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EL GRUPO CERÚLEO: COLLABORATION TO ASSESS NONBREEDING RANGE OF CERULEAN WARBLER IN SOUTH AMERICA

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Resumen. – Esfuerzo cooperativo de el Grupo Cerúleo para determinar el rango no reproductivo de la Reinita Cerúlea en Sur América. – La Reinita Cerúlea (*Dendroica cerulea*: Parulidae) ha sido listada como una especie vulnerable por la Unión Internacional para la Conservación de la Naturaleza, debido a su reciente reducción poblacional. En el 2001 se creó el Grupo Técnico de la Reinita Cerúlea como un esfuerzo internacional proactivo para desarrollar estrategias para su conservación. Uno de sus subcomités, El Grupo Cerúleo, realiza actividades en sus cuarteles de invierno dirigidas a promover la protección de esta especie por medio de la conservación de hábitats, la investigación de la ecología de esta ave, campañas de divulgación, y el desarrollo de un modelo predictivo para permitir la evaluación y el monitoreo de la Reinita Cerúlea. La mayoría de los esfuerzos recientes de este Grupo se han enfocado en el estudio y el entendimiento de la distribución espacial de esta especie en Sur América por medio de modelos predictivos, como una estrategia esencial para el conocimiento de la ocurrencia de esta ave y, de esta forma, identificar hábitats importantes y áreas de concentración en el Neotrópico. Para esto, El Grupo Cerúleo desarrolló cinco modelos hipotéticos de la distribución potencial de la especie en el norte de los Andes basados en registros históricos y muestreos realizados por miembros del mismo grupo. Con el objeto de validar el resultado de la modelación, seleccionamos localidades para verificar la ocurrencia de la especie, basados en un diseño estratificado al azar, las cuales fueron predichas por los cinco modelos. Elaboramos protocolos de campo para muestrear estas localidades. La información resultante será analizada empleando técnicas de modelamiento de ocupación. Se presentarán los diseños básicos para llevar a cabo el muestreo en campo, así como resultados preliminares del primer año de estudio.

Abstract. – Cerulean Warbler (*Dendroica cerulea*: Parulidae) has been listed as a vulnerable species by the International Union for the Conservation of Nature because of recent population declines. An international, proactive approach to Cerulean Warbler conservation, the Cerulean Warbler Technical Group, was founded in 2001. One of its subcommittees, El Grupo Cerúleo, addresses nonbreeding season issues to promote the protection of this bird through habitat conservation, field research on Cerulean Warbler winter ecology, public awareness, and the development of a predictive model to allow for assessment and monitoring of Cerulean Warbler. Most of the recent efforts of this group have been devoted to studying

and understanding the spatial distribution of the Cerulean Warbler in South America through predictive models as a highly necessary strategy to elucidating the bird's occurrence, and thereby to identify and locate important nonbreeding habitats and areas of concentration in the Neotropics. To address this issue, members of El Grupo Cerúleo developed five hypothetical models of potential distribution of the bird in the northern Andes based on existing historical records and surveys conducted by El Grupo members. In order to validate the model output, we selected locations to verify the occurrence of the species, based on a stratified-random design, using locations where the Cerulean Warbler was predicted to occur by all five models. We elaborated field protocols to survey these locations. Resulting data will be structured for analysis using the techniques of occupancy modeling. Basic survey designs to carry out the fieldwork as well as preliminary results of the first year's fieldwork are presented. *Accepted 5 December 2007.*

Key words: Cerulean Warbler, *Dendroica cerulea*, El Grupo Cerúleo, modeling assessment, distributional maps.

INTRODUCTION

Effective conservation must encompass the entire range of a species. No single entity can accomplish the needed activities in isolation from others, who either must add or accommodate their activities to the conservation process. Whereas the range of a species bridges a variety of national and physiographic bounds, the relative importance of different entities such as habitat types, management context, and threats is potentially great, conflicting, and mutually unknown. A sense of urgency attends the study of species concern, such as the Cerulean Warbler (Hamel *et al.* 2004), a Neotropical migrant listed as a vulnerable species by the International Union for the Conservation of Nature because of persistent and widespread population declines (Hamel 2000, Robbins *et al.* 1992). Though particular reasons behind the decline of the species are not well understood, it is believed that this decline may be related to habitat loss through its entire breeding, migratory and wintering range, mainly due to deforestation and degradation of its habitats, and the conversion of current shade plantations into sun coffee or open field for livestock, particularly in Colombia and Venezuela. Moreover, despite the increase of research efforts on the breeding grounds, little has been published on its wintering habits and habitats (Robbins *et al.* 1992, Jones *et al.* 2000). Based on this, international cooperative efforts must be carried out to thwart the effects of these threats on the survival of this species. As well as for endangered Neotropical migrants, conservation must be addressed through a continental approach in terms of research, land management, public awareness, and a complete knowledge of the distribution of the species through its entire range.

The primary objective of this work is to produce an useful predictive understanding of Cerulean Warbler distribution that can contribute to conservation of this species in northern Andean landscapes. To address this objective, an extensive international collaboration has been developed to produce an initial model of Cerulean Warbler distribution susceptible for testing.

The purpose of the present contribution to the work is to outline the process by which the model was developed, the protocols that will be used to evaluate the model, and the results of the initial field season of evaluation. This paper consists of two parts. The first outlines our process and provides a summary of the history of El Grupo Cerúleo, a North and South American initiative created to conduct research and conservation actions directed at this species on its nonbreeding grounds. The second presents the current field verification effort to evaluate a GIS-

based distributional model of predicted occurrence of Cerulean Warbler in the northern Andes. This part includes basic survey designs and protocols to carry out the fieldwork as well as preliminary results of the first year's fieldwork.

EL GRUPO CERÚLEO: A COOPERATIVE EFFORT FOR THE CONSERVATION OF A NEOTROPICAL MIGRANT

As an effort to promote Cerulean Warbler research and conservation, the Cerulean Warbler Technical Group (CWTG) was founded in 2001. This group was developed to create a broad-based, technically sound approach to conservation and management of this species (Hamel *et al.* 2004). Realizing that the Cerulean Warbler and most other long-distance Neotropical migrant landbirds presumably suffer conservation constraints across their entire range, the CWTG extended its interest from the breeding to the nonbreeding grounds. During the first Cerulean Warbler Summit, held in Shepherdstown, West Virginia, in December 2002, representatives from Colombia, Ecuador and Venezuela shared their experiences regarding study and conservation of the Cerulean Warbler in the northern Andes. A primary outcome of the summit was recognition of the high-priority need for improved information on the nonbreeding distribution and biology of the species. A subcommittee of the CWTG was created to assess the non-breeding range of the bird called El Grupo Cerúleo ("The Cerulean Group").

This subcommittee was created as an international collaboration for the conservation of a particular Neotropical migrant., but achieving its aims requires a broader approach, given the fact that this species, as well as many other Neotropical migrants, uses the same habitats as resident species of equal and often higher conservation concern. Thus, a fundamental premise of the group is that the study and preservation of both migrants and residents will enable conservation not only of one species of bird, but through a multispecies approach, of a whole bird community with all its interactions, processes and habitats. Cerulean Warbler is an important example of the need for a multispecies approach, because it joins mixed-species flocks of both resident and migrant birds when foraging on its wintering grounds. Indeed, the extent to which such flocks are a requisite part of the species nonbreeding biology is an important area of research (Jones *et al.* 2000, 2002).

To address the task assigned to it, El Grupo Cerúleo has conducted two important regional meetings in Ecuador in 2003 and 2005 with the participation of representatives of countries from the entire range of the species. This group evaluated existing information and developed plans for Cerulean Warbler research and conservation from a South American perspective.

As a result of this interchange, this subcommittee addresses nonbreeding season issues related to the promotion of the protection and knowledge of this bird through several approaches such as habitat conservation, gathering scarce information available for this species in the Neotropics into one database, carrying out field research on Cerulean Warbler winter ecology, conducting public awareness, and developing a predictive model of the potential distribution of the species to allow for its assessment and monitoring (Barker *et al.* 2006). El Grupo Cerúleo has emphasized the latter task as a primary objective because knowledge about the ecological distribution of this species away from the breeding grounds is fragmentary.

In February 2007, this subcommittee joined the second Cerulean Warbler Summit hosted in Morgantown, West Virginia. Virtually all the countries in the northern Andean

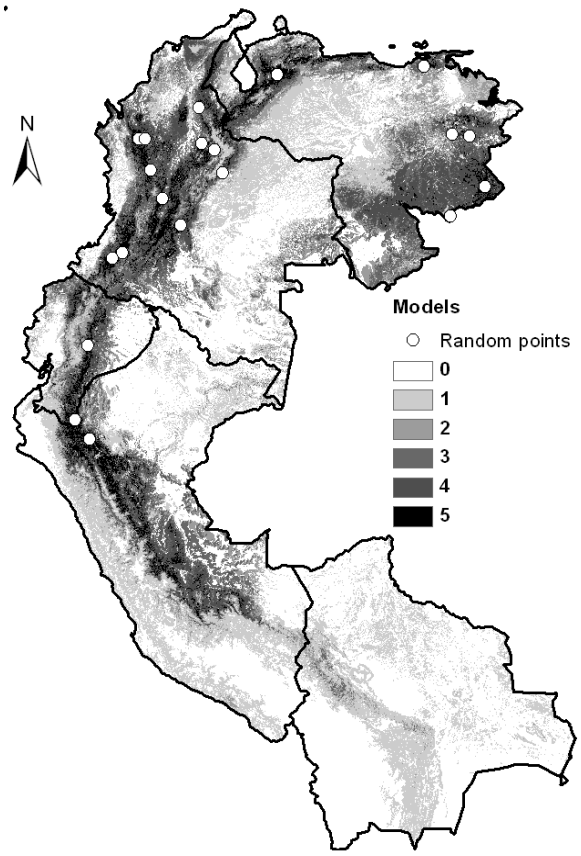

FIG. 1. Cerulean Warbler potential distribution in the northern Andes based on combined predictive models (Barker *et al.* 2006). Shading indicates number of models predicting Cerulean Warbler occurrence in a given 1-km^2 pixel. Open circles indicate locations of 20 random points to be surveyed.

range of the Cerulean Warbler were represented. El Grupo Cerúleo members described research and conservation initiatives carried out during the last 3 years. Further information regarding this can be found on the Web page of El Grupo Cerúleo http://www.srs.fs.usda.gov/egc/

MODEL-BASED GIS-DISTRIBUTIONAL MAPS AS A RESEARCH AND CONSERVATION TOOL

El Grupo Cerúleo identified a general lack of information in most of the issues related to the nonbreeding of the Cerulean Warbler, but particularly on its distribution in the Andes. Successful conservation of this species requires detailed knowledge of the species' range to elucidate the bird's occurrence as well as identify and locate important nonbreeding habitats and areas of concentration in the Neotropics. Members of El Grupo Cerúleo developed five hypothetical models of potential distribution of the Cerulean Warbler in the northern Andes, based on existing historical and recent records – many recorded

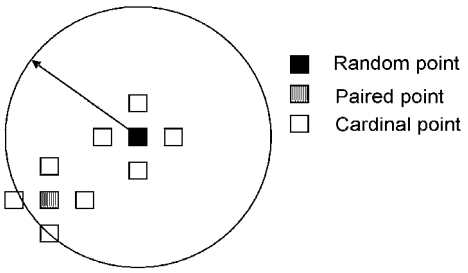

FIG. 2. Twenty schematic of sampling design indicating array of random, paired, and cardinal points sampled for the occurrence of Cerulean Warblers (Note: figure not drawn to scale).

by group members themselves – of the species in the Neotropics (Barker *et al.* 2006). See Barker *et al.* (2006) for details regarding the methodological approaches employed for modelling the distribution of this species. Crucial to the model development process is the quality of the initial data. Many of the data involved in this process exist as historical records with little documentation of the actual geographic precision; furthermore modification of land use at previously occupied sites is a frequent and confounding problem in their use in model development.

The final result of this process was the combination of the five different models in one distributional map that represents the locations with the highest probability of occurrence of the species. Colombia, Ecuador and Perú resulted as countries with the highest potential concentrations of Cerulean Warblers in the rorthern Andes. The combined model predicted as potentially suitable no fewer than 200 km^2 of northern Andean landscapes (Fig. 1).

METHODS

Basic survey design. To evaluate the accuracy and predictive power of the resulting map presented by Barker *et al.* (2006), we used a stratified-random design to select 20 locations (hereafter called random points) to verify the occurrence of the species. Each of the random points, represented by a 1-km^2 area (or pixel) in the GIS map, was predicted to be Cerulean Warbler habitat by all five hypothetical models. These points represented our sample of suitable locations with high probability of being occupied by the species (Fig. 1).

Each of these 20 random points was paired with a randomly selected point (paired point) defined to have been selected by three or fewer of the five models as potential habitat within a 5-km radius circle radius of the random point. Where all pixels within a circle were predicted by four or five models, the closest pixel outside the circle predicted by two or fewer models was selected. These points, called paired points, represent our sample of less suitable locations.

Finally, around each of the random and paired points a systematically arrayed grid of four additional 1-km^2 survey sites oriented in the cardinal directions and located 1 km from the central random or paired point was selected (cardinal points) (Fig. 2). The resulting total of ten 1-km^2 pixels at each location constitutes a block in the experimental design. The final sample consists of two hundred pixels to be surveyed in the Northern Andes, representing 0.1% of the predicted range of the species.

Basic field sampling. Three 100-m line transects were placed in each pixel to survey bird fauna. Transects were located entirely within relatively homogeneous habitats, separated by 250 m, following a constant elevation, and sampling the range of elevations within the pixel. All birds detected were recorded and a perpendicular distance to the main line was estimated, based on the technique of line transects with variable distance (Bibby *et al.* 1992). Transects were walked at constant rate, scanning mid-story, upper-story, and emer-

TABLE 1. Locations visited and surveyed for Cerulean Warbler in Colombia January–March 2007. Estimated habitat quality for Cerulean Warbler is the initial assessment in the field of the surveyor. Habitat types are 1) Open field with isolated trees, 2) Riparian secondary forests, 3) Fallows and successional vegetation cover, and 4) Xerophitic savannas.

Locations (Provinces, municipalities)	Coordinates	Elevation (m)	Habitat types	Estimated habitat quality for Cerulean Warblers	Cerulean Warbler presence
Boyacá, Covarachía	06°32'45"N, 72°49'14,88"W	850	4	Low	N
Boyacá, Covarachía	06°33'14,5"N, 72°49'18,7"W	1185	4	Low	N
Antioquia, Abejorral	05°42'45"N 75°31'14,88"W	1140	1,2,3	Moderate	N
Antioquia, Abejorral	05°42'44.9"N 75°32'19,1"W	615	1,2,3	Moderate	N
Antioquia, Abejorral	05°41'38.7"N, 75°31'14,8" W	617	1,2,3	Moderate	N
Boyacá, Paya	05°36'15"N 72°29'44,9"W	1507	1, 2, 3	Moderate	Y
Boyacá, Paya	05°35'38.7"N 72°28'35,3"W	1940	1, 2, 3	Moderate	N
Ibagué, Tolima	04°30'15"N 75°0'45"W	560	1, 2	Low	N
Ibagué, Tolima	04°29'10.3"N 75°0'38.8"W	627	1, 2	Low	N
Ibagué, Tolima	04°30'21"N 74°59'40"W	592	1, 2	Low	N
Rosas, Cauca	02°13'45"N 76°44'15"W	1590	1, 2, 3	Moderate	N
Rosas, Cauca	02°14'49,4"N 76°44'15"W	1730	1, 2, 3	Moderate	Y

gent trees for mixed-species flocks and single foraging birds, spending approximately 30 min traversing the transect. Three surveys of each transect were conducted. If Cerulean Warblers were found in a flock, additional data were recorded. Such additional information included location, habitat, foraging behavior, and flock structure and composition.

Vegetation was measured using the methods of James & Shugart (1970) with some slight modifications. Habitat variables such as tree species richness, density, frequency and structure were used to evaluate important components of the habitat occupied by Cerulean Warbler in each location.

Vegetation was measured on each 100-m line transect. Two circular plots of 0.04 ha (11.28 m radius) for vegetation sampling were surveyed on each transect, for a total of six plots within each pixel. Each 100-m transect was divided in 20-m sections, for a total of six section boundary points. The center of the vegetation plot was selected randomly among these six points. When adjacent points were selected for sampling, plots were located so they did not overlap.

Plots were placed within the same habitat and at least 50 m from edge where possible. Composition (tree species richness), structure (diameter at breast height and canopy height), shrub density, and canopy and ground cover were registered in each plot.

We intend to analyze the bird count data using the techniques of occupancy modeling (MacKenzie *et al.* 2006). Our modeling will estimate the rated of occupancy (corrected for imperfect probability of detection) for localities based on their prediction by the model as suitable (predicted by five models) or less suitable for Cerulean Warbler (predicted by three or fewer models). We will incorporate random effects for observer and habitat and fixed effects related to physical and spatial environmental factors.

RESULTS

The initial stage of this survey was conducted from September 2006 to March 2007. In December most of the logistics were arranged and protocols were finalized, meanwhile fieldwork was started in Colombia in January 2007 in the provinces of Antioquia, Tolima, Cesar, Santander, Boyacá and Cauca representing all three Andean ranges. All surveys were conducted before the middle of March in order to ensure that the species still had a high probability of being in the area and had not started to migrate. The complete fieldwork is estimated to be finished during the following two wintering seasons.

We focused our initial field effort in Colombia because the random sample included many locations there. During the initial 3 months of the first stage of this field evaluation, 12 1-km^2 pixels were surveyed. An average of 3 days was required per location, distributed between bird surveys and vegetation sampling. Cerulean Warblers were detected in two of the 12 locations visited during these 2 months (17% naïve presence) (Table 1). No Cerulean Warblers were detected during the transect sampling; all observations were sporadic sightings. Three locations in Antioquia, Cesar and Cauca provinces were not surveyed because of the danger posed by public disorder in the areas.

The typical landscape in the subtropical forests of Colombia was clearly reflected on the surveyed pixels: a dominant matrix of open fields with isolated trees, followed by fallows and successional secondary forest along streams, small cultivated plots such as cassava (*Manihot esculenta*), sun and shade coffee (*Coffea arabica*, *C. canephora*) plantations, plantain (*Musa* sp.), and isolated remnants of secondary forest in steeply slopes. None of the areas has shown what is typically considered to be high-quality habitat for the Cerulean Warbler, particularly large tracts of

mature primary or secondary forest or shading plantations [e.g., coffee, cardamom (*Elatteria cardamomu*)].

Main problems experienced during the fieldwork have been (in order of importance) access and distance to selected locations, availability of suitable habitat for Cerulean Warbler, and public disorder.

DISCUSSION

The difference between potential and available habitat in the selected locations is evident from the initial stage of this research. Heavily modified landscapes thought to be low-quality habitat are a general occurrence in most of the locations sampled to date. This might be an important factor determining the presence of the Cerulean Warbler in the random locations. This situation indicates how preservation of a sufficient amount of presumed high-quality habitat such as extensive forested tracts in both breeding and nonbreeding range is the single most important conservation need for supporting healthy populations. In spite of this, Cerulean Warblers have been detected in some locations. The practical effort to gather the bird and vegetation parameter values is challenging, requiring a substantial commitment of time and resources.

An important finding in the small amount of work conducted in this first year is the effect of public disorder within the nonbreeding range of Cerulean Warbler in Colombia, and perhaps others areas as well. The areal extent is not trivial, and differences in land use and thus suitability for the species between secure and unsecure areas may affect Cerulean Warbler conservation.

CONCLUSION

Cooperative efforts such as El Grupo Cerúleo may become productive tools for conservation of this Neotropical migrant and probably for other resident and migrant birds as well. Moreover, if we consider that migrants are an international resource shared by several countries, research and conservation initiatives that are coordinated with each other should produce a more effective response than isolated efforts. This must lead to a better understanding of the nonbreeding ecology of species of concern such as the Cerulean Warbler.

Protocols implemented here are relatively simple to conduct in the field. The bird and vegetation data gathered under this procedure, will allow estimation of the validity of the current predicted distribution map for the Cerulean Warbler, as well as to carry out model refinements and improve understanding of bird communities in northern Andean habitats.

The potential effect of public disorder on Cerulean Warbler habitats and their conservation is not a trivial one.

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REFERENCES

Barker, S., S. Benítez, J. Baldy, D. Cisneros Heredia, G. Colorado Zuluaga, F. Cuesta, I. Davidson, D. Díaz, A. Ganzenmueller, S. García, M. K. Girvan, E. Guevara, P. Hamel, A. B. Hennessey, O. L. Hernández, S. Herzog, D. Mehlman, M. I. Moreno, E. Ozdenerol, P. Ramoni-Perazzi, M.Romero, D. Romo, P. Salaman, T.Santander, C. Tovar, M. Welton, T. Will, C. Pedraza, & G. Galindo. 2006. Modeling the

South American range of the Cerulean Warbler. Proc. 26th ESRI International User Conference. Available at: http://gis.esri.com/library/userconf/proc06/papers/papers/pap_1656.pdf

Bibby, C. J., N. D. Burgess, & D. A. Hill. 1992. Bird census techniques. Academic Press, San Diego, California.

Hamel P. B., D. K. Dawson, & P. D. Keyser. 2004. How we can learn more about the Cerulean Warbler (*Dendroica cerulea*). Auk 121: 7–14.

Jones, J., P. Ramoni-Perazzi, E. H. Carruthers, & R. J. Robertson. 2000. Sociality and foraging behavior of the Cerulean Warbler in Venezuelan shade coff ee plantations. Condor 102: 958–962.

Jones, J., P. Ramoni-Perazzi, E. H. Carruthers, & R. J. Robertson. 2002. Species composition of bird communities in shade coffee plantations in the Venezuelan Andes. Ornitol. Neotrop.l 13: 397–412

MacKenzie, K. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy estimation and modeling – Inferring patterns and dynamics of species occurrence. Elsevier Publishing, Amsterdam, The Netherlands.

Parker, T. A., III. 1994. Habitat, behavior, and spring migration of Cerulean Warbler in Belize. Am. Birds 48: 70–75.