

PASSING THE BATON OF ACTION FROM RESEARCH TO CONSERVATION IMPLEMENTATION FOR CERULEAN WARBLER (*SETOPHAGA CERULEA*)

Paul B. Hamel¹, David Mehlman², Sebastian Herzog³, Kenneth V. Rosenberg⁴, & Jason
Jones⁵

¹US Forest Service, Center for Bottomland Hardwoods Research, P. O. Box 227, 432
Stoneville Rd., Stoneville, MS 38776 USA, *E-mail*: phamel@fs.fed.us

²The Nature Conservancy, Migratory Bird Program, 212 E. Marcy St., Suite 200,
Santa Fe, NM 87501 USA

³Asociación Civil Armonía, Av. Lomas de Arena # 400 “Barrio Palmira”, (Zona Palmasola),
Santa Cruz, BOLIVIA

⁴Cornell Lab of Ornithology, Cornell Lab of Ornithology, 159 Sapsucker Woods Rd.,
Ithaca, NY 14850 USA

⁵Tetra Tech, Inc., 800 - 555 West Hastings Street, Vancouver, BC V6B 1M1 CANADA

Resumen. – Pasando el bastón de mando desde investigación a implementación conservacionista para la Reinita Cerúlea (*Setophaga cerulea*). – Cuando El Grupo Cerúleo fue creado en el año 2002, la tarea de dilucidar la distribución no reproductiva, ecología y comportamiento de la Reinita Cerúlea (*Setophaga cerulea*) era enorme, nuestro entendimiento de los requerimientos de hábitat limitados, el temor fundado a la existencia de poco hábitat de buena calidad y las redes de socios de conservación dentro de Latino América y entre el Norte, Centro y Sudamérica eran pocas y distantes entre sí. Nuestros continuos esfuerzos por identificar y cultivar redes de socios en los numerosos países por los cuales pasa la Reinita Cerúlea, ha resultado en la generación de nuevo conocimiento acerca de la especie en sus territorios no reproductivos. El tiempo también ha llegado, a la luz de este conocimiento, para extender el trabajo del grupo desde un enfoque centrado en la investigación y adquisición de conocimiento a uno dirigido principalmente al manejo y restauración del hábitat y el desarrollo de estrategias de protección. El desarrollo e implementación de un programa de monitoreo que evalúe el éxito de las estrategias de conservación implementadas es esencial. Este programa debe también cumplir las muchas otras necesidades de propietarios de tierra y administradores. Dado el estado actual de la tenencia de tierra y las restricciones de recursos en materia de conservación en la mayor parte de América Latina, este cambio de enfoque representa un mayor énfasis en la educación, el alcance a y el diálogo con los administradores de la tierra y comunidades productoras de materia prima básica, quienes realmente impactan el hábitat en la mayor parte del ámbito geográfico. Además, el compromiso y participación continua de los consumidores de productos, muchos de los cuales pueden vivir lejos de los productores, será esencial para incrementar la disponibilidad de recursos destinados a conservación. La ampliación del énfasis hacia la implementación y educación requiere de la aplicación de un conjunto de habilidades diferentes a los que se requirieron durante las actividades iniciales de investigación. Nuestro resumen de las contribuciones del simposio y de los logros y deficiencias del Grupo desde el año 2002 esboza una visión de un futuro seguro y sostenible para las poblaciones de la Reinita Cerúlea.

Abstract. – When El Grupo Cerúleo, a sub-committee of the Cerulean Warbler Technical Group, was formed in 2002, the task of elucidating the nonbreeding distribution, ecology and behavior of the Cerulean Warbler (*Setophaga cerulea*) was large, our understanding of habitat needs was limited, there was fear that little suitable habitat existed, and conservation partnerships within Latin America and between North, South, and Middle America were few and far between. Our continuing efforts have led to a network of partners in the numerous countries through which the species passes or spends up to 7-8 months in winter and a new

body of knowledge about the Cerulean Warbler on its nonbreeding range. The time has come, in light of this knowledge, to shift the focus of the group from research and information gathering to one primarily directed to habitat protection, management, and restoration. Developing a monitoring program that measures success of implemented conservation strategies and adaptively informs, as well as fits the constraints of land owners and managers, is essential. Given the current status of land ownership and resources available for conservation in most of Latin America, this change in focus means an increased emphasis on education of, outreach to, and dialogue with commodity-producing industries and communities who have responsibility for most land management across the species' geographic range. Furthermore, increased engagement and participation of commodity consumers, many of whom live far away from the producers, will be essential to generate additional resources for conservation. The extension of emphasis to implementation and education requires application of different skill-sets than the initial research activities required. Our summary of symposium contributions and the achievements and shortcomings of the Cerulean Warbler Technical Group, in particular those of El Grupo Cerúleo since 2002, outlines a vision for a sustainable and secure future for Cerulean Warbler populations.

Key words: Cerulean Warbler, *Dendroica cerulea*, *Setophaga cerulea*, implementing research agenda, conservation planning, local conservation action, international partnerships, coordinating agendas, integration of biodiversity with economic activity, trade-offs

INTRODUCTION

Declining population trends of Cerulean Warbler (*Setophaga cerulea*) on its North American breeding grounds (Sauer *et al.* 2011) have sparked intense research and conservation action as well as considerable public policy attention (Hamel *et al.* 2004, U.S. Fish and Wildlife Service 2006a, Dawson *et al.* 2012). Coordinated management, conservation, monitoring, and research activities throughout the species' extensive range are believed to be important to its future persistence (U.S. Fish and Wildlife Service 2007, Fundación ProAves *et al.* 2010). This IUCN-listed Vulnerable bird (BirdLife International 2008) is a potential flagship species (Bowen-Jones & Entwistle 2002, Clucas *et al.* 2008) for conservation of a diverse breeding avifauna in the Appalachian and Central Hardwood ecoregions of eastern North America, as well as for the extremely diverse Neotropical resident and Nearctic migratory birds of the northern Andes in Venezuela, Colombia, Ecuador, Peru, and Bolivia. Popularity of Cerulean Warbler with the North American public, reflected in a recent novel (Franzen 2010), memoir (Fallon 2011), and children's television program

(Universal Studios 2011), bolsters this potential, at least for activities in which North Americans are engaged. In 2001 the Cerulean Warbler Technical Group (CWTG) was formed to coordinate collaborative research and conservation related to this species.

Under guidance from the U.S. Fish and Wildlife Service Focal Species Program, the CWTG collectively developed a rangewide conservation action plan for the Cerulean Warbler (U.S. Fish and Wildlife Service 2007). More recently, a framework conservation plan for the Cerulean Warbler during the nonbreeding season has been produced and distributed (Fundación ProAves *et al.* 2010). Our collective efforts have produced strategically important policy assistance to the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 2002, 2006a, 2006b), to IUCN in status determination of the species (Birdlife International 2008), and to land managers. Throughout this process, the CWTG has served as a model for a cooperative, science-based, and non-regulatory approach to conservation that has been emulated by groups focused on other potential flagship species, such as Golden-winged Warbler (*Vermivora chrysoptera*), Bicknell's Thrush (*Catharus bicknelli*), and Rusty Blackbird (*Euphagus carolinus*).

The 2011 symposium “Biología de la conservación de la Reinita Cerúlea, una especie migratoria vulnerable que depende de tierras cultivadas para café, carbón y productos forestales” (Libro de resúmenes, IX Congreso de Ornitología Neotropical, Cusco, Perú, Nov 2011) reviewed the structure, progress, and accomplishments of the CWTG, particularly those of the nonbreeding season subcommittee, El Grupo Cerúleo, over the period 2001-2011. One of the explicit goals of the symposium and associated meetings among CWTG members was to build on the conservation plan for the non-breeding range, outline the next steps for nonbreeding-season conservation, and re-energize a network of partners dedicated to conserving species and ecosystems in the northern Andes. In this paper, we summarize work of the CWTG and the main findings presented at the 2011 symposium, and reflect on the next research and conservation steps for this iconic species.

ADVANCING UNDERSTANDING OF THE SPECIES

Activities of the CWTG conducted since its formation in 2001 (Hamel *et al.* 2004, Dawson *et al.* 2012) demonstrate the capacity of a focused group of collaborators to address and fill vital gaps in our understanding of this species, and to clear up numerous biological misunderstandings. In 2002, the CWTG organized into four subcommittees devoted to Breeding Season Research, Breeding Season Monitoring, Breeding Season Conservation, and Nonbreeding Season Issues, to facilitate development of reliable information that would support effective conservation action relevant to the full life-cycle of the birds. Subcommittee assignments reflect the limits of knowledge at the time CWTG formed, namely gaps in biological knowledge, and in methods to estimate population size and to produce

or enhance habitats for the species. The vital public education function was assigned to each subcommittee. Because knowledge of nonbreeding biology and distribution was particularly limited, El Grupo Cerúleo was assigned the challenge and opportunity of addressing all nonbreeding season concerns (Dawson *et al.* 2012).

Contributions to the symposium indicate the immense progress that has been achieved in each of these areas of CWTG activity. In each area, the limits of activities outline needs for the future.

Breeding Season Research. Larkin *et al.* (2012) present the highlights of the extensive forest management experiment carried out in the core of the breeding range directed to understanding Cerulean Warbler population biology and the response of the species to a range of intensities of forest management. The research demonstrated a clear positive response by the birds to an intermediate intensity of forest harvest. How that response is reflected in demographic parameters of the species suggests that management strategies may need to vary across the landscape depending upon abundance and population trends of local populations (Larkin *et al.* 2012, cf. Boves 2011). Islam *et al.* (2012) describe a similar manipulative experiment of forest management in a more peripheral area of the range, in which territorial males responded positively to even-aged management and negatively to uneven-aged management; nesting success was similar among the treatments in that study. Curley *et al.* (2012) document basic distributional and habitat features of the species in a location in New Jersey where the population is expanding. Density of territorial males there was generally lower than in the core of the range, and tree species composition of territories reflected discrimination by the birds for some tree species and against others.

Breeding Season Monitoring. Activities of the CWTG supplemented the comprehensive Cerulean Warbler atlas project (Rosenberg *et al.* 2000), and together with the ongoing analyses of the Breeding Bird Survey data set (Sauer *et al.* 2011) offer a regular estimate of the distribution, size, and trend of the breeding population. These activities are models for potential future counterparts in the nonbreeding grounds. Although no paper in the symposium dealt strictly with breeding season monitoring activities, efforts are underway to develop a sampling design and protocol to carry out long-term trend monitoring at a finer scale than possible with the Breeding Bird Survey. In addition, it may be advisable to carry out a second Cerulean Warbler Atlas, to provide a new “snapshot” of the status of key sites and populations identified during the 1990s.

Breeding Season Conservation. Results of the forest management experiment and increased knowledge of the locations of breeding concentrations of the species, particularly in regard to Appalachian coal deposits (Buehler *et al.* 2006), set the stage for important opportunities for conservation and integrated management of Cerulean Warblers in association with extraction of both renewable and nonrenewable resources. Smith *et al.* (2012) summarize the progress and opportunities in this important arena. Collaboration with other conservation entities, such as the Appalachian Regional Reforestation Initiative (ARRI), will bear fruit in rehabilitated habitats for the species in the future (Smith *et al.* 2012). The model of cooperation with ARRI may be applicable to nonbreeding season conservation in the Andes, and certainly offers opportunity for interaction between people in both parts of the species’ range (Patrick N. Angel, pers. comm.). Recognition that Cerulean Warblers depend on lands rich in coal deposits for breeding habitats (Buehler *et al.* 2006) and lands vital to the production of coffee (*Coffea*

arabica) in the nonbreeding range (Sánchez-Clavijo *et al.* 2008, 2009, Bakermans *et al.* 2009) have led to linkages with other cooperative land management and conservation initiatives (Smith *et al.* 2012, Skolnik *et al.* 2012).

Nonbreeding Season Issues. Five contributions to the symposium deal directly with nonbreeding season biology and conservation of Cerulean Warbler. Welton *et al.* (2012) are the first to report results from a systematic, hypothesis-driven survey of the species’ distribution and ecology during migration periods. Muñoz & Colorado (2012) address foraging and behavioral ecology of the birds in Colombia during the nonbreeding period, including interspecific interactions with other migratory species, interactions which Cerulean Warblers routinely lose. Colorado *et al.* (2012) summarize preliminary results of a rigorous field validation (Colorado *et al.* 2008, Colorado 2011) of a nonbreeding season model of Cerulean Warbler distribution in the Andes. The model was developed by Barker *et al.* (2006) through a series of workshops organized by El Grupo Cerúleo members. While reinforcing some previous ideas about the geographic distribution of the species, Colorado *et al.* (2012) extend our understanding of the nonbreeding habitats and elevational range of the Cerulean Warbler in the Andes, thereby suggesting some conservation activities. The workshops resulting in Barker *et al.* (2006) also contributed to development of the nonbreeding conservation plan (Fundación ProAves *et al.* 2010). Contributions to the symposium by Santander *et al.* (2012) and Skolnik *et al.* (2012) reflect expanded interest in conservation in South America.

PASSING THE BATON OF ACTION

These successes suggest that the time has arrived to shift from a focus driven primarily by research needs to one emphasizing

conservation implementation in which research supports and evaluates conservation action as well as develops and clarifies biological theory. Each CWTG function— biological research, population monitoring, conservation action and evaluation, and capacity building and public awareness— requires individuals with specific and frequently non-overlapping expertise and inclinations. We believe that our experience in passing through this transition will be useful to others engaged in integrating biological research into meaningful conservation action in multiple countries.

The hallmark of our approach to these activities, and probable key to the success achieved in the last ten years, is the conscious commitment of members of CWTG to work in concert with each other. Two useful principles of engagement include admonitions to: (a) leave individual and institutional agendas outside the room and (b) draw circles to include, that is, include all relevant perspectives in the conversation. Both of these principles recognize that for each participant in a discussion related to this or other species, individual knowledge has limits and is conditioned by the experience of the individual, the policy and business climate of the institution for which they work, and the general attitude of the institutional sector.

Members of the CWTG won three awards for their collaborative efforts during the period 2001-2011. In 2007, El Grupo Cerúleo was recognized with a Wings Across the Americas International Cooperation Award from the U.S. Forest Service for the Cerulean Warbler Nonbreeding Habitat Assessment (Barker *et al.* 2006). The award recognized 41 individuals representing almost as many institutions in Bolivia, Canada, Colombia, Ecuador, Peru, United States, and Venezuela. In 2008, El Grupo Cerúleo was awarded the U.S. Forest Service Southern Research Station Director's Global Stewardship Award, again recognizing the partnership efforts of individuals from

the seven principal countries in the species' breeding and nonbreeding ranges. In 2011, the first U.S. Presidential Migratory Bird Federal Stewardship Award recognized the contribution of the Office of Surface Mining of the U.S. Department of the Interior for the work of the ARRI, including its contribution to the future conservation of the Cerulean Warbler.

Five members of El Grupo Cerúleo, representing Colombia, Ecuador, Peru, and United States, were involved in the planning of the 2011 symposium. Fifty-two different people from these countries, as well as Bolivia and Canada, contributed to at least one paper in the symposium representing the breadth of effort expended by CWTG members to produce high quality technical information about the species (Hamel *et al.* 2004). These achievements are especially noteworthy given the great difficulty of studying this species in the field.

Linking research accomplishments to conservation implementation through a process that includes monitoring feedback is a vital unmet need. In this context, the differing approaches of research biologists, conservation implementers, and mobilizers of public awareness may collide in less than useful ways. We anticipate that maintaining a collective balance between potentially competing interests will be difficult but worth the effort to maintain. Another challenge in collaborative efforts is the inevitable tension between individual success and collective achievement, in which collective work toward common goals yields a greater degree of ultimate achievement than does emphasis on personal gain. To date, combined efforts of individual members of the CWTG have yielded both personal success illustrated by the abundant literature on the species developed over the decade, and collective achievement of new insights possible only through collaboration of teams of investigators (e.g.,

Jones *et al.* 2007, Buehler *et al.* 2008, Larkin *et al.* 2012).

WHAT ARE THE NEXT RESEARCH STEPS FOR THE CWTG TO TAKE?

Dawson *et al.* (2012) describe succinctly the CWTG's coordinated, interconnected and comprehensive approach to develop technical information about Cerulean Warblers needed to address the species' conservation needs. We have learned an impressive amount of new information about Cerulean Warbler biology, demography, distribution, population status, management, and natural history that can be used to formulate and focus conservation actions, assess a much wider array of questions, and connect information about a single species to more general topics in biology and conservation practice.

However, the limits of our knowledge are extensive as well. Breeding season studies of demography and response to experimental forest management have still not led to tested and demonstrated best management practices. Validation of the nonbreeding distribution model of Barker *et al.* (2006), by Colorado *et al.* (2008, 2012) and Colorado (2011), represent only a beginning, although a solid one, to understanding the species' nonbreeding distribution and habitat requirements. For example, recent sightings of Cerulean Warbler in Bolivia (Tobias & Seddon 2007, Q. Vidoz, pers. comm.) and southern Perú (www.eBird.org) suggest that vast areas within the wintering distribution remain very poorly known.

Cerulean Warbler remains a species notoriously difficult to study, for which high effort is required to achieve small sample sizes, few publishable results, and limited dependable knowledge to support conservation action. Collaborative efforts, demonstrated to be possible by the CWTG forest management research project (Larkin *et al.* 2012), may be the only way to further gains. Many important questions remain, among them the following:

Breeding Season Questions

- What are the economic implications of implementing silvicultural treatments that enhance Cerulean Warbler habitat at various spatial and temporal scales?
- Assuming management guidelines are established, what level of implementation would be required to result in region-wide or range-wide population increases?
- What are the longer-term responses of Cerulean Warblers to forest-management treatments, especially in regard to adult and juvenile survival, male vs. female response, nest predation and other causes of nest failure, and to changes in Lepidopteran and other food resources?
- What are recommended best management practices for Cerulean Warbler breeding habitat rangewide?

Migratory Season Questions

- What are the seasonal dynamics of use by Cerulean Warblers at identified migration stopover sites (will require continuous monitoring of specific sites)?
- Can we refine a migration stopover model with additional surveys and monitoring?
- What are the key threats and conservation opportunities at identified migration stopover sites?
- Where are critical stopover sites for Cerulean Warblers that migrate directly across the Gulf of Mexico or Caribbean?

Nonbreeding Residency Season Questions

- What are the relative contributions of different measurable factors to the survival of Cerulean Warblers during the nonbreeding period? Are any of these limiting? Is the combination itself limiting?
- What is the relative importance of native forest vs agroforestry landscapes

throughout the species' nonbreeding range? Does individual survivorship differ in these landscapes, and among the habitats that comprise them? Does differential survivorship of sexes exist in different habitats?

- Are anthropogenic habitats adequate to support healthy populations of Cerulean Warblers into the future?
- How does our understanding of connectivity between breeding and nonbreeding seasons for different portions of the population inform our understanding of the relative importance of Venezuelan and Colombian habitats vs those in Peru and Bolivia?
- How can we strengthen our understanding of Cerulean Warbler migratory connectivity that links specific breeding populations to specific wintering sites, thus enhancing the potential for linkages between conservation actions on the breeding and nonbreeding grounds?
- Is Cerulean Warbler vulnerable to interspecific interactions in mixed-species flocks during the nonbreeding period? Is the presence of mixed-species flocks a limiting factor for Cerulean Warbler distribution and survival?

Addressing these questions will require significant efforts. How can we motivate research interest in this high effort – low reward species? We offer two examples.

1. *Filling information gaps hindering Cerulean Warbler conservation and management will provide useful contributions to important ecological theories.* On the breeding grounds, two obvious conservation-related information gaps are (a) dispersal (adult, natal, post-fledging) and (b) factors limiting productivity. Dispersal must be understood in order to create and manage breeding habitat and habitat connectivity. Information about factors limiting productivity is a critical piece of

understanding population dynamics and trajectories. Dispersal and productivity also are elements of key ecological theories such as those regarding metapopulation dynamics (Hanski 1998). Linking information gaps for Cerulean Warbler to current debates about ecological theory should broaden interest in the species as a research subject and increase funding opportunities from traditional science venues for students and established researchers.

2. *Conservation questions can be better answered through data sharing networks that maximize return on financial and field time investment.* Many incoming graduate students face the challenge of not only developing research ideas but developing a network of knowledge and colleagues that provide the foundation for a successful research effort. Groups like the CWTG can be a tremendous resource for individuals and organizations trying to break into a field and for facilitating large-scale research projects. The CWTG could moderate and provide a code of conduct for collaborative data-sharing among graduate students and other researchers at different institutions, and could serve as a repository of information. Published data could be made available to facilitate meta-analyses or other wide ranging efforts (e.g., Buehler *et al.* 2008). The network could also house natural history observations that may be only a curiosity when viewed as an n of 1 (e.g., conspecific egg destruction; Boves *et al.* 2011) but whose value increases as similar observations are made in other locations (e.g., nest material kleptoparasitism; Jones *et al.* 2007). An internet communication listserv has been developed for those interested in Cerulean Warblers (Brian Smith, pers. comm.).

A stellar example of this kind of opportunity is the CWTG forest management study detailed by Larkin *et al.* (2012). A potential research collaboration on dispersal is another example of how this network could operate. Similar approaches to the study of differential body condition and its effect on survival, as well as nonbreeding habitat distribution, can be described. The study of adult and natal dispersal for a species with a broad geographic range requires the collection of data over a large spatial area and multiple years. The two published studies that have examined Cerulean Warbler dispersal (Veit *et al.* 2005, Girvan *et al.* 2007) were only successful through intense collaboration and support from a wide range of people. Both studies would have benefited greatly by the existence of a communication and data sharing network. Such an active network would facilitate identification of individuals with (a) similar interests and (b) the ability to collect useful ancillary data. For example, if three students based in three geographic regions (e.g., Illinois, West Virginia, Tennessee) were all interested in dispersal of Cerulean Warblers as a thesis topic and all three knew that each other existed, it should be a relatively simple exercise to establish a research program that would allow each to have a stand-alone project while contributing data to the other two projects. Not only can the study of dispersal be divided by dispersal type (e.g., adult, natal, post-fledging), it can be divided by quantification technique (e.g., isotopes, genetics, radio telemetry, mark-recapture/re-sight) and by the research context (e.g., managed versus unmanaged forest landscapes). The individual students would benefit from reduced research costs and increased sample sizes; the research community would benefit from robust sampling designs and the development of multiple lines of evidence; the conservation community would benefit from having access to robust data upon which to make management decisions; and the species

would benefit from the successful application of research-driven management practices.

WHAT ARE THE NEXT CONSERVATION STEPS FOR THE CWTG TO TAKE?

We believe there are several important questions that the CWTG should consider.

- Can conservation activities on the nonbreeding grounds affect enough habitat in the near term, perhaps the next ten years, to increase survivorship of the Cerulean Warbler population by 5% annually?
- Can conservation activities on the breeding and nonbreeding grounds improve habitat conditions sufficiently for an increase of 5% in population abundance in the next ten years?
- Can research and monitoring provide sufficiently precise evaluation data on conservation projects to answer the above questions?

Next steps for Cerulean Warbler conservation on the nonbreeding grounds involve turning the existing conservation plan (Fundación ProAves *et al.* 2010) into an action plan that can guide implementation. In Bogotá and San Vicente de Chucurí, Colombia, in 2008, CWTG established a strong connection with the Colombian coffee industry and made substantial initial progress toward a “best management practices” approach to conservation of Cerulean Warblers in the context in coffee production. However, due to recent downturns in the Colombian coffee industry and in the global economy, this connection appears to have weakened and it may be appropriate to re-evaluate the emphasis on it in the conservation plan. For example, a shift in emphasis from management of coffee landscapes to management of watersheds may offer a way to restructure this focus. Once an

action plan is developed, CWTG and partners can move forward with carrying out the actions, using on-going research and monitoring in an adaptive way to assess their effect on demographic parameters such as survivorship and population size and then to refine them as necessary. Conservation hotspots will need to be identified and confirmed, likely through the use of occupancy-based modelling (e.g., Colorado *et al.* 2012), to focus conservation actions where they are likely to be most effective. Coordinating international partners and adapting conservation approaches to fit conditions in different countries and regions will require considerable skill and understanding of the needs of individual partners. Appropriate to this will be to develop innovative ways to recognize the important contributions of different entities (governmental, nongovernmental, commercial, and individual) to the conservation effort (Skolnik *et al.* 2012). Evaluation of success of intended conservation actions will require partners to refine and expand existing survey and monitoring projects and use them as models to replicate in other locales, both on the wintering grounds and at migration stopover sites.

Smith *et al.* (2012) reinforce these notions by emphasizing the importance of developing conservation strategies applicable at multiple spatial and temporal scales that can deliver, through flexible partnerships, current, high-quality scientific information to those whose activities are likely to affect Cerulean Warblers. Critically important in this respect are both the sustainable extraction of natural resources (e.g., timber, coal) within the Cerulean Warbler's range and the continued economic viability of the rural communities, value chains, and investors reliant on those resources. Conservation will be most successful if local communities, corporations, conservation entities, and governments are engaged in the work. The ARRI is an excellent example of

successful collaborative conservation that is worthy of imitation elsewhere such as in the coffee producing regions of the nonbreeding range. Future conservation efforts need to maintain as high priority both the intended conservation outcomes and the activities and needs of local communities (e.g., Santander *et al.* 2012, Skolnik *et al.* 2012, Smith *et al.* 2012). For example, outreach to children is essential to implementation and long-term success of conservation projects.

For Cerulean Warbler, it is critical to maintain both forest on Appalachian ridges underlain by substantial coal deposits and agroforestry land uses on Andean slopes suitable for production of coffee. Those coal deposits and coffee resources also represent vital natural resources for humans. In each locale, the livelihood of the local population and of all those involved in the associated value chains depends upon the production, harvest, and export of those natural resources. Investors and consumers worldwide also benefit from coal and coffee production. Future viability of the Cerulean Warbler depends upon the balance between these needs. Activities coordinated through the Cerulean Warbler Technical Group demonstrate the opportunities, difficulties, frustrations, failures, and remarkable successes made possible by collaborative partnerships. As such, the biology of the bird, and the working of the conservation partnership surrounding it, are a model for other international and interdisciplinary partnerships. The challenges that lie ahead for the CWTG are daunting, and much work remains.

ACKNOWLEDGMENTS

We are especially grateful to Tom Will for important help to our thinking about this paper. All of us owe a debt to Dave Buehler for insisting that leadership develop in understanding biology of Cerulean Warbler.

This manuscript benefitted from the kind attention of T. Bently Wigley, Deanna Dawson, and Paolo Ramoni-Perazzi. They, as well as all of the authors of this paper, and Kamal Islam, Jeff Larkin, Kim Smith, Scott Stoleson, Tito Vilella, Tom Will, and Petra Bohall Wood served the important role of peer reviewers for papers in this symposium. Esteban Guevara and Tatiana Santander kindly translated our abstract into a proper Resumen for us, as well as those of most of the remaining papers in the symposium. We are grateful to Carl Smith for assistance with technical editing of this and other contributions to the symposium. Jack Clinton Eitniear has extended numerous courtesies during the preparation of the manuscripts. The efforts of so many members of El Grupo Cerúleo and the Cerulean Warbler Technical Group demonstrate that there is no end to what we can accomplish when we work together.

REFERENCES

- Bakermans, M. H., A. C. Vitz, A. D. Rodewald, & C. G. Rengifo. 2009. Migratory songbird use of shade coffee in the Venezuelan Andes with implications for conservation of Cerulean Warbler. *Biol. Conserv.* 142: 2476–2483.
- 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. *In* Proceedings of the 2006 ESRI International User Conference, San Diego, California, USA. Available at proceedings.esri.com/library/userconf/proc06/papers/papers/pap_1656.pdf
- BirdLife International. 2008. *Dendroica cerulea*. *In* IUCN 2011. IUCN Red List of Threatened Species (version 2011.2). Available at www.iucnredlist.org/ [Accessed 20 December 2011]
- Boves, T. J. 2011. Multiple responses by Cerulean Warblers to experimental forest disturbance in the Appalachian Mountains. Ph.D. diss., Univ. of Tennessee, Knoxville, Tennessee, USA.
- Boves, T. J., D. A. Buehler, & N. E. Boves. 2011. Conspecific egg destruction by a female Cerulean Warbler. *Wilson J. Ornithol.* 123:401–403.
- Bowen-Jones, E. & A. Entwistle. 2002. Identifying appropriate flagship species: the importance of culture and local contexts. *Oryx* 36: 189–195.
- Buehler, D. A., M. J. Welton, & T. A. Beachy. 2006. Predicting Cerulean Warbler habitat use in the Cumberland Mountains of Tennessee. *J. Wildl. Manag.* 1763–1769.
- Buehler, D. A., J. J. Giocomo, J. Jones, P. B. Hamel, C. M. Rogers, T. A. Beachy, D. W. Varble, C. P. Nicholson, K. L. Roth, J. Barg, R. J. Robertson, J. R. Robb, & K. Islam. 2008. Cerulean Warbler reproduction, survival, and models of population decline. *J. Wildl. Manag.* 72: 646–653.
- Clucas, B., K. McHugh & T. Caro. 2008. Flagship species on covers of US conservation and nature magazines. *Biodivers. Conserv.* 17: 1517–1528.
- Colorado, G. J. 2011. Ecology and conservation of Neotropical-Nearctic migratory birds and mixed-species flocks in the Andes. Ph.D. diss. Ohio State Univ., Columbus, Ohio, USA. Available at <http://etd.ohiolink.edu/send-pdf.cgi/Colorado%20Gabriel%20J.pdf?osu1291646331/> [Accessed 25 January 2012]
- Colorado, G., P. Hamel, A. Rodewald, & W. Thogmartin. 2008. El Grupo Cerúleo: collaboration to assess nonbreeding range of Cerulean Warbler in South America. *Ornitol. Neotrop.* 19(Suppl.): 521–529.
- Colorado, G. J., P. B. Hamel, A. D. Rodewald, & D. Mehlman. 2012. Advancing our understanding of the non-breeding distribution of Cerulean Warbler (*Setophaga cerulea*) in the Andes. *Ornitol. Neotrop.* 23(Suppl.): xxx–xxx.

- Curley, S., T. Master, & G. George. 2012. Population distribution, density and habitat preference of the Cerulean Warbler (*Setophaga cerulea*) in the Delaware Water Gap National Recreation Area. *Ornitol. Neotrop.* 23(Suppl.): xxx–xxx.
- Dawson, D. K., T. B. Wigley, & P. D. Keyser. 2012. Cerulean Warbler Technical Group: Coordinating international research and conservation. *Ornitol. Neotrop.* 23(Suppl.): xxx–xxx.
- Fallon, K. 2011. *Cerulean Blues*. Ruka Press, Washington, D.C. USA
- Franzen, J. 2010. *Freedom*. Farrar, Strauss, and Giroux, New York, New York, USA.
- Fundación ProAves, American Bird Conservancy & El Grupo Cerúleo. 2010. Conservation Plan for the Cerulean Warbler on its nonbreeding range - Plan de conservación para la Reinita Cerúlea sobre su rango no reproductivo. *Conserv. Colomb* 12: 1–62.
- Girvan, M. K., J. Jones, D. R. Norris, J. J. Barg, T. K. Kyser & R. J. Robertson. 2007. Long-distance dispersal patterns of male Cerulean Warblers (*Dendroica cerulea*) measured by stable-hydrogen isotopes. *Avian Conserv. Ecol. – Écol. et conserv. oiseaux* 2(2): 3. [online] URL: <http://www.ace-eco.org/vol2/iss2/art3/>
- 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.
- Hanski, I. 1998. Metapopulation dynamics. *Nature* 396: 41–49.
- Islam, K., J. Wagner, R. Dibala, M. MacNeil, K. Kaminski, & L. (P.) Young. 2012. Cerulean Warbler (*Setophaga cerulea*) response to changes in forest structure in Indiana. *Ornitol. Neotrop.* 23(suppl.): xxx–xxx.
- Jones, K. C., K. L. Roth, K. Islam, P. B. Hamel & C. G. Smith III. 2007. Incidence of nest material kleptoparasitism involving Cerulean Warblers. *Wilson J. Ornithol.* 119: 271–275.
- Larkin, J. L., P. B. Wood, T. J. Boves, J. Sheehan, D. A. Buchler, P. D. Keyser, A. D. Rodewald, T. A. Beachy, M. H. Bakermans, A. Evans, G. A. George, M. E. McDermott, F. L. Newell, K. A. Perkins, M. White, & T. B. Wigley. 2012. Breeding season concerns and response to forest management: Can forest management produce more breeding birds? *Ornitol. Neotrop.* 23(Suppl.): xxx–xxx.
- Muñoz, J. M., & G. J. Colorado. 2012. Foraging ecology of the Cerulean Warbler (*Setophaga cerulea*) in Andean agroforestry ecosystems. *Ornitol. Neotrop.* 23(suppl.): xxx–xxx.
- Rosenberg, K. V., S. E. Barker, & R. W. Rohrbaugh. 2000. An atlas of Cerulean Warbler populations. Final Report to USFWS: 1997–2000 Breeding Seasons. Cornell Lab of Ornithology, Ithaca, NY 14850
- Sánchez-Clavijo, L. M., R. Espinosa, J. E. Botero, A. M. López & N. G. Franco. 2008. La Reinita Cerúlea: una especie que depende del café y del carbón. *Biocarta* 13, Cenicafé, Chinchiná, Caldas, Colombia.
- Sánchez-Clavijo, L.M., J.E. Botero, & R. Espinosa. 2009. Assessing the value of shade coffee for bird conservation in the Colombian Andes at a local, regional, and national level. Pp. 148–157 in T. Rich, M. del Coro Arizmendi, C. Thompson, & D. Demarest, (eds.) *Proceedings of the 4th International Partners in Flight Conference*, McAllen, Texas, 13-16 Feb 2008. Available at http://www.pwrc.usgs.gov/pif/pubs/McAllenProc/articles/PIF09_Bird%20Communities/SanchezClavijo_PIF09.pdf
- Santander, T., A. Soria, & E. A. Guevara. 2012. Conservando el hábitat invernal de la Reinita Cerúlea (*Setophaga cerulea*) en Ecuador. *Ornitol. Neotrop.* 23(suppl.): xxx–xxx.
- Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., & W. A. Link. 2011. *The North American Breeding Bird Survey, results and analysis 1966 – 2009 (version 3.23.2011)*. USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA. Available at <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html/> [Accessed 20 December 2011]
- Skolnik, B., D. Wiedenfeld, R. Dettmers, C. Auca, L. Daza, H. Valle, F. Sornoza, J. Robayo, D. Díaz, J. Fitzgerald, D. Lebbin, & P. B. Hamel. 2012. Conservation planning and accomplishments

- for protection of Cerulean Warbler (*Setophaga cerulea*) nonbreeding habitat. *Ornitol. Neotrop.* 23(Suppl.): xxx–xxx.
- Smith, B. W., J. Botero, J. L. Larkin, A. D. Rodewald, P. B. Wood, P. N. Angel, & S. E. Eggerud. 2012. Integrating conservation management, species protection and economic viability into sustainable land use practices for the Cerulean Warbler (*Setophaga cerulea*) in the Appalachian and Northern Andes Mountains. *Ornitol. Neotrop.* 23(suppl.): xxx–xxx.
- Tobias, J. A., & N. Seddon. 2007. Nine bird species new to Bolivia and notes on other significant records. *Bull. Br. Ornithol. Club* 127: 49–84.
- Universal Studios. 2011. Curious George, The Big Picture. Television show 65/4-4, 23 Nov 2009. <http://curiousgeorge.com/#/item/155>
- U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; 90-day finding on a petition to list the cerulean warbler as threatened with critical habitat. *Fed. Regist.* 67: 65083–65086.
- U.S. Fish and Wildlife Service. 2006a. Endangered and Threatened Wildlife and Plants; 12-month finding on a petition to list the Cerulean Warbler (*Dendroica cerulea*) as Threatened with Critical Habitat. *Fed. Regist.* 71: 70717–70733.
- U.S. Fish and Wildlife Service. 2006b. Proceedings from a Cerulean Warbler Risk Assessment & Conservation Planning Workshop. Available at <http://www.fws.gov/midwest/es/soc/birds/cerw/cerw06ra.html> [Accessed 29 March 2012]
- U.S. Fish and Wildlife Service. 2007. A conservation action plan for the Cerulean Warbler (*Dendroica cerulea*). Available at <http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/FocalSpecies/Plans/CeruleanWarbler.pdf> [Accessed 20 December 2011]
- Veit, M. L., R. J. Robertson, P. B. Hamel, & V. L. Friesen. 2005. Population genetic structure and dispersal across a fragmented landscape in cerulean warblers (*Dendroica cerulea*). *Conserv. Genet.* 6: 159–174.
- Welton, M. J., D. L. Anderson, G. J. Colorado, P. B. Hamel, & D. Calderón-F. 2012. Cerulean Warbler (*Setophaga cerulea*) spring migration stopover in northern Middle America. *Ornitol. Neotrop.* 23(suppl.): xxx–xxx.