FINAL REPORT

As Required by

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. TX E-129-R-1

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Endangered and Threatened Species Conservation

A protocol for increasing capture probability of Golden-cheeked Warblers at wintering sites

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FINAL REPORT

STATE: ____Texas_______________ **GRANT NUMBER:** ___TX E-129-R-1___

GRANT TITLE: A protocol for increasing capture probability of Golden-cheeked Warblers at wintering sites

REPORTING PERIOD: ____1 Sep 10 to 31 Aug 13_

OBJECTIVE(S):

Develop a mist-netting protocol to increase capture probability of Golden-cheeked Warbler at wintering sites to further knowledge about migration patterns.

Segment Objectives:

Task 1. November 2010-February 2011 - operate at least 12, 12 m mist nets an average of 4 days per week alternating between 2 sites in Chiapas, México. For any individual Golden-cheeked warbler captured, researchers will apply a USGS aluminum band, a unique combination of color bands, and sample tissue (pull two tail feathers and two breast feathers or clip a toe nail) for stable isotope material. After release, a researcher will follow the flock using protocol developed during a winter distribution study to assess feasibility of implementing a large-scale mark/resight study to examine overwinter survival. Researchers will field test a guide to ageing and sexing Golden-cheeked Warblers during the non-breeding season.

Task 2. March 2011 - visit breeding site for further training in extracting birds from mist nets and applying USGS aluminum bands, a unique combination of color bands, and tissue sampling.

Task 3. October 2011-February 2012 – continue netting as in Task 1, above. Pronatura Sur will train researchers studying the Golden-cheeked Warbler across its winter range in techniques to increase capture probability and to age and sex Golden-cheeked Warblers during the non-breeding season.

Task 4. October 2012-February 2013 - continue netting as in Task 1, above. Pronatura Sur will develop and disseminate to other researchers working with the species at wintering sites an electronic copy of a protocol to increase capture probability of the warbler at wintering sites.

Significant Deviations:

None.

Summary Of Progress:

Please see Attachment A.

Location: Chiapas, Mexico.

Cost: ___Costs were not available at time of this report, they will be available upon completion of the Final Report and conclusion of the project.__

Prepared by: _Craig Farquhar_____________ **Date:** _1 October 2013

Approved by: ______________________________ **Date:** 1 October 2013
C. Craig Farquhar

ATTACHMENT A

Photo: second-year male Golden-cheeked Warbler captured in Moxviquil Ecological Reserve, Chiapas, México.
By Eric Hernández Molina

A protocol for increasing capture probability of Golden-cheeked Warblers at wintering sites

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Abstract. The Golden-cheeked Warbler Recovery Plan outline lists the need to “determine optimum distribution of areas to be protected in winter range and migration corridor” as a recovery task needed to attain the objective of delisting this species. An understanding of a species’ migratory connectivity among winter and reproductive grounds is integral to developing the optimum distribution of habitat to protect for it. Stable isotope technology provides a mechanism for researchers to study migratory connectivity between breeding and wintering populations. However, collecting these data for this bird species may not possible given the low capture probability of individuals at wintering sites using a standard protocol. We developed and implemented a mist-netting protocol that increased capture probability of Golden-cheeked Warblers at wintering sites. Our mist-netting protocol required 7% to 10% percent the effort to capture one Golden-cheeked Warbler compared a standard protocol implemented at other wintering sites. We attribute our decrease in effort to elevating and placing mist nets at known Golden-cheeked Warbler foraging locations. Even though our protocol did increase capture probability relative to a standard protocol, it probably did not increase the capture rate enough to be a viable method for determining migratory connectivity for populations of this bird species. Technological advances necessary to overcome limitations associated with the use of geolocators will likely occur sooner than we could collect enough samples for isotopic analysis. Given the high capture rate for this bird species at breeding sites, using geolocators to obtain these data would be a more viable alternative for studying migratory connectivity. Nonetheless, we advocate capturing and marking individual Golden-cheeked Warblers at wintering sites, as well as other flock members, so that researchers can gain a better understanding of the structure and dynamics of mixed-species foraging flocks, winter site fidelity, overwinter survival, and the propensity of Golden-cheeked Warblers to segregate by sex during the winter period.

Introduction

The Golden-cheeked Warbler *(Setophaga chrysoparia)* is a federally endangered migratory passerine whose population declines have been attributed to habitat loss and fragmentation throughout its range. In 1990, the U.S. Fish and Wildlife Service emergency listed this bird species as federally endangered due to ongoing concerns over breeding habitat loss and fragmentation attributed to urban development, agricultural practices, and flood-control impoundments (U.S. Fish and Wildlife Service 1992). Golden-cheeked Warblers overwinter in the Central American pine-oak *(Pinus spp.-Quercus spp.)* forest region, which extends from southern Mexico to northwestern Nicaragua (Alliance for the Conservation of Mesoamerican Pine-Oak Forests 2007). The World Wildlife Fund has listed this forest region as critically endangered due to the accelerated pace of deforestation, high poverty indices, and unsustainable use of resources (World Wildlife Fund 2007).

The Golden-cheeked Warbler Recovery Plan outline lists the need to "determine optimum distribution of areas to be protected in winter range and migration corridor" as a recovery task needed to attain the objective of delisting this species (U.S. Fish and Wildlife Service 1992, task 1.311). An understanding of a species' migratory connectivity, or how populations are geographically connected during different parts of their annual cycle, is integral to developing the optimum distribution of Central American pine-oak forest habitat to protect for the warbler. Migratory connectivity patterns range from strong, where most individuals that breed near each other also overwinter together, to weak, where most individuals from a breeding population migrate to several different sites across the wintering grounds (Webster et al. 2002). Researchers have hypothesized that strongly connected populations may be more vulnerable to large-scale perturbations, such as habitat loss and climate change, than weakly connected populations because strongly connected populations contain individuals from the same breeding area and hence, are less likely to contain genetic variation for migratory behaviors which could allow them to respond to perturbations and prevent population declines (Dolman and Sutherland 1994, Esler 2000, Marra et al. 2006, Jones et al. 2008).

Mark-recapture/resight techniques have not proven effective in furthering our knowledge of migratory connectivity for most bird species. Although the geographical areas and numbers of individuals marked are large, most of the bird species are small and thus, the probability of recapturing or resighting an individual marked on its breeding grounds during the non-breeding season is very low (Webster et al. 2002). Recent advances in stable isotope technology provide a mechanism for researchers to study migratory connectivity between breeding and wintering populations (Chamberlain et al. 1997, Hobson et al. 1997). Animals incorporate stable isotopes of elements like carbon and hydrogen into their tissues (feathers, bones, muscles, etc.) when they eat plants or other animals. The fact that stable isotopes vary in predictable ways geographically and ecologically makes it possible to determine where the tissue formed. Thus, researchers can take a feather that was molted on the breeding grounds, from a migratory bird on its wintering grounds, and analyze the feather's isotopic signature to determine where the bird bred.

Golden-cheeked Warblers have proven challenging to capture during the non-breeding season. Unlike the breeding season, they do not respond to recorded vocalizations of conspecific individuals at wintering sites (O. Komar unpublished data). Consequently, target mist-netting is not an option for increasing capture probability of this bird species during this part of their annual cycle. Additionally, Golden-cheeked Warblers occur in mixed-species foraging flocks during the non-breeding season. Studies examining the movement patterns of these flocks have found that most of the flocks contain only one Golden-cheeked Warbler (Vidal et al. 1994, Rappole et al. 1999, Braun et al. 1986, Thompson 1995, Komar et al. 2011). Despite these challenges, researchers captured two Golden-cheeked Warblers in mist nets at wintering sites in 2008. One capture occurred at Cusuco National Park in Honduras and the other at Montecristo National Park in El Salvador. However, researchers had operated mist nets at Cusuco National Park for six years and Montecristo National Park for four years prior to these captures.

The objective of the banding stations established at these two wintering sites is to develop estimates of overwinter survivorship for migratory bird species (DeSante et al. 2005). Thus, their protocol emphasizes standardization in station operation from year-to-year as well as continuity over years. This protocol could contribute to low capture rates for Golden-cheeked Warblers at wintering sites for a variety of reasons. First, the protocol calls for mist nets to be placed in the same location at each station over the course of the study. Researchers studying the movement patterns of Golden-cheeked Warblers in mixed-species foraging flocks, often detect Golden-cheeked Warblers foraging in the same trees at wintering sites throughout the non-breeding season (Vidal et al. 1994, Komar et al. 2011), so placement of mist nets at these foraging locations instead of the same location over the course of the study could increase capture probability for Golden-cheeked Warblers. Second, the protocol calls for placement of mist nets at a standard height above ground, approximately 3 m. Komar et al. (2011) reported that observers detected Golden-cheeked Warblers foraging on average 10.09 m above ground in habitat with an average tree height of 12.93 m such that individuals of this species foraged approximately 20% below the canopy and 80% above ground. Consequently, elevation of mist nets into the upper part of the forest canopy also could increase capture probability for Golden-cheeked Warblers.

Establishing how Golden-cheeked Warbler populations are geographically connected during parts of their annual cycle, or their migratory connectivity, is an essential component of determining the optimum distribution of areas to protect across the wintering grounds and migration corridor and ultimately, enhancing the probability of the continued existence of this bird species. Stable isotope technology is a means of gathering the data needed to answer that question. However, collecting these data for Golden-cheeked Warbler populations may not possible given the low capture probability of individuals at wintering sites using a standard protocol. A study to determine whether or not researchers can increase capture probability for Golden-cheeked Warblers at wintering sites should be conducted prior to implementing a costly, large-scale study.

Objective

Our objective was to develop a mist-netting protocol to increase capture probability of Golden-cheeked Warblers at wintering sites and further knowledge about migration patterns. In this report, we present optimal height and placement of mist nets, the protocol for elevating mist nets, and the equipment and labor required for implementation of our protocol to increase capture probability of this bird species at wintering sites. We summarize the results from the 2010 through 2012 field seasons. We discuss the adequacy of this protocol for collecting stable isotope data and possible alternatives to understanding migratory connectivity of Golden-cheeked Warbler populations.

Location

We conducted the study on two sites located near San Cristóbal de Las Casas, Chiapas, Mexico (16° 44' 12" N 92° 38' 18" W) during the 2010 through 2012 non-breeding seasons. The sites ranged from 2100 to 2550 m above sea level. One site is Moxviquil Ecological Reserve, a 78-ha reserve which is managed by Pronatura Sur. The other site is La Tovilla-Encuentro, a 146-ha preserve which is privately owned. These two sites were established to protect oak and pine-oak forests representative of this region and were surveyed as part of a previous study to determine the distribution of the warbler and its habitat across the wintering range (Komar et al. 2011).

Methods

Previous studies have detected Golden-cheeked Warblers foraging at mean heights (95% confidence interval) of 10.09 m (9.56–10.62 m) and 10.00 m (7.69–12.31 m) (Vidal 1994, Komar et al. 2011, respectively). Given these data, we elevated mist nets so that the bottom mist-net trammel was approximately 7 m above ground and the top trammel 10 m. Field assistants also differentiated mixed-species foraging flocks from each other based on composition of the flocks and distance between sightings during those two studies. We used these data to establish net lanes in the home ranges of two different mixed-species foraging flocks, as identified by the field assistants, at Moxviquil and La Tovilla-Encuentro. Within each home range, we placed eight mist nets at locations where field assistants had recorded Golden-cheeked Warblers foraging during the previous studies.

Because our mist nets were 12 m in length, we established net lanes between two trees that were 14 to 15 m apart from each other. This distance allowed field assistants to accommodate for stretching of mist nets that occurs over time and to adjust the amount of tension associated with the mist net trammels. When possible, we placed mist nets in natural forest openings located near Golden-cheeked Warbler foraging locations to minimize the amount of foliage field assistants needed to remove to construct a net lane (Appendix 1, Figures 1 and 2). At each tree, we constructed a pulley from nylon rope and a metal stake and used the pulley to raise and lower the ends of the mist net. We tied the nylon rope to a rock (Appendix 1, Figure 3) and either threw the rock or used a sling shot to propel the rock over a branch located in the upper part of the tree to form the upper portion of the pulley (Appendix 1, Figure 4). Using a rubber mallet, we secured a metal stake in the ground at the base of each tree and used it to form the lower portion of the pulley (Appendix 1, Figure 5). We tied the loops of the four mist net trammels to the nylon rope (Appendix 1, Figure 6) and adjusted the tension of the mist net with guy lines (Appendix 1, Figure 7). Over time, the nylon rope became worn because of the friction associated with it rubbing against the tree branch and the metal stake. Field assistants replaced the worn nylon rope by tying new nylon rope to one end of it and pulling both the worn and new nylon rope over the tree branch and down to the metal stake. See Appendix 2 for a complete list of equipment needed to implement this mist-netting protocol.

Field assistants operated eight 30-mm mesh black nylon mist nets (12 x 2.6 m, four tiers) for six morning hours per day, beginning at local sunrise, for approximately four consecutive days per flock each month during the 2010 through 2012 seasons. After capture, we banded migratory passerines with a U.S. Geological Survey aluminum band and used criteria described in Pyle (1997) to age and sex them. For Golden-cheeked Warblers, we also applied a unique combination of colored leg bands. We released bird species not covered under our permit (e.g., hummingbird and raptor species) without banding them. We also examined the alula of other members of the *virens* complex (Golden-cheeked, Black-throated Green [*Setophaga virens*], Hermit [*Setophaga occidentalis*], Townsend's [*Setophaga townsendi*], and Black-throated Gray [*Setophaga nigrescens*] Warblers; Mengel 1964), for presence of retained alula from the juvenal plumage versus replaced alula from the basic plumage as described in Peak and Lusk (2009). Additionally, we documented signs of molt and effort data (i.e., the number and timing of net hours on each day of operation).

We used a Garmin 12 (Garmin International, Olathe, Kansas) global positioning system unit to record Universal Transverse Mercator coordinates for each mist net location and banded individual that we recaptured or resighted. Using ArcGIS (Environmental Systems Research Institute, Inc., Redlands, California, USA), we plotted the locations of the mist nets and individuals on imagery.

Results

We recorded a total of one hundred ninety-five captures of forty-three species (Table 1). Among individual species, Townsend's Warbler was the most frequently captured species followed by Wilson's Warbler (*Cardellina pusilla)*, Black-throated Green Warbler, Hutton's Vireo (*Vireo huttoni)*, Black-and-White Warbler (*Mniotilta varia)*, and Crescent-chested Warbler (*Oreothlypis superciliosa)* (Table 1). We recaptured twenty-eight individuals (Table 1). We captured more individuals at Moxviquil than La Tovilla-Encuentro (Table 1).

We accumulated 528 net-hours during the 2010 field season, 1192 during the 2011 field season, and 664 during the 2012 field season for a total mist-netting effort of 2384 net-hours. We captured a total of three Golden-cheeked Warblers over the course of the study (Table 1). During the 2010 field season, we captured one second-year male Golden-cheeked Warbler. We captured one hatching-year male and one after-second-year female during the 2011 field season. None of the three individuals was recaptured or resighted in a season other than the one in which it was first captured. Our capture rate was one Golden-cheeked Warbler per 795 net-hours or 16.5 days.

We recaptured two banded individuals in the home range of flocks different from the flocks to which field assistants had originally assigned them and resighted one color banded individual while following one of the flocks (Figure 1). Individual one was banded the first field season as member of a flock that we decided not to continue monitoring, but was recaptured later that season in the home range of flock one (Figure 1). Individual two was banded the second field season as a member of flock two, but was recaptured later that season in the home range of flock one (Figure 1). Individual three was banded the second field season as a member of flock two and was resighted in an area between the two flocks during the third field season (Figure 1).

Discussion

Composition of the mixed-species foraging flocks we studied was generally similar to that reported for other studies of mixed-species foraging flocks of which Golden-cheeked Warblers were members. Townsend's Warbler was the most frequent species detected by Vidal et al (1994), while Wilson's Warbler was the most frequent species detected by Rappole et al. (1999), King and Rappole (2000), and Komar et al. (2011). Other bird species frequently encountered by observers during these studies included Black-throated Green Warbler, Blue-headed Vireo (*Vireo solitarius)*, Hermit Warbler, Black-and-White Warbler, and Red-faced Warbler (*Cardellina rubrifrons)*. Differences in composition of flocks between our study and previous studies can be attributed to the fact that previous studies sampled more habitat occupied by Golden-cheeked Warblers across a larger portion of their wintering range and some bird species are more abundant in areas with a certain habitat component. For example, Hermit Warblers are more abundant in open-canopy pine forest (Vidal et al. 1994, King and Rappole 2000) than other habitat types. Also, observers in previous studies followed flocks to make visual observations of individuals rather than capturing them in mist nets. We captured more individuals at Moxviquil Ecological Reserve than La Tovilla-Encuentro because our pulleys were continually stolen from the latter site, so we abandoned it during the second field season.

The mist-netting protocol that we developed and implemented did increase capture probability for Golden-cheeked Warblers at wintering sites. Our capture rate was one individual per 795 net-hours. The capture rate for the banding station at Cusuco National Park in Honduras was one individual per 12000 net-hours and at Montecristo National Park in El Salvador was one individual per 8000 net-hours. In other words, our mist-netting protocol required 7% and 10 % the effort, respectively, to capture one Golden-cheeked Warbler than the standard protocol implemented at the other wintering sites. We attribute this decrease in effort to our elevating and placing mist nets at Golden-cheeked Warbler foraging locations.

Two studies have attempted to estimate density of Golden-cheeked Warblers across their wintering range. Rappole et al. (2003) used transect data to calculate mean density of mixed-species foraging flocks per ha using program DISTANCE (Buckland et al. 1993) and multiplied the result by mean number of Golden-cheeked Warblers per occupied flock. Komar et al. (2011) followed mixed-species foraging flocks to obtain a mean estimate of the area occupied by the flock and divided mean number of Golden-cheeked Warblers per flock by the area estimate. Both methods rely on the assumptions that individuals included as members of the flock do not join and leave it (i.e., the flock is cohesive), movement of the flock is restricted to a discrete home range, and observers are able to differentiate flocks from each other. Neither of these studies followed any marked individuals. Furthermore, the flocks we studied at our Moxviquil site also were followed during Komar et al. (2011). The fact that we recaptured individuals in the home range of flock one, but those individuals were originally captured as part of a different flock as identified by field assistants, suggests that flocks may not be cohesive, their movement may not be restricted to a discrete home range, observers are not able to differentiate flocks from each other, or a combination of these assumptions. This result demonstrates the need to implement mark-recapture/resight studies for mixed-species foraging flocks if flock-related data are going to be used to estimate density, and perhaps other demographic parameters, of its members. We recommend color banding individuals of the most common species (e.g., Townsend's Warbler, Wilson's Warbler, Black-throated Green Warbler, Black-and-White Warbler) to increase resighting probability and thus, improve flock-related data and the estimates associated with them.

Even though our protocol did increase capture probability for Golden-cheeked Warblers at wintering sites relative to a standard protocol implemented at other banding stations, it did not increase the capture rate enough to be a time-effective method for determining migratory connectivity of Golden-cheeked Warbler populations. Our protocol calls for two, preferably three, field assistants to safely operate eight mist nets per site for six hours a day, ≥4 days a month, three months a year. Converting our capture rate of one individual per 795 net-hours to days yields a capture of one individual every 16.5 days. According studies examining migratory connectivity for other songbird populations (Rubenstein et al. 2002, Smith et al. 2003, Jones et al. 2008), we would need to sample hundreds of individuals across the wintering range to construct models to compare to breeding range isotopic patterns from which to infer connectivity between the two ranges for Golden-cheeked Warbler populations. Given how labor intensive this effort would be because the density of this bird species at wintering sites is low, it could take decades to capture enough individuals to obtain an adequate sample size for analysis. It is likely that technological advances necessary to overcome the limitations associated with the use of geolocators (e.g., size of hardware, data error caused by environmental factors) will occur sooner than we could collect enough samples from wintering sites for isotopic analysis. If those advances are made, then using geolocators to obtain these data would be a more viable alternative for studying migratory connectivity of Golden-cheeked Warbler populations given the high capture rate for this bird species at breeding sites. Nonetheless, we advocate implementing mark-recapture/resight studies for Golden-cheeked Warblers and other members of mixed-species foraging flocks at wintering sites, so that researchers can gain a better understanding of the structure and dynamics of mixed-species foraging flocks of which Golden-cheeked Warblers are members, as well as winter site fidelity, overwinter survival, and the propensity of Golden-cheeked Warblers to segregate by sex during the winter period.

Acknowledgments

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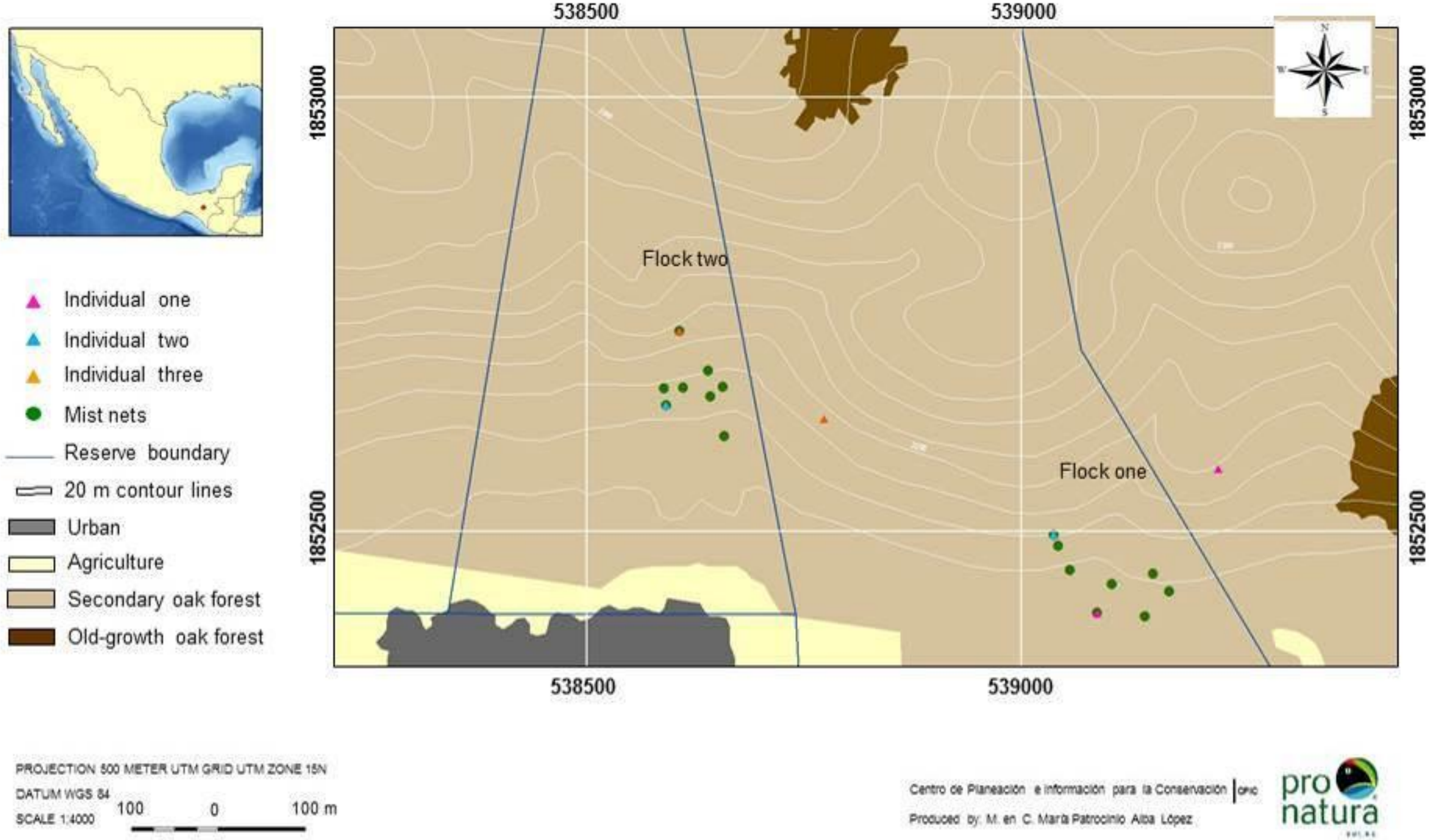


Figure 1. Distribution of mist nets and marked individuals recaptured or resighed at Moxviquil Ecological Reserve, Chiapas, Mexico, during the 2010-2012 non-breeding seasons.

Table 1. Summary and status (B = banded, U = unbanded, R = recapture) for bird species captured at Moxviquil Ecological Reserve and La Tovilla-Encuentro, Chiapas, Mexico during the 2010–2012 non-breeding seasons.

	Moxviquil			La Tovilla-Encuentro		
Species	B	U	R	B	U	R
Amethyst-throated Hummingbird *(Lampornis amethystinus)*	0	1	0	0	0	0
Black-and-white Warbler *(Mniotilta varia)*	11	0	2	0	0	0
Black-headed Siskin *(Spinus notata)*	0	1	0	0	0	0
Black-throated Blue Warbler *(Setophaga caerulescens)*	1	0	0	0	0	0
Black-throated Green Warbler *(Setophaga virens)*	13	0	1	0	0	0
Blue-headed Vireo *(Vireo solitarius)*	7	0	2	0	0	0
Broad-winged Hawk *(Buteo platypterus)*	0	1	0	0	0	0
Broad-tailed Hummingbird *(Selasphorus platycercus)*	0	0	0	0	0	0
Brown-backed Solitaire *(Myadestes occidentalis)*	0	2	0	0	0	0
Bushtit *(Psaltriparus minimus)*	0	3	0	0	0	0
Crescent-chested Warbler *(Oreothlypis superciliosa)*	11	0	2	0	0	0
Dusky-capped Flycatcher *(Myiarchus tuberculifer)*	1	0	0	0	0	0
Garnet-throated Hummingbird *(Lamprolaima rhami)*	0	1	0	0	0	0
Golden-browed Warbler *(Basileuterus belli)*	0	0	0	1	0	0
Golden-cheeked Warbler *(Setophaga chrysoparia)*	3	0	2	0	0	0
Gray Catbird *(Dumetella carolinensis)*	1	0	0	0	0	0
Gray-cheeked Thrush *(Catharus minimus)*	1	0	0	0	0	0
Greater Pewee *(Contopus pertinax)*	3	0	0	0	0	0
Grey Silky-flycatcher *(Ptilogonys cinereus)*	0	3	0	0	0	0
Hairy Woodpecker *(Picoides villosus)*	1	0	0	0	0	0
Hepatic Tanager *(Piranga flava)*	2	0	0	0	0	0
Hermit Warbler *(Setophaga occidentalis)*	1	0	1	0	0	0
Hooded Grosbeak *(Coccothraustes abeillei)*	0	1	0	0	0	0
Hutton's Vireo *(Vireo huttoni)*	13	0	3	0	0	0
Indigo Bunting *(Passerina cyanea)*	2	0	0	0	0	0
Least Flycatcher *(Empidonax minimus)*	0	0	0	1	0	0
Magnificent Hummingbird *(Eugenes fulgens)*	0	5	0	0	1	0
Magnolia Warbler *(Setophaga magnolia)*	1	0	0	0	0	0
Nashville Warbler *(Oreothlypis ruficapilla)*	3	0	0	0	0	0
Northern Flicker *(Colaptes auratus)*	0	1	0	0	0	0
Painted Redstart *(Myioborus pictus)*	0	0	0	0	0	0
Red-faced Warbler *(Cardellina rubrifrons)*	2	0	0	1	0	0

Table 1 continued.

	Moxviquil			LaTovilla-Encuentro		
Species	B	U	R	B	U	R
Ruby-throated Hummingbird *(Arcbilocus colubris)*	0	1	0	0	0	0
Rufous-collared Thrush *(Turdus rufitorques)*	0	2	0	0	0	0
Rufous-collared Sparrow *(Zonotrichia capensis)*	0	0	0	0	0	0
Slate-throated Redstart *(Myioborus miniatus)*	5	0	0	1	0	0
Swainson’s Thrush *(Catharus ustulatus)*	0	0	0	0	0	0
Townsend’s Warbler *(Setophaga townsendi)*	50	0	11	2	0	0
Warbling Vireo *(Vireo gilvus)*	4	0	1	0	0	0
Western Tanager *(Piranga ludoviciana)*	1	0	0	0	0	0
White-eared Hummingbird *(Hylocharis leucotis)*	0	8	0	0	2	0
Wilson’s Warbler *(Cardellina pusilla)*	16	0	3	2	0	0
Yellow-bellied Sapsucker *(Sphyrapicus varius)*	0	2	0	0	0	0

Appendix 1. Establishment and operation of elevated mist nets in Golden-cheeked Warbler wintering habitat.

Figure 1

Figure 2

Appendix 1 continued.

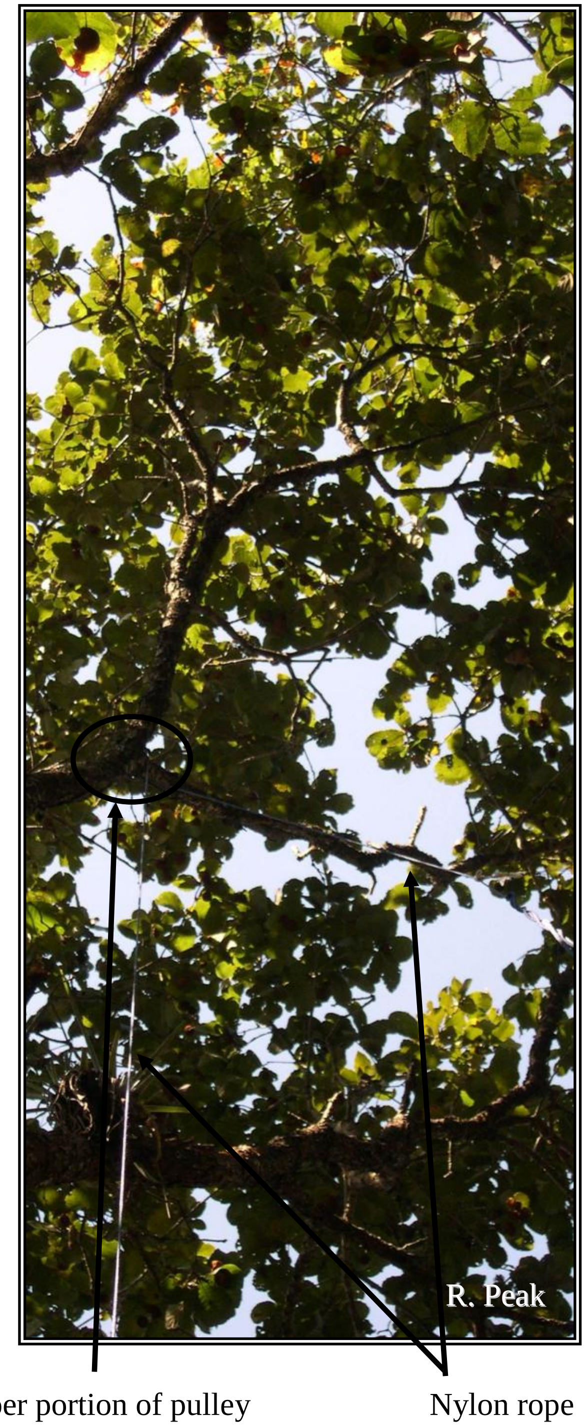


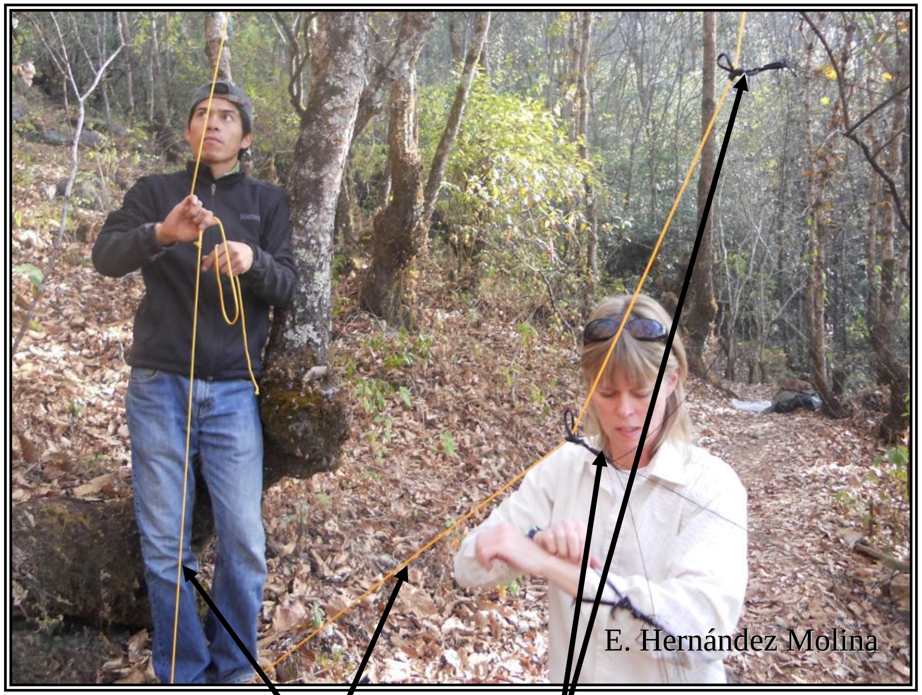
Figure 3

Figure 4

Appendix 1 continued.

Nylon rope   Lower portion of pulley   Metal stake

Figure 5



Pulley   Loops of mist net trammels

Figure 6

Appendix 1 continued.

Pulley

Guy line

Second-year male Golden-cheeked Warbler captured at Moxviquil Ecological Reserve during the 2011 non-breeding season.

Figure 7

Figure 8

Appendix 2. List of equipment and associated costs for establishment and operation of elevated mist nets in Golden-cheeked Warbler wintering habitat.

Equipment	Quantity	Cost (dollars)
mist nets, 30 mm mesh, 12 m length, 2.6 m height, 4 shelves, black nylon	8 per site	$1216.00
Michigan banding pliers for sizes 0A-1A, $75.00	2 per site	$170.00
German banding pliers for sizes 0A-5, $72.00	1 per site	$72.00
bird bags	40 per site	$144.20
wing rule 15 cm, $8.50	2 per site	$17.00
wing rule 30cm, $25	1 per site	$25.00
Darvic bands size XFD, colors red, orange, yellow, dark green, dark blue, black, and white	100 per color	$91.00
celluloid bands size XF (2.3 mm), colors light, hot pink , mauve, and light green.	100 per color	$52.00
leg band remover for sizes 0A-3B	1 per site	$50.00
leg Gauge	1 per site	$12.00
portable digital scale (optional)	1 per site	$115.00
Swiss Army knife	3 per site	$72.00
nylon rope	1000 m per site	$120.00
back pack	2 per site	$155.00
Identification Guide to North American passerines	1 per site	$107.00
GPS unit	1 per site	$300.00
machete	3 per site	$60.00
rubber mallet (3 per site)	3 per site	$25.00
clip board	1 per site	$22.00
metal stakes	2 per net	$120.00
TOTAL		**$2945.20**