BLACK-CAPPED VIREO
POPULATION AND HABITAT VIABILITY ASSESSMENT
REPORT

Report of a Workshop arranged by the U.S. Fish and Wildlife Service

Compiled and Edited by
Carol Beardmore, Jeff Hatfield, and Jim Lewis
in conjunction with the participants
of the PHVA workshop held in
Austin, Texas
September 18-21, 1995

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EXECUTIVE SUMMARY

The black-capped vireo (*Vireo atricapillus*) nests in shrublands of central Texas, west-central Oklahoma, and Coahuila, Mexico and winters along the Pacific slope of Mexico. This vireo was listed as endangered in 1987. The principal threats are cowbird parasitism, destruction and modification of nesting habitat, and possible conversion of wintering habitat.

Thirty-six biologists representing 26 agencies, organizations, universities, or companies met September 18-21, 1995, in Austin, Texas, to participate in a Population and Habitat Viability Assessment Workshop for the black-capped vireo. The workshop was funded by a grant from the National Biological Service, U.S. Department of the Interior, and arranged by the U.S. Fish and Wildlife Service. The Service's goal for the workshop was development of population targets and conservation recommendations, through consensus-building by participants, that could be used by individuals, or groups of landowners and land managers, to develop and implement conservation strategies for the black-capped vireo.

Workshop participants developed the following goals at the beginning of the 3.5-day meeting.

1. Update and describe rangewide distribution and status (breeding, wintering).
2. Update information on spatial and temporal habitat characteristics. Review methods and standardize.
3. Identify and rank threats.
4. Describe population dynamics, extinction probability (rangewide, special cases); define and estimate minimum viable population sizes.
5. Evaluate data on critical biological parameters, review methods and recommend standardization.
6. Identify stakeholders/partners (agencies, organizations, private sector) and resources for implementing recovery.
7. Develop a cooperative urban and rural outreach strategy (education, inventory).
8. Describe short-term/long-term consequences of action or inaction by stakeholders.
9. Specify research needs.
10. Determine management needs for cowbirds, habitat (public and private ownership); cost-benefit analyses; incentives and disincentives.

Participants identified the following four subgroups they felt were necessary to achieve the above goals: (1) Population Biology and Modelling, (2) Habitat Management Strategies, (3) Outreach and Partnerships, and (4) Distribution, Status, and Threats. These subgroups met during the workshop to develop subgroup reports, which became chapters of this report.

The Distribution, Status, and Threats subgroup summarized vireo distribution as currently known, listed counties that need distribution studies, made recommendations for redrawing the recovery units outlined in the Black-capped Vireo Recovery Plan, worked with the Habitat Management Strategies subgroup to rank threats to the black-capped vireo, and made recommendations for further research.

The Population Biology and Modelling subgroup compiled and evaluated current survivorship and fecundity data. They simulated various scenarios to assess the viability of vireos populations and their probability of extinction. Results were presented in tabular form for various fecundity levels and carrying capacities.

The Habitat Management Strategies subgroup described habitat characteristics, identified and ranked threats, and provided guidelines for habitat maintenance, enhancement, restoration, and creation. They also discussed a cowbird management strategy and offered cowbird control options.

The Outreach and Partnerships subgroup outlined two possible scenarios for rural landowner-based habitat conservation plans (HCP). One is known as Safe Harbor and has been used for the red-cockaded woodpecker in the southeastern United States. The other scenario is called the Rural, Incentive-based HCP. Information and education resources available from various agencies were also provided.

LITERATURE CITATION

Literature citations for this document should read as follows:

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I. INTRODUCTION

A Population and Habitat Viability Assessment (PHVA) workshop was held in Austin, Texas, September 18-21, 1995 to assess the current state of knowledge of the biology of the black-capped vireo (*Vireo atricapillus*), attempt to predict its probability of extinction/survival under various management scenarios, and to reach group consensus about what constitutes a viable population and how to achieve these viable populations as described in the Black-capped Vireo Recovery Plan (U.S. Fish and Wildlife Service 1991; recovery plan). The workshop was hosted by the U.S. Fish and Wildlife Service's Austin Ecological Services Office and was funded by a grant from the National Biological Service.

A group of biologists representing federal, state, county, and local governments, universities, consulting companies, and nongovernmental organizations were invited to participate in the workshop. These biologists have either direct research experience with the vireo in the field, direct association with managing habitat for vireos on public land, or responsibility for information/education projects that would benefit vireo recovery. The group was purposefully kept small to facilitate group discussion. One person per company, department/division, or group was encouraged to attend to represent the data or information held by that entity.

The format of the workshop was similar to workshops conducted by the IUCN's Conservation Breeding Specialist Group (CBSG). CBSG often includes as many stakeholders as possible in their workshops. However, because of the complexity of the black-capped vireo's plight, the Fish and Wildlife Service (Service) decided to hold an initial workshop focusing on the biological needs of the species and how biology relates to the vireo's recovery strategy. Future workshops are envisioned (and are intended) to involve landowners and land managers and encourage their participation in developing and implementing recovery solutions.

The workshop was facilitated by Jim Lewis, Fish and Wildlife Service, who is trained and experienced in leading PHVA workshops in conjunction with CBSG. The consensus-building group discussion format was an important aspect of the workshop. The group suggested and agreed to the goals of the workshop, and the focus of the subgroups. Individuals chose the subgroup in which they participated. Each subgroup had its own internal dynamics. The entire group provided comment to each subgroup in plenary sessions. People with dissenting opinions could draft their ideas separately and submit them for inclusion in the report. Although the Service organized and hosted the workshop, Service biologists in attendance functioned no differently from the rest

of the participants. Critical to the spirit of the workshop, the facilitator and participants put aside individual goals and objectively strove to meet the group's goals.

The following introductory material was presented. Carol Beardmore (Fish and Wildlife Service) discussed recovery strategies. Pete Schenkkan (University of Texas-Law School) presented a nonbiological perspective and discussed the need to inform the public of what is needed to recover endangered species. Phil Miller (IUCN-CBSG) presented an overview of small population biology. Joe Grzybowski (University of Central Oklahoma) and Howard Weinberg (Army Corps of Engineers, Construction Engineering and Research Laboratory) presented biological data collected since the recovery plan was published. Jeff Hatfield (National Biological Service) demonstrated the RAMAS-Metapop simulation software.

The group brainstormed, refined, and agreed to a set of goals for the workshop. The goals were as follows:

1. Update and describe rangewide distribution and status (breeding, wintering).
2. Update information on spatial and temporal habitat characteristics. Review methods and standardize.
3. Identify and rank threats.
4. Describe population dynamics, extinction probability (rangewide, special cases); define and estimate minimum viable population sizes.
5. Evaluate data on critical biological parameters, review methods and recommend standardization.
6. Identify stakeholders/partners (agencies, organizations, private sector) and resources for implementing recovery.
7. Develop a cooperative urban and rural outreach strategy (education, inventory).
8. Describe short-term and long-term consequences of action or inaction by stakeholders.
9. Specify research needs.
10. Determine management needs for cowbirds, habitat (public and private ownership); cost-benefit analyses; incentives and disincentives.

The group chose the following four subgroups to address the goals: Population Biology and Modelling, Habitat Management Strategies, Outreach and Partnerships, and Distribution, Status, and Threats. The Population Biology and Modelling subgroup addressed goals #4 and #5; the Habitat Management Strategies subgroup addressed goals #2, #3, and #10; the Outreach and Partnerships subgroup addressed goals #6, #7, and #8; and the Distribution, Status, and Threats subgroup addressed goal #1.

All subgroups identified future research needs (#9) for their topics.

Each subgroup developed their own way of addressing their goal(s). The subgroups' draft reports reflect the different ways of accomplishing their task. The subgroups worked for a period of time, reported to the entire group, modified their report based on the plenary session comments. Subgroups again reported to the group and modified their draft report twice more in this fashion, and then finalized a draft report, which became a chapter of a draft document.

Service participants compiled and edited the reports into a draft document. Editing was done not to change the content or intent, but to put the reports into similar format, check grammar, provide background information about the purpose of the workshop, and summarize information needs.

During the workshop, the participants requested that a follow-up meeting be held after they had the opportunity to review the draft document. Participants wished to read the draft document, consider the ideas and recommendations, and then have the opportunity to discuss the results one more time before the report was finalized. The follow-up meeting was held on December 1, 1995. During the meeting, the entire group discussed several concerns they had with the draft report. Then subgroups worked on and submitted the final versions of their chapters. Service participants again compiled and edited the final versions of the chapters into this final report.

The Service also thinks it is important to summarize some of the general feelings expressed by participants, especially in regard to the use of the document. Some participants were concerned that the modelling effort was premature because scientific data collected on the vireo were insufficient to provide the accurate values necessary for the model. Four datasets on survivorship from band returns have been generated: Fort Hood Military Reservation has conducted their vireo banding project for 8 years; Joe Grzybowski has conducted banding on the Kerr Wildlife Management Area (Kerr WMA) and the Wichita Mountains Wildlife Refuge for 7 years; and various workers in western Travis County, Texas, have conducted vireo banding for 12 years. Fecundity estimates were established in conjunction with these projects, but dispersal distances and rates are known only from a few instances. While it is true that shortcomings in the data and parameter estimations exist, the Service, other agencies, and people interested in conserving the vireo felt it important to convey to landowners and land managers more specifically what is needed for recovery. This document presents our current level of knowledge and management scenarios based on this knowledge. To

delay management decisions another 5 years for data collection to be more complete would be insensitive to the uncertainty that many landowners and land managers feel.

Some concern was expressed at the vireo workshop that the results of the workshop could be misinterpreted, and many participants were also present when this was discussed at the Golden-cheeked Warbler PHVA workshop. Recent experience with misuse and/or misinterpretation of scientific articles, statements to the press, administrative and regulatory actions, etc. has shown that no matter how many caveats and assumptions are described herein, certain points could undoubtedly be misrepresented or misused. However, to not report the workshop's accomplishments would be scientifically irresponsible. **We, therefore, urge that care be taken with interpreting the document's statements, that is, they should not be taken out of context, because the assumptions and explanations surrounding them are very important to their use and understanding.**

Many participants felt that one of the values of the workshop was the list of information and research needs. It is important to note that this list does not include development of theory, but rather research that applies directly to recovery. The process of developing the information and research needs list resulted in an appreciation of the importance of long-term banding projects and other work related to PHVA. The recovery plan outlines research needs, but the PHVA exercise refocused our thinking and commitment to collect and analyze data for a population and habitat viability model and to address more specific recovery scenarios. The participants also felt that within 3 to 5 more years as additional data are collected, a customized model should be developed and simulations should be run again. In other words, the group felt an interactive, adaptive process was indicated.

II. WHAT IS A POPULATION AND HABITAT VIABILITY ASSESSMENT?

Population and habitat viability **analysis** usually (and in the context of this document) refers to computer modelling of biological processes, whereas population and habitat viability **assessments** are an in-depth examination and synthesis of the species' life history, ecology, management, and other factors to determine courses of action to manage for viable populations. Assessments include consideration of model analysis, habitat management, captive breeding (if appropriate), genetic tracking (if appropriate), life history, status, threats, geographic distribution, education and information, other conservation efforts, human demography/dimensions, research, and any other component that is deemed necessary. By itself, model analysis would have little real world usefulness without consideration of the context in which the species lives. Habitat management, human influences, and other components are therefore assessed and added into the conservation/recovery equation, at least, qualitatively.

Population and Habitat Viability Assessments can be thought of as a tool to compile, evaluate, and synthesize data and build a framework for conservation action. The workshop process that was used recognized that much of the knowledge about a species is not published and is often in the heads of the experts. Group dynamics were important in obtaining information from individuals that would benefit the entire group's effort. Respecting the use of that information should be observed.

PHVA workshops are not intended to be the final answer, but are intended to be the beginning of a dynamic process. Groups often commit to meeting again, as did this group. When new information about processes, threats, and/or the species are found, a reassessment may be needed.

III. DISTRIBUTION, STATUS, AND THREATS

Keith Arnold, Doug Booher, Jackie Davis, Mark Lockwood, Cal Newnam, Chuck Sexton, Lori Sparkman, and Paul Sunby.

The purpose of this chapter is to review the status and distribution of black-capped vireo in Texas and Oklahoma. Due to limited population and distribution information in Coahuila, this portion of the species' range is not fully addressed.

A. DISTRIBUTION

Texas counties listed in the recovery plan as containing black-capped vireos are found in Table 1. The information presented in this table is based on input from multiple sources, including reports and personal communications of observations from TPWD, TxDOT, Fort Hood/DOD, and Service representatives; David Steed; Joe Grzybowski; Chuck Sexton; and other PHVA participants. Column one includes those counties currently known or suspected to contain vireos. This column also includes the number of vireos observed in each county. All numbers greater than one are based on observations from 1990 to present. Counties designated as having one male vireo fall into one of two categories. First, counties in which vireos are believed to occur, but have not been documented since 1990, are designated with the year of the most recent vireo sighting. The second category includes counties that are listed in the recovery plan as having vireos but have not been surveyed since 1990. Numbers given for the counties do not represent the total vireo population; rather, they are an estimate of the absolute minimum number of vireos known to be present in that county. Although no population estimate is available, based on the numbers presented in Table 1, the minimum number of male vireos in Texas is 1,636. (Editor's note: As already stated, this number is derived from spotty observations from multiple sources and years, and does not represent a population estimate.)

Column two includes counties where the presence of vireos is unconfirmed. Counties in this column either have historical vireo breeding records or are within the range of the vireo and, based on geology, are considered likely to contain suitable vireo habitat. The vast majority of known vireo habitat occurs on outcrops of Edwards or Fredericksburg Limestone. Reasons for this are not fully understood, but are likely related to these formations ability to retain and transmit water and overlying soils that generate a suitable configuration of vireo habitat. Note: at least three areas in Texas known to support black-capped vireos are not underlain by Edwards or Fredericksburg Limestone. These areas are Colorado Bend State Park in San Saba County (22

territories), which is underlain by the Marble Falls Formation, a Pennsylvanian limestone; a Lower Colorado River Authority (LCRA) property in Burnet County (15 territories) underlain by alluvial sands originating from Cambrian sandstones; and along the Devil's River in eastern Val Verde County (18 territories), which is underlain by Cretaceous limestones of the Washita Group.

Column three includes those counties where black-capped vireos have been recently extirpated.

Table 1. Distribution of the black-capped vireo in Texas counties.

Known (# of Males)		Need Confirmation	Recently Extirpated
Bandera	(48)	Brown	Dallas
Bell	(150)	Coleman	
Bexar	(16)	Comal	
Blanco	(6)	Comanche	
Bosque (1986)	(1)	Concho	
Brewster	(16)	Hood	
Burnet	(47)	Johnson	
Coke	(32)	Llano	
Coryell	(150)	McCulloch	
Crockett	(9)	Medina	
Edwards	(67)	Menard	
Erath (1985)	(1)	Parker	
Gillespie (1988)	(1)	Schleicher	
Hamilton	(1)		

Hays (1)		
Irion (18)		
Kendall (1985) (1)		
Kerr (602)		
Kimble (26)		
Kinney (105)		
Lampasas (1)		
Mason (2)		
Mills (2)		
Nolan (1)		
Palo Pinto (1)		
Pecos (3)		
Real (23)		
Runnels (5)		
San Saba (22)		
Somervell (3)		
Stephens (1)		
Sterling (1)		
Sutton (1988) (1)		
Taylor (1988) (1)		
Terrell (8)		

Tom Green (13)		
Travis (60)		
Uvalde (4)		
Val Verde (173)		
Williamson (13)		

Three counties in Oklahoma are known to contain black-capped vireos; fourteen additional counties have historically contained the species (Grzybowski et al. 1986, Grzybowski 1995). About seven of those 14 counties are believed to contain suitable vireo habitat and warrant additional surveys (Gryzbowski, pers. comm.) A total of 170 male vireos is known to occur in Oklahoma, an estimate that may approach the total population (Table 2). The most current estimates were obtained from J. Shackford (Blaine Co.), V. Byre (Cleveland County), and J. Grzybowski (Comanche County).

In the early 1990s, J. Grzybowski and the Oklahoma Chapter of The Nature Conservancy conducted vireo surveys in counties where the species had previously occurred. These surveys were conducted from county roads at points known to have contained vireos in the 1980s. Surveys done in the 1980s were also generally done from county roads. In Caddo and Canadian counties, local groups of vireos were monitored until they were no longer found (Grzybowski 1992).

We recommend that landowners be contacted for permission to survey in suitable habitat on private land in the seven counties listed in column 2 of Table 2. Extensive, systematic surveys across the historical range are needed to determine if vireos remain in these counties.

Table. 2. Distribution of the Black-capped Vireo in Oklahoma, by county.

Counties where presence is confirmed (No. of territories)		Counties needing surveys		
Blaine	(17)	Caddo	last seen	1990
Cleveland	(3)	Canadian		1988

Counties where presence is confirmed (No. of territories)	Counties needing surveys
Comanche (150)	Dewey 1964
	Kiowa 1963
	Oklahoma 1984
	Logan 1967
	Garvin 1962

The number of vireos present in Coahuila, Mexico is unknown. Benson and Benson (1990) extrapolated that there are 3,139 to 9,463 pairs from their observation of 28 birds. Scott and Garton (1991) express cautions regarding this extrapolation.

B. RECOMMENDATIONS

Suggested changes to recovery units

The recovery units presented in the recovery plan were defined by the population of vireos within distinct physiographic regions. In Figure 1, the boundaries of the black-capped recovery units for Texas have been portrayed to conform to county lines. Recovery units bounded by county lines facilitate data management and outreach and recovery strategies. In almost every instance, the county lines nearest the existing recovery unit boundaries were depicted in Figure 1.

We recommend combining Texas recovery unit 1 with unit 2 and recovery unit 6 with unit 5, based on the relatively low populations of vireos within units 1 and 6 (Figure 1). We also recommend that a viable population with at least three to five subpopulations be maintained in each of the resulting four proposed recovery units (Editor's Note: This recommendation is not derived from the modelling conducted at this PHVA workshop, but should be included as a scenario in future modelling efforts.) The current recovery strategy calls for at least one viable population in four of the six Texas recovery units (US Fish and Wildlife Service 1991). (Note: The Service revises or amends recovery plans with input and review. A change in the recovery units and criteria such as that suggested above would be considered during the revision or amendment process.)

Information Needs

- Determine the status of black-capped vireos in the 20 counties identified as needing further study in Tables 1 and 2.

- Identify population sizes and distributions in Texas recovery units 1, 4, 5, and 6.

- Describe population status and distribution on breeding grounds in Mexico.

- Search for additional vireo populations or potentially suitable habitat in Oklahoma.

- Describe wintering habitat requirements, wintering distribution, and threats, if any, to wintering habitat.

Figure 1. The range of the black-capped vireo in Texas with minimum population abundances and recovery unit boundaries drawn to nearest county line

Develop a library

As required by law, all federal endangered species permit holders must submit annual reports to the Service. These public documents, as well as section 6 reports, should be placed into a library with a bibliography and made accessible to the public.

C. SUMMARY

Black-capped vireos are known or considered likely to occur in 40 Texas counties. Suitable habitat for the species may be present in an additional 13 counties, but its presence in these counties is unconfirmed. Although no population estimate is available, based on survey information collected from 1990 to present, a minimum of 1,636 male vireos are known to occur in Texas. (Editor's Note: This number is derived from spotty observations from multiple sources and years, and does not represent a population estimate.)

A total of 170 male vireos are known to occur in three counties in Oklahoma. Vireos have occurred in an additional nine counties in relatively recent times. Suitable habitat for the species may

still be present in seven of these counties (Grzybowski, pers. comm.), and surveys are needed to determine the current status of the vireo in these areas.

It is recommended that the boundaries of the Texas recovery units presented in the vireo recovery plan be changed to conform to county lines. It is further recommended that Texas recovery units 1 and 2 be combined and units 5 and 6 be combined because of the relatively low populations of vireos within units 1 and 6. Viable populations consisting of three to five sub-populations should be maintained within each of the four resulting recovery units. (Editor's Note: This recommendation is not derived from the modelling conducted at this PHVA workshop, but should be included as a scenario in future modelling efforts.)

IV. POPULATION BIOLOGY AND MODELLING

Carol Beardmore, Terry Cook, John Cornelius, Joe Grzybowski, Jeff Hatfield, Robert Melton, and Howard Weinberg

A. INTRODUCTION

Fundamental to any conservation effort is the development of a series of complimentary strategies designed to minimize the risk of population loss. Population viability analysis (PVA) is one quantitative technique that can be used to assess population responses to a number of life history parameters. Some of these parameters (e.g., reproduction, habitat carrying capacity) may be moderated with different management techniques.

PVA is essentially a set of computer simulations used to represent or characterize a biological population with respect to its expected survival time, or expected probability of extinction during a given time interval. A PVA is a simplification or abstraction of how we perceive the organization of the system. Primary properties and vital processes are incorporated into the structure of the model and those attributes that are viewed as secondary to the overall behavior and long-term dynamics of the population tend to be omitted.

PVA results should be viewed in terms of the assumptions and caveats inherent to the model development and application. Additionally, results should also be viewed in terms of the robustness of the data that are used in the model. Frequently, data that are used for model development are geographically restricted, cover a very short time frame relative to the simulations, and/or are an extrapolation or inference based on data from a related species or derived from expert opinion. Thus, parameter estimates based on these data have assumptions associated with them and may be biased or imprecise due to sampling design or analysis.

One of the benefits of using PVA as a part of a conservation effort is that it allows a diversity of participants to formulate questions concerning the population and offers insights into possible population responses. Several common questions asked during the PVA process include:

1. How will the abundance of the population change over time?
2. How long will the population persist?
3. What is the probability of extinction over a period of time into the future, say 100 years.
4. What is the minimum viable population size?
5. How much habitat is required to maintain a population?

B. PVA METHODS

A number of general models exist in which the viability of populations can be assessed. The PVA workshop for the black-capped vireo used the RAMAS metapopulation model (Akçakaya 1994). RAMAS was chosen because it allows for ages (or stages) of individuals to have different vital rates, such as fecundity, survival, and the variability of these rates over years (i.e., temporal variance), among the age classes. This model will also allow, when more data and better parameter estimates become available in the future, simulations for a species that occupies multiple subpopulations, which when considered together define a metapopulation. RAMAS incorporates the spatial aspects of metapopulation dynamics, such as the configuration of the subpopulations, dispersal and recolonization among subpopulations, and similarity (or dissimilarity) of environmental patterns experienced by the subpopulations.

Simulation model

A two-age-class, pre-breeding census model was chosen for the black-capped vireo, with the age classes being hatch year (HY) and after-hatch-year (AHY). Only breeding females were simulated, primarily because females can renest with different males within a season and the estimates of seasonal fecundity were available for females (where fecundity is defined as the number of female fledglings produced in that season per breeding female, including females who produced 0 fledglings). Thus, the model we used was

$$N(t+1) = [F_{AHY}(t)S_{HY}(t) + S_{AHY}(t)]N(t), \qquad (1)$$

where N(t) is the number of breeding females just prior to breeding in year t, F(t) is the seasonal fecundity rate in that year, and S(t) is the yearly survival rate.

A total of 1,000 replications were conducted for each simulation, with each replication run for 100 years into the future. Our modelling philosophy has been to simulate populations with a variety of carrying capacities (i.e., how many breeding females a given area can support in its vireo habitat) and with a variety of assumptions about vital rates. It should be noted that all of these simulations are sensitive to the vital rate estimates we used. If these estimates are imprecise or biased, then the results will also be imprecise or biased. Future research should focus on refining the estimates we used in our simulations and developing better PVA models when this information becomes available (see research needs below).

Estimates of vital rates

For survival rate estimates, mark-recapture data from Fort Hood for 1987-94 (H. Weinberg and R. Melton, Construction Engineering Research Laboratory, USACERL, pers. comm.) and data from western Travis County for 1983-94 (D. Steed, DLS and Associates, pers. comm., and C. Newnam, TxDOT, pers. comm.) were analyzed using standard mark-recapture methods (i.e., Jolly-Seber estimation, Jim Nichols and Jim Hines, NBS, pers. comm.). Note that these methods do not distinguish between mortality and permanent emigration from a study area, therefore underestimating the survival rates. For Fort Hood, the estimate of mean yearly survival rate for HY females was 0.12 and for AHY females, the estimate was 0.45. For Travis County, these estimates were 0.71 and 0.43, respectively. An estimate of 0.57 for AHY female survival was available for data collected from Kerr Wildlife Management Area (Kerr WMA), 1986-91 (J. Grzybowski, University of Central Oklahoma, pers. comm.). This estimate is higher than the other AHY estimates above because sampling was more complete and the estimate is adjusted for permanent emigration. Because of this adjustment, we used this estimate in our simulations. For HY female survival, we used 0.43 because this is the value needed to yield a stable population from equation 1 if female fecundity is 1 and there is no variability included in the model. The data from the Wichita Mountains Wildlife Refuge support these assumptions (J. Grzybowski, pers. comm.).

Temporal variance of survival rates could only be estimated for AHY males from Fort Hood because this was the best data set and the estimation procedure gave negative results for the other data sets. Equation 2 of Link and Nichols (1994) was used to yield an estimate of 0.0147 for the variance among years in survival rates of AHY males. The estimate of 0.0147 was used for HY and AHY females as well, and twice (2x) this estimate was used for a "high" temporal variance scenario for HY females. We conducted a complete set of all simulations in which both HY and AHY females had constant survival rates over time (i.e., temporal variance = 0) although this is probably unrealistic and overly optimistic because survival rates undoubtedly vary over time.

Several on-going studies provided estimates of seasonal fecundity under various cowbird control scenarios. However, for our simulations we ran a variety of fecundity levels to assess the effects that cowbird control might have. A model by Pease and Grzybowski (in press) 1995 generated tables of seasonal fecundity expected under various amounts of cowbird parasitism and predation, and these tables are found below (Tables 1 and 2, note that these tables include both sexes for the fecundity estimate and these values must be divided by 2 when discussing fecundities

of females only). The RAMAS simulation model we used (i.e., equation 1 along with the survival rates we used), predicts extinction if the mean seasonal fecundity is less than 1 female offspring per breeding female (or 2 offspring per female in Tables 1 and 2). Therefore, we ran values of seasonal fecundity ranging from 1 to 1.3 female offspring per female to determine the mean fecundity needed for a near zero probability of extinction in 100 years.

For the temporal variance of fecundity, we used a variance of 0.0432, which was obtained from the study on Wichita Mountains Wildlife Refuge (J. Grzybowski, pers. comm.).

Several technical assumptions relevant to vital rates, explained in detail in Akçakaya (1994), were used in our simulations. When fecundity and survival rates were assumed to vary over time, a log-normal (i.e., skewed) distribution was used to simulate this variability. Demographic stochasticity was used in all our simulations. Demographic stochasticity is random fluctuation in population variables, which can cause random fluctuation in population size and can result in the extinction of small populations (Schonewald-Cox et al. 1983). For simulations in which both fecundity and survival were assumed to vary over time, they were assumed to vary independently. Furthermore, Equation 5 of Goodman (1960) was used to estimate the variance of the product of fecundity and survival for HY and AHY females when both survival and fecundity were variable.

Carrying capacities

Because the carrying capacities for black-capped vireos are currently unknown, we ran a variety of carrying capacities (i.e., maximum population size) ranging from K = 200 to K = 10,000 breeding females to allow these results to be used for a broad range of populations. Because initial starting abundances are also not currently known, we started each of our simulations at a population size of ½K.

The workshop group decided that a probability of extinction of greater than 5% in 100 years was unacceptable.

Table 1. Expected changes in seasonal fecundity (F_{AHY})* with parasitism or predation when other variables held at constants indicated. Period for nest initiations 62 days, approximating that expected in Oklahoma populations (from Pease & Grzybowski 1995). Fecundities in bold indicate unacceptable extinction probabilities.

	fu=3.1, fp=0.2**					fu=2.7, fp=0.9				
% nests parasitized	Predation level held at					Predation level held at				
	0%	20%	50%	70%	90%	0%	20%	50%	70%	90%
0	6.20	5.35	3.98	2.86	**1.35**	5.40	4.66	3.46	2.49	**1.17**
10	5.85	5.02	3.71	2.66	**1.24**	5.18	4.44	3.28	2.36	**1.10**
20	5.47	4.67	3.43	**2.46**	**1.14**	4.93	4.21	3.10	2.21	**1.03**
30	5.05	4.30	3.15	**2.24**	**1.04**	4.65	3.96	2.90	2.07	**0.95**
40	4.59	3.90	2.85	**2.03**	**0.93**	4.34	3.69	2.69	**1.91**	**0.88**
50	4.11	3.49	2.54	**1.80**	**0.82**	4.00	3.40	**2.47**	**1.75**	**0.80**
60	3.58	3.05	**2.22**	**1.56**	**0.71**	3.62	3.08	**2.24**	**1.58**	**0.71**
70	3.02	2.57	**1.87**	**1.31**	**0.59**	3.21	2.73	**1.99**	**1.40**	**0.62**
80	**2.40**	**2.05**	**1.49**	**1.04**	**0.46**	2.74	**2.34**	**1.70**	**1.19**	**0.53**
90	**1.68**	**1.44**	**1.05**	**0.72**	**0.31**	**2.17**	**1.86**	**1.35**	**0.93**	**0.40**
% nests depredated	Parasitism level held at					Parasitism level held at				
	0%	20%	50%	70%	90%	0%	20%	50%	70%	90%
0	6.20	5.47	4.11	3.02	**1.68**	5.40	4.93	4.00	3.21	**2.17**
10	5.78	5.07	3.80	2.79	**1.56**	5.04	4.57	3.70	2.97	**2.02**
20	5.35	4.67	3.49	2.57	**1.44**	4.66	4.21	3.40	2.73	**1.86**
30	4.92	4.27	3.18	**2.35**	**1.32**	4.28	3.85	3.10	**2.50**	**1.70**
40	4.46	3.86	2.86	**2.11**	**1.19**	3.88	3.48	2.79	**2.25**	**1.53**
50	3.98	3.43	2.54	**1.87**	**1.05**	3.46	3.10	**2.47**	**1.99**	**1.35**
60	3.45	2.97	**2.19**	**1.61**	**0.89**	3.01	2.68	**2.13**	**1.71**	**1.15**
70	2.86	**2.46**	**1.80**	**1.31**	**0.72**	**2.49**	**2.21**	**1.75**	**1.40**	**0.93**
80	**2.19**	**1.87**	**1.36**	**0.98**	**0.53**	**1.90**	**1.68**	**1.32**	**1.05**	**0.69**
90	**1.35**	**1.14**	**0.82**	**0.59**	**0.31**	**1.17**	**1.03**	**0.80**	**0.62**	**0.40**

* Fecundities should be divided by two to give female fecundity.
** fu is the mean number of observed vireo young fledged per unparasitized nest and fp is the mean number of observed vireo young fledged per parasitized nest.

Table 2. Expected changes in seasonal fecundity (F_{AHY})* with parasitism or predation when other variables held at constants indicated. Period for nest initiations 68 days, approximating that observed on the Kerr WMA, central Texas (from Pease & Grzybowski 1995). Fecundities in bold indicate unacceptable extinction probabilities.

	fu=3.1, fp=0.2**					fu=2.7, fp=0.9				
% nests parasitized	Predation level held at					Predation level held at				
	0%	20%	50%	70%	90%	0%	20%	50%	70%	90%
0	6.20	5.54	4.23	3.08	**1.45**	5.40	4.82	3.69	2.68	**1.27**
10	5.86	5.20	3.95	2.86	**1.34**	5.19	4.60	3.50	2.53	**1.19**
20	5.51	4.86	3.66	2.64	**1.23**	4.97	4.38	3.30	**2.38**	**1.11**
30	5.13	4.49	3.36	**2.41**	**1.12**	4.73	4.13	3.10	**2.22**	**1.03**
40	4.72	4.10	3.05	**2.18**	**1.00**	4.46	3.88	2.88	**2.06**	**0.95**
50	4.27	3.69	2.73	**1.94**	**0.89**	4.16	3.60	2.66	**1.89**	**0.86**
60	3.78	3.25	**2.39**	**1.69**	**0.76**	3.83	3.29	**2.42**	**1.71**	**0.77**
70	3.23	2.77	**2.02**	**1.42**	**0.63**	3.44	2.94	**2.15**	**1.51**	**0.67**
80	2.60	**2.22**	**1.61**	**1.13**	**0.50**	2.97	2.54	**1.84**	**1.29**	**0.57**
90	**1.84**	**1.57**	**1.13**	**0.78**	**0.34**	**2.37**	**2.03**	**1.46**	**1.01**	**0.43**
% nests depredated	Parasitism level held at					Parasitism level held at				
	0%	20%	50%	70%	90%	0%	20%	50%	70%	90%
0	6.20	5.51	4.27	3.23	**1.84**	5.40	4.97	4.16	3.44	**2.37**
10	5.89	5.20	3.99	3.00	**1.71**	5.13	4.69	3.89	3.19	**2.20**
20	5.54	4.85	3.69	2.77	**1.57**	4.82	4.38	3.60	2.94	**2.03**
30	5.15	4.49	3.39	2.53	**1.43**	4.49	4.05	3.30	2.69	**1.85**
40	4.71	4.09	3.07	**2.28**	**1.29**	4.10	3.69	2.99	**2.42**	**1.66**
50	4.23	3.66	2.73	**2.02**	**1.13**	3.69	3.30	2.66	**2.15**	**1.46**
60	3.69	3.08	**2.36**	**1.73**	**0.97**	3.22	2.87	**2.30**	**1.85**	**1.24**
70	3.08	2.64	**1.94**	**1.42**	**0.78**	2.68	**2.38**	**1.89**	**1.51**	**1.01**
80	**2.35**	**2.01**	**1.47**	**1.06**	**0.58**	**2.05**	**1.81**	**1.43**	**1.13**	**0.74**
90	**1.45**	**1.23**	**0.89**	**0.63**	**0.34**	**1.27**	**1.11**	**0.86**	**0.67**	**0.43**

* Fecundities should be divided by two to give female fecundity.
** fu is the mean number of observed vireo young fledged per unparasitized nest and fp is the mean number of observed vireo young fledged per parasitized nest.

C. RESULTS AND DISCUSSION

The probability of extinction over 100 years for our simulations is shown in Table 3. Clearly, there is a low probability (< 5%) of extinction when the mean fecundity is ≥ 1.25 female offspring per female, which, assuming a 1:1 sex ratio, implies 2.5 offspring of either sex per female when comparing to Tables 1 and 2. (All values with an extinction probability of >0.05 are shown in bold, indicating an unacceptable extinction probability.) If the carrying capacity of a given population is K ≥ 1000 breeding females, however, then the mean fecundity can be somewhat lower than 1.25 and still yield a low probability of extinction in some cases (Table 3), although the mean seasonal fecundity must still be ≥ 1 to prevent extinction.

Calculations from the model by Pease and Grzybowski (1995) indicate that the highest levels of seasonal fecundity without predation or parasitism would be 2.7-3.1 female young per adult female. Actual fecundities of 1.2-1.25 female young per adult female needed to maintain long-term viability of vireo populations may occur in some populations, but in those studied across a broad portion of the vireo's range in Oklahoma and central Texas, these levels of fecundity have only been achieved when cowbird removal was implemented. In some situations, observed reproductive success of vireos has been as high as 1.9 female young per adult female, but most have fallen in the range of 1.0-1.4 (Grzybowski 1995). Thus, cowbird removal will likely be a requisite of management schemes at most sites in Oklahoma and Texas.

Table 3. Probability of extinction within 100 years (HY survival = 0.43, AHY survival = 0.57, mean fecundity = mean number of female offspring per female per season, K = carrying capacity of the number of females, and initial abundance = ½K). Note that the mean seasonal fecundities given here should be multiplied by 2 when comparing with Tables 1 and 2. Numbers in bold indicate unacceptable probabilities of extinction.

Mean		Carrying capacity (K)								
Fecundity		200	400	600	800	1000	2000	3000	5000	10000
1.00	A	**.237**	**.080**	.040	.022	.006	.001	.000	.000	.000
	B	**.577**	**.391**	**.311**	**.252**	**.226**	**.117**	**.071**	.036	.024
	C	**.657**	**.498**	**.431**	**.378**	**.325**	**.201**	**.155**	**.096**	**.051**
1.05	A	.032	.005	.003	.000	.000	.000	.000	.000	.000
	B	**.297**	**.146**	**.084**	**.074**	.048	.016	.009	.006	.001
	C	**.457**	**.272**	**.200**	**.149**	**.119**	**.055**	.036	.022	.010
1.10	A	.001	.000	.000	.000	.000	.000	.000	.000	.000
	B	**.095**	.036	.010	.012	.003	.001	.000	.000	.000
	C	**.235**	**.110**	**.077**	.044	.035	.008	.007	.002	.000
1.15	A	.001	.000	.000	.000	.000	.000	.000	.000	.000
	B	.029	.004	.004	.000	.000	.000	.000	.000	.000
	C	**.106**	.036	.014	.014	.007	.003	.001	.000	.000
1.20	A	.000	.000	.000	.000	.000	.000	.000	.000	.000
	B	.007	.001	.000	.000	.000	.000	.000	.000	.000
	C	.032	.007	.002	.004	.000	.000	.000	.000	.000
1.25	A	.000	.000	.000	.000	.000	.000	.000	.000	.000
	B	.001	.000	.000	.000	.000	.000	.000	.000	.000
	C	.016	.002	.000	.000	.000	.000	.000	.000	.000
1.30	A	.000	.000	.000	.000	.000	.000	.000	.000	.000
	B	.000	.000	.000	.000	.000	.000	.000	.000	.000
	C	.001	.001	.000	.000	.000	.000	.000	.000	.000

A = Constant survival, variable fecundity.
B = Variable survival (HY variance = AHY variance) and fecundity.
C = Variable survival (HY variance =2AHY variance) and fecundity.

D. INFORMATION NEEDS

PVAs are assessments of population viability and set quantitative goals to be achieved. RAMAS model simulations attempt to develop targets for recovery that allow populations to persist over time with a low (or no) probability of extinction. Model parameters are important to this determination, and thus central to all the actions and recommendations made in this document.

In establishing parameter estimates for the PVA, it became clear that the links between existing data and parameter estimates were still poorly developed. A substantial amount of data were underanalyzed such that values for a number of parameters were derived indirectly. Some formats of analysis and quantification of critical parameters (such as survivorship, fecundity, dispersal, and variance in these parameters) still needed to be developed. Estimates that were derived by different researchers were not always comparable, and raised issues of sampling. Thus, there is a general analysis procedure need that should be addressed.

In addition, data that had been collected addressed only certain dimensions of the RAMAS model most frequently involving local scale rather than broader scales encompassing metapopulation phenomena, or limited to demographic parameters rather than environmental or genetic parameters. Thus, there is still a broad data need.

Thirdly, to be successful in both analyses and data collection, sampling design should be derived from meaningful research questions. Development of research questions requires consideration of their use in process-oriented models rather than techniques-oriented procedures. The recommendations presented below attempt to develop these three basic research areas.

1. A consideration in developing design for preserve or habitat patch management is dispersal dynamics. Development of generalized dispersal models is needed that identify factors such as differential dispersal among age and sex classes.

2. Two of the three important parameters in the RAMAS model are female and juvenile survivorship. Analysis procedures for existing data, and designs for future empirically-based data collection should be developed to improve parameter estimates.

3. Fecundity is another of the three important parameters in the RAMAS model. A method of standardizing estimates of existing fecundity data and assessing annual variation for different subpopulations (i.e., in large patches of habitat; smaller and more isolated groups; different age classes of females) is needed.

4. Habitat distribution and dynamics are important to development of a functional metapopulation structure. Vireo habitat (including habitat patches of different sizes and their degree of isolation) and vireo numbers (and/or densities) associated with various types of habitat patches should be mapped. Methods for assessing vireo remote sensing are also important to this process.

5. Some data suggest that there may be differential survival between males and females. Because the number of breeding females is a critical component of population growth or decline, factors affecting variance in sex ratios should be investigated. An initial step in this process is rigorous analysis of existing data, and development of specific questions that can be used to design future work.

6. Some components of the vireo's life history strategy may play a critical role in dynamics of vireo populations. Identifying and investigating life history strategies such as mating strategies may be important to PVA results.

7. Because the RAMAS model is a generalized model, not all components of the model are consistent with vireo biology. Critical analysis of current model behavior and creation of a customized model may improve model predictions especially if vireo life history, spatial analyses, and patch dynamics are incorporated.

8. A workshop that addresses the standardization of data collection and sample design would prove useful. The recent Pease and Grzybowski (in press 1995) model for assessing seasonal fecundity, parasitism and predation rates may serve as a model for such discussion.

9. Investigating the problem of color instability of colored leg bands is needed to identify materials that will not, or colors that do not, fade with exposure to the sun.

E. SUMMARY AND RECOMMENDATIONS

Population Modelling Subgroup

The RAMAS model allowed us to examine population viability and probabilities of extinction when a number of population parameters are varied. RAMAS application here has extended our perceptions of target values for seasonal fecundity that would allow persistence of vireo populations under a series of base population sizes and a number of parameter estimates. These are the types of values that allow us to assess the potential future status of extant vireo populations, and the targets of seasonal fecundity for management schemes, such as those involving manipulation of cowbird numbers.

At present, the estimates generated depend heavily on a number of factors: (1) sampling design and accuracy of the data collected; (2) appropriateness and validity of analysis designs which use these data to generate estimates for basic parameters of the model; (3) intrinsic assumptions inherent in design of the RAMAS model and its relevance and concordance with life history parameters for black-capped vireos; and (4) limitations in the data collected (i.e., how well the existing data match the parameters of the model). The results of the model are only as good as the data used, the methods of developing parameter estimates, and the concordance of model assumptions with the life history strategies of the vireo.

From this standpoint, there is still an array of question development, model or hypothesis development, analysis development, and data collection design that need to be implemented. Some sampling designs have been more successful than others, and these need to be refined and more broadly applied to future research. Much of this involves standardizing procedures that can factor out variables (such as observer biases) that may influence results, but are not related to biological processes. Some designs involve developing schemes that appropriately analyze existing data. Analyses for estimating parasitism levels and seasonal fecundity, for example, have only recently been developed. An analysis procedure for using existing banding data needs to be developed that can accommodate the problems of separating mortality from emigration and immigration.

The RAMAS model, although versatile in the situations to which it can be applied, does not match all life history strategies of the vireo. One generalized component is the manner in which it addresses carrying capacity. While the model enforces mortality on vireo abundances over carrying capacity, in reality, these birds may simply become part of a non-breeding population, and serve as replacements for incidental mortality that occurs in the effective breeding population. Customization of a model specific to the black-capped vireo may allow refinements in predictions and management recommendations in the future.

Limitations of the current analysis may appear to outweigh benefits, but a customized PVA is only expected to refine estimates, not result in gross scale changes. The current PVA presents results of value in many of its management recommendations, and narrows the direction and focus of future research efforts.

V. HABITAT MANAGEMENT STRATEGIES

Bill Armstrong, Mary Capperino, John Cornelius, Jim Gallagher, Mike Krueger, Clifton Ladd, Nora Jones, Mike McMurry, Steve Nelle, Scott Rowin, Tim Schumann, Lee Stone, Noreen Walsh

A. INTRODUCTION

Nesting habitat of the black-capped vireo in Texas and Oklahoma was described in the recovery plan (U. S. Fish and Wildlife Service 1991). Since that time, further characterization of nesting habitat has been published by Grzybowski et al. (1994) Grzybowski (1995), and Greenman (1995). Information on migration routes and winter habitat is generally lacking (Grzybowski 1995).

Through most of the range, edaphic (soil) factors, fire history, and climate interact to produce the vegetation structure preferred by vireos. Fire suppression, natural succession, and grazing practices are hypothesized as reasons for changes in the structure and extent of vireo habitat throughout the nesting range (U. S. Fish and Wildlife Service 1991, Grzybowski 1995). Invasion of areas by Ashe and redberry juniper and Eastern redcedar has been a direct result of fire suppression in many areas and has significantly altered community structures.

The most stable vireo habitats are maintained primarily by edaphic characteristics (e.g., Devil's River, Texas). Dry areas in the western part of the nesting range, or areas on steep slopes with dry, rocky soils, tend to maintain vegetation in a configuration suitable for vireo nesting longer than other areas. Habitats primarily maintained by fire occurred in a shifting mosaic across the original landscape (e.g., crosstimbers). Fire plus soil conditions are important at sites such as Fort Hood, Texas and the Wichita Mountains, Oklahoma. Over the long-term, climate interacts with the other factors to determine the rate of change in suitable vegetation structure at these sites.

Vireo nesting habitat has always existed as a shifting mosaic at a landscape level, but blocks of suitable habitat were probably larger and closer together than at present. While currently occupied, suitable, habitat can be maintained for the short-term benefit of the vireo, long-term expansion of the population requires a landscape level plan for habitat restoration and management. Restoration of enough habitat is needed to support an expanding population and to allow for shifts in vireo populations over time.

Structural characteristics of vireo habitat have been described for the nesting range exclusive of West Texas and Mexico

(Grzybowski et al. 1994, Greenman 1995). Land managers can use such information to maintain and restore habitat through mechanical manipulation, fire management, and grazing practices. Successful examples of habitat management occur on public lands in the Wichita Mountains, Oklahoma, and at Ft. Hood and Kerr WMA, Texas. Outreach to private landowners about economically viable range management practices is vital to large-scale restoration of nesting habitat, because most potential habitat is privately owned. Outreach is especially important near areas with known vireo populations, to promote expansion of those populations.

Brown-headed cowbird population levels and vireo brood parasitism are also influenced by land use practices. A strategy for control of cowbird populations on private lands, throughout the range of the black-capped vireo, must also be developed. Use of existing resources (i.e., U. S. Department of Agriculture, Animal Damage Control) should also be investigated.

Strategies for accomplishing large-scale habitat restoration and management include:

1. Incentives for habitat restoration and black-capped vireo inventories on private lands (see "VI. Outreach and Partnerships" for some ideas).

2. Landscape level identification of current suitable habitat using GIS.

3. Landscape level planning for restoration projects using GIS.

4. Outreach on economically viable, land management options that benefit black-capped vireos, other neotropical migrant birds, and wildlife in general.

B. RANKED THREATS

Brood Parasitism - 1

Brood parasitism is considered the most immediate threat to the black-capped vireo. Brown-headed cowbirds (*Molothrus ater*) are the primary species parasitizing vireo nests. Cowbirds are often associated with livestock, farms, and grain fields where they feed on waste grain and insects. With increasing conversion of land for agricultural purposes over the last century, favorable conditions were created for cowbird population increase and range expansion (Snyder 1957, Friedmann 1929, Mayfield 1965, Hanka 1985). Cowbirds often move into areas looking for nests to parasitize in the morning, move off to feeding areas in the afternoon, and move to roosting areas in the evenings. Movements

between these areas may be several kilometers (Rothstein et al. 1984, Thompson *in press*, and Cook et al. 1996).

Because the severe problem of brood parasitism was recognized by many individuals and agencies, control efforts are underway in many areas. Extensive efforts in trapping cowbirds, or removing cowbird eggs or young from vireo nests, now exist for several black-capped vireo population units. Few samples of parasitism rates exist for areas not managed to reduce cowbirds (Grzybowski 1995, p.15). However, observations of the daily rate of parasitism on Kerr WMA in Texas without control was extrapolated to an estimate of 90% of nests actually being affected (Grzybowski 1995). Rates of parasitism apparently do not decline throughout the vireo breeding season (Graber 1961, Tazik 1991).

Data from Fort Hood, Texas, show that from 42-45% of nests parasitized by cowbirds were abandoned (Tazik 1991). When a vireo nest is not abandoned upon parasitism, the cowbird egg hatches several days prior to the vireo eggs. Cowbird nestlings are larger than vireo nestlings, and vireo nestlings usually die soon after hatching because they are unable to compete for food and space. Thus, few parasitized nests actually produce vireo fledglings. Estimates of vireo young fledged from parasitized nests ranged from 0-0.94 in areas without cowbird control (Fish and Wildlife Service 1991). In populations studied between 1985 and 1993, where influence of cowbirds was not manipulated, seasonal fecundity (calculated from all nests) ranged from 0-2.25 young/female (Grzybowski 1995). However, in areas where cowbird removal successfully reduced parasitism rate to levels less than 15%, 1.7-3.8 young per female were produced (Grzybowski 1995).

Modelling presented earlier in this document shows that at current estimates of adult and juvenile survival, fecundity estimates obtained under conditions of uncontrolled brood parasitism result in very high probabilities of extinction. If parasitism rates in a given area exceed approximately 20% (see Tables 1 and 2), cowbird control should be initiated as a necessary first step to prevent extinction and recover the vireo. Restoration of vireo habitat will be a futile exercise if brood parasitism is not controlled.

Loss and Fragmentation of Nesting Habitat - 2

Range Management Practices Overbrowsing by sheep, goats, and native and exotic (e.g., axis deer and sika deer) wildlife can result in direct loss of vireo habitat. Specifically, the proliferation of goats on the Edwards Plateau has resulted in the loss of large areas of vireo habitat. The use of goats as recommended biological control agents for juniper invasion is detrimental to vireos because goats will consume other preferred

browse before consuming juniper. In this way, goats remove much low-growing vegetation suitable for vireo nests. Overgrazing by livestock can also reduce grass cover to the point that prescribed burning is not possible. The use of the herbicide tebuthiuron for control of oaks, as well as excessive and improper mechanical brush control, may also be a threat to vireo habitat.

In general, heavy stocking of cattle, sheep, goats, or exotic wildlife, and conversion of shrubland to grassland are detrimental to the black-capped vireo. Excessive populations of deer and free ranging exotic wildlife species will also degrade vireo habitat. The proliferation of exotic game animals that has occurred throughout the vireos' range in Texas has not occurred to the same extent in Oklahoma.

In Oklahoma, the largest remaining population of black-capped vireos occurs on the Wichita Mountains Wildlife Refuge where grazing by bison and longhorn cattle is closely managed. The black-capped vireo population in Blaine County, Oklahoma, exists among cattle grazing areas, but known vireo nesting is currently restricted to steep slopes of gypsum canyons. Cattle are less likely to graze on the steep slopes that have maintained low-growing deciduous cover suitable for vireo nesting. However, these same slopes are becoming dominated by Eastern red cedar. In Oklahoma and Texas, management practices that do not control excessive invasion by cedar or juniper, and maturation of habitat remain a serious threat to long-term availability of vireo habitat.

Fire Suppression Loss of black-capped vireo nesting habitat across the vireos' range has occurred through control of natural fires. Black-capped vireos often occupy nesting habitat that is in a particular successional stage, and lack of disturbance such as fire has resulted in growth of vegetation beyond the suitable successional stage. Although some fires still occur, the probability of a given area being returned to the stage necessary for vireo nesting is lower now than in the past. A lack of adequate grass for fuel is the primary reason why fire is limited in Texas. Excessive grazing is the major factor causing this lack of fuel. Fire suppression resulted in significant areas being invaded by Eastern redcedar (*Juniperus virginianus*) in Oklahoma, while Ashe juniper (*Juniperus asheii*) and redberry juniper (*J. pinchotii*) have increased in Texas.

Fragmentation All of the above habitat loss factors have combined to result in increasingly fragmented areas of vireo habitat, and in small, isolated vireo populations. Fragmented habitat patches and isolated populations can have severe negative consequences for the future of this species.

Small, isolated populations in patchy habitat are more vulnerable to the effects of demographic stochasticity. Very low survival or fecundity rates in any given year could result in extirpation of that local population unit, whereas larger populations could better withstand an occasional year of low survival or reproduction. Once such population units are extirpated, short dispersal distances suggest that the rate of recolonization of these isolated patches may be reduced even if suitable habitat remains.

Although some juveniles have been detected dispersing up to 21 km from their natal site, 96% of adult male vireos return to nest in the same territory as the previous year (Grzybowski 1995). Thus, first-year and second-year birds are the most likely to disperse to other existing populations or to colonize new areas. However, the maximum dispersal distance recorded for a juvenile (21 km) is less than the distance between many remaining population units. Genetic issues may become a concern when populations experience little interchange (Fazio 1994).

Urbanization In central Texas, conversion of grassland/shrubland areas to suburban or urban developments has also resulted in loss of vireo nesting habitat. Specifically in the area of the Balcones Escarpment, road construction and housing developments have impacted nesting areas through direct destruction of habitat (Espey, Huston and Associates 1988, DLS Associates 1989). Urban development in Oklahoma has been less threat to vireo habitat than in Texas. However, plans were recently unveiled to create an extensive parkland around Lake Stanley Draper, near Oklahoma City. This area was home to nine black-capped vireos in 1995. The Service in Oklahoma hopes to work with Oklahoma City in planning for vireo habitat within and around the proposed park.

Landowner perception Some landowners fear a potential loss of control of land use if vireos or their habitat are found on their property. This perception increases the probability of destruction of habitat and misidentification of habitat, and hinders the assessment of populations and their status.

Loss and Fragmentation of Wintering Habitat - 3

The black-capped vireo winters on the Pacific slope of Mexico (Graber 1957, Marshall et al. 1985). However, few details about wintering distribution and habitat are known. Grzybowski (1995) hypothesized that substantial returns of adult birds from wintering grounds to breeding areas would suggest that overwinter survival is not a severe problem. The status of habitat on the winter range needs to be studied. Observations of the wide range of habitats used in western Mexico tend to suggest that winter

habitat loss is an unlikely limiting factor (C. Beardmore, U.S. Fish and Wildlife Service, pers. comm.).

Predation - 4

Common nest predators include snakes, raccoons, other birds, and fire ants. In black-capped vireo habitat on Fort Hood, Texas, coachwhips, Texas rat snakes, and copperheads are commonly observed. As brood parasitism by cowbirds is decreased through cowbird trapping, predation on nests may become the next management concern to pursue to increase fecundity of vireos. However, J. Grzybowski commented that natural levels of predation on the Kerr WMA were 0.35 nests/day (Pease and Grzybowski in press 1995), and appear to be lower than that observed for many other passerine species. He concluded that predation on nests would be of concern only for a few local populations, particularly those in suburban settings.

C. HABITAT MANAGEMENT GUIDELINES

The basis for managing habitat for the black-capped vireo is sound ecosystem management. Ecosystem management that provides habitat for black-capped vireos and other neotropical migrants can be compatible with land-uses that have traditionally occurred within the black-capped vireo's range. Because the majority of land within the range of the black-capped vireo is privately owned, the recovery of the species will be largely dependent upon the land management practices of private landowners. Landowners should discuss with the U. S. Fish and Wildlife Service or the appropriate state wildlife agency to coordinate management of occupied vireo habitat.

Habitat Maintenance and Enhancement

On lands where existing plant communities have suitable structure and plant species diversity, management should emphasize maintaining and enhancing habitat suitability. Fire and/or mechanical treatments can be used periodically to maintain the desired structure of the vegetation. Fire is a natural component of rangelands, and prescribed burning has many range and wildlife management benefits in addition to maintaining and enhancing black-capped vireo habitat. These benefits include improved forage quality and availability for livestock and deer, and maintenance of desirable plant composition and structure. Control of domestic and wild browsing animals must be used in

combination with fire and mechanical treatments to prevent excessive use of low-growing browse.

Prescribed Burning Prescribed burning is an economical habitat management tool that can be used to:

1. Maintain desired vegetation structure for black-capped vireo nesting (i.e., a mosaic of shrubs and open grassland with abundant woody foliage below 6 feet).

2. Control the invasion of small (generally less than 3 feet tall) juniper to maintain the relatively open shrubland preferred by black-capped vireo.

The type of burn (i.e., "hot" versus "cool") and the frequency of burns will depend on the management objective. Cool season burns, conducted prior to March 15, are recommended to control junipers and reduce the size and density of small woody plants and motts of shrubs. Prescribed burns conducted under hotter conditions during the growing season can be used to set back plant succession and reduce the size and density of larger, older motts of shrubs. However, warm season burns, because they occur during the black-capped vireo breeding season, should be done only in areas that are not currently occupied by black-capped vireos. In currently occupied habitat, burns should only be conducted during the non-nesting season (i.e., burns should not be conducted March - September), when the vireo is not present in the area.

On grazed rangeland, prescribed burns should be coordinated with livestock rotation to allow needed deferments prior to and after the burn. It is best to avoid burning relatively small areas within large pastures. This will prevent heavy grazing and browsing pressure on relatively small areas by livestock or deer attracted to the new growth.

Desirable intervals for cool season burns vary throughout the black-capped vireos' range, depending on rainfall and vegetation type. A burning interval of 4 to 10 years is generally considered desirable to limit juniper invasion and allow regrowth of broad-leaved shrubs. Burns should be monitored to identify the appropriate frequency in various locations across vireo summer range.

Assistance from people experienced with the use of prescribed burning is highly recommended. Landowners are encouraged to have a complete, written, prescribed burn plan addressing the

objectives of the burn, required weather conditions, grazing deferments, fireguard preparations, personnel and equipment needed, a detailed map showing how the burn will be conducted, and notification and safety procedures. Landowners may contact the Natural Resource Conservation Service, or the local Agriculture Extension Service to obtain assistance in designing a prescribed burn.

Selective Brush Management Extensive increases in juniper and other woody species can easily cause areas to grow in succession beyond the patchy, low shrub cover that provides suitable vireo habitat. In the eastern portion of the black-capped vireos range in Texas, good nesting habitat generally has between 30-60% shrub canopy (juniper should be kept below 10%). However, in areas were amounts of deciduous vegetation are marginal (e.g., western Edwards Plateau region and to the southwest in Texas), junipers may contribute important cover for nesting vireos (Grzybowski 1995). In these areas, control of juniper should be carefully evaluated.

Selective brush removal with herbicides or mechanical means can be used to keep habitat favorable for vireo nesting. For example, selective removal of juniper, mesquite, or pricklypear serves to maintain a relatively open shrub canopy and encourages growth of associated broad-leaved shrubs. Selective brush removal should strive to maintain the low shrubby structure. Radical changes in shrub canopy over relatively large areas should normally be avoided to ensure adequate nesting habitat. Rangelands comprised primarily of mesquite, often referred to as mesquite flats, are not considered black-capped vireo habitat. Therefore, mesquite control in these areas will likely not affect vireos.

When using herbicides, careful attention to the type, amount, timing, and application technique will achieve the best control of target species at minimum cost. Precise application also reduces the risk of environmental contamination and off-site effects. It is best to choose highly selective individual plant treatment methods, whenever practical, to avoid damage to desirable shrubs such as live oak, shin oak, Texas oak, hackberry, Texas persimmon, sumac, redbud, elm, and blackjack oak. Herbicides should always be used in strict accordance with label directions, including those for proper storage and disposal of containers and rinse water. Herbicide applications should only occur during the non-nesting season (October-February), except for basal applications or individual plant treatment of prickly pear pads.

Handcutting or carefully planned mechanical methods of brush management such as chaining, roller chopping, or shredding can be used to stimulate basal sprouting of key woody species in order

to maintain, enhance, or create black-capped vireo habitat. Mechanical methods should only be used during the non-nesting season (October-February). Good grazing management and moderate stocking rates can reduce woody plant invasion and therefore reduce the need for expensive brush control practices.

Landowners should seek technical assistance when planning brush management practices in habitat that is known or could be reasonably thought to be occupied by black-capped vireos. Because brush management activities can affect habitat for golden-cheeked warblers and Tobusch fishhook cactus, land managers are encouraged to learn about the habitat requirements of other endangered species.

Grazing and Browsing Management Excessive browsing by goats, exotic animals, and white-tailed deer destroys the thick woody growth needed for nest concealment. Livestock and deer management is needed, which allows woody plants such as live oak, shin oak, sumac, Texas persimmon, elbowbush, redbud, and hackberry to make dense growth from 0 to 6 feet. Moderate stocking rates, rotation of livestock, controlling deer and exotic wildlife numbers, and proper use of desirable browse plants will benefit deer and livestock as well as black-capped vireos. **As stated earlier, the benefits of fire and mechanical habitat treatments will be negated if excessive utilization by browsing animals is not controlled.**

To provide adequate nesting cover for black-capped vireos, woody plants should receive only limited browsing during the spring and summer. If animal numbers (livestock, deer, and exotics) are well-managed and kept within recommended stocking rates, this can be achieved. Ranges stocked with cattle and deer tend to maintain better vireo nesting cover than ranges stocked with goats and exotic animals. Browsing surveys should observe stem growth rather than leaf growth, since leaf production in many shrubs varies widely, depending on season and weather conditions. Also, the amount of leaf production depends in part on the amount of stem and bud growth available on the plant. Research is lacking concerning how various levels of browsing pressure affect habitat structure and nesting use. However, a conservative approach would be to limit browsing pressure, especially during the growing season, to no more than 50% of the total annual growth (young, tender twigs) within reach of animals on any given plant. This will maintain plants that are already vigorous and allow improvement of those with less than ideal structure. As a rule of thumb, if you can "see through" a browse plant, then too much stem and leaf growth have been removed.

Careful management of woody plants will not only provide for the habitat needs of black-capped vireos, but will also create high

quality habitat for deer and other wildlife as well as livestock.

Habitat Restoration and Creation

Habitat can be restored or created on lands that have potential habitat, but currently do not support black-capped vireos. The following suggestions are offered for landowners wishing to restore or create habitat for black-capped vireos in areas that are currently unsuitable. The reasons why the current habitat is not suitable must first be identified before any restoration can be addressed.

One type of restorable habitat is an open shrubland capable of growing a diversity of woody plants, but where much of the low growing cover has been removed through overbrowsing by livestock or deer. Controlling browsing pressure by reducing animal numbers and providing pasture rest will allow the natural reestablishment of low-growing shrub cover needed by black-capped vireos.

Habitat restoration may also be possible in areas where the shrub layer has become too tall or dense. In these areas, well-planned use of controlled fire can reduce overall shrub height, stimulate basal sprouting of shrubs, and reduce shrub density to produce more favorable habitat for vireos. In these types of tall, dense, habitats, some form of mechanical treatment may be needed before fire can be effective. Selective thinning could be done to remove individual stems of large juniper and other plants deemed undesirable. Carefully planned mechanical brush management by chaining, roller chopping, and hydro-axing could be used to remove and/or lower the height of woody vegetation. Top removal/reduction encourages regeneration and lateral branching of desirable shrubs by allowing sunlight to reach the ground. In each of these examples, the idea is to restore areas that may once have provided habitat to the relatively open, low growing shrub/grassland vegetation preferred by vireos. Because mature vireo habitat may succeed into golden-cheeked warbler habitat, it is recommended that landowners be familiar with warbler habitat requirements also.

Technical Assistance

U. S. Fish and Wildlife Service - In Oklahoma and Texas, landowners wishing to restore habitat for black-capped vireos and other migratory birds can participate in the Service's Partners for Wildlife program. This program is designed to provide technical and financial assistance to landowners wishing to restore habitats for threatened and endangered species, migratory

birds, and wetlands. Interested landowners can phone the Tulsa Field Office at (918) 581-7458 or the Austin Field Office at (512) 490-0057 to ask about the program. A Service representative will discuss the project idea with the landowner and meet with him/her at the site to determine if potential for restoration exists. If the project is suitable, the landowner signs a cooperative agreement with the Service to restore the area and manage it for wildlife; agreements are for a minimum of 12 years. Cost of restoration activities are shared between the Service and the landowner.

Other sources of technical assistance are available from:

Natural Resource Conservation Service - in Texas and Oklahoma

Texas Parks and Wildlife Department

Oklahoma Department of Wildlife Conservation

Agricultural Extension Service - in Texas and Oklahoma

D. COWBIRD MANAGEMENT STRATEGY

Brood parasitism by brown-headed cowbirds has been identified elsewhere in this document as the primary threat to black-capped vireo populations. Although comparatively low populations of brown-headed cowbirds in the western part of the vireo's range may reduce impacts of parasitism at some sites, in most of the breeding range, assessing and likely reducing brown-headed cowbird parasitism levels should be the first consideration of the land manager.

Knowledge of several aspects of brown-headed cowbird ecology and breeding biology are important in developing a strategy for managing cowbirds. Telemetry studies (Rothstein et al. 1984, Thompson *in press*, Cook et al. 1996) have shown that cowbirds separate their feeding, breeding, and roosting activities into discreet areas. Cowbirds exhibit strong social behavior, congregating in large flocks in feeding and roosting areas. Female brown-headed cowbirds have been shown to defend territories in breeding areas to assure adequate supplies of host nests for parasitism. Cowbirds are largely migratory, wintering in tremendous concentrations in South Texas and the Coastal Plains before dispersing through Central Texas to other parts of the continent during their breeding season. However, in some parts of the range of the black-capped vireo, brown-headed cowbirds may be partially resident. Both farming and ranching

practices have dramatically increased populations of cowbirds since the late 1800's. These increases have had a major negative impact on fecundity of numerous songbird species, possibly contributing significantly to observed declines in neotropical migrant songbirds over the last half-century.

Management Options Available for Brown-headed Cowbird Control

The are several management options available to control cowbird impacts. These are:

1. Land Use Modification

a. Removal of livestock - Recent radio telemetry data (Fort Hood, ongoing; Thompson *in press*) indicate that most movements between breeding and feeding areas are less than 2 km but in extreme cases may exceed 15 km. Impacts from brown-headed cowbirds may be reduced by removing livestock in a 2 km radius from vireo habitat.

b. Modification of grazing impacts - Brown-headed cowbirds generally feed in shortgrass areas. The effects of livestock that attract cowbirds, such as livestock concentration, spilled grain, or overgrazing, may be lessened through management. Allowing areas within the 2 km buffer zone to revegetate to mid or tall grasses also will reduce desirability to cowbirds.

c. Grazing Systems - Grazing systems have been shown to be useful in managing concentrations of brown-headed cowbirds. Several options are available to land managers. These include:

- Off-season grazing - because brown-headed cowbirds are migratory and are attracted to grazed areas, absence of livestock during the nesting season (March-September) may reduce incidence of parasitism and overall brown-headed cowbird numbers. As mentioned above, extensive areas (>2km radius) must be managed for grazing in order to effectively reduce cowbird density.

- High-intensity grazing systems - Continuous grazing is not recommended. We recommend the use of multiple pastures where cattle are grazed in a given pasture for a short period of time followed by a long period of rest. Such systems allow for better control of range conditions, cattle concentrations, herd location, and improved cowbird trapping success.

2. Physical Removal of Brown-headed Cowbirds

At least two methods have been successful in reducing brown-headed cowbird numbers and parasitism levels:

a. Trapping - Large cage-type traps are placed in strategic locations where brown-headed cowbirds concentrate. Traps are stocked with live decoy birds, food, and water to attract other brown-headed cowbirds. Several trap designs are available depending on management objectives and scale of effort. These may be portable or semi-permanent. Portable traps may be designed to be easily loaded onto trailers or may be permanently trailer mounted. For information on trap design, contact Lisa O'Donnell, Austin Field Office at (512) 490-0057, or John Cornelius, Fort Hood, at (817) 287-3114.

Trapping strategies may be localized or regional. Localized trapping may be used to protect a specific black-capped vireo site. Portable traps are most commonly used for this purpose. Larger more permanent traps are effective when trying to protect large areas and are placed where brown-headed cowbirds traditionally congregate, such as feed lots, stables, livestock pens, watering areas, and golf courses.

An initial strategy for protecting a county-sized area should be to use a trap-line of portable traps for the first season to evaluate effectiveness of site placement. As "hot spots" are identified, small traps should be replaced with large traps to improve effectiveness. An optimal design, based on current knowledge, is a trap line of large traps at proven locations, with a smaller group of portable traps used to test potential new sites and to provide the flexibility to react to variations in brown-headed cowbird distributions.

Proper site placement of traps is important. The site should be open with short grass. A nearby perch such as a snag,

power pole, etc. will improve capture rates. Sites should be easily accessible for service during all weather conditions.

If livestock are being grazed, traps should be placed close to livestock concentrations such as watering sites or loafing areas. Grazing systems are particularly effective at concentrating livestock and improving trapping efficiency. Higher livestock concentrations produce greater trapping success, thus reducing overall costs. Trailer-mounted traps are very compatible with grazing systems that require frequent cattle relocation.

Trapping may be conducted on a seasonal or year-round basis. Due to relatively large capital outlays, personnel, administrative, and logistical considerations, large regional efforts may be more effective if continued year round. Some current data indicate that at least in the eastern Edwards Plateau, there are some resident brown-headed cowbirds that overwinter in adjacent farm lands. Small localized site protection may be more cost effective during the active nesting season (March-July).

Traps must be serviced to ensure adequate food and water, and to remove excess and non-target birds. Non-target captures (e.g., cardinals, mockingbirds, loggerhead shrike) are potentially a serious issue, but can be minimized with proper trap design, placement, and frequent servicing. Non-target captures usually occur during excessive hot or cold weather, and during the late summer period when young fledglings are dispersing. During these times, daily servicing of traps is essential. Servicing of traps every 48 hours is adequate during milder weather, but traps should be monitored daily during the first two weeks of their operation, when most cowbirds are captured.

Because cowbirds and non-target birds are protected by the Migratory Bird Treaty Act (MBTA), a permit is needed to authorize trapping and to cover the possibility that nontarget birds may die in traps (see ideas to minimize such occurrences above). If individuals are interested in trapping cowbirds, the Service and TPWD or another agency may be able to work out an arrangement where an agency could hold an umbrella permit to cover these individuals. This idea will have to be pursued to ensure legal issues are satisfied.

Costs to successfully reduce brown-headed cowbird numbers by trapping are extremely variable. Factors influencing costs include:

- Scale of project
- Road accessibility
- Types of traps used
    - Spatial configuration of suitable trap sites

Specific Costs - the following cost figures are based on mid-1995 material costs.

Large traps (16x16 ft panel design) - $800 (materials). With proper equipment (Pneumatic nailer and stapler, nibbler) and experience, a trap can be assembled and installed by 3 workers in 8 hours.

Small traps (6x8 ft portable) cost about $275 for materials. A 2-worker crew can assemble and set up 2 traps in 8 hours. Additional costs will be incurred if the trap is to be trailer mounted. Trailer cost is likely to be $400-$1000 depending on size and construction.

Operational costs are highly variable. However, for general planning purposes, the following case study is reported:

For a roughly circular block of land encompassing about 150,000 acres, with a good network of hard surface roads, a single trapper (full-time, year-round position) driving about 100 miles for each trap line round, services about 40 traps (25 large, 15 small). This level of effort is reducing parasitism to below 20% on approximately 9,000 acres of black-capped vireo habitat from a previously documented level above 90%.

b. Shooting - Shooting territorial female brown-headed cowbirds in black-capped vireo habitat can effectively complement a trapping effort, particularly in protecting small, localized sites. Shooting is most effective during the first 2 hours after daylight and is conducted by driving or walking through habitat areas, periodically stopping to play a taped recording of a female brown-headed cowbird's rattle call.

3.Chemical

a. Sterilization - this method of cowbird control is currently being researched.

b. Avicides - this method of control is not species-specific and is not recommended by most workshop participants. However, one participant believes that avicides could be effective at large winter roosts, but should only be used by individuals experienced in the application of avicides (such as Animal Damage Control) and at roosts that can specifically target cowbirds.

Monitoring to Evaluate Management Actions

To determine if cowbird control is effective in reducing parasitism rates, a black-capped vireo monitoring system should be implemented. This system, at the minimum, should determine if the black-capped vireo population is increasing on a yearly basis, although there will be a response time-lag in this approach of one to several years. Singing male counts could be used. If manpower and time are available the number of fledglings produced per female (fecundity) should also be determined because this parameter is an important indicator of cowbird trapping success (see the Discussion and Results section of the Population Biology and Modelling chapter). If trapping success is not sufficient to achieve a sustainable population, other forms of management such as improving habitat quality or control of predation (in rare cases where predation is a serious threat) may be needed.

E. HUMAN IMPACTS

Human recreational activities may have a detrimental effect on black-capped vireos in habitat with public access. These activities may include, but are not limited to, mountain biking, hiking, jogging, walking, camping, driving off-road vehicles, horseback riding, bird watching, and picnicking. The impact of these activities is a function of their timing, duration, and disturbance level. In public access areas, use of trails and roads should be controlled and minimized during the nesting season. Human use should be monitored for negative impacts on vireo behavior and habitat components. Hunting is believed to be a compatible activity, since it controls browsers and is conducted during the non-nesting season.

F. LANDSCAPE SCALE PLANNING

Planning on a regional scale is essential. Multiple levels of government cooperation and participation by private landowners are critical. Regional recovery goals should guide habitat recovery actions within a landscape context. An assessment of vireo habitat distribution is needed. Habitat incentive mechanisms across the different levels of government should be further developed and pooled.

Regional planning efforts should consider spatial and temporal scales. For example, relationships among existing populations, regional populations, and potential habitat should be considered to meet total population and regional habitat targets. Planning must consider vegetation within the context of past and future land uses. Land in private and public ownership should be considered as part of a total recovery plan.

Monitoring implementation and assessment are important components to regional planning. A regional GIS approach should be used to integrate baseline monitoring of vegetation configuration and black-capped vireo population status. A regional landuse analysis is recommended. Such planning should include issues of current land use by region and future land use planned in the region.

G. SUMMARY

There are two major habitat issues associated with black-capped vireos: cowbird parasitism and loss of nesting habitat. Brood parasitism by cowbirds increased as a result of changing land use practices that favored cowbirds and resulted in increased densities. Rates of parasitism by cowbirds can be locally controlled through trapping and modifications in agricultural or land use practices.

Periodic prescribed burning, selective brush management, control of deer and exotic wildlife numbers, and good grazing management practices, including proper stocking and rotational grazing, are management options that can be used to create and maintain black-capped vireo habitat. These same management tools will also maintain diverse and productive rangelands. Well-managed rangelands provide habitat for a wide variety of wildlife and benefits such as clean water and sustainable agriculture.

VI. OUTREACH AND PARTNERSHIPS

John Kelly, Linda Campbell Kissock, Chuck Sexton, Alisa Shull, Raymond Skiles, Rex Wahl

A. INTRODUCTION

Recovery of the black-capped vireo will be accomplished when there is at least one viable population within each of six recovery zones (as outlined in the recovery plan). A recovered population will have the following characteristics: (1) a viable population size, (2) reproductive success at a sufficient level to sustain a viable population, and (3) treatment of the major threats (management).

Government agencies, private groups, landowners, and academic institutions all have a role or interest in recovery of the black-capped vireo. Recovery will result in freedom from regulatory restraints, thus stakeholders with a primarily economic interest will also benefit from recovery. Table 4 includes a list of stakeholders and their potential contribution to recovery efforts.

Recovery strategies must attempt to address the requirements and needs of these groups. The following identifies major groups and their needs as perceived by this subgroup, which does not mean that we presume to speak for these groups.

B. NEEDS OF STAKEHOLDERS

Agency Needs

Under the Endangered Species Act, federal and state agencies with the responsibility to support recovery have the need to: (1) recover the species, (2) monitor species status, and (3) be assured that threats to species are addressed and continue to be addressed.

Landowners Needs

Preservation of vireos on private land is essential to recovery because the area of public land is inadequate to provide for black-capped vireo recovery. Many landowners fear having an endangered species on their property, believing their uses of the land will be constrained. To alleviate such fears, the following is needed: (1) freedom from economic loss, (2) a minimum of regulation, (3) certainty that the "rules" will not change, if

they participate in recovery, (4) local control, and (5) flexibility of management options. Many land-use practices are

Table 4. Stakeholders and their potential contributions to recovery of black-capped vireos.

Stakeholder	Resources that they may be able to contribute to						
	Hab-	Regul-itat	Funds ations	Tech.	Out-Guid.	reach	Re-search
Priv. lndwnr*	x						
USFWS		x	x	x x	x	x	
NPS	x		x	x			
DOD	x	x	x		x		
TPWD		x	x	x x	x	x	
LCRA		x	x	x x	x		
TXDOT		x		x			
GLO	x						
UT lands	x						
TAMU lands		x					
Local gov.'t	x	x	x				
TX RR Comm.			x				
TDA		x					
Water Districts	x						
Att. General	x						
Elected officials		x	x				
ASCS					x		
NRCS					x	x	x
USDOT				x			
Governor's off.				x			
TX Ag. Ext. Serv.				x x			
General Public					x		
Media						x	
Interest Groups			x	x			
NBS				x		x	
Universities	x					x	

* May include, for example, ranchers, developers, recreational homeowners, hunting reserves, non-governmental organizations' land, small landowners (<15 acres), non-agricultural/industrial.

Fish and Wildlife Service-USFWS
Department of Transportation-USDOT
National Park Service-NPS
Texas Agriculture Extension Service-TX Ag. Ext. Serv.
Department of Defense-DOD
National Biological Service-NBS
Texas Parks and Wildlife Department-TPWD

Lower Colorado River Authority-LCRA
Texas Department of Transportation-TXDOT
General Land Office-GLO
University of Texas-UT
Texas A&M University-TAMU
Texas Railroad Commission-TX RR Comm.
Texas Department of Agriculture-TDA
Agriculture Stabilization and Conservation Service-ASCS
Natural Resources Conservation Service-NRCS

compatible with vireo management, while benefiting other wildlife species (such as deer) as well.

Conservation Group Needs

Conservation groups seek to ensure agencies meet their mandates for accomplishing species recovery. These organizations need: (1) species recovery, (2) demonstrated, verifiable results, and (3) the ability to participate in the recovery planning process.

Some of the consequences of recovery for all stakeholders include:

1. Species conservation,
2. Freedom from regulation,
3. Quality range/habitat conditions, and
4. Reduction of economic concerns.

There was a strong sense at the PHVA workshop that local control and a system of incentives are essential to furthering recovery. Incentives may include regulatory relief through certain actions (for example, Safe Harbor or other Habitat Conservation Plans described later), tax incentives for conservation, technical assistance, and cash incentives. Key to success in planning is a clear understanding of all parties' information and process needs. Below some preliminary recommendations are made for approaches to the issue. These are recommendations and can be combined or modified upon the advice of a larger stakeholder committee seeking a local solution.

There are a range of approaches possible, from a system based largely on large government-owned reserves to a completely private, incentive-based solution. We discuss several approaches for black-capped vireo recovery that seem to satisfy or address stakeholder needs.

C. APPROACHES

Safe Harbor Habitat Conservation Plan (HCP)

A new, creative approach has recently been developed for the red-cockaded woodpecker in the Sandhills region of North Carolina. The primary objective of this approach is to encourage voluntary habitat restoration or enhancement activities by relieving a landowner who enters into a cooperative agreement with the Service from any additional liability under the Endangered Species Act beyond that which exists at the time the agreement is signed (these existing responsibilities, if any, are referred to as "baseline" responsibilities). The objective is to protect landowners (safe harbor) from added liability. The purpose of the "Safe Harbor" program is to reach those landowners whose land management practices could benefit the red-cockaded woodpecker, but who are unwilling or hesitant to carry out such practices because of concerns about the legal consequences. To persuade such landowners to carry out these practices, a financial or regulatory incentive is needed. An alternative to the "safe harbor" approach is paying landowners for desired management practices, and this could be accomplished without allowing any incidental taking. The cost of such a program is likely to be commensurate with the cost of a program to acquire conservation easements. The Service is in no position to fund such a program. Instead, the "safe harbor" approach was developed to provide incentive for management by allowing for "incidental take" of this endangered species by private landowners under section 10 of the Act (permitting). Although incidental taking (refers to a listed species being killed, injured, or harassed unintentionally as part of some legal activity) is authorized under this approach, it is still expected to attract sufficient interest among landowners to generate real benefits for the red-cockaded woodpecker.

More detailed information on the Safe Harbor HCP is provided in the Appendix. Similar provisions may be applicable to the black-capped vireo's situation in rural counties within the vireo's range. If a Safe Harbor approach is used, details for the vireo's situation will need to be worked out at that time.

Modified Safe Harbor - Rural, Incentive-based HCP

(Note: The following idea is based on Wahl (1994).) Development of recovery zones (RZ), based on the regional habitat conservation plan model, may furnish significant economic incentives to conserve, enhance, and even create vireo habitat. The desired outcome would be the creation of groupings of private reserves, with each grouping centered around large government- or privately-owned vireo refuges.

(1)Each refuge-plus-grouping would constitute a RZ (note that RZs are not necessarily synonymous with the recovery units

listed in the Black-capped Vireo Recovery Plan). A manager (the permit holder under Section l0a of the Endangered Species Act; for example, TPWD, private consortiums, county or multi-county authority, local conservation district, conservation groups, etc.) would be designated for each RZ and would be responsible for maintaining a viable vireo population within the RZ (the minimum viable population to be determined by the Service). The core of the RZ would be a refuge managed for the vireo's benefit and also dedicated in perpetuity for preservation of the vireo (examples would be the Devils River SNA and The Nature Conservancy's Dolan Falls). The manager would then build on the vireo population safeguarded in the RZ's core area by recruiting private landowners for participation in the RZ effort. These landowners would provide the additional habitat necessary to meet the minimum population goals established by the Service. An example of how this might be set up follows:

(a)Each participant in the RZ effort would be contractually guaranteed an incentive payment. There are a number of possible bases on which payment could be made (such as number of vireo territories or the acreage of occupied vireo habitat). Regardless of the basis eventually selected, to receive an incentive payment the landowner would agree to allow representatives of the RZ manager access to vireo habitat on his property. Access would include permission to census the vireo population and to determine vireo breeding success. The landowner would also agree to forego making any significant modifications to vireo habitat, but could agree to implement a grazing management plan. The landowner would also agree to consider implementing a management plan individually tailored for the habitat, a plan that would be designed to fit within the ranch's overall goals while at the same time improving habitat for the vireo. To encourage active consideration of these plans, the landowner would be guaranteed bonuses for an increase in vireo reproduction rates.

(b)Each contract would run for five years. At the end of this period, landowners would have the option of either renewing the contract or opting out. Should the landowner elect to opt out, there would be no penalty--even if he decided to convert his vireo habitat to other uses.

(c)The reason for this no-penalty provision is that the RZ manager would have previously secured new participants for the program, in anticipation of the departure of other participants. At all times, the manager would be responsible for maintaining the RZ's vireo population

at a specified minimum level in order to retain the Section l0a permit. Specific areas dedicated to vireo conservation might change over time, with the overall goal of ensuring that the total number of protected vireo territories always meets Service criteria. To retain the permit, the manager would also be required to make periodic reports to the Service which could include the number of vireo territories within the RZ, the acreage of lands in the RZ program, breeding success rates, etc. As a check, the Service or other appropriate entity could periodically visit lands enrolled in the program.

(2)As long as the vireo population meets Service population goals for the RZ, the survival and recovery of the vireo would be ensured. If incidental take is covered under the HCP, no further restrictions imposed by the Act would apply. This, in turn, would provide the incentive for state and local entities to support the RZ program. These entities would be responsible for securing financing for the plan.

Funding Possibilities

The Service's Partners for Wildlife program could provide cost-share assistance to carry out habitat and other wildlife improvements on private land. The National Fish & Wildlife Foundation has a matching grant program. Section 6 is a matching grant program between the Service and States under section 6 of the Act. Federal Aid within the Service could possibly fund, through state wildlife agencies, work that also benefits game species. Private sources could be explored.

D. OTHER ECONOMIC INCENTIVES

Reform Inheritance Tax Laws

An additional incentive for vireo habitat conservation might be tied to changes in the inheritance tax laws. Currently, heirs are often forced to divide and sell large properties in order to pay inheritance taxes. From the perspective of endangered species habitat, this often leads to development of the property and hence to destructive habitat changes. A reform of the tax code to allow large properties to remain intact, perhaps with the proviso that a portion of each property be maintained in perpetuity as endangered species habitat, might solve a problem for both landowners and endangered species.

Conservation Easements

Similarly, efforts directed at establishing conservation easements might serve to preserve vireo habitat, while at the same time reduce both the current tax liabilities of landowners and the future tax liabilities of their heirs. Another form of easement, the easement gift, can reduce estate taxes while leaving current tax liabilities unaffected.

Changes in Subsidy Programs and Tax Exemptions

Changes in agricultural subsidy programs (for example, the impending elimination of the mohair and wool subsidies) may motivate some landowners to investigate new sources of income while at the same time encourage them to reduce their expenses. Under the heading of expense reduction, for example, the Open Lands amendment to the Texas Constitution may lead landowners to abandon agriculturally uneconomic uses of their land in favor of managing it as wildlife habitat. Though this could mean creation or enhancement of vireo habitat, other uses might incidentally have the same effect. Managing for trophy deer, for example, could be quite compatible with the maintenance of good vireo habitat.

E. EDUCATION AND OUTREACH RESOURCES

There are a number of publications, videos, and programs available from various agencies, parks, and organizations concerning endangered and threatened species and specifically the black-capped vireo. The following is a partial list of the resources available for education/outreach efforts.

Texas Parks and Wildlife Department, Endangered Resources Branch (800-792-1112)
(512-912-7011) [in Austin]

Endangered and Threatened Animals of Texas - full color publication describing life history, habitat, threats, recovery efforts, and management of Texas' federally-listed animals

Texas Endangered Species Activity Book - targeted at grades 4 through 7, concerning rare resources in Texas, including the black-capped vireo (in press).

Video describing the life history, habitat, and management of the black-capped vireo targeted at land managers and natural resource professionals (in final production phase).

Ecoregions of Texas - video and classroom curriculum concerning rare natural and cultural resources of Texas targeted at grades 4 through 8.

Endangered Species Poster Series, including information on each species (planned).

Endangered Species Trading Cards, including the black-capped vireo (planned).

Information on endangered and threatened species, including the black-capped vireo, to be available on Texas Parks and Wildlife Home Page on the Worldwide Web (in progress).

Balcones Canyonlands National Wildlife Refuge (512-339-9432)

A Wing and a Prayer - The Story of Two Endangered Songbirds and Balcones Canyonlands National Wildlife Refuge - Brochure discussing the life history, habitat, and threats of the black-capped vireo and the golden-cheeked warbler.

Public tours to view habitat and birds (planned).

U.S. Natural Resources Conservation Service, Temple, Texas (817-774-1291)

Direct assistance to landowners and managers concerning habitat management.

The Use and Management of Browse in the Edwards Plateau of Texas - full color leaflet describing proper management of browse plants, important from the standpoint of vireo habitat management.

U.S. Fish and Wildlife Service, Austin, Texas (512-490-0057)

Why Save Endangered Species? - Brochure discussing why we should care about natural diversity and endangered species.

Funding of education/outreach efforts through section 6 of the Endangered Species Act. Proposals due each year in October.

Wild Basin Preserve, Austin, Texas (512-327-7622)

Educational tours, student activities, brochure, and coloring book addressing black-capped vireos along with other native plants and animals of the site.

Friedrich Wilderness Park, San Antonio, Texas (210-698-1057)

Interpretive programs on rare resources, including the black-capped vireo.

TPWD Kerr Wildlife Management Area, Hunt, Texas (210-238-4483)

Field days, tours, and educational programs for landowners, students, hunters, and the public - programs include information on overall management, including specific habitat management for black-capped vireos.

U. S. Fish and Wildlife Service, Tulsa, Oklahoma (918-581-7458)

Endangered and Threatened Species of Oklahoma - This 45-page full-color publication focuses on all of Oklahoma's Federally listed threatened and endangered species. Information on status, description, life history, habitat, distribution, causes of decline, and recovery needs are included for each species. A color photograph of each species and a state-wide distribution map highlight known ranges. Produced in cooperation with Oklahoma Cooperative Extension Service, Oklahoma State University, Oklahoma Department of Wildlife Conservation, U.S. Environmental Protection Agency, Oklahoma Department of Agriculture and Oklahoma Natural Heritage Inventory Program. 1993. Available free to the public.

Oklahoma's Threatened and Endangered Species Poster - Produced and funded cooperatively by U.S. Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation, U.S. Army Corps of Engineers, Oklahoma Cooperative Extension Service, Oklahoma State University and The Nature Conservancy. This 17" x 22" full-color poster highlights all of Oklahoma's Federally listed threatened and endangered species as well as some of the State's listed species. Color photographs are used on the front while the back has black/white line drawings and species descriptions, threats, habitat, range, diet and special notes of interest. 1994. Available free to the public.

Oklahoma's Partners for Wildlife...Private Lands Habitat Improvement - The full-color brochure outlines the goals and objectives of the Oklahoma Partners for Wildlife Program. Qualified Oklahoma private landowners receive technical and financial cost-share assistance in improving their property for wildlife. Several federally listed endangered/threatened species are benefiting from habitat improvements initiated via the Partners for Wildlife Program. Cooperators include

U.S. Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation, OSU Cooperative Extension Service, USDA Soil Conservation Service, Oklahoma Conservation Commission and Ducks Unlimited. 1992. Available free to the public.

Managing Fish and Wildlife Resources for the People...Oklahoma Ecological Services - This one-color brochure highlights the goals, mission and responsibilities of the Oklahoma Ecological Services office. Specific endangered species information on the Service's role in prelisting, listing, consultations and recovery are outlined. Produced by U.S. Fish and Wildlife Service. 1995. Available free to the public.

Endangered Species...Endangered Means There's Still Time - A 16-page one-color brochure that focuses on the various facets of the Service's Endangered Species Program. Information on the history of the Endangered Species Act of 1973, legal protection provided by the Act, listing and recovery are explained. Also, several endangered species success stories are discussed. Produced by U.S. Fish and Wildlife Service. Not dated. Available free to the public.

Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma (405-521-3851)

Habitat Improvement
Improving Your Acres for Wildlife
Wildlife: The Environmental Barometer
Oklahoma's Endangered Species

The above brochures are produced by the Oklahoma Department of Wildlife Conservation and are available free of charge.

F. RECOMMENDATIONS OF THE OUTREACH SUBGROUP

1. Implement a pilot project(s) combining aspects of Safe Harbor concepts and an incentive-based strategy for landowners to participate in the conservation of the vireo.

2. Fund an economic evaluation of the feasibility of the alternatives presented in the above section.

3. Fund a study of landowner sentiments in the vireo's range in order to understand their attitudes and needs.

4. Continue to investigate other innovative approaches to encourage local control of recovery efforts, such as tax reform, conservation easements, technical assistance, cash incentives, etc.

5. Develop a travelling exhibit (similar to the one TPWD is developing for the Houston toad) for use by community groups, schools, and organizations - may want to develop one portable exhibit for each recovery unit.

6. Implement the public outreach recommendations listed in the golden-cheeked warbler PHVA report.

VII. SUMMARY AND RECOMMENDATIONS

The Distribution, Status, and Threats subgroup lists 40 Texas counties in which vireos are known to occur or have occurred in the past but have not been documented since 1990. Thirteen additional counties need confirmation of vireo occurrence. Vireos in Dallas County have recently been extirpated. Similarly, vireos are known to occur in 3 Oklahoma counties, and 7 counties need surveys to confirm presence.

The Distribution, Status, and Threats subgroup suggest moving recovery unit boundaries to conform to county lines, which would facilitate data management and outreach and other recovery strategies. They also recommend combining recovery units 1 and 2, and 5 and 6 based on small populations in units 1 and 6. Information needs such as investigating the status and distribution of vireos in Oklahoma, Texas (particularly recovery units 1, 4, 5, and 6) and Mexico are identified.

The Population Biology and Modelling subgroup discusses how model variables were estimated and used. They also discuss assumptions and caveats related to modelling results. The RAMAS-metapop simulation model predicts extinction if the average seasonal fecundity is less than 1 female offspring produced per breeding female. Fecundities of at least 1.20-1.25 female young per adult female may be needed to maintain long-term viable vireo populations. Cowbird removal will likely be necessary to achieve the minimum fecundity for a viable population. Information and research needs identified include standardization of data collection, continuing analysis and refinement of estimates of important model parameters, and customizing a model to vireo life history strategies.

The Habitat Management Strategies subgroup ranked brood parasitism as the #1 threat to vireos with the loss and fragmentation of nesting habitat as the second threat. A cowbird management strategy is recommended and discussed. The use of fire, mechanical treatments, and grazing and browsing management to maintain, restore, and create vireo habitat is also discussed.

The Outreach and Partnerships subgroup identify stakeholders and the resources they may be able to contribute to vireo recovery. The subgroup discusses two Habitat Conservation Plan-type approaches to recovery and recommends a pilot HCP project to test the concept. Other economic incentives such as inheritance tax law reform, conservation easements, and tax exemptions are recommended. Some endangered species and black-capped vireo education resources are

listed. An economic evaluation of the feasibility of HCP approaches and a study of landowner sentiments about possible approaches to recovery are recommended.

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IX. APPENDIX

Following is a brief description of the provisions of the red-cockaded woodpecker Safe Harbor HCP.

Provisions of red-cockaded woodpecker HCP

-10a permit under the Act was issued to USFWS.
-Non-federal landowners can participate in the program voluntarily.
-Participating private landowners who enter into cooperative agreements with the Service will be included within the scope of the permit by certificates of inclusion.
-Participating landowners are asked to sign a cooperative agreement with the Service. This agreement will include (1) a description of the property to which the agreement applies and a record of the condition of the site (i.e. through maps, photos, and biological surveys), (2) identifies any existing red-cockaded woodpecker baseline responsibilities, and (3) specifies any proposed habitat improvement, describing the actions that the landowner agrees to implement (or will allow to be implemented) to improve red-cockaded woodpecker habitat on the property and the time period within which those actions will be implemented and maintained.
-Co-op agreements may be for varying periods of time and are revocable by the landowner.
-If, after carrying out the management practices agreed upon, a red-cockaded woodpecker group is established on the property, the landowner may, upon termination of the agreement, carry out any land use that results in the incidental taking of the group thus established without violating the Act.
-So long as a participating landowner's future land use practices maintain the red-cockaded woodpecker baseline established at the time the cooperative agreement was signed, any subsequent incidental taking of red-cockaded woodpeckers by the landowner will be authorized by the Section 10 permit.
-Subject to maintenance of red-cockaded woodpecker baseline responsibilities, a participating landowner may, after the period when the agreement is no longer in effect (except during the red-cockaded woodpecker reproductive season from March to August, unless otherwise authorized by the Service), remove trees as part of a timber harvest operation or a conversion to nonforest use, where such tree removal is expected to result in the loss of an active cluster(s) on the described land, provided only that the Service be notified 60 days in advance of such tree removal and given the opportunity to capture and relocate any affected red-cockaded woodpeckers.
-If funds are provided to landowners by the Service under the Safe Harbor program, the Service will impose repayment obligations in the event of noncompliance by participating landowners.
-Ordinarily, a landowner's red-cockaded woodpecker baseline responsibilities will be associated with specific red-cockaded woodpecker groups in existence at the time they entered into the

cooperative agreement. In certain limited circumstances, however, participating landowners may shift their red-cockaded woodpecker baseline responsibilities to a new group that was formed on their property subsequent to the cooperative agreement.

-The life of the permit is 99 years.

-Priority is placed on securing cooperative agreements with landowners where the land has the potential to benefit the red-cockaded woodpecker.

Other considerations

-The expectation was that, even with this program, the bulk of the Sandhills red-cockaded woodpecker population would remain on public land, specifically on Fort Bragg.

-If the program continues for an extended period (for example, for 99 years), with new land parcels constantly coming under agreement as agreements covering other land parcels expire, the net effect will be a shifting matrix of land being managed for red-cockaded woodpecker conservation, with a net beneficial impact upon the status quo. However, because participating landowners are free at the termination of their cooperative agreements to eliminate the nesting or foraging habitat they have restored or enhanced, red-cockaded woodpeckers occupying that habitat have no assurance of long-term protection. For that reason, the Service proposes to count toward the stated recovery goal any active red-cockaded woodpecker clusters on land enrolled in this program where (1) all necessary foraging and nesting habitat is protected on such land through a permanent agreement, (2) the cluster is not demographically isolated, and (3) such agreement runs with the land.

-The conservation plan was aimed at encouraging habitat restoration and enhancement for the red-cockaded woodpecker. However, the possibility exists that other listed or rare species occur on some of the land that might be considered for participation in the conservation plan. Therefore, provisions are included to address these cases and assure that the other listed species are not jeopardized and that incidental taking of them is minimized. If the participating landowner agrees to implement recommended measures for any candidate species, he or she will be protected from any further restrictions or obligations under the Act if the species is listed as endangered or threatened in the future.