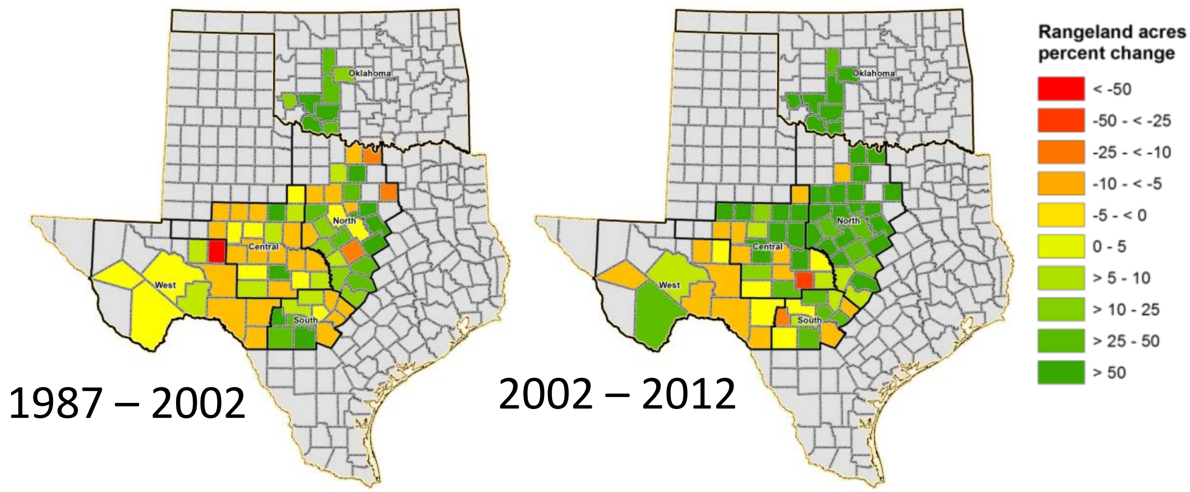

Figure 11. Percent change in rangeland acres across the U.S. portion of the black-capped vireo breeding range from 1987 to 2002 and from 2002 to 2012.

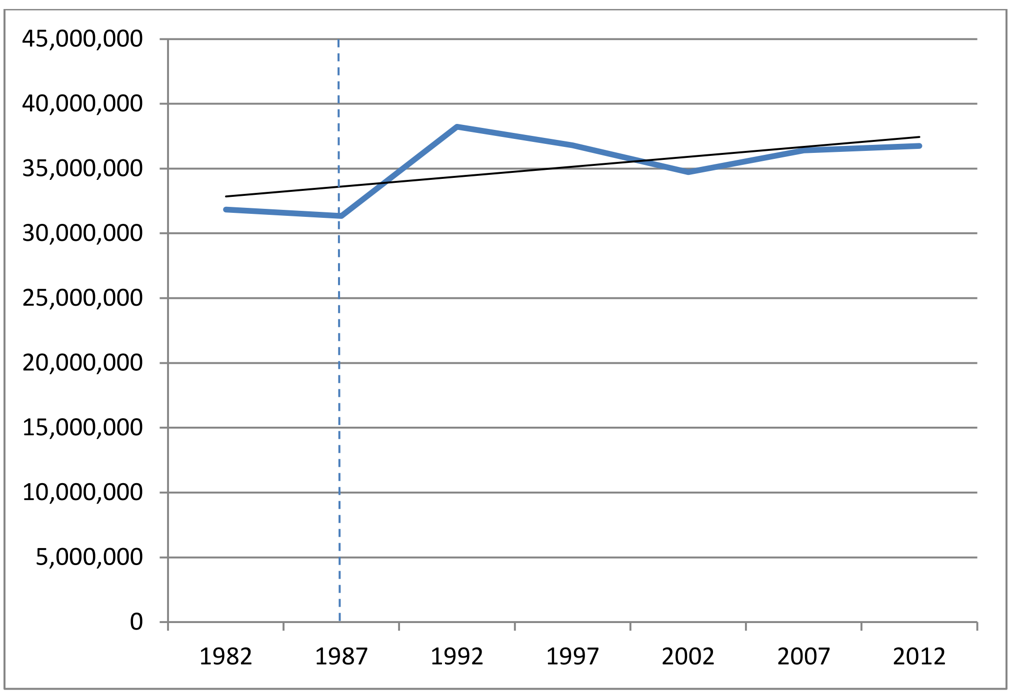

Figure 12. Total rangeland acres by year (excluding those withheld to avoid disclosing data for individual farms) over entire U.S. black-capped vireo breeding range. Dashed line shows year in which black-capped vireo was listed (1987). Black line illustrates regression trend line.

Table 3. Percent change of rangeland acres (excluding those data withheld to avoid disclosing data for individual farms) by Recovery Unit and state from 1982–2012, 1987–2002, 1987–2012, and 2002–2012, where overall values represent percent change over entire black-capped vireo breeding range for the specified time period. *Data from USDA Agricultural Census.*

	1982–2012	**1987–2002**	**1987–2012**	**2002–2012**
North	25.2	-0.4	25.4	25.9
Central	6.5	9.7	13.9	3.9
West	14.1	18.8	13.6	-4.4
South	12.5	7.3	7.4	0.1
Texas	13.9	10.6	15.5	4.4
Oklahoma	49.0	16.5	58.4	35.9
Overall	15.4	10.8	17.3	5.8

The general trend in reported rangeland statistics has remained relatively stable over the last 20 years, and has increased since the black-capped vireo was listed. Although rangeland statistics do not directly correspond to availability of black-capped vireo breeding habitat, it provides indirect information on the conditions for suitable habitat to exist. Available rangeland, coupled with decreased livestock densities (discussed below), have likely improved overall habitat conditions within the breeding range of the vireo. Changes in landownership, better land stewardship, and an emphasis on the importance of wildlife and recreational land use are probable factors that may be contributing to healthier rangeland conditions in Texas (Wilcox *et al.* 2012, p. 316). In this context, the rangeland conditions for breeding habitat to exist, be created or maintained, has generally improved across the U.S. portion of black-capped vireo's range.

3.3 Grazing and Browsing

Livestock grazing and browsing, largely by sheep and goats, were identified as primary threats to the black-capped vireo in the listing of the species (52 FR, p. 37421, October 6, 1987). Overgrazing, particularly by browsers (goats, deer, exotics), typically removes vegetation at the heights needed by black-capped vireos (Grzybowski 1995, p. 5). The presence of cattle in black-capped vireo habitat may also encourage use by brown-headed cowbirds (see Section 3.5). Overgrazing can reduce grass cover to the point that naturally occurring fires and/or prescribed burning are no longer possible leading to woody plant encroachment into grasslands because it reduces the amount of fine fuel available for burning (Fowler and Dunlap 1986, p. 146; Engle *et al.* 1995, p. 7). Additionally, cattle effectively disperse the seeds of invasive plants such as juniper (Brown and Archer 1987, p. 2; Brown and Carter 1998, p. 93). In the 2007 5-year review, the following trends in grazing and browsing pressures are summarized based on data from the time of listing (in 1987) to 2002:

- Goats – There was a 19.1 percent decrease in the number of goats reported in the USDA Agricultural Census across the black-capped vireo range in Texas and Oklahoma. There was a substantial difference, however, between the two states. Texas had a 22.6 percent decrease in goat numbers, while Oklahoma had a 277.2 percent increase in goat numbers during the same time span. The overall decrease of 19.1 percent was due to the proportion of black-capped vireo's range located in Texas. Regardless of increase or decrease, goat densities remained relatively small for both states (8.3 goats in Oklahoma and 28.7 goats in Texas per 1,000 acres of rangeland).
- Cattle – There was a 2.8 percent increase in cattle numbers across the black-capped vireo range in Texas and Oklahoma. Individually, Texas had a 9.6 percent decrease while Oklahoma had a 12.5 percent increase in cattle across the black-capped vireo's range.
- White-tailed deer density declined in general across the black-capped vireo range in Texas, although some areas such as the Edwards Plateau in central Texas were increasing and considered above carrying capacity for that area.
- Exotic ungulates – Axis deer, blackbuck, nilgai antelope, aoudad sheep, sika deer, etc., introduced across the black-capped vireo range primarily in Texas had increased in population across the period analyzed (1963–1994) primarily in the Edwards Plateau region. While an increasing trend was observed, specific population data were unavailable.

3.3.1 Trends in Goat Numbers

Since the 2007 5-year review, density of goats in the U.S. portion of the black-capped vireo's range continues to show a substantial decline. USDA Agricultural Census data collected from 2002 through 2012 show a 32.3 percent decrease in goat density across the black-capped vireo range in Texas and Oklahoma (USDA 2002a, 2002b, 2012a, and 2012b; Figure 13). During this time span, Texas had a 32.9 percent decrease in goat numbers per 1,000 rangeland acres, but Oklahoma had a 101.7 percent increase in goat numbers (Figure 14). Although the 101.7 percent increase in Oklahoma may seem high, in 2012 actual goat density in Oklahoma (2.8 goats per 1,000 rangeland acres) was nearly an order of magnitude lower than the Texas Recovery Units average density of 22.7 goats per 1,000 rangeland acres. This represented an increase of 1.4 goats per 1,000 rangeland acres in Oklahoma from 2002 through 2012. During this same period, there was a 32.9 percent decrease in goats per 1,000 rangeland acres in Texas, which represented a decrease of 10.8 goats per 1,000 rangeland acres, resulting in the 32.3 percent net decrease of goats per 1,000 rangeland acres throughout the black-capped vireo breeding range in Texas and Oklahoma. Since 1987, the reported goat density throughout the U.S. breeding range has decreased by 46.8 percent (Table 4, Figure 15, Appendix C).

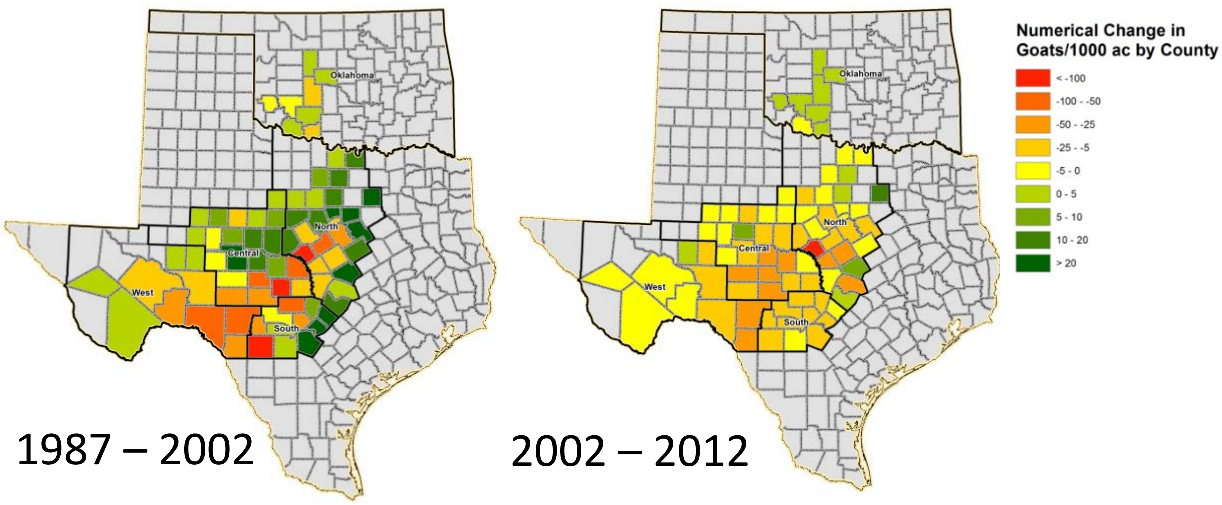

Figure 13. Numerical change in number of goats per 1,000 acres of rangeland across the black-capped vireo breeding range in the U.S. from 1987 to 2002 and 2002 to 2012.

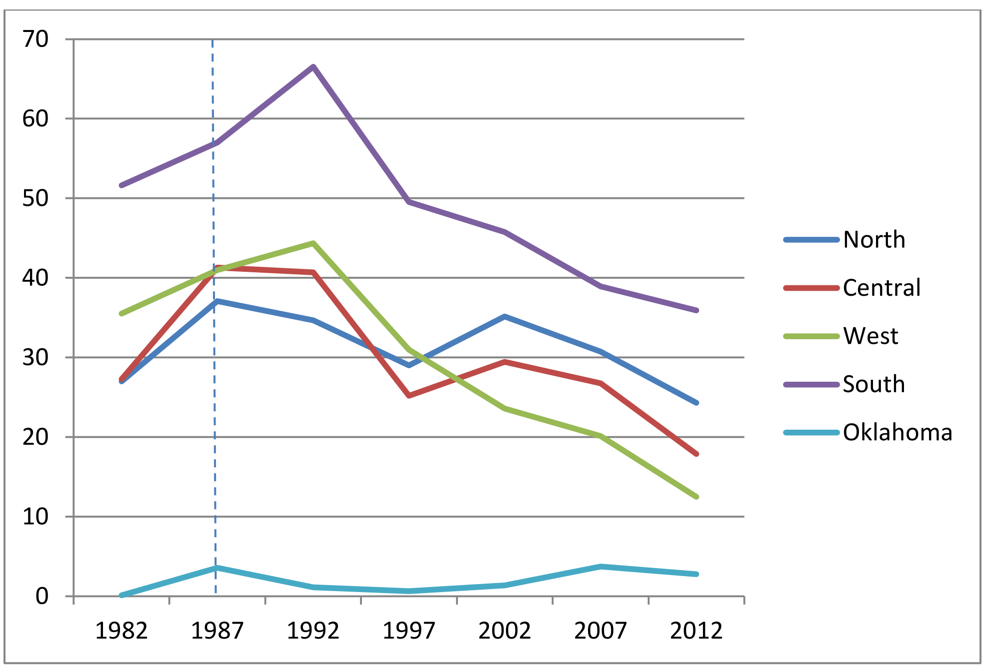

Figure 14. Average number of goats (per 1000 rangeland acres) by Recovery Unit in the U.S. Dashed line shows year in which black-capped vireo was listed (1987).

Table 4. Percent change of goats per 1,000 rangeland acres (excluding those data withheld to avoid disclosing data for individual farms) by Recovery Unit and state from 1982–2012, 1987–2002, 1987–2012, and 2002–2012, where overall values represent percent change over entire black-capped vireo breeding range for the specified time period.

	1982–2012	**1987–2002**	**1987–2012**	**2002–2012**
North	-10.0	-5.2	-22.3	-30.9
Central	-34.4	-28.8	-56.7	-39.2
West	-64.8	-42.4	-34.5	-47.0
South	-30.4	-19.7	-37.0	-21.5
Texas	-31.1	-21.1	-69.5	-32.9
Oklahoma	2,378.0*	-61.5	-47.1	101.7
Overall	-30.1	-21.5	-46.8	-32.3

* According to census data from 1982, there was an average of 0.113 goats per 1,000 rangeland acres per county, whereas in 2012 it was 2.8 per 1,000 acres, resulting in the 2,378% increase.

Similar information on trends in goat numbers is not available for Mexico. Anecdotal evidence exists that locally, goats may have an impact on black-capped vireo populations (Farquhar and Gonzalez 2005, p. 25). Goats were not specifically identified as a threat in Mexico as recently as 2013 (Morrison *et al.* 2014, p. 37). Additionally, some black-capped vireo populations in Nuevo León and Tamaulipas may be buffered from the effects of goats and other livestock due to a geographic separation based on topography (Farquhar and Gonzalez 2005, p. 30).

The trend in goat and sheep densities is important to the availability of habitat for the black-capped vireo. Goats can denude vegetation up to 2 m (6.6 ft) above the ground, foliage that is essential for vireo nesting. The removal of goats allows deciduous vegetation to re-sprout (Grzybowski 1994, p. 541), thereby becoming suitable for black-capped vireos.

The significant goat (and sheep) decline in the U.S. is directly related to the expiration of the National Wool Act of 1954 (Wool Act). The Wool Act provided a new and permanent price support program for wool and mohair that encouraged increased domestic production (Anderson 2001, entire). Incentive payments were paid to farmers who achieved increased production and/or obtained high market prices. Congress passed legislation that phased out the Wool Act support program in 1993. The last incentive payments under the Wool Act were made in 1996. In the 1990s, approximately 80 percent of goat herds were eliminated in Texas due in part to the end of the Wool Act (Anderson 2001, entire, Figure 15).

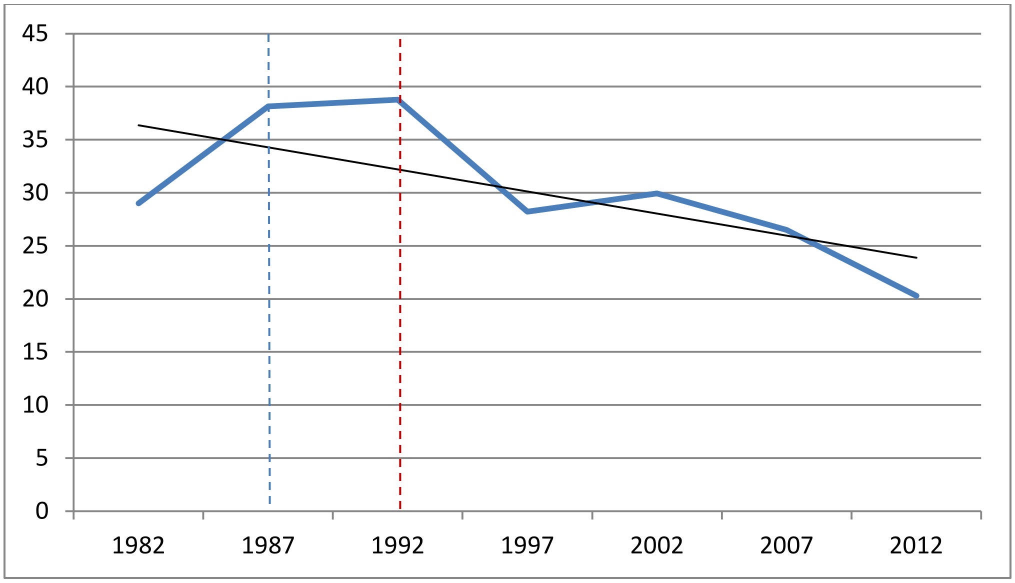

Figure 15. Average number of goats (per 1,000 rangeland acres) over entire U.S. black-capped vireo breeding range. Dashed blue line shows year in which black-capped vireo was listed (1987). Dashed red line shows last year of goat data collected (1992) prior to the expiration of the National Wool Act of 1954 in 1993. Black line illustrates regression trend line.

3.3.2 Trends in Cattle Numbers

Data for cattle collected from 2002 through 2012 show a 36 percent decrease across the black-capped vireo range in Texas and Oklahoma (Figure 16). Individually, Texas had a 34.2 percent decrease while Oklahoma had a 40.8 percent decrease in cattle across the black-capped vireo's range (Figure 17). Since 1987, reported cattle density throughout the U.S. breeding range of the black-capped vireo has decreased by 37.2 percent (Table 5, Figure 18, Appendix D).

Cattle trend data across the black-capped vireo breeding range in Mexico are unavailable. In some areas, information suggests cattle stocking rates to be low compared to areas in Texas (Morrison *et al.* 2014, p. 37). Nonetheless, "small-scale" livestock ranching is the main economic activity in the area (Morrison *et al.* 2014, p. 37). As with goat ranching, black-capped vireo populations, within portions of Mexico, may have limited exposure to cattle due to preferences in grazing areas that are topographically distinct from vireo nesting grounds (Farquhar and Gonzalez 2005, p. 30).

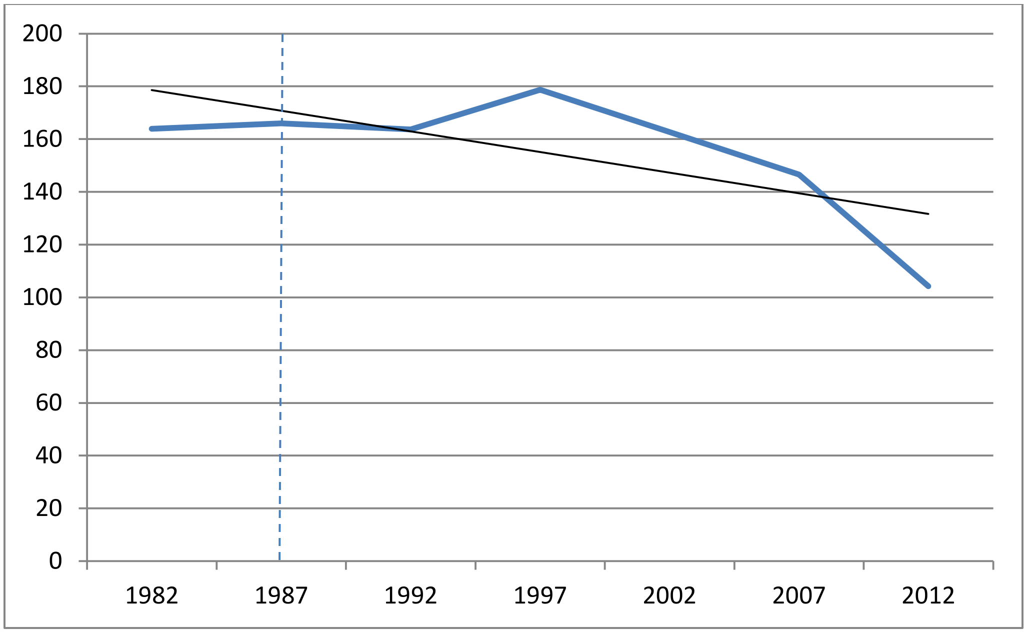

Figure 16. Average number of cattle (per 1,000 rangeland acres) over entire U.S. black-capped vireo breeding range. Dashed line shows year in which black-capped vireo was listed (1987). Black line illustrates regression trend line.

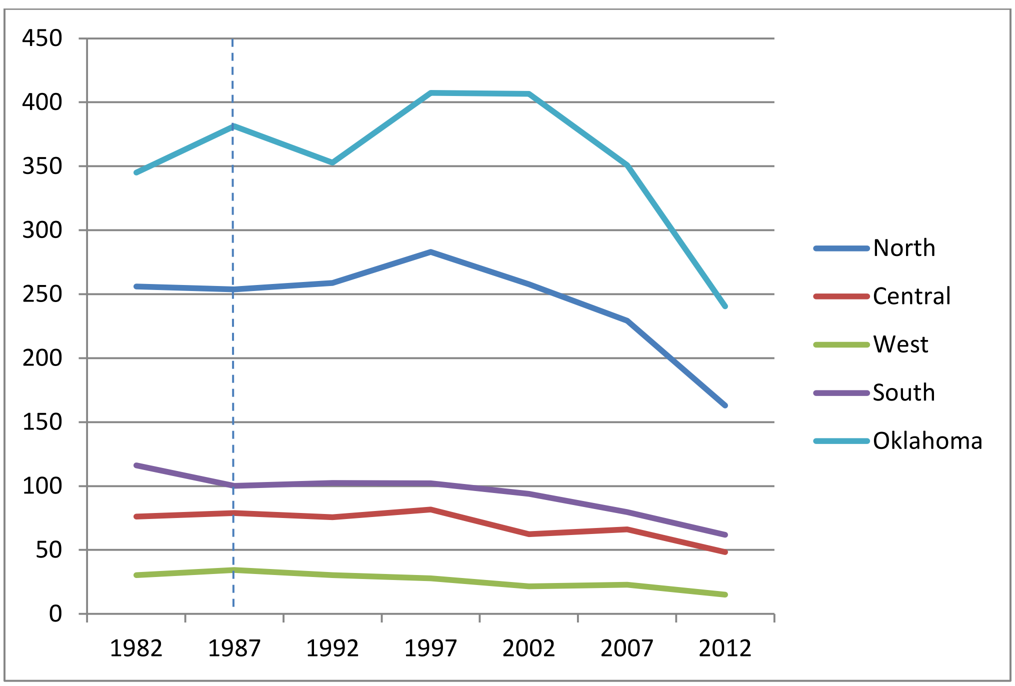

Figure 17. Average number of cattle (per 1,000 rangeland acres) by Recovery Unit in the U.S. Dashed line shows year in which black-capped vireo was listed (1987).

Table 5. Percent change of cattle per 1,000 rangeland acres (excluding those data withheld to avoid disclosing data for individual farms) by Recovery Unit and state from 1982–2012, 1987–2002, 1987–2012, and 2002–2012, where overall values represent percent change over entire black-capped vireo breeding range for the specified time period.

	1982–2012	**1987–2002**	**1987–2012**	**2002–2012**
North	-34.5	1.5	-35.8	-36.7
Central	-56.7	-21.0	-38.6	-22.3
West	-69.5	-37.1	-56.2	-30.4
South	-37.0	-6.2	-38.1	-34.0
Texas	-47.1	-4.7	-37.3	-34.2
Oklahoma	-22.3	6.6	-36.9	-40.8
Overall	-46.8	-2.0	-37.2	-36.0

Overgrazing by cattle can negatively impact vegetative cover near ground level, possibly making it unsuitable for black-capped vireos (Grzybowski *et al.* 1986, p. 1157). Indirect effects of overgrazing include weathering and erosion (Graber 1961, p. 316); however, evidence exists that grazing by cattle, in general, is not likely to have an overall negative impact on black-capped vireos (Shaw *et al*. 1989, p. 29; Wilkins *et al.* 2006, pp. 52–54). In some circumstances, cattle under a "light" grazing plan in combination with active habitat and brown-headed cowbird management within lands managed specifically for the black-capped vireo may utilize available forage without measurable impacts to breeding vireos (USFWS 2013, p. 26).

3.3.3 Trends in Deer and Exotics

According to the Texas Parks and Wildlife Department's (TPWD) White-tailed Deer Population and Harvest Summary FY 2015, deer populations, in general, have increased across the state of Texas (TPWD 2015, p. 27). Accounting for Resource Management Units that overlap the U.S. breeding range of the black-capped vireo, deer densities have risen slightly since 2005. The percent change in deer densities from 2005 to 2014 within this range increased by 18.3 percent (Table 6).

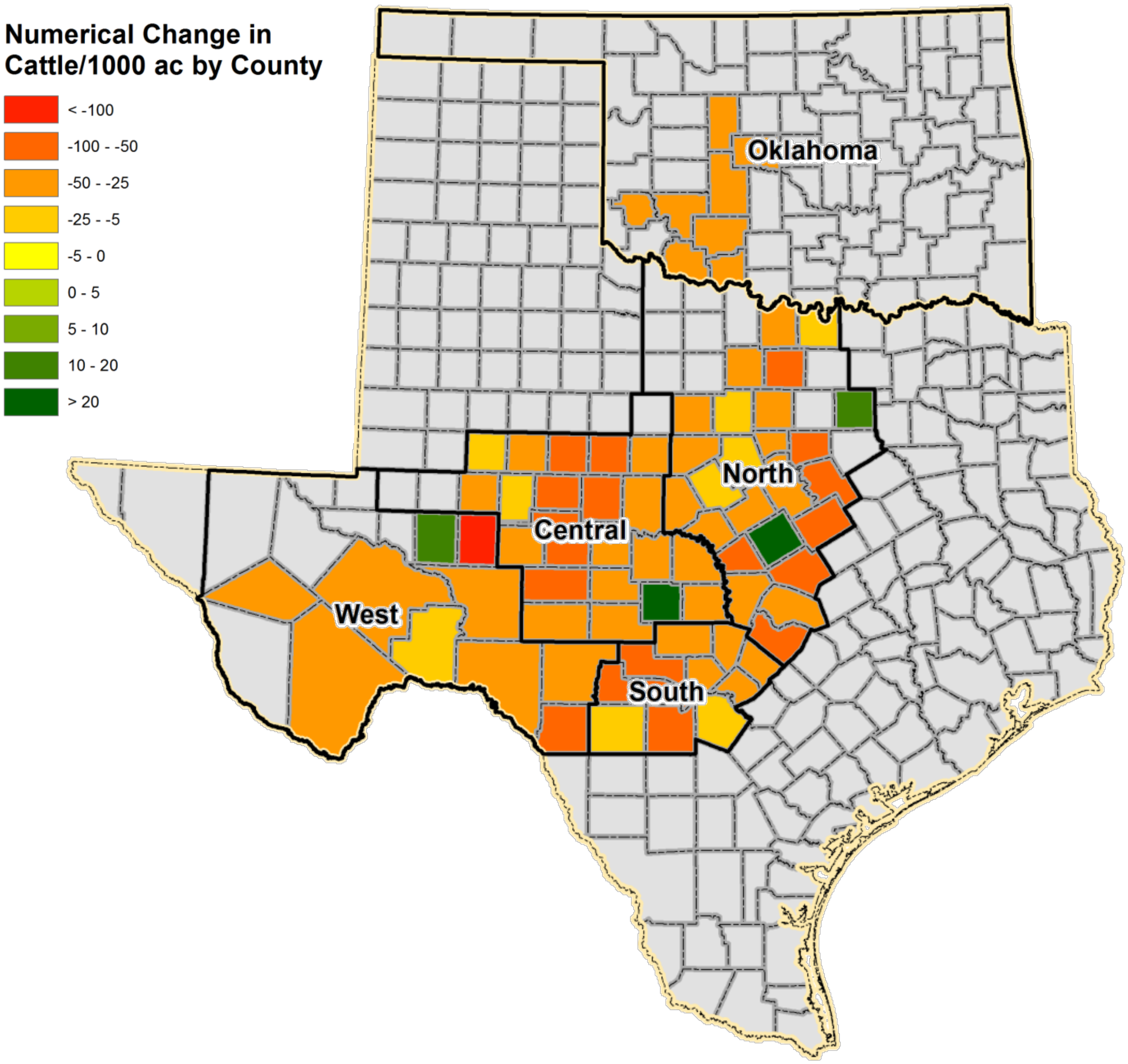

Figure 18. Changes in cattle numbers per 1,000 acres of rangeland in the U.S. by county in the black-capped vireo range from 1987 to 2012. Green counties represent increases in reported cattle numbers; yellow to red represent a decrease.

Table 6. Deer population estimates in 2005 and 2014 in Resource Management Units that overlap the black-capped vireo range in Texas.

Ecoregion (as outlined by TPWD)	Hectares (acres)	Resource Management Unit	2005 Deer/1,000 ac	2014 Deer/1,000 ac	Percent Change
Southern High Plains	810,505 (2,002,801)	2	15.8	7.1	-55.3
Trans Pecos	693,080 (1,712,638)	3	90.7	42.3	-53.4
Edwards Plateau	1,308,326 (3,232,944)	4	90.8	57.0	-37.2
Edwards Plateau	2,807,841 (6,938,326)	5	114.7	132.5	15.5
Edwards Plateau	583,685 (1,442,317)	6	123.7	188.7	52.5
Edwards Plateau	1,909,010 (4,717,266)	7	99.3	137.2	38.2
Edwards Plateau	1,246,008 (3,078,953)	28	70.8	63.5	-10.2
Edwards Plateau Overall			99.9	115.8	15.9
Blackland Prairie*	731,745 (1,808,181)	20			
Blackland Prairie*	367,820 (908,903)	21			
Cross Timbers	771,971 (1,907,581)	22	9.5	18.5	94.3
Cross Timbers	1,430,907 (3,535,848)	23	50.4	107.3	112.9
Cross Timbers	1,080,818 (2,670,759)	24	13.6	33.8	148.3
Cross Timbers	1,552,348 (3,835,935)	25	31.1	45.4	45.8
Ecoregion Overall			25.4	50.5	98.9
Rolling Plains (Eastern)**	1,162,939 (2,873,684)	27	25.6	37.8	47.9
Average over black-capped vireo U.S. range.			61.3	72.6	18.3
Statewide			34.5	40.5	17.6

*Annual surveys were not performed for the Blackland Prairies Resource Management Unit due to overall low densities of deer (A. Cain, pers. comm. January 5, 2016). ** The Eastern Rolling Plains ecoregion contains only the single Resource Management Unit that overlaps with the black-capped vireo range.

Deer and exotic ungulates select for forbs and browse when available, consume it preferentially over grasses, and browse vegetation at a similar height as nesting black-capped vireos (Marshall *et al*. 1985 p. 25; Rust and Tazik 1990, p. 30; Gryzbowski 1995, p. 20). Browsing by deer may aid in maintaining nesting vegetation (*e.g.*, oaks) at a low-growth early successional state (Marshall *et al.* 1985, p. 15); however, if deer exceed the carrying capacity of an area then the resultant overbrowsing would have a deleterious effect on black-capped vireo habitat. Many factors determine the desirable deer density per acre in an area and generally, densities of 12–15 acres (or greater) per deer (67 to 83 deer/1000 acres) would allow for the successful recruitment of hardwood species and optimal foliage cover for black-capped vireos (USFWS 2013, p. 26; Alan Cain 2016, pers. comm.). Based on 2014 deer surveys, three resource management units in the Edwards Plateau Ecoregion and one in the Cross Timbers Ecoregion exceed the recommended density (Table 6). While these grazing habits directly affect nesting habitat of black-capped vireos, impacts from moderate levels of deer foraging are typically less destructive to black-capped vireos than non-native animals (*i.e.*, goats and exotics)(Graber 1961, p. 316; Guilfoyle 2002, p. 8).

Statistical information on population trends of exotic ungulates since the 5-year review is lacking. Although quantitative data are scarce, the Exotic Wildlife Association asserts that populations of exotics in Texas and Oklahoma continue to increase (Charly Seale 2015, pers. comm.).

3.4 Vegetational Succession

Vegetational succession is generally an increase in the canopy cover and stature of woody vegetation beyond the early to mid-successional stage suitable for breeding black-capped vireos. The 5-year review documented that much of the increase can be attributed to the expansion of junipers (*Juniperus* spp.) beyond their historical range (Fowler and Dunlap 1986, p. 146; Ansley *et al.* 1995, p. 50; Engle *et al.* 1995, p. 50; Thurow and Thurow 1997, pp. 13–25; Ueckert 1997, pp. 23–34). This encroachment by junipers corresponds with a period of more intensive livestock grazing and the suppression of fire (Archer 1994 p. 13; Fuhlendorf *et al.* 1996 p. 245; Smeins *et al.* 1997 pp. 1–3). The 5-year review found that since the time of listing, juniper invasion had contributed to an overall afforestation of rangeland habitats throughout much of the species' range. This was especially true within the eastern portion of the species' range where fire is important in the maintenance of breeding habitat.

Several factors continue to contribute to vegetational succession in mesic areas trending toward an increase in the canopy cover and stature of woody vegetation beyond the mid- to early successional state suitable for breeding black-capped vireo. Historically, wildfires retarded or reversed invasions by fire-sensitive trees or shrubs and fire once may have been the most important ecological factor in maintaining black-capped vireo habitat in the eastern breeding range. Fire suppression, in combination with heavy grazing and browsing, can transform a mixed-oak savanna into oak woodland with dense under-story and mid-story juniper making it unsuitable as nesting habitat for black-capped vireos (Marshall *et al.* 1985, p. 24). With the proper burning conditions, fires can kill or retard invading junipers and favor the regrowth of fire-adapted oak, sumac and other deciduous species. This produces areas of dense foliage at the low level required by black-capped vireos (USFWS 1991, p. 22; Campbell 1995, p. 29; Grzybowski 1995, p. 5).

Multiple studies have demonstrated the beneficial effects of fire on black-capped vireo habitat and populations. A study at Kerr WMA found that 53.8 percent of winter-season prescribed burns resulted in increased black-capped vireo numbers within the same year as the burn, and that 92.1 percent of the burns produced larger numbers of black-capped vireos within 2 years of the burn (Dufault 2004, p. 42). Post-wildfire monitoring at Fort Hood demonstrated increasing black-capped vireo numbers within burned areas over time, while remaining relatively constant on unburned areas of the property (Cimprich 2002, p. 6). From a mature woody community, fire can produce suitable breeding habitat in approximately 5 years, which may remain suitable for 20 to 25 years (Tazik 1991, p. 125). Genetic data analysis by Vázquez-Miranda *et al.* 2015 (p. 1) suggests that fluctuations in historical black-capped vireo population levels are consistent with fluctuations in historical fire regimes since the last inter-glacial period 70,000 years before present. Fire suppression continues to be an indirect cause of habitat loss in the form of vegetational succession in areas that would succeed to closed canopy woodland.

Within the Texas portion of the species' range, differences in breeding habitat have been noted with respect to its successional state and management needs (Keddy-Hector 1992, App. A, p. 2; Hayden *et al.* 2001, p. 32; Farquhar and Gonzalez 2005, pp. 31–32; McFarland *et al.* 2012, p. 5). Fire suppression is a natural occurrence of European settlement in the U.S., which has led to shrublands in many mesic areas to grow into late successional or mature communities (Vázquez-Miranda *et al.* 2015, entire). However, within Texas it has been observed that conditions for vegetational succession largely occur within the "eastern" portion of the species' range, where annual precipitation and soil conditions promote woody vegetation growth; shrubland habitat within the "western" portion of the range may occur largely as mature habitat (Hayden *et al.* 2001, p. 32; Farquhar and Gonzalez 2005, p. 32; McFarland *et al.* 2012, p. 5). Thus, while prescribed fire is important as a management tool for shrubland habitat, it is more important to populations in Oklahoma and the eastern portion of the range in Texas. However, fire may be important across the entire range as a tool to address invasive Ashe juniper and eastern red cedar.

To illustrate the differences between the eastern and western habitats of the black-capped vireo, we separated the Texas range using two Geographic Information System datasets: the Diamond (2007) golden-cheeked warbler habitat model C and an index of aridity (Zomer *et al.* 2008, entire). The golden-cheeked warbler breeds only in Texas and its range almost completely occurs within the breeding range of the black-capped vireo. The warbler's habitat is considered mature oak-juniper woodlands that occur along the Balcones Escarpment and Edwards Plateau ecoregions of central Texas. On the western edge of the warbler's range, differences in soil type and depth and decreasing precipitation (and higher aridity) preclude the development of mature woodlands and result in a more shrub-dominated landscape utilized by the black-capped vireo. This western edge of oak-juniper woodland (Figure 19) coincides greatly with higher aridity within the 2998–4640 index range (Figure 20)(McFarland *et al.* 2012, p. 5). The aridity index is calculated as the mean annual precipitation divided by the mean annual potential evapotranspiration, multiplied by 10,000 (Zomer *et al.* 2008).

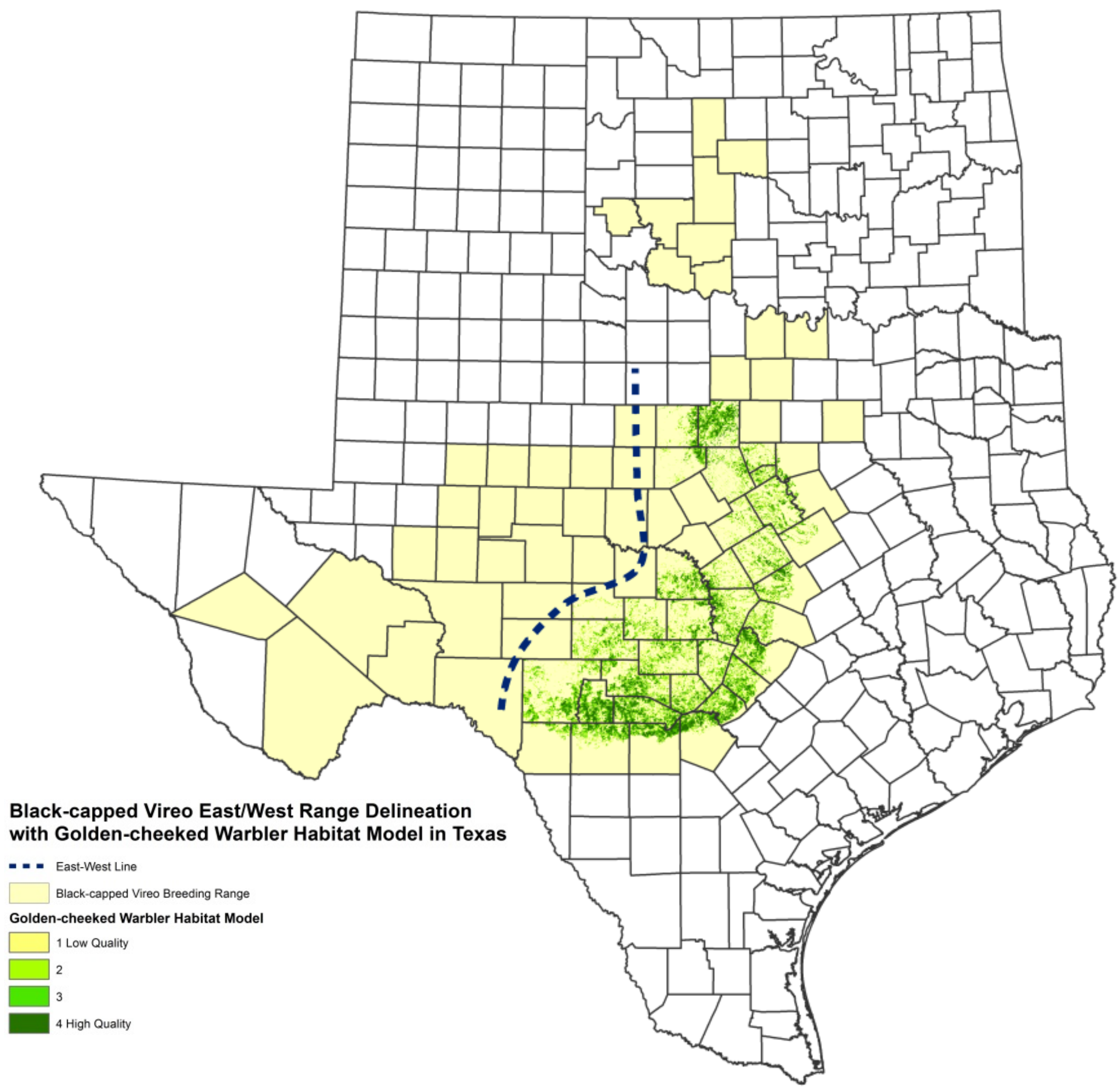

Figure 19. Illustration of difference between the east and west portions of the black-capped vireo breeding range in Texas based on proximity to modeled habitat for the golden-cheeked warbler.

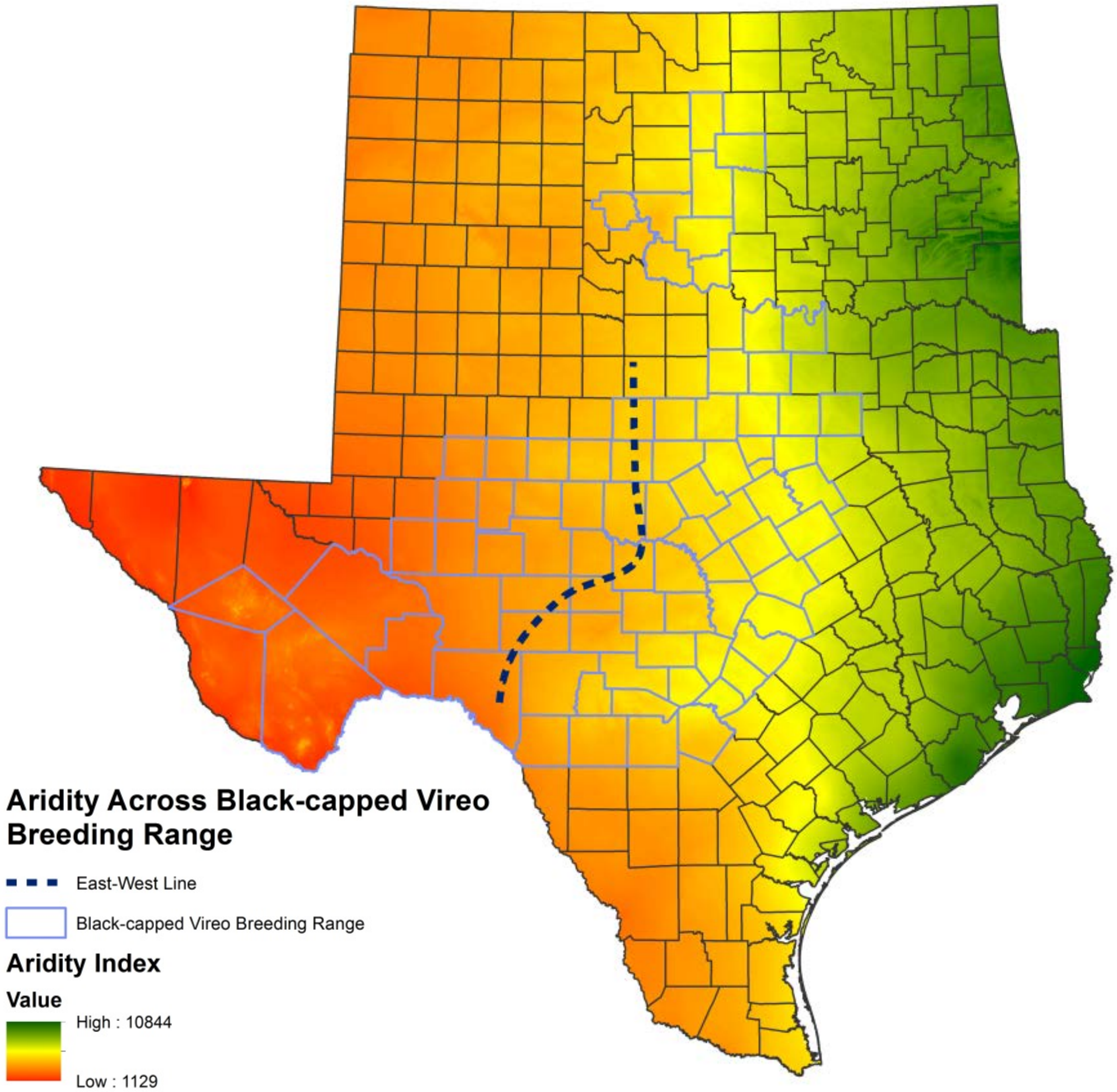

Figure 20. Illustration of the east and west portions of the black-capped vireo breeding range in Texas as related to the aridity index used from Consultative Group on International Agricultural Research (CGIAR; Zomer *et al.* 2008).

There are no available data to track the effects of vegetational succession in important black-capped vireo habitats across the breeding range. Prescribed fire as a habitat management tool can be a cost effective way to restore and enhance grasslands, shrublands, and woodlands, reduce cover of invasive species such as juniper, and is often used to benefit game species (*e.g.*, deer and wild turkey). Such management actions may directly and indirectly benefit black-capped vireos when they occur within the eastern portion of the breeding range. However, there is no current mechanism to track management actions effectively to understand the benefits of prescribed fires on the species rangewide. It is important to note that fire management of habitat may not be important to populations occurring in portions of Mexico, where a substantial breeding range exists (Farquhar and Gonzalez 2005, entire). Vegetational succession continues to be an important factor affecting the viability of populations of black-capped vireo in the U.S., mostly in the eastern portion of the range.

3.5. Brown-headed cowbird parasitism

Brown-headed cowbirds are brood parasites; females remove eggs from a host species nest, lay their own egg(s) to be raised by the adult hosts, and the result usually causes the death of the remaining host nestlings (Rothstein 2004, p. 375). Brown-headed cowbirds once followed herds of American bison (*Bison bison*), but are now associated with cattle and feed on the insects stirred up by their movement (Lowther 1993, entire). Originally thought to be limited to the open grasslands of the Great Plains, the distribution of the brown-headed cowbird has expanded substantially across the U.S. since European settlement (Mayfield 1965, pp. 13–18; Rothstein 1994, entire). In the eastern U.S., cowbird numbers began increasing in the mid- to late 1700s (Mayfield 1965, pp. 16–17) and in the west around 1900 (Rothstein 1994, entire). The expansion of the cowbirds ancestral range into the eastern and western states occurred largely due to the widespread clearing of forests in the east, Sierra Nevada, Cascades and Pacific Northwest, and irrigation and agriculture in the southwest (May and Robinson 1985, p. 475; Rothstein 1994, pp. 302–307).

Brown-headed cowbirds select short grass or bare ground for foraging and are often found foraging among large ungulates (Rothstein 1994, p. 301; Wilkins *et al.* 2006, p. 69). They use different habitats for foraging and breeding activities, establishing separate home ranges for both (Chace *et al.* 2005, p. 46). This results in daily movements between separate breeding and foraging sites, as they maintain home ranges in each throughout the breeding season (Rothstein *et al.* 1984, p. 77; Thompson 1994, p. 979; Gates and Evans 1998, p. 31; Goguen and Mathews 2001, p. 1533). Research has demonstrated that local cowbird abundance declines with increasing distances from foraging habitat to breeding habitat (Morse and Robinson 1999, p. 327; Tewksbury *et al.* 1999, p. 23; Young and Hutto 1999, p. 41; Goguen and Mathews 2000, p. 1862; Chace *et al.* 2003, p. 179) and several multivariate models indicate that one of the most important determinants of cowbird abundance is the distance between foraging sites (Tewksbury *et al.* 1999, p. 23; Young and Hutto 1999, p. 49; Goguen and Mathews 2000, pp. 1866–1867). Cowbird abundance can also be influenced by the number of foraging sites in an area (Chace *et al.* 2005, p. 49). Increasing cowbird abundance is associated with human-altered habitats (Lowther 1993, entire) and habitat fragmentation (Ortega 1998, pp. 139–140, 146, 207).

Another influence on cowbird abundance may be the abundance of other host species (Wilkins *et al.* 2006, p. 69) as multiple studies have shown a significant correlation between the two (Robinson and Wilcove 1994, pp. 238–239; Thompson *et al.* 2000, p. 271). Barber and Martin (1997, pp. 598–599) found higher cowbird parasitism rates on black-capped vireos with increasing host populations, specifically northern cardinals (*Cardinalis cardinalis*).

3.5.1 Effects of Cowbird Parasitism

Cowbird parasitism has been documented as a threat to the black-capped vireo due to its negative effect on seasonal fecundity (Grzybowski *et al.* 1986, p. 1157; USFWS 1991, pp. 26–28), but it can affect other aspects of breeding bird ecology including adult/nestling sex ratios (Zanette *et al.* 2005, p. 815; Grzybowski, unpublished data), increased mortality rates of nesting females (Robinson *et al.* 1995, p. 440) and reduced female return rates in a breeding population (Grzybowski 1991, p. 2). Female cowbirds typically remove a host egg (Robinson *et al.* 1995, p. 438) or host nestlings (Stake and Cavanagh 2001, p. 458) from the parasitized nest. Successful parasitism attempts result in reduced fitness of host females and host nestlings as resources are devoted to cowbird offspring. With an incubation period of 11 days, cowbird eggs typically hatch prior to the host's eggs, contributing to the larger cowbird nestling's ability to out-compete the smaller host nestlings (Rothstein 2004, p. 375); however, in many parasitized nests, vireo eggs completely fail to hatch (Cimprich pers. comm.). The result is the partial or total loss of the host's offspring (Rothstein 2004, p. 375). The incubation period for black-capped vireo eggs is 14–17 days (Graber 1961, p. 327) and few parasitized vireo nests are successful (Graber 1957, p. 59; Grzybowski *et al.* 1986, p. 1157). At Kerr WMA, parasitized black-capped vireo nests produced 0.2 fledglings per nest in 1986–1987 (Grzybowski 1995, p. 16) and parasitized black-capped nests at Fort Hood (n=13) produced 0.1 fledglings per nest (Tazik 1991, p. 78). Over fifty years ago, in the northern portion of the black-capped vireo's range, Graber (1961, p. 331) observed no black-capped vireo young fledged from parasitized nests at a site in Oklahoma, and a 40 percent loss of all eggs laid due to cowbird activity.

Rates of cowbird parasitism are not constant throughout the range of the black-capped vireo, but rather differ among populations through space and time (Wilkins *et al.* 2006, p.76). Reported parasitism rates on black-capped vireo nests at Kerr WMA in Kerr County, Texas fluctuated from 65 percent in 1985 (n=20) to 90 percent in 1988 (n=10)(Grzybowski 1991, p. 4). In Oklahoma, parasitism on black-capped vireo nests across several locations decreased from 92 percent in 1986 (n=13) to 58 percent in 1987 (n=19), and in Texas, parasitism fluctuated from 76 percent in 1986 (n=37) to 53 percent in 1987 (n=15)(Grzybowski 1988, pp. 37–38).

With overlapping historical ranges and habitat selection, it is likely that the brown-headed cowbird and black-capped vireo have existed sympatrically for over 10,000 years (Boves *et al.* 2014, p. 365; Rothstein and Peers 2005, p. 104). As a result, the vireo is one of the most parasitized species and among the least tolerant of cowbird parasitism, having developed defense strategies (Mayfield 1965, p. 23; Boves *et al.* 2014, p. 365). Desertion of parasitized nests and re-nesting is a defense strategy well documented for the black-capped vireo (Graber 1961, p. 331; USFWS 1991, p. 27; Tazik and Cornelius 1993, p. 19; Boves *et al.* 2014, p. 369). Parasitized nests were deserted six times more often than un-parasitized nests at Fort Hood (Tazik 1991, p. 120). Cowbird parasitism may also indirectly increase nest loss during the nestling stage (Tazik 1991, pp. 119–120). Ejection of brown-headed cowbird eggs from nests by adult black-capped vireos has also been documented (Boves *et al.* 2014, p. 369).

3.5.2 Population Level Impact

Since female cowbirds use multiple host species (Friedmann 1963, p. 5; Fleischer 1985, p. 91; Hahn *et al.* 1999, p. 204), declines in one particular host species will not produce a corresponding decline in cowbird populations (Grzybowski and Pease 1999, p. 209). As a result, cowbird parasitism is a relatively greater threat to host species that already have small populations due to other factors (Wilkins *et al.* 2006, p.76). Thus, cowbird parasitism has been deemed a primary threat for several endangered species such as Kirtland's warbler (*Dendroica kirtlandii*)(Mayfield 1977, p. 108), black-capped vireo (Grzybowski *et al.* 1986, p. 1157; USFWS 1991, p. 26), Least Bell's vireo (*V. bellii pusillus*)(Goldwasser *et al.* 1980, p. 742; Franzreb 1989, pp. 46–47), and southwestern willow flycatcher (*Empidonax traillii extimus*)(Brown 1988, p. 25).

It has been suggested that parasitism is a concern when it affects more than 30 percent of a host population (Halterman *et al.* 1999, p. 156). This level was set to indicate a significant impact based on Mayfield (1977, p. 156) and Laymon (1987, p. 66), where a 30 percent parasitism rate would likely make a host population unstable. However, Mayfield (1977, p. 112) also noted that ovenbirds (*Seiurus aurocapillus*) reproduced well despite 50 percent parasitism from brown-headed cowbirds. Grzybowski and Pease (2000, p. 153) demonstrated through modeling that the relationship between percent parasitism and seasonal reproductive success (seasonal fecundity) is complex, and that 30 percent of nests parasitized is probably too low to be a threshold of concern for most host species. They suggest that passerines can often tolerate parasitism exceeding 50 percent. Based on this information, and the fact that parasitism rates can be variable in space and time, Smith (1999, pp. 107–108) suggests that managers should consider implementing cowbird management programs only when parasitism rates in a local sample of 30 or more nests exceeds 50 percent over a time span of at least 2 consecutive years. Tazik and Cornelius (1993, p.46) estimated parasitism rates between 16–38 percent as a possible level for maintaining a stable black-capped vireo population at Fort Hood. Smith *et al.* (2013, p. 5) recommended a 30 percent parasitism rate for sustainability of black-capped vireo populations. Recent population modeling performed by Wilsey *et al.* (2014, p. 568) estimated a maximum sustainable parasitism level of 31–40 percent for moderate population growth at Fort Hood. Under a high growth scenario model, parasitism rates above 49 percent could cause population decline even at a fecundity rate of 2.5 fledglings per female (Wilsey *et al.* 2014, p. 568).

Cowbird trapping has been associated with dramatic reductions in cowbird parasitism for multiple species including Kirtland's warbler, least Bell's vireo, southwestern willow flycatcher and black-capped vireo (Bocetti 1994, p. 96; Griffith and Griffith 2000, p. 342; Whitfield *et al.* 1999, p. 260; Eckrich *et al.* 1999, pp. 153–154; Kostecke *et al.* 2005, p. 28). Research conducted at Fort Hood between 1987 and 2004, found a strong negative correlation between the number of female cowbirds trapped during the black-capped vireo breeding season and the incidence of cowbird parasitism on black-capped vireo nests (Summers and Norman 2004, p. 1; Kostecke *et al.* 2005, p. 57).

At Fort Hood, Texas, brood parasitism of black-capped vireo nests exceeded 90 percent (*e.g.*, Hayden *et al.* 2000, pp. 357–370) prior to cowbird control in 1988. Implementation of the cowbird control program at Fort Hood has coincided with reduced parasitism levels and increased nesting success for the black-capped vireo (Eckrich *et al.* 1999, pp. 153–154; Kostecke *et al.* 2005, p. 57). Cowbird trapping programs elsewhere in Texas and Oklahoma have also dramatically decreased parasitism rates and improved black-capped vireo nesting success (Wilkins *et al.* 2006, p.84; Campomizzi *et al.* 2013, pp. 714–715). From 1988 to 1990, parasitism rates at Fort Hood exceeded 50 percent, but fell to just 8.6 percent by 1997, while the number of breeding male black-capped vireos increased from 85 to 357 (Koloszar 1998, pp. 7–27) over the same 10-year span. Intensive cowbird trapping continues and parasitism rates of black-capped vireo nests remains low, with overall mean annual parasitism rates ranging from 5.4 percent to 7.4 percent between 1999 and 2004 (Summers *et al.* 2000, p. 5; Summers and Norman 2002, p. 1; Summers and Norman 2003, p. 4; Summers and Norman 2004, p. 4) and not exceeding 10 percent (Wilkins *et al.* 2006, p.84). Additionally, nest success at Fort Hood shows a strong negative correlation with parasitism rates, while the mean number of territorial male black-capped vireos has increased significantly (Kostecke *et al.* 2005, pp. 31–32).

To evaluate the efficacy of the cowbird control program at Fort Hood, an experimental cessation of brown-headed cowbird trapping on approximately half of the installation was conducted between 2006 and 2010. The result was an increase in frequency of nest parasitism under no cowbird control 10 times greater than the area managed for cowbirds (Kostecke *et al.* 2010, p. 109).

At Kerr WMA, seasonal black-capped vireo production increased from 0 to 3.8 young per female under a cowbird trapping program that reduced the parasitism rate to three percent (Grzybowski 1995, p.16). Among several sites in Oklahoma and Texas between 1983 and 1987, parasitism rates on black-capped vireo nests were 74 percent (n=35) in Oklahoma and 73 percent (n=91) in

Texas without cowbird control, but only 44 percent (n=34) in Oklahoma and 36 percent (n=84) in Texas with cowbird control (Grzybowski 1988, p.80).

Few studies have been conducted on rates of brown-headed cowbird parasitism on the black-capped vireo in Mexico. The first actual record of brood parasitism in Mexico was documented in 2004 (Farquhar and Gonzalez 2005, p. 30). Known parasitism rates from population studies in 2012 and 2013 show a very low rate compared to populations in Oklahoma and Texas. In Coahuila, black-capped vireo nests were parasitized at 6.7 percent (n=49) and in Nuevo León the rate was 20 percent (n=15). The limited amount of parasitism recorded was attributed to intact habitat and limited anthropogenic disturbance in the area (Morrison *et al.* 2014, p 18).

3.5.3 Brown-headed Cowbird Abundance

For the past several decades, brown-headed cowbird numbers have decreased across North America (Rothstein and Peer 2005, p. 101). Breeding Bird Survey (BBS) data show a long term annual trend of -0.7 percent when averaged across the years 1966–2013 (Sauer *et al.* 2014, entire, Figure 21). From 2003 to 2013, BBS data shows a -0.06 percent annual trend in brown-headed cowbird numbers across North America (Sauer *et al.* 2014, entire). Since the listing of the black-capped vireo in 1987 to 2013, the brown-headed cowbird annual trend has averaged -2.1 percent in Texas and -1.7 percent in Oklahoma (Sauer *et al.* 2014, entire).

To analyze the relationship of brown-headed cowbird abundance with the range of the black-capped vireo, BBS data were selected from the ecoregions that overlapped with the vireo's recovery units in Texas, and all data from Oklahoma (Figure 22). From 1967 to 2013, brown-headed cowbird annual trend declined within each of the BBS ecoregions: Oaks and Prairies (North Recovery Unit) -2.1 percent, Edwards Plateau (Central and South Recovery Units) -2.3 percent, Central Mixed Grass Prairie (Central Recovery Unit) -0.3 percent, and the Chihuahua desert (West Recovery Unit) -1.0 percent (Sauer *et al.* 2014, entire, Figure 23).

Survey information on brown-headed cowbirds for the Mexican breeding range is lacking; however, reports indicate a low abundance relative to the U.S. breeding range (Farquhar and Gonzalez 2005, p. 30; Morrison *et al.* 2014, p. 18). The bronzed cowbird (*Molothrus aeneus*) also overlaps the breeding range in Mexico. Although it is also a brood parasite, sparse information exists that it is a threat to the black-capped vireo (Farquhar and Gonzalez 2005, p. 5).

Evidence exists that parasitism by brown-headed cowbirds is less pervasive in the western portion of its breeding range. Smith *et al.* (2012, p. 281) reported parasitism rates of 36 and 27 percent in their study area in west Texas for 2009 and 2010, respectively. A study at Kickapoo Caverns State Park (Edwards and Kinney Counties, Texas) documented a nest parasitism rate of

24.7 percent (20 of 81 nests) in 1992 (Keddy-Hector 1992, p. 4). At Devils River State Natural Area (Val Verde County, Texas), the parasitism rate was 48 percent without cowbird control, but black-capped vireos were still able to maintain 50 percent nesting success (n=93 territories) in 1990 (Bryan and Stuart 1990, p. 5). These rates are substantially less than rates within the eastern portion of the range where parasitism rates are often greater than 75 percent in the absence of cowbird management. The extent of lower rates of parasitism extends to the western range in Mexico, where substantially lower rates (<20 percent) have been reported (Morrison *et al.* 2014, p. 18). Additionally, black-capped vireos in the western portion of the range exhibit a longer breeding season, up to two weeks earlier than other parts of the range, which appears to provide increased productivity (Smith *et al.* 2013, p. 283). Brood parasitism may be less of a threat in the western portion of the black-capped vireo's range as noted by Farquhar and Maresh (1996, p. 2).

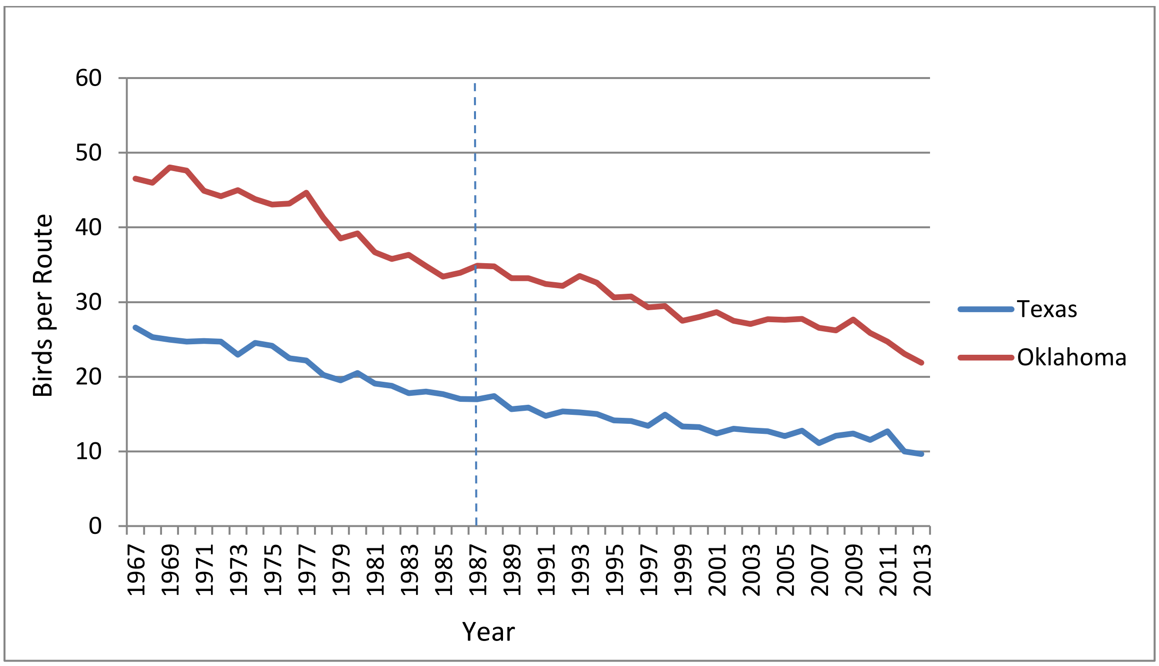

Figure 21. Relative abundance trend for brown-headed cowbirds in Texas and Oklahoma based on Breeding Bird Survey data (Sauer *et al.* 2013). Dashed line shows year when black-capped vireo was listed (1987).

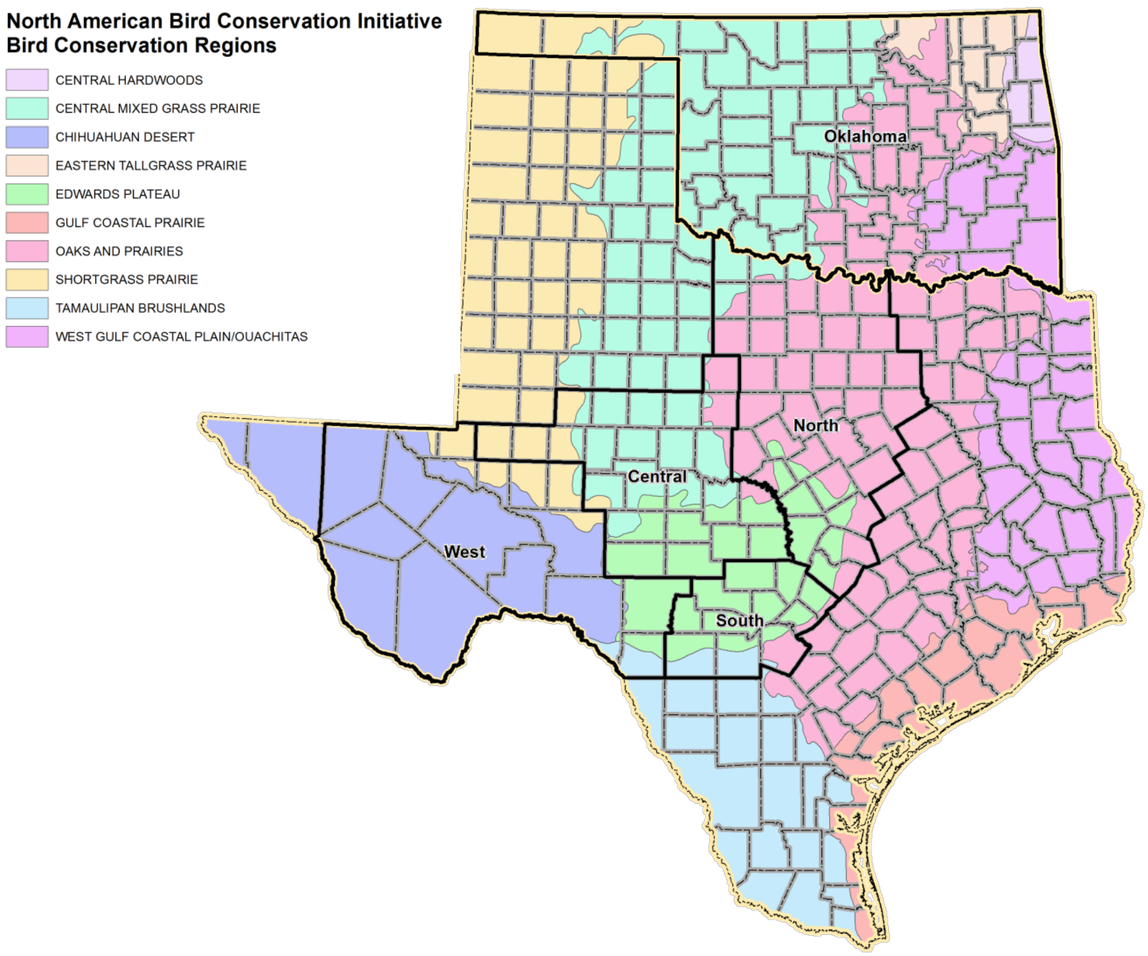

Figure 22. Map of Bird Conservation Regions and black-capped vireo Recovery Units in the U.S. portion of the range.

Brown-headed cowbird trapping data are available for several black-capped vireo populations and counties within three of the four Texas ecoregions/Recovery Units and Oklahoma. For the black-capped vireo populations, the most recent 10-year span of data is described below and was provided by the subject property. Brown-headed cowbird trapping data provided by county is maintained by the U.S. Fish and Wildlife Service's Migratory Birds Division (Southwest Region) from annual reports associated with the Depredation Order for Blackbirds, Grackles, Cowbirds, Magpies and Crows (50 CFR 21.43) under the Migratory Bird Treaty Act. The county trapping data are summarized by year.

Oklahoma Recovery Unit – From 2006 to 2015, an average of 608 female brown-headed cowbirds were removed per year at Wichita Mountains Wildlife Refuge (WMWR, unpublished data).

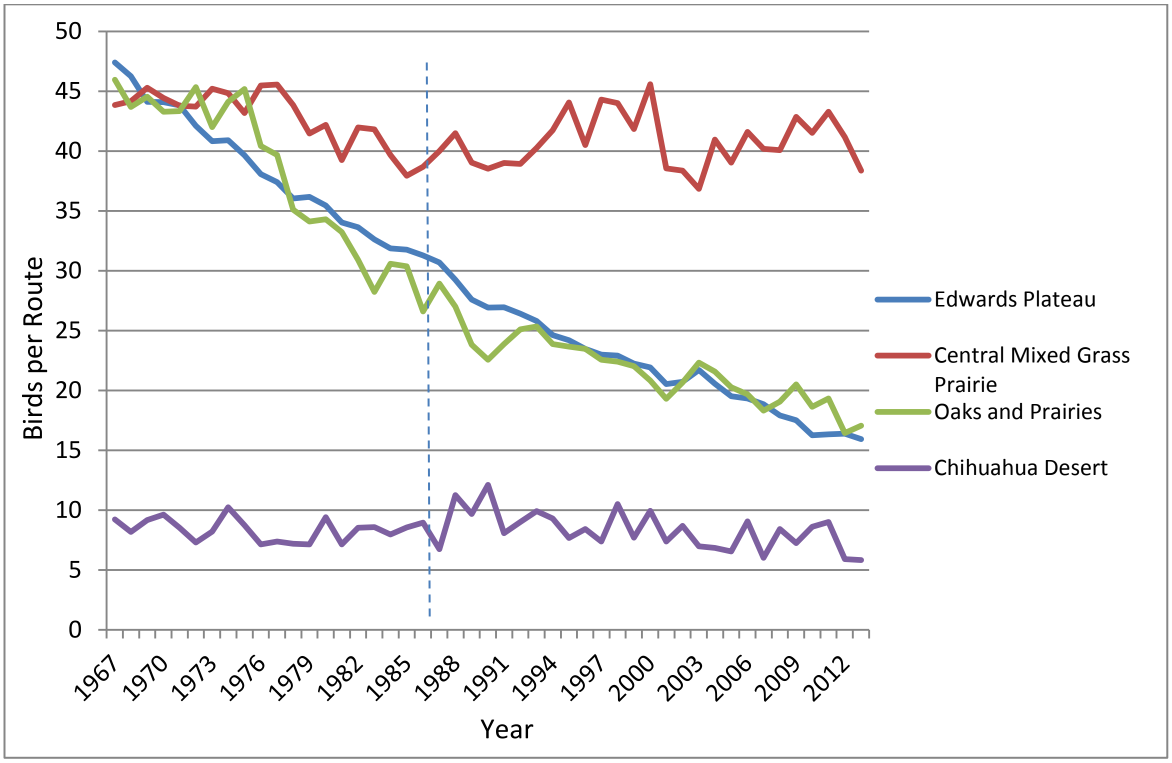

Figure 23. Relative abundance trend for brown-headed cowbirds in Texas ecoregions based on Breeding Bird Survey data (Sauer *et al.* 2013). Dashed line shows year when black-capped vireo was listed (1987).

North Recovery Unit – At Fort Hood, the number of female brown-headed cowbirds removed per year averaged 1,592 from 2005 to 2014; the corresponding parasitism rate of black-capped vireo nests averaged 8.9 percent (Fort Hood, unpublished data). At Balcones Canyonlands National Wildlife Refuge (NWR), the number of female brown-headed cowbirds removed averaged 170 per year from 2006 to 2015 (BCNWR, unpublished data). The brown-headed cowbird removal program at Balcones Canyonlands NWR was altered in 2014 resulting in a greater number of female brown-headed cowbirds being removed. From 2014 to 2015 the number of female brown-headed cowbirds removed averaged 465 per year (BCNWR unpublished data). On the City of Austin's Balcones Canyonlands Preserve properties, an average of 30 female brown-headed cowbirds per year were removed from 2005 to 2012. Trapping was discontinued on the Preserve in 2013. In 2012, two brown-headed cowbird females were removed in Wichita County and in 2014, 69 were removed between Dallas and Tarrant Counties. In 2015, 51 were removed in Bosque, 21 in Denton, 323 in Mills, 11 in Travis and 117 in Williamson Counties.

South Recovery Unit – At Kerr WMA, the average number of female brown-headed cowbirds removed from 2005 to 2014 was 219 (TPWD, unpublished data). Eleven female brown-headed cowbirds were removed in Bexar County in 2012. In 2015, the number of female brown-headed cowbirds removed totaled 94 in Comal County, 99 in Kendall County and 1,108 in Uvalde County.

Central Recovery Unit – In Tom Green County, 3,689 female brown-headed cowbirds were removed in 2014 and 350 female brown-headed cowbirds were removed in Llano County in 2015.

West Recovery Unit – No brown-headed cowbird trapping information is available for this recovery unit.

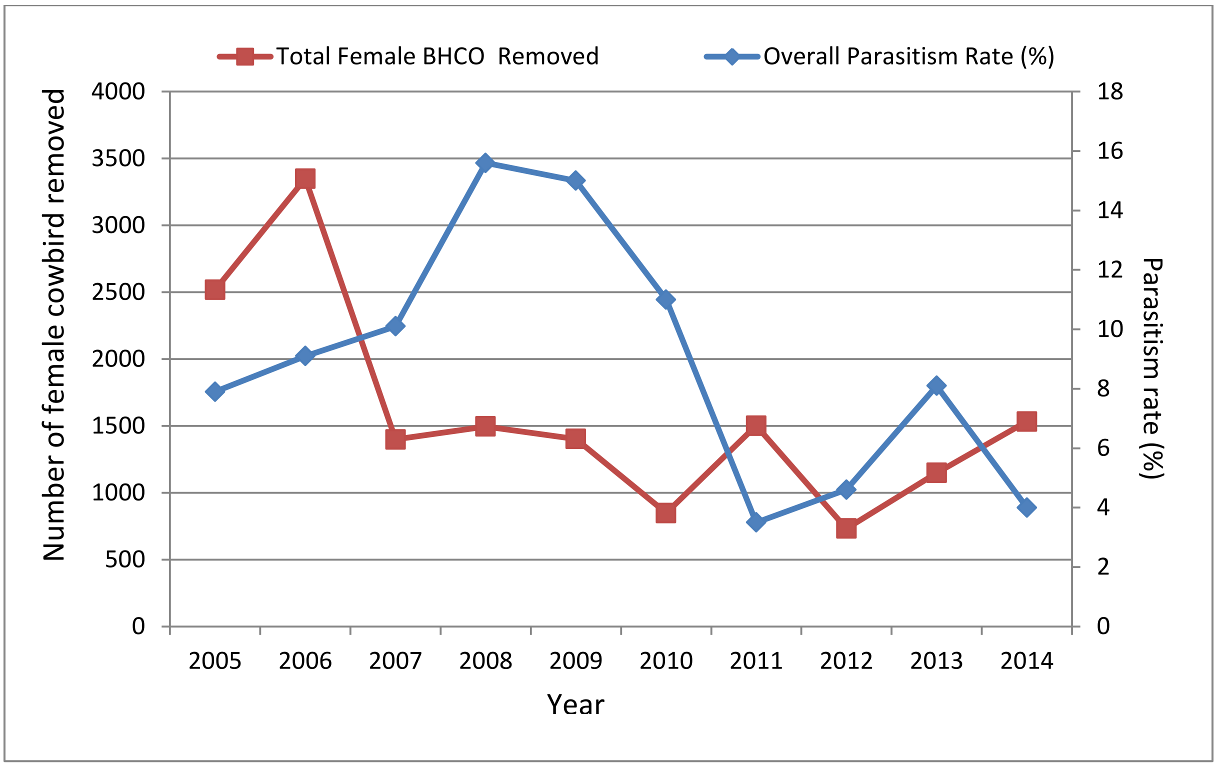

Figure 24. 10-year span of brown-headed cowbird brood parasitism rates of black-capped vireo nests and number of female brown-headed cowbirds removed at Fort Hood (Fort Hood unpublished data). The spike in parasitism rate from 2008–2010 coincides with a research study which curtailed cowbird trapping on the western portion of the installation.

While information pertaining to brood parasitism of black-capped vireo nests is not readily available for all black-capped vireo populations, Fort Hood continues to record this data. Figure 24 displays the latest 10-year span of brown-headed cowbird brood parasitism rates of black-capped vireo nests as well as the number of female brown-headed cowbirds removed at Fort Hood. Ongoing brown-headed cowbird trapping efforts occur at Fort Sill, Kerr WMA, and

Wichita Mountains Wildlife Refuge in pursuit of limiting parasitism rates to levels to promote sustainable black-capped vireo populations.

3.6 Climate Change

The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements (IPCC 2014, pp. 119–120). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (*e.g.*, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014, p. 120).

Millions of hectares of woodlands in the southwestern U.S. have been altered by severe drought conditions since the late 1990s. Extreme heat and lack of moisture have resulted in widespread mortality of many species of grasses, shrubs, trees, and cacti (Allen 2007, p. 799).
The geographic ranges of most plant and animal species are limited by climatic factors, including temperature, precipitation, soil moisture, humidity, and wind. Any shift in the magnitude or variability of these factors in a given location will impact the organisms living there. Species sensitive to temperature may respond to a warmer climate by moving to cooler locations at higher latitudes or elevations. Although the response to warming is generally understood, it is difficult to predict how concurrent changes in other climatic factors also affect species distributions. Despite the uncertainties, ecological models predict that the distribution of world biomes will shift as a result of the climate changes associated with increased greenhouse gases. Although some rangelands are fragile and easily disturbed by anthropogenic activity, others are resistant to change. Semi-arid and arid ecosystems are considered among the most sensitive because these ecosystems often are water-limited and have marginal nutrient reserves (IPCC 1998, 8.3.1.1).

In Texas, air temperature data from 1900 to 2000 do not support a warming trend across much of the state (Nielsen-Gammon 2011, p. 2.21). However, data within the last three decades do support a clear warming trend (Banner *et al*. 2010, p. 8). Climate change models generally predict a three to four degree Fahrenheit (1.6 to 2.2 °C) increase in temperature by mid-21st century (Jiang and Yang 2012, p. 238; Nielsen-Gammon 2011, p. 2.23; Banner *et al*. 2010, p. 8), but predictions on precipitation trends over Texas are not as clear (Nielsen-Gammon 2011, p. 2.28). Some models predict wetter trends in central and southwest Texas in the summer months (Jiang and Yang 2012, pp. 13–14), although other models tend to suggest that Texas weather will become more dry (Banner *et al*. 2010, p. 8) potentially resulting in substantial drought conditions in the southwest and central plains of the U.S. (Cook *et al.* 2015, pp. 5–6). Variation in model predictions indicate it is not prudent to assume precipitation will be steady (Nielsen-Gammon 2011, p. 30).

A report published by the Environmental Protection Agency provided a framework to place species considered threatened or endangered in categories of susceptibility to climate change (EPA 2009, entire). The framework requires several variables on a specific species be scored across four modules, ultimately categorizing the target species' vulnerability to climate change as critically, highly, less, or least vulnerable, and adds a qualitative category on the level of certainty.

Completing the scoring for a species requires specific information, such as current population size and population trend in the last 50 years, which is not available for the black-capped vireo and therefore, would require substantial speculation. It should be noted that an example framework was provided by EPA (2009, p 42) for the endangered golden-cheeked warbler, which has a breeding range that overlaps the black-capped vireo. The framework narrative concluded the warbler was "critically vulnerable" to future climate change. However, the population size used a maximum of 30,000 individuals for scoring, which was reasonable at the time; however, recent estimates of over 260,000 male warblers have been reported (USFWS 2014, p. 5), adding more uncertainty to the ability to predict population estimates and trends based on climate models.

The distribution and abundance of species is associated with the biotic and abiotic factors, including climate, within their habitats (Hanson *et al.* 1999, p. 1464; White *et al.* 2011, p. 537). During the breeding season, the black-capped vireo's shrubland habitat essentially provides its needs. Although the rate of change from climate change on shrubland habitat preferred by the black-capped vireo is uncertain, shrub encroachment into grasslands in North America, primarily due to fire suppression and livestock grazing, is well documented (Van Auken 2000, entire; Briggs *et al.* 2005, entire; Knapp *et al.* 2007, p. 616). Projected warming temperatures and dry conditions will likely have an influence on future shrubland dominance (Van Auken 2000, p. 206). Evidence suggests that within the far west portion of the vireo's range, the effect of climate change and fire suppression would result in a shrubland dominated landscape (White *et al.* 2011, p. 541). In this scenario, the availability of shrub habitat would be the least affected, and potentially more prevalent on the landscape.

In the northern portion of the Mexican breeding range and the western portion of the vireo's range in Texas, breeding habitat is adapted to xeric and semi-arid conditions, more tolerant of higher temperatures and limited precipitation. In contrast, the eastern portion of the breeding range, moister soils and higher annual rates of precipitation support black-capped vireo habitat in early to mid-successional stages, which are ephemeral, fire dependent, and subject to afforestation. This range in biotic and abiotic factors that supports habitat across the breeding range, suggests warming trends may not limit habitat availability, and where shrubland dominance is predicted, may favor breeding habitat availability for the black-capped vireo. The distribution of the black-capped vireo has fluctuated since the 1950s in a pattern that does not follow a logical result of warming temperatures: contracting on the northern extent of the range, and greatly expanding on the southern extent. This trend follows the results of niche models that indicate that the ancestral range of the black-capped vireo as far back as the mid-Holocene period (approximately 6,000 years ago) closely resembles the current known distribution (Vázquez-Miranda *et al.* 2015, p. 7).

3.7 Winter (non-breeding) Range.

Threats to the species on its wintering grounds were not identified at the time of listing or during the 2007 5-year review. Habitat for wintering is more general and exists as arid/semi-arid scrub and secondary growth. Vega Rivera *et al.* (2010, p. 102) describes the variety of habitats within the context of overall tropical dry forest. Dry forests in Mexico are of conservation concern (Miles *et al.* 2006, p. 2006) and have historically been modified for agricultural and other purposes (Powell 2013, p. 100). The majority of impacts to tropical dry forests (>55 percent) occurred prior to the listing of the black-capped vireo (Powell 2013, pp. 101–102). Habitat loss still occurs (Powell 2013, pp. 101–102), but the extent of habitat specifically important to wintering vireos is unknown, considering the variety of habitats used. Vireos have also been documented using disturbed habitats (*e.g.*, fruit and vegetable plantations) within larger landscapes of dry forests (Vega Rivera *et al.* 2010, p. 102; Colón *et al.* 2016, p. 316), which may be important winter resources. It is estimated that only 7.1 percent of modeled habitat (103,000 to 141,000 km^2 (39,769 to 54,440 mi^2)) is under some degree of protection in Mexico (Vega Rivera *et al.* 2010, pp. 102–103). Additional protection may occur on rough terrain and steep slopes, which is largely unsuitable for development, where much of tropical dry forests remain intact (Powell 2013, pp. 101–102).

As an indirect measure, population health and growth on the breeding grounds can be useful to evaluate wintering habitat availability. Long term monitored populations at Fort Hood, Fort Sill, Wichita Mountains Wildlife Refuge and Kerr WMA (see Section 4.2.6), have shown stable populations and, at Fort Hood, substantial population growth since 2005. Based on this information, it is inferred that winter range habitat continues to support these breeding populations during the non-breeding season.

3.8 Summary of Causes and Effects

When the black-capped vireo was listed in 1987, the known threats influencing its status were breeding habitat loss and parasitism by brown-headed cowbirds. These threats continue to be primary factors affecting the species’ viability. Breeding habitat loss in the U.S. has been linked to vegetational succession (due to fire suppression), grazing/browsing from livestock and native/exotic ungulates, and the conversion of breeding habitat to other land uses.

Trends in lands categorized as rangeland is an indirect measure useful in estimating effects of land use changes on the black-capped vireo. In evaluating available USDA Agricultural Census data for reported rangeland within the black-capped vireo's U.S. breeding range, a general increasing trend has occurred since 1987. Additionally, a 35.9 percent increase in Oklahoma and 4.4 percent increase in Texas and has occurred since 2002.

The prevalence of goats in Texas was a specifically named threat to black-capped vireo in 1987. Since that time, goats within the U.S. range of the vireo have dramatically decreased, largely attributed to the 1993 expiration of the Wool Act. A decrease of 46.8 percent in goat numbers was reported from 1987 to 2012 in counties where black-capped vireos are known to occur. Cattle, white-tailed deer and exotic ungulates are also known to impact vireo habitat, however, to a lesser extent than goats. Cattle numbers reported by county have also decreased across the vireo range from 1987 to 2012 by 37.2 percent. Data on the density of exotic ungulates in Texas and Oklahoma are unavailable; white-tailed deer densities in the vireo range in Texas have increased by 18.3 percent from 2005 to 2014. While deer and exotic ungulates in high numbers can degrade habitat, they are generally considered to have much less of an impact compared to goats. In Mexico, a primary economic activity is livestock ranching within the breeding range, although trend data are not available. In some areas, livestock appears to be at low densities (small scale) and may be separated from breeding vireos by elevation, and therefore, may not be in direct contact with habitat.

Vegetational succession continues to affect the species' habitat in the eastern portion of the range in Texas and in Oklahoma. Habitat considered early successional is created naturally or artificially by disturbance, usually fire. In the absence of wildfire or prescribed fire, early successional habitats grow to mature habitat unsuitable for vireo nesting. In the western portion of the range in Texas and Mexico, vireo habitat exists largely as mature habitat, and succession management is less important.

Brood parasitism by brown-headed cowbirds has been documented to affect more than 90 percent of black-capped vireo nests in some Texas study areas. Control of cowbirds through trapping has been shown to significantly reduce parasitism and increase population productivity. An evaluation of BBS data shows brown-headed cowbird detections have been decreasing in Texas and Oklahoma since 1967, specifically in ecoregions where black-capped vireo are known to occur. Available data and anecdotal information suggest geographic differences in the impact cowbirds have on breeding vireos. As with vegetational succession, cowbird parasitism appears to be less prevalent on the western portion of the vireo's range and in Mexico. Cowbird control continues to be necessary for populations in the eastern portion of the range in Texas and in Oklahoma.

Climate change is of concern to ecosystems sensitive to warming temperatures and decreased precipitation, such as arid and semi-arid habitats. A warming trend is detected in much of the vireo's breeding range; however, precipitation models are not as conclusive. There appears to be no clear evidence on the magnitude or rate of change from the effects of climate change on the vireo, and at least some evidence shows the distribution of the species has remained relatively stable for thousands of years, and shrubland habitats (used for vireo breeding and nesting) may be dominate under climate change scenarios.

Habitat models have suggested the winter range may be up to 141,000 km^2 (54,440 mi^2) in size. Black-capped vireos are more general in habitat selection for wintering, and can use scrub, disturbed habitats, secondary growth habitats and tropical dry forests. Tropical dry forests in Mexico have been greatly impacted, much of which occurred prior to the listing of the vireo. The remaining habitats may be inaccessible to anthropogenic impacts, and thus removed from potential stressors, because it occurs on canyons and slopes.

CHAPTER 4 – SPECIES CURRENT CONDITIONS

In this chapter we review the current condition of the species in terms of the individuals, populations, and rangewide. We look at the limited available information on known populations and review the current range and distribution of the species. We also provide a summary of the current conditions within the locations containing the most significant known populations at Fort Hood and Fort Sill Military Installations, Kerr WMA, Wichita Mountains Wildlife Refuge, and Val Verde County, Texas. We then review the known current status of the black-capped vireo within the U.S., with respect to Recovery Units and the Mexican breeding and wintering ranges.

The known distribution and population of the black-capped vireo has expanded substantially since its listing. This is a result of new information on the species gathered during conservation research and recovery efforts and conservation and management actions on public and private lands. The black-capped vireo was known to historically inhabit portions of Kansas, Oklahoma, Texas and central Coahuila, Mexico. The black-capped vireo has not been confirmed in Kansas since 1953, and at the time of listing had only been documented in Comanche County, Oklahoma near the southern border with Texas. The known population of the black-capped vireo in the breeding range between 2009 and 2014 was reported at 5,244 adult males, compared to 4,464 adult males from 2000 to 2005; only 350 birds known at the time of listing in 1987. We acknowledge variable consistency of effort in information collected; however, this represents the best information of population abundance and distribution, along with a documented reduction in threats, to demonstrate an increase in the known population and distribution. The breeding range no longer appears to extend farther north than central Oklahoma, but extends further south into Mexico than was previously known (Farquhar and Gonzalez 2005, p. 16; González-Rojas *et al.* 2014, entire). Additional details of the black-capped vireo's current range and conditions are discussed below.

4.1 Assumptions

There are no available estimates of the number of black-capped vireos in the rangewide breeding population. For this reason, past evaluations (*i.e.*, the 1985 status assessment, 1996 PHVA, 2007 5-year review) have relied upon compiling the known records of species occurrence over a specific timeframe. This information is gathered by different researchers or entities, using inconsistent methodologies, may be incomplete for certain localities, and ascertained for different purposes. However, it is the best available information about the known localities, abundance, and distribution of the species. Thus, for the purpose of this assessment, available data on known localities from different timeframes is reported for comparison. In doing so, it is acknowledged that it is limited to the "known population" of those time periods.

These data are also not directly comparable with past assessments due to inherent differences in survey effort and availability. That is, following the listing of the black-capped vireo under the Act, surveys for occurrence of the species have increased. Thus, it is not implied that a reported higher number of individuals in one timeframe over the previous timeframe represents an increase in the population. It is an increase in what has been reported.

4.2 Condition of Populations

Information on black-capped vireo populations is available from public lands, properties surveyed for various reasons (*e.g.*, due diligence for development), private conservation lands, and miscellaneous surveys and reports. Data on black-capped vireo occurrence within the breeding range are inconsistent and collected by different methodologies for different purposes. For this analysis, reported adult male vireos (most often the subject of surveys) are compiled between two timeframes. While these data were not collected as part of a systematic census of the species, they represent the best available information on its occurrence in the breeding range.

Information on what constitutes a black-capped vireo population is lacking and generally inconsistent. Male vireos that successfully pair on the breeding grounds generally return the following season to the same area (Grzybowski 1995, p. 18). Dispersal of young from birth site (natal dispersal) is the primary factor in colonization of new sites and ensuring gene flow. Observed natal dispersal distance is generally 21 to 30 km (13 to 19 mi)(Grzybowski 1995, p. 18; Cimprich *et al.* 2009, p. 46); however, the longest known distance was recorded as 78.1 km (48.5 mi)(Cimprich *et al.* 2009, entire). Metapopulation dynamics, at least demographically, may also be a factor in occupied patches proximal to each other (Grzybowski 1995, p. 19; Zink *et al.* 2010, pp. 801–802). Data from surveys are often limited to property boundaries, and may represent a population, or only a portion of a population. In such instances, different land uses or management activities may occur between property boundaries and influence resiliency by location. So, for this assessment, populations are considered as the occurrence of multiple breeding black-capped vireos on localities under a single management authority (*e.g.*, a privately owned ranch). For this assessment, likely resilient populations (breeding habitat with 100 or more adult males) and manageable populations (breeding habitat with 30 or more males but less than 100) will be described in terms of distinct locations where single year surveys have been conducted.

Information evaluated for the 2007 5-year review, indicate that from 2000 to 2005, 64 percent of the known black-capped vireo breeding population occurred on four major properties in the U.S.: Fort Hood and Fort Sill Military Installations, Kerr WMA, and the Wichita Mountains Wildlife Refuge[1]. These properties, all under public management, still support the largest known

[1] The known population described in the 2007 5-year review has been modified for this assessment to account for corrections and most relevant reports from long term monitored sites. See Appendix E for details.

populations within the breeding range of the species, however, data from 2009–2014 indicate these properties represent only 40 percent of the entire known breeding population (USFWS 2014, unpublished). The decreased portion of the known population occurring on these properties is in part due to changes made in survey methodology at Fort Hood and Wichita Mountains, however, it is also due to increases in known populations across the range, particularly in Val Verde County, Texas, as well as newly documented locations.

Data reported from 2009 to 2014 indicate there are at least 34 black-capped vireo localities of 30 or greater adult male black-capped vireos; 29 in Texas, two in Oklahoma, and three in Mexico (USFWS unpublished; Morrison *et al.* 2014, p. 16). Of these locations, fourteen have greater than 100 adult males, nine of which occur on managed lands. Of the 20 localities with 30 or more male vireos, but less than 100, 10 occur on managed lands. In all, there are 40 localities in the U.S. that are under ownership or management by Federal, state, or municipal government, or by a private conservation organization or under easement, that have documented vireos from 2009 to 2014 (Table 7). These properties provide a level of protection to breeding birds and represent 70 percent of the entire known breeding population. In 2013, over 100 adult males were documented in two of the three breeding locations in Mexico. Locations with known breeding vireos of more than 30 males on private lands are listed by county or Mexico State in Table 8.

Table 7. Known localities of black-capped vireo on U.S. properties under management through public ownership (Federal, state, municipal) or easement. Total number of known adult males: 3,695.

Black-capped vireo Recovery Unit	Locality	Property Acres (Hectares)	Most recent estimate of available black-capped vireo habitat acres (hectares)	# of black-capped vireos	Year of black-capped vireo survey.	Active brown-headed cowbird trapping program (yes/no/comment)	Active prescribed fire/black-capped vireo mgmt. program (yes/no/ comment)
Oklahoma	Fort Sill *Comanche Co.*	93,000 (37,636)	16,000 (6,475)	603 709*	2014	Yes	Yes
	Wichita Mountains Wildlife Refuge *Comanche Co.*	59,020 (23,885)	27,016 (10,933)	121 3,300*	2014	Yes	Yes
	Quartz Mountain State Park *Greer Co.*	4,284 (1,734)	Unavailable	15	2014	Unavailable	Unavailable
North	Balcones Canyonlands NWR *Burnet/Travis/Williamson Co.*	24,500 (9,915)	2,200 (890)	158	2014	Yes	Yes
	Balcones Preserve-City of Austin *Travis Co.*	13,608 (5,507)	Unavailable	6	2011	Unavailable	Unavailable

	Balcones Preserve-Travis County *Travis Co.*	8,861 (3,586)	Unavailable	13	2009	Yes	Unavailable
	Barton Creek Habitat Preserve *Travis Co.*	4,084 (1,653)	150 (61)	2	2009	Unavailable	Yes
	Parrie Haynes Ranch *Bell Co.*	4,500 (1,821)	Unavailable	2	2009	Unavailable	Unavailable
	Clearwater Ranch Conservation Easement *Burnet Co.*	5255 (2,127)	1,245 (Oncor annual report) (504)	24	2013	Yes	Yes
	Dinosaur Valley State Park *Somervell Co.*	1,587 (642)	Unavailable	2	2009	No	Prescribed fire plan under development
	Fall-off Creek Mitigation Bank *Coryell Co.*	690 (279)	Unavailable	2	2010	Unavailable	Unavailable
	Fort Hood *Bell/Coryell Co.*	219,000 (88,626)	22,000 (8,903)	918 7,478*	2014	Yes	Yes
	Inks Lake State Park *Burnet Co.*	1,200 (486)	Unavailable	5	2009	No	Prescribed fire plan under development
	Possum Kingdom State Park *Palo Pinto Co.*	1,528 (618)	Unavailable	5	2014	No	Majority of park burned during 2011 wildfire
	LCRA Canyon of the Eagles *Burnet Co.*	950 (385)	498 (2014) (202)	45	2011	Yes	No
South	Camp Bullis Military Installation *Bexar Co.*	24,887 (10,071)	153 (62)	2	2010	Yes	Unavailable
	Garner State Park *Uvalde Co.*	1,774 (718)	Unavailable	7	2011	No	Yes
	Hill Country State Natural Area *Bandera Co.*	5,400 (2,185)	Unavailable	4	2009	No	Yes
	Kerr WMA *Kerr Co.*	6,493 (2,628)	4,000 (1,619)	463 879*	2014	Yes	Yes
	Little Bear Creek Tract-City of Austin *Hays Co.*	1,325 (536)	Unavailable	2	2014	Unavailable	Unavailable
	Lost Maples State Park *Bandera Co.*	2,174 (880)	Unavailable	21	2012	No	Yes
	Love Creek Preserve (TNC) *Bandera Co.*	2,508 (1,015)	Unavailable	30	2011	Unavailable	Yes
	Mills Spring Ranch-Bandera Corridor Conservation Bank *Bandera Co.*	641 (259)	Unavailable	6	2009	Unavailable	Unavailable
	Rancho Diana-City of San Antonio *Bexar Co.*	1,300 (526)	Unavailable	37	2013	No	No

	S4/Spangler Ranch-Bandera Corridor Conservation Bank *Bandera Co.*	1,159 (469)	Unavailable	6	2009	Unavailable	Unavailable
	Shield Ranch Camp Wood Conservation Easement *Real Co.*	1,407 (569)	1,055 (required to maintain 75%) (427)	54	2013	Yes	Yes
	Wagon Track Ranch-Bandera Corridor Conservation Bank *Bandera Co.*	1216 (492)	Unavailable	5	2009	Unavailable	Unavailable
Central	Cedar Point Recreation Area-LCRA *Llano Co.*	400 (162)	Unavailable	1	2010	No	No
	Colorado Bend State Park *San Saba Co.*	5,328 (2,156)	Several hundred acres	22	2012	No	Yes
	Mason Mountain WMA *Mason Co.*	5,301 (2,145)	Unavailable	126	2009	Yes	Yes
	Walter Buck WMA (Llano River State Park) *Kimble Co.*	2,200 (890)	Unavailable	95	2011	No	Yes
West	Big Bend National Park *Brewster Co.*	801,163 (324,219)	Unavailable	30	2010	Unavailable	Unavailable
	Independence Creek Preserve and Chandler Easement *Terrell Co.*	21,128 (8,550)	Unavailable	39	2012	No	No
	Devils River State Natural Area Del Norte *Val Verde Co.*	20,000 (8,094)	Unavailable	171	2011	No	Yes
	Devils River State Natural Area Hugh Unit *Val Verde Co.*	17,000 (6,880)	Unavailable	81	2012	No	Yes
	Devils River Conservation Easements-TNC *Val Verde Co.*	89,583 (36,253)	25,458 (10,303)	357	2013	No	Some brush management
	Devils Sinkhole State Natural Area *Edwards Co.*	1,860 (753)	Unavailable	40	2009	No	Yes
	Dolan Falls Ranch Preserve-TNC *Val Verde Co.*	4,965 (2,009)	Unavailable	102	2013	No	No
	Escondido Draw Recreational Area *Crockett Co.*	3,300 (1,336)	Unavailable	9	2014	Unavailable	Unavailable
	Kickapoo Caverns State Park *Edwards/Kinney Co.*	6,368 (2,577)	Unavailable	64	2010	No	Yes

*Population Estimate

Table 8. Counties with private land locations with 30 or more male black-capped vireos.

Recovery Unit	U.S. County (Mexico State)	Number of Males	Source Year
TX North	Coryell	52	2009
TX South	Bandera	85	2012
	Bandera	90	2012
	Kerr	85	2010
	Real	151	2012
TX Central	Kimble	40	2013
	San Saba	30	2012
	Taylor	85	2011
TX West	Edwards	73	2012
	Edwards	169	2011
	Val Verde	33	2013
	Val Verde	110	2014
Mexico	Coahuila	126	2013
	Nuevo León	58	2013
	Tamaulipas	101	2013

A comparison of data collected between 2000 and 2005 and between 2009 to 2014 by U.S. county is shown in Figure 25. There are 14 counties with documented black-capped vireo occurrences in the 2009 to 2014 timeframe that were previously unknown from 2000 to 2005, and 10 counties in the 2000 to 2005 timeframe not reported from 2009 to 2014. The known population has substantially increased since 1987, and has been stable to increasing since 2005. Details within Mexico, Oklahoma, and the Texas Recovery Units are discussed below.

4.2.1 Oklahoma

The extent of black-capped vireos in Oklahoma is generally limited to the Wichita Mountains area, where a major population occurs at two localities: Wichita Mountains Wildlife Refuge and Fort Sill. These properties adjoin one another, thus functioning as a single black-capped vireo population; however, the properties are managed by two different entities. Wichita Mountains estimates 3,300 males and Fort Sill another 709 for a total of 4,009 males in 2014, compared to 35 to 51 birds thought to exist 28 years ago. Active management occurs on both properties, including prescribed fire, brown-headed cowbird control and grazing management. Apart from this area, vireos have been documented in four additional counties in Oklahoma since 2009. These observations extend from the Wichita Mountains to the north and west, possible dispersal from the occupied habitats on the Refuge and Fort Sill. The Wichita Mountains area may serve as a source for vireo expansion in surrounding areas depending on the availability of suitable breeding habitat.

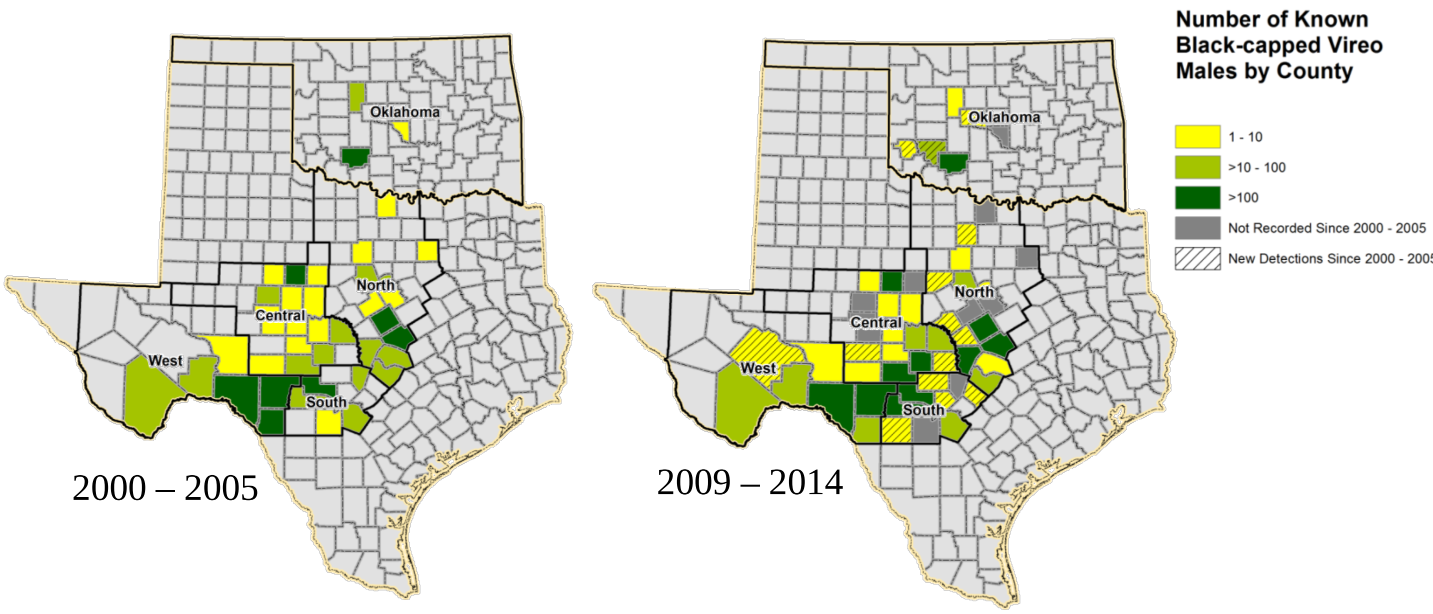

Figure 25. Comparison of the known population in the U.S. by county from 2000 to 2005 and from 2009 to 2014.

4.2.2 Texas: North Recovery Unit

Locations of 100 males or more occur within the North Recovery Unit at Fort Hood and Balcones Canyonlands NWR. The Fort Hood black-capped vireo population is managed to conserve the species and was estimated at 7,478 as of 2014. The Balcones Canyonlands NWR also manages a population of approximately 158 male vireos. Additionally, a smaller number (19 males) occurs at the Balcones Canyonlands Preserve (City of Austin and Travis County). Adequate habitat restoration throughout these properties may continue to promote dispersal (Grzybowski 1995, p. 18), thus allowing these groups to merge in the future. One additional locality of greater than 30 male vireos occurs on public land at Canyon of the Eagles and another on private land in Coryell County.

4.2.3 Texas: South Recovery Unit

In the South Recovery Unit, there are two localities of 100 males or more; one at TPWD's Kerr WMA and one on private land in Real County. The Kerr WMA black-capped vireo population is managed for habitat and cowbirds and was estimated at 879 as of 2014. There are three additional populations of 30 or more on managed lands in this Recovery Unit. Two of the properties, Love Creek Preserve and Lost Maples State Park are approximately 25 km (15.5 mi) from Kerr WMA, as well as the Bandera Corridor Conservation Bank, which also has a small population. Twenty five km (15.5 mi) is within the dispersal distance of black-capped vireo (Cimprich *et al.* 2009, p. 46). Another three localities of more than 30 birds occur on private lands in this Unit.

4.2.4 Texas: Central Recovery Unit

One locality of greater than 100 vireos occurs in the Central Recovery Unit on TPWD's Mason Mountain WMA. Four additional properties with 30 or more vireos occur in the Unit, one on State-managed land and the others on private land.

4.2.5 Texas: West Recovery Unit

Due to their close proximity, the Devils River State Natural Area (SNA) Del Norte Unit, Devils River SNA Hugh Unit, Dolan Falls Ranch Preserve and TNC's Devils River Ranch Conservation Easements in Val Verde County likely function as a single black-capped vireo population. This area has been identified as a major population comparable to the four previously identified (Fort Hood, Fort Sill, Wichita Mountains Wildlife Refuge and Kerr WMA). The known population of the combined Val Verde properties is 711 birds. The combined area of these properties is over 60,000 ha (150,000 ac). A portion of the properties with approximately 10,521 ha (26,000 ac) of breeding habitat is estimated to have more than 2,000 adult males (Kostecke *et al.* 2013, p. 6). Two additional localities of greater than 100 birds occur on private lands in Val Verde and Edwards Counties. Three public lands, Big Bend National Park, Kickapoo Caverns State Park, and Devils Sinkhole SNA have 30 or more vireos, and an additional two occur on private lands.

4.2.6 Population Trends

Information gathered from annual black-capped vireo monitoring at four major public lands containing the largest known black-capped vireo populations represents some of the best data available on the species' population trends. Although these localities employ management actions for the vireo, the stability of the population provides insight on the future conditions of the species, both on the breeding grounds and during migration and wintering. Figure 26 illustrates population estimates of male black-capped vireos since the 2005 breeding season, revealing a general increase in population within these areas since 2008. Overall estimates of vireo abundance at Kerr WMA and Fort Sill have been relatively stable over the time-frame. The decrease in estimates at Wichita Mountains from 2011 to 2014 is attributed to wildfires and drought in 2010 and 2011 (McDonald 2014, p. 1). These populations, along with Devils River Conservation Easements, in total were estimated to consist of 14,418 adult males in 2013-14.

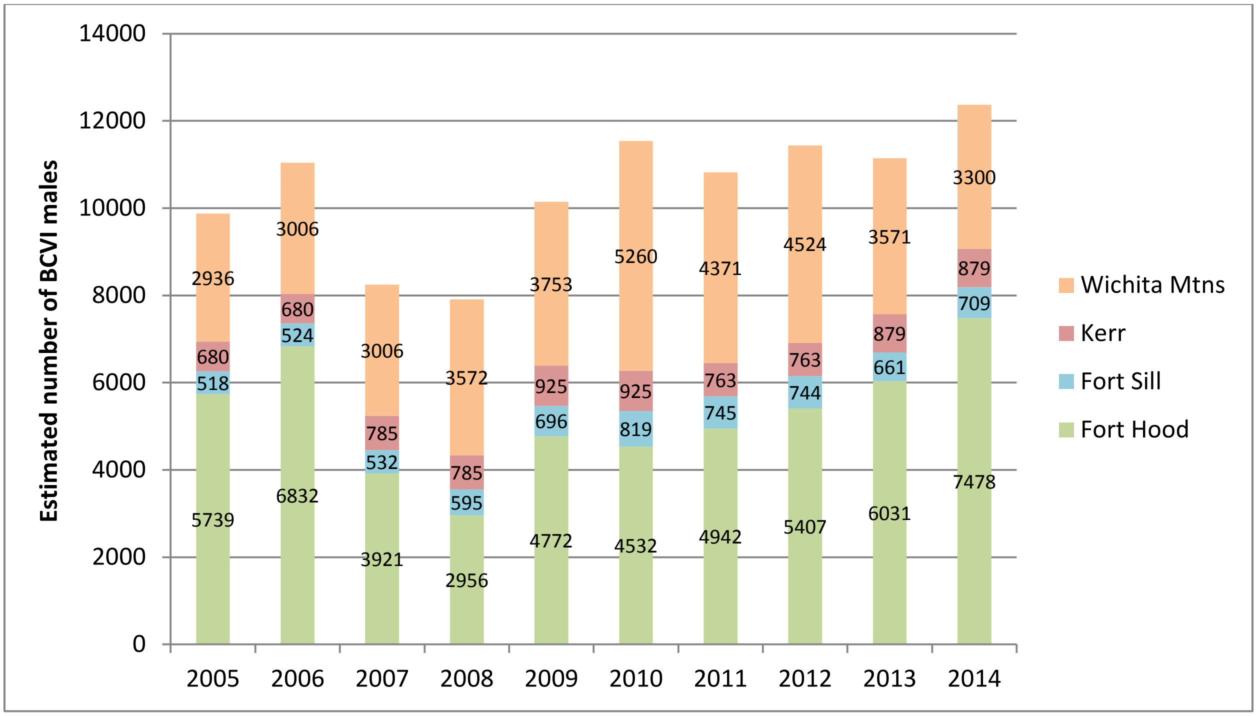

Figure 26. Black-capped vireo population estimates on four regularly surveyed public lands.

The estimated available suitable black-capped vireo breeding habitat within the four major public lands is shown in Table 9. In total these areas manage approximately 27,930 ha (69,000 ac) of breeding habitat. Each of these facilities institutes a prescribed fire/black-capped vireo management program in order to maintain vegetative succession at levels conducive to black-capped vireo breeding habitat.

Table 9. Estimated size of black-capped vireo breeding habitat within the four public lands managing major populations.

Major public land with black-capped vireo habitat	**Estimated hectares (acres) of black-capped vireo breeding habitat**
Fort Hood	8,903 hectares (22,000 ac)
Fort Sill	6,475 hectares (16,000 ac)
Kerr Wildlife Management Area	1,619 hectares (4,000 ac)
Wichita Mountains Wildlife Refuge	10,933 hectares (27,016 ac)

In order for populations to maintain high resiliency, nest parasitism by brown-headed cowbirds should not exceed a rate sustainable by black-capped vireos. Recent population modeling performed by Wilsey *et al.* 2014 (p. 568) estimated a maximum sustainable parasitism level of 40 percent or less for moderate black-capped vireo population growth at Fort Hood. Cowbird control programs began at Fort Hood in 1988, greatly reducing parasitism levels from over 90 percent prior to control efforts to annual levels typically below 10 percent. Similar ongoing brown-headed cowbird trapping efforts occur at Fort Sill, Kerr WMA, and Wichita Mountains Wildlife Refuge in pursuit of limiting parasitism rates to levels which allow sustainable black-capped vireo nesting productivity. Cowbird management is promoted by TPWD and does occur on some private lands (see Section 4.5.3); however, parasitism rates are generally unknown for populations on private lands. In the western portion of the species' range, lower parasitism rates have been documented and the known population has increased (from 133 males to 867 males since 2005 in Val Verde County only) indicating cowbird management may not be necessary in some areas.

The breeding black-capped vireo populations appear to be thriving at these four properties due in part to the management activities directed specifically to benefit the species. Therefore, the current conditions related to nesting and foraging habitat quality and availability, and acceptable brown-headed cowbird parasitism rates, appear to provide the essential components needed for these populations to remain resilient.

4.3 Condition of Species Rangewide

4.3.1 Breeding Range Trends

Throughout its range, black-capped vireo populations are distributed across a multitude of ownerships, possessing varying degrees of habitat protection and varying levels of active black-capped vireo management (including none). Due to the majority of private land ownership within the breeding range and non-systematic effort in data collection, there are limitations in quantitatively comparing survey data. Where available, data from known populations that have been studied over time shows that numbers of individuals within these populations are stable or increasing (see Section 4.2). This at least suggests that the species has increased in abundance under management of threats and that sufficient needs during migration and wintering are met.

Overall numbers for the known populations from 2000 and 2005 compared to those from 2009 to 2014 are provided by Texas Recovery Unit, Oklahoma and Mexico (Table 10). For locations where the four major populations occur, estimates from those locations are added to the known numbers as an additional measure. In each of these units, the known populations have increased, with the exception of Oklahoma showing a 61 percent decrease. However, the decrease is due to a change in survey methodology, where the 2014 number reflects a smaller sampling area. When incorporating population estimates from the major populations, all units show an increase. From 2005 to 2014, there was an increase of 17.5 percent in the known breeding population.

Table 10. Comparison of known and estimated numbers of black-capped vireos collected from 2000 to 2005 and 2009 to 2014. Known number of vireos is from reported census data within the time-frame. For Recovery Units that include one of the four regularly surveyed properties, an additional number (footnoted number) uses the 2014 population estimate of that property added to the other census data for the Recovery Unit.

Recovery Unit	Black-capped vireo Count ('00–'05)	Black-capped vireo Count ('09–'14)	Change	Percent Change
TX Central	290	520	230	79.3%
TX North	5,995[1] 846	7,858[1] 1,298	1,863[1] 452	31.1%[1] 53.4%
TX South	942[2] 620	1,486[2] 1,070	544[2] 450	57.7%[2] 72.6%
TX West	501	1,305	804	160.5%
Oklahoma	3,475[3] 1,948	4,044[3] 759	569[3] -1,189	16.4%[3] -61%
Mexico	259	285	26	10%
Population with estimates	**11,462**	**15,498**	**4,036**	**35.2%**
Known Population	**4,464**	**5,244**	**780**	**17.5%**

[1]Includes population estimates from Fort Hood
[2]Includes population estimates from Kerr WMA
[3]Includes population estimates from Wichita Mts. Wildlife Refuge and Fort Sill

All available data compiled since listing also show increases in abundance since 1987. Table 11 provides the known number of black-capped vireos, as well as geographic information across four dates when census information was compiled.

Another measure of condition of the species is gene flow between breeding populations. Populations with higher heterozygosity are considered healthier than homozygous ones because there is more variation in the population's gene pool. This higher heterozygosity, among other things, helps populations adapt to environmental changes. Initial efforts to characterize genetic heterozygosity and population structuring in the black-capped vireo have found substantial variability, considering the apparent limited dispersal between isolated populations, within four geographically isolated populations in Texas and Oklahoma (Fazio *et al*. 2004, pp. 379–380). Within-population heterozygosity was high relative to other species within the family Vireonidae and comparable to the mean for birds (Fazio *et al.* 2004, p. 379).

Table 11. Known populations of black-capped vireos across the breeding range from four different time intervals.

	Known Population*	**Oklahoma**	**Texas**	**Mexico**
Final Listing Rule (1987)	350	45-51 birds	280 birds	24 birds
		4 counties	21 counties	1 state
1996 PHVA**	1,803	170 birds	1,633	-
		3 counties	40 counties	-
2000-2005	4,464	1,948 birds	2,257 birds	259 birds
		3 counties	38 counties	3 states
2009-2014	5,244	759 birds	4,200 birds	285 birds
		5 counties	40 counties	3 states

*Cumulative number of individuals reported from known surveys.
**Black-capped Vireo Population and Habitat Viability Assessment Report (USFWS 1996).

Since the work of Fazio *et al.* (2004), further genetic analysis has yielded mixed results. Using microsatellites from nuclear DNA, Barr *et al.* (2008, p. 3629) interpreted results to indicate significant population differentiation throughout the black-capped vireo's range and that gene flow is limited between populations. To the contrary, Zink *et al.* (2010, p.127) analyzed mitochondrial DNA to conclude no evidence of genetic structure or barriers to gene flow among populations.

Although the above research presents different interpretations regarding genetic structuring across the black-capped vireo's range, Vázquez-Miranda *et al.* 2015, sequenced multiple nuclear loci and used coalescence methods to obtain what they suggest to be a deeper understanding of historical population trends than that typically available from microsatellites (Barr *et al.* 2008) or mitochondrial DNA (Zink *et al.* 2010). Their conclusions indicate that the black-capped vireo population rangewide is genetically unstructured, and that population structure across known populations does not exist due to a lack of gene flow (Vázquez-Miranda *et al.* 2015, p. 9).

4.3.2 Geographic Distribution

The distribution of the breeding range of the black-capped vireo is substantially larger than known at the time of listing. In 1987, the black-capped vireo's breeding range was known to occupy 21 counties in Texas, 4 in Oklahoma, and 1 Mexican state. Information collected from 2009 to 2014 shows the species' known range has expanded to include 40 Texas counties, 5 in Oklahoma, and 3 Mexican states. The Mexican portion of the breeding range is known to extend approximately 520 km (323 mi) further south than thought prior and densities of breeding black-capped vireos may be up to six times higher than those in the U.S. range (Farquhar and Gonzalez 2005, p. 25; Wilkins *et al.* 2006, p. 28; González-Rojas *et al.* 2014, p. 151).

When listed in 1987, concentrations of the black-capped vireo were largely known to occur in disjunct clusters near Austin, Texas, Wichita Mountains Wildlife Refuge in Oklahoma, and Coahuila, Mexico. Currently, the known occupied range (Figure 3) includes many new localities between these widely spaced clusters, revealing more connectivity between major populations than previously known. Evidence suggests more available habitat and vireo populations may occur in poorly surveyed areas in the western portion of the vireo's range (McFarland *et al.* 2012, p. 51).

4.3.3 Habitat Availability

The availability of black-capped vireo breeding habitat was limited to the known populations and anecdotal observations at the time of its listing. The documentation of numerous populations since that time has vastly increased the amount of known black-capped vireo breeding habitat across the landscape.

Construction of suitable models utilizing remote sensing for predicting location and abundance of black-capped vireo breeding habitat is limited due to the difficulty in distinguishing canopy-to-ground foliage cover, which is necessary for identifying suitable black-capped vireo habitats. Since the species was listed, there have been observations of vireos using habitat previously thought to be unsuitable, or not considered traditional breeding habitat. Such areas include the "donut" habitat at Fort Hood (Cimprich and Kostecke 2006, p. 101) and dense thickets in Mexico (Benson and Benson 1991, p. 779). Such observations in the context of substantial reduction in cowbird parasitism suggest habitat availability may not be a limiting factor in some areas (Wilsey *et al.* 2014, p. 569).

The only wide-ranging estimates of suitable habitat for the species are reported in a USFWS Biological Opinion for brush management in Texas (USFWS 2004). The biological assessment developed for the project relied heavily upon roadside surveys of 53 Texas counties conducted between July 1996 and August 1998 (Maresh *et al*. 1999; Maresh and Rowell 2000). The 53 counties inventoried contained approximately 586,794 ha (1.45 million ac) of potential habitat. This is equivalent to about 3.3 percent of the total land area considered. We found no estimates of black-capped vireo habitat available for Oklahoma or Mexico, however, an estimate of the probable breeding range in Mexico was provided by Farquhar and Gonzalez (2005, Figure 6, p. 24). The area encompasses the three states known to have breeding populations and is approximately two-thirds the size of the breeding range in Texas.

Available data recorded from 1992–2002 suggested that habitat availability in the form of reported rangeland acres had remained stable in Oklahoma, while Texas had an 8.6 percent loss of rangeland. Between 2002 and 2012 (most recent data available), reported rangeland in Oklahoma has shown a 73.3 percent increase and a 15.5 percent increase in Texas. Total rangeland area reported has increased by 30.4 percent across the U.S. black-capped vireo breeding range (see Section 3.2 for specific details). Although certainly not all rangeland within the black-capped vireo's range is suitable breeding habitat, this trend suggests a decreasing threat of land use changes that would affect habitat availability.

A more substantial measure of rangewide health is the decrease in goats (46.8 percent) and cattle (37.2 percent) across the range of the black-capped vireo between 1987 and 2012 (see Section 3.3 for specific details). Both goats and cattle, which were identified as threats at the time of listing, can impact shrub foliage and render habitat unsuitable, attract parasitic brown-headed cowbirds, and may involve land-use practices incompatible with suitable black-capped vireo breeding habitat. Although quantifiable data are unavailable, the reduction in goats, and to a lesser extent cattle, also suggests stable and potentially increasing amount of available breeding habitat.

Research and management endeavors directed toward the conservation of the black-capped vireo have led to improvements in targeted efforts to expand and improve suitable breeding habitat on public and private lands. This includes vegetation management through prescribed burning and other vegetation manipulation where it is most beneficial (*e.g.*, the eastern portion of the species' range); brown-headed cowbird control, managing predation from snakes, ants, etc.; and modifying agricultural practices to minimize adverse impacts to black-capped vireos and their habitat. Although quantifiable data are unavailable, implementation of these practices also suggest a stable and potentially increasing amount of available breeding habitat across the species' range.

4.4 Winter Range and Migration

Habitat modelling has suggested wintering areas in Mexico occur across 103,000 to 141,000 km^2 (39,769 to 54,440 mi^2) and extend further than previous records have identified, including the states of Guerrero and Chiapas (Vega Rivera *et al.* 2010, p 101; Powell 2013, pp. 34–38). Wintering habitat for the black-capped vireo is more flexible than its breeding requirements, and it has been known to utilize shade coffee plantations, thorn forest, riparian forest, pine-oak forest and deciduous forest (Wilkins *et al.* 2006, p. 19). As discussed in Section 3.7, there is a concern of loss of tropical dry forests within Mexico that are utilized by numerous neotropical migrants, including the black-capped vireo. Remaining areas of forest occur on rough terrain and steep slopes, which are mostly inaccessible for anthropological purposes (Powell 2013, pp. 101–102). Of the estimated winter distribution, 1,000,000 ha (2,471,053 ac) or 7.1 percent, occurs on natural protected areas (National parks, reserves, etc.)(Vega Rivera *et al.* 2011, pp. 98–102). Additionally, there are approximately 1,492,400 ha (3,687,801 ac) of lands designated as "important bird areas" covering the estimated winter range (Vega Rivera *et al.* 2011, p. 103).

As an indirect measure of the condition of the wintering range, studies on return rates of banded birds can be evaluated. That is, birds banded on the breeding grounds that return in following years, indicates the availability of resources on the wintering grounds. Survival rates (estimated from return rates) for black-capped vireos at Fort Hood ranged from 0.36 to 0.60 (n=912) for the 10-year period of 1997 to 2006 (Kostecke and Cimprich 2008, p. 254). These rates are comparable to the rates of other passerines, which range from 40 to 60 percent (Ricklefs 1973; Martin 1995).

The white-eyed vireo is another neotropical migrant that occurs in Texas and at Fort Hood, but winters in the far southeastern U.S., eastern Mexico and Central America (Hopp *et al.* 1995 entire). Nine years of white-eyed vireo banding data showed a male return rate of 48.3 percent (n=74) and 50 percent of females (n=5; Hopp *et al.* 1999, p. 48). In general, black-capped vireo return rates suggest sufficient resources are available during migration and wintering.

4.5 Conservation Efforts

The threats to black-capped vireo habitat are dynamic throughout the range, necessitating the long term commitment to habitat protection and management. Preservation and restoration of black-capped vireo habitat will play an important role in the persistence of the species both in the short and long term. This means reasonable protection from disturbance that destroys, significantly alters, or precludes the development of suitable breeding habitat, and vegetation and cowbird management at existing localities. Conservation actions throughout the range have reversed black-capped vireo declines within several populations. Conservation programs and measures implemented to reduce the threats to the species include active management on public or otherwise protected lands (conservation easements, mitigation lands, etc.), a 37-county Safe Harbor Agreement in Texas, private lands incentives (*e.g.*, USDA Environmental Quality Incentive Program), cowbird removal programs, and public outreach. Most of these measures have occurred within the species' range in Texas and target the major threats to the species – loss of breeding habitat and brood parasitism. Continuance of these conservation efforts and implementation within additional populations would help reduce threats, improving the status of this species. Other opportunities for conserving the black-capped vireo include: 1) reducing or excluding grazing by goats or sheep (and exotics) and rotational cattle grazing to sustain suitable vegetation structure; 2) implementing site appropriate prescribed fire regimes to address vegetation succession and minimize the risk of severe wildland fire; 3) continuation and promotion of brown-headed cowbird control programs based on the occurrence and rate of brood parasitism: 4) continuing research on critical aspects of black-capped vireo life history (*e.g.*, reproduction, abundance, survival and dispersal behavior); and 5) surveying additional areas of potential suitable habitat for the existence of undocumented black-capped vireo populations or localities. A number of existing and potential conservation strategies are discussed below.

4.5.1 Managed Lands

The majority of the U.S. portion of the black-capped vireo's breeding range occurs on lands under private ownership or management. Populations that occur on public lands or lands under easement for conservation purposes are generally protected to some extent from land use changes that would affect breeding habitat. Lands managed by Federal, state, county or municipal entities, as well as lands used for mitigation or are under conservation easement for the purpose of managing black-capped vireo populations are generally stable regarding land management and are often surveyed for the species and habitat. These populations may be subject to varying levels of active management. Active management includes maintaining, restoring or enhancing black-capped vireo habitat conditions through prescribed fire and/or rangeland management and depending upon the occurrence and rate of brood parasitism, continued implementation of brown-headed cowbird control. Because such information does not exist in a consistent way across the breeding range, these areas are important sources of information for the species and offer insight on the probability of continued habitat management across the breeding range. From 2009 to 2014, there were 40 managed localities documented within Oklahoma and Texas (Table 7, Section 4.2).

4.5.2 Prescribed Fire

The contribution of prescribed fire and wildfire to the development of suitable breeding habitats in Oklahoma and the eastern portion of the species' Texas range is well documented (USFWS 1991, p. 22; Campbell 1995, p. 29; Grzybowski 1995, p. 5), although in the western portion of the species' breeding range in Texas and in Mexico, fire is not as essential in maintaining habitat suitability. The use of prescribed fire as a habitat management tool is increasing or remains constant across most of the U.S. (National Prescribed Fire Use Survey Report 2015, p.10). Across a ten-year average (2004–2014), over 1 million ha (2.6 million ac) are burned annually in the U.S. as a result of prescribed fire (NIFC 2014a). Over 3,157 ha (7,800 ac) in Oklahoma and over 48,562 ha (120,000 ac) in Texas have been burned annually (2004–2014) with prescribed fire and much additional acreage is burned by unplanned wildfire (Oklahoma avg. approx.

158,000; Texas avg. approx. 798,000)(NIFC 2014b). Although the majority of these burns were on Federal lands outside of the vireo's range, there has been an overall increase in the use of prescribed fire as a cost effective tool for range and wildlife management. Promoting the use of prescribed fire on and adjacent to properties with occupied black-capped vireo habitat and the utilization of cost assistance from various state and Federal programs could secure or develop additional black-capped vireo breeding habitat.

4.5.3 Cowbird Management

Given the relationship between brown-headed cowbird removal and increased black-capped vireo breeding success (Eckrich *et al.* 1999 pp. 153–154; Kostecke *et al.* 2005 p. 57; Wilkins *et al.* 2006, p.84; Campomizzi *et al.* 2013, pp. 714–715), the continuation of brown-headed cowbird trapping on those Federal and private properties and expansion to other properties experiencing brown-headed cowbird parasitism in excess of 40 percent is vital to sustaining and expanding black-capped vireo populations. In an effort to manage the brown-headed cowbird populations in Texas, TPWD implements a Cowbird Trapping Program, which provides participating landowners a training and certification process.

4.5.4 Safe Harbor Agreements

Environmental Defense Fund (EDF) is a national non-profit conservation organization which implements diverse programs and activities for the conservation of wildlife. It works with private landowners to promote voluntary, incentive-based conservation efforts for endangered species throughout the country. A Safe Harbor Agreement and associated permit for the black-capped vireo and endangered golden-cheeked warbler was issued to EDF in December 2000. The Safe Harbor Agreement originally covered 25 counties in Texas, but was amended in 2005 to include an additional 12 counties in Texas. To date, seven landowners in five counties have enrolled 2,325 ha (5,746 ac) for black-capped vireo conservation and management (EDF 2010). The permit for the Agreement expires in 2030.

4.5.5 Mitigation Lands

Section 10 of the Act provides a regulatory mechanism to permit the incidental take of federally-listed fish and wildlife species by private interests and non-Federal government agencies during otherwise lawful activities. Section 10(a)(2)(A) of the Act requires an applicant for an incidental take permit to submit a "conservation plan" that specifies, among other things, the impacts that are likely to result from the taking and the measures the permit applicant will undertake to minimize and mitigate such impacts. Conservation plans under the Act have come to be known as "habitat conservation plans" (HCP). Since the vireo was listed, eight HCPs have been approved for project related impacts resulting in "incidental take" to the black-capped vireo, all of which are in Texas. In total, approximately 7,843.2 ha (19,381 ac) of black-capped vireo may be impacted, either directly or indirectly resulting from authorized activities. To mitigate black-capped vireo habitat loss, approximately 8,239.4 ha (20,360 ac) of habitat would be preserved and funding provided for habitat restoration and management for off-site black-capped vireo habitats. Table 12 below provides pertinent information for each HCP.

Table 12. Habitat conservation plans involving private and non-federal activities impacting the black-capped vireo.

Black-capped vireo Recovery Unit	**Habitat Conservation Plan**	**Expiration Date**	**Habitat Impact**	**Habitat Mitigation**
North	Balcones Canyonlands Preserve	May 02, 2026	459.3 ha (1,135 ac)	404.7 ha (1,000 ac)
	TXU Energy Copperas Cove	January 16, 2012	2.8 ha (7 ac)	Provided funding for off-site habitat management
	Williamson County	October 16, 2038	1,726.8 ha (4,267 ac)	451.6 ha (1,116 ac)
South	Comal County	February 18, 2044	404.7 ha (1,000 ac)	404.7 ha (1,000 ac)
	Hays County	June 30, 2042	1,335.5 ha (3,300 ac)	526.1 ha (1,300 ac)
All Recovery Units	Oncor Electric Delivery Company - Programmatic	March 1, 2042	899.6 ha direct (2,223 ac) 1,412.8 ha indirect (3,491 ac)	3,212 ha (7,937 ac)
Central and South	Lower Colorado River Authority	June 05, 2042	92.7 ha direct (229 ac) 440.7 ha indirect (1,089 ac)	569.4 ha (1,407 ac)
South	Southern Edwards Plateau	February 28, 2046	1,068.4 ha (2,640 ac)	2,670.9 ha (6,600 ac)

Due to the permitted losses of black-capped vireo habitat and the mitigation requirements of HCPs, the need arose for guidelines for establishing consistency for black-capped vireo habitat mitigation that effectively promotes the recovery of the species. As a result, in July 2013, the Service developed *Guidelines for the Establishment, Management, and Operations of Golden-cheeked Warbler and Black-capped Vireo Mitigation Lands*, providing guidance for those involved in conservation banking and other mitigation projects. The Service believes that an effective strategy to conserve the black-capped vireo involves protecting large patches of habitat, which are more resilient to other stressors such as wildfires. The total amount of habitat to achieve recovery in a region may be reduced with large contiguous patches of habitat versus more, smaller fragmented patches. All mitigation lands must have an active management plan that includes goals and objectives specific to maintaining the habitat for the continued use of the black-capped vireo in perpetuity. In addition management plans must adhere to performance standards, which are measurable attributes used to determine if the management plan meets the agreed upon goals and objectives. To date, approximately 931 ha (2,300 ac) of black-capped vireo habitat with 78 black-capped vireo territories are under agreement.

4.5.6 Mexico

The black-capped vireo has been listed as “endangered” by the Mexican government since 2001. However, the designation does not protect habitat and conservation actions in the country are largely a result of non-profit organizations. In the winter range, natural protected areas only amounted to 1.6 percent of the estimated winter distribution as of 2002. Since 2002, several protected areas were added amounting to 10,000 square km (3,861 mi^2; 2,471,053 ac) or 7.1 percent of the winter range (Vega Rivera *et al.* 2011, pp. 98–102). Additionally, there are approximately 14,924 square km (3,687,801 ac) of lands designated as “important bird areas” covering the estimated winter range (Vega Rivera *et al.* 2011, p. 103).

4.6 Summary of Species Current Conditions

The known distribution and population of the black-capped vireo has increased since it was listed in 1987 and remained relatively stable in the last 10 to 15 years. There are fourteen known localities with 100 males or more (likely resilient locality) throughout the breeding range, nine of which occur on managed lands in the U.S. An additional 20 manageable localities (30 or more adult males, but less than 100), 10 of which occur on managed lands, are distributed throughout the range. Within the U.S., 14 counties have documented new occurrences and 10 previously known to have vireos were not documented based on data from 2009 to 2014.

Population trends on four regularly surveyed public lands show stable or increasing population estimates since 2005. These major populations represent 40 percent of the known rangewide breeding population, which occurs on approximately 27,930 ha (69,000 ac) of habitat. The largest increase in known abundance is apparent in an additional major population documented in Val Verde County, Texas. Several public lands and private conservation lands and easements in the county occur in the Devils River area, where the vireo has been known to occur, but surveys have been sparse and the extent of habitat unclear. Wilkins *et al.* (2006) identified records from 2000 to 2005, which documented 133 males from Val Verde County. From 2009 to 2014, surveys from lands managed or owned by The Nature Conservancy and TPWD provided a known male population of 711 male black-capped vireos on more than 60,000 ha (150,000 ac) in the county.

The known population of the black-capped vireo in the breeding range from 2009 to 2014 was documented at 5,244 adult males, a 17.5 percent increase from data used for the last review period (2000 to 2005). At the time of listing in 1987, only 350 birds were known. While the consistency of effort in information collected to identify occupied areas and population size varies, it is the best information available to evaluate abundance and distribution rangewide. Trends in known threats to the species are more useful to evaluate species viability. Specifically, livestock trends (mainly goats), land use change and brown-headed cowbird abundance are available. Both goat and cattle numbers have declined substantially over the species known range since 1987, as has cowbird abundance. Reported rangeland acres, where black-capped vireo habitat is likely to occur, has increased over the same timeframe.

The results of genetic studies of the rangewide condition of the species with respect to population structuring have varied. Several studies have shown levels of gene flow between extant populations indicating adequate genetic diversity.

Information on migration and wintering of black-capped vireos in Mexico is limited to a few studies that document the extent of the wintering range and estimate habitat areas. Winter habitat utilized is more general and diverse than that of the breeding grounds. While specific requirements of winter habitat availability are unknown, tropical dry forests exist in areas generally inaccessible to develop. As an indication of winter habitat conditions, return rates of vireos banded on the breeding grounds is informative. The most robust data come from banded birds at Fort Hood, which show return rates are within the range of other similar migrating passerines, indicating sufficient resources are available for migrating and wintering vireos.

With a diversity of landownerships throughout the U.S. portion of the black-capped vireo's range, from private-lands to several forms of public ownership, various conservation actions and programs have been developed and implemented in an effort to recover the species. These conservation actions implemented on public and private-lands throughout the current range have reversed black-capped vireo declines within several populations. Ongoing active management on public lands and those under conservation easements have resulted in 40 managed localities in Oklahoma and Texas, varying in size from a single territory to an estimated 7,478 territories. Although information in Mexico is limited, the vireo is afforded protected status and approximately 7.1 percent of the winter range is under some form of protection.

Fire, which plays an important role in vegetation conditions in mesic areas, has returned to the landscape within the current range of the black-capped vireo, occurring on managed private lands. Promoting the use of prescribed fire on and adjacent to occupied black-capped vireo habitat and the utilization of cost assistance from various state and Federal programs could expand or develop additional black-capped vireo breeding habitat. To address the issue of brood parasitism, the TPWD developed a cowbird trapping program in an effort to manage brown-headed cowbird populations in Texas. Through the implementation of Safe Harbor, seven landowners in five counties have enrolled 2,325 ha (5,746 ac) for black-capped vireo management (EDF 2010). To aid in the development of HCPs and other conservation efforts, the Service developed guidance for the establishment, management, and operation of black-capped vireo mitigation lands. To date, approximately 931 ha (2,300 ac) of black-capped vireo habitat with 78 black-capped vireo territories are under agreement. Continuance of these conservation efforts, as well as their implementation within additional populations and the inclusion of others such as grazing management, research and surveying for undocumented black-capped vireo populations may further reduce threats, thus improving the status of this species.

CHAPTER 5 – FUTURE CONDITIONS

In this chapter, we summarize the overall viability of the black-capped vireo based on the analysis in this review in the context of resiliency, redundancy, and representation. This evaluation of viability considers previous analyses of stressors to the species as they relate to current conditions and, as possible, future condition of the species. Species viability, or the ability to survive long term, is related to the species ability to withstand catastrophic population and species-level events (redundancy), the ability to adapt to changing environmental conditions (representation), and the ability to withstand disturbances of varying magnitude and duration (resiliency). The viability of species is also dependent on the likelihood of new stressors or continued threats now and in the future that act to reduce a species' redundancy, representation, and resiliency. This chapter discusses the known breeding population in terms of the manageable and likely resilient localities compared to past information.

5.1 Resiliency

Resiliency is the ability of a species to withstand stochastic events. For the black-capped vireo this is best measured by their abundance within known populations, the availability of suitable habitat across the species' range, and suitable levels of certain biotic and abiotic factors within that habitat.

It is estimated that breeding habitat to support a population of ≥30 adult males could constitute a sustainable population with management (Tazik 1991, p. 33; USFWS 2013, p. 20). As a conservative measure, a likely resilient population or locality may be defined as breeding habitat supporting at least 100 adult males. Data reported from 2009 to 2014 indicate there are at least 34 localities of 30 or greater adult male black-capped vireos; 29 in Texas, two in Oklahoma, and three in Mexico (USFWS unpublished; Morrison *et al.* 2014, p. 16). Nineteen of these localities occur on managed lands in the U.S. Fourteen have greater than 100 adult males, nine of which occur on managed lands in the U.S. Since 1985, there has been a substantial increase in overall known abundance, and abundance within populations (refer to Chapter 4). Five major population centers distributed across the U.S. portion of the range (Wichita Mountains Wildlife Refuge/Fort Sill, Fort Hood, Kerr WMA, and Devils River Conservation Easements) had an estimated population of 14,418 adult males in 2013–2014. Over the past 30 years, resiliency in the black-capped vireo has increased.

The black-capped vireo appears to be a conservation-reliant species (Scott *et al.* 2010, entire; Wilsey *et al.* 2014, p. 569). Across a large portion of the black-capped vireo's range, active management to improve or stabilize breeding habitat and control cowbirds is necessary for the species to prosper. Populations or localities of ≥30 adult male black-capped vireos lack resiliency without active management, particularly in the eastern portion of the range. Likely resilient populations or localities (≥ 100 adult males) may still need active management, in the eastern portion of the range, but are better suited to withstand random abundance fluctuations. In evaluating the persistence of a manageable and likely resilient locality, two scenarios that affect the outcome are probable:

1) habitat and cowbird management as needed continues into the long term (30 to 50 years), and
2) habitat and cowbird management diminishes in scale or frequency that does not provide for the needs of the species in the short and long term or ceases altogether.

A third scenario, that an increase in goat numbers (a major threat to habitat) within the range due to demand or legislative incentive (*e.g.*, the Wool Act) is considered highly unlikely to occur in the short and long term, and therefore, not evaluated further.

To evaluate the two scenarios, we forecasted the persistence of the 34 known manageable and likely resilient localities based on criteria developed from the Species Needs and Causes and Effects Chapters of this assessment. Based on these criteria, the flowcharts in Figures 27 and 28 illustrate the projection process for both short term and long term scenarios, respectively. At each stage of the flowchart, the criteria are meant to provide additional certainty in the forecast of each locality. The criteria are:

1) <u>Does the locality occur on a managed property?</u> Vireo localities existing on properties under management through public ownership (Federal, state, municipal) or easement are better suited to persist under short and long term conditions. Even under diminished management specific to the species, many of these locations are better suited to provide resources for the black-capped vireo, often due to the conservation mission of the property (*e.g.*, state parks). The option for the continued management scenario is not applied to private localities, due to the uncertainty of current and future management practices.

2) <u>Does the locality occur in the western range?</u> Sources of stressors to the vireo are known to be less prevalent or less impactful in the western range. Specifically, vegetational succession and brown-headed cowbird parasitism are reduced in the western range, and thus, localities in this area are anticipated to be more resilient. In each scenario, localities in the western range are expected to persist into the long term.

3) <u>Is the locality within natal dispersal proximity (30 km (19mi)) to another known locality?</u> Localities in close proximity to each other are more likely to persist by acting as sources for immigration. Source localities are important to buffer against random events (*e.g.*, wildfire) that temporarily affect another nearby locality.

4) Is the known abundance substantially more than its designation as manageable or likely resilient? Localities with known abundances larger than the designation of manageable or likely resilient are buffered from stressors or random events that may negatively affect resiliency. For our assessment, we expect manageable localities of twice the minimum (≥ 60 males) and likely resilient localities of 1.5 times the minimum (≥ 150 males) are adequately buffered under short and long term scenarios.

In the scenarios for short and long term, priority is placed on properties under some management (Figure 27 and 28), which receive a high likelihood of persistence under continued managed conditions. Localities not under management, or managed properties in the decreased management scenario, are ranked as a high likelihood if they meet more than one of criteria 2 through 4 above, and are ranked a moderate likelihood if only one is met. Localities not meeting any of the criteria are ranked as a low likelihood of persistence. For the purposes of this assessment, we consider a low likelihood as having less than a 50 percent chance of persistence, moderate likelihood of between 50 to 75 percent chance of persistence, and a high likelihood of greater than 75 percent chance of persistence.

The priorities for persistence are localities occurring on managed lands and continued management. Unmanaged lands in the eastern range only have a moderate to high likelihood of persistence if they also occur within close proximity to another locality or the known abundance is larger relative to its designation as manageable or likely resilient. To address uncertainty in the long term scenario, expected persistent localities would meet both the large abundance and source proximity criteria. Localities in Mexico were not considered in this analysis, due to differences in habitat type and stressors (Chapter 3), which may favor persistence of these localities. Major localities (Fort Hood, Fort Sill, Wichita Mountains Wildlife Refuge, and Kerr WMA) were given high likelihoods under long term scenarios, regardless of the flowchart outcome, due to the substantially large estimated abundances, which would be expected to persist under each circumstance. The outcomes of each locality under short and long term, managed and decreased management are presented in Table 13 and shown in Figure 29.

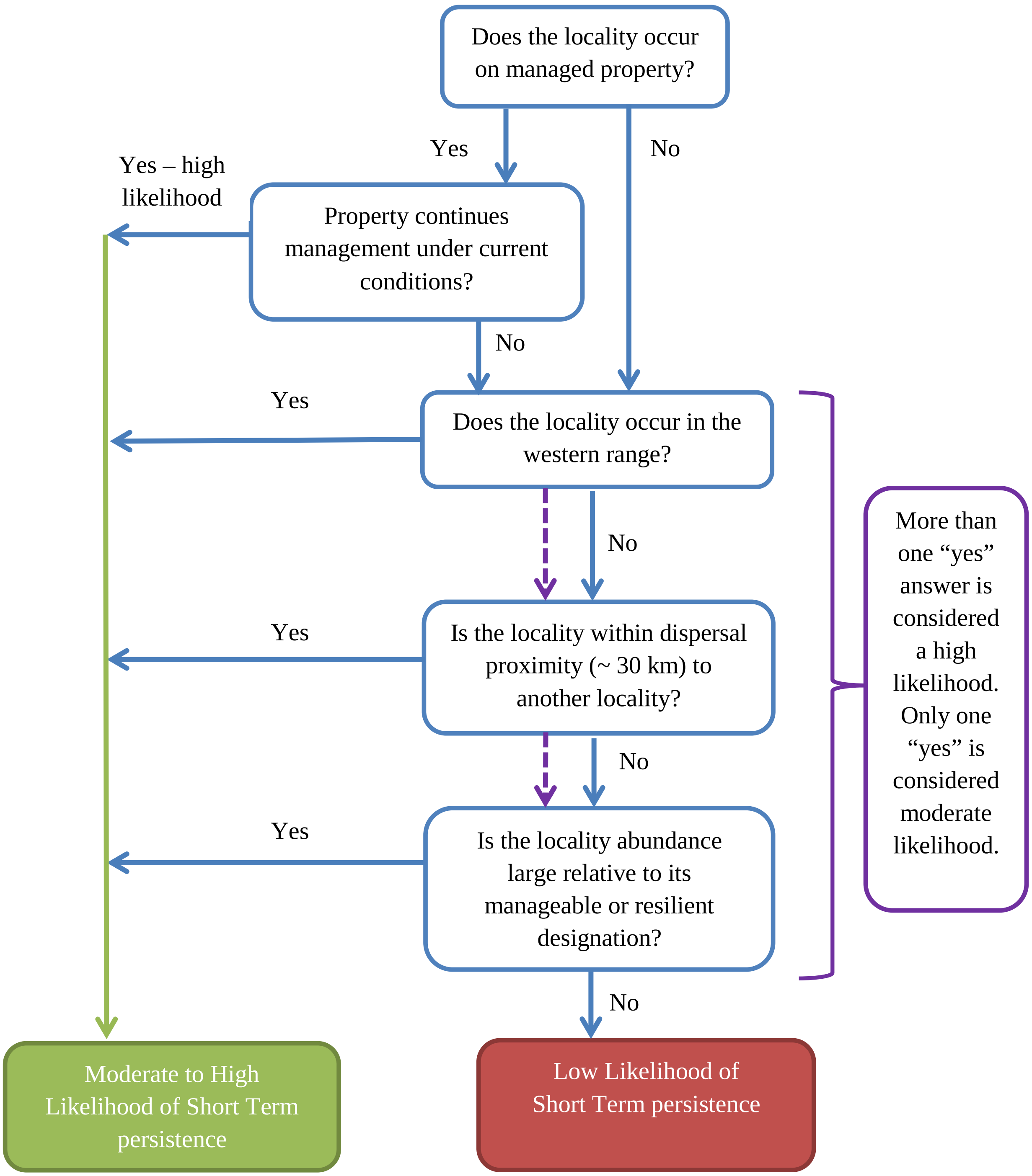

Figure 27. Likelihood of persistence criteria for manageable and likely resilient localities under short term (up to 30 years) scenario. Managed properties consist of Federal, state, or municipal properties or lands under conservation easement. Dashed purple line is followed in "yes" situations to determine moderate or high likelihoods as explained in purple box.

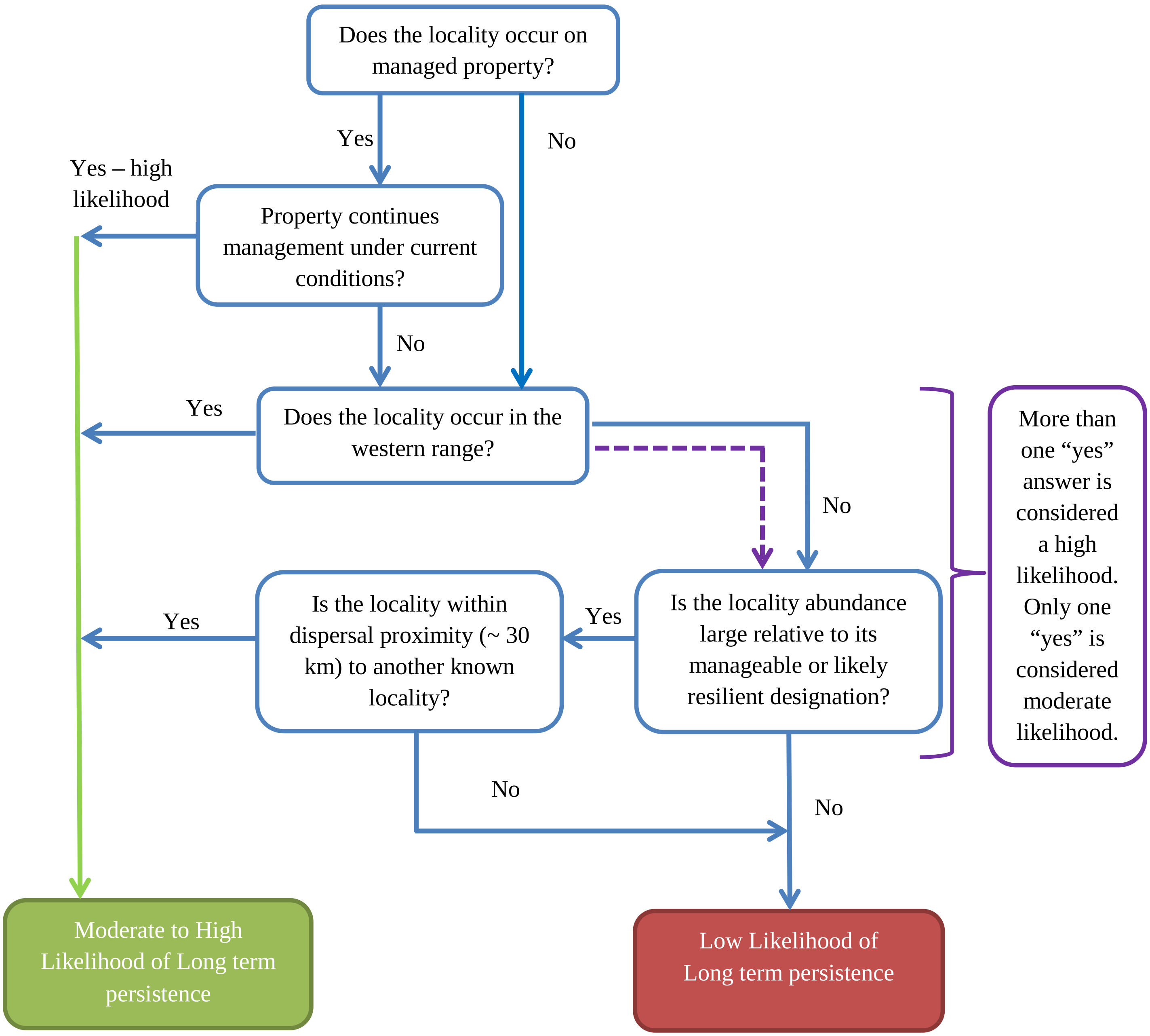

Figure 28. Likelihood of persistence criteria for manageable and likely resilient localities under long term (30 to 50 years) scenario. Managed properties consist of Federal, state, or municipal properties or lands under conservation easement. Dashed purple line is followed in "yes" situations to determine moderate or high likelihoods as explained in purple box.

Table 13. Results of manageable and likely resilient locality persistence under short and long term, managed and decreased management scenarios. Blue highlighted rows indicate likely resilient localities.

Unit	Locality (Label for Figure 29)	Locality Type (Known # of males)	Short Term		Long Term	
			Managed	Decreased Mgmt.	Managed	Decreased Mgmt.
Oklahoma	Wichita Mountains Wildlife Refuge	Likely Resilient (121)*	High	High	High	High*
	Fort Sill	Likely Resilient (603)	High	High	High	High*
TX Central	Private Land - *San Saba Co.* (11)	Manageable (30)	Low	Low	Low	Low
	Private Land – *Kimble Co.* (12)	Manageable (40)	Mod.	Mod.	Low	Low
	Private Land – *Taylor Co.* (13)	Manageable (85)	High	High	Mod.	Mod.
	Walter Buck Wildlife Management Area (5)	Manageable (95)	High	High	High	Mod.
	Mason Mountain Wildlife Management Area (24)	Likely Resilient (126)	High	Low	High	Low
TX North	LCRA Canyon of the Eagles (2)	Manageable (45)	High	Low	High	Low
	Private Land – *Coryell Co.* (14)	Manageable (52)	Mod.	Mod.	Low	Low
	Balcones Canyonlands National Wildlife Refuge (21)	Likely Resilient (158)	High	Mod.	High	Low
	Fort Hood (22)	Likely Resilient (918)	High	High	High	High*
TX South	Love Creek Preserve (6)	Manageable (30)	High	Mod.	High	Low
	City of San Antonio Rancho Diana South (7)	Manageable (37)	High	Low	High	Low
	Shield Ranch (8)	Manageable (54)	High	Mod.	High	Low
	Private Land – *Kerr Co.* (20)	Manageable (85)	High	High	Mod.	Mod.
	Private Land – *Bandera Co.* (15)	Manageable (85)	High	High	Mod.	Mod.
	Private Land – *Bandera Co.* (16)	Manageable (90)	High	High	Mod.	Mod.
	Private Land – *Real Co.* (26)	Likely Resilient (151)	High	High	Mod.	Mod.
	Kerr Wildlife Management Area (23)	Likely Resilient (463)	High	High	High	High*
TX West	Big Bend National Park (1)	Manageable (30)	High	Mod.	High	Mod.
	Private Land - *Val Verde Co.* (17)	Manageable (33)	High	High	Mod.	Mod.

	Chandler Independence Creek Preserve (3)	Manageable (39)	High	Mod.	High	Mod.
	Devils Sinkhole State Natural Area (9)	Manageable (40)	High	Mod.	High	Low
	Kickapoo Cavern State Park (4)	Manageable (64)	High	High	High	Mod.
	Private Land – *Edwards Co.* (18)	Manageable (73)	High	High	Mod.	Mod.
	Devils River State Park - Southern Property (19)	Manageable (81)	High	High	High	High
	Dolan Falls Preserve (31)	Likely Resilient (102)	High	High	High	Mod.
	Private Land - *Val Verde Co.* (33)	Likely Resilient (110)	Mod.	Mod.	Low	Low
	Private Land – *Edwards Co.* (34)	Likely Resilient (169)	High	High	Mod.	Mod.
	Devils River State Natural Area (25)	Likely Resilient (171)	High	High	High	High
	Devils River Conservation Area Easements (32)	Likely Resilient (357)	High	High	High	High
Mexico	Private Land – Nuevo León	Manageable (58)	**	**	**	**
	Private Land - Tamaulipas	Likely Resilient (101)	**	**	**	**
	Private Land - Coahuila	Likely Resilient (126)	**	**	**	**

*Major localities which are regularly surveyed and have large populations that would be expected to persist into the long term, which may have not been indicated by the flowchart criteria.
**Forecast scenarios did not include Mexico localities.

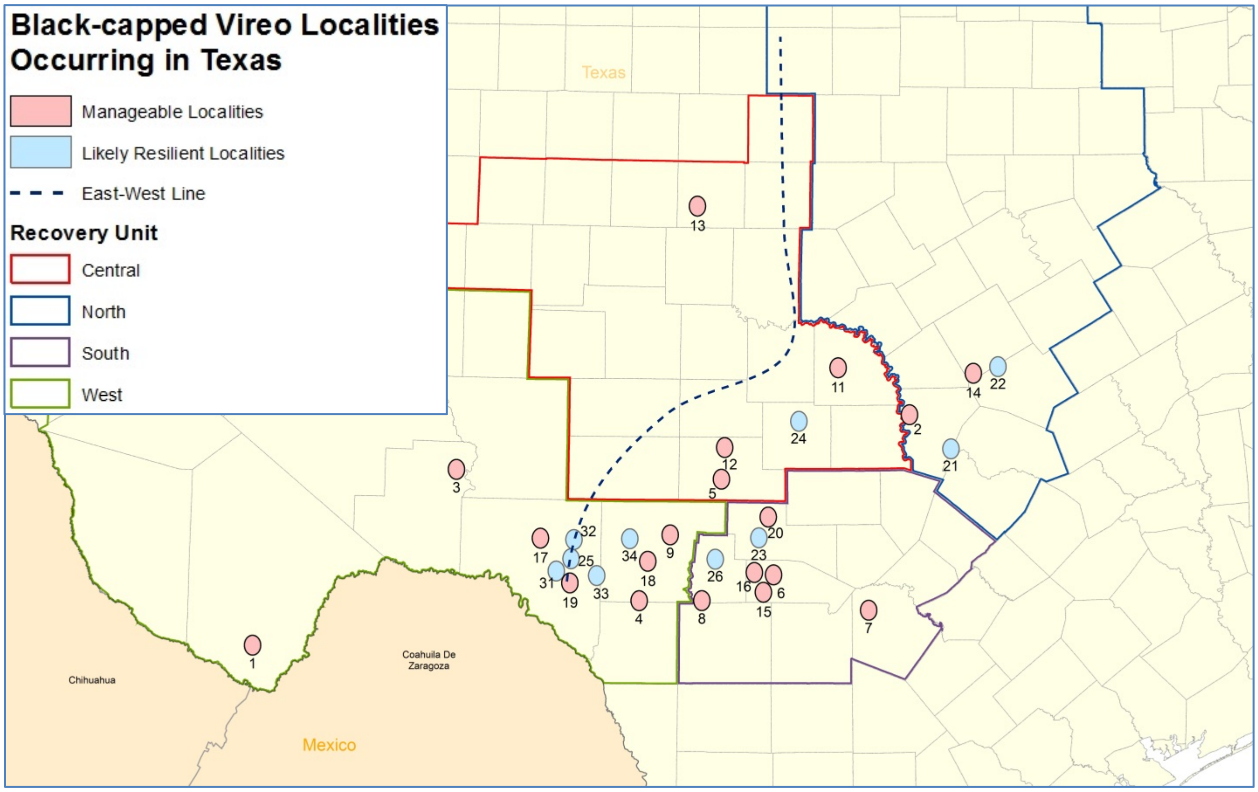

Figure 29. General locations of likely resilient and manageable localities in Texas. Location labels are identified in Table 13.

5.2 Redundancy

Redundancy is the ability of a species to withstand catastrophic events by spreading risk and can be evaluated by the distribution of resilient populations across the range of the species. For the black-capped vireo, distribution is represented by both likely resilient and manageable localities within the breeding range. The greater the number of localities a species has distributed over a larger landscape, the more likely it can withstand catastrophic events.

The extent of redundancy for the black-capped vireo is based on the reported distribution from 2009 to 2014. From this timeframe, there are 14 likely resilient localities and 20 manageable localities. These likely resilient and manageable localities represent 92 percent of the known breeding population, 67 percent of which occur on managed properties in the U.S.

To evaluate adequate redundancy for the black-capped vireo, it is informative to compare known abundance from previous timeframes. On a county basis in the U.S., Figure 25 shows increases and decreases in the known abundance and distribution from 2000 to 2005 and from 2009 to 2014. As noted above, data reported for 2009 to 2014 show 14 likely resilient localities and 20 manageable localities within the breeding range. Data reported from 2000 to 2005 indicate there were seven likely resilient localities and 14 manageable localities. The increase by county in the

U.S. and localities within the entire breeding range indicate an increasing level of redundancy over the past 10 to 15 years.

To forecast future conditions of redundancy, measured by the distribution of the known localities, we evaluated three scenarios under both managed and decreased management conditions:

1) existing number of known localities,
2) moderate increase in number of localities from restoration and survey effort, and
3) enhanced number of localities from restoration and survey effort.

The first scenario compiles the results from Table 13 for the possible fate of known localities over the short and long term. The localities with a low likelihood of persistence are subtracted from current conditions. In this scenario, current redundancy remains fixed and does not consider potential increases in manageable and likely resilient localities from future survey and restoration efforts. For the Mexico localities, we added two situations: 1) Mexico localities remain constant through all scenarios and 2) U.S. only, not considering the localities in Mexico. However, based on the substantial increases in both the known abundance and distribution of the black-capped vireo in northern Mexico, we suggest that at a minimum, the constant situation in Mexico is most likely.

The second and third scenarios account for the potential of future survey and restoration efforts to enhance redundancy with an increase of manageable and likely resilient localities on private and public lands. We provide an estimate of the potential increase in the number of localities based on the comparison of reported occurrences from the 2000 to 2005 and 2009 to 2014 timeframes as noted above. During the 10 to 15 year period, there was an increase of seven likely resilient and six manageable localities reported. Using this actual increase, we suggest a conservative estimate of an increase of two to six likely resilient and four to eight manageable localities may be reported over the long term (50 years). Under this estimate, we created future moderate and best case scenarios using the low end of the range for the short term and high end for the long term. For decreased management scenarios, the estimate was reduced by half. The results of both scenarios by recovery unit are shown in Table 14.

In each situation under scenario 1, no increase in redundancy occurs and the current condition in distribution of the species is reduced, most substantially in the long term. However, the future condition remains above the 2000 to 2005 conditions for redundancy (14 manageable and seven likely resilient) in every scenario. For scenario 2, redundancy increases under all managed conditions and a loss of redundancy only occurs under long term decreased management. Scenario 3 shows an increase in redundancy in all situations, with the exception of long term, decreased management, where the current conditions remain constant. Considering the substantial increase in the known overall population in the previous 30 years and the increase in manageable and likely resilient localities in the last 15 years, we believe accounting for additional redundancy, as in scenarios 2 and 3, in future conditions is reasonable. However, the estimation of enhanced redundancy assumes that 1) resources for survey and restoration effort would be available, 2) probable localities previously undocumented would be targeted, and 3) information on survey and restoration effort would be reported.

Table 14. Three scenarios displaying projected number of manageable (ML) and likely resilient localities (LRL) based on current conditions under short and long term, managed and decreased management conditions.

	Unit	Current Conditions		Short Term				Long Term			
				Managed		Decreased Mgmt.		Managed		Decreased Mgmt.	
		ML	LRL	ML	LRL	ML	LRL	ML	LRL	ML	LRL
Scenario 1: Existing Number of Known Localities	Oklahoma	0	2	0	2	0	2	0	2	0	2
	Central	4	1	3	1	3	1	2	1	2+1	0
	North	2	2	2	2	1	2	1	2	1+1	1
	South	6	2	6	2	5	2	6	2	3	2
	West	7	5	7	5	7+1	4	7+1	4	6+1	4
	Mexico Constant	1	2	1	2	1	2	1	2	1	2
	Total (Mexico Constant)	20	14	**19**	**14**	**18**	**13**	**18**	**13**	**16**	**11**
	Total (U.S. only)	19	12	**18**	**12**	**17**	**11**	**17**	**11**	**15**	**9**
Scenario 2: Moderate Increase in Number of Localities	Forecasted Increase	20	14	4	2	2	1	6	4	3	2
	Total (Mexico Constant)	20	14	**23**	**16**	**20**	**14**	**24**	**17**	**19**	**13**
	Total (U.S. Only)	19	12	**22**	**14**	**19**	**13**	**23**	**15**	**18**	**11**
Scenario 3: Enhanced Number of Localities	Forecasted Increase	20	14	6	4	3	2	8	6	4	3
	Total (Mexico Constant)	20	14	**25**	**18**	**21**	**15**	**26**	**21**	**20**	**14**
	Total (U.S. only)	19	12	**24**	**16**	**20**	**13**	**25**	**19**	**19**	**12**

Red shaded numbers indicate a decrease from current conditions, green indicates an increase. Manageable locality numbers with a "+" indicate the loss of a likely resilient locality(ies) to a manageable locality(ies); i.e., abundance is projected to be <100 males, but >30.

5.3 Representation

Representation is defined as the ability of a species to adapt to changing environmental conditions. Representation can be measured through the breadth of genetic diversity within and among populations and the ecological diversity (also called environmental variation) of populations across the species' range. The more representation or diversity a species has, the more it is capable of adapting to changes (natural or human caused) in its environment.

Higher heterozygosity within a population refers to the presence of more genetic variation within that population's gene pool. This state would be considered healthier than populations with low heterozygosity because higher heterozygosity aids populations, among other things, in adapting to environmental changes. Gene flow between breeding populations is generally considered essential to ensure high heterozygosity within populations.

Although research on genetic diversity in black-capped vireos is inconsistent in results regarding genetic structuring across the breeding range, the conclusions of Vázquez-Miranda *et al.* (2015, p. 9) and Zink *et al.* (2010, entire) indicate that the black-capped vireo population rangewide is genetically unstructured, and that population structure across known populations from a lack of gene flow does not exist.

The known likely resilient localities of the black-capped vireo are spread across a geographically wide historical range ensuring that the global population is not singular and isolated, and in total demonstrate robust representation when considering the heterozygosity and lack of genetic structuring across these populations. Refer to section 2.13.4 for more detailed information regarding past and recent genetic analysis of the black-capped vireo.

Black-capped vireo breeding habitat has been outlined as contiguous, early successional shrub mottes ≤3 m (10 ft) in height with open spaces throughout (Grzybowski 1995, p. 4). The major population located at Fort Hood, Texas demonstrates the ability of the black-capped vireo to adapt to changing landscapes and utilize non-typical habitat. Studies have documented black-capped vireos at Fort Hood exploiting small patches of shrubby vegetation centered on one or several large trees (locally referred to as "donut" habitat) and surrounded by disturbed area in conjunction with using typical shrubland habitat (Cimprich and Kostecke 2006, p. 101; Noa *et al.* 2007, p. 1043). It has been reported that vireos at Fort Hood occupy habitats previously considered unsuitable for breeding in the late 1980s (Wilsey *et al.* 2014, p. 569).

A study conducted on a major black-capped vireo population in Kerr County, Texas reported black-capped vireos nesting in several substrates with nest survival and fecundity not differing significantly between nests constructed in shrubland, deciduous woodlands, or oak-juniper woodlands (Pope *et al*. 2013, p. 997). In fact, Pope *et al.* (2013, p. 997), found that nest parasitism was nearly twice as high in shrubland compared to deciduous or oak-juniper woodland vegetation types. In Mexico, breeding habitat for the black-capped vireo has been described as "dense thickets with few spaces between clumps of vegetation" (Benson and Benson 1990, p. 779). Farquhar and Gonzalez (2005, p. 11) often found black-capped vireos in habitat ranging from "dense, low stature (<3 m; 10 ft) thornscrub" to "open scrub oak woodlands and thornscrub." In Oklahoma, breeding habitat is dominated by blackjack oak, post oak and eastern red cedar (Graber 1961, p. 316; Grzybowski *et al.* 1994, p. 540); these trees are absent (except for eastern red cedar) from breeding localities in Texas and Mexico.

The information on genetic and ecological diversity indicates the black-capped vireo displays adequate representation to adapt to environmental changes. When considering the species' apparent heterozygosity and lack of genetic structuring, its breadth of likely resilient localities geographically spread across its historical range, and that it displays adaptability to variations in habitat within and across populations, the black-capped vireo appears to be adaptable and persistent when faced with a changing environment. The black-capped vireo's adequate representation is highly likely to persist in the short and long term provided the managed conditions of resiliency and redundancy remain stable or increase.

5.4 Summary of Future Conditions

We evaluated the viability of the black-capped vireo in terms of its resiliency, redundancy, and representation in its current condition and predicted short and long term conditions. The black-capped vireo appears to have adequate representation both ecologically and genetically.

Resiliency for a portion of the black-capped vireo breeding range is dependent on vegetation and cowbird management. We forecasted known manageable and likely resilient localities based on the scenario of continued management and decreased management over the short and long term. In all scenarios, many localities have a moderate to high likelihood of persisting into the long term; however, some localities would not be expected to persist.

The predictions of redundancy included three scenarios of the current conditions remaining static and the likelihood of moderate and enhanced increases in redundancy based on future survey and restoration efforts. The scenarios include the results of forecasted resiliency through the long term.

Scenario 1, existing number of localities: The worst case scenario under managed and unmanaged conditions. The black-capped vireo's viability is expected to be characterized by losses of redundancy in the short and long term, mostly occurring under decreased management conditions. However, in both the short and long term projections with decreased management, redundancy is expected to remain above the level reported from 2000 to 2005.

Scenario 2, Moderate increase in number of localities: The moderate case scenario with the expectation of increased redundancy in the short and long term. Viability of the black-capped vireo is characterized by slight increases in redundancy under all managed conditions, and a loss of redundancy under long term decreased management.

Scenario 3, enhanced number of localities: The best case scenario under managed and decreased management. Viability of the vireo is characterized by increases in redundancy under all conditions except for long term decreased management, where the level remains the same as the current conditions.

The black-capped vireo is a conservation-reliant species, in which some localities require management activities, especially in the eastern portion of the breeding range, to persist. In considering its management needs, the forecast of future conditions includes scenarios based on the needs of the species, stressors and future survey and restoration efforts. Our forecasts that produce stable or increasing resiliency and redundancy reflect the differences in the current conditions of the species compared to the status assessment conducted 30 years ago. We consider active management of threats, where necessary, to be essential to the persistence of the species, as evidenced by the historical increases in the known population and distribution.

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APPENDIX A

Comparison of Black-capped Vireo numbers by County between 2000 and 2005, compared to information between 2009 and 2014. Empty cells indicate a county within the vireo breeding range, but with no survey data from the time period.

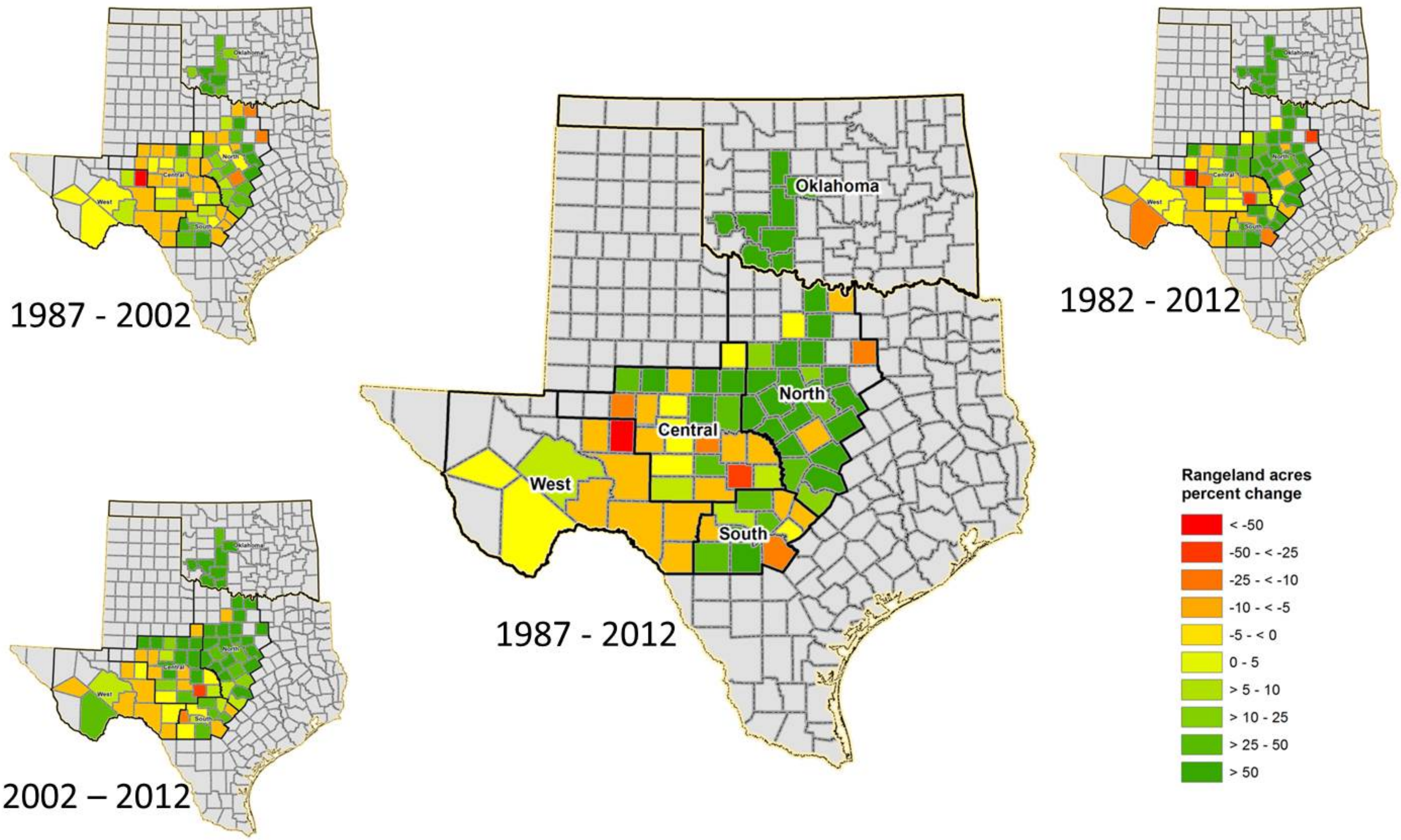
State	County	USFWS ('00–'05)	USFWS ('09–'14)	Change Increase - Green Decrease - Red	Recovery Unit
Texas	Callahan	2		-2	Central
Texas	Coke	12		-12	Central
Texas	Coleman	6	3	-3	Central
Texas	Concho	1	4	3	Central
Texas	Glasscock				Central
Texas	Howard				Central
Texas	Irion				Central
Texas	Kimble	35	164	129	Central
Texas	Llano		1	1	Central
Texas	Mason	77	131	54	Central
Texas	McCulloch	1	33	32	Central
Texas	Menard	8	7	-1	Central
Texas	Mitchell				Central
Texas	Nolan	3	4	1	Central
Texas	Runnells	2	3	1	Central
Texas	San Saba	11	52	41	Central
Texas	Schleicher		4	4	Central
Texas	Shackelford				Central
Texas	Sterling				Central
Texas	Sutton	1	3	2	Central
Texas	Taylor	125	111	-14	Central
Texas	Tom Green	6		-6	Central
Texas	Bell	126	136	-10	North
Texas	Bosque	1		-1	North
Texas	Brown				North
Texas	Burnet	88	182	94	North
Texas	Comanche				North

Texas	Cooke				North
Texas	Coryell	531	843	312	North
Texas	Dallas	1		-1	North
Texas	Eastland		10	10	North
Texas	Erath	16	19	3	North
Texas	Hamilton	4		-4	North
Texas	Hill				North
Texas	Hood				North
Texas	Jack		9	9	North
Texas	Johnson				North
Texas	Lampasas		10	10	North
Texas	McLellan				North
Texas	Mills		4	4	North
Texas	Montague	1		-1	North
Texas	Palo Pinto	1	5	4	North
Texas	Parker				North
Texas	Somervell	20	9	-11	North
Texas	Stephens				North
Texas	Travis	43	70	27	North
Texas	Wise				North
Texas	Williamson	14	8	-6	North
Texas	Bandera	28	247	219	South
Texas	Bexar	45	40	-5	South
Texas	Blanco	14		-14	South
Texas	Comal				South
Texas	Gillespie		9	9	South
Texas	Hays		2	2	South
Texas	Kendall		3	3	South
Texas	Kerr	436	548	112	South
Texas	Medina	4		-4	South
Texas	Real	93	214	121	South
Texas	Uvalde		7	7	South
Texas	Brewster	15	30	15	West
Texas	Crockett	2	9	7	West
Texas	Edwards	223	295	72	West

Texas	Jeff Davis				West
Texas	Kinney	42	63	21	West
Texas	Pecos		2	2	West
Texas	Reagan				West
Texas	Terrell	86	39	-47	West
Texas	Upton				West
Texas	Val Verde	133	867	734	West
Oklahoma	Blaine	17	1	-16	Oklahoma
Oklahoma	Canadian		2	2	Oklahoma
Oklahoma	Cleveland*	4		-4	Oklahoma
Oklahoma	Comanche	1927	729	-1198	Oklahoma
Oklahoma	Caddo				Oklahoma
Oklahoma	Tillman				Oklahoma
Oklahoma	Cotton				Oklahoma
Oklahoma	Greer		1	1	Oklahoma
Oklahoma	Kiowa		26	26	Oklahoma
Sum		**4205**	**4959**	**754**	
Count		**41**	**45**	**55**	
Decrease				**-19**	
Increase				**36**	

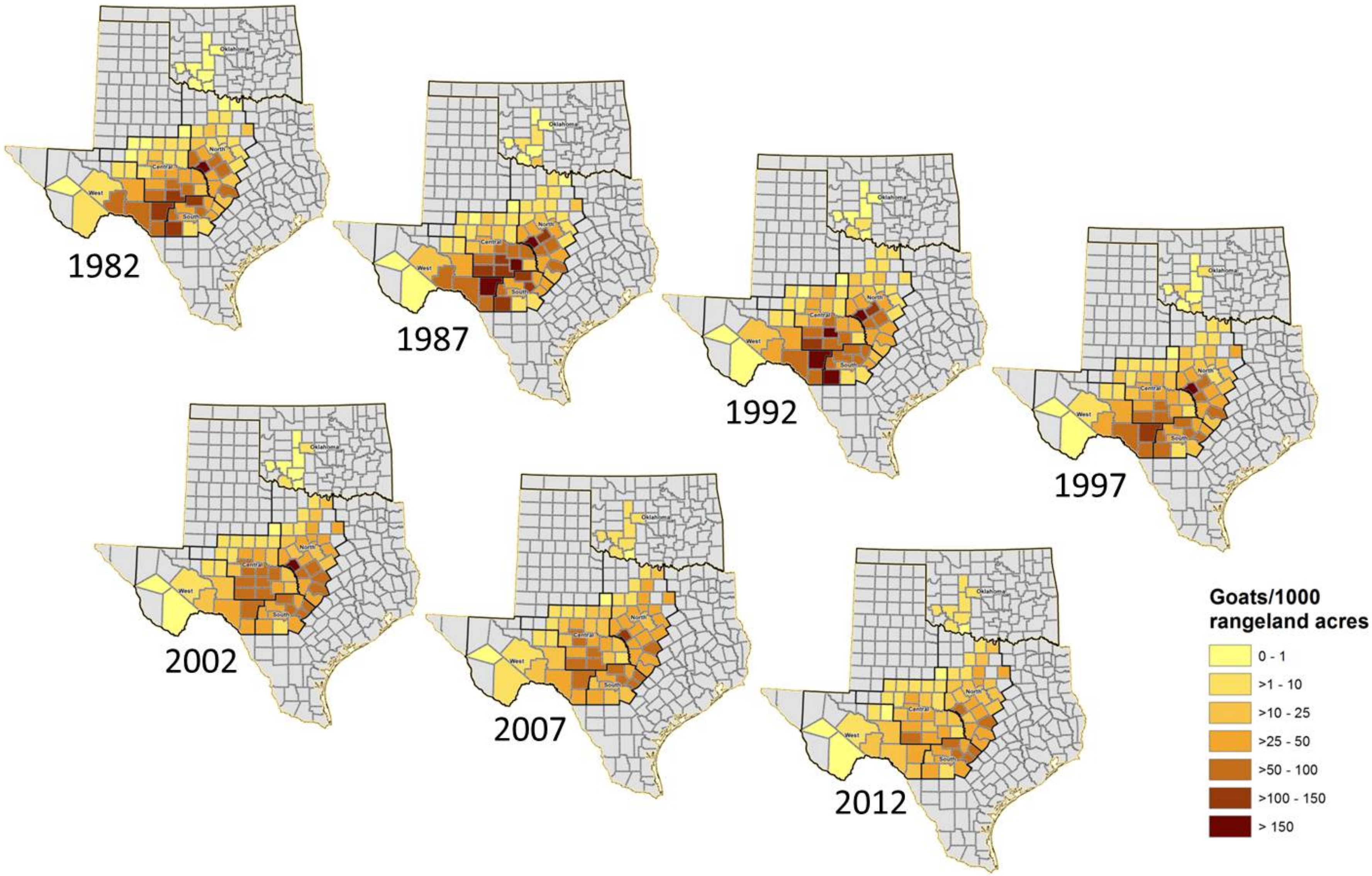
APPENDIX B

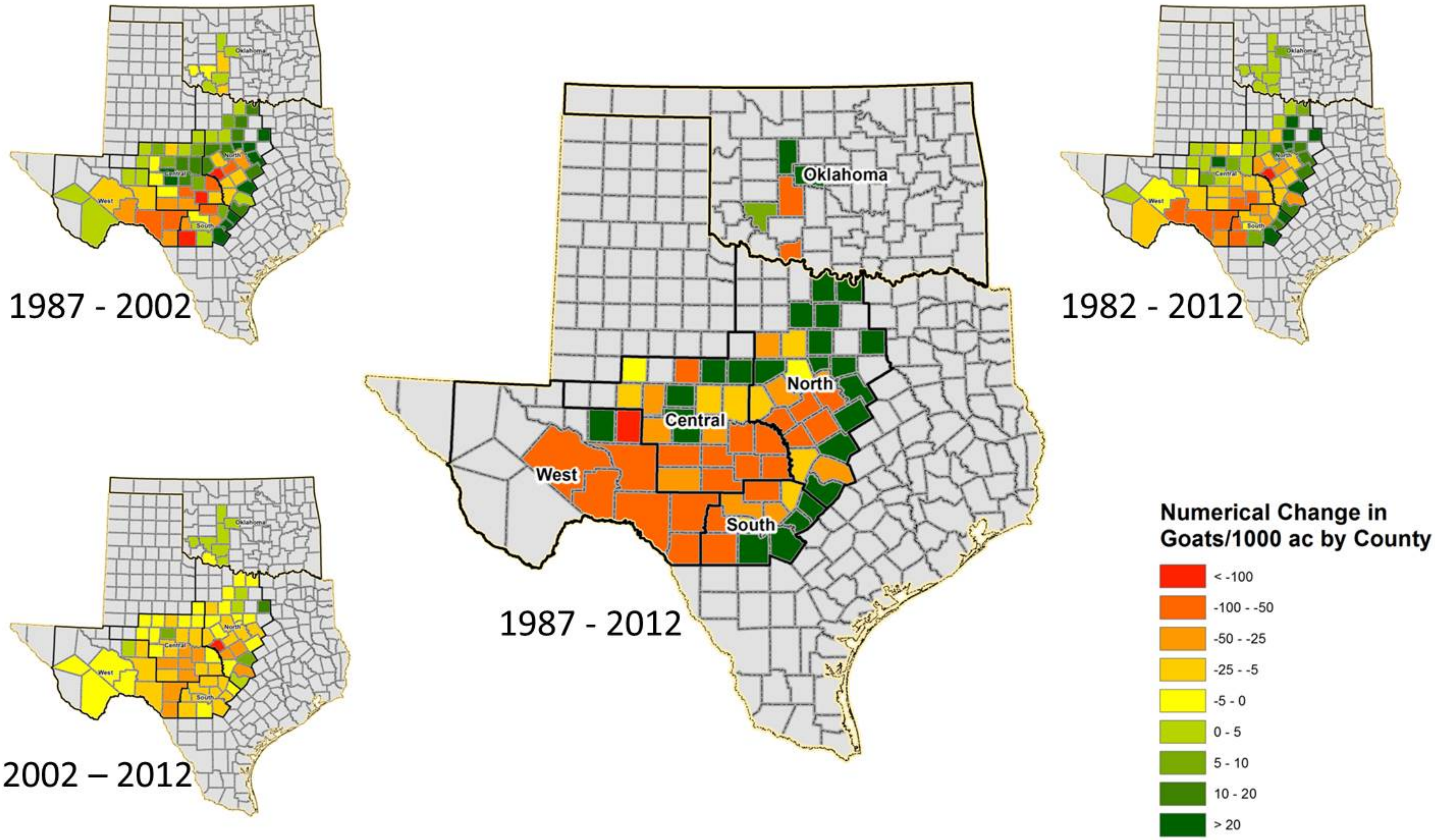
Changes in land categorized as rangeland reported in the U.S. breeding range. *Source: USDA Agricultural Census.*

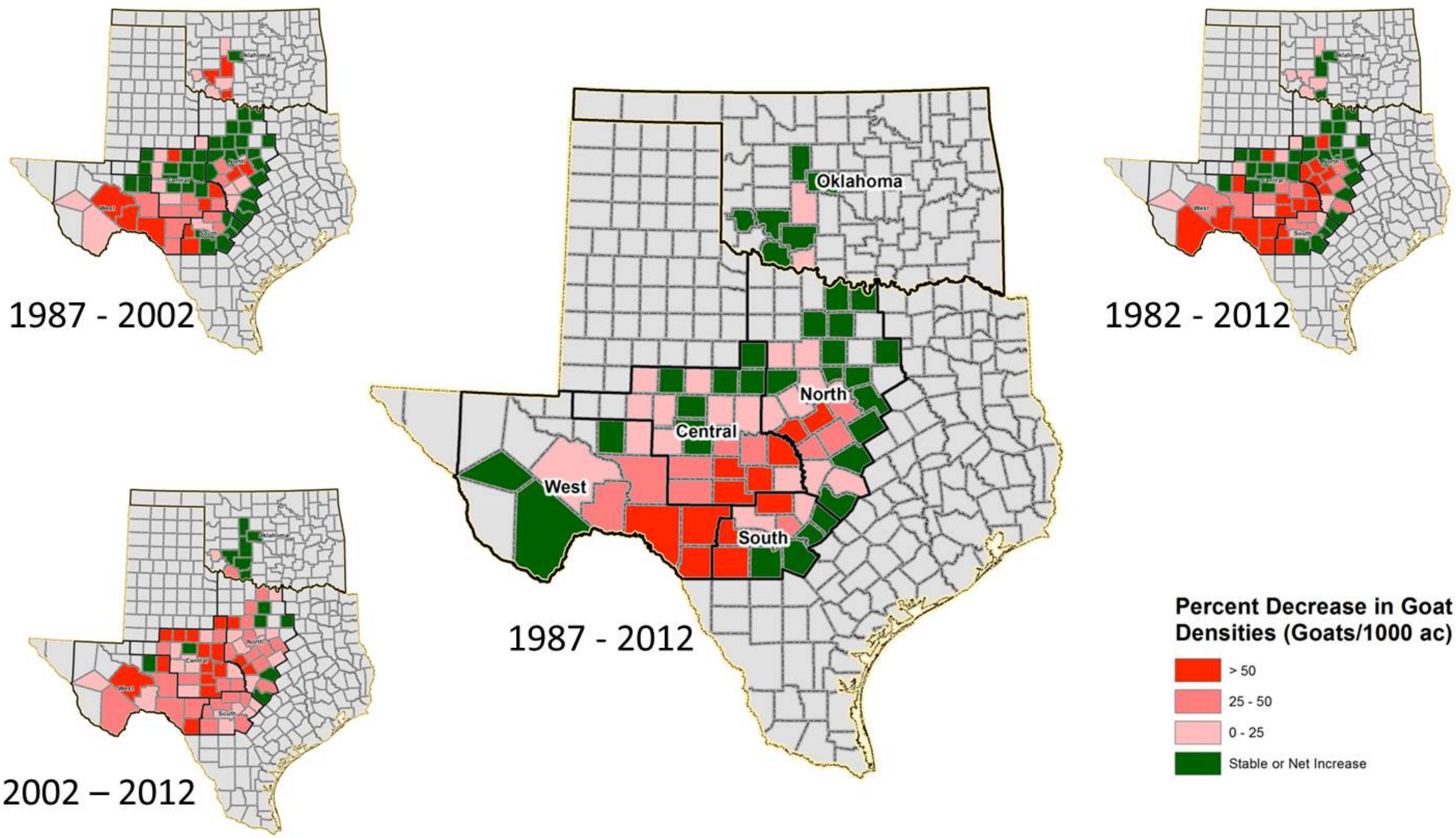


APPENDIX C

Changes in reported goat numbers across the U.S. breeding range. *Source: USDA Agricultural Census.*



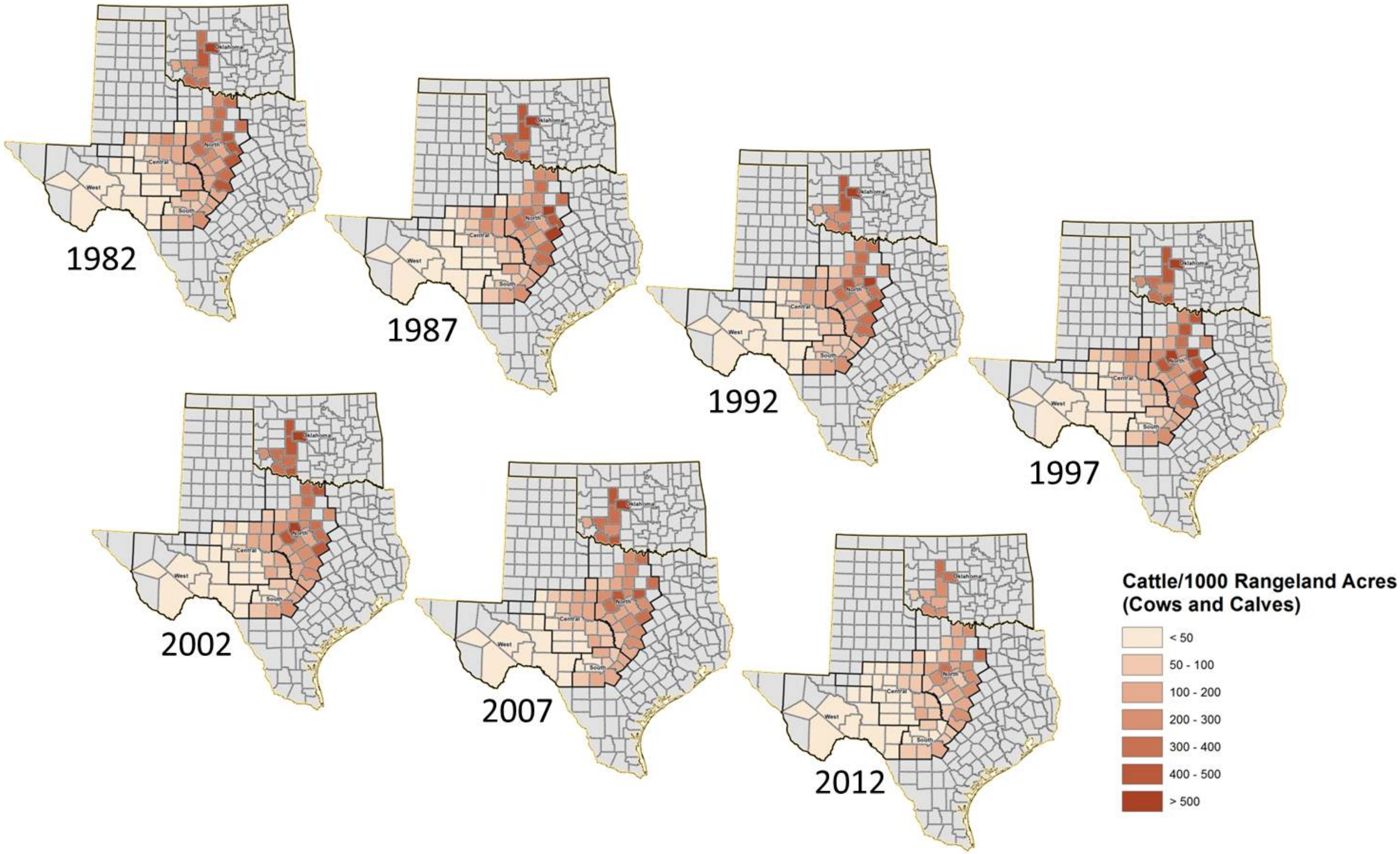

1987 - 2002
1982 - 2012
2002 – 2012
1987 - 2012
Oklahoma
North
Central
West
South
Numerical Change in
Goats/1000 ac by County
< -100
-100 - -50
-50 - -25
-25 - -5
-5 - 0
0 - 5
5 - 10
10 - 20
> 20

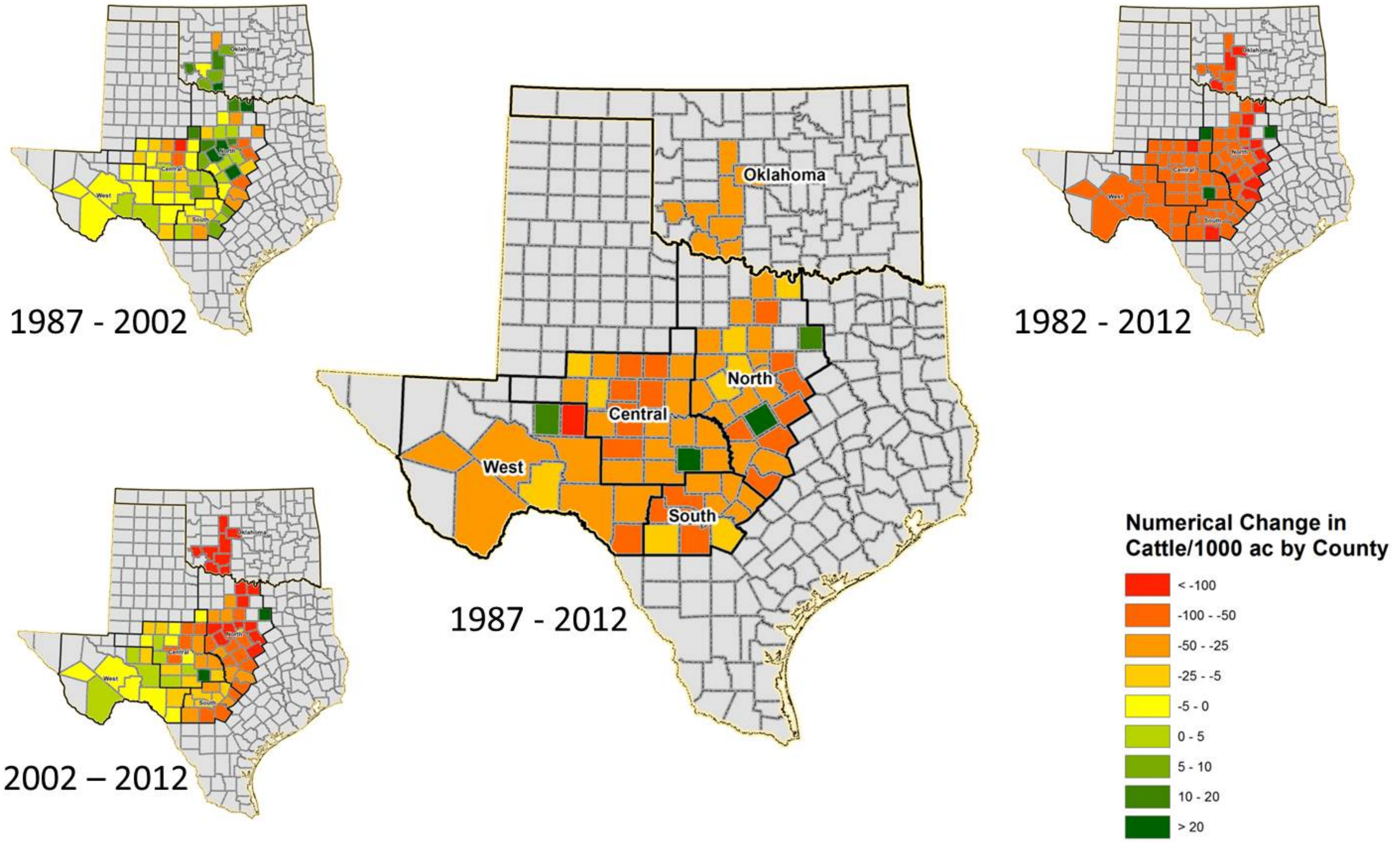


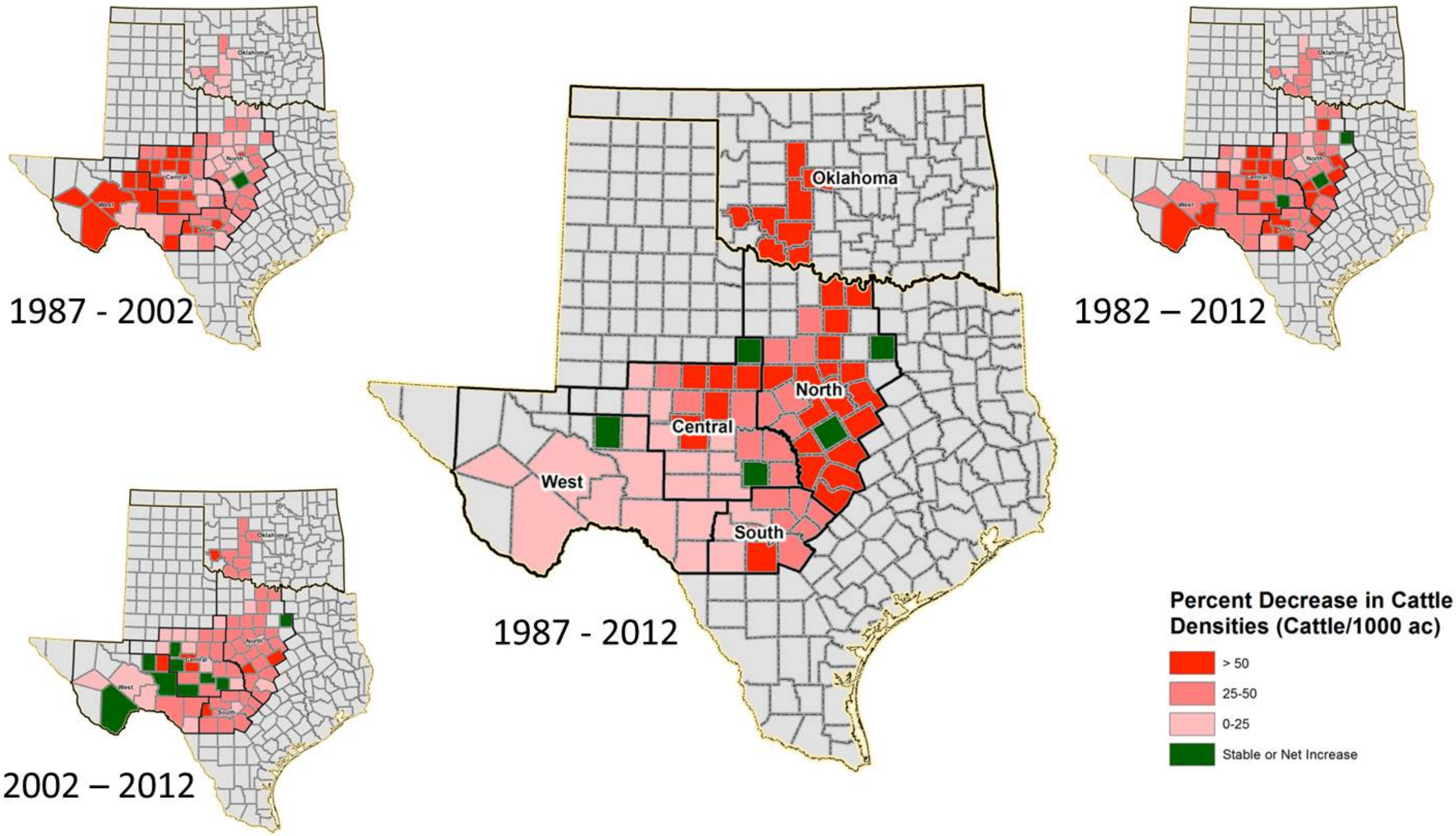
1987 - 2002
1982 - 2012
2002 – 2012
1987 - 2012
Oklahoma
North
Central
West
South
Percent Decrease in Goat Densities (Goats/1000 ac)
> 50
25 - 50
0 - 25
Stable or Net Increase

APPENDIX D

Changes in reported cattle numbers across the U.S. breeding range. *Source: USDA Agricultural Census.*




1987 - 2002
1982 - 2012
Oklahoma
North
Central
West
South
1987 - 2012
2002 – 2012
Numerical Change in Cattle/1000 ac by County
< -100
-100 - -50
-50 - -25
-25 - -5
-5 - 0
0 - 5
5 - 10
10 - 20
> 20


1987 - 2002
1982 – 2012
2002 – 2012
1987 - 2012
Oklahoma
North
Central
West
South
Percent Decrease in Cattle Densities (Cattle/1000 ac)
> 50
25-50
0-25
Stable or Net Increase

APPENDIX E

Known populations numbers from 2000 to 2005 and 2009 to 2014 used in this assessment.

This SSA uses reported numbers of black-capped vireos as the best available information regarding the known population. The “known” population is the reported numbers from a specific timeframe. The 2007 5-year review used numbers available at the time, primarily information reported by Wilkins *et al.* (2006). In that report, the timeframe of 2000 to 2005 was used to determine the known population.

This SSA report uses an equivalent timeframe of 2009 to 2014 for comparison to the 2007 5-year review (USFWS 2007). To account for the four major localities with regular surveys, we used the most current survey (2014) for reporting the known population. For consistency, we adjusted the reported known population for Fort Hood and Fort Sill from our 2007 5-year review to use the most current reporting year (2005) for the 2000 to 2005 time period.

Additionally, Wilkins *et al.* (2006) used a draft report for the known population at Wichita Mountains Wildlife Refuge. The final number is substantially different, and used in this SSA. One minor correction was also adjusted, where a single bird was reported twice in Wilkins *et al.* 2006. The result of these adjustments is a reduction of 1,805 known males reported in the 2007 five year review (Table E-1).

Table E-1. Adjusted black-capped vireo numbers from 2000 to 2005 reported in Wilkins *et al.* (2006) and used in the Service’s 2007 5-year review.

Location	Wilkins *et al.* 2006	Adjusted Number	Difference
Fort Hood	1,847 males (2003 reporting year)	590 males (2005 reporting year)	-1,257
Fort Sill	355 males (2004 reporting year)	459 males (2005 reporting year)	104
Wichita Mountains	2,119 males	1,468 males	-651
Montague County	2 males	1 male	-1
Totals	4,323	2,518	-1,805