BALCONES CANYONLANDS PRESERVE
LAND MANAGEMENT PLAN

TIER IIA

CHAPTER VII
GOLDEN-CHEEKED WARBLER MANAGEMENT

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1.0 BACKGROUND INFORMATION

The Balcones Canyonlands Conservation Plan (BCCP) section 10(a)(1)(B) permit issued to the City of Austin and Travis County by the U. S. Fish and Wildlife Service (USFWS) March 1996 required the creation of the Balcones Canyonlands Preserve (BCP). The intent of the Preserve is to protect the endangered golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA) and seven other locally endangered species. Travis County and surrounding areas contain the largest blocks of GCWA breeding habitat within the species' breeding range and thus will play a critical role in the species' recovery (USFWS 1992). A broad zone of GCWA habitat extends north of Highway 71 in the Barton Creek watershed and northwestward along the Colorado River and dissipates in the vicinity of the Burnet County line in the Post Oak Ridge area. The habitat is increasingly fragmented in the western portion of the permit area.

The greatest concentration of high-quality, contiguous warbler habitat is found in the Cypress Creek, North Lake Austin, and Bull Creek macrosites, all of which are north of Lake Austin and west of downtown Austin (Final HCP-EIS 1996). Based on the findings of the Biological Advisory Team, the Final HCP-EIS (1996) recommends that acquisition of warbler habitat in the Bull Creek macrosite be a priority. However, all of the land parcels within the proposed preserve system are critical for the BCP to succeed.

The BCCP 10(a) permit required that at least two golden-cheeked warbler populations be protected in the Travis County area. Currently, one population is located on the Balcones Canyonlands National Wildlife Refuge (BCNWR), and the other population is located within the BCP. Based on data gathered for survival, fecundity, and territory size, a viable population of golden-cheeked warblers is estimated to be 1,000 to 3,000 singing males (USFWS 1996). According to the Final HCP-EIS (1996), a minimum of 11,086 acres of GCWA breeding habitat could support, at best, 665 to 1330 GCWA pairs. The recommended BCP acquisition area contains a total of 13,969 acres of potential warbler habitat.

The original 46,000-acre acquisition area for BCNWR contained an estimated 17,500 acres of actual or potential warbler habitat (USFWS 2001). Substantial additional acreage of warbler habitat occurs in the 34,000-acre addition approved in 2000 but the total amount of habitat within the expanded 80,000-acre acquisition area has not been quantified recently (USFWS 2001). A review in 1996 suggested that nearly 500 warbler territories were present on then-existing 14,260 acres of federally owned tracts (Sexton 1996). By October 2004 the Refuge had increased to 21,000 federally protected acres

and harbored an estimated 700 to 800 territories (Sexton, pers. comm.); several hundred additional territories probably occupy habitat on the remaining private lands within the 80,000-acre acquisition boundary (USFWS 2001). The Refuge thus represents a significant warbler population in proximity to the BCCP permit area, yet sufficiently separated to provide substantial protection against catastrophes (Final HCP-EIS 1996).

Ideally, preserve tracts should be contiguous and the overall shape as circular as possible in order to minimize edge effects. However, since the preserve is fragmented and most parcels are not buffered from urban and other developed areas, intensive management is essential to maintain viable survival and fecundity rates.

2.0 BIOLOGICAL OVERVIEW

For literature on the golden-cheeked warbler, see Sexton et al (2000).

2.1 Habitat Description

Except where noted, the bulleted items below are taken from the *Golden-cheeked Warbler Population and Habitat Viability Assessment Report* (USFWS 1996).

- *Topography and Habitat:* Monitoring of GCWA by BCP biologists over the past five years indicates that in Travis County GCWAs occupy a range of topographical niches. Breeding GCWAs occur on upland plateaus, gently sloping hills, and steep canyon slopes. GCWA territories are sometimes located in relatively open-canopy woodlands in both lowland and upland areas and even in live oak savannahs. Fledglings were often observed foraging with their parents in live oak savannah habitat (Abbruzzese 1999, 2000, 2001, 2002, 2003; Gass 1998; Travis County 1999, 2000, 2001, 2002, 2003).

- *Geology/Soils:* Geology and soils influence the development of plant communities. Golden-cheeked warbler habitat is typically found on shallow limestone soils of the Edwards Plateau.

- *Vegetation:* The vegetation must be a combination of mature Ashe juniper and broad-leaved hardwoods greater than 10 feet in height. In occupied habitat, junipers account for 10% to 90% of individual trees, and broad-leaved trees account for 10% to 85% of individual trees. Tree canopy cover must generally be at least 50%; greater than 50% cover is better. However, some areas with tree canopy cover between 35% and 50% are used. Stem densities of trees greater than 10 feet in height generally range from 140 stems/acre to 776 stems/acre.

Vegetation must include both low (below 5 m) and high (above 5 m) foraging substrates (Beardmore 1994). In general, GCWAs forage and display in Plateau live oaks (*Quercus fusiformis*), shin oak (*Quercus sinuata*), and cedar elms (*Ulmus crassifolia*) more frequently than expected, based on measurements of foliage-volume availability (Beardmore 1994).

- *Water:* Golden-cheeked warblers may require access to water; however, this is usually not a concern as breeding habitat generally includes rivers or streams in canyon bottoms. Although some streams may be ephemeral, they are likely to be flowing during the breeding season (USFWS 1992; USFWS 1996). However, increasing urbanization adjacent to GCWA habitat may negatively affect the quality and quantity of water available to GCWAs during the breeding season (USFWS Austin Ecological Service pers. comm.1998).

- *Buffer areas:* A buffer area around sites that are consistently used by golden-cheeked warblers may be needed to reduce edge effects from adjacent land use. Due to the potentially negative effects of domestic cats, blue jays, and light and noise pollution, urban development generally has a greater negative impact on golden-cheeked warbler populations than rural and agricultural land uses (USFWS 1992; USFWS 1996).

2.2 Threats

The main threats to golden-cheeked warbler survival are habitat loss and habitat fragmentation. Habitat loss results from urbanization, clearing associated with agricultural practices, and large flood control projects (USFWS 1992; Campbell 1995; USFWS 1996). Reservoirs promote further habitat loss with the development of lakeside communities.

Habitat fragmentation results in an increase in the edge to area ratio, which in turn can lead to increased rates of predation, cowbird parasitism, noise and light pollution and may reduce prey abundance (USFWS 1992; Campbell 1995; USFWS 1996). Red imported fire ants (*Solenopsis invicta*), which are more common in disturbed areas, are known to prey on GCWA nestlings (L. Jette' pers. comm; D. Hernandez pers. comm; Stake 2001). Increased populations of blue jays (*Cyanocitta cristata*) and brown-headed cowbirds (*Molothrus ater*), which are common in urban and agricultural areas, may also cause increased mortality, parasitism, and stress, compared to areas less impacted by humans. At least one documented GCWA mortality has resulted from a window collision, and this threat could increase where preserve tracts abut developed areas

(USFWS Austin Ecological Service pers. comm. 1998). In addition, increasing distances between habitat patches may make re-colonization of vacated habitat more difficult for golden-cheeked warblers (Burke and Nol 1998; Coldren 1998; Horne 2000).

While some literature has suggested brood parasitism by brown-headed cowbirds is not a significant threat to golden-cheeked warblers (Campbell 1995; USFWS 1996), BCP biologists have directly observed eight instances of a GCWA parent feeding a brown-headed cowbird fledgling from 1999 through 2003 (Abbruzzese 1999, 2000, 2001, 2002, 2003; Travis County 1999, 2000, 2001, 2002, 2003). At Ft. Hood, where cowbird trapping is extensive, only one instance of brood parasitism was documented during these same years (Anders 2000; Holiman and Craft 2000; Anders 2001; Pekins 2002; Peak 2003).

On BCP lands, the increase in brown-headed cowbird observations appears to be correlated with recent urban development along the perimeters of the preserve. Brood parasitism by brown-headed cowbirds coupled with other predator pressure may have serious negative affects on declining golden-cheeked warbler populations, especially in areas where habitat is highly fragmented or adjacent to livestock.

Other factors, including loss of hardwoods and overbrowsing, also contribute to habitat degradation and possibly eventual habitat loss. Trees of several oak species (*Quercus* spp.) are susceptible to oak wilt, while over-browsing by white-tailed deer, goats and exotic ungulates results in reduced hardwood seedling survival (Campbell 1995; USFWS 1996; Russell and Fowler 1998).

Finally, recent literature, as well as observations by BCP biologists, has documented the detrimental effects of human disturbance on the foraging and nesting behavior of GCWAs (Pekins 2002; Abbruzzese 2003; Graber and Dearborn *in prep*.). Studies of other songbirds also indicate that the presence of humans may have a detrimental impact on GCWA behavior, causing flushing, reduced singing rates, nest abandonment, lower nestling survival rates, and displacement of birds from foraging areas (Tremblay and Ellison 1979; Burger 1981; Kaiser and Fritzell 1984; Westmoreland and Best 1985; Gutzwiller et al 1994; Sparkman 1996; Marzluff 1997; Jordan 2000).

3.0 MANAGEMENT PROGRAM

The most immediate concern of the BCCP continues to be the maintenance of a viable population of GCWAs within the recommended preserve size and configuration. Basic

concerns of GCWA management include nest parasitism and predation; vegetation dynamics; habitat fragmentation and edge effects; conflicts between black-capped vireo and golden-checked warbler habitat requisites, and management for the two species when in close proximity to each other (Final HCP-EIS 1996).

3.1 Management Goal

13,969 acres of potential GCWA habitat will be bought or otherwise protected and managed in order to maintain and, if possible, increase the population of golden-cheeked warblers in the BCP. The focus of management should be to produce rates of occupancy, fecundity, and survivorship (on the breeding grounds) that equal or exceed those recommended in the *Golden-cheeked Warbler Population and Habitat Viability Assessment Report* (USFWS 1996). (These levels should be modified as new data becomes available.)

3.2 Issues

- Where possible, preserves need to be buffered from adjacent developed areas to reduce the negative impacts of urbanization (e.g., feral animals, noise, trespassers, and increased populations of predators) (USFWS 1992; USFWS 1996).

- Because the preserve is fragmented and will be near the minimum recommended size, GCWA habitat area should be increased wherever possible within preserve boundaries.

- Public access may negatively impact habitat quality for golden-cheeked warblers. Visitors may potentially increase canopy openings (e.g. trailblazing), contribute to greater occurrence of warbler avoidance behavior, and reduce the ability of intra-specific communication as a result of increased noise levels. See Tier II-A, Chapter XIV: Public Access.

3.3 Management Objectives

Management will focus on increasing occupancy and productivity of GCWAs in order to maintain a source population within the preserve (i.e., a population in which the output of offspring exceeds the carrying capacity of the local habitat, promoting dispersal (Koford et al 1994)).

Habitat areas will be monitored for hardwood stand replacement and other long-term effects of management practices. Predators and parasites will be monitored, and control

measures will be taken when necessary (see Tier II-A, Chapter X: Animal Management). Efforts to increase public awareness and sensitivity to GCWAs and other endangered species will be continued, as will monitoring of both conservation efforts and negative impacts to habitat due to urbanization and other disturbances.

3.4 Specific Strategies

General site characteristics, current vegetation cover type, land use history, terms and conditions of the section 10(a) permit, and the location of individual tracts within the preserve system are considered when determining management practices at any given location. Management plans for contiguous or adjacent tracts are developed to be compatible with each another. If adjacent tracts are managed by different agencies, the land management plans for each tract should be coordinated with the respective preserve managers (Final HCP-EIS 1996).

The following is a summary of more detailed management information that is contained in several documents. Much of this information can be found in the *Golden-cheeked Warbler Population and Habitat Viability Assessment Report* (USFWS 1996) and in *Endangered and Threatened Animals of Texas: Their Life History and Management* (Campbell 1995).

3.4.1 Habitat maintenance/enhancement/creation

Maintenance: Minimum protective measures recommended by the USFWS (USFWS Austin Ecological Service1998) are:

- Fencing and signs for all preserve tracts.
- Intensive public outreach and educational programs within the BCP and with adjacent landowners to manage threats (including public access, oak wilt, predators, etc. (See Tier II-A, Chapter 13: Outreach and Education).
- *Permanent closure of trails that cross through interiors of warbler habitat and elimination of internal fragmentation through active habitat restoration and reforestation. Where easements, roads, and trails are already established, site-specific maintenance should be directed toward reducing their impacts (Final HCP-EIS 1996). See Section 3.4.2 below.
- Routine surveillance to ensure no unauthorized public access or other problems occurs within the preserve.

- *Elimination of recreational access to all GCWA habitats during the breeding season.

- *Restrict supervised, guided tours to the periphery of preserves during the breeding season and rotate areas that are visited.

- *Prohibition of unauthorized recreational activities (mountain biking, horseback riding, all-terrain vehicles, etc.) unless clearly demonstrated through scientific research (in areas outside the preserve) that they are not a threat, and they are introduced slowly with monitoring and oversight to ensure no negative impact occurs.

- *Permanent exclusion of activities that may promote the degradation or destruction of GCWA habitat (e.g., erosion, habitat fragmentation, introduction of exotic species, noise, fire, etc.).

- Contingency fire management plan (see Tier II-A, Chapter 6: Fire Management).

*Except on "grandfathered" tracts (Wild Basin Wilderness Preserve, Hamilton Pool Preserve, Barton Creek Greenbelt, Bull Creek Greenbelt, Bull Creek District Park, and St. Edward's Park) where recreational access was already allowed before the creation of the BCP. On these tracts, access should be held near the level that occurred at the time the permit was issued in 1996. Similar variances from these guidelines are allowed on conservation easement tracts managed by permit partners and on 10(a) permitted tracts through the USFWS, both of which are included in the total acreage of the BCP.

Additionally, hardwood regeneration should be encouraged by protecting against oak wilt and overbrowsing (See Tier II-A, Chapter 3: Oak Wilt, and Chapter X: Wildlife Management).

When the habitats (or potential habitats) of golden-cheeked warblers and black-capped vireos overlap, conflicts may arise over which environmental variables to emphasize in habitat management. Existing golden-cheeked warbler habitat should be maintained as golden-cheeked warbler habitat, rather than creating black-capped vireo habitat.

Major construction and repairs of fences, roads and trails within occupied habitat should be done in the non-nesting season. Activities in occupied habitat must be carried out at least 300 feet from the edge of the nearest occupied territory. Minor repairs related to

public safety or GCWA protection, such as repair of vandalized directional signs on trails, trail closures, or fencing, are permitted within occupied habitat during the nesting season. Such work should be accomplished with hand tools only.

Acorn weevils may be affecting oak replacement in some areas; however, information on rates of weevil infestation in normal, healthy juniper-oak woodlands is insufficient to allow comparison. Infestation levels may vary between years and locations, and may depend on the size of the acorn crop (Sexton pers. comm.). Although fire has been used to control acorn weevils in other types of plant communities, fire could have adverse effects on GCWA habitat, and an uncontrolled fire could cause significant habitat loss. Thus, understory prescription burns in GCWA habitat are not an acceptable option. More research into questions of acorn weevil infestations and control measures would be valuable, but should not take precedence over research and management regarding oak wilt and high deer populations (USFWS 1996).

Enhancement and creation: Unoccupied habitat (habitat which has not been occupied by GCWAs for a period of three consecutive years or more) may be manipulated outside of the nesting season for the purpose of enhancing or creating GCWA breeding habitat (Campbell 1995). However, before any GCWA habitat is manipulated in excess of the guidelines stated in this document or in Campbell (1995), a detailed plan of action will be written and submitted to USFWS for approval. Land managers should conform to the following guidelines when planning vegetation manipulation.

Habitat should be enhanced by promoting regeneration of oak-juniper woodlands in areas that have been previously cleared, thinned, or burned (e.g., trails, roads, or pastures). In areas where larger Ashe junipers are dominant, several small openings per acre may be created. These openings should be protected from browsing. Native hardwood seedlings may be planted to speed the process of hardwood regeneration. Slash may provide protection for hardwood seedlings (Campbell 1995). Conversely, juniper may be encouraged in areas where they have been cleared and only hardwoods remain.

Managers may remove selected young "bushy" junipers, less than 10 ft in height, within habitat as long as the tree canopy is not disturbed. Likewise, thin straight junipers may be removed from areas within habitat with a high density of juniper compared with hardwoods. The trees that are removed must have a relatively small individual canopy, and the tree selections must be scattered over the area. Such removal is predicated on basic forestry techniques, to encourage growth in the remaining trees by thinning

competitors and reducing competition for water and light.

Areas in which efforts have been made to enhance or create habitat should be monitored for increases in densities or re-colonization by golden-cheeked warblers (USFWS 1992; Campbell 1995; USFWS 1996).

3.4.2 Additional Vegetation Management and Fire Restriction

Clearing of roads and trails should be minimized, especially where clearing would reduce canopy cover. Canopy cover should be maintained at 50% or greater. Linear openings, such as those needed for fence lines, should be less than 16 feet, from stem to stem, in order to allow the canopy to partially close across the gap. All vegetation work will be carried out during the non-breeding season (Final HCP-EIS 1996; USFWS 1996).

Because uncontrolled hot fires have the capacity to destroy GCWA habitat, use of prescribed burns should be restricted until the full effects are known (based on scientific research conducted outside of the preserve), and a contingency plan has been developed for dealing with hot, uncontrolled fires. (See Tier II-A, Chapter VI: Fire Management).

3.4.3 Animal Management

Certain animals have been identified as potential threats to GCWAs. Animal control efforts on preserve tracts will include public education, manipulation of habitat, and management of individual problem animals. Control methods should maximize selectivity and minimize cost (Final HCP-EIS 1996).

Browsing or Grazing Ungulates. Exotic ungulates such as goats, exotic deer, etc. will be excluded from the preserve. Grazing by cattle may be employed on preserve land as a limited vegetation management tool to further conservation goals when approved by both the Coordinating Committee and the USFWS. Browsing animal control programs should be instituted when declines in important vegetation components have been documented at a particular site. Deer control efforts will require perimeter fencing of preserve segments, long-term monitoring, hunting programs or other intensive control efforts. (USFWS 1992; Campbell 1995; Final HCP-EIS 1996).

Feral Hogs. Damage to mesic uplands, riparian corridors, springs, spring seeps, and canyon bottom soils and vegetation will suppress the abundance, diversity, and distribution of broad-leaved trees, shrubs, and seedlings in GCWA habitat. Feral hog control efforts should be instituted when damage by hogs rooting and feeding have been

documented at a particular site.

Brown-headed Cowbirds. Nest parasitism should be controlled using a unified approach among all BCP partners and in cooperation with adjacent landowners. Intensive cowbird trapping or other lethal control should be performed on tracts where observations indicate high BHCO abundance and/or there is direct evidence of parasitism. It may be especially important to monitor and possibly trap cowbirds in areas where preserve land is adjacent to livestock operations. Leaving woody vegetation adjacent to golden-cheeked warbler habitat intact may also help reduce rates of cowbird parasitism (USFWS 1992; Campbell 1995; Final HCP-EIS 1996; USFWS 1996,).

Predators. Animals that prey on songbird eggs and young include domestic and feral cats, raccoons, opossums, snakes, jays, skunks, and red imported fire ants. These animals should be monitored and managed as necessary (Final HCP-EIS 1996, USFWS 1996). A public information and education program for adjacent landowners has been instituted and should be expanded. (See Tier II-A, Chapter XIII: Education and Outreach, and Chapter X: Animal Management.)

3.4.4 Visitor Management

The preserve system offers public access and recreational opportunities at selected sites. Public access may be allowed where and when such access does not threaten the viability of the GCWA population, nor cause the degradation of soil, vegetation, or water resources (Final HCP-EIS 1996). (See Tier II-A, Chapter XII: Public Access.)

4.0 MONITORING

The GCWA population within the BCP will be monitored through a regional program to determine population size, territory density and trends, distribution, productivity, use of marginal habitat, and to determine the effects of habitat manipulation, urbanization, and recreation. Occupancy, survivorship, and productivity data are critical to assess population viability. Participants in this monitoring program include partners in the BCP (City of Austin, Travis County, LCRA, Travis Audubon Society, Wild Basin Preserve, and the Nature Conservancy of Texas) and the BCNWR.

Guidelines are provided for various levels of monitoring including presence/absence, territory mapping, pair detection and productivity. Only personnel or volunteers who are familiar with bird vocalizations and are adept at orienteering and mapping should undertake GCWA monitoring. Field personnel must have scientific permits issued by the

USFWS for endangered species surveying and/or banding. As BCP managers gain additional knowledge of management practices and the biology of the target species, the following monitoring protocols may require modification.

4.1 Methods

4.1.1 System-wide Monitoring

Because the entire acreage of the BCP is too extensive for complete surveying of GCWAs, a monitoring program was developed by the BCP monitoring committee that uses a series of 100-acre plots to sample a subset of the GCWA population. Monitoring results will be included in the BCCP annual report to USFWS with this information available to the Scientific Advisory Committee and the public. This program is described below.

Plot Selection: GCWAs will be monitored by mapping territorial males on a minimum of 17 permanent, pre-designated plots on the BCP and at the BCNWR. As of September 2004, 13 plots are monitored in prime habitat, and six plots are monitored in transitional habitat. As more land is acquired, additional 100-acre plots should be established.

Prime sites are defined as sites containing a minimum of 75% GCWA habitat, as described in Campbell (1995), and at least 70% canopy cover. Prime plots will be randomly selected, using habitat (as described by Campbell (1995)) as a guide rather than observations of warbler density. Some consideration may be given to plot accessibility and ease of establishment. For example, marked boundaries or fence lines may be used as plot boundaries as long as they are not along a "hard" edge (i.e., an abrupt change to a different habitat type or man-made structure, such as a highway).

Transitional habitat is defined as habitat that may have zero to a few warbler territories and has the potential to improve as GCWA habitat within the next 30 years. Prime and transitional plots should be approximately 100 acres in size. The shape should be as square as is reasonably possible in order to minimize differences between plots in the edge to area ratio.

Table 1. Locations of 100-acre golden-cheeked warbler research plots as of September 2004 on the Balcones Canyonlands Preserve and the Balcones Canyonlands National Wildlife Refuge.

Macrosite	Manager	Tract	Prime	Transitional
BCNWR	BCNWR	Rodgers: SE	1	
	BCNWR	Kindred	1	
	BCNWR	Victoria	1	
	BCNWR	Rodgers Valley		1
	BCNWR	Webster		1
Cypress Creek	Travis Audubon	Sanctuary	1	
	LCRA	Wheless (prime)	1	
	LCRA	Wheless (trans)		1
	Travis County	Bunten	1	
	Travis County	Lake Perspectives	1	
Bull Creek	CoA	Ivanhoe	1	
	CoA	Forest Ridge	1	
	CoA	3M/St. Eds	1	
	CoA	Canyon Creek		1
N. Lake Austin	CoA	Emma Long MP	1	
S. Lake Austin	CoA	Bohls	1	
	CoA	Double J&T		1
Barton Creek	CoA	Barton Creek Greenbelt	1	
Pedernales	Travis County	Hamilton Pool		1
		Total	**13**	**6**

Territory Mapping: Warbler territories should be mapped using methods described by the International Bird Census Committee (IBCC 1970). Surveys should be conducted on "days when weather conditions are suitable for the detection of bird singing" (including a wind speed of less than 12 mph) (USFWS 1994). All warbler surveys should be conducted when the ambient temperature is above 55 degrees F, as GCWAs are known to sing less frequently below this temperature (DLS 1994, USFWS 1994). Ideally, the visits should be spread out during the field season, including late season visits to obtain productivity data. Singing males are often best differentiated from one another by following individual males and by listening for counter-singing between nearby males (Bibbey et al 1992). Taped recordings of GCWAs may be used to elicit a response from a territorial male, although such playback should be used judiciously to avoid any disturbance the recordings might cause. Observations of females, nests, and fledgling groups originating from the prime study plots are critical to determining productivity and mated status. See detailed protocol for territory mapping (Appendix A).

Banding: When funding and time are available, land managers may band GCWAs with USFWS aluminum bands and color bands in conjunction with the 100-acre study plots. A banding program will increase a field observer's ability to identify individual birds and to collect data on site fidelity, survivorship, age structure, and other demographic variables (Jette' et al 1998). However, before instituting such a program, land managers should first consider the inherent risk involved in banding birds, including injury and death of the birds. Only qualified, trained personnel should conduct the banding activities (MAPS [Monitoring Avian Productivity and Survivorship] training or the equivalent is preferable). The Scientific Advisory Committee should review banding plans; the USFWS will review the scientific permit application before issuing a permit to conduct banding. In addition, any banding of GCWAs will require special permits from the Bird Banding Lab (USGS).

Other Observations: Territories or observations of blue jays and brown-headed cowbirds should also be mapped in order to document their distribution and any changes in their populations. Observations of other potential predators, such as rat snakes, fire ants, raccoons, feral cats, and western scrub jays, should also be noted. Incidental sightings of GCWAs, including single observations or sightings from the public, should be mapped separately.

4.1.2 Minimal Effort Monitoring

If resources are not available to undertake the above monitoring plan, land managers may wish to use alternate methods to monitor GCWAs, such as determining the presence or absence of GCWAs and number of territories. Territorial enumeration is preferred to simple presence/absence surveys as it provides information on densities and distribution. Enumeration of territories requires 3-4 visits per plot during good weather. When possible, enumerating or mapping territories outside of designated 100-acre plots would also be beneficial.

4.1.3 Vegetation Monitoring

Objective: To monitor GCWA habitat plant community response to management practices.

Methods: Data obtained from Land Condition Trend Analysis (LCTA) (Tazik et al 1992) can be used to evaluate soil erosion, plant composition, wildlife habitat, and to ground truth remotely sensed imagery.

Complete monitoring using both a belt and line transect is recommended for the initial year and may be repeated every fifth year. A simplified version is useful for annual or biannual measurements of ground cover and woody species. This modified LCTA uses a point intercept method to document ground cover, canopy cover, and surface disturbance. This sampling method consists of recording the vegetation that crosses a two dimensional plane that is 8.5 m in height and 100 m in length. Recordings are taken at one-meter intervals along the 100 m "centerline" tape. Line intercept sampling is collected every meter starting at the 0.5-meter mark on the tape. A telescoping rod is positioned at the intercept point and perpendicular to the ground. Ground cover that contacts the rod is recorded at each intercept point as is the category of surface disturbance. The rod is then raised to the height at which it comes in contact with vegetation. The species contacted is recorded for each bracket-height, as limbs, foliage, etc., come in contact with the telescoping rod. Bracket-heights are in 1 dm increments up to 2 m, and 0.5 m increments from 2 m to 8.5 m. For more details on this protocol, see Tazik et al. (1992).

4.2 Guidelines for Biological Research by Non-BCP Staff

BCP managers may receive requests from outside groups or organizations asking for permission to carry out biological research on BCP properties. Such research must be in agreement with the goals of management plans and guidelines (i.e. should not result in the "take" of an endangered species or in any way degrade endangered species habitat). All researchers must obtain approval from the land managers of the tracts to be used for the research. If the proposed research involves endangered species the researchers must obtain a permit from U.S. Fish and Wildlife Service. Land managers may also have potential researchers sign a standard form stating that they will abide by the rules of the BCP management plans or preserve rules.

5.0 RESEARCH NEEDS

The following research topics related to golden-cheeked warblers, their ecology, and their habitat were identified by BCP staff, other scientists, managers, and regulators. This list is not meant to be exhaustive nor is it meant to identify these topics by priority.

- Have an independent policy assessment group measure the success of current warbler conservation policies and make recommendations
- Analyze current GCWA data/information on: 1) average numbers of territories and territory sizes, 2) male-female ratios, 3) mated frequency, and 4) numbers of unmated males and females.

- Using contemporaneous studies, determine the productivity across different portions of the GCWA range.
- Add to the knowledge about the use of understory structure in GCWA breeding habitat.
- Determine relationships among insect abundance, plant species composition, GCWA survival and reproduction.
- Evaluate the minimum size of patch in terms of GCWA extinction probabilities.
- Evaluate GCWA occupancy in relation to patch size using GIS.
- Determine the relationship of limiting factors such as brood parasitism, predation, and fire ants to GCWA.
- Determine size of buffer zones needed to reduce impacts of urbanization on GCWA.
- Study the dynamics of hardwood regeneration in older mixed deciduous-juniper associations.
- Study the effects of human activity (bird watching, running, biking, etc.) on GCWA during foraging, breeding and nesting activity.
- Study the accuracy of the current 100-acre plot monitoring methodology by GCWA banding and blind cohort study.
- Monitor GCWA habitat and populations in Mexico and Central America.
- Determine the current distribution and availability of GCWA habitat in the winter range and migration corridor.
- Compare diversity and abundance of Neotropical species closely associated with GCWA/BCVI habitat.

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APPENDIX A

100-ACRE PLOT PROTOCOL FOR FIELD SEASON 2002 AND BEYOND

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

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

Plot shape: square as possible

Plot characteristics:

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

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

Standardization of methods:

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

Start time: ½ hour after sunrise

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

Visits during season:

Prime sites: 10x

Transitional: 3x: Transitional sites only need to be surveyed every other year. PRODUCTIVITY DATA NOT GATHERED

Hours per visit: Six hours per visit

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

Playback tapes: No playback tapes

Data Analysis:

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

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

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

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

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

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

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APPENDIX B

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