ORNITOLOGIA NEOTROPICAL 23: 273–280, 2012

CERULEAN WARBLER TECHNICAL GROUP: COORDINATING INTERNATIONAL RESEARCH AND CONSERVATION

Deanna K. Dawson[1], T. Bently Wigley[2], & Patrick D. Keyser[3]

[1] USGS Patuxent Wildlife Research Center, Laurel, MD, USA. *E-mail:* ddawson@usgs.gov
[2] National Council for Air and Stream Improvement, Inc., Clemson, SC, USA.
[3] Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, TN, USA.

Resumen. – El Grupo Técnico de la Reinita Cerúlea: coordinación de investigación y conservación internacional. – La conservación eficaz de especies de preocupación requiere del intercambio y colaboración entre los conservacionistas y actores locales. El Grupo Técnico de la Reinita Cerúlea (GTRC) es un consorcio de biólogos y administradores de agencias de gobierno, organizaciones no gubernamentales, personas del ámbito académico e industrial, que están dedicados a encontrar soluciones pro-activas, basadas en la ciencia para la conservación de la Reinita Cerúlea (*Setophaga cerulea*). Constituido en los Estados Unidos en 2001, el alcance del GTRC pronto se amplió para tratar la ecología y conservación de la especie tanto en su área reproductiva como no-reproductiva, conjuntamente con biólogos de Sur y Centro América. En 2004, el GTRC hace el lanzamiento de la Iniciativa de Conservación de la Reinita Cerúlea, un conjunto de actividades que tienen como objetivo abordar las necesidades de información y conservación de la especie. Esto incluye (1) estudios para evaluar la respuesta de la Reinita Cerúlea a las prácticas de manejo forestal en el núcleo de su área de reproducción y la identificación de tierras sujeto de minería que podrían ser reforestadas en beneficio de la especie, (2) estudios de ecología y demografía en el área invernal e (3) investigación de la distribución de la Reinita Cerúlea en las áreas reproductivas y de invernada además durante la migración. Se ha completado un amplio plan de acción para la conservación, junto con un plan de conservación del rango de distribución no-reproductivo más detallado. El GTRC y sus socios ahora avanzan con actividades de conservación en los sitios, mientras se abordan necesidades de información todavía no satisfechas.

Abstract. – Effective conservation for species of concern requires interchange and collaboration among conservationists and stakeholders. The Cerulean Warbler Technical Group (CWTG) is a consortium of biologists and managers from government agencies, non-governmental organizations, academia, and industry, who are dedicated to finding pro-active, science-based solutions for conservation of the Cerulean Warbler (*Setophaga cerulea*). Formed in the United States in 2001, CWTG's scope soon broadened to address the species' ecology and conservation on both the breeding and non-breeding ranges, in partnership with biologists from South and Central America. In 2004, CWTG launched the Cerulean Warbler Conservation Initiative, a set of activities aimed at addressing information and conservation needs for the species. These include (1) studies in the core breeding range to assess Cerulean Warbler response to forest management practices and to identify mined lands that could be reforested to benefit the species, (2) ecological and demographic studies on the winter range, and (3) surveys of Cerulean Warbler distribution on the breeding and winter ranges and during migration. A rangewide conservation action plan has been completed, along with a more detailed conservation plan for the non-breeding range. CWTG and partners now move forward with on-the-ground conservation, while still addressing unmet information needs.

Key Words: Cerulean Warbler, *Setophaga cerulea,* Cerulean Warbler Technical Group, Appalachians, northern Andes, international conservation, conservation partnerships.

INTRODUCTION

Persistent and widespread declines in breeding populations of the Cerulean Warbler (*Setophaga cerulea*) have made it a species of conservation concern (Rich *et al.* 2004). The species is a Neotropical migrant, nesting in eastern North America, and wintering in the Andean region of northwestern South America (primarily Colombia, Venezuela, and Ecuador). Population trends estimated from data from the North American Breeding Bird Survey (BBS) show a decline across the breeding range of 3% per year from 1966, when the BBS was started, through 2009 (Sauer *et al.* 2011), although the trend has leveled somewhat (-1.22% per year) since 2000. Population trends have declined similarly in the core breeding range in the Appalachian Mountains Bird Conservation Region (Ohio Hills and Northern Cumberland Plateau physiographic areas; see http://www.partnersinflight.org/bcps/pifplans.htm).

Habitat loss and alteration are considered to be important limiting factors for the species. On the breeding range, Cerulean Warblers use mature deciduous forests, most commonly in uplands but also along rivers, with large trees and a broken, structurally diverse canopy, in predominantly forested landscapes. Much of the core breeding range is managed as commercial forestland, and is underlain by coal deposits; mining by mountaintop removal/valley fill is of particular concern in some locations. On the winter range, Cerulean Warblers occupy a relatively narrow band of elevation (~500-2,500 m) that roughly coincides with the prime growing zone for coffee; cattle grazing and other agricultural land uses are also prevalent in this region (Guhl 2008). There, they use broad-leaved evergreen forests and agroforestry systems, especially coffee grown under shade.

Cerulean Warblers are protected in the United States under the Migratory Bird Treaty Act. In 2000, a coalition of conservation groups, seeking extra protection for the species and its habitats, petitioned the U.S. Fish and Wildlife Service (USFWS), the federal agency charged with managing and conserving migratory birds in the U.S., to list Cerulean Warbler as Threatened under the Endangered Species Act. USFWS ruled in December 2006 that listing the species was not warranted (U.S. Fish and Wildlife Service 2006), but has designated Cerulean Warbler as a Focal Species, to receive priority emphasis and attention; the agency also committed to support collaborative international conservation efforts for the species. In Canada, Cerulean Warbler is listed as Threatened under the federal Species at Risk Act, but was reclassified as Endangered in November 2010 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010). Cerulean Warbler is listed as Vulnerable by the International Union for Conservation of Nature and Natural Resources (BirdLife International 2008), but has no legal protection in countries in the non-breeding range.

CERULEAN WARBLER TECHNICAL GROUP

The Cerulean Warbler Technical Group (CWTG) is a consortium of biologists and managers from government agencies, non-governmental organizations, academia, and industry, who are dedicated to finding pro-active, science-based solutions for conservation of the Cerulean Warbler. Formed in the U.S. in 2001, CWTG's scope soon broadened to address the species' ecology and conservation during all phases of its annual cycle, in partnership with biologists from South and Central America. The first Cerulean Warbler 'summit' was held in Shepherdstown, West Virginia, in December 2002. A steering committee was appointed, as were subcommittees to address issues and foster research, monitoring, or conservation activities on the breeding and non-breeding

ranges; the subcommittee that focuses on the non-breeding range became known as 'El Grupo Cerúleo'. Participation in CWTG and its subcommittees has always been voluntary and flexible, but usually a core group of individuals is involved, with others drawn in as interested or needed to assist with specific tasks.

From its inception, CWTG has included both technical experts and stakeholders, so they could work collaboratively to identify and implement conservation actions. Indeed, wildlife biologists from the forest products industry, a major land owner in the core breeding range, were among CWTG's founding members (Hamel *et al.* 2004). CWTG also has reached out to the coal industry, hosting a meeting in Charleston, West Virginia, in March 2006, to learn about their operations and economic constraints, to provide them with background information on Cerulean Warblers, and to discuss how they could participate in Cerulean Warbler conservation. More recently, CWTG has sought to engage the South American coffee industry in conservation of Cerulean Warblers and associated resident bird species of concern.

CERULEAN WARBLER CONSERVATION INITIATIVE

In 2004, CWTG launched the Cerulean Warbler Conservation Initiative (CWCI). The initial focus was to address rangewide information needs deemed critical to devise an effective conservation strategy for the species. It was recognized that certain forest management practices likely are detrimental to Cerulean Warblers, while others might enhance habitat for the species. Existing information on Cerulean Warbler habitat associations was synthesized to develop preliminary guidelines for managing forests to improve their suitability for the species (Hamel 2006, Hamel & Rosenberg 2007). Surveys were conducted on private lands in the core breeding range, especially those owned or managed by the forest industry, to fill gaps in data on Cerulean Warbler distribution collected in the earlier Cerulean Warbler Atlas Project (Rosenberg *et al.* 2000). In addition, a research experiment was conducted to assess response of Cerulean Warblers and associated bird species of concern to commonly applied forest management practices, replicated at one or more study areas in Kentucky, Ohio, Tennessee, and West Virginia (Larkin *et al.* 2012). This research was complemented by other studies of Cerulean Warbler response to forest management in Arkansas (Hamel *et al.* 2010), Indiana (Register & Islam 2008, Islam *et al.* 2012), Pennsylvania (Rodewald 2004, Stoleson 2004), and West Virginia (Wood *et al.* 2005). Research results are being used to refine the preliminary forest management guidelines to produce Best Management Practices for improving forest structure for Cerulean Warblers.

Cerulean Warblers are generally associated with ridges in the core breeding range (Rosenberg *et al.* 2000, Weakland & Wood 2005); thus, coal mining by mountaintop removal can have significant negative impacts through direct destruction of breeding habitat and degradation of the adjacent forest by creating extensive 'hard' edges (Buehler *et al.* 2006, Wood *et al.* 2006). The CWCI advanced long-term habitat restoration on mined lands by using geospatial models and maps of Cerulean Warbler distribution and abundance (Shumar 2009) to identify and prioritize areas that could be reforested to benefit the species (Wood *et al.* 2010), in partnership with the Appalachian Regional Reforestation Initiative (Smith *et al.* 2012).

On the non-breeding range, a workshop, held in Quito, Ecuador, in November 2005, brought together Cerulean Warbler biologists and Geographic Information System experts from North America, Colombia, Venezuela, Ecuador, Peru, and Bolivia to evaluate available digital geospatial data, and to integrate data

across the winter range. Cerulean Warbler locations, compiled from documented observations and museum specimens, and physical, climatic, and land cover variables were used to develop a predictive model of their winter distribution (Barker *et al.* 2006). Field surveys were conducted to confirm historic locations and find new ones, and to test the preliminary distribution model. The model was then refined, in order to identify regions and habitats likely to be important for the species, and thus focus on-the-ground conservation efforts (Colorado *et al.* 2008, Fundación ProAves *et al.* 2010). In a parallel effort, spring surveys were carried out in Central America and Mexico to identify sites and habitats used by Cerulean Warblers on their northward migration (Welton *et al.* 2012). A preliminary model of potential stopover habitat was generated, and awaits further testing and refinement. Ecological and demographic studies of overwintering Cerulean Warblers were conducted in Colombia (Colorado 2011, Colorado *et al.* 2012, Muñoz & Colorado 2012), complementing earlier and concurrent research in Venezuela (Jones *et al.* 2000, Bakermans *et al.* 2009). These studies highlight the importance to Cerulean Warblers of shade-grown coffee plantations, indicating that partnering with coffee growers or the coffee industry holds promise as a conservation strategy for the winter range.

The surveys and research component of the CWCI were funded largely by a series of challenge grants from the National Fish and Wildlife Foundation, matched by non-federal in-kind and monetary contributions from participating institutions, the forest industry, non-governmental organizations, and individuals. Additional funding from the USDA Forest Service (International Programs) and The Nature Conservancy supported field investigations on the winter range.

While the various survey and research activities were underway, initial on-the-ground conservation actions were undertaken (Santander *et al.* 2012, Skolnik *et al.* 2012), including establishment, by Fundación ProAves and American Bird Conservancy, of a Cerulean Warbler reserve in Colombia, the first South American reserve established to benefit a bird species that breeds in North America. CWTG also worked to formulate a conservation strategy and lay the groundwork for future conservation actions. The second international Cerulean Warbler summit was convened in Morgantown, West Virginia, in February 2007, at which participants set a desired goal of doubling the current population, and identified conservation actions needed to achieve that goal. The resulting rangewide Conservation Action Plan (U.S. Fish and Wildlife Service 2007) outlines general conservation actions to address information gaps and threats to habitat during both the breeding and non-breeding periods, and to identify and address non-habitat limiting factors.

In October 2008, CWTG met jointly with the Golden-winged Warbler (*Vermivora chrysoptera*) Working Group in Bogotá and San Vicente de Chucurí, Colombia, at a workshop on conservation planning for migratory and resident birds in the Northern Andes. Presentations at this combined international summit, the third to focus on Cerulean Warbler and the second on Golden-winged Warbler, provided updates on their non-breeding distribution and ecology, and on ongoing research and conservation activities. Background information was presented on the history and status of coffee and cacao production in Colombia, and opportunities for collaborative conservation with industry, growers, and local communities were discussed. Objectives and possible actions for on-the-ground conservation were identified, and remaining information needs were prioritized. A conservation plan for Cerulean Warbler on its non-breeding range was completed in August 2010 (Fundación ProAves *et al.* 2010); this effort was led by Fundación ProAves and

American Bird Conservancy, with considerable input and assistance from CWTG.

DISCUSSION

Our accomplishments over the past decade are considerable, and have greatly expanded understanding of Cerulean Warbler distribution and ecology (Hamel *et al.* 2004). Information gaps remain, particularly the routes and stopover habitats used during migration, but the time has arrived for CWTG to pass the baton to the conservation community. An important element of a comprehensive conservation program is to protect sites that host significant populations of Cerulean Warblers or receive high or regular use. However, conservation efforts based solely on land acquisition and preservation are no longer realistic, and likely would not be effective for this species. Habitat manipulations (e.g., thinning, planting) may be required to enhance forests in Appalachia or agroforestry systems in the Andes to benefit Cerulean Warblers; because the economic productivity of these lands must be sustained, partnering with land owners or managers is a necessity. It is critical, however, that on-the-ground conservation be conducted in an adaptive framework that includes monitoring the response of Cerulean Warblers and other species of concern, so that management actions can be tailored to achieve the desired outcome and to increase our knowledge of the species' ecology and habitat requirements. In this way, the research and conservation communities will continue to collaborate in conservation efforts to provide for the Cerulean Warbler and increase its numbers.

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]

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.

Chesser, R. T., R. C. Banks, F. K. Barker, C. Cicero, J. L. Dunn, A. W. Kratter, I. J. Lovette, P. C. Rasmussen, J. V. Remsen, Jr., J. D. Rising, D. F. Stotz, & K. Winker. 2011. Fifty-second supplement to the American Ornithologists' Union *Check-list of North American Birds*. Auk 128: 600–613.

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.

COSEWIC. 2010. COSEWIC assessment and status report on the Cerulean Warbler *Dendroica cerulea* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Canada. Available at http:// www.sararegistry.gc.ca/status/status_e.cfm/ [Accessed 21 February 2012]

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.

Guhl, A. 2008. Café y cambio de paisaje en Colombia, 1970–2005. Fondo Editorial Universidad EAFIT, Banco de la República, Medellín, Colombia.

Hamel, P. B. 2006. Adaptive forest management to improve habitats for Cerulean Warbler. Proceedings of Society of American Forests national convention.

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.

Hamel, P. B., & K. V. Rosenberg. 2007. Developing management guidelines for Cerulean Warbler breeding habitat. Pp. 264–374 *in* Buckley, D. S., & W. R. Clatterbuck (eds). Proceedings of the 15th central hardwood forest conference, USDA Forest Service Gen. Tech. Rep. SRS-101.

Hamel, P. B., M. Staten, R. Wishard, & C. G. Smith, III. 2010. Cerulean Warbler response to silvicultural manipulations on managed forestland in Desha Co., Arkansas, third year results. Pp. 475–479 *in* Stanturf, J. A. (ed.). Proceedings of the 14th biennial southern silvicultural research conference. USDA Forest Service Gen. Tech. Rep. SRS-121.

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

Larkin, J. L., P. B. Wood, T. J. Boves, J. Sheehan, D. A. Buehler, 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.

Register, S. M., & K. Islam. 2008. Effects of silvicultural treatments on Cerulean Warbler (*Dendroica cerulea*) abundance in southern Indiana. Forest Ecol. Manag. 255: 3502–3505.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, & T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, New York, USA.

Rodewald, A. D. 2004. Landscape and local influences of forest management on Cerulean Warblers in Pennsylvania. Pp. 472–477 *in* Yaussy, D. A., D. M. Hix, R. P. Long, & P. C. Goebel (eds). Proceedings of the 14th central hardwood forest conference. USDA Forest Service Gen. Tech. Rep. NE-316.

Rosenberg, K. V., S. E. Barker, & R. W. Rohrbaugh. 2000. An atlas of Cerulean Warbler populations: 1997–2000 breeding seasons. Final Report submitted to U.S. Fish and Wildlife Service. Cornell Lab of Ornithology, Ithaca, NY, USA.

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]

Shumar, M. B. 2009. Predictive modeling techniques with application to the Cerulean Warbler (*Dendroica cerulea*) in the Appalachian Mountains Bird Conservation Region. M.Sc. thesis, West Virginia Univ., Morgantown, West Virginia, USA. Available at http://wvuscholar.wvu.edu:8881

Skolnik, B., D. Wiedenfeld, R. Dettmers, C. Aucca, L. Daza, H. Valle, F. Sornoza, J. Robayo, D. Diaz, 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.

Stoleson, S. H. 2004. Cerulean Warbler habitat use in an oak-northern hardwoods transition zone: implications for management. *In* Yaussy, D. A., D. M. Hix, R. P. Long, & P. C. Goebel (eds). Proceedings of the 14th central hardwood forest conference. USDA Forest Service Gen. Tech. Rep. NE-316.

U.S. Fish and Wildlife Service. 2006. 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. 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]

Weakland, C. A., & P. B. Wood. 2005. Cerulean warbler (*Dendroica cerulea*) microhabitat and landscape-level habitat characteristics in southern West Virginia. Auk 122: 497–508.

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.

Wood, P. B., J. P. Duguay, & J. V. Nichols. 2005. Cerulean warbler use of regenerated clearcut and two-age harvests. Wildl. Soc. Bull. 33: 851–858.

Wood, P. B., S. B. Bosworth, & R. Dettmers. 2006. Cerulean Warbler abundance and occurrence relative to large scale edge and habitat characteristics. Condor 108: 154–165.

Wood, P. B., M. E. McDermott, & M. B. Shumar. 2010. Cerulean Warbler conservation initiative 4: identify and prioritize mined lands for reforestation. Final Report to National Council for Air and Stream Improvement.