

THE STATUS OF WINTERING GOLDEN-CHEEKED WARBLERS IN NICARAGUA

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Abstract. The Golden-cheeked Warbler (*Dendroica chrysoparia*) is an endangered Neotropical-Nearctic migrant that winters in Mexico and Central America. Although previous studies delineated the winter range of this species in Mexico, Guatemala and Honduras and established that wintering Golden-cheeked Warblers are closely associated with montane forest pine-oak forest with abundant narrow-leaved "encino" oaks (Rappole et al. 1999, 2000, 2003), until recently, the presence of this species in Nicaragua was based on two museum specimens and anecdotal reports. We surveyed potentially suitable habitat in northwestern Nicaragua to assess the status of Golden-cheeked Warblers in this portion of their range. We encountered warblers on 36 occasions from late November 2006 to January 2008 that represented a minimum of 23 individuals. The majority of birds were located in montane pine-oak forest above 1300 m in elevation. Sites where birds were located had greater basal area of encino oaks than unoccupied areas, which is consistent with findings on habitat use from the core of their range (Rappole et al. 1999, 2000). Our observation of Golden-cheeked Warblers in Nicaragua is notable in that until recently the last published reports of this species in Nicaragua outside of the breeding season were of two individuals collected in September, 1891 (Pulich 1976). It does not appear that there is much suitable habitat in Nicaragua, which consists mostly of a narrow band of habitat along the Honduran border. Golden-cheeked Warbler habitat in Nicaragua is threatened by agricultural activity and unregulated logging.

Key Words: *Dendroica chrysoparia*, habitat, Neotropical migrant, non-breeding, pine-oak.

ESTATUS DE DENDROICA CHRYSOPARIA DURANTE EL INVIERNO EN NICARAGUA

Abstract. La reinita dorada (*Dendroica chrysoparia*) es un ave migratoria en peligro de extinción que invernán en México y América Central. Aunque los estudios anteriores delinearon la gama del invierno de esta especie en México, Guatemala y Honduras y establecieron que las reinitas doradas se asocian con bosque montano del pino-roble con robles abundantes del "encino" (Rappole et al. 1999, 2000, 2003), hasta hace poco tiempo, la presencia de esta especie en Nicaragua fue basada en dos especímenes del museo e informes anecdóticos. Examinamos el hábitat potencialmente conveniente en Nicaragua del noroeste para determinar el estado de reinitas doradas en esta porción de su gama. Encontramos reinitas en 36 ocasiones de último del noviembre de 2006 al enero de 2008 que representó a un mínimo de 23 individuos. La mayoría de pájaros fue situada en bosque montano del pino-roble sobre 1300 m en la elevación. Los sitios en donde los pájaros fueron localizados tenían mayor zona basimétrica de los robles del encino que áreas vacantes, que es constante con resultados en uso del hábitat de la base de su gama (Rappole y otros 1999, 2000). Nuestra observación de reinitas doradas en Nicaragua es notable en esa hasta hace poco tiempo que los informes publicados pasados de esta especie en Nicaragua fuera de la estación de la cría estaban de dos individuos recogidos en septiembre de 1891 (Pulich 1976). No aparece que hay hábitat mucho conveniente en Nicaragua, que consiste sobre todo en una banda estrecha del hábitat a lo largo de la frontera del Honduras. El hábitat de la reinita dorada en Nicaragua es amenazado por actividad agrícola y la registración no regulada.

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INTRODUCTION

The Golden-cheeked Warbler (*Dendroica chrysoparia*) is a Neotropical-Nearctic migrant that breeds in central Texas in mature oak-ashe juniper habitat (Pulich 1976, Ladd and Gass 1999). The Golden-cheeked Warbler (GCWA) was listed as a Federally Endangered Species in 1990 because of extensive loss and fragmentation of breeding habitat as well as evidence of range retraction (U.S. Fish and Wildlife Service 1990). Subsequent research has verified that the abundance and nesting success of breeding GCWAs are adversely affected by habitat destruction and fragmentation (DeBoer and Diamond 2006, Magness et al. 2006, Peak 2007).

GCWAs spend less than half of the annual cycle on the breeding grounds (Pulich 1976), thus populations clearly can be affected by habitat conditions on their tropical wintering grounds (Rappole and MacDonald 1994). Only recently, however, has there been quantitative information on the winter ecology of this species. This information indicates that GCWAs are closely associated with humid montane pine-oak forests with abundant narrow-leaved "encino" oaks such as *Quercus sapotaefolia*, and *Q. eliptica* (Thompson 1995, Rappole et al. 2000) on which they specialize for foraging (Rappole et al. 1999).

Although the non-breeding habitat use of the GCWA has been described in detail, there are many other aspects of their non-breeding ecology and distribution that remain unresolved, including the full extent of their winter range. Prior to the 1990s, the GCWA was known only from 40 specimens collected outside of the breeding range (Pulich 1976). Of these, only 14 had been collected between November and January, the period considered as the "winter period" by Pulich (1976). Although these records indicate wintering GCWAs occur primarily in Honduras and Guatemala, more recent work indicates that there also are wintering populations in Chiapas, Mexico (Vidal et al. 1994).

The southeastern end of the winter range has generally been considered to be northern Nicaragua, based on the two specimens taken in September 1891 near Matagalpa. This evidence for the presence of GCWAs in Nicaragua is equivocal, however, because these specimens were collected outside of the "winter period" as defined by Pulich (1976). Thus, they might have been birds in migration (Pulich 1976, Rappole et al. 2000). In a range-wide assessment of winter habitat extent based on remote sensing, Rappole et al. (2000) reported that suitable pine-oak habitat extends into northwestern Nicaragua. However until recently (Morales et al. 2008) there have been no published field

studies reporting wintering GCWAs in this region since the original specimen records from 1891, and there have been no quantitative studies of habitat use in Nicaragua.

In an effort to help resolve the question of the winter status of GCWAs in Nicaragua, we conducted field surveys during the winter seasons of 2006/2007 and 2007/2008. Our objectives were to: (1) Provide additional confirmation of the presence of this species in Nicaragua during the winter season, (2) determine whether patterns of habitat selection in Nicaragua were similar to findings from the rest of the species' range, and (3) assess threats to the species and its habitat in Nicaragua.

METHODS

We searched for GCWAs in forested areas within the Department of Nueva Segovia in northwestern Nicaragua—an area which encompasses the two existing museum records (Pulich 1976). This area also encompasses most of the montane pine-oak forest in the country (Taylor 1963), and is also in closest proximity to known populations in neighboring Honduras (Rappole et al. 2000). Because most GCWAs occur in pine-oak forest above 1,300 m in the core of the species range (Rappole et al. 2000), we focused survey efforts in pine-oak forest above 1,000 m in elevation.

We concentrated field surveys within the Reserva Natural Cordillera Dipilto Jalapa, a 42,000-ha protected area near the Honduran border. This area is located within the Dipilto-Jalapa mountain range and consists largely of open pine forest at lower elevations grading into pine-oak forest at 1,200–1,500 m and thereafter grading into cloud forest that extends north to the Honduran border. Surveys were conducted within the reserve, as well as in the surrounding communities of Macuelizo, San Fernando, Ciudad Antigua, Susucayan and Santa Clara.

In addition, we also surveyed two smaller sites with pine-oak, the 9,339-ha Reserva Natural Tisey Estanzuela, located in the Department of Esteli, approximately 80 km south of Dipilto-Jalapa, and a patch of remnant forest in Cusmapa en Somoto, approximately 40 km south southwest of Dipilto-Jalapa. Finally, we visited a site east of San Rafael del Norte, as well as sites near Jalapa, which were identified as potential habitat due to their elevation, >1,000 m. Recent published information indicates that these study sites encompassed all of the significant areas of montane pine-oak forest in Nicaragua (Perez et al. 2008).

GCWAs were located by walking transects through forested habitats, often along roads or



FIGURE 1. Golden-cheeked Warbler foraging in encino oaks in the Dipilto-Jalapa Reserve, Nicaragua, 2006. Photo by S. Hernandez.

paths, searching visually for individual GCWAs and listening for vocal members of the mixed-species flocks frequented by GCWAs (King and Rappole 2000), such as the Greater Pewee (*Contopus pertinax*), Dusky-capped Flycatcher (*Myiarchus tuberculifer*), and Painted Redstart (*Myioborus pictus*). When a flock was located, the observer stayed with it until either a GCWA had been sighted or the observer determined that it was unlikely that a GCWA accompanied the flock.

GCWAs are sympatric on the wintering grounds with other species of *Dendroica* warblers that are similar in appearance: Black-throated Green Warbler (*Dendroica virens*), Townsend's Warbler (*D. townsendi*), and Hermit Warbler (*D. occidentalis*). We were aware of the potential for misidentifying one of these species as a GCWA, especially some plumage variants of the Black-throated Green Warbler. All birds classified as GCWAs had a sharp black or gray eyeline against a bright yellow cheek in combination with a jet black or streaked back, and a complete lack of yellow on the underparts (Fig. 1).

GPS coordinates were recorded for each sighting (Appendix 1). These locations were later plotted in ArcView 3.2 and observations that were <350 m apart were considered to be possible re-sightings of the same bird. This was justified based on observations by King and Rappole (2000) that the maximum home range size for flocks in Central American pine-oak forests was 10 ha, which, assuming home ranges

are roughly circular, would correspond to a diameter of 350 m.

Habitat variables were measured on 0.04-ha plots (James and Shugart 1970) centered at the point at which a GCWA was first sighted, as well as sites that were searched, but where no GCWAs were found. The following vegetation parameters were measured: number of trees by species and James and Shugart (1970) size class, canopy cover, ground cover, and slope. Shapiro-Wilk's tests indicated that habitat variables were not normally distributed, even when transformed. Therefore, we compared habitat characteristics between occupied and unoccupied sites using Mann-Whitney tests. Statistical tests were considered significant at $P \leq 0.05$.

RESULTS

We encountered GCWAs on 36 occasions from late November 2006 to January 2008 that represented a minimum of 23 individuals (Fig. 2). Of these 23 individuals, the majority (14) were located in an area extending from the Reserva Natural Cordillera Dipilto Jalapa west 20 km to the town of La Esperanza. GCWAs were not encountered during visits to Jalapa 25 km to the northeast, nor Susucayan 15 km to the east southeast. A substantial number of birds (7) were located in the Reserva Natural Tisey Estanzuela. Birds were not located during visits to Quiabuc to the northwest, Tomabu to the southeast, or Cerro Jalacate 40 km to the east

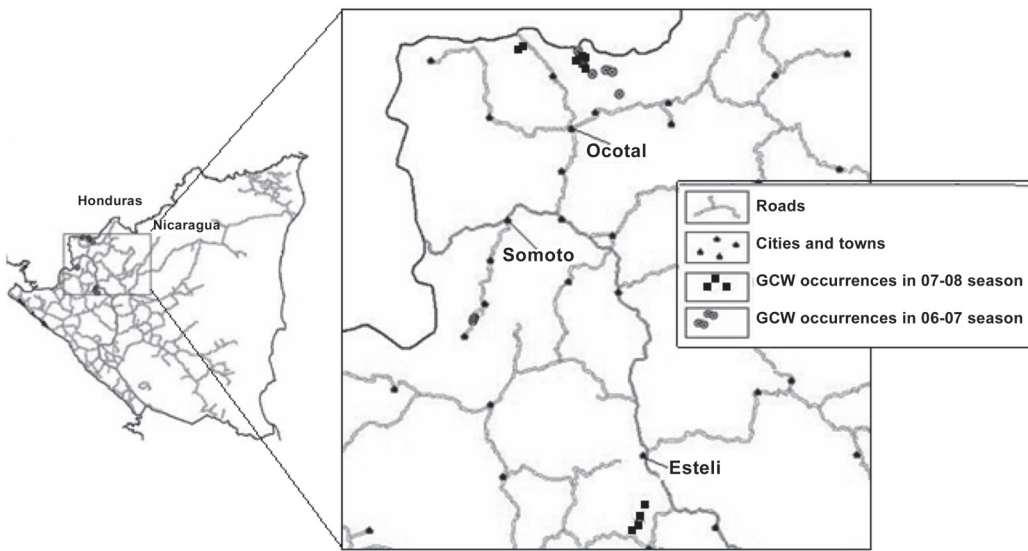


FIGURE 2. Locations where Golden-cheeked Warblers were found in the Departments of Nueva Segovia and Esteli, Nicaragua, 2006–2008.

northeast. Finally, two individuals were located at Cusmapa near Somoto.

The GCWAs we located were at elevations between 1,136 m and 1,690 m in elevation (mean = 1,485 m). Encino oaks were present at 21 out of 23 GCWA locations. Sites occupied by GCWAs had fewer pines, greater basal area of encino oaks, more ground cover and were at higher elevations than sites where GCWAs were not found (Table 1).

All of the GCWAs we observed were members of mixed species flocks. The most common flock associates were Black-throated Green Warbler, Townsend's Warbler, Yellow-throated Warbler (*Dendroica dominica*), Hermit Warbler, Greater Pewee, Baltimore Oriole (*Icterus galbula*), Painted Redstart (*Myioborus pictus*), Black-and-white Warbler (*Mniotilta varia*), Dusky-capped Flycatcher, Acorn Woodpecker (*Melanerpes formicivorus*), Blue-headed Vireo (*Vireo solitarius*) and Wilson's Warbler (*Wilsonia pusilla*).

Discussion

Our observation of GCWAs in Nicaragua is notable in that until recently (Morales et al. 2008), the last published reports of this species in Nicaragua were of two individuals collected in September 1891 (Pulich 1976, Rappole et al. 2000), and with the exception of two sightings reported by Morales et al. (2008), there have been no published accounts of this species during the winter period as defined by Pulich (1976). Our observations confirm speculation by

Rappole et al. (2000) that the winter range of the GCWA extends into northwestern Nicaragua.

Our finding that all but two of 23 GCWAs were at sites with pine and encino oaks present is consistent with findings on habitat use from the core of their range (Rappole et al. 2000), who reported that 92% of sites occupied by 148 GCWAs were in pine-oak forest with abundant encino oaks. Similarly, our results from Nicaragua indicate that 88% of locations were >1,300 m in elevation, which is consistent with findings from Honduras and Guatemala, which indicate that GCWAs are significantly more abundant above 1,300 m (Rappole et al. 2000). The average elevation of birds in Nicaragua was somewhat lower than the mean elevation of 1,651 m reported by Rappole et al. (2000).

The selection for areas with fewer pines, greater basal area of encinos, and greater ground cover in Nicaragua was similar to that exhibited by GCWAs in the core of their winter range. It is not clear why GCWAs use areas with fewer pines. However, the association between GCWAs and encino oaks is probably due to their preference for encino foliage for foraging (Rappole et al. 1999). Rappole et al. (1999) speculated that higher ground cover at sites occupied by GCWAs reflected lower levels of burning and grazing that might also eliminate encinos. Morales et al. (2008) observed Golden-cheeked Warblers in coffee and cloud forest in Nicaragua, habitats seldom used in the core of their range (Rappole et al. 2000), however three of five individuals they observed were outside

TABLE 1. MEAN VALUES (\pm SE) FOR HABITAT CHARACTERISTICS AT SITES WHERE GOLDEN-CHEEKED WARBLERS WERE LOCATED COMPARED WITH LOCATIONS WHERE GOLDEN-CHEEKED WARBLERS WERE NOT LOCATED IN THE DEPARTMENTS OF NUEVA SEGOVIA AND ESTELI, NICARAGUA, 2006-2008.

	GCWA (<i>n</i> = 36)	No GCWA (<i>n</i> = 24)	Mann-Whitney <i>P</i>
Number of pines	3.97 \pm 0.97	9.54 \pm 2.16	0.05
Basal area pines (m ² ha ⁻¹)	2.18 \pm 0.70	4.57 \pm 1.21	0.07
Number of encino oaks	9.39 \pm 1.59	10.1 \pm 2.03	0.86
Basal area encino oaks (m ² ha ⁻¹)	5.90 \pm 1.19	3.56 \pm 1.11	0.05
Ground cover (%)	78.6 \pm 3.82	58.3 \pm 6.93	0.04
Canopy cover (%)	63.8 \pm 4.79	60.6 \pm 6.78	0.76
Elevation (m)	1449 \pm 25.8	1331 \pm 31.6	0.005

of the “winter period” as defined by Pulich (1976), and might have represented birds in migration, which often exhibit wider habitat breadth than sedentary individuals (Rappole et al. 1999).

All of the GCWAs we observed were members of mixed-species flocks, which is consistent with reports by Rappole et al. (1999) from Honduras and Guatemala. Furthermore, the species most commonly associated with GCWAs in Nicaragua were also among the most commonly encountered species associated with GCWAs in the rest of their wintering range (Rappole et al. 1999, King and Rappole 2000). Rappole et al. (1999) suggested that the nearly obligate association of GCWAs with mixed-species flocks makes them potentially more vulnerable to forest fragmentation because fragmentation reduces the suitability of the remaining habitat for mixed-species flocks (Rappole and Morton 1985).

Although we have demonstrated that GCWAs do overwinter in Nicaragua, it does not appear that there is much suitable habitat in the country. Although Taylor (1963) reported that upland pine forest, a plant community which includes pine-oak forest, covered 1500 km² in Nicaragua, the current amount of suitable habitat for GCWAs is probably far less than this for the following reasons. First, deforestation rates in Nicaragua averaged 2.31% between 1961 and 1992 (FAO 1993), and, if this rate is representative of upland pine forests, the amount cited by Taylor (1963) would have been reduced to less than half by 2006. This would correspond closely with the recent estimate of 774 km² of GCWA habitat by Perez et al. (2008).

Based on this information as well as our own observations, it appears that most of the suitable pine-oak habitat in Nicaragua occurs in the Dipilto region along the Honduran border, with smaller amounts of habitat near Esteli and Cusmapa. Although the majority of this habitat is under various forms of statutory protection, it

is still threatened by agricultural activities and unregulated logging, and at least one site was deforested during the study period.

Future research and conservation efforts should include: (1) The implementation of the Plan de Conservación de los Bosques de Pino-Encino de Centroamérica y el Ave Migratoria *Dendroica chrysoparia* (Perez et al. 2008); (2) surveys to determine whether additional suitable habitat exists in parts of Nicaragua that we did not visit, such as Jinotega; (3) studies of the tolerance of GCWAs to habitat disturbance, such as agricultural development and logging; (4) collaboration with local and federal conservation agencies and organizations to enforce current protections and develop more sustainable land use practices; and (5) education and outreach to raise awareness about the importance of this region to GCWAs, as well as how land users can help ensure this species persistence for future generations.

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LITERATURE CITED

- DEBOER, T. S., AND D. D. DIAMOND. 2006. Predicting presence-absence of the endangered Golden-cheeked Warbler (*Dendroica chrysoparia*). *Southwestern Naturalist* 51:181-190
- FAO. 1993. Production Yearbook, Food & Agriculture Organization of the United Nations, Rome, Italy.

- JAMES, F. C., AND H. H. SHUGART. 1970. A quantitative method of habitat description. *American Birds* 24:721-736.
- KING, D. I., AND J. H. RAPPOLE. 2000. Mixed-species foraging flocks in montane pine forests of Middle America. *Condor* 102:664-672.
- LADD, C., AND L. GASS. 1999. Golden-cheeked Warbler (*Dendroica chrysoparia*). A. Poole [ed.], *The Birds of North America Online*. Cornell Lab of Ornithology. Ithaca, NY. [Online.] <<http://bna.birds.cornell.edu/bna/species/420>> (2 January 2009).
- MAGNESS, D. R., R. N. WILKINS, AND S. J. HEJL. 2006. Quantitative relationships among Golden-cheeked Warbler occurrence and landscape size, composition, and structure. *Wildlife Society Bulletin* 34:473-479.
- MORALES, S., A. MARTÍNEZ-SALINAS, W. J. ARENDT, AND M. A. TÓRREZ. 2008. Redescubrimiento de *Dendroica chrysoparia* en Nicaragua. *Zeledonia* 12:30-34.
- PEAK, R. G. 2007. Forest edges negatively affect Golden-cheeked Warbler nest survival. *Condor* 109:628-637.
- PEREZ, E. S., E. SECAIRA, C. MACIA, S. MORALES, AND I. AMEZCUA. 2008. Plan de conservación de los bosques de pino-encino de Centroamérica y el ave migratoria *Dendroica chrysoparia*, Fundación Defensores de la Naturaleza y The Nature Conservancy, Guatemala.
- PULICH, W., SR. 1976. The Golden-cheeked Warbler. A bioecological study. Texas Parks and Wildlife Department. Austin, TX.
- RAPPOLE, J. H., D. I. KING, AND W. BARROW. 1999. Winter ecology of the endangered Golden-cheeked Warbler (*Dendroica chrysoparia*). *Condor* 101:762-770.
- RAPPOLE, J. H., D. I. KING, AND P. LEIMGRUBER. 2000. Winter habitat and distribution of the endangered Golden-cheeked Warbler (*Dendroica chrysoparia*). *Animal Conservation* 2:45-59.
- RAPPOLE, J. H., D. I. KING, J. DIEZ, AND J. H. VEGA RIVERA. 2005. Factors affecting population size in Texas's Golden-cheeked Warbler. *Endangered Species Update* 22:95-103.
- RAPPOLE, J. H., D. I. KING, AND J. DIEZ. 2003. Winter versus breeding habitat limitation for an endangered avian migrant. *Ecological Applications* 13:735-742.
- RAPPOLE, J. H., AND M. V. McDONALD. 1994. Cause and effect in migratory bird population changes. *Auk* 111:652-660.
- TAYLOR, B. W. 1963. An outline of the vegetation of Nicaragua. *Journal of Ecology* 51:27-54.
- THOMPSON, D. E. 1995. Observations of golden-cheeked warblers wintering in Guatemala and Honduras. U.S. Fish and Wildlife Service contract no. 1448-00002-94-0846. Austin, TX.
- U.S. FISH AND WILDLIFE SERVICE. 1990. Endangered and threatened wildlife and plants; final rule to list the Golden-cheeked Warbler as endangered. *Federal Register* 55(87):53153-53160.
- VIDAL, R. M., C. MACIAS-CABALLERO, AND C. D. DUNCAN. 1994. The occurrence and ecology of the Golden-cheeked Warbler in the highlands of northern Chiapas, Mexico. *Condor* 96:684-691.

APPENDIX 1. LOCATIONS OF GOLDEN-CHEEKED WARBLERS EXPRESSED IN UTM COORDINATES, WITH DATE AND ELEVATION FOR GOLDEN-CHEEKED WARBLER LOCATIONS IN THE DEPARTMENTS OF NUEVA SEGOVIA AND ESTELI, NICARAGUA, 2006-2008.

Individual	North (units)	West (units)	Date	Elevation (m)
1	563224	1518074	14-Nov-06	1393
2	558629	1519629	15-Nov-06	1392
3	565326	1513686	6-Jan-07	1461
4	558778	1519833	8-Jan-07	1460
5	557752	1519868	9-Jan-07	1621
6	557752	1519868	9-Jan-07	1621
7	560392	1517386	13-Jan-07	1315
8	562896	1518189	13-Jan-07	1136
9	568812	1435340	25-Jan-07	1491
10	569047	1434721	28-Jan-07	1405
11	568824	1435821	29-Jan-07	1456
12	568824	1435821	29-Jan-07	1456
13	538957	1471929	1-Feb-07	1346
14	547178	1522096	3-Feb-07	1449
15	564112	1517818	4-Feb-07	1510
16	564112	1517818	4-Feb-07	1510
17	557575	1520084	6-Feb-07	1651
18	557728	1599330	6-Feb-07	1652
19	557728	1599330	6-Feb-07	1652
20	557756	1521699	7-Feb-07	1662
21	557695	1520080	8-Feb-07	1612
22	558687	1520004	8-Feb-07	1349
23	568769	1435988	14-Nov-07	1453
24	568578	1433959	17-Nov-07	1392
25	567380	1433438	18-Nov-07	1374
26	567509	1433669	19-Nov-07	1364
27	569910	1437972	20-Nov-07	1192
28	572952	1429152	21-Nov-07	1265
29	558688	1518937	28-Dec-07	1272
30	558630	1519777	30-Dec-07	1411
31	558733	1520110	30-Dec-07	1445
32	558696	1519760	16-Jan-08	1371
33	557674	1520276	17-Jan-08	1690
34	557762	1520102	18-Jan-08	1636
35	547230	1522106	18-Jan-08	1348
36	539007	1472474	21-Nov-08	1368