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ORIGINAL ARTICLE

STATUS OF THE THREE-WATTLED BELLBIRD (*PROCNIAS TRICARUNCULATUS*) IN THE NICOYA MOUNTAINS, COSTA RICA

Adam C. Stein[1,4] · Kyle Elliott[2] · Mélanie F. Guigueno[2] · Victoria Kalinina[3]

[1]Council on International Educational Exchange, Apartado postal 5655-45, Monteverde, Puntarenas, Costa Rica.
[2]Department of Natural Resource Sciences, McGill University, Montreal, Canada H3A 0G4.
[3]Amur State University, Ignatievskoe sh. 21, Blagoveshchensk 675027, Russian Federation.
[4]E-mail: Adam C. Stein · adamcarstenstein@gmail.com

Abstract · Wildlife conservation often relies on accurate data of species distributions, yet scientific knowledge is often limited in scope. Local knowledge and habitat mapping can provide additional information particularly useful in assessing the absence or presence of a species or population. In May 2015, we combined point counts, local interviews, citizen science databases, and habitat mapping to assess the presence of breeding Three-wattled Bellbirds (*Procnias tricarunculatus*), a species listed as Vulnerable by the IUCN, in the Nicoya Mountains of Costa Rica, where a disjunct population had previously been reported. Our point counts, local interviews, and citizen science databases provided strong evidence that bellbirds no longer breed in the Nicoya Mountains, and our habitat mapping demonstrated that a minimum of 23% of the bellbird habitat is now pasture. We conclude that a putative historic resident population of this species is now most likely non-existent in the Nicoya Mountains.

Resumen · Estatus del Pájaro Campana (*Procnias tricarunculatus*) en las montañas de Nicoya, Costa Rica
La conservación de la vida silvestre se basa comúnmente en el conocimiento exacto de la distribución de las especies, sin embargo este conocimiento es limitado para muchas especies. El conocimiento local y mapeo del hábitat pueden proveer información adicional, particularmente útil en la evaluación de la presencia o ausencia de especies o poblaciones. En mayo de 2015, combinamos puntos de conteo, entrevistas locales, bases de datos de ciencia ciudadana, y mapeo de hábitat para determinar la presencia de poblaciones reproductivas de Pájaro Campana (*Procnias tricarunculatus*), especie enlistada como vulnerable por la IUCN, en las montañas de Nicoya, Costa Rica, donde una población ha sido reportada previamente. Nuestros puntos de conteo, entrevistas a locales, y bases de datos de ciencia ciudadana indican que el Pájaro Campana no se reproduce en las montañas de Nicoya; nuestro mapeo de hábitat demuestra que un 23% del hábitat del Pájaro Campana ha sido transformado en pastizales. Concluimos que una supuesta población residente histórica de esta especie es ahora muy probablemente inexistente en las montañas de Nicoya.

Key words: Conservation · Costa Rica · Habitat assessment · Interview · Nicoya Mountains · Point counts · *Procnias tricaruculatus* · Three-wattled Bellbird

INTRODUCTION

Biologists increasingly rely on current and accurate species distribution maps to measure the species richness of a given region, evaluate the spreading potential of invasive species, assess the potential impacts of climate change, and to identify and manage threatened species (Franklin & Miller 2009). Given the importance of species distribution maps, biologists are continually refining the techniques and statistical approaches used to generate reliable, fine-scaled distribution maps (Araujo et al. 2005). However, detailed information regarding habitat specificity and presence-absence data needed to generate such precise distribution maps may only be available for well-known charismatic species (Araujo et al. 2005). Even within well-known species, information used to generate distribution maps maybe called into question (Molinari-Jobin et al. 2012). Outdated or inaccurate information could lead to false-negatives, areas not included although they harbor the species, or false-positives, areas that do not or no longer harbor the species but are included in the distribution maps (Gu & Swihart 2003, Loiselle et al. 2003).

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When conservation practitioners use distribution maps with false-positives they may erroneously inflate a current species population estimates. However, confirming that a species is absent from an area is much more of a difficult task than identifying its presence (Gu & Swihart 2004). Diamond (1987) highlights the issue that biologists must bear the burden proving that a species is absent from an area. For the International Union for the Conservation of Nature (IUCN), to declare a species or population extinct, there needs to be no reasonable doubt that the last individual has died (www.iucnredlist.org). This means that scientists must show that repeated efforts to find a species in a given area have failed to any individuals or any evidence that it still persists.

Given that there are millions of species and most scientific effort occurs in developed regions close to urban centers, it seems unlikely that all species can be censused repeatedly in detail. In contrast, the use of local knowledge surveys, citizen science programs and aerial surveys can provide a 'weight of evidence' approach, providing strong evidence for the presence or absence of a particular species. Local knowledge and citizen science programs are likely to be particularly useful for charismatic, easily-detected species.

The Three-wattled Bellbird (*Procnias tricarunculatus*, family Cotingidae) is endemic to Central America (Snow 1982). Between the months of March and June, male bellbirds display in exploded leks where males spend most of the daylight hours continuously calling from a high calling post and continuously call (Snow 1982). Their calls are reported as being the loudest of any living bird and can be easily heard for over a kilometer (Snow 1982). Bellbirds are listed as Vulnerable on the IUCN red list due to their small population size, small range, and habitat destruction of their limited breeding habitat in cloud forests. Being a charismatic species restricted to Central America, bellbirds have attracted both scientific research (e.g., Powell & Bjork 2004) and large-scale ecotourism. However, virtually all research and ecotourism is restricted to a few sites in Panama and Costa Rica, and little is known about other populations. Consequently, inaccuracies in our understanding of its current distribution have been widely discussed (Sandoval pers. comm.). Stiles & Skutch (1989) reported that the bellbird "breeds mainly 1200–2300 m a.s.l. in Cordillera de Tilarán, Caribbean slope of Cordillera Central, both slopes on the Cordillera Talamanca, and as low as 900 m a.s.l. on the Cordillera de Guanacaste and highest mountains of Peninsula de Nicoya." Since Stiles & Skutch's (1989) book was published, Powell & Bjork (2004) have elucidated the complex annual movements of Three-wattled Bellbirds and demonstrated that birds from the Tilarán population utilize the Nicoya Mountains in the non-breeding season. Nevertheless, a belief has perpetuated that a resident breeding population exists in the Nicoya Mountains of northwestern Costa Rica (Birdlife International 2012, Garrigues & Dean 2014; Figure 1), even though many current experts believe that there was never a resident population and that bellbirds no longer, if ever, breed there.

In this study, we employed multiple methods that could be used to verify a species presence or absence in a region, to determine if a resident breeding population of the Three-wattled Bellbird exists in the Nicoya Mountains of northwestern Costa Rica. Specifically, we 1) conducted point counts during the breeding season, 2) surveyed local households, 3) analyzed data from citizen science web-based resources, and 4) determined the maximum percentage of potential suitable habitat using aerial photographs. Because the bellbird is a charismatic, well-known species with a distinctive, loud call, it is an ideal species for determining presence using local knowledge.

METHODS

From 25–30 May 2015, we surveyed for the presence of Three-wattled Bellbirds in their reported range within the Nicoya Mountains (Guanacaste province; 10°08'52.26" N, 85°37'46.26" W; > 900 m a.s.l.) using both point counts and interviews with the locals living and working in the area. Point counts were conducted between the hours of 06:30–17:00 h, and each point was approximately one kilometer apart (Figure 2A). At each point, we surveyed for bellbirds both visually and acoustically for 20 minutes. Given the rough and steep topography, when necessary, the points were conducted by two people, each listening and scanning opposing ridges and valleys.

To receive input from locals living and working in the Nicoya Mountains, we conducted interviews with willing households and individuals following a specific protocol. First, participants were asked to listen to audio recordings of three bird species with distinct and far-carrying songs and to respond "yes" or "no" if they had heard that call within or near their property. The three calls were played in random orders and consisted of 1) the Long-tailed Manakin (*Chiroxiphia linearis*), a bird that was heard consistently and continually throughout the study site, 2) the Eurasian Cuckoo (*Cuculus canorus*), a species native to Europe and Asia and thus not found within the study site, and 3) the Three-wattled Bellbird, the species of interest. All audio recordings used were downloaded from www.xeno-canto.org.

If respondents said "yes" to hearing any of the recorded bird songs, we would continue with follow-up questions: (1) How frequently do you hear this bird? (2) At what times of the year do you hear this bird? (3) When was the last time that you heard this bird? (4) Would you consider this bird common here? If participants responded with "yes" for all the bird calls and did not provide any additional information, their responses were categorized as "unreliable". In multiple instances, respondents said "no" to hearing the bellbird, but voluntarily shared that they knew the bird and that the species used to be heard near their home. In these cases, we categorized their response as "yes", but noted that the observation was

Figure 1. The Nicoya Mountains in northwestern Costa Rica where the Three-wattled Bellbird (*Procnias tricarunculatus*) was previously reported as resident. Photo: Adam C. Stein.

in the past (not within the last five years). In cases where respondents said "yes" or "possibly", but could not provide any additional information on the follow-up questions, we categorized their response as a "yes" but noted that they were uncertain. At no time during the interview process, did we reveal to the participants that we were particularly interested in the status of the bellbird.

We also took advantage of a web-based citizen science source, specifically eBird, to see when and if bellbirds have been recorded in the Nicoya Mountains (Sullivan et al. 2009). First, we searched the database for Three-wattled Bellbird sightings and searched the interactive map for any records made in the Nicoya Mountains or the immediate vicinity. Secondly, to further demonstrate that the birds were never recorded from the area vs the area having never been surveyed we searched two common resident birds, Long-tailed Manakin and Black Vulture (*Coragyps atratus*). Each of these species would have inevitably made it onto any diligent observers list and demonstrate that the area was surveyed and bellbirds were not seen.

Lastly, we used aerial photographs from 2014 to determine habitat suitability within the region identified as the range of bellbirds by the IUCN in the Nicoya Mountains. We classified land as either forest or pasture.

RESULTS

We were unable to record bellbirds at any of the 37 point counts (Figure 2A). All surveyed households reported hearing the manakin on or near their property, while 12 out of the 26 households reported hearing the cuckoo and 14 out of 26 households reported hearing the bellbird on their property (Figure 3A). Three out of the 26 surveyed households answered 'yes' to all three without providing additional feedback or comments. We counted these households as unreliable. Of the remaining nine households that reported hearing cuckoos, four indicated that they were uncertain (Figure 3C). Additional follow-up questions revealed that five of the households mistook the cuckoo's call for that of a dove (family Columbidae) or motmot (family Motmotidae), birds with a similar cooing call (Figure 3C). For the 11 'reliable' households that reported hearing the bellbird, eight clarified that it was in the past (not within the last five years; Figure 3B) and three clarified that they only heard bellbirds during the months of December/January. It is also worth noting that

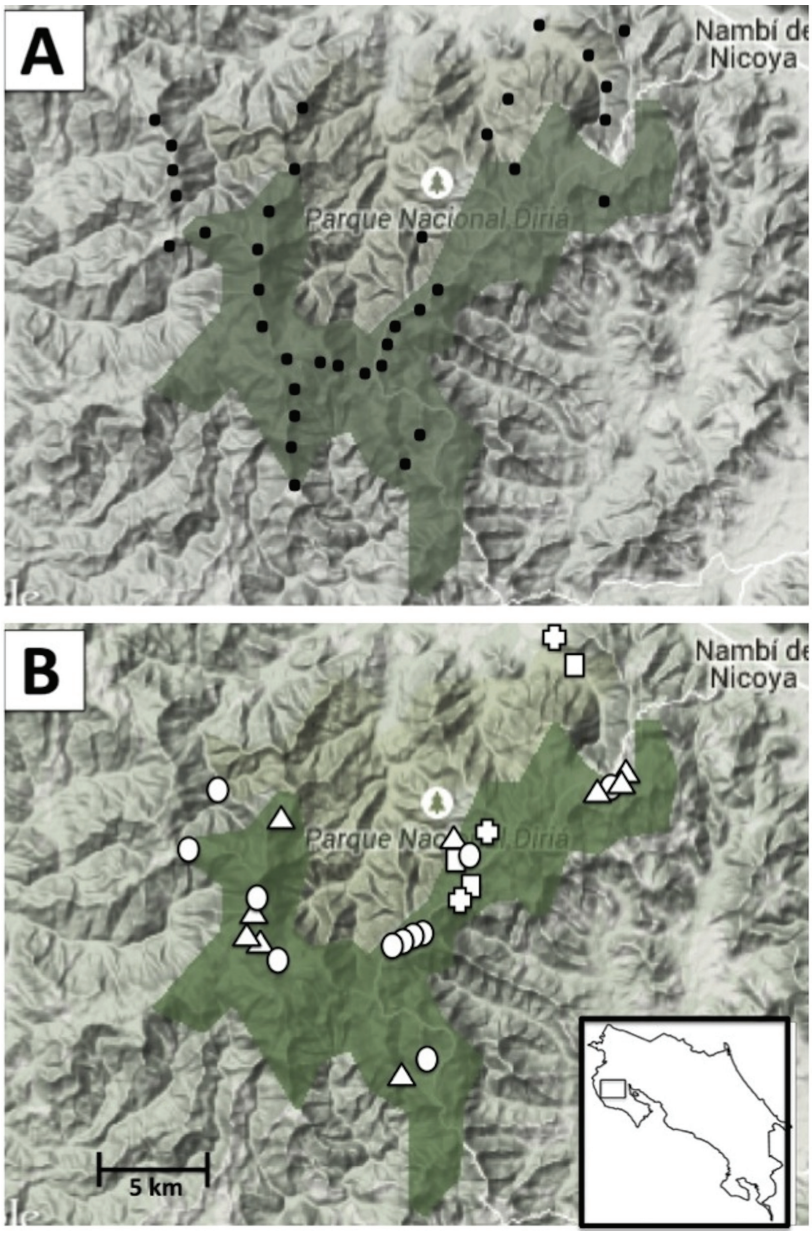

Figure 2. Map of the study area. The shaded area indicates the reported range of a resident population of Three-wattled Bellbirds (*Procnias tricarunculatus*) in the Nicoya Mountains, Costa Rica (Birdlife International 2012). A. Approximate locations of where the point counts were conducted. Black circles represent the locations of 20 minute point counts. B. Approximate locations of household interviews. Circles indicate households that reported never hearing a bellbird on their property; triangles indicate households that reported hearing bellbirds in the past; crosses indicate households that reported hearing bellbirds recently; and squares indicate households whose answers were unreliable.

each of the 11 households immediately identified the call as a bellbird.

Searching the term "Three-wattled Bellbird" in eBird yielded hundreds of reports. However, only six reports were listed from the entire Nicoya Peninsula (eBird 2016). The six reports were all centered near the beach community of Montezuma between the years 2000–2016 and took place during the months of December–February (eBird 2016). Conversely, searches for "Black Vulture" and "Long-tailed Manakin" produced lists from all over the Nicoya Peninsula, including locations within the study area (eBird 2016). These lists span from 2001–2014 and included the months of March and July (eBird 2016).

Aerial photographs (Figure 4) demonstrated that a minimum of 23% of the land indicated as bellbird habitat by the IUCN is now pasture, while the rest consists of regenerating forests and tree plantations.

DISCUSSION

Our point counts, household surveys, and aerial survey data all provided evidence that a resident, breeding population of the Three-wattled Bellbird does not

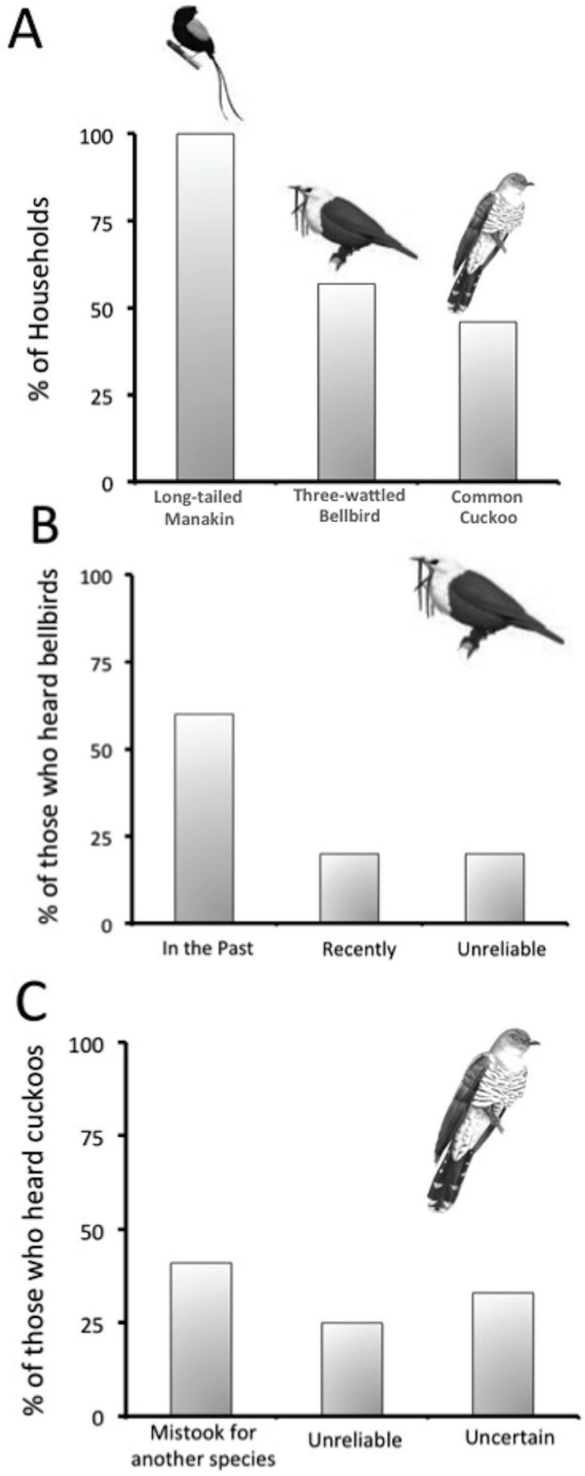

Figure 3. Results of household surveys conducted in the Nicoya Mountains region of Costa Rica. A. Percentage of the 26 households interviewed that reported hearing Long-tailed Manakins (*Chiroxiphia linearis*), Three-wattled Bellbirds (*Procnias tricarunculatus*), and Eurasian Cuckoos (*Cuculus canorus*) on or near their property. B. Percentage of the 15 households that reported hearing Three-wattled Bellbirds in the past (not within the last five years), recently (within a year), and those whose answers were deemed unreliable based on (C). C. Percentage of the 10 households that reported hearing Eurasian Cuckoos which mistook the call for another species, which were uncertain about the call, and those households which were deemed unreliable because they replied with certainty that they had heard the call but could not name the species. Images courtesy of Robert Dean and Victoria Kalinina.

exist in the Nicoya Mountains. We failed to observe/hear a bellbird on any of our 37 survey points despite our personal observations of intense bellbird activity in the Tilarán Mountains, ca. 90 km to the west both immediately before and immediately after the survey (unpub. data). Moreover, there were no reports on

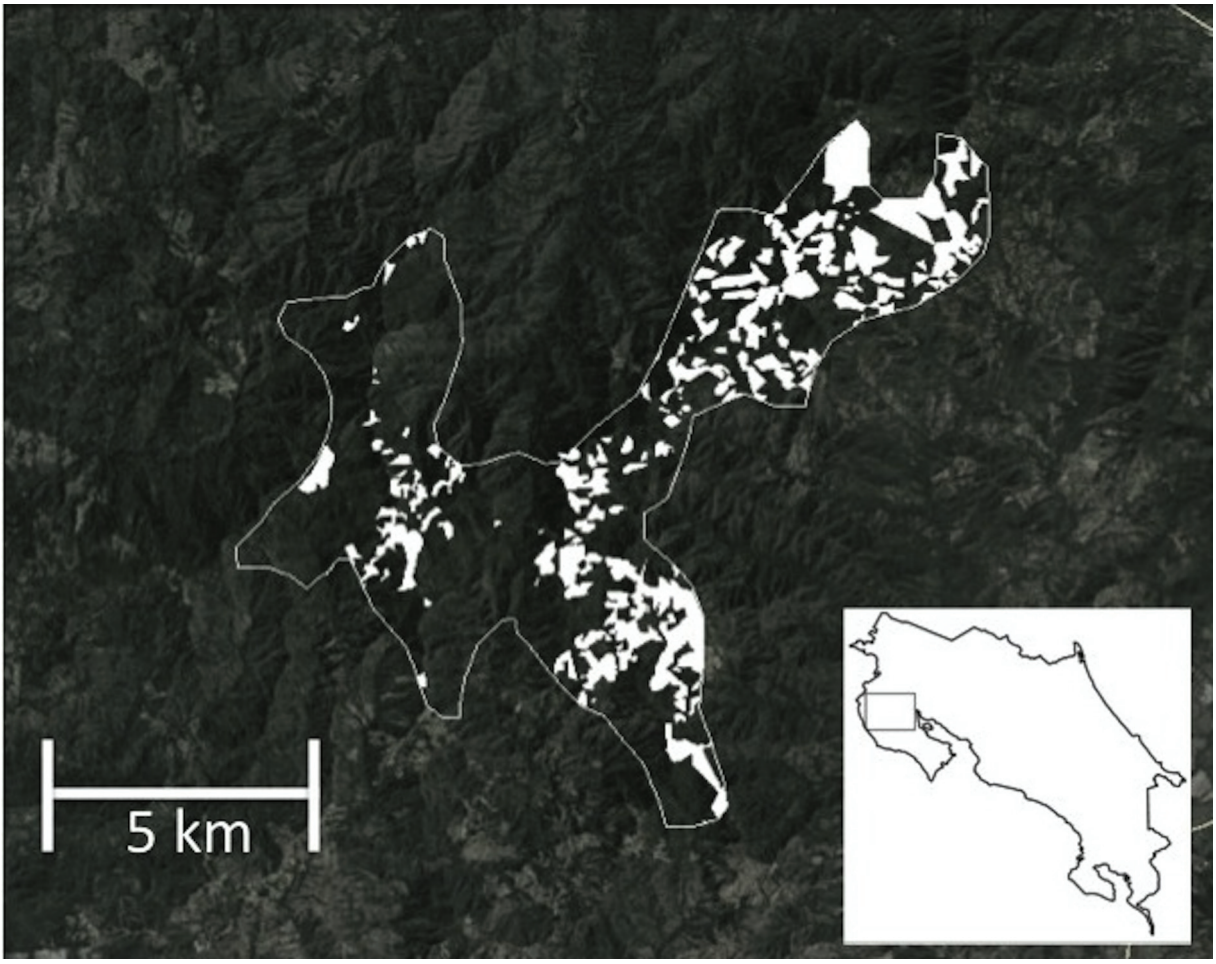

Figure 4. Satellite image (from 2014) of the study site in the Nicoya Mountains of Costa Rica, courtesy of Google Earth. The white line represents the approximate reported range of a resident population of Three-wattled Bellbirds (*Procnias tricarunculatus*) in the Nicoya Mountains (Birdlife International 2012), and the white areas are deforested areas unusable to bellbirds as determined by satellite images.

eBird of bellbirds occurring in the Nicoya Mountains, despite several detailed lists being submitted for the region (eBird 2016). There were six reports from the Montezuma region of the Nicoya Peninsula in December–February (eBird 2016) when bellbirds from the central Cordillera population are known to frequent the Pacific coast (Powell & Bjork 2004).

Our household surveys produced additional evidence that a resident, breeding population of Three-wattled Bellbirds is absent from the Nicoya Mountains. The only positive reports were from respondents that stated (1) bellbirds once occurred in the region but were no longer present; (2) bellbirds occurred during the months of December–February (when bellbirds from the breeding populations in the Tilarán Cordillera are known to be present; Powell & Bjork 2004); or (3) also claimed European Cuckoos were present. Those individuals that claimed that they had recently heard both bellbirds and European Cuckoos were unwilling to answer additional questions about local birds and were unwilling to identify the species giving the call. We considered those respondents as unreliable, and they were simply responding in a manner they deemed polite or helpful. Thus, except for those individuals that were unreliable because they reported recently hearing European Cuckoos but were unable to identify the species, the local consensus coincides with Powell and Bjork's (2004) study on the movement of populations from the Tilarán Cordillera and that a resident population does not exist in the Nicoya Mountains.

Taken together, we feel that there is sufficient evidence to conclude that a resident population of Three-wattled Bellbird does not exist in the Nicoya Mountains as originally reported by Stiles & Skutch (1989). If a population did exist, it was most likely a small population (Birdlife International, 2012), and the loss of this population would bring up several conservation considerations. First, it could have represented a unique genetic population (Hughes & Erlich 2000), although this appears unlikely given the potential to mix with the Tilarán population (Powell & Bjork 2004). In addition, bellbirds are important seed dispersers (Snow 1982) and, with its absence, the regeneration of abandoned pastureland in the Nicoya Mountains could be stunted. The Nicoya Mountain

population would have also represented the only population of Three-wattled Bellbirds to spend the entire year within Costa Rica's borders. Costa Rica is often considered the vanguard for tropical conservation (Brockett & Gottfried 2002), and having a population under its progressive environmental policies could prove good insurance for the bellbird. Furthermore, if a Nicoya Mountain population does not exist, it highlights the need to protect habitat for known populations, especially the areas of immediate threat in Nicaragua's Indio Maiz Biosphere reserve (Meyer & Huete-Pérez 2014). It is very possible that a permanent resident population never existed in the Nicoya Mountains and that the birds that led Stiles & Skutch (1989) to this conclusion were taking advantage of aberrant conditions in the Nicoya Mountains to breed or avoiding aberrant conditions in their traditional breeding sites. If this is the case, we could expect unusual years where bellbirds return to the Nicoya Mountains to breed. Regardless, we recommend the removal of the Nicoya Mountains from the breeding range distribution for Three-wattled Bellbirds.

Aerial survey data showed that nearly one-fourth of the IUCN-classified bellbird range in the Nicoya Mountains was not suitable. In this context, it is important to note that the Nicoya region experienced intense deforestation during the 1960–1980's (Arroyo-Mora et al. 2005). Several homeowners noted that most of the mountains were cleared by the 1980's when the Costa Rican government provided financial incentives to clear native forest for pasture. More recently, not only has Costa Rica become less dependent economically on agriculture, the government has provided financial incentives to plant or preserve native forests. Thus, even though the aerial photographs show that 23% of habitat is now pasture, it was most likely a much higher percentage several decades ago. It is possible that there was a habitat bottleneck too severe for a putative population to have survived, and this could have also led to the past noted decline of the Tilarán population, which relies on the Nicoya Mountains for portions of its annual movements.

In most circumstances it is very difficult to prove evidence of absence, and our efforts cannot disprove that bellbirds breed in small numbers or at other times of year in the Nicoya Mountains. However, by bringing four pieces of information together (local knowledge, point counts, citizen science via eBird and aerial surveys), we argue that the weight of evidence is against the presence of a breeding population in the Nicoya Mountains. We encourage the involvement of multiple datasets and a weight-of-evidence approach to assessment of animal distributions for conservation purposes, especially those in regions away from typical scientific inventories.

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REFERENCES

Allouche, O, A Tsoar & R Kadmon (2006) Assessing the accuracy of species distribution models: prevalence, kappa and the true skill statistic (TSS). *Journal of Applied Ecology* 23: 1223–1232.

Araújo, MB, W Thuiller, PH Williams & I Reginster (2005) Downscaling European species atlas distributions to a finer resolution: implications for conservation planning. *Global Ecology and Biogeography* 14: 17–30.

Arroyo-Mora, J, G Sanchez-Azofeira, B Rivard, J Calvo & D Janzen (2005) Dynamics in landscape structure and composition for the Chorotega region, Costa Rica from 1960 to 2000. *Agriculture, Ecosystems and Environment* 106: 27–39.

BirdLife International (2012) *Procnias tricarunculatus*. The IUCN Red List of Threatened Species 2012. e.T22700946-A38303179.http://dx.doi.org/10.2305/IUCN.UK.2012-1. RLTS.T22700946A38303179.en. Downloaded on 16 March 2016.

Brockett, CD & RR Gottfried (2002) State policies and the preservation of forest cover: lessons from contrasting public-policy regimes in Costa Rica. *Latin American Research Reviews* 37: 7–40.

Diamond, JM (1987) Extant unless proven extinct? Or, extinct unless proven extant? *Conservation Biology,* 1: 77–79.

eBird (2016) eBird: An online database of bird distribution and abundance [web application]. Cornell Lab of Ornithology, Ithaca, New York, USA. Available at http://www.ebird.org [Accessed March 2016].

Franklin, J & JA Miller (2009) *Mapping species distributions.* Cambridge Univ. Press, New York, New York, USA.

Garrigues, R. & Dean, R. (2014) *The birds of Costa Rica: a field guide*. Zona Tropical Publications, New York, New York, USA.

Gu, W & RK Swihart (2004) Absent or undetected? Effects of non-detection of species occurrence on wildlife–habitat models*. Biological Conservation* 116: 195–203.

Hughes, JB, GC Daily & P Ehrlich (2000) The loss of population diversity and why it matters*.* Pp 71–83 *in* Ravens, PH & T Williams (eds). *Nature and human society: the quest for a sustainable world*. National Academies Press, Washington, D.C., USA.

Molinari-Jobin, A, M Kéry, E Marboutin, P Molinari, I Koren, C Fuxjäger, C Breitenmoser-Würsten, S Wölfl, M Fasel, I Kos, M Wölfl & U Breitenmoser (2012) Monitoring in the presence of species misidentification: the case of the Eurasian lynx in the Alps. *Animal Conservation* 15: 266–273.

Meyer, A & J Huete-Pérez (2014) Nicaragua Canal could wreak environmental ruin. *Nature* 506: 287–289.

Powell, G & R Bjork (2004) Habitat linkages and conservation of tropical biodiversity as indicated by seasonal migrations of Three-wattled Bellbirds. *Conservation Biology* 18: 500–509.

Snow, D (1982). *The cotingas.* Cornell Univ. Press, Ithaca, New York, USA.

Stiles, G & A Skutch (1989). *A guide to the birds of Costa Rica*. Cornell Univ. Press, Ithaca, New York, USA.

Sullivan, BL, C Wood, M Iliff, R Bonney, D Fink & S Kelling (2009) eBird: a citizen-based bird observation network in the biological sciences. *Biological Conservation* 142: 2282–2292.