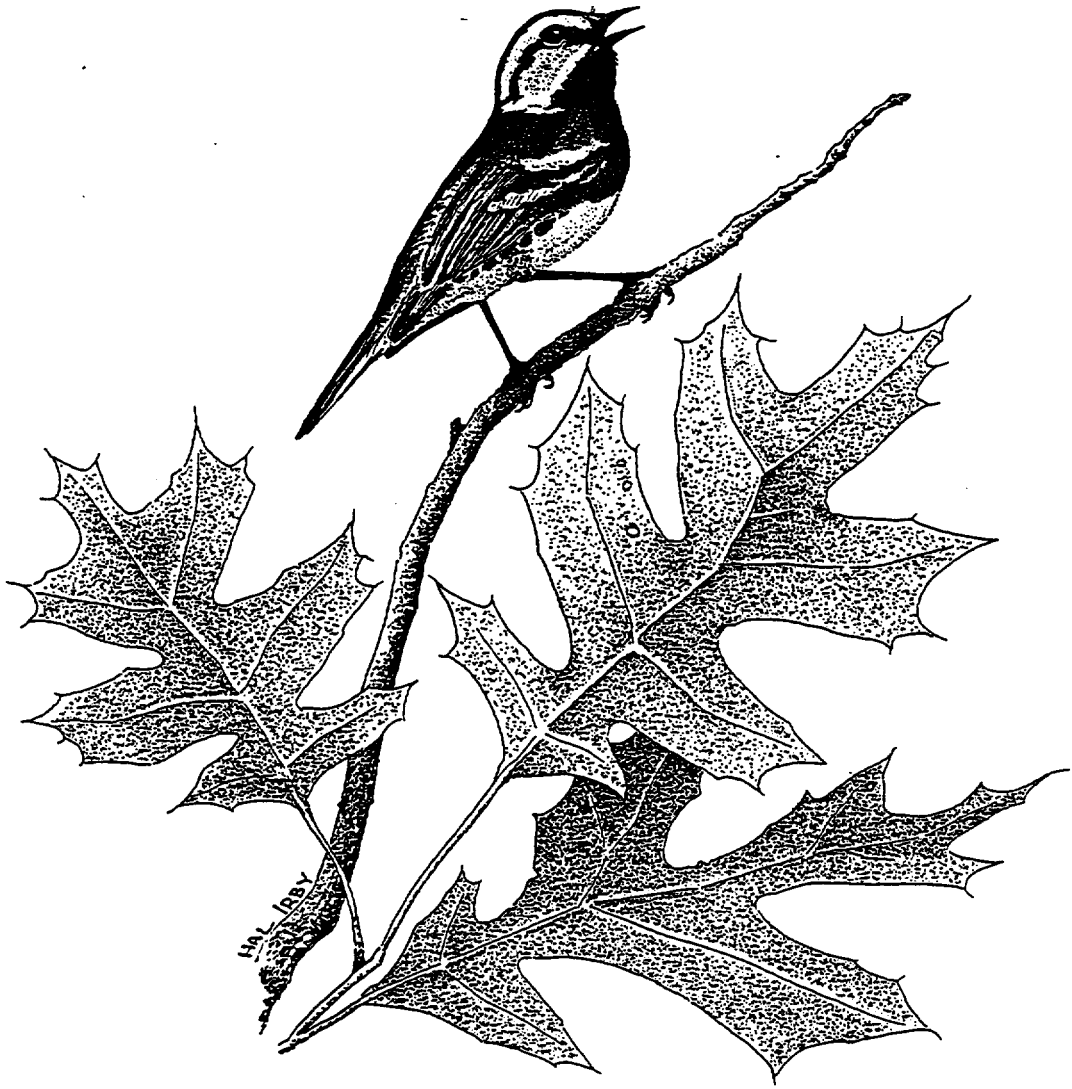
GOLDEN-CHEEKED WARBLER

RECOVERY PLAN



U.S. FISH AND WILDLIFE SERVICE

REGION 2, ALBUQUERQUE, NEW MEXICO

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GOLDEN-CHEEKED WARBLER
(*Dendroica chrysoparia*)
RECOVERY PLAN

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Literature Citations

Literature citations of this document should read as follows:

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The illustration on the cover was drawn by and provided compliments of Hal Irby.

Executive Summary

Current Species Status: The golden-cheeked warbler is listed as endangered. Habitat destruction in the breeding range has accelerated (Wahl et al. 1990), since the initial surveys of Pulich (1976). Clearing of pine-oak woodlands in Mexico and Central America is eliminating habitat on the winter range and migration corridor.

Habitat Requirements and Limiting Factors: During the breeding season, golden-cheeked warblers inhabit woodlands containing Ashe juniper (Juniperus ashei) in combination with various deciduous trees such as Texas oak (Quercus buckleyi), scaley bark oak (Q. sinuata var. breviloba), and Plateau live oak (Q. fusiformis). The essential breeding season requirement is the presence of suitable nesting material in the form of bark strips from Ashe junipers. Other limiting factors may include availability of arthropod prey, a moderate to high degree of canopy cover, nest parasitism and predation, and proximity to water.

Recovery Objective: Delisting.

Recovery Criteria: The golden-cheeked warbler will be considered for delisting when (1) sufficient breeding habitat has been protected to ensure the continued existence of at least one viable, self-sustaining population in each of eight regions outlined in the plan, (2) the potential for gene flow exists across regions between demographically self-sustaining populations where needed for long-term viability; (3) sufficient and sustainable non-breeding habitat exists to support the breeding populations, (4) all existing golden-cheeked warbler populations on public lands are protected and managed to ensure their continued existence, and (5) all of these criteria have been met for 10 consecutive years.

Actions Needed:

1. Studies of golden-cheeked warbler population status and biology, ecology, habitat requirements, and threats on the breeding ground and in the winter range and along their migration corridor.
2. Protection of existing populations and habitat in the breeding range, wintering range, and along the migration corridor.
3. Increased voluntary protection of warbler habitat.
4. Enhancement and maintenance of the quality of warbler habitat on public and private lands.
5. Increased public awareness of the importance of the species and other endangered species.
6. Regulatory protection.

Total Estimated Cost of Recovery (Dollars x 1000):

Fiscal Year	Priority 1 Tasks	Priority 2 Tasks	Priority 3 Tasks	Total
1993	2,136	499	243	$ 2,878
1994	2,081	560	137	$ 2,778
1995	1,537	540	152	$ 2,229
1996	1,000	300	75	$ 1,375
1997	500	250	30	$ 780
1998	500	200	30	$ 730
1999	250	200	30	$ 480
2000-2008	100	200	30	$ 330
				$11,889

Date of Recovery: If the plan is implemented as outlined, the anticipated year that the delisting criteria should be met is 2008.

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I. INTRODUCTION AND BACKGROUND

The Golden-cheeked warbler (Dendroica chrysoparia) (GCW or warbler) breeds only in the mixed evergreen-deciduous woodlands of central Texas and winters in the highland pine-oak woodlands of southern Mexico and northern Central America. Human activities have eliminated much warbler habitat within parts of the warbler's range that existed at the time of Pulich's (1976) initial surveys in 1962. Recent surveys suggest that the rate of habitat loss is accelerating as suburban developments spread into prime warbler habitat along the Balcones Escarpment, especially in the growth corridor from Austin to San Antonio (Wahl et al. 1990).

A. LEGAL STATUS AND RECOVERY PRIORITY

The Golden-cheeked warbler was placed on the Endangered Species list on May 4, 1990 by means of an emergency rule (55 FR 18844). At the same time the emergency rule was published, a proposed rule to "permanently" list the species was published (55 FR 18846). The final rule listing the golden-cheeked warbler as endangered under the Endangered Species Act was published on December 27, 1990 (55 FR 53153). This species was added to the Texas Parks and Wildlife Department's list of endangered species on February 19, 1991 (Executive Order No. 91-001).

The GCW has a recovery priority of 2C. According to the Service's criteria, this indicates a species with a high degree of threats; in conflict with construction or development projects or other forms of economic activity; and, a high potential for recovery.

B. DESCRIPTION

Adult males in breeding plumage have yellow cheeks outlined in black with a thin black line through each eye and extending backwards from the eye. Upper breast and throat are black. Lower breast and belly are white with some lateral black spotting or streaking. The back is blackish. Wings are blackish with two white wingbars. Tail feathers are black, except that the outermost tail feather on each side is white with a black shaft line. Upper and lower mandibles are black. Legs and feet are black. Eyes are dark brown. The male is the only North American warbler with brilliant yellow cheeks completely outlined in black (Ridgway 1902, Bent 1953, Griscom and Sprunt 1957, Pulich 1965, Oberholser 1974, Pulich 1976).

Winter plumage of adult males is similar to the breeding plumage except that the black feathers of the throat are edged with yellow or cream.

Adult females are less strikingly marked than adult males. The back is dark olive-green with thin black streaks. The cheeks of females are yellowish but less brilliant than in males. The center of the throat is also yellowish, grading to pale buff or white on the abdomen. Sides of the throat are black with feathers tipped in white. Flanks are covered with black streaks (Oberholser 1974).

Juveniles are similar to adult females. Their backs are brownish olive. Wings are dark drab, wing-bars brownish, and cheeks are dull buff-colored. Throat, chest, and abdomen are drab or grayish white.

Pulich (1976) found average breeding weights were 10.2 g for 7 adult males, and 9.4 g for 11 adult females.

C. TAXONOMY

Early History: The golden-cheeked warbler was unknown to science until 1859 when Osbert Salvin collected two specimens near Tactic, Vera Paz, Guatemala on 4 November; it was later described by Sclater and Salvin (1860). D.C. Ogden collected the first United States specimen in 1864 near the confluence of the Medina and San Antonio Rivers in Bexar County, Texas (Dresser 1865). G. H. Ragsdale collected a second United States specimen in 1878 along the Brazos River in Bosque County, Texas (Purdie 1879). Werner found the first United States nest of the GCW in 1878 in Comal County (Brewster 1879, Bent 1953).

Evolutionary History: Mengel (1964) described a reasonable scenario for the derivation of the GCW, Townsend's warbler (Dendroica townsendi), hermit warbler (D. occidentalis), and black-throated gray warbler (D. nigrescens) from an ancestral form of the black-throated green warbler (D. virens). The GCW is the most recently derived of these species and is thought to have separated from the ancestral stock during one of the most recent Pleistocene interpluvial episodes about 20,000 years before the present. The validity of this scenario is supported by similarities in plumage, vocalizations, and habitat preferences of these species (Stein 1962, Mengel 1964), and Pleistocene vegetation distribution (Axelrod 1958, Van Devender 1986).

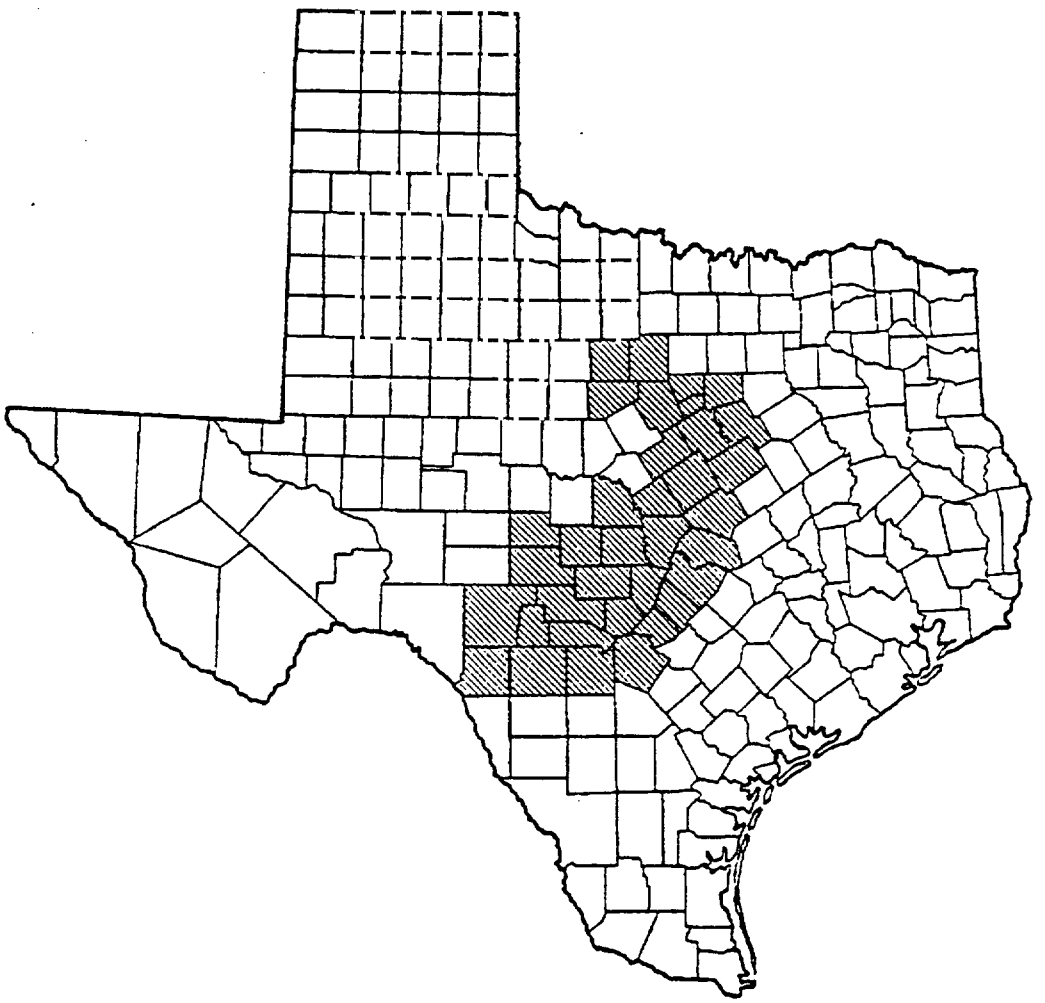
D. DISTRIBUTION

Breeding Range: GCWs nest on the Edwards Plateau, Lampasas Cut-Plain, and Llano Uplift regions of central Texas. The GCW has been reported as a breeding species from the following counties: Bandera, Bastrop, Bell, Bexar, Blanco, Bosque, Burnet, Comal, Concho, Coryell, Dallas, Eastland, Edwards, Erath, Gillespie, Hamilton, Hays, Hood, Johnson, Kendall, Kerr, Kimble, Kinney, Lampasas, Lee, Llano, McLennan, Medina, Palo Pinto, Real, San Saba, Somervell, Stephens, Tom Green, Travis, Uvalde, and Williamson (Figure 1) (see Pulich 1976 for supporting specimens and literature for each county).

The GCW may no longer nest in Tom Green, Concho, Dallas, Lee, McLennan, and Bastrop counties (Pulich 1976).

Winter Range and Migration Corridor: GCWs winter in the highlands of southern Mexico (Chiapas) and Central America (Figure 2). In the period July-October, GCWs migrate southward through the coniferous-oak woodlands of the Sierra Madre Oriental of Coahuila, Nuevo Leon, Tamaulipas, Queretaro, Veracruz, and Chiapas (Pulich 1976, Alvarez del Toro 1980, Lyons 1990, Perrigo et al. 1990). Records indicate GCWs winter at 1500-2600 m in the pine-oak woodlands of the Sierra Los Cuchumatanes and Sierra de las Minas of Guatemala, in the highlands of Honduras and northern Nicaragua, and in the Sierra Madre of Chiapas, Mexico (Sclater and Salvin 1860, Land 1962, Monroe 1968, Pulich 1976, Kroll 1980, Braun et al. 1986).

Figure 1. Breeding range of the golden-cheeked warbler (from Pulich 1976).*



* Cross-hatched counties indicate the current breeding range of the golden-cheeked warbler.

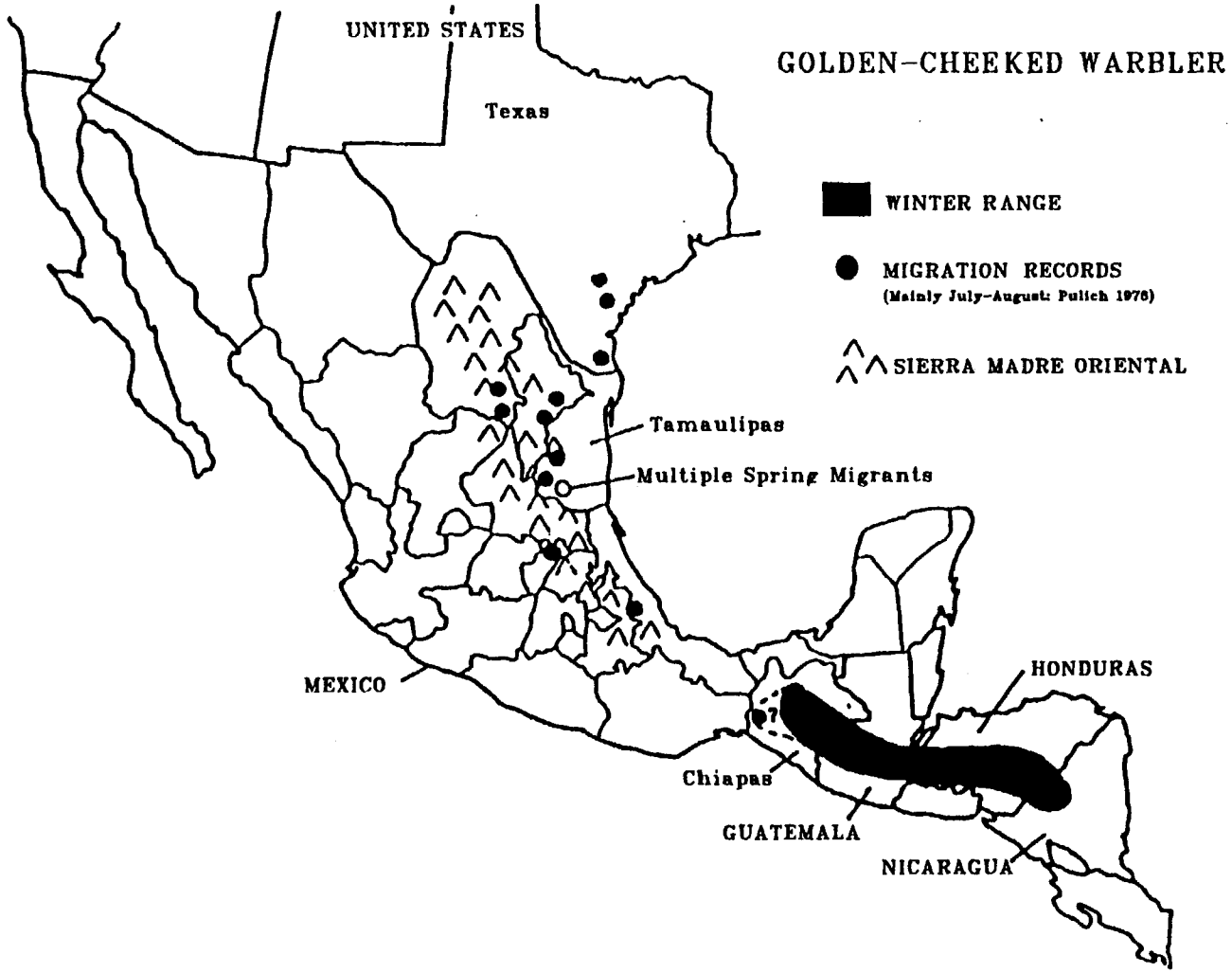


Figure 2. Winter range and migration records of the golden-cheeked warbler (from Perrigo et al. 1990).

E. HABITAT

Nesting Habitat - Tree Species Composition: On the breeding range, GCWs inhabit dense forests and woodlands (often locally called "brakes") containing Ashe juniper (Juniperus ashei) and a variety of other, mostly deciduous species including plateau live oak (Quercus fusiformis), Texas oak (Q. buckleyi), scaley bark oak (Q. sinuata var. breviloba), Lacey oak (Q. glaucoides), post oak (Q. stellata), black-jack oak (Q. marilandica), American elm (Ulmus americana), cedar elm (U. crassifolia), hackberry (Celtis reticulata), sugarberry (C. laevigata), little walnut (Juglans microcarpa), Arizona walnut (J. major), sycamore (Platanus occidentalis), Texas ash (Fraxinus texana), Mexican persimmon (Diospyros texana), coma (Bumelia lanuginosa), redbud (Cercis canadensis), evergreen sumac (Rhus virens), soapberry (Sapindus drummondii), deciduous holly (Ilex decidua), escarpment cherry (Prunus serotina), Mexican buckeye (Ungnadia speciosa), red mulberry (Morus rubra), big-tooth maple (Acer grandidentatum), and Texas mountain laurel (Sophora secundiflora) (Attwater in Chapman 1907, Johnston et al. 1952, Pulich 1976, Kroll 1980, Ladd 1985, Riskind and Diamond 1986, Wahl et al. 1990).

Although the species composition of woody vegetation varies greatly within suitable warbler breeding habitat, Ashe juniper is typically (often, but not always) the dominant species and occurs at all sites inhabited by nesting GCWs. Ladd (1985), for example, found that the most common trees at ten GCW sites (in order of frequency of occurrence or "relative dominance") were Ashe juniper, Texas oak, scaley bark oak, cedar elm, Plateau live oak, little walnut, hackberry, and Texas ash. Ashe juniper comprised 10% to 83% of total trees at 27 sites scattered throughout the breeding distribution of the GCW (Johnston et al. 1952, Pulich 1976, Kroll 1980, Ladd 1985, Wahl et al. 1990). At 14 sites measured by Wahl et al. (1990) the density of Ashe juniper ranged from 56 to 1,098 junipers per ha (sample mean = 422 junipers per ha).

Nesting Habitat - Structure: Wahl et al. (1990) characterized GCW habitat as "closed canopy Ashe juniper-oak woodland." This is true to the extent that GCWs prefer areas with a moderate to high density of trees and dense foliage usually at upper levels. For example, 15 sites inhabited by GCWs and measured by Kroll (1980), Wahl et al. (1990), and Beardmore (unpublished MS) contained on average 771 trees/ha (range 343 to 1562 trees/ha). In suitable habitat at Meridian State Park, Kroll (1980) found average tree densities of 988 stems per ha. Cover has been used to estimate foliage density in different height classes. Total cover at 14 GCW sites averaged 67% at 3 m (44%-117%), 73% at

5 m (21%-155%), and 68% above 5.5 m (12%-200%) (total cover can attain a figure of over 100% due to overlapping canopies) (Wahl et al. 1990).

Stepwise discriminant analysis applied to Kroll's measurements of woody vegetation suggested that presence of Q. sinuata and Ashe juniper, greater distances between trees, lower densities of Q. sinuata and Ashe juniper, and lower height of the stand were the most important variables associated with the presence of GCWs at Meridian State Park (Kroll 1980). A regression model created by Wahl et al. (1990) suggested that greater variability in tree heights, greater density of deciduous oaks, and greater average tree height were associated with higher densities of warblers.

Nesting Habitat - Availability of Nesting Material: GCWs construct nests from strips of bark found on Ashe junipers, consequently the presence of some junipers with shredding bark is a nesting habitat requirement for this species (Werner in Brewster 1879, Attwater in Chapman 1907, Pulich 1976). Ashe junipers begin shedding bark near ground level around 20 years of age (5 cm diameter at breast height (dbh)) (Kroll 1980). Shedding then progresses upward through the larger branches by the time the tree is 40 years old (10-15 cm dbh). These ages, however, may not be accurate because of differences in growth rates among junipers and because of the difficulty of accurately aging junipers by growth ring analysis (Pulich 1976). Female warblers have been observed obtaining bark strips for nest building from Ashe junipers with dbh's as small as 7.5 cm (C. Beardmore, USFWS, and L. O'Donnell, USFWS, personal communications).

Nesting Habitat - Availability of Water: An additional factor that may improve habitat quality is proximity to a watering/bathing site. Pulich (1976) and others (D. Lyter, Espey, Huston and Associates, and B. Armstrong, Texas Parks and Wildlife Department, personal communications) have noticed the tendency of GCWs to frequent springs and a watering trough outside of their territories. If proximity to free water is a limiting factor, then loss of springs and seeps may be a threat to GCWs.

Nesting Habitat - Importance of Canyon Slopes. Attwater (in Chapman 1907) and Ladd (1985) noticed that suitable warbler habitat coincided with steep slopes or rugged terrain. Although suitable GCW habitat is limited to canyon slopes in many areas, this habitat feature may not be a requirement for GCWs. Instead, GCWs may be associated with canyon slopes because of some combination of the following factors that influence habitat quality: (1) greater surface run-off and seepage, which favors luxuriant growth of deciduous

trees and concomitantly greater arthropod availability, (2) greater protection against the effects of range fires, or (3) greater protection against clearing because of the high cost incurred in clearing steeper slopes.

It seems reasonable that moist canyon slopes should favor optimal conditions for warblers. It is also apparent, however, that warblers will occupy drier upland sites such as areas inhabited at Ft. Hood Military Reservation and Travis County Audubon Sanctuary (J. Cornelius and T. Hayden, DOD, and D. Lyter, P. Turner, Espey, Huston, and Associates, personal communications). Flat, riparian drainages with a cedar elm/live oak association such as those at Camp Bullis also are occupied by GCWs (S. Rust, Stewardship Services). David Steed (DLS Associates, personal communication) has described the intermittent occupancy by GCWs of drier, more open situations in Travis County. Unfortunately, the relative stability and productivity of GCW populations in these situations is not well known.

Nesting Habitat - Importance of Stand Age and Stature: Pulich (1976) described the oak-juniper associations preferred by GCWs as ". . . climax stands where trees have average heights of 20 feet [6.1 m] with some deciduous cover . . . ." Supporting this view are measurements made by Wahl et al. (1990), which show tree heights in suitable habitat (n=14 sites) average 6.5 m (range of mean values: 4.5-9.8 m). In addition, Kroll (1980) found that the oak-juniper associations occupied by warblers contained junipers averaging roughly twice the age and girth of junipers in unoccupied oak-juniper associations.

Interestingly, at Kroll's study site (Meridian State Park) occupied habitat contained shorter trees (mean = 3.4 m) than unoccupied habitat (mean = 6.1 m). This reaffirms the cautionary statements of Pulich (1976) regarding the difficulties of aging junipers based on stature. It also suggests that habitat suitability may be influenced more by stand age, habitat structure, tree species diversity, and/or other limiting factors than simply by height of the woody vegetation.

Older closed-canopy woods may be excellent habitat for GCWs because such associations maintain favorable conditions (abundant food, reduced wind shear, and elevated humidities) for warblers and their prey (Saunders et al. 1991), while simultaneously providing greater security against nest parasites and predators (Lovejoy et al. 1986, Wolf 1987). Ashe juniper contributes to the maintenance of such conditions because it is resilient, fast-growing, densely branched, and relatively long-lived.

Today, the great majority of woodlands inhabited by GCWs are not in the pristine condition implied by the term "old-growth". The juniper component of GCW habitat at Meridian State Park, Travis County Audubon Sanctuary, Ft. Hood Military Reservation, and some of the sites sampled by Wahl et al. (1990), has either been selectively cut or mostly cleared within the last 50 years. Scattered through these sites, however, are the requisite older junipers. The most important points in this regard are that (1) strict adherence to a definition of GCW habitat as "old-growth" woodland will likely exclude much suitable habitat that is certainly not old-growth, and (2) proper management of degraded GCW habitat in some cases may restore habitat quality within 2-4 decades.

Nesting Habitat - Importance of "Edge": Because of the cryptic nature of the female, relatively few GCW nests have been located. Therefore, the following discussion is based in part on locations of territories as determined by singing males. Pulich (1976) found the shape of each territory was determined by vegetation composition, as influenced by its ecological edge effect, rather than by the slope or terrain of habitat. Ladd (1985) observed several territories at Kerr Wildlife Management Area (KMA) that were bounded by an edge. Kroll (1980) found territories along trails, roadways, and grassland/woodland interfaces, described the GCW as an "edge species", and recommended improving GCW habitat by cutting extensive oak-juniper woodlands into narrow strips designed to mimic the alleged former distribution of juniper-dominated associations on canyon slopes. D. Lyter (personal communication) has found nests along trails and grassland/woodland interfaces but only in association with wooded canyonlands. Morse (1989) summarizing knowledge to date (citing Kroll 1980 and Ladd 1985) further proliferated the "edge-species view" of the GCW when he described it as a relictual denizen of woodland margins.

However, this point of view is at odds with the currently accepted view that GCWs do best in large blocks of unfragmented habitat (Biological Advisory Team 1990, Wahl et al. 1990, Pease and Gingerich, unpublished MS). The traditional definition of an edge species is one which is found along the interface between two habitat types such as grassland and woodland, and uses resources from both types to survive. GCWs forage and breed within the woodland matrix, and not in adjacent open areas. Although they seem tolerant of living in woodland habitat which is adjacent to an opening, there is no information on whether these birds are more reproductively successful than those in the woodland interior. Hayes et al. (1987) described how GCW habitat at Meridian State Park was thinned and opened up in

an effort to increase the amount of woodland edge habitat available for occupancy by GCWs. The result of this thinning has not been completely studied, however, it appears that the 24-28 territories found by Kroll (1980) have been reduced to 5 territories in 1991 (F. Gehlbach, Baylor University, personal communication).

Another problem with the "edge species" rationale is its dependence on a limited view of the vegetational history of the plateau. "Edge species" rationales depend on concepts of Edwards Plateau vegetation as predominantly grasslands and/or savannas interspersed with fragmented woodlands. An examination of plateau vegetation over the full evolutionary life span of the GCW does not necessarily support the "edge species" view of habitat requirements.

Since the origin of the GCW, Edwards Plateau vegetation has been dynamic. During the Pleistocene, conditions were more moist and the plateau was forested. Various woodland formations (both evergreen and deciduous) were widespread and at times even connected with woodlands of the Rocky Mountains, Gulf-Coastal plain, and Sierra Madre Oriental (Axelrod 1958, Mengel 1964, Lundelius 1986, Van Devender 1986).

At present, there is no quantitative evidence suggesting that warblers living along woodland "edges" are more abundant, more frequently paired with a female, or more productive along edges than in woodland interiors. Conversely, there is also no evidence that the species does best in woodland interior locations. Critical assessment of the problem is essential to the recovery of the GCW. Incorrect acceptance of the "edge-species" view with its implied requirement of high edge/interior ratio could lead to destruction of suitable woodland interior habitat and expose a greater portion of a population's nesting attempts to the heightened rates of nest predation and parasitism typical of forest margins (Gates and Gysel 1978, Brittingham and Temple 1983, Wilcove 1985). In the same way, incorrect acceptance of the "forest interior species" view would favor maintenance of woodland-interior habitat at the expense of high-quality woodland edge habitat.

Winter Habitat: There has been only one quantitative study of winter habitat use by GCWs (Kroll 1980). The elevation of Kroll's study site in Honduras was about 1500 m. Pines (Pinus oocarpa) dominated the overstory. Oaks, particularly Quercus oleioides, comprised 63%, and sweetgum (Liquidambar styraciflua) another 21% of total understory trees and shrubs at this site. Other collection localities and observation sites on the migration corridor and winter range have also been pine-oak woodlands (Land 1962, Alvarez del Toro 1980, Braun et al. 1986).

F. NESTING ECOLOGY

Establishment of Breeding Territories: GCWs return to central Texas from their wintering grounds by mid-March. Earliest arrival dates for males are in the first week of March (Attwater in Chapman 1907, Pulich 1976). Females usually arrive a few days to a week later. Males quickly select territories and begin displaying vocally from prominent perches. These territorial displays continue steadily and frequently until the young fledge, then essentially cease. Few territorial songs are heard after mid-July (Pulich 1976).

Nest Construction and Nesting Situations: Females begin building nests the first week of April (Pulich 1976). All known nests are comprised primarily of strips of juniper bark, 20-110 mm long, that are secured by cobwebs (Pulich 1976). The lining may be composed of bird feathers, grass, oak leaves, bits of moss, etc. (Werner in Brewster 1879, Attwater in Chapman 1907, Pulich 1976). Each completed nest is a compact cup-like structure averaging 80 mm outside diameter and 50 mm outside depth (n=13, Pulich 1976). GCWs apparently nest once a season unless the first attempt fails (Pulich 1976).

Attwater (in Chapman 1907) and Pulich (1976) indicate females usually place nests in the upper two-thirds of nest trees. Average nest height based on three studies of nests (n = 63) is 4.8 m (range 1.8-9.8 m) (Attwater in Chapman 1907, Quillen in Pulich 1976, Pulich 1976). Although Ashe juniper is the most common nest tree, GCWs also build nests in cedar elms, various oaks, walnuts, pecans, bald cypress, and presumably other species.

Incubation Period: Female warblers produce clutches of 3-4 (and rarely 5) creamy white eggs covered with scattered darker markings. The eggs average 17.7 mm by 13.7 mm (n = 50, Bent 1953).

Most complete sets of GCW eggs have been found during the period 3 April to 27 June (Pulich 1976). Clutches laid after the end of April probably are second renest attempts following failed or abandoned first attempts.

Incubation begins on the day before the last egg is laid and lasts 12 days (Pulich 1976). Females apparently perform all incubation duties in this and other Dendroica species (Mayfield 1960, Nolan 1978, Walkinshaw 1983). Pulich (1976) estimated that females spend at least 75% of daylight hours on the nest.

Care of Nestlings and Fledglings: Hatching success for 55 eggs laid in 33 GCW nests was 36.4% (or 20 eggs; Pulich 1976). Adult females brood recently-hatched nestlings and conduct most feedings. Males gradually participate in more feedings. Fledging occurs at about 9 days (Pulich 1976).

Fledgling success was 27% (15 fledglings from 55 eggs) for 33 nests studied by Pulich (1976). This was the lowest fledgling success of five other wood warblers summarized by Pulich (1976). Fledglings are dependent on their parents for at least 4 weeks. Often each adult feeds a portion of the brood and these single parent family groups may wander away from the original territory as the adult searches for food (Pulich 1976). Fledglings begin migrating south as soon as they gain their independence (Pulich 1976).

Migration: Although some GCWs stay in central Texas as late as August (Pulich 1976), most have left the breeding grounds by the end of July (Chapman 1907, Simmons 1924, Pulich 1976). The northward return is more synchronous, with most birds arriving during the second or third week in March (Pulich 1976).

Vocalizations: The territorial display songs of male GCWs and male black-throated green warblers (Dendroica virens) are very similar and have about the same quality as the song of the Bewick's wren (Thryomanes bewickii). GCW vocalizations tend to decline sometime during the nesting and fledgling period and continue to decline through the time when they migrate.

Males also produce incomplete or muffled versions of the standard territorial song. In other warblers such calls are often given after territorial disputes or when a male is close to the nest or the female (Ficken and Ficken 1962). Several workers have noticed subtle differences between the songs of GCWs in different populations (C. Sexton, City of Austin, Dept. of Environmental and Conservation Services; C. Beardmore, personal communications) and even the same male GCW may sing different song varieties (C. Beardmore, personal communication).

Adult male, female, and fledgling GCWs also produce high-pitched single "chips" or so-called "double-chip" notes. These sounds may function as contact notes or alarm calls (Morse 1967). Detection of this call is the best means for locating the female and offspring (Pulich 1976).

Predators: Pulich (1976) reported one instance of a rat snake (Elaphe obseleta) eating a brood of nestling GCWs. He also observed a coachwhip (Masticophis flagellum) in the vicinity of another nest. Blue jays (Cyanocitta cristata)

may have a considerable effect on GCWs to the point of excluding GCWs from areas of apparently suitable habitat in urban areas (Tom Engels, unpubl. data; C. Pease, University of Texas, and C. Sexton, personal communications). Scrub jays (Aphelocoma coerulescens), great-tailed grackles (Quiscalus mexicanus), opossums (Didelphis virginianus), and fox squirrels (Sciurus niger) are other likely predators of eggs and young warblers. Fire ants affect other bird species by eating hatchlings, causing adults to abandon nests, and possibly reducing the invertebrate prey base. However, their effect on GCWs has not been determined.

Nest Parasitism: Pulich (1976) summarizes information on brown-headed cowbird (Molothrus ater) parasitism of GCW nests. In his Kendall County study area, 28 nests were studied to conclusion. Of those, 19 nests were parasitized. Out of those 19 nests, 3 golden-cheeked warblers and 9 cowbirds fledged. The 9 unparasitized nests produced 12 GCW fledglings. In a summary of all nests Pulich (1976) looked at, both in his study and museum specimens (n=61), he found 39% were parasitized. Cowbird eggs hatch two days before the eggs of GCWs (Pulich 1976) giving them an advantage over GCW hatchlings. In three years of study, Pulich (1976) found 9 cowbirds fledged out of 23 cowbird eggs laid. GCWs apparently will either abandon parasitized nests or raise young cowbirds in addition to their own young. The recent arrival of the shiny cowbird (Molothrus bonariensis) in Texas (one was caught in a trap on Fort Hood Military Reservation in May 1990) may present an additional threat to GCWs. This species of cowbird has recently expanded its range from South America to the United States. The threat of cowbird parasitism to GCWs is discussed later in the section "Reasons for listing and current threats".

G. DIET AND FEEDING BEHAVIOR

Analysis of stomach contents of 21 collected GCWs showed that out of 75 prey items identified, beetles (32%), caterpillars (17%), homoptera (17%), hemiptera (13%), and spiders (11%) were the most common prey of GCWs (Pulich 1976). Pulich (1976) also observed warblers feeding on spiders, caterpillars, lacewings, small cicadas, katydids, walking sticks, deer flies, crane flies, adult moths, and adult butterflies. Most prey items taken by GCWs at Meridian State Park (Bosque County) were lepidopteran larvae (54%, n = 82) or various orthoptera (13%, n = 20) (Kroll 1980). GCWs seem to avoid feeding on various spiny moth larvae such as tent caterpillars (Pulich 1976).

Although Simmons (1924) and Smith (1916) described GCWs making aerial sallies after volent insect prey, most foraging time is spent on foot moving from branch to branch gleaning small insects from the foliage (Pulich 1976).

Pulich (1976) observed that GCWs forage ". . .in the upper two-third level of its habitat." Sexton (1987) found that GCWs spent relatively more time foraging in the 1.5-9.1 m zone, and relatively less time foraging below this level. Beardmore (unpublished MS) found that male GCWs forage 60.9% of the time in the 5 m and greater zone before young fledge and 16.8% of the time in the 5 m and greater zone after fledging.

Pulich (1976) pointed out the close relation between the breeding time of GCWs and the appearance of numerous soft-bodied lepidopteran larvae in deciduous trees such as Q. buckleyi and Q. sinuata. The existence of this relationship is supported by the observations of Kroll (1980), Sexton (1987), and Beardmore (unpublished MS) that GCWs spend disproportionately more time in oaks (compared to the relative abundance of oaks) than in junipers. Beardmore (unpublished MS), however, also determined that GCWs did not show this strong preference for oaks later in the breeding season, but split their foraging time between oaks and junipers. Sexton's unpublished data have preliminarily indicated differences in the abundance and composition of potential warbler food items through the warbler nesting season and among key tree species.

H. POPULATION SIZE

Territory Size: Estimates of territory size ranged from 1.3-2.4 ha/territory (mean = 1.7 ha/territory, n = 14 territories) on one 28 ha study area examined by Pulich (1976). These values were based on intensive focal animal sampling and therefore are likely to represent accurate spatial requirements of territorial males. Kroll (1980) estimated 4.5-8.5 ha/pair (n = 10 territories); these values were also derived from focal animal sampling, but it is not clear whether they represent the space covered by individual displaying males.

Little is known about the area covered by females, non-displaying males, and family groups. Pulich (1976) believed that adults of both sexes would leave territories to visit watering/bathing areas. He also believed, however, that females generally limited most of their movements to a portion of the male's territory.

Population Density: Several authorities have attempted to determine total numbers of GCW "pairs" in limited areas studied intensively. Lacey (in Cooke 1923) found an average of 3.8 pairs (2-6 pairs, n = 5 years) per year on one 16 ha woodlot. Johnston et al. (1952 and 1953) and Webster Jr. (1954) found an average of 6.2 pairs (5.5-6.5 pairs, n = 3 years) on 15 ha. In a one year survey, Pulich (1976) found 14 pairs on 28 ha. A summary of these studies produces densities of 9.5-20 pairs/40 ha (100 ac).

Population Size: Pulich (1976) noted that estimates of territory size or population densities of displaying males should not be used to extrapolate GCW population sizes over extensive areas of oak-juniper woodland. Such extrapolation is inappropriate because (1) GCWs and other wood warblers do not always saturate extensive expanses of suitable habitat (Ficken and Ficken 1968, Pulich 1976, Sealy 1979, Ryel 1979, Gill 1980), (2) a large portion of displaying males in a given population may be unpaired (Gibbs and Faaborg 1990), and (3) non-displaying, non-territorial individuals may comprise a large portion of a given songbird population (Smith and Arcese 1984).

To allow for the presence of some unoccupied areas within expanses of occupied, suitable habitat, Pulich (1976) used 8 ha/pair in "good" habitat, 20 ha/pair in "average" habitat, and 33 ha/pair in "marginal" habitat to calculate total GCW population size for range-wide expanses of oak-juniper woodland. Pulich (1976) then applied these values to his own and to Soil Conservation Service (SCS) estimates

of available "Virgin juniper" habitat (Table 1) to calculate potential numbers of paired GCWs. The SCS estimates of habitat availability when multiplied by Pulich's density estimate in average habitat, at 20 ha/pair, gave a value of 18,486 pairs in 1962 and 14,750 pairs in 1974, a 20% loss in 12 years (1.6% per year). In contrast, using Pulich's (1976) estimates of habitat availability, with habitat graded into the three levels of habitat quality, gave values of 7,815 pairs in 1962, and 7,475 pairs in 1974, an 8% loss in 12 years.

Comparing the earlier (1962 and 1974) estimates with the recent survey attempt of Wahl et al. (1990) is complicated by differences in methodologies. Wahl et al. (1990) used LANDSAT MSS (Multi-spectral scanner) imagery in combination with scattered ground surveys of vegetation and warbler abundance. Unfortunately, the satellite imagery did not cover all portions of the GCW breeding distribution, plus the LANDSAT imagery came from three distinct periods -- 1974, 1979, and 1981.

Obviously, the asynchronous timing of the remote sensing imagery creates difficulties in determining the year to which habitat availability estimates should be linked. The lag between the creation of the remote sensing imagery and subsequent field surveys has also likely increased the frequency of habitat classification errors. Despite these problems, remote-sensing coupled with thorough ground surveys should be the most comprehensive of the methods discussed thus far.

Wahl et al. (1990) did attempt to correct for the changes in vegetation that had taken place between the dates of the satellite imagery by ground truthing a portion of the study. In doing so, they produced the following estimates of total available habitat: (1) 338,035 ha of total habitat uncorrected for changes since dates of satellite imagery, (2) 237,163 ha of total habitat corrected for changes since dates of satellite imagery, and (3) 32,149-106,776 ha of total habitat in patches greater than 50 ha. They then calculated a potential population size of 4,822-16,016 "pairs" (at 15 "males"/100 ha or 6.7 ha/"male").

These estimates can be modified in two ways for purposes of comparison with the population estimates of Pulich (1976). First, the density values of Pulich (1976) should be substituted for the one used by Wahl et al. (1990). This occurs because Wahl et al. (1990) derived the value, 6.7 ha/pair (or "male"), using a modified form of the Emlen Transect method (Ramsey and Scott 1981), while Pulich (1976) derived his population estimates from spot-mapping data gathered from a marked population. DeSante (1981),

Table 1. Historical changes in amounts of golden-cheeked warbler breeding habitat.

	Available Habitat (ha)	Percent Habitat Loss
SCS ESTIMATES OF VIRGIN JUNIPER* HABITAT (Pulich 1976)		
1962	367,705	
1974	295,858	20%
STATUS REPORT ESTIMATES OF GCW HABITAT (Wahl et al. 1990)		
1974-1981 Habitat Detected by LANDSAT Imagery	338,035**	
LANDSAT Imagery corrected by 1989 ground truthing	237,163	30%
Potential total loss of habitat from 1962 to 1990	130,542	35%

* Virgin Ashe juniper was 33.5% of all cedar brakes estimated by the SCS in 1962. Likewise, virgin Ashe juniper comprised 24.6% of cedar brakes in 1974. This amounts to a 21% decrease in virgin Ashe juniper between 1962 and 1974, and a 9% increase in cedar brakes.

** Status report was in error. This is the corrected value.

Tilghman and Rusch (1981), Jolly (1981), and van Riper(1981) have pointed out the unreliability of transect methods (in comparison with spot-mapping) for estimating absolute densities of terrestrial birds. Furthermore, Ramsey and Scott (1981) have suggested that in work with sensitive species, derivation of density estimates from transect counts should be done conservatively to reduce the risk of overestimating population size. In this regard, if 8 ha/pair is assumed to be an accurate maximum density for GCWs in large expanses of "good" habitat, then uniform application of the density value of 6.7 ha/territory would overestimate the number of GCW territories by 19% (2,425 territories per 100,000 ha).

Second, patches 50 ha and smaller should be retained in the total of habitat assumed to contain some GCWs. Thirty-four percent (36/107) of patches of habitat smaller than 50 ha were inhabited by GCWs (Benson 1990).

An additional correction, which allows for more uniform comparison, is to assume that proportions of "good" (@ 8 ha/territory), "average" (@ 20 ha/territory), and "marginal" habitat (@ 33 ha/territory) were the same in the Pulich (1976), as in the Wahl et al. (1990) study (23%, 31%, and 46%, respectively). Using these corrections, the resulting 1990 population estimate then becomes 13,800 territories or a decline of 25% (4,686 territories) in the 28 years since the 1962 estimate.

I. REASONS FOR LISTING AND CURRENT THREATS

Habitat Loss: Loss of habitat is the most important threat to the existence of the GCW. In particular, on-going and imminent habitat destruction was used to justify the emergency listing of the GCW in 1990 (55 FR 18844). Habitat loss was from urbanization and clearing associated with agricultural practices. When a species has such limited and definable habitat requirements, habitat loss most likely results in a population reduction.

Effects of secondary factors such as declining oak regeneration, cowbird parasitism, habitat fragmentation, and proximity to urbanized areas have not been well-studied. Consequently, long-term impacts of these secondary factors on GCWs and their habitat must be either projected from current trends or inferred from studies with other species and communities.

Regarding the rate of loss of suitable nesting habitat, SCS estimates (Pulich 1976) and the estimates of Wahl et al. (1990) suggest there has been a loss of 130,542 ha (326,355 ac) or 35% of the habitat available since 1962 (Table 1). The data of Wahl et al. (1990) indicate that the rate of decline of habitat has actually accelerated in recent years. There appears to have been a 30% loss of habitat in the 9-16 years since the original LANDSAT imagery was collected.

Previously, the main reason for steady loss of habitat was the clearing of juniper to improve pasture conditions for cattle grazing (Pulich 1976). Other reasons for loss of juniper woodlands included cutting of junipers for fence posts, furniture wood, and cedar oil. Most recent losses in nesting habitat have occurred in counties such as Travis, Williamson, and Bexar, in which rapid suburban development has spread into oak-juniper woodlands. Wahl et al. (1990), for example, found that 80,829 ha (80%) out of a total of 101,286 ha of recent habitat losses had taken place in 12 counties undergoing significant urban expansion or recreational lake and second home development (Table 2).

Creation of impoundments for flood control and livestock has destroyed additional habitat for the GCW. Such losses occurred because oak-juniper communities often survive only along canyon slopes adjacent to springs and streams, which have been dammed. Pulich (1976) recounts the destruction of warbler populations by reservoirs such as Canyon Dam (Comal County) and Lake Whitney (Bosque and Hill counties). Larger reservoirs have inundated about 67,000 ha within the distribution of the GCW (C. Loeffler, Texas Parks and Wildlife Department, unpublished data; Dowell and Petty 1974). Smaller impoundments (11.25 ha or smaller) may have

Table 2. Counties containing at least 1,000 ha of golden-cheeked warbler habitat in 1988 (counties denoted by an asterisk are undergoing urbanization or recreational lake and second home development; adapted from Wahl et al. 1990).

COUNTY	SIZE OF COUNTY (ha)	AVAILABLE HABITAT (ha)
TRAVIS*	265,010	43,098
REAL	180,262	26,782
COMAL*	149,344	24,796
BANDERA	212,265	21,631
HAYS*	176,076	20,495
BURNET*	263,721	18,845
KERR*	276,869	18,163
EDWARDS	543,291	17,189
UVALDE*	405,247	16,541
WILLIAMSON*	293,183	14,989
KENDALL*	171,885	13,295
KIMBLE	323,886	12,765
MASON	240,658	10,832
BLANCO*	183,681	9,831
BEXAR*	325,010	8,778
CORYELL	273,634	8,294
BELL	278,929	8,270
GILLESPIE*	275,935	8,175
LLANO	249,368	7,429
BOSQUE	257,093	6,389
MEDINA*	345,294	4,878
KINNEY	351,440	2,455
MENARD	234,947	2,030
McLENNNAN	276,189	2,030
SOMERVELL	48,712	1,909
JOHNSON	189,408	1,644
TOTAL	6,791,343	329,503

inundated an additional 112,000 ha (Clarke 1985). Proposed large reservoirs would further inundate about 8,288 ha within the nesting range (Frye and Curtis 1990, Dowell and Petty 1974).

These values are pertinent because the coincidence of former warbler habitat and existing reservoir sites suggests that a large portion of presently flooded terrain once supported GCW populations. Construction of large reservoirs has also led to destruction of much adjacent GCW habitat due to rapid development of land surrounding lake-side communities.

Loss of Winter and Migration Habitat: Most wood warblers spend the major portion of each year away from the breeding range (Schwartz 1980, Morse 1989). This is also true of the GCW, which are either in-transit along the migration corridor or on the winter range for at least 7 months each year. This fact emphasizes the critical importance of GCW habitat in Mexico and Central America.

A recent report by Lyons (1990) summarized the threats facing GCW habitat in Guatemala. Foremost among these is logging and clearing of pine-oak woodlands for commercial lumber, wood pulp, charcoal, firewood, marble quarrying, and farmland (Leonard 1984, Universidad Rafael Landivar 1984). One source estimated that the Guatemalan highlands will be completely logged over in 25-40 years if measures are not taken to halt or reverse the present course (Universidad Rafael Landivar 1984).

Destruction of Oaks: An additional factor that may reduce habitat quality for GCWs is the loss of oaks to various fungal infections (Johnson and Appel 1984). Of primary concern are the effects of the "Oak Wilt" fungus (Ceratocystis fagacearum). All oak species may be infected by this fungus, but red oaks, particularly live oaks, Texas oaks, and blackjack oaks are especially susceptible. White oaks, such as post oak and shin oak, appear to be more resistant to oak wilt (USDA 1990).

Oak wilt is rapidly transmitted in live oaks via interconnected root systems. Such local spread of the infection can radiate from sites of initial infection at rates of up to 40 m/year (Appel et al. 1989). Some infected patches already cover 80 ha and contain hundreds of dead or dying oaks (Appel and Maggio 1984). Unlike in live oaks, the oak wilt fungus forms mats beneath the bark of Texas and blackjack oaks. Sap-feeding beetles are attracted to these fungal mats and may transmit fungal spores over long distances by feeding on fresh wounds of other oaks. Fungal

mats may develop on live or dead (i.e., fire wood) trees and branches (USDA 1990).

The effects of this disease on GCWs should be most pronounced where Texas oak and live oak are major components of warbler habitat and where the importance of other deciduous canopy species is low. Oak wilt may have contributed to the decline of warblers at the Kerrville State Recreation Area (Wahl et al. 1990).

In many parts of central Texas, over-browsing by white-tailed deer (Odocoileus virginianus), goats, and various exotic ungulates has adversely impacted recruitment (i.e., young organisms attaining adulthood, reproducing, and thus replenishing the population) of deciduous trees (Wahl et al. 1990). Overbrowsing, coupled with the broadening impact of oak wilt, suggests that the species composition of oak-juniper woodlands is changing toward greater dominance of juniper. Although GCWs show great tolerance for variability in relative dominance of juniper, the tendency of GCWs to avoid juniper monocultures suggests that the combined influence of overbrowsing and oak wilt could lead to a reduction in the carrying capacity of warbler habitat.

Nest Parasitism: Some wood warblers such as Kirtland's warbler (Dendroica kirtlandii) are undoubtedly threatened by cowbird parasitism. Prior to initiation of an intensive cowbird removal program, up to 75% of all nests of this species were parasitized (Walkinshaw 1983). Kirtland's warbler lacks defenses (such as rejection of cowbird eggs or abandonment of parasitized nests) that can reduce the impact of nest parasitism (Mayfield 1960). Furthermore, habitat degradation on the breeding and/or winter grounds may have depressed the total population of this species to only about 200 pairs (Ryel 1981). Obviously, at this population size, any deleterious effect of recruitment represents a serious threat to the survival of the species.

Pulich (1976) found eggs of cowbirds in 19 of 33 (58%) GCW nests. However, the effect of cowbird parasitism on GCW populations is unknown because (1) GCWs will abandon parasitized clutches and re-nest later in the season when the intensity of parasitism declines (Payne 1973, 1976; Pulich 1976; Nolan 1978); and (2) adult GCWs can successfully rear their own young plus young cowbirds (Pulich 1976, Wahl et al. 1990). This may indicate a partial adaptation to cowbird parasitism that may suggest some contact with cowbirds through the evolutionary history of the warbler.

However, several anthropogenic (human caused) factors, including urbanization and certain agricultural practices

have greatly increased the density and access of cowbirds to a variety of habitats. Cowbirds historically occupied short-grass prairies of the Great Plains west of the Mississippi River, and followed migrating buffalo herds. With the clearing of forested lands, the cowbird's range has greatly expanded (Friedman 1929, Mayfield 1965). Current livestock practices tend to concentrate cowbirds in a given area through the cowbird's reproductive season, greatly increasing the rate and length of exposure of host nests to parasitism events. Other agricultural practices have also led to increased cowbird populations by decreasing winter mortality, such as leaving waste grains in harvested fields and in feed lots, on which flocks of cowbirds and other blackbirds congregate to feed (Brittingham and Temple 1983). In addition, the abandonment of first nests due to cowbirds, or the raising of cowbird young in addition to their own, decreases the total number of GCW young produced by GCW females and the survivability of their young.

An additional complication is that concentrations of livestock may elevate rates of nest parasitism (Rothstein et al. 1987, Gryzbowski 1988) in concert with habitat fragmentation in more exposed (Nice 1937) or edge nest sites (Brittingham and Temple 1983, Wolf 1987). The localized increase in nest parasitism in exposed or edge areas, where researchers and casual observers are more likely to find nests, makes it difficult to draw conclusions about the overall significance of nest parasitism. Finally, cowbird parasitism may interact synergistically or antagonistically with factors such as nest predation (Nolan 1978). These considerations emphasize the difficulties inherent in correctly assessing the effect of cowbird parasitism or effectiveness of cowbird control programs by using only simple measures such as nest parasitism rates or numbers of cowbirds destroyed.

Although the degree of impact of cowbird parasitism on GCW productivity is not determinable at this time and research to determine whether cowbirds are a threat to warbler recovery should be done, current information indicates that it may be prudent to design management strategies that would reduce the chance that nests are parasitized by cowbirds. In this regard, obvious procedures for reducing the impact of nest parasitism on GCW populations would include the following: (1) restoration of fragmented oak-juniper communities so that the open areas preferred by cowbirds become less available and of smaller size close to GCW nesting habitat; (2) elimination of cowbird feeding areas near GCW habitat; and (3) some localized trapping of cowbird females and juveniles may be necessary at management sites with highly fragmented habitat. However, trapping is not recommended unless data

collected over a 2-year period indicate a given warbler population is unable to sustain itself without human intervention or unless cowbird parasitism is extreme the first year.

Complicating these management procedures is the ability of cowbirds to traverse great distances (up to 13 km) between feeding and nesting areas (Smith 1981; Rothstein et al. 1984, 1987). If cowbirds can traverse great distances while maintaining high reproductive output, then removal of livestock and livestock feeding areas from GCW management areas may be ineffective unless these management areas are very large, and livestock are uncommon in surrounding lands.

Rothstein et al. (1987) came to the same conclusion in reference to effectiveness of cowbird trapping stations. In their study, cowbird trapping at a "pack station" in the Sierra Nevada had little impact on numbers of adult resident females in surrounding areas. The interpretation of Rothstein et al. (1987) was that the removal program failed locally because the abundance of free-ranging cattle in the area diminished the tendency of local resident adults to use the trap-site feeding station.

The type, extent, and cost of cowbird control measures should be carefully considered before initiation to justify the appropriateness. For example, although localized trapping of cowbirds may be justifiable as a short-term means to boost GCW productivity in highly fragmented sites, too little is known about effects of cowbird parasitism on GCWs to justify intensive investment in large-scale cowbird removal programs.

Initial cowbird trapping efforts conducted at the Ft. Hood Military Reservation were ineffective in reducing the incidence of parasitism on black-capped vireos (Vireo atricapillus), and these same efforts may have actually increased parasitism rates by attracting cowbirds to localized vireo populations (Tazik and Cornelius 1990). More recent data, however, suggest that greatly intensified trapping efforts and reduction of livestock numbers on Ft. Hood have significantly decreased parasitism rates and increased vireo productivity (Hayden, personal communication).

Habitat Fragmentation: Fragmentation of habitat reduces habitat quality for woodland songbirds in the following ways: (1) small patch size and thus small population size make extant populations more susceptible to random extinction or effects of inbreeding; (2) increased distance between patches reduces gene flow between populations and makes recolonization of vacant patches more difficult; and,

(3) increased proportion of habitat edge in small patches may so alter patterns of insect abundance, vegetation structure, and songbird foraging activity (due to changes in the microclimate) (Brett 1989, Klein 1989, Parker 1989, Reville et al. 1990, Saunders et al. 1991), or so heighten rates of nest parasitism and nest predation that the surviving songbird populations cannot maintain themselves (Lovejoy et al. 1986, Wilcove et al. 1986).

Proximity to urban areas may compound the problem of fragmentation by exposing edge habitats to high densities of certain nest predators such as blue jays (Cyanocitta cristata). Additional research is needed to determine impacts associated with jay predation. Wilcove (1985), for example, also found that small suburban fragments experienced higher predation rates than nests in small rural fragments.

Wood warblers typically produce only one rather small brood of young per year and usually construct open nests (Chapman 1907, Bent 1953, Griscom and Sprunt, Jr. 1957), thus we would expect wood warbler species to be sensitive to any factor such as habitat fragmentation that reduces foraging efficiency and increases nest predation (Morse 1989). Despite this generalization, wood warblers vary in their sensitivity to habitat fragmentation. Some species, such as black-and-white warblers (Mniotilta varia) and ovenbirds (Seiurus aurocapillus), quickly disappear when otherwise suitable habitat is chopped into small patches. Other species such as yellowthroats (Geothlypis trichas) and Kentucky warblers (Oporornis formosus) seem to be at least superficially tolerant of fragmentation effects (Whitcomb et al. 1977, 1981; Gibbs and Faaborg 1990).

Pulich (1976), Kroll (1980) and Ladd (1985) have pointed out that GCWs will inhabit territories in woodlands along habitat edges. However, the nature of those territories (i.e., whether occupied by unmated males, mated pairs, or successfully reproducing pairs) is unknown.

Effects of isolation on GCWs depend in part on the dispersal ability of the species. Although GCWs travel great distances on migration, site fidelity may restrict breeding season dispersal movements. As patches become more isolated, local populations of warblers become isolated and more subject to the deleterious effects of inbreeding. Furthermore, rates of juvenile returns to birth sites in many passerine species are low despite high winter survivorship (Morse 1989). As nesting populations become more isolated, the ability of returning juveniles to locate suitable habitat and mating opportunities declines, thus nullifying programs such as cowbird trapping that try to

elevate the reproductive success of host species (Mayfield 1983). In addition, the further isolated an area is, the harder it is for a given area to be recolonized if the population is extirpated.

J. CONSERVATION MEASURES

Current Research: A number of studies of various aspects of GCW ecology are currently in progress. C. Beardmore's examination of GCW behavior (MS in preparation), for example, will augment those of Kroll (1980) and Sexton (1987) by providing detailed information on sexual differences in GCW foraging behavior and foraging substrate preferences.

Population monitoring projects currently in progress include studies at the following sites: (1) Camp Bullis Military Reservation and Friedrich Wilderness Park, Bexar County (Susan Rust, personal communication); (2) Travis County Audubon Sanctuary (David Lyter, and Paul Turner, TPWD, personal communication); (3) Hamilton Pool Natural Area (Terri Seigenthaler, Austin Parks and Recreation Department, personal communication); (4) Ft. Hood Military Reservation (John Cornelius and Tim Hayden, personal communication); (5) Kerr Wildlife Management Area (Tim Schumann, U.S. Fish and Wildlife Service, and Verajean Hatfield, Hatfield Consultations, personal communications), (6) Lower Colorado River Authority, Wheless and McGregor Tracts (Sherri Kuhl, LCRA, personal communication); (7) Cypress Creek Watershed, Travis County, Texas Department of Transportation (Bill Hood, Texas DOT); and (8) Bull Creek Watershed and 3M Austin Center (DLS Associates, 1990, 1991, 1992). In addition, the Balcones Canyonlands National Wildlife Refuge (BCNWR), which is being established to protect endangered species habitat and serve in an interpretive/educational role, began monitoring GCWs in 1992 on about 3,000 acres and will continue and expand this in the future.

John Cornelius and Tim Hayden are conducting intensive studies of GCW population biology at the Ft. Hood Military Reservation. In 1991 and 1992, this work resulted in the banding of about 300 GCWs and will set the stage for the first thorough examination of this species' population biology. In addition, a Section 6 project was started at the Kerr Wildlife Management Area that proposes to determine the territory size and return rate of GCWs and the relationship of GCW occupation of habitat to forest edge and interior situations.

The Nature Conservancy of Texas and Texas Parks and Wildlife Department in cooperation with the U.S. Fish and Wildlife Service have begun a detailed remote sensing study of the distribution of GCW nesting habitat. Results of this project should be valuable in monitoring patterns in habitat availability. A similar study is needed over the entire migration corridor and wintering range.

Other Conservation Measures: The U.S. Fish and Wildlife Service has formed a GCW Recovery Team. This recovery team will provide advice to the U.S. Fish and Wildlife Service on conservation of the GCW.

The Balcones Canyonlands Conservation Plan (BCCP) is a conservation plan (as defined in Section 10(a) of the Endangered Species Act) that is being developed in Travis County. The BCCP would set up a system of preserves for the GCW and other endangered and candidate species along with other conservation measures. The BCCP is still developing and has not yet been submitted to the U.S. Fish and Wildlife Service for approval.

Another protection effort under way in Travis, Burnet, and Williamson counties is the establishment of the Balcones Canyonlands National Wildlife Refuge by the U.S. Fish and Wildlife Service. It is hoped that, in conjunction with the BCCP and surrounding areas, the Refuge can support a significant population of GCWs. The refuge has already purchased 3,500 acres and proposes to be at least 41,000 acres when completed.

Many private landowners in Central Texas have contacted the U.S. Fish and Wildlife Service for assistance in determining whether or not GCW habitat occurs on their properties and what conservation measures are necessary to protect the warbler. Several of these individuals are voluntarily managing their lands to preserve, enhance, and voluntarily restore GCW breeding habitat.

Prospects for habitat preservation in southern Mexico and Central America are not well known. In Chiapas, Mexico, the Lagunas de Montebello National Park may preserve some pine-oak woods along the Guatemalan border. The Guatemalan Congress has recently been considering declaring much of the Sierra de las Minas as a protected area. In addition, the Guatemalan Audubon Society is presently negotiating for the acquisition of an 896 ha preserve in the same mountain range and an additional preserve near Chelem-ha (Lyons 1990).

K. EXISTING PUBLIC LANDS WITH GCW HABITAT

A number of public parks, recreation areas, wilderness areas, and military reservations already protect some GCW habitat within the breeding distribution (Figure 3, Table 3). Of particular importance are existing public lands that already protect large blocks of GCW habitat.

Foremost among the public lands with large GCW populations is the 87,800 ha U.S. Army reservation at Ft. Hood (Coryell and Bell counties). This military base contains at least 2,786 ha of warbler habitat and represents the single largest existing habitat area in one ownership. The 11,152 ha Camp Bullis military reservation (Bexar County) also contains GCW habitat.

Unfortunately, the amount of GCW habitat present on most publicly held sites is not well known. Studies to determine the amount and occupancy rate of GCW habitat need to be done. This amount of habitat may be only a small portion of the total of existing GCW habitat, but it might be increased through efforts to improve the quality and quantity of warbler habitat on state and other public lands. This approach may also provide a significant future public

Figure 3. Distribution of some public lands within the breeding range of the Golden-cheeked Warbler (underlining indicates "GCWs present": (1) Possum Kingdom SP, (2) Lake Mineral Wells SP, (3) Dinosaur Valley SP, (4) Meridian SP, (5) Lake Whitney SP, (6) Naval Industrial Reservation Ordnance Park, (7) Ft. Hood Military Reservation, (8) Colorado Bend SP, (9) Inks Lake and Longhorn Caverns SPs, (10) Lake Georgetown, (11) Buck WMA, (12) Enchanted Rock SNA, (13) Balcones Canyonlands NWR, (14) LBJ SP and National Park, (15) Pedernales Falls SP, (16) Hamilton Pool and Westcave preserves, (17) Kerr WMA, (18) Guadalupe SP and Honey Creek Ranch SNA, (19) Lost Maples SNA, (20) Garner SP, (21) Hill Country SNA, (22) Camp Bullis Military Reservation/Friedrich Wilderness Area, (23) Kickapoo Caverns SP, (24) Lake Whitney SRA, (25) Mother Neff State Park.

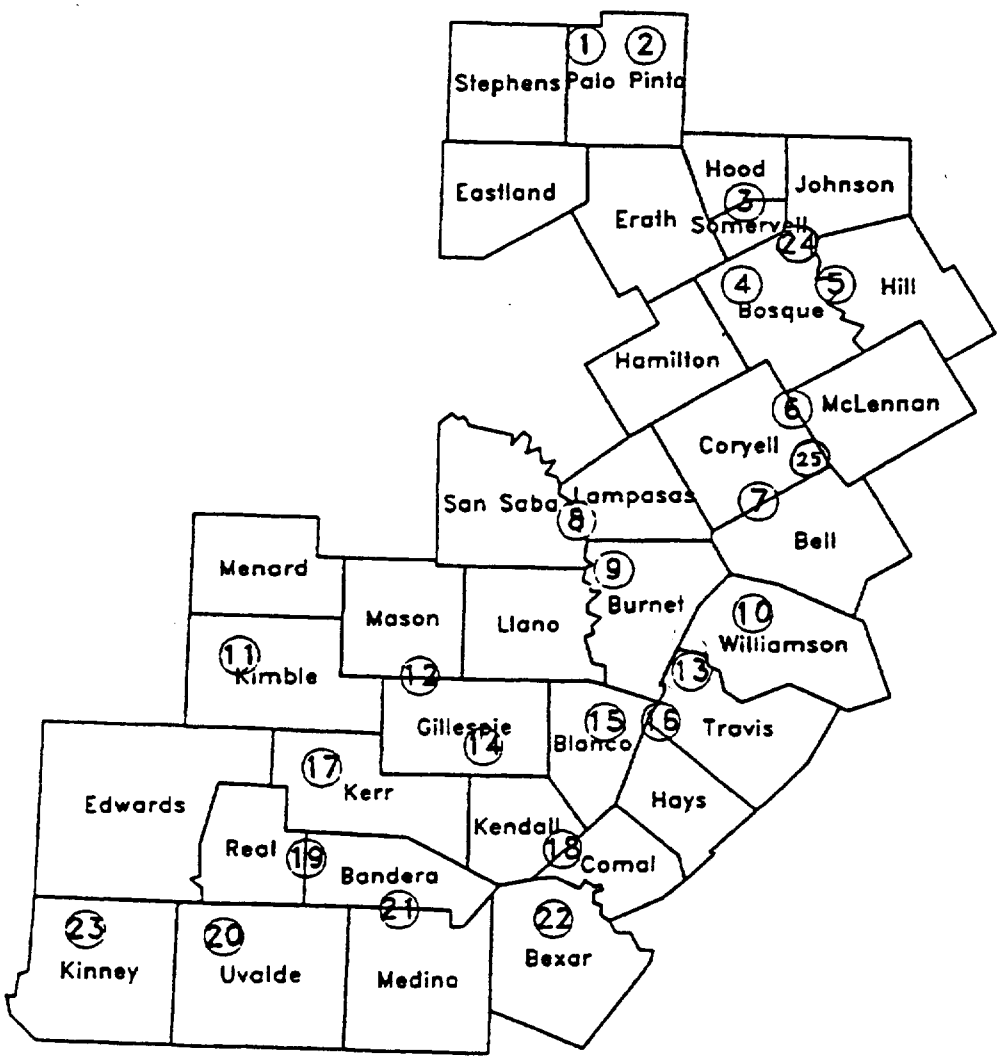


Table 3. Total hectares of some state and federal lands within the breeding distribution of the golden-cheeked warbler.

NAME	COUNTY	TOTAL HECTARES
STATE LANDS		
HILL COUNTRY SNA	BANDERA/MEDINA	2,148*
LOST MAPLES SNA	BANDERA	870*
BLANCO SRA	BLANCO	42
PEDERNALES FALLS SP	BLANCO	1,944*
MERIDIAN SRA	BOSQUE	201*
LAKE WHITNEY SRA	BOSQUE/JOHNSON/SOMERVELL	382
INKS LAKE SP	BURNET	481
LONGHORN CAVERN SP	BURNET	256*
GUADALUPE RIVER SP	COMAL/KENDALL	775*
HONEY CREEK RANCH SNA	COMAL	917*
MOTHER NEFF SP	CORYELL	104
CEDAR HILL	DALLAS	731
ENCHANTED ROCK SNA	GILLESPIE/LLANO	657
LBJ STATE HISTORIC PARK	GILLESPIE	293
CLEBURNE SRA	JOHNSON	212
KERR WMA	KERR	2,597*
KERRVILLE SRA	KERR	207
BUCK WMA	KIMBLE	849
COLORADO BEND SP	LAMPASAS	2,131*
POSSUM KINGDOM SRA	PALO PINTO	612*
LAKE MINERAL WELLS SP	PARKER	1,162
DEVIL'S SINKHOLE SNA	REAL	716
DINOSAUR VALLEY SP	SOMERVELL	510*
EAGLE MOUNTAIN SRA	TARRANT	160
GARNER SP	UVALDE	568*
SUBTOTAL		20,300
FEDERAL LANDS		
FT. HOOD MR	CORYELL/BELL	86,800*
CAMP BULLIS MR	BEXAR	11,152*
LAKE GEORGETOWN	WILLIAMSON	5,000*
BALCONES CANYONLAND NWR	TRAVIS/BURNET/ WILLIAMSON	3,500*
SUBTOTAL		106,452
TOTAL		126,752

* denotes those sites known to have GCWs

relations benefit by reducing pressure on the private landowner to maintain GCW habitat.

The largest state properties that contain occupied GCW habitat include Hill Country State Natural Area (Bandera and Medina counties), Pedernales Falls State Park (Blanco County), Kerr Wildlife Management Area (Kerr County), and Colorado Bend State Park (Lampasas County). Numerous smaller public properties managed by Texas Parks and Wildlife Department, Lower Colorado River Authority, and various federal, state, county, and municipal lands also contain some GCW habitat.

L. RECOVERY STRATEGY

Before discussing recovery strategy, some terminology used throughout the remainder of the recovery plan that is necessary to understand the recovery strategy and recovery criteria is defined below.

A **population** is a set of organisms belonging to a species that is geographically delimited and capable of freely interbreeding with one another under natural conditions (Wilson 1975).

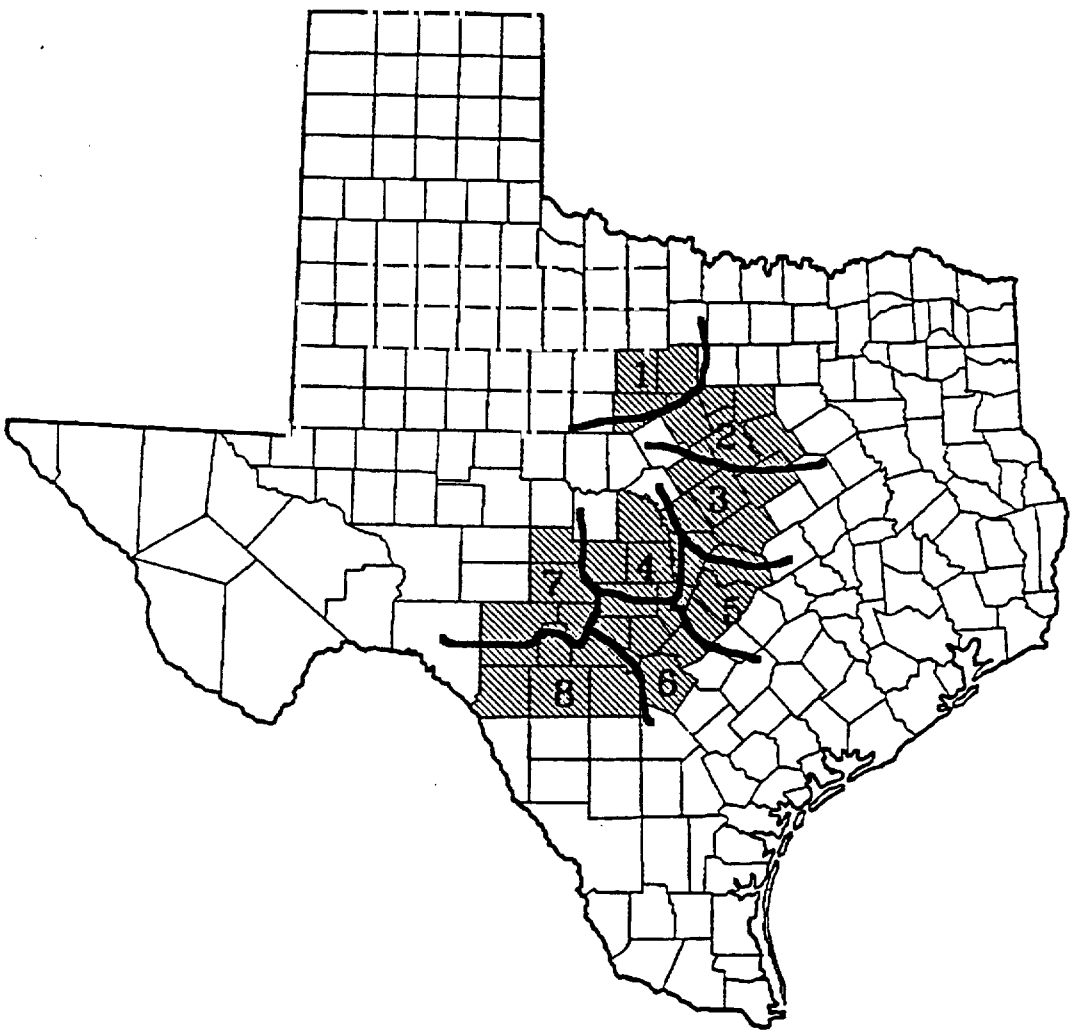
A **viable population** is a population that "maintains its vigor and its potential for evolutionary adaptation" (Soulé 1987) and that "is self-sustaining with minimal demographic or genetic intervention over the long term" (Wilcox 1986).

Focal area is used to mean areas targeted for meeting the recovery criteria. These areas may consist of a single population or one or more populations that are in more or less isolated patches but are interconnected with other populations through gene flow (that is, a metapopulation).

This recovery plan assumes that attainment of the recovery criteria presented in Section II will provide for long-term maintenance of this species. These criteria include the following:

(1) Sufficient breeding habitat should be protected to ensure the continued existence in each of eight regions, outlined in Figure 4, of at least one self-sustaining population that is either viable on its own or through its connection to other populations. The eight regions were delineated based on such considerations as geologic, vegetational, or watershed boundaries. These regions were also delineated to cover the entire breeding distribution of the GCW. The population sizes and arrangements necessary to attain and maintain viability need to be defined as part of recovery. Ideally, this criteria should be accomplished by targeting focal areas that coincide with public lands to the maximum extent practicable and by building voluntary relationships with private landowners to protect additional habitat needed to assure viability.

Figure 4. Regions 1-8 for golden-cheeked warbler populations.



(2) If no population in a given region is a viable population by itself, then there should be at least one population in the region that is (a) large enough to be demographically self-sustaining (though it can be dependent on its connection to other populations to be genetically viable) and (b) has the potential for gene flow to be maintained between the population and at least one other self-sustaining population so that genetic viability is provided for.

(3) Sufficient wintering habitat and migration corridor habitat for this species should be protected south of the breeding range. The success of this part of the plan will depend largely on cooperative efforts among many public and private entities over several international boundaries.

(4) Until information is obtained that will determine the size and arrangement of the populations and habitat needed for recovery, all existing occupied GCW habitat on public areas should be protected.

(5) All of the above conditions should be maintained for at least 10 consecutive years, so that a high degree of confidence in the perpetuation of the conditions is assured.

It is not known if gene flow occurs or could occur throughout the entire breeding range of the warbler, or whether gene flow is geographically restricted in certain areas. For example, GCW's may be so site tenacious behaviorally to certain watersheds or other portions of the breeding range that they would not likely select a territory in any other part of the breeding range and are, therefore, geographically limited.

Accurate models for predicting viable population sizes for specific species are not yet available (Grumbine 1990). Lande and Barrowclough (1987) suggested that 500 individuals may at least be the correct order of magnitude for maintenance of a population. Modeling efforts of Pease and Gingerich (unpublished MS) indicate that a viable population for generalized small songbird populations needs to be at least 500-1000 pairs. A stochastic modeling approach used by Dennis et al. (1991), however, demonstrates sensitivity of the extinction process to species-specific demographic attributes. Soulé (1987) summarized recommendations by the contributors to his book, Viable Populations for Conservation, and suggested a viable population size in the low thousands for most vertebrates. Although these

estimates for viable populations are relatively similar, it demonstrates the difference of opinion on the subject. Viability of the GCW populations will be determined by research tasks recommended in the recovery outline.

The purpose of recovery is to ensure that the species can maintain itself for an extended period of time without intervention. In this regard, the approach should be cautious; in other words, it would be better to target a few more pairs than is estimated for recovery than too few pairs and have the species dwindle to the point of extinction. This plan recommends against allowing a reduction of potentially healthy GCW groups to dwindle to a threshold level where sustainability and viability have a low probability.

Fundamental to the recovery strategy is the creation of a system of protected populations scattered over the present breeding distribution. In some cases, interconnectivity of populations is necessary to protect populations against effects of inbreeding and to provide for recolonization of sites if local populations are extirpated. Essentially nothing is known about the dispersal abilities of GCWs. Consequently, the only way to assure that managed populations are interconnected is to encourage maintenance of abundant and scattered patches of habitat outside of the focal areas. This strategy of identification and establishment of viable, self-sustaining populations should include, among other things: (1) research tasks such as the remote sensing/GIS survey work and ground truthing to locate existing large patches of habitat; (2) improved public relations, incentives, assistance, and/or educational programs designed to increase voluntary protection of warbler habitat; and (3) methods for establishing and maintaining public and private management areas in Mexico and Central America to assure preservation of adequate habitat along the migration corridor and in the winter range.

There are several approaches that could lead to the attainment of the populations and associated habitats. The approach most likely to succeed is to increase protection of habitat through enhanced public relations/public education, incentives, assistance, and cooperative arrangements with landowners. Coupled with this approach should be intensified protection and management for the GCW on existing public lands. Habitat acquisition is an approach that is available in limited instances, such as in the case of the Balcones Canyonlands National Wildlife Refuge. However, direct acquisition of enough habitat to recover this species is not probable and cannot be viewed, by itself, as a means of recovering the species. Although it

is likely that a combination of these two approaches will be employed, full recovery will be dependent in large part on the cooperative efforts of private landowners and public entities, and an effort should be made to emphasize creative alternatives at every opportunity.

Research aimed at elucidating various aspects of the ecology and population biology of the GCW will be critical to accomplishing the objective of this plan. In particular, the results of carefully-designed studies must be available for designing management techniques and detailed strategies and evaluating (1) the effectiveness of management techniques, (2) the appropriateness of the recovery criteria, and (3) the progress of recovery. Definitive studies will require more than a single field season. Collaboration among the various parties conducting research can maximize the efficiency associated with conducting the needed GCW research.

Federal agencies have a responsibility to comply with Section 7 of the Endangered Species Act. Specifically, the Act says "all other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species." Several Federal agencies have programs that can contribute to the conservation of the GCW.

The U.S. Fish and Wildlife Service will coordinate the implementation of this recovery plan with other recovery plans and efforts that overlap the range of the GCW both in Texas and in Mexico and Central America.

II. RECOVERY

A. OBJECTIVE AND CRITERIA

Objective: The objective of this recovery plan is to outline steps necessary to recover the golden-cheeked warbler to the point that it can be removed from the Endangered and Threatened Species List.

Criteria: The golden-cheeked warbler will be considered for delisting (removal from the List) when:

(1) sufficient breeding habitat has been protected to ensure the continued existence of at least one viable, self-sustaining population in each of eight regions outlined in Figure 4;

(2) if no population in a given region is viable by itself, then there should be at least one population in the region that (a) is large enough to be demographically self-sustaining and (b) has the potential for gene flow to be maintained between the population and at least one other self-sustaining population so that genetic viability is provided for;

(3) sufficient and sustainable non-breeding habitat exists to support the breeding populations in #1 above;

(4) all existing GCW populations on public lands are protected and managed to ensure their continued existence, at least until the optimum and spatial arrangement of populations needed for long-term maintenance of the species (viability) is determined;

(5) all of the above have been maintained for at least 10 consecutive years.

These reclassification criteria are preliminary and may be revised on the basis of new information (including research specified by this recovery plan). The size and location of the populations within the eight regions will be determined as a result of completion of some of the tasks in the recovery outline. The estimated date for attaining the objective of this plan (delisting) is 2008.

B. RECOVERY OUTLINE

The following is an outline of recovery tasks needed to attain the objective of this plan. The following section (C.) includes more detailed information on the tasks.

1.0 Research Needs

1.1 Population Biology

1.11 Determine survivorship, dispersal, reproductive success, and other population parameters.
1.12 Determine population sizes, etc., necessary to attain and maintain viability.
1.13 Determine whether gene flow is provided for among populations.

1.2 Ecology and Behavior

1.21 Study foraging behavior and prey species.
1.22 Study the movements within populations and during the post-breeding period.
1.23 Study distribution in relation to productivity.
1.24 Study the relationship of various predators to GCW reproductive success.
1.25 Determine the rate and extent of cowbird parasitism and whether it is a threat to recovery.
1.26 Study the biology and behavior of wintering and migrating GCWs.

1.3 Habitat Requirements and Availability

1.31 Determine habitat requirements and habitat selection patterns in the breeding range.
1.32 Study habitat patch size requirements and determine the effects of disturbance on reproductive success.
1.33 Determine the effects of urbanization and other land use practices on patch size requirements.
1.34 Study the dynamics of hardwood regeneration in older mixed deciduous-juniper associations.
1.35 Study habitat requirements of GCWs during migration and on their wintering grounds.
1.36 Determine current distribution of existing habitat on private and public land in the breeding range.

1.37 Determine locations of the focal areas and associated habitat.
1.38 Determine size of buffer zones needed to reduce impacts of urbanization and agricultural activities.
1.39 Study the effects of management options in Task 3.0.
1.310 Determine current distribution and availability of habitat in the winter range and migration corridor.
1.311 Determine the optimum distribution of areas to be protected in the winter range and migration corridor.

1.4 Monitoring

1.41 Monitor target populations.
1.42 Monitor the effects of management tasks in 3.0.
1.43 Develop a post-recovery monitoring plan.
1.44 Monitor habitat and populations in Mexico and Central America.

2.0 Habitat Needs

2.1 Establish a system of focal areas, and interconnecting habitat where necessary, within the eight regions in the breeding range.
2.11 Protect populations on public land.
2.12 Protect populations on private land.
2.121 Locate landowners interested in voluntarily protecting GCW habitat.
2.122 Encourage voluntary protection and improve incentives for voluntary protection of GCW habitat.

2.2 Protect habitat in the winter range and along the migration corridor.
2.21 Identify currently protected areas within potential GCW winter and migratory habitat.
2.22 Make contacts, encourage and assist, where possible, with efforts by governmental and conservation organizations and individuals in these countries.
2.23 Identify and encourage funding of conservation efforts.
2.24 Investigate and encourage options to protect habitat.

3.0 Management Needs

- 3.1 Enhance and maintain quality of GCW habitat on public and private lands.
- 3.2 Maintain hardwood regeneration within GCW management sites.
- 3.3 Promote the regeneration of oak-juniper woodlands in certain areas previously cleared, thinned, or burned.
- 3.4 Develop management options for formation of GCW habitat.
- 3.5 Adopt management strategies that reduce the impact of cowbird parasitism and nest predation on GCW populations.
- 3.6 Minimize the extent to which GCWs are affected by agriculture and urbanization.
- 3.7 Develop management guidelines and provide technical assistance to landowners.
- 3.8 Investigate and encourage sustainable development options for GCW habitat in Mexico and Central America.

4.0 Public Information and Education

- 4.1 Increase public awareness of the importance of the GCW and natural ecosystems.
- 4.2 Develop curriculum/media for childhood and adult natural history/endangered species education.
- 4.3 Develop and disseminate informative brochures and pamphlets on GCW management and natural history.
- 4.4 Develop and provide information and educational materials for Mexico and Central America.
- 4.5 Develop demonstration ranches and public areas.

5.0 Regulatory

C. NARRATIVE OUTLINE FOR RECOVERY ACTIONS

1.0 Research needs

Because female GCWs are difficult to observe, typical habitat is very dense, and nests are extremely cryptic, many details of the species' life history have not been adequately studied. It is also often difficult to obtain access to census populations on habitats in private ownership.

1.1 Population biology

1.11 Determine survivorship, dispersal, reproductive success, and other population parameters. Determine rates of population turn-over, rates of return to the same area year after year, rates of nesting productivity, the proportion of mated pairs and unmated individuals within populations, and rates and distances of interpopulational movements of adults and returning juveniles, by means of a mark-recapture study. This information will be used in developing viability models (1.12), determining when viable population targets for delisting have been met, and assisting with determining whether gene flow among populations is provided.

1.12 Determine population sizes, etc., necessary to attain and maintain viability. Use the information from 1.11 to develop viability models and determine population sizes, amount of area, and necessary distribution of habitat and populations (including corridors) needed to assure viable populations in each of the eight regions.

1.13 Determine whether gene flow is provided for among populations. Use the information from 1.11 and 1.12 or gather other genetic information to determine whether gene flow is provided for where needed. Gene flow is closely tied to viability (Task 1.12) and determining the locations of focal areas (Task 1.37). A consideration in determining the locations of target populations (focal areas) is the potential for gene flow and enhancement of adaptive genetic variation. The positioning of the populations should be evaluated from a theoretical perspective, but the proposed

populations and associated habitat need to be designed with existing populations and habitat in mind. Area selection should be influenced by the distance to and location of other viable or self-sustaining populations.

1.2 Ecology and Behavior

1.21 Study foraging behavior and prey species. Further study of foraging behavior as it relates to various ecological and physical aspects of the habitat is needed, particularly post-breeding foraging behavior. Other studies are also needed, such as determining the types and abundances of prey species as they relate to vegetation species composition and other ecological and physical variables that may influence prey abundance.

1.22 Study movements within populations and during the post-breeding period. This information is particularly important in relation to habitat types and quality and will be applied to further defining the habitat requirements of the species. This task could be done in conjunction with Tasks 1.11 and/or 1.23.

1.23 Study distribution in relation to productivity. This study would document the productivity of GCWs in relation to the habitat used. It would address questions such as: (1) are there unmated individuals, what habitats are they using, and are they essential for recovery, and (2) is there a habitat type that is more productive than others, so that protection efforts can focus on more productive habitat. This study should be done in conjunction with fragmentation studies (Tasks 1.32 and 1.33).

1.24 Study the relationship of various predators to GCW reproductive success. Various predators may have a significant impact on the reproductive success of GCWs. This study would document predation rates in relation to fragmentation and land use practices.

1.25 Determine the rate and extent of cowbird parasitism and whether it is a threat to recovery. Cowbird abundances, rates of cowbird nest parasitism, and the effects on GCW productivity should be identified at several experimental sites. Then, various livestock densities and rotational schemes and other variables should be manipulated at those sites to determine if there is an effect on cowbird concentrations, rates of nest parasitism, and GCW productivity. In addition, the effects of fragmentation should be studied to determine if rates of cowbird parasitism and GCW productivity are affected. Adequate evaluation of these impacts may require several years of study.

1.26 Study the biology and behavior of wintering and migrating GCWs. Studies are needed of warbler distribution and movements, and foraging behavior in their winter range and migration corridor. Banding stations should be established at wintering and migrating sites. Studies should be coordinated with Mexican and Central American programs, as well as other programs such as Partners in Flight, U.S. Forest Service's Sister Forest Program, and Smithsonian research programs.

1.3 Habitat requirements and availability

1.31 Determine habitat requirements and habitat selection patterns in the breeding range. A definitive study of the habitat requirements and habitat selection patterns of GCWs is needed. Previous work has focused on vegetative structure in suitable habitat or on foraging substrate preferences without attempting to examine potential underlying causal relationships.

This study of the breeding habitat should include measurements of vegetation structure/form, warbler foraging behavior (Task 1.21), warbler movements (Task 1.22), patterns of warbler abundance (Task 1.23), and examination of factors influencing abundance of warbler prey (Task 1.21), GCW predators (Task 1.24), and nest parasites (Task 1.25). The importance of water to the quality of GCW nesting territories

needs to be clarified. Habitat selection studies could focus around nest site selection studies.

1.32 Study habitat patch size requirements and determine the effects of patch size on reproductive success. Expand the research that has already been done on patch size requirements. Map locations of territorial males and, if possible, distributions of mated pairs and productive pairs in relation to size and location within the patches of habitat. This task could be done in conjunction with Task 1.33.

1.33 Determine the effects of urbanization and other land use practices on GCW abundance. The effects of urbanization and other land use practices are difficult to treat separately, however, some of the variables that might be investigated include: trails, roads, fence lines, rights-of-way in urban versus rural situations, low and high density housing, recreational activities and developments, commercial and business development, brush clearing, increased predators, increased nest parasitism, noise, and lighting. This task could be done in conjunction with Task 1.32, especially to determine effects of land use practices on reproductive success and the interaction of these effects with patch size.

1.34 Study the dynamics of hardwood regeneration in older mixed deciduous-juniper associations. Long-term monitoring studies are needed that will provide information on the plant population biology and the dynamics of plant succession in central Texas woodlands. In particular, focus is needed on the effects of oak wilt and overbrowsing on hardwood regeneration and resulting plant population dynamics and community composition. This study should also determine browsing levels that would be compatible with GCW habitat regeneration. Browsing studies should include the effects of deer and exotic and domestic animals.

1.35 Study the habitat requirements of GCWs during migration and on their wintering grounds. Describe the vegetation species composition and structure of migration stop-over points and winter range. This work will require coordination of field surveys with remote sensing work designed to locate extant patches of winter habitat (Task 1.310).

1.36 Determine current distribution of existing habitat on private and public land in the breeding range. The ongoing remote sensing study of GCW habitat distribution in central Texas should be completed. The study should provide maps indicating the distribution and total area of suitable habitat on public and private lands in all counties within the breeding distribution of the GCW. This study should also search the periphery of the range in an effort to detect any habitat where GCW populations might be surviving in counties where the species is thought to have been extirpated. This study should also include a measure of habitat quality and relative density of GCWs by habitat type.

1.37 Determine the availability and placement of the focal areas and associated habitat. These focal areas should be selected in such a way as to include habitat that would meet delisting criteria for at least one viable, self-sustaining population for each region. Information should also be used from research conducted under Task 1.0 to determine the size and distribution of the focal areas and the interconnecting habitat. Preservation of the distribution of the GCW including the extremities of the breeding range is part of the recovery strategy. Focal areas should coincide with public land to the maximum extent practicable. A more complete survey of public lands for GCWs is needed. Ultimately, there should be well distributed patches of protected habitat on public and private lands throughout the present breeding distribution of the species. Distribution of dispersal habitat should also be considered.

1.38 Determine size of buffer zones needed to reduce impacts of urbanization and agricultural activities. The size of the area needed to support target populations should consider the need for buffer zones in some areas to reduce the impacts of urbanization and agricultural activities. Information obtained in Tasks 1.1, 1.2 and 1.3 should be used to determine the size of buffers.

1.39 Study the effects of management options in Task 3.0. Study the effects of management options in Task 3.0. Before comprehensive management guidelines are disseminated, management options should be tested for success in both producing GCW habitat and recolonization by GCWs.

1.310 Determine the current distribution and availability of habitat in the winter range and migration corridor. Relatively few records exist for wintering and migratory GCW. A thorough exploration of the known habitat types and other areas of similar habitat is needed. A remote sensing study and associated GIS that can be used to monitor the distribution and rate of change of suitable winter habitat for the GCW should be developed. The ground-truthing for this project should be coordinated with field survey activities called for in Task 1.35.

1.311 Determine the optimum distribution of areas to be protected in the winter range and migration corridor. Based on information collected in Tasks 1.35, 1.310, and 2.21, the locations of areas to be managed and protected should be determined. Where possible, target areas should coincide with currently protected areas. While positioning should be evaluated from a theoretical perspective, the practicability and ease of protection should also be considered.

1.4 Monitoring

1.41 Monitor target populations. Select and implement a censusing methodology to monitor target populations in focal areas,

and in connecting habitat where necessary, to assist with determination of whether the delisting criteria have been met. Each population should be monitored to determine if they are viable. If possible, this task should be accomplished by field surveys of territories during the first part of the breeding season (mid-March through mid-May). Design of surveys must provide unbiased information on dispersion and density of territories and any other information necessary to determine if populations are viable.

1.42 Monitor the effects of management tasks in 3.0. Long-term results of managing GCW habitat, nest parasites, and nest predators (Task 3.0) should be monitored. Ideally, reproductive success and overall survival of GCWs subjected to the management scheme should be the gauge to determine if a management scheme is benefitting the species.

1.43 Develop a post-recovery monitoring plan. The Endangered Species Act requires implementation of a plan in cooperation with the States to monitor effectively for not less than 5 years the status of all species that have recovered and have been removed from the Endangered and Threatened Species List. The post-recovery monitoring plan should be developed before the species is delisted.

1.44 Monitor habitat and populations in Mexico and Central America. Select and implement a surveying methodology to monitor populations in the wintering and migrating areas.

2.0 Habitat Needs

2.1 Establish a system of focal areas and interconnecting habitat, where necessary, within the eight regions in the breeding range. It is intended that the focal areas, where feasible, will be on existing public lands. In many instances, however, the amount of habitat available on public lands will be insufficient to meet the delisting criteria. In this case, other methods of providing for the habitat needs of the

species should be explored, such as conservation agreements, conservation easements, or land acquisition from willing sellers. Creation of the Balcones Canyonlands National Wildlife Refuge (16,400 ha or 41,000 ac; USFWS 1991) in conjunction with implementation of the Balcones Canyonlands Conservation Plan (8,400 ha or 21,000 ac; Butler/EH&A Team 1991) is an example of a potential focal area that would coincide largely with public lands.

2.11 Protect populations on public land. This task (one of the delisting criteria) requires protection of GCW habitat (identified as part of Task 1.37) now located on public lands (Figure 3, Table 3). This protection should be provided at least until sufficient information is available to delineate the focal areas and associated habitat necessary for long-term maintenance of the species, determined under Task 1.37.

2.12 Protect populations on private land.

2.121 Locate landowners interested in voluntarily protecting GCW habitat. Landowners within the distribution of GCWs should be canvassed to determine who has an interest in voluntarily managing their property in a way that is consistent with maintaining viable populations of GCWs. Landowners within the focal areas should be given priority; however, habitat outside focal areas may still be important in maintaining interconnectivity through dispersal behavior.

2.122 Encourage voluntary protection and improve incentives for voluntary protection of GCW habitat. Interested individuals and agencies should be assisted

in their efforts to protect habitat. Efforts should be accelerated for providing landowners with incentives for preserving GCW habitat and for investigating and expanding the options private landowners can use to protect and manage GCW habitat. Incentives could be in the form of technical guidance and assistance, private lands/landowner assistance programs, conservation easements, or state wildlife management tax exemptions. This effort should be linked with the development of educational curricula and endangered species habitat management guidelines so concerned landowners can be kept as involved in the recovery effort as possible (Task 4.3).

2.2 Protect habitat in the winter range and along the migration corridor. Encourage and assist with habitat protection efforts in cooperation with the governments and conservation organizations of Mexico, Honduras, Guatemala, and Nicaragua. The methods used need to be tailored to those most appropriate for each country. Focus should be on areas identified in Task 1.311.

2.21 Identify currently protected areas within potential GCW winter and migratory habitat. Identify and offer support to ongoing efforts to protect GCW winter and migratory habitat. Encourage studies to identify potential habitat in other protected areas. Information from such studies may also be useful in determining the optimum distribution of areas to be protected in the nonbreeding range (Task 1.311).

2.22 Make contacts, encourage and assist, where possible, with efforts by governmental and conservation organizations and individuals in these countries. Various organizations

and individuals are already working on issues related to recovery of the GCW. It would be more efficient to identify those programs and facilitate protection and research through established projects.

2.23 Identify and encourage funding of conservation efforts. Funding possibilities through programs such as World Bank, Assistance for International Development, and the North American Free Trade Agreement (NAFTA) should be explored. Funding could be facilitated through contacts made in Task 2.22.

2.24 Investigate and encourage options to protect habitat. Creative and sustainable ways to protect habitat at the private, local, state, and/or national level should be encouraged.

3.0 Management

3.1 Enhance and maintain quality of GCW habitat on public and private lands. Focal areas and associated habitat should be managed to enhance and maintain the quality of GCW habitat. Factors such as oak wilt, overbrowsing, and cowbird parasitism may progressively reduce habitat quality and population viability in focal areas unless appropriate habitat management procedures are applied. Appropriate habitat management procedures should be developed and monitored (Task 1.42) to identify their benefit to the species.

3.2 Maintain hardwood regeneration within GCW management sites. GCW populations should be protected against the effects of oak wilt and overbrowsing. Activities, such as moving infected firewood from place to place, that make oaks more susceptible to oak wilt should be avoided. Populations of white-tailed deer, goats, exotic ungulates, and other browsing animals within GCW target populations may need to be managed to ensure hardwood regeneration. The response of GCWs to these practices should be researched and monitored, as indicated in Tasks 1.39 and 1.42.

3.3 Promote the regeneration of oak-juniper woodlands in certain areas previously cleared, thinned, or burned. In some areas targeted for GCW populations, enhancement of habitat for GCWs may

be desirable. In those areas, where secondary succession of pure junipers occurs and GCWs are not present, scattered younger juniper may be thinned and replaced with hardwood seedlings. This process should be monitored to see if GCWs will colonize such managed stands. Conversely, juniper could also be encouraged in areas where they have been cut out and where mature hardwoods remain.

3.4 Develop management guidelines for formation of GCW habitat. Depending on the results of Task 1.32 and 1.33, it may be advisable to allow adjacent patches of GCW habitat to coalesce into a single continuous expanse of habitat or to create edge. Woodland/grassland interfaces that are irregular may need to regrow so that the resulting interface is relatively smooth. Additional fragmentation of blocks of habitat with trails, roads, fenceline rights-of-way, or any other type of right-of-way may need to be avoided.

3.5 Adopt management strategies that reduce the impact of cowbird parasitism and nest predation on GCW populations. If the results of Tasks 1.24 and 1.25 indicate that cowbird parasitism or predation is a threat to the recovery of the GCW, then methods to reduce the number or productivity of female cowbirds and potential warbler predators in the vicinity of GCW populations, or otherwise reduce population-wide rates of nest parasitism and predation, may be necessary. Experimental nest predator and nest parasite removal programs may be appropriate. This approach may be the only feasible way to maintain productivity of some GCW populations, although it is considered a short-term solution. Localized threats may have to be addressed at some sites where they are seriously impacting the warbler population. These determinations can be made on a site-by-site basis. If predator control is contemplated, careful consideration should be given to determining its necessity and ecological impact prior to implementation.

3.6 Minimize the extent to which GCWs are affected by agriculture and urbanization. In the interim, until information is gained from research called for in Tasks 1.33 and 1.38, the extent to which GCW populations are affected by urban and agricultural activities that might increase rates

of predation, nest parasitism, and disturbance of GCWs should be limited.

3.7 Develop management guidelines and provide technical assistance to landowners. Interim guidelines should be formulated to provide management options a landowner or manager could adopt that would benefit the species. Especially included should be how to integrate warbler needs into existing land management programs. This could be developed through existing networks such as the Texas Agricultural Extension Service, the Soil Conservation Service, Texas Parks and Wildlife Department, or other state, local, and federal technical guidance programs that reach private landowners.

3.8 Investigate and encourage sustainable development options for GCW habitat in Mexico and Central America. Various uses such as selective extraction of medicinal plants may be compatible with GCW habitat protection. Sustainable development should be encouraged with the voluntary cooperation of these countries.

4.0 Public education and information

4.1 Increase public awareness of the importance of the GCW and natural ecosystems. To accomplish this task, informative and exciting natural history programs should be developed for all age groups. Such programs should acquaint the audience with typical regional ecosystems. In particular, the audience should become acquainted with the basic appearance and natural history of the more common, more dramatic, and more sensitive local organisms, including the GCW.

4.2 Develop curriculum/media for childhood and adult natural history/endangered species education. Consult with science and natural history education specialists to determine the most effective formats for curriculum packages. Develop multi-age group curricula. Use existing photographic material, such as Adams and Adams (1976), to increase public familiarity with the natural history and plight of GCWs. Distribute curricula as appropriate to public and private schools, college-level programs, and public media outlets. This effort should be coordinated with other existing environmental education programs such as Project WILD.

4.3 Develop and disseminate informative brochures and pamphlets on GCW management and natural history. Information developed in Task 3.7 should be provided to landowners. Information may also be given in workshop format.

4.4 Develop and provide information and educational materials for Mexico and Central America. Information identified in Task 3.8 and others should be provided to the public, agencies, and organizations.

4.5 Develop demonstration ranches and public areas. Using the guidelines developed in Task 3.7, demonstration areas should be managed where landowners can observe recovery efforts. Candidates for such demonstration areas on public lands might be the Kerr Wildlife Management Area and the Balcones Canyonlands NWR. Some private lands may also serve as demonstration areas.

5.0 Regulatory

Habitat should be protected through available regulatory measures, with particular emphasis placed on areas likely to be within the focal areas. Large expanses of oak-juniper woodland judged suitable for GCWs should be protected. Section 9 of the Endangered Species Act specifically prohibits the take of an endangered species without a permit. Section 7 of the Act requires that Federal agencies consult with the Service on any action they authorize, fund, or carry out that may affect listed endangered or threatened species. Several other Federal, state, and local regulations (such as the Lacey Act, the Migratory Bird Treaty Act, Texas Parks and Wildlife regulations, and the City of Austin Endangered Species Survey Ordinance) have been implemented specifically for protecting endangered species.

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III. RECOVERY PLAN IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program. It is a guide for meeting the objective discussed in Part II of this Plan. This schedule indicates tasks, task priorities, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat. It should be noted that the estimated monetary needs for all parties involved in recovery are identified for only a 3 year period and, therefore, Part III does not reflect the total estimated financial requirements for the recovery of this species.

Priorities in column one of the following implementation schedule are assigned using the following guidelines:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to meet the recovery objectives.

Key to Acronyms used in Implementation Schedule

APRD - Austin Parks and Recreation Department
BCCP - Balcones Canyonlands Conservation Plan
DOD - Department of Defense
FWS - U.S. Fish and Wildlife Service
  ES - Ecological Services
  IA - International Affairs
  LE - Law Enforcement
  Refuge - Refuges
  PA - Public Affairs
  Res - Research
  MBMO - Migratory Bird Management Office
Guat - Guatemala
Hond - Honduras
LCRA - Lower Colorado River Authority
Mex - Mexico
Nica - Nicaragua
SCS - Soil Conservation Service
TAEX - Texas Agricultural Extension Service

TFS - Texas Forest Service
TNC - The Nature Conservancy or the Texas Nature Conservancy
TPWD - Texas Parks and Wildlife Department
SA - City of San Antonio Parks Department

GOLDEN-CHEEKED WARBLER RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
1	1.11	Determine survivorship, dispersal, reproductive success, etc.	8	2	ES		30	30	30	This information is needed for task 1.12 and may also need to be collected later to determine if delisting criteria are met.
				2	Refuge		10	10	10	
				8	Res		1	1	1	
						TPWD	10	10	10	
						DOD	20	20	20	
1	1.35	Study habitat requirements in Mexico and Central America.	3	2	ES					
				9	IA					
				9	MBMO		1	1	1	
						TNC	10	10	10	
						Mex	20	20	20	
						Guat	20	20	20	
						Nica	20	20	20	
						Hond	20	20	20	
1	1.36	Determine current distribution of habitat in breeding range.	2	2	ES		20	5		
						TPWD	15	10		
						TNC	15	10		
1	1.37	Determine location of focal areas.	2	2	ES		5	5		In coordination with Recovery Team
1	1.310	Determine distribution of habitat on the winter range and migration corridor.	3	2	ES		2	2	2	
				9	IA		15	15	15	
				9	MBMO		1	1	1	
						TNC	15	5	5	
						Mex	10	5	5	
						Guat	10	5	5	
						Hond	10	5	5	
						Nica	10	5	5	
1	1.311	Determine optimum distribution of areas to be protected in the winter range and migration corridor.	2	2	ES				2	
				9	IA				5	
				9	MBMO				1	
						TNC			2	
						Mex			2	
						Guat			2	
						Hond			2	
						Nica			2	
1	2.11	Protect populations on public land.	ongoing	2	ES					Cost estimates for refuges include land acquisition costs for BCNWR. Cost estimates for acquiring land for the BCCP are provided in the Black-capped Vireo Recovery Plan and are not duplicated here.
				2	Refuges		500	500	500	
						TPWD	3	3	3	
						DOD	16	16	16	
						SA	1	1	1	
						APRD	1	1	1	
						LCRA	3	3	3	

GOLDEN-CHEEKED WARBLER RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
3	1.22	Study movements of GCWs.	2	2	ES		9	6		May be done in conjunction with task 1.11 or 1.23.
				2	Refuge		3	2		
						TPWD	3	2		
						DOD	3	2		
3	1.26	Study ecology of wintering and migrating GCWs.	3	2	ES		10	5	5	
				9	IA		10	5	5	
				9	MBMO		10	5	5	
						TNC	5			
						Mex	10	5	5	
						Hond	10	5	5	
						Guat	10	5	5	
						Nica	10	5	5	
3	1.43	Develop post-recovery monitoring.	2	2	ES					Develop prior to delisting
						TPWD				
3	4.1	Increase public awareness.	ongoing	2	ES		15	5	5	
				2	Refuge		25	20	15	
				2	PA		15	5	5	
						TPWD	10	5	5	
						SCS	5	5	5	
						DOD	5	5	5	
						TNC	5	5	5	
						TAEX	10	5	5	
						BCCP	5	5	5	
3	4.2	Develop curriculum/media on endangered species.	3	2	ES		30	15	5	
				2	Refuge		10	10	5	
						TPWD	15	5	5	

GOLDEN-CHEEKED WARBLER RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
1	2.121	Locate landowners interested in voluntarily protecting GCW habitat.	5	2	ES		5	5	5	
						TPWD	5	5	5	
						SCS	5	5	5	
						TNC	5	5	5	
1	2.122	Encourage voluntary protection and improve incentives for voluntary protection of GCW habitat.	ongoing	2	ES		100	100	100	Cost estimates represent salaries or partial salaries of staff conducting technical assistance.
						TPWD	100	100	100	
						SCS	100	100	100	
						TNC	100	100	100	
						TAEX	50	50	50	
1	2.22	Make contacts, encourage and assist with ongoing conservation efforts in Mexico and Central America.	3	2	ES		5	5	5	
				9	IA		30	30	30	
				9	MBMO		1	1	1	
						TNC	5	5	5	
						Mex	5	5	5	
						Guat	5	5	5	
						Hond	5	5	5	
						Nica	5	5	5	
1	2.23	Identify and facilitate funding in Mexico and Central America.	ongoing	2	ES		2	2	2	
				9	IA		5	5	5	
				9	MBMO		1	1	1	
						TNC	5	5	5	
						Mex	2	2	2	
						Guat	2	2	2	
						Hond	2	2	2	
						Nica	2	2	2	
1	3.7	Development guidelines and provide assistance for landowners.	ongoing	2	ES		20	20	10	
				2	Refuge		5	5	1	
						TPWD	50	50	40	
						DOD	5	5	1	
						SCS	50	50	40	
						TAEX	50	50	40	
2	1.12	Determine population sizes and arangements necessary to attain and maintain viability.	2	2	ES				30	Collect data in 1.11 first.
				8	Res				2	
						TPWD			10	
2	1.21	Study foraging and prey species.	2	2	ES		15	15		
						TPWD	5	5		
						DOD	5	5		
2	1.23	Study distribution in relation to productivity.	3	2	ES		15	15	15	
				8	Res		1	1	1	
						TPWD	5	5	5	

GOLDEN-CHEEKED WARBLER RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
2	1.24	Study relationship of predators.	3	2 8	ES Res	 TPWD	9 1 3	9 1 3	9 1 3	
2	1.25	Determine rate of cowbird parasitism.	3	2	ES	 TPWD DOD	9 3 5	9 3 5	9 3 5	
2	1.31	Determine habitat requirements in breeding range.	5	2 2	ES Refuge	 TPWD DOD	5 3 2 2	5 3 2 2		Task should be done concurrently with Tasks 1.21-1.25.
2	1.32	Study patch size requirements and effects of disturbance.	3	2 8	ES Res	 TPWD LCRA	1 1 5 2	1 1 5 2	1 1 1 1	
2	1.33	Determine effects of land use practices.	3	2	ES	 TPWD DOD	12 4 5	12 4 5	12 4 5	
2	1.34	Study hardwood regeneration	2	2	ES	 TPWD TFS		5 1 9	5 1 9	
2	1.38	Determine buffer zones.	2	2	ES	 TPWD DOD	5 1 3	5 1 3		
2	1.39	Study effects of management options in Task 3.0.	3	2 2	ES Refuge	 TPWD DOD		9 10 3 5	9 10 3 5	
2	1.41	Monitor target populations.	ongoing	2 2	ES Refuge	 TPWD DOD	2 1 5 5	2 1 5 5	2	
2	1.42	Monitor the effects of management tasks.	ongoing	2 2 8	ES Refuge Res	 TPWD DOD	1 1 1 5 3	1 1 1 5 3	1 1 1 5 3	

GOLDEN-CHEEKED WARBLER RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
2	1.44	Monitor habitat in Mexico and Central America.	ongoing	2	ES			1	1	
				8	Res			5	5	
						Mex		5	5	
						Guat		5	5	
						Hond		5	5	
						Nica		5	5	
2	2.21	Identify currently protected areas within potential GCW winter & migratory habitat.	2	2	ES		1	1		
				9	IA		2	2		
				9	MBMO		1	1		
						TNC	2	2		
						Mex	2	2		
						Guat	2	2		
						Hond	2	2		
						Nica	2	2		
2	2.24	Investigate options to protect habitat.	ongoing	2	ES		1	1	1	
				9	IA		50	50	50	
				9	MBMO		1	1	1	
						TNC	50	50	50	
						Mex	100	100	100	
						Guat	100	100	100	
						Hond	100	100	100	
						Nica	100	100	100	
2	3.1	Enhance and maintain GCW habitat.	ongoing	2	ES		30	20	20	
				2	Refuge		20	20	20	
						TPWD	50	50	50	
						DOD	25	25	25	
						SCS	20	30	30	
2	3.2	Maintain hardwood regeneration.	ongoing	2	ES		5	2	1	
				2	Refuge		5	2	2	
						TPWD	10	5	5	
						DOD	5	2	2	
						TFS	10	5	5	
						SCS	10	5	5	
2	3.3	Promote regeneration of habitat.	ongoing	2	ES		15	10	5	
				2	Refuge		2	1	1	
						TPWD	15	10	5	
						SCS	10	5	2	
						DOD	2	1	1	
2	3.4	Develop management options for formation of GCW habitat.	ongoing	2	ES					
				2	Refuge		1	1	1	
						TPWD	5	5	3	
						SCS	2	2	1	
						DOD	1	1	1	

GOLDEN-CHEEKED WARBLER RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
2	3.5	Reduce cowbird parasitism and predation, if warranted.	ongoing	2	ES		5	3	2	
				2	Refuge		1	1	1	
						TPWD	10	5	3	
						SCS	5	5	3	
						DOD	5	2	1	
2	3.6	Minimize effect of urbanization & agriculture.	ongoing	2	ES		20	20	20	
				2	Refuge		1	1	1	
						TPWD	1	1	1	
						SCS	1	1	1	
						BCCP	5	5	5	
2	3.8	Investigate sustainable development options for GCW habitat in Mexico and Central America.	ongoing	2	ES		1	1	5	
				9	IA		5	5	5	
						TPWD	1	1	1	
						TNC	1	1	10	
						Mex	5	5	10	
						Hond	5	5	10	
						Guat	5	5	10	
						Nica	5	5	10	
2	4.3	Develop and disseminate brochures.	ongoing	2	ES		3	10	5	Two years to develop; Second year costs also reflect printing costs
						TPWD	5	10	5	
						SCS	5	5	5	
						TAEX	5	5	5	
2	4.4	Develop information materials for Mexico and Central America.	3	2	ES			1	1	
				9	IA			5	5	
						Mex		5	5	
						Hond		5	5	
						Guat		5	5	
						Nica		5	5	
2	4.5	Develop demonstration areas.	3	2	ES			2	2	
				2	Refuge		1	2	2	
						TPWD	3	5	5	
						TNC	1	2	2	
2	5.0	Regulatory	ongoing	2	ES		30	30	30	
				2	LE		30	30	30	
				2	Refuge		1	1	1	
3	1.13	Determine if gene flow is provided for.	3	2	ES				30	Collect data in 1.11 first.
				8	Res				10	
						TPWD			7	

IV. Appendix

INDIVIDUALS AND AGENCIES PROVIDING COMMENTS ON
THE DRAFT GOLDEN-CHEEKED WARBLER RECOVERY PLAN

ANDERSON, ROLAND AND THELMA, private property owners

ARNOLD, KEITH A., Professor, Texas A&M University, Department of Wildlife and Fisheries Sciences

ARROYO, BRYAN, Wildlife Biologist, U.S. Fish and Wildlife Service

BALTHROPE, WILLIAM D., rancher

BARLOW, JON C., Curator, Department of Ornithology, Royal Ontario Museum

BERRY, JOHN M., landowner

BESSENT, CHRISTINE, member National Bluebird Society, participant Bird Atlas of Texas project

BRUNS, DUSTY, Land Manager, Camp Bullis Training Site, Department of the Army

BUSHONG, LUTHER C. AND LOIS, private landowners

CAVIN, E.D. AND CLAUDIA, Ph.D's

CLARKE, DON, Gulf Coast Research Group, Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service

CORNELIUS, JOHN, D.E.H., Fish and Wildlife Branch, HQ III, Corps of Engineers

CRENWELGE, DENNIS D., Ph.D., Managing Partner, Crenwelge Livestock Company

DAVIS, JONATHAN R., Attorney

DENISON, CHARLES A., rancher

DIERKS, WILLARD and ALICE, landowners and ranchers

GAFFORD, BILL, Concan Sales & Service

GIPSON, LILLIAN, private property owner

HAM, MARSHALL A., Acting Chief, Office of Migratory Bird Management, U.S. Fish and Wildlife Service

HAYDEN, TIM, Wildlife Biologist, U.S. Army CERL

HOLLE, DEBORAH, Refuge Manager, Balcones Canyonlands National Wildlife Refuge, U.S. Fish and Wildlife Service

HOOVER, BILLY, rural landowner

JOHNSON, R. ROY, Senior Ecologist, Johnson and Haight

KUHL, SHERRI, Environmental Protection, Lower Colorado River Authority

KYLE, WESLEY, private citizen

LADD, CLIFTON, Senior Staff Ecologist, Espey, Huston & Associates, Inc.

McCLURE, DONALD, rural landowner and rancher

McMULLAN, DEBBIE, rancher

McTEE, CHARLY, General Manager, Texas Wildlife Association

MICHELS, STEPHANIE, landowner

MILLS, G. SCOTT, SWCA Environmental Consultants

MINNICH, DON W., Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service

NAGEL, ARTHUR W., President, Riverside and Landowners Protection Coalition

NORRIS, DWAYNE, landowner and rancher

NORRIS, MALDON, landowner and rancher

O'DONNELL, LISA, Wildlife Biologist, U.S. Fish and Wildlife Service

ONETH, HARRY W., State Conservationist, Soil Conservation Service, U.S. Department of Agriculture

PERNER, GINGER and PAUL, rural landowners

POERNER, COL. HOMER W., Camp Buck Ranch, ranch owner and manager

ROGERS, FRIEDA R., landowner

RUST, SUSAN P., Consulting Ecologist, Stewardship Services

SCHEELE, GARY, private landowner

SEXTON, CHARLES, Environmental Specialist, City of Austin, Environmental and Conservation Services Department

STEVENS, CHRISTI, Earth First! Austin

TURNBO, ANN, rancher

TURNBO, HARDY, rancher

WARREN, HENRY J., President, San Saba County Property Owners Association

WITTS, DAVID A., attorney

WOMACK, JESS Y., private landowner

WOOD, WENDELL, property owner

THE FOLLOWING INDIVIDUALS' OR AGENCIES' COMMENTS WERE RECEIVED AFTER THE AUGUST 31, 1992 DEADLINE AND WERE CONSIDERED BUT ARE NOT FORMALLY ADDRESSED IN THIS APPENDIX

ARMSTRONG, BILL, Biologist, Kerr Wildlife Management Area, Texas Parks and Wildlife Department

BALLEW, HELEN, Project Director, Hill Country Foundation

BUREAU OF RECLAMATION, Department of the Interior

GRZYBOWSKI, JOSEPH A., Ph.D.

HOHMANN, MR. AND MRS. LEONARD, landowners

KROLL, JAMES C., Ph.D., Stephen F. Austin State University

LANCASTER, W.A., Director of Highway Design, Texas Department of Transportation

MARSHALL, BARBARA, landowner, Marshall Cattle Company

PEAVY, DAN C., D.D.S., landowner

STEED, DAVID L., Ph.D., DLS Associates

WILCOVE, DAVID, Ph.D., Senior Ecologist, Environmental Defense Fund

PRINCIPAL COMMENTS RECEIVED ON THE GOLDEN-CHEEKED WARBLER DRAFT RECOVERY PLAN

This recovery plan was available for technical/public review in July of 1992. The public comment period ended August 31, 1992. The Service distributed almost 300 copies of the draft plan, as well as notifying 144 county managers, agencies, and individuals by letter that the plan was available for public review and comment. Comments from 75 individuals or agencies were received by the August 31, 1992, deadline. All comments were considered when developing the final plan. The Service appreciates the time that each of the commenters took to review the draft and to submit their comments.

The comments discussed below represent a composite of those received. Comments of a similar nature are grouped together. Substantive comments that question approach, methodology, or financial needs called for in the draft plan, or suggest changes to the plan are discussed here. Comments received that relate to the original listing decision, general comments about the Endangered Species Act that did not relate to the golden-cheeked warbler, or comments regarding simple editorial changes, are not discussed here. Many favorable, supportive comments were also received but are not discussed below.

All comments received are retained as a part of the Administrative Record of recovery plan development in the Austin, Texas, Ecological Services office.

Comment: How many birds were there in 1973 and how many are there now?

Service Response: Historical and current population levels are discussed in the Introduction and Background (Population Size section) of the recovery plan.

Comment: The government plans to dictate to farmers and ranchers how they can use their land.

Service Response: The recovery strategy section of the plan stresses the need to work cooperatively and creatively with landowners to recover the species. The recovery tasks outline voluntary protection on the part of private landowners. In addition, the recovery plan is a planning document, it does not promulgate any rules or regulations.

Comment: The government is planning to eliminate goats, cows, etc.

Service Response: The recovery plan discusses the possible impact of goats, cows, and other hoofed species on recruitment of the hardwood component of golden-cheeked warbler habitat and on cowbird populations. In the recovery section, research on the impact of these species on recruitment and cowbird populations is proposed. The recovery plan does not propose to eliminate these animals.

Comment: Please provide the people of the involved counties practical information for preserving this species. The USFWS should work with landowners on this project.

Service Response: The recovery strategy calls for "enhanced public relations/public education". The Service agrees that informing landowners and managers is an important point and has added a task that specifically addresses the development and dissemination of informative brochures and workshops on management for golden-cheeked warblers. Tasks 2.121 and 2.122 refer to encouraging voluntary protection by private landowners. The Service would like to be contacted by landowners who are interested in protecting habitat, so that suggestions can be made and compatible uses can be discussed.

Comment: The Service should recognize that many landowners do preserve habitat for warblers and other wildlife.

Service Response: The Service recognizes this fact. However, it was inadvertently left out of the Conservation Measures section in the draft plan. A new paragraph was inserted in the final plan discussing this matter.

Comment: The reference to an "intensified enforcement effort" should be dropped.

Service Response: The wording of Task 5.0 Regulatory was changed.

Comment: Habitat must be preserved on public lands as well.

Service Response: This is part of the delisting criteria. The focal areas should use public lands to the maximum extent practicable. GCW populations on public land may count toward the viable, self-sustaining populations called for in the recovery criteria.

Comment: Whether this particular plan succeeds or not will eventually depend on the preservation of migration routes and wintering grounds.

Service Response: In designing the recovery tasks, the Service tried to treat the migration and wintering habitat, and the breeding habitat with equal importance. For every major type of task on the breeding ground, a similar or complementary task for the migration and wintering habitat was included. To strengthen this concern, the Service added tasks under monitoring, management, and public information and education to be carried out in Mexico and Central America. In addition, an effort will be made to coordinate with other ongoing conservation programs in Mexico and Central America and to facilitate funding, training, equipping, and communicating with Mexican and Central American biologists.

Comment: A male golden-cheeked warbler was reportedly observed by a qualified ornithologist in the mountains of Queretaro, Mexico in early January 1972. A more thorough examination of the wintering range is needed.

Service Response: This sighting is unknown to the drafter of the plan and to the Service. We are contacting the commenter for more information. Task 1.310 was augmented to include determining the current wintering and migrating distribution and examining other potential habitat areas.

Comment: Determining what kind of disturbance the golden-cheeked warbler can tolerate, particularly in regard to the edge vs. interior debate, is the most important point in establishing management policies for the GCW.

Service Response: The Service recognizes that this is an important point and tasks 1.23, 1.31, 1.32, 1.33, and 1.38 address this issue.

Comment: With territories averaging 2-4.2 ha/pair on tracts, extrapolations to state-wide estimates become highly suspect.

Service Response: The size of an average territory is not used to determine the range-wide population estimate. Instead, an estimate of density (usually pairs or males per 100 ha) is used, which is often derived from a transect line or point count. The reason density estimates are used is that territories are not usually contiguous or continuous

and a certain amount of unoccupied habitat is included in the density estimate. Likewise, estimates of potentially suitable habitat for the golden-cheek include habitat that is not occupied.

Comment: We do not have information to justify brown-headed cowbird management.

Service Response: No other summary or study of the impact of brown-headed cowbird parasitism on golden-cheeked warblers has been done since Pulich's work. In his Kendall County study area, 28 nests were studied to conclusion. Of those, 19 nests were parasitized. Out of those 19 nests, 3 golden-cheeked warblers and nine cowbirds fledged. The 9 unparasitized nests produced 12 GCW fledglings. In a summary of all nests Pulich looked at both in his study and museum specimens (n=61), he found 39% were parasitized. Pulich (1976) also points out that the success rate of GCW nests (27%) is the lowest of all the other wood warblers he investigated. The above information suggests that GCWs are impacted by cowbirds. To what degree this affects the productivity of GCWs is not known. Recovery task 1.25 addresses this research need. Other recovery efforts, particularly management efforts, should incorporate consideration of the results of the cowbird research.

Comment: The recovery plan did not identify the focal areas.

Service Response: The Service does not believe that we have all the information necessary on which to base that decision. Therefore, gathering that information was made one of the recovery tasks.

Comments: The amounts of money and the agencies responsible mentioned in the implementation schedule probably will not or can not commit to these projects or amounts.

Service Response: The implementation schedule is a planning tool. It does not commit any agency or any agency's money to a task. It can be used to prioritize tasks, estimate costs, and serve as a basis for requesting endangered species appropriations. The tasks or ideas put forward in recovery plans are implemented as time and money is available.

Comment: Research focused on developing prescriptions for restoring a "natural landscape" reflective of some past time would seem to be the most efficient direction to take in addressing the needs of this bird and the rest of the biota dependent on the same ecosystem.

Service Response: Although species specific, several of the tasks in both the research and management sections may provide information applicable to restoring "natural landscapes". The Service is also interested in landscape-level biodiversity.

Comment: Are the tasks prioritized? Research on habitat needs and management are far more important than on single species biology.

Service Response: The tasks are prioritized as 1, 2, or 3 as defined in the introduction to the implementation schedule. Research on habitat and management are important, but some life history information is usually needed to determine what is recommended to protect or manage a species.

Comment: The recovery plan treats all counties within the range of the golden-cheeked warbler the same. Rapid urbanization does not apply to several of the counties within the range.

Service Response: Habitat loss due to urbanization and certain agricultural practices is the primary threat to the existence of the warbler. Urbanization along the Waco-Austin-San Antonio corridor is an immediate threat. However, Pulich (1976) and Wahl et al. (1990) documented the loss of habitat in rural settings also. For purposes of recovery, the threat from urbanization is often considered more serious than agricultural activities because habitat is permanently removed and is usually replaced by structures of some sort. Also the secondary impacts of noise, lighting, expanded infrastructure, urban predators, etc. in urban areas may have an additional negative impact on GCWs and their habitat. In agricultural areas, cleared habitat may be able to be restored and secondary impacts are usually not increased over what is already existing.

Comment: The plan proposes to encourage the growth of juniper.

Service Response: The plan proposes to encourage the protection and growth of GCW habitat which is an oak-juniper woodland in areas needed for recovery. The plan proposes to encourage the growth of juniper in limited areas that have the hardwood vegetation species composition and structure similar to what warblers use as a demonstration to see if warbler habitat can be restored and used by the species. The plan does not propose to encourage the growth of monoculture juniper or the conversion of open pastureland to GCW habitat.

Comment: Habitat preservation for GCWs should be demonstrated on public lands and ranches.

Service Response: A task that would develop public and private demonstration areas was added to the Public Information and Education Section of the recovery outline.

Comment: Notify only persons with potential habitat on their property -- not a massive distribution to unaffected people.

Service Response: Through the tasks listed under Public Information and Education, the Service proposes to develop and disseminate information on how to recognize golden-cheeked warbler habitat, what management activities a landowner can use to enhance and/or protect habitat, and what activities are compatible with GCWs. This information may be distributed through brochures, workshops and/or contacts with technical assistance programs of involved agencies. The primary audiences will be those that have potential habitat or opportunities to promote conservation of GCWs.

Comment: The plan should be based on a thorough knowledge of the biology of the species.

Service Response: Recovery plans outline what is needed to recover a species. Rarely do we know enough about a species during the initial development of a recovery plan to definitively state what strategies are needed to recover a species. It is not unusual for research to be the primary need for recovery in the early stages of conservation work, and its importance in devising effective management techniques should not be underestimated. Recovery planning

is a continuous process, and plans are amended and revised as necessary to incorporate research results and include more site specific, management-oriented tasks as they are devised.

Comment: The recovery plan offers no guidance or priority for the management of the species.

Service Response: Development of management guidelines for the species were recommended in the Management Needs tasks of the draft Recovery Plan; however, in the final plan the Service has made this a separate task and put additional emphasis on management guidelines by also including dissemination of this information in the Public Information and Education tasks.

Comment: If the estimate of warblers is as the plan suggests, 13,800 territories, and if recovery is requiring only 7,500 breeding pairs, then it appears that thousands of warblers could be killed and we would still achieve recovery.

Service Response: The 13,800 territories is an estimate based on density estimates in certain specific localities and then extrapolated over the estimated habitat acreage projected by ground-truthed Landsat imagery. Territories may or may not be occupied by mated males, and mated males may or may not actually breed and produce young. Additionally, there are difficulties associated with making population estimates as discussed on page 17. After much consideration, the figure of 7,500 breeding pairs was dropped from the recovery criteria, as well as, the 15 populations. Instead the plan now uses at least one viable, self-sustaining population per eight regions in place of the above two former recovery criteria. The eight regions were delineated based on geology, vegetation, and watershed boundaries. This strategy preserves the current distribution of the species. The numbers and spatial arrangement of populations needed to assure viability of the populations and the ability of the populations to sustain themselves has yet to be determined and is a recovery task. In addition, warblers cannot be taken under the provisions of the Endangered Species Act as long as they are listed. Before the species is delisted the Service should have a more specific idea of the numbers needed to maintain the species for the long-term. In addition, the other delisting criteria should also be met to achieve recovery.

Comment: Pulich's 1962 estimate of 18,385 pairs of GCWs should be the minimum recovery goal.

Service Response: The recovery criteria have been changed. The number of warblers and other factors needed to provide self-sustaining, viable populations will be determined after completion of several tasks in the plan.

Comment: Not enough emphasis has been placed on bringing other branches of the federal government into compliance with the Endangered Species Act. The Army has been helpful in their efforts, but other agencies such as the Soil Conservation Service, the Army Corps of Engineers, and U.S. Dept. of Agriculture are likely agents of GCW habitat destruction.

Service Response: Federal agencies under Section 7 of the ESA must consult if their action "may affect" an endangered species. This is a legislated responsibility. Federal agencies are also responsible for utilizing "their authorities in furtherance of the purposes of [the] Act by carrying out programs for the conservation of endangered species...". Federal agencies are identified in the Implementation Schedule where they can assist with various research, management, and education tasks.

Comment: Some discrepancies or confusion exists in Table 3 and the discussion of Pulich's population estimates.

Service Response: We have added extra clarification on these two points in the final plan.

Comment: The goal of showing the 15 populations to be genetically interconnected is unlikely to occur.

Service Response: This was changed in the final plan. The plan now indicates that if populations are not viable without genetic interconnectedness then the "potential for gene flow" should be maintained. What is necessary to provide that potential will be determined through tasks in the Recovery Plan.

Comment: The birds have been around for 125 years, they should be smart enough to find other places to nest.

Service Response: Golden-cheeked warblers are habitat specialists and are found only in only about 31 counties in Texas. Studies have shown that most small songbirds inhabit all habitat that is suitable for their life requirements.

The elimination of one territory within that habitat results in the affected pair moving to another already occupied territory or to less suitable habitat where they fail to reproduce. If the displaced pair goes to already occupied habitat then they either out compete the pair in residence or fail to reproduce. If the pair in residence is moved out then they try to out compete a third pair or fail to reproduce. The net result is the loss of one pair. In other words there are limited places to nest successfully. Golden-cheeked warblers were first described from Texas in 1865. The species was first described by science in 1860 from a specimen taken in Guatemala in 1859. As described in the text of the plan the golden-cheeked warbler probably had its origin during the Wisconsin glacial period, about 20,000 years before the present.

Comment: A major part of this recovery plan should target monies and research to improve the overall range conditions and thereby improve the quality of GCW habitat. The SCS could and should handle this kind of program.

Service Response: The goal of recovery plans are to conserve particular species in their ecosystems. Resources for carrying out these plans are limited, and therefore a major part of the recovery plan is focussed on actions that will directly benefit the species. However, the Service believes that improving the overall range conditions of the Edwards Plateau is an admirable goal and would benefit many species; and while this covers a broader goal than the GCW recovery plan, implementation of this recovery plan may contribute to the broader goal. The Service would be glad to work through the SCS or any other entity to benefit species and ecosystems of concern and has identified the SCS as a responsible party in several tasks in the implementation schedule.

Comment: Is a single continuous expanse of habitat (read juniper) necessary?

Service Response: No. A continuous expanse of all juniper is not golden-cheeked warbler habitat. It must also have the other elements described in the Background section. A single, continuous expanse of habitat is not intended for recovery. Instead, what the recovery plan says is that the larger expanses of habitat should be given priority for protection efforts.

Comment: Captive breeding was not considered.

Service Response: Captive breeding has an important role in recovery of some endangered species, but we do not currently believe it is necessary or justified for the recovery of the golden-cheeked warbler. It was not considered because the habitat for the golden-cheeked warbler is still present. The species is not to the point where captive breeding is needed to augment the natural populations. Captive breeding is also an extremely costly endeavor. If in the future captive breeding does seem to be necessary then the Service will consider including it in the recovery efforts.

Comment: Prior to the implementation of the recovery plan there should be a social, economic, and environmental study made and approved through the public hearing process.

Service Response: Recovery plans are excluded from the National Environmental Policy Act (NEPA) process. However, implementation of tasks in a recovery plan is subject to the NEPA process. Public hearings may be held if an Environmental Impact Statement is required to implement various parts of this recovery plan.

Comment: Would a property owner lose the rights to use his property forever if they are granted a conservation easement?

Service Response: There are many different levels of protection and conditions associated with conservation easements. Each one is tailored to habitat protection needs and concerns of the landowner.

Comment: Would access to and the use of public lands and parks be denied in an effort to protect potential habitat?

Service Response: There are compatible uses associated with GCW habitat. Camping, hiking, bird watching, and fishing in established public areas are not likely to affect GCWs. However, there are some exceptions to this general statement, such as bird watchers repeatedly playing GCW song tapes to elicit GCW responses, which may adversely impact the birds.