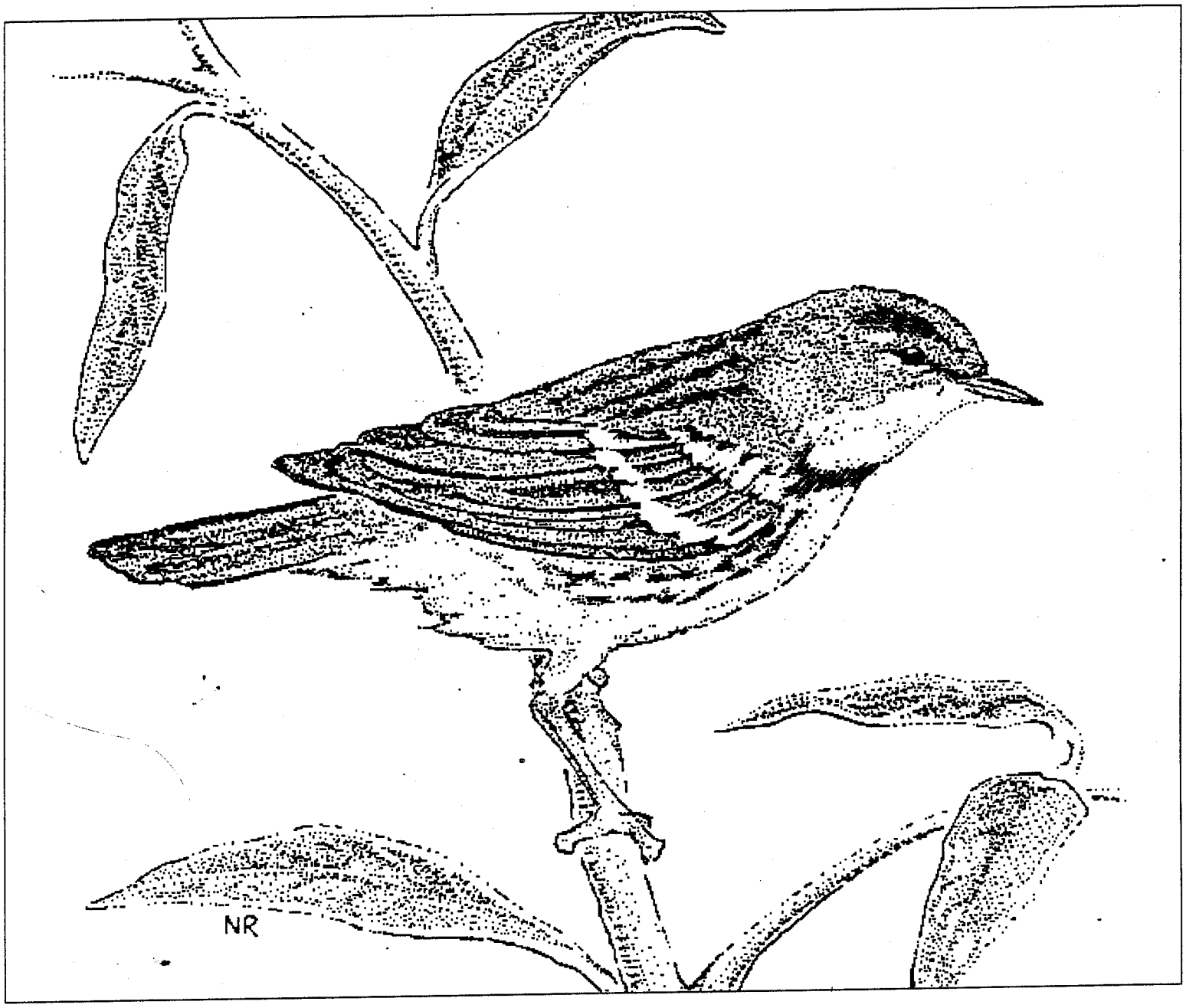
U.S. Fish & Wildlife Service

Cerulean Warbler

Status Assessment

April 2000



Prepared by:
Paul B. Hamel
U.S. Forest Service
Southern Research Station
Box 227
Stoneville, MS 38776

For more information contact:
U.S. Fish and Wildlife Service
Nongame Bird Coordinator
Federal Building, 1 Federal Drive
Fort Snelling, MN 55111-4056

CERULEAN WARBLER STATUS ASSESSMENT

Prepared by:

Paul B. Hamel
U. S. Forest Service
Southern Research Station
Box 227
Stoneville, MS 38776

April 2000

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES v

DISCLAIMER vii

SUMMARY vii

ACKNOWLEDGMENTS x

1. INTRODUCTION 1

2. TAXONOMY 1

3. PHYSICAL DESCRIPTION 2

4. RANGE 2
   - 4.1. Breeding Range 3
   - 4.2. Non-breeding Range 3
     - 4.2.1 Belize 4
     - 4.2.2 Bolivia 4
     - 4.2.3 Colombia 4
     - 4.2.4 Costa Rica 4
     - 4.2.5 Ecuador 5
     - 4.2.6 Guatemala 5
     - 4.2.7 Honduras 5
     - 4.2.8 Mexico 5
     - 4.2.9 Panama 5
     - 4.2.10 Peru 5
     - 4.2.11 Venezuela 6

5. BIOLOGY/NATURAL HISTORY 6
   - 5.1. Reproduction 6
     - 5.1.1. Breeding Behavior 6
     - 5.1.2. Territory Size 7
     - 5.1.3. Nest Site 7
     - 5.1.4. Number of Broods 8
     - 5.1.5. Clutch Size 8
     - 5.1.6. Incubation Period 8
     - 5.1.7. Nestling Period 8
     - 5.1.8. Nesting Success 8
     - 5.1.9. Mortality 9
     - 5.1.10. Longevity 9
     - 5.1.11. Banding Data 9
     - 5.1.12. Site Fidelity 10

5.2. Migration 10
5.3. Food Habits 11

6. HABITAT 12
6.1. Breeding Season Habitat 12
6.1.1. General Descriptive Information 12
6.1.2. Summary of Preferred Microhabitats 14
6.1.3. Tree Species 14
6.1.4. Tree Size 15
6.1.5. Canopy Cover 16
6.1.6. Tract Size 16
6.1.7. Topography 18
6.2. Non-breeding Season Habitat 18
6.2.1. Winter Habitats 18
6.2.2. Migration Stopover Habitats 19

7. POPULATION TRENDS AND ESTIMATES 20
7.1. North American Breeding Bird Survey 20
7.1.1. Physiographic Area Summaries 24
7.2. Breeding Bird Census 25
7.3. Breeding Bird Atlases 26
7.4. Geographical Area Summaries 26
7.4.1. Central and South America 27
7.4.2. Canada 27
Nova Scotia 27
Ontario 27
Quebec 27
7.4.3. United States 28
U. S. Fish and Wildlife Service Region 1 28
Nevada 28
U. S. Fish and Wildlife Service Region 2 28
Oklahoma 29
Texas 29
U. S. Fish and Wildlife Service Region 3 29
Illinois 30
Indiana 31
Iowa 31
Michigan 32
Minnesota 32
Missouri 33
Ohio 34
Wisconsin 35
U. S. Fish and Wildlife Service Region 4 36
Alabama 36
Arkansas 37

Florida 37
Georgia 38
Kentucky 38
Louisiana 39
Mississippi 40
North Carolina 40
South Carolina 40
Tennessee 41
U. S. Fish and Wildlife Service Region 5 41
Connecticut 42
Delaware 42
Maryland and District of Columbia 43
Massachusetts 43
New Hampshire 43
New Jersey 44
New York 44
Pennsylvania 45
Rhode Island 45
Vermont 46
Virginia 46
West Virginia 47
U. S. Fish and Wildlife Service Region 6 48
Colorado 48
Kansas 48
Nebraska 48
South Dakota 48

8. THREATS 49
8.1. Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range 49
8.1.1. Present and Historical Breeding Habitat Loss 51
8.1.2. Present and Potential Non-breeding Habitat Loss 53
Winter Habitat 53
Migratory Stopover Habitat 53
8.2. Overutilization for Commercial, Recreational, Scientific or Educational Purposes 54
8.3. Disease or Predation 54
8.4. Inadequacy of Existing Regulatory Mechanisms 55
8.5. Other Natural or Man-made Factors Affecting its Continued Existence . . 57

9. SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION FOR POPULATIONS 57

10. MANAGEMENT ACTIVITIES 57
10.1. General Management Approach 58

10.1.1. Silviculture of Breeding Habitat 58
10.1.2. Winter Habitat Management 59
10.1.3. Other Management Considerations and Opportunities 60
10.2. Monitoring Effects of Management Activities 60

11. PAST AND CURRENT CONSERVATION ACTIVITIES UNDERTAKEN TO BENEFIT THE SPECIES 61
11.1. Partners in Flight 61

12. SURVEYS, MONITORING, AND RESEARCH NEEDS 62
12.1. Surveys 62
12.2. Monitoring 63
12.3. Research Needs 64
12.3.1. High Priority Activities 64
12.3.2. Moderate Priority Activities 65
12.3.3. Low Priority Activities 66

13. LITERATURE CITED 67

14. APPENDIX 126

15. LIST OF CONTACTS 131
Information Requests 131
Requests for Review 137

LIST OF TABLES AND FIGURES

Table 1.a. List of measurements of cerulean warbler specimens, from a sample of 45 specimens in various plumages in the collections of the U.S. National Museum, and banding records from two locations. Measurements in mm (1mm = 0.039 in). 87

Table 1.b. Weights of cerulean warblers, from various sources. Measurements in g (1g = 0.036 oz). 89

Table 2. Synopsis of the distribution of cerulean warblers in North America, from DeSante and Pyle (1986). 90

Table 3.a. Tree species of published nest sites of the cerulean warbler. Sources as in Table 3.b. 92

Table 3.b. Published nest heights of cerulean warbler. 93

Table 4. Summary of historical nest site and clutch size data for cerulean warblers, including clutch records from the collections of the Western Foundation for Vertebrate Zoology and nest record cards from Cornell Laboratory of Ornithology and other published sources. Heights and dimensions of nests from literature sources cited in Table 3.b. 95

Table 5. Summary of recent observations of nest sites from study sites at edges of range of cerulean warblers, with reference to data from Table 4. . . . 98

Table 6. Cerulean warbler bandings by locality, from the records of the Bird Banding Laboratory, 1955-1995[a]. 100

Table 7. Summary of migration information on the cerulean warbler. 103

Table 8. Breeding Bird Survey trend data for the cerulean warbler, current through 26 June 1996. Areas for which trends could confidently be estimated, using criteria of adequate sample size provided by the BBS office, minimally 10 routes/interval. 111

Table 9. Breeding Bird Survey trend data for the cerulean warbler, current through 26 June 1996. Areas for which trends could not confidently be estimated, primarily because of small sample sizes of routes, minimally 10 routes/interval. 113

Table 10. Physiographic areas, or strata, employed in the North American Breeding Bird Survey and mapped in Figure 2, from Robbins et al. (1986). . . . 115

Table 11. Current population estimates of cerulean warblers as proportion of 1966 populations, estimated from trend data in Table 8. These are projections of mean annual trends to the entire survey period. 117

Table 12. Legal status and Heritage Program rank of cerulean warbler in the political divisions of its range. 119

Figure 1. Geographic range of the cerulean warbler. Sources are as listed in the section on **Range**. Winter range includes specimen and sight records from Robbins et al. (1992a). 122

Figure 2. Physiographic areas, or strata, used in the North American Breeding Bird Survey, from Robbins et al. (1986). Stratum numbers and names are included in Table 10. 123

Figure 3. Cerulean warbler breeding density as recorded on Breeding Bird Census plots. Only plots censused at least 5 times between 1932 and 1993 are included. 124

Figure 4. Numbers of cerulean warblers on a study area in Morgan and Berkeley Counties, West Virginia (personal communication of Jennifer Bell and Robert Whitmore, 17 September 1996). 125

DISCLAIMER

This document is a compilation of biological data and a description of past, present, and likely future threats to the cerulean warbler (*Dendroica cerulea*). It does not represent a decision by the U.S. Fish and Wildlife Service (Service) on whether this species should be designated as a candidate species for listing as threatened or endangered under the Federal Endangered Species Act. That decision will be made by the Service after reviewing this document; other relevant biological and threat data not included herein; and all relevant laws, regulations, and policies. The result of that decision will be posted on the Service's Region 3 web site (refer to: *http://www.fws.gov/r3pao/eco_serv/endangrd/lists/concern.html*).

If designated as a candidate species, the cerulean warbler will subsequently be added to the Service's candidate species list that is periodically published in the Federal Register and posted on the World Wide Web (refer to: *http://www.fws.gov*). Even if the species does not warrant candidate status it should benefit from the conservation recommendations that are contained in this document. Candidate species receive no protection under the Federal Endangered Species Act. Rather, candidate status indicates that the Service has sufficient information to propose a taxon for threatened or endangered status, and intends to do so as higher priority listing actions are completed.

SUMMARY

Cerulean warbler, *Dendroica cerulea* (Wilson), is a wood warbler in the Subfamily Parulinae of the Family Emberizidae, Order Passeriformes. No controversial or unsettled issues exist in the taxonomy of this bird.

The numbers of cerulean warblers are declining at rates comparable to the most precipitous rates documented among North American birds by the cooperative Breeding Bird Survey. Recent evidence suggests that events on breeding, stopover, and wintering grounds are implicated in this decline. However, no detailed life history study of the species exists. This status assessment is an attempt to assemble what is known of the species into a form that will enable biologists in the U.S. Fish and Wildlife Service to make a decision on whether or not to propose listing of the species under the Endangered Species Act. The report will also help the Service and others establish priorities for monitoring; research; and habitat protection, restoration, and management that will conserve this species.

Cerulean warbler is a small, neotropical migratory bird that weighs approximately 8-10 grams, and has relatively long, pointed wings and a short tail. All plumages have two white wing bars and white tail spots. Males have streaked backs in all plumages; females do not. Males in breeding plumage are blue above, white below, with a blue-black neck ring. Females in breeding plumage are bluish green above, white below washed with yellow, with a white or yellowish line over the eye. Young birds are similar

to the adult females but greener.

Cerulean warblers feed primarily on insects throughout the year. Open-cup nests are placed in the canopy of forest trees where the birds raise usually a single brood. Clutch size is usually 3-4 eggs. Adult and juvenile mortality rates are unknown. The longevity record is at least 6 years. Only 1 of 1399 banded individuals has been encountered later away from the original capture locality.

Conventional wisdom about habitat for cerulean warblers is that the birds breed in large tracts of deciduous forest having large trees and an open understory. These tracts may be in upland or bottomland situations. Migratory and winter season habitats are poorly known.

Cerulean warblers breed in eastern North America primarily in the Ohio and Mississippi River valleys. The range generally extends from the eastern Great Plains, north to Minnesota; east to Massachusetts; and south to North Carolina and Louisiana. During migration the birds pass through the southern U.S., across the Gulf of Mexico to the highlands of Central America, and on to South America. They winter in the lower elevations of the subtropical zone of the eastern slope of the Andes and other mountains in northern South America.

Historical data on the occurrence and abundance of the species are sparse and do not permit estimation of total numbers. However, it is clear that this species was a conspicuous and abundant bird throughout the Ohio and Mississippi River valleys in the past century. Currently the birds are much less numerous in areas where formerly they were abundant. The North American Breeding Bird Survey suggests that, during the past 30 years, the population has declined at an average annual rate of approximately 4%. Summaries of the Breeding Bird Survey, Breeding Bird Census, Breeding Bird Atlas, conservation status, and other information pertinent to individual nations, states, and provinces are presented for each political division within the range of the species.

Current numbers and distribution of the species are such that an adequate summary of occurrence by land ownership categories cannot be prepared, other than to state that the birds are found on public lands, industrial forest lands, and other private lands. One study found the birds more frequently on public than on other land ownerships. The extent of public lands, both state and Federal, is such that substantial amounts of breeding habitat management for the species could be done there.

Summary of status and threats to the continued persistence and expansion of populations of the species includes several categories of threats, of which destruction of habitat is the most prominent.

A. Present or threatened destruction, modification, or curtailment of its habitat or range - Habitat destruction, fragmentation, and modification, on breeding and nonbreeding areas, are believed most likely to be

responsible for the decline of the species, both at the present time and in the historic past.

B. Overutilization for commercial, recreational, scientific, or educational purposes - This is not an important factor in the decline of the species.

C. Disease or predation - Poorly known, but nest parasitism by brown-headed cowbirds may be one important factor affecting populations.

D. Inadequacy of existing regulatory mechanisms - Existing regulatory mechanisms may not be sufficient to ensure that the population will persist at the current level or increase to a previous level, especially on the winter grounds.

E. Other natural or man-made factors affecting its continued existence - Lack of knowledge of the effects of silviculture on breeding and winter habitat, and lack of knowledge of reproductive success, survivorship, and other demographic processes in breeding and wintering grounds hinders reasonable understanding of the relationship between landscape and habitat characteristics, and predation and parasitism on the birds.

Primary threat to the species is the loss of habitat on the breeding and on the winter grounds. Clear documentation of this exists. Arresting declines in habitat will require policy decision making as well as incorporation of information about the species into land-use and land management decisions. Other factors such as predation, nest parasitism, or reduced survivorship during migration, are believed to be directly related to the primary factor which is loss of area of breeding and winter habitat. Neither breeding nor winter habitat is known currently to be the more serious limiting factor. Importance of stopover habitat is not known either. Some losses to population occur as migration catastrophes, and are not directly related to habitat loss.

Successful conservation of cerulean warblers depends upon managing forested landscapes on the breeding and nonbreeding grounds to provide high quality habitat. At the present time, no projects involving reintroductions or other population manipulations are underway, nor are actions designed to manage human interactions with the species contemplated. Identifying those specific silvicultural manipulations and other land management activities that create the appropriate vegetation structure in which cerulean warblers can successfully breed, as well as winter, is a critical step in the process. This step has not yet been taken; it is perhaps likely the full range of actions, involving restoration of abandoned agricultural lands, protection of some existing forests, as well as manipulation of vegetation in other forests will be required. Current suggestions for management involve production of large sawtimber trees on long rotations. Specific management treatments have not been determined.

Currently conservation activities for the species consist of local projects, both of

inventory and monitoring nature, in several areas from Ontario to Mississippi, and Minnesota to North Carolina. A rangewide atlas project has been completed, the species forms an important part of planning activities in several areas in the Partners in Flight network, and numerous land managers have become sensitized to the potential of their lands to support the species.

Research into the demography of the species is sorely needed, to determine differences in survivorship and productivity of the species in different landscapes, different parts of the range and under different land management activities, including silvicultural treatments of breeding habitats. Research into the winter survivorship, distribution and relative abundance by habitat in South America is desperately needed. Intensive monitoring of known populations and their responses to management treatments will provide invaluable information about management activities appropriate to the perpetuation of the species. Concern over the distribution of the species in the interior of large tracts of forest suggests that surveys into the occurrence of the species on roadside vs. off-road counts in the same areas will be useful as well. Research into the migratory movements and stopover sites will also be useful.

The species is not in danger of imminent extinction, but it is rare enough to warrant concern, and its future is not assured. Based upon extensive BBS data, cerulean warblers have declined sharply over the past 30 years. Should that trend continue another 30 years, population sizes are predicted to be only 8% of the 1966 levels. It is unclear whether the species could persist with numbers as low as those. Threats to reproductive increase and to survivorship apparently exist in all parts of the annual cycle, necessitating attention to many aspects of the life cycle in recovery or future production efforts. Management programs can be instituted at the present time that do not require major changes in land use practices, but do consider silviculture appropriate to producing habitat for the species.

ACKNOWLEDGMENTS

I appreciate the assistance of many people who supplied data and information toward this project. Lloyd Kiff, former director of the Western Foundation of Vertebrate Zoology, provided information on egg sets in the collection of that institution. Pixie Senesac provided data on the Nest Record Cards in the collections of the Cornell Laboratory of Ornithology. Kathy Klimkiewicz provided data from the Bird Banding Laboratory. Bruce Peterjohn provided data from the Breeding Bird Survey. J. Van Remsen at the Louisiana State University Museum of Natural Science, Richard C. Banks at the U.S. National Museum of Natural History, and Mark S. Woodrey at the Mississippi Museum of Natural Science provided specimens and hospitality to work in their collections. Winston Smith graciously encouraged my work on this bird. Renée Hamel, Peter Hamel, and Rhonda Watson were helpful in tracking down certain references on the species. I appreciate the assistance of the following individuals with various parts of the work: Linda Andrews, Giff Beaton, Marvin Coleman, Eric Feuss,

Curtis Flather, Pedro Hocking, Wm. C. Hunter, Jeffery Magniez, Patricio Mena Valenzuela, Robert Mulvihill, Marilyn Niedermeier, Shannon Parsons, David Pashley, Edward and Jeannette Peartree, Orfa Rodriguez, Andres Sada, F. Gary Stiles, Walter Weber, Chris Woodson. The Conservation Science Division of The Nature Conservancy provided a listing of the ranks and status determinations for the species from their database. Numerous other contacts, listed in the Appendix, provided specific information on the occurrence of the birds in their locations.

Numerous reviewers provided additional publications and thoughtful comments on the rough draft of this document. It is immeasurably more thorough and more clearly written as a result of their attention to it. Chief among these reviewers is Stephen J. Lewis, whose patient editing has been essential to completing the project. Randy Dettmers assisted in this process as the draft approached completion. I also acknowledge with gratitude Pierre Aquin, Gerry Bade, Lee A. Barclay, Giff Beaton, Bradford G. Blodget, Marc L. Bosch, Daniel Brauning, David Buehler, J. Scott Butterworth, John S. Castrale, John E. Cely, Richard Coon, Jerry W. Davis, Randy Dettmers, John Faaborg, Richard L. Ferren, David W. Frugé, Lisa Gelvin-Innvaer, Larry Hedrick, Wm. C. Hunter, Jason Jones, Stephanie L. Jones, Charles G. Kjos, Melinda Knutson, Sue Lauzon, M. Victoria McDonald, Chris McGrath, Robert L. Miller, Michael J. Mossman, Catherine J. Oliarnyk, David Pashley, Bruce G. Peterjohn, Dan Petit, Rick Reynolds, Kenneth Rosenberg, John Schukman, Brian Schultz, Kimberly G. Smith, Robert J. Stoll, Frank R. Thompson, Bill Vermillion, Emily Jo Williams in this regard.

Of course, in spite of the attention of these individuals, errors likely still exist in the document. I take full responsibility for them, as well as for all the opinions expressed here.

1. INTRODUCTION

The numbers of cerulean warbler , *Dendroica cerulea* (Wilson), a small neotropical migratory bird, are declining at rates comparable to the most precipitous rates documented among North American birds by the cooperative Breeding Bird Survey (BBS, Peterjohn et al. 1995, see below). Evidence presented by Robbins et al. (1992a) suggests that events on breeding, stopover, and wintering grounds may be causing this decline. However, no detailed life history study of the species exists. Bent (1953) summarized information known about cerulean warblers through approximately 1948. Current work on the species is fragmented and important questions remain. Before a clear understanding of the species can be attained, literature and other information on the species must be reviewed, and additional research in several geographic localities addressing vital biological questions must be conducted.

This status assessment was prepared under contract for the U. S. Fish and Wildlife Service to:

1) summarize relevant historical and current biological information pertaining to cerulean warblers,

2) develop hypotheses concerning the status of the species consistent with that summary,

3) evaluate the status in such a way that the U.S. Fish and Wildlife Service can make a decision on whether or not to propose to list the species for protection under the Endangered Species Act, and

4) propose research strategies capable of evaluating the hypotheses. Results of that research should outline a course that will ensure a stable future for the species.

2. TAXONOMY

The cerulean warbler belongs to the Order Passeriformes, Family Emberizidae, Subfamily Parulinae. The species was originally described as two separate species. Alexander Wilson named the male *Sylvia cerulea* Wilson (1810), and the female, *Sylvia rara* Wilson (1811). All workers have considered the species to be monomorphic, with no subspecies described or suggested. No controversial or unsettled taxonomic issues exist for this species. Affinity has been recognized universally with wood warblers and the genus *Dendroica*. In the past 90 years, *Dendroica cerulea* has been the only Latin name used for the species.

Amadon (1950) noted a case of a ♀ cerulean warbler in Lyons, NJ, that built a nest and laid eggs that didn't hatch. Evidently no male cerulean warbler was involved in this

activity. Amadon (1950) considered this as an example of a situation where, outside of the normal breeding range of its species, a bird might hybridize with another species. A hybrid individual (*Dendroica cerulea* x *Mniotilta varia*) was collected during spring migration in Cameron Parish, Louisiana, in April 1954 (Parkes 1978).

3. PHYSICAL DESCRIPTION

Cerulean warbler is a small, neotropical migratory bird that weighs approximately 8-10 grams, and has relatively long, pointed wings and a short tail. Statistically significant differences exist in some mensural characters between sexes among adults, but considerable overlap exists (Willson et al. 1975). Average measurements are presented in Table 1. All plumages have two white wing bars, and white tail spots. Males have streaked backs in all plumages, females do not. Undertail coverts extend far out under the tail spots on the center of the tail feathers. Males in breeding (Alternate) plumage are blue above, white below, with a blue-black neck ring. Non-breeding (Basic) plumage of males is similar to breeding plumage, but the back may have a slight greenish wash and neck ring may be reduced. Females in breeding (Alternate) plumage are bluish green above, white washed with yellow below, with a white or yellowish line over the eye. Non-breeding (Basic) plumage of females is similar to breeding plumage, with slightly yellower underparts and greener upperparts. First fall males (in First Basic plumage) are similar to non-breeding females with streaks on their backs and flanks. First fall females (in First Basic plumage) are similar to non-breeding females but much more olive green above, yellower below, and with a yellower line over the eye.

4. RANGE

Cerulean warblers breed in eastern North America primarily in the Ohio and Mississippi River valleys and adjacent areas east of the Appalachians, in New England and southern Canada, and in the Great Lakes region. The range generally extends from the eastern Great Plains, north to Minnesota, and east to Massachusetts, south to North Carolina and Louisiana. A distribution map of the species is presented in Figure 1.

The birds winter in the lower elevations of the subtropical zone of the eastern slope of the Andes and other mountains in northern South America. During migration the birds pass through the southern U.S., across the Gulf of Mexico to the highlands of Central America, and on to South America.

Breeding areas are too numerous and dispersed to identify significant breeding areas at the present time. Wintering areas are too poorly known to identify significant wintering areas at the present time. Significant migration areas likewise cannot be enumerated,

although Kennesaw Mountain, Georgia, (Giff Beaton, pers. comm.) is a very regular location for observing migration.

4.1. Breeding Range

The general breeding range of the species (American Ornithologists' Union [A.O.U.] 1998) extends "from central and southeastern Minnesota, central Wisconsin, central Michigan, southeastern Ontario, New York, Connecticut, and Rhode Island south through central and northeastern Iowa and Missouri to southern Arkansas, east-central Mississippi, central Alabama, eastern North Carolina, central Virginia, northeastern Maryland, northern Delaware, and northern New Jersey. Also rarely or formerly in southeastern South Dakota, northern Michigan, southwestern Quebec, northwestern Vermont, central Massachusetts, southeastern Nebraska, eastern Oklahoma, north-central Texas (to Dallas area), northern Louisiana, northern Georgia, and northwestern South Carolina."

Recent maps summarizing the breeding range, based upon the Breeding Bird Survey and a geostatistical averaging procedure called kriging, have been produced by Curtis Flather (USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, pers. comm., 7 June 1996; see also Villard and Maurer 1996). Each of these depictions shows the concentration of the birds in the upper Ohio River valley during the breeding season.

DeSante and Pyle (1986) summarized the distribution of the species in a shorthand account for each state and province of Canada and the United States, here repeated as Table 2.

4.2. Non-breeding Range

Winter range (A.O.U. 1998) extends "from Colombia and Venezuela south, mostly along the eastern slope of the Andes, to southern Peru and perhaps northern Bolivia." A few birds remain in Grand Cayman as non-breeding residents (Raffaele 1998). December, January, and February specimen records are confined to Venezuela, Colombia, Ecuador, and Peru (D. Pashley, American Bird Conservancy, pers. comm., 24 July 1996).

During migration, cerulean warblers pass "through the southeastern United States (west to central and southern Texas in spring), Cuba, the Isle of Pines, the Cayman Islands, Jamaica and, uncommonly, along the Caribbean slope and offshore islands from southern Veracruz, Chiapas, and the Yucatan Peninsula south to Panama (also the Pearl Islands, off Pacific Panama, but not recorded from Nicaragua), casually through the Bahama Islands (recorded from Cay Lobos, New Providence). Common spring migrant in Maya Mountains of Belize." (A.O.U. 1998).

"Casual north to southwestern Manitoba, North Dakota, northern Minnesota, northern Wisconsin, central Ontario, New Hampshire, Maine, New Brunswick, and Nova Scotia, in western North America to California, northern Baja California, southern Nevada, southeastern Arizona, Colorado and New Mexico; sight reports for Newfoundland, Bermuda, and southeastern Brazil." (A.O.U. 1998).

Parker (1994) documented substantial movement of the birds through the highlands of Belize, indicating that their movements through Central America, although perhaps not well-documented along the Caribbean slope, may be substantial.

Winter range is little documented. The following is a brief compilation of accounts by country in the nonbreeding range of the species.

4.2.1. Belize

Russell (1964) noted the birds at lowland localities in Belize in both spring and fall. Parker (1994) showed the importance of the highlands of Belize as a staging ground for the birds during spring migration.

4.2.2. Bolivia

Bond and de Schauensee (1941) note two records from La Paz province in northeastern Bolivia, without giving dates. Dott (1985) did not find the species.

4.2.3. Colombia

de Schauensee (1951) notes the birds as winter residents recorded from the western Andes to the east slope of the eastern Andes from November through March. Walter Weber (pers. comm., 16 Aug 1995, 16 Jan 1996) provided information on three observations from the Medellin area, two in primary forest at 1200-1400 m (3900-4500), and the other in a shade coffee plantation. F. G. Stiles (pers. comm. 22 Aug 1995) provided several specimen and sight records from 500-1400 m (1600-4500 ft) October-February, and a single specimen record from 2600 m (8500 ft) in September. In his experience the species is uncommon in canopy and edges of secondary and disturbed primary forest, and likely also to occur in primary forest and shade coffee plantations, where it is often associated with canopy flocks of tanagers-honeycreepers-flycatchers.

4.2.4. Costa Rica

The one recovery of a banded bird away from the original banding locality was of a Hatching-Year bird banded in Pennsylvania and found dead in Tortuguero National Park, Costa Rica, later in the same year (Leberman and Clench 1975).

4.2.5. Ecuador

Primary occurrence is in the eastern slopes of the Andes, 500-1500 m (1600-5000 ft; Ridgely and Greenfield, in press). A single record exists for the western slopes (Orfa Rodriguez, pers. comm. 5 September 1995). A frequent location at which the birds are observed in Ecuador is in the secondary forests near the location at which the Cascada de San Rafael can be observed, near Reventador in Oriente Province.

4.2.6. Guatemala

Land (1970) reported a single record from the country. Jehl (1974) later took a ♂ specimen which appeared aboard his study vessel 30 mi (50 km) SW of San Jose on 17 April, one of very few records for the west coast of Central America.

4.2.7. Honduras

Monroe (1968) noted cerulean warbler to be an uncommon to rare migrant, primarily in the Caribbean lowlands below 750 m, primarily in the fall. He listed the species as using open rain forest, forest edge, and second growth.

4.2.8. Mexico

Records from Mexico are scarce, during migration (Edwards 1972). In response to request for information Andres M. Sada (pers. comm. 11 April 1994) noted that he had but a single record from 15 trips during spring to the rain forest of Campeche, 7 April 1982. He added "The place is now deforested."

4.2.9. Panama

Wetmore et al. (1984) indicate that the birds are "uncommon," predominantly migrants through Panama from late August-early October and mid- to late March. Extreme dates include 4 November, 14 April, and a single winter record by Ridgely on 1 January 1969. Greenberg (pers. comm., February 1997) noted that the birds often occur as "pairs," a male and a female, in association with mixed species flocks of canopy insectivores.

4.2.10. Peru

Zimmer (1949) noted the birds to be winter visitors with records in Huambo, Pumamarca, Ropaybamba, Amable Maria, Monterico, Chanchamayo, Río Colorado, Huachipa, La Gloria, San Emilio, Idma, and Huaynapata. Stephens and Traylor (1983) give elevations of these localities as generally between 700-1630 m (2300-4600 ft). Parker et al. (1982) list the birds as migrants of uncertain abundance in the humid tropical life zone of the east slopes of the Andes in Peru, elevations 150-900 m (500-3000 ft). Robinson et al. (1988) studied the birds of primary moist forest, maximum canopy height 35 m, in the upper tropical zone of the Andean foothills, 1981-1985.

They found the cerulean warbler in five of 13 mixed-species flocks between 850-1250 m. Requests for information yielded a response from P. Hocking (pers. comm., Aug 1995), that he had no observations to report.

4.2.11. Venezuela

Phelps and Phelps (1950) indicate that in the northern winter these birds can be found in the subtropical zone in the mountain ranges of the northern part of Venezuela, including Sierra de Perijá in Zulia, Bramón in Táchira, to Los Altos in Sucre Province. J. Jones (pers. comm., Aug. 1996; Jones and Robertson 1997) is conducting a study of the birds in the winter in Venezuela.

5. BIOLOGY/NATURAL HISTORY

Cerulean warblers are neotropical migratory birds that feed primarily on insects throughout the year. Open-cup nests are placed in the canopy of forest trees where the birds raise usually a single brood. Clutch size is usually 3-5. Adult and juvenile mortality are unknown. Longevity record is at least 6 years. Only 2 of 1207 banded individuals have been encountered later away from the original capture locality.

5.1. Reproduction

5.1.1. Breeding Behavior

Observers frequently note that the birds occur in aggregates, groups, or "colonies" during the breeding season. Bagg (1900) noted 25 or more of the birds inhabiting a single patch of woods in New York. Peck and James (1987) used this information to infer that the birds have a narrow habitat preference. The determination that the birds are distributed in a statistically clumped fashion has not been made. Research into the topic of how the birds are distributed is important because it will assist in interpretation of how the birds use their habitats.

Breeding birds can be very aggressive toward each other (pers. obs.), males sometimes attacking each other at canopy heights of 20m or more, and falling to the ground grappling. Similar fights have been observed between females, and between pairs (Hamel, unpubl. obs.) Murray and Gill (1976) noted that cerulean warblers were attacked by both blue-winged (*Vermivora pinus*) and golden-winged warblers (*V. chrysoptera*).

Audubon (1856, p. 45) pointed out that the adults took their fledglings to areas with extensive tangles of grape vines (*Vitis* sp.). Birds in the Mississippi Alluvial Valley[1] appear to do the same (Hamel unpubl. obs.).

5.1.2. Territory Size

Oliarnyk (1996) reported a mean breeding territory size of 1.04 ± 0.16 ha (2.6 ± 0.4 acres) based on 18 Ontario territories that ranged in size from 0.38-2.4 ha (1-6 acres).

5.1.3. Nest Site

Selection of trees for nesting is an important issue for the management of habitats for the species. It is clear (Table 3) that the birds will utilize a great variety of tree species. Whether the birds actually select certain species as nest trees in greater frequency than the species occur in the environment has not been determined.

Nests are placed usually on lateral limbs of deciduous trees in midstory or overstory canopy, usually concealed from above by clumps of live leaves on small twigs of the nest tree, or by clumps of leaves of vines growing along the nest branch.

Nest heights are summarized for published literature in Table 4. Analysis of variance of nest height information in Table 4 for Michigan, New York, Ontario, and Pennsylvania nests indicates significant differences in mean nest height from one part of the range to another. Differences among nest heights may be related to the general physiognomy of the vegetation at the breeding locality.

Nest and vegetation heights from recent survey work in Ontario (Oliarnyk and Robertson 1996) and the Mississippi Alluvial Valley (Hamel, unpubl. data) are compared to historical data (rangewide values) in Table 5. All Mississippi Alluvial Valley nest measurements are significantly greater than values from Ontario and rangewide values from literature, by pooled t-test (Snedecor and Cochran 1967). Ontario values exceed rangewide values from literature for nest height, but not for distance from bole of tree, by same tests. These comparisons indicate that habitats in which cerulean warblers breed exhibit a wide range of heights.

Nests are often located over an open space, which may be as small as one meter between the nest branch and a lower branch of the same tree. More often, however, the open space may be 5 to 20 m from the nest to the tops of intermediate or suppressed trees below the nesting branch, to the tops of shrubs beneath the nest tree, or to the herbaceous layer or bare ground. This situation, in which the nest is above or adjacent to an open space, complicates understanding and interpreting published

---

[1] Throughout this document, "Mississippi Alluvial Valley" is used to mean the floodplain of the Mississippi River from the confluence of the Ohio and Mississippi Rivers at Cairo, Illinois, and farther downstream. Some would state that it is proper to term this area the Lower Mississippi Alluvial Valley.

descriptions of nest sites as "over openings." It is not clear whether these openings were canopy gaps where sunlight reaches to the vegetation layer beneath the nest, or were shaded spaces within the canopy structure itself. The variety of situations in which nests are located within the canopy indicates the difficulty with characterizations of the habitat based on metrics such as "distance to gap" and the like. Understanding this aspect of the reproductive biology will be a great step toward understanding the status, silviculture, and conservation of these birds. Research is needed on this topic.

5.1.4. Number of Broods

Cerulean warblers usually raise a single brood to independence. Failed nesting attempts are often followed by renesting attempts (Oliarnyk and Robertson 1996; Hamel, unpubl. obs.). Females routinely use portions of old nests, probably the caterpillar silk and spider webs used to attach the nests to branches, in the construction of new nests (Gray 1924, Oliarnyk and Robertson 1996, Hamel, pers. obs.). Color-marked pairs have renested after first nesting attempts produced young that were depredated late in nest life or just at the point of fledging (Hamel, pers. obs.). Production of more than a single brood of chicks that successfully fledged has not been documented.

5.1.5. Clutch Size

Oliarnyk (1996) examined six nests whose clutches ranged from 2-5 eggs (mean 3.8 ± 0.2 S.E.). Wood (1951) lists egg dates in Michigan as late May to early July, giving clutch size as 3-4 (usually). Peck and James (1987) note a clutch size range of 36 Ontario nests as 1-4 eggs, with the mode of 4 eggs. Additional data on clutch size in Table 4 indicate that 3-4 eggs is typical. Baicich and Harrison (1997) give an illustration of the egg of the species.

5.1.6. Incubation Period

Oliarnyk (1996) estimated incubation period in Ontario, based on eight nests, as between 11 (n=5) and 12 (n=3) days.

5.1.7. Nestling Period

Oliarnyk (1996) estimated nestling period in Ontario, based on ten nests, as between 10 (n=6) and 11 (n=4) days.

5.1.8. Nesting Success

Oliarnyk (1996) presented data on 27 nests found in 1994 (n=10) or 1995 (n=17) on three study sites in Ontario. Eighteen of the nests (67%) produced fledglings which, together with observations of fledglings in territories where no nests were found, represented 20 of 27 pairs successfully fledging young over the two years. Four nests

were probably depredated, two each during incubation and nestling periods. Reason for abandonment of five other nests was not known. No parasitism by brown-headed cowbirds (*Molothrus ater*) was observed by Oliarnyk (1996).

In another Ontario dataset, Peck and James (1987) recorded 18% nest parasitism by brown-headed cowbirds. Brown-headed cowbird parasitism is more common in preliminary data from the Mississippi Alluvial Valley (Hamel, unpubl. data) than that observed by Oliarnyk (1996) in Ontario. Nest predation and parasitism, as well as interference competition with other species such as blue-gray gnatcatchers (*Polioptila caerulea*), northern parulas (*Parula americana*), and American redstarts (*Setophaga ruticilla*), all have some negative effect on reproductive success in the study areas in the Mississippi Alluvial Valley.

These studies may not be representative of the average situation faced by cerulean warblers across the breeding range of the species. More data are needed on this topic.

5.1.9. Mortality

No data on this topic exist. Groups in Ontario and the Mississippi Alluvial Valley are currently studying color-banded birds in an effort to assess survivorship.

5.1.10. Longevity

The longevity record for the species is an adult male banded by E. and J. Peartree of Sauk City, Wisconsin (pers. comm. 12 August 1996, and 1 September 1996) on 7 August 1966 and recaptured at the same site in 1971, making it at least six years old.

5.1.11. Banding Data

As of August 1999, a total of 1399 individuals have been banded (K. Klimkiewicz, Biologist, Bird Banding Laboratory, pers. comm., September 1999) since 1955, of which 2 have been later recaptured. High count for any year is 53 birds in 1966; low is 4 in 1959. Cerulean warblers (data through Aug 1996, K. Klimkiewicz, Biologist, Bird Banding Laboratory, pers. comm., 1 July 1996) have been banded in 35 states (n=1080), 2 Canadian provinces (n=88), and 6 countries on the migration and winter grounds (n=12; Table 6). The majority of bandings in most of North America has taken place on the breeding grounds, May-July; in the southern U. S., the majority of bandings occurred during spring migration, March-April. Only one individual has been banded during December, January, or February (Table 6).

Two banded birds have been recaptured. The first is the longevity record listed above. The other is a Hatching Year individual of undetermined sex banded in Pennsylvania on 22 July 1973 and found dead in Costa Rica on 12 September of the same year (Leberman and Clench 1975). Hamel (unpubl. data) has found color-marked individuals returning to known breeding grounds in subsequent years, as has Oliarnyk

(pers. comm. 10 June 1996). Numbers of returning individuals are at present too small to estimate return rates.

5.1.12. Site Fidelity

Individual color-banded birds have returned to breeding sites in Ontario (C. Oliarnyk, unpubl. obs.) and in the Mississippi Alluvial Valley (Hamel, unpubl. obs.) for at least two consecutive years. One of two subsequent encounters with banded cerulean warblers was a male that returned to the banding location five years later (E. and J. Peartree of Sauk City, Wisconsin, pers. comm. 12 August 1996, and 1 September 1996).

5.2. Migration

Cerulean warblers migrate from breeding grounds in eastern North America to winter grounds in South America. Spring migration occupies approximately two months, while the fall migration extends over more than four months. Wintering areas are as far south as those of any warbler species. Averill (1920) noted that the longest migrations in a group of related birds were made by those with longer wings, shorter tails, and smaller bills and feet. He further indicated that cerulean warblers were well proportioned for such long flights, without knowing the actual length of cerulean warbler migratory flights. Typical of warblers that migrate long distances, e.g. bay-breasted (*Dendroica castanea*), blackpoll (*D. striata*), and blackburnian (*D. fusca*), the wing formula of cerulean warblers is more pointed, with the three outer primaries longer than the rest, as opposed to less pointed, in which the four outer primaries are longest (Banks and Baird 1978).

Cerulean warblers migrate primarily through the Mississippi and Ohio River Valleys in North America. In Central America they appear to move north through Panama and Costa Rica to the highlands of Belize in spring (Parker 1994), probably primarily in March, from which they depart across the Gulf of Mexico to the coast of Louisiana and Texas. Nocturnal trans-Gulf migration is demonstrated by collection of an individual, among hundreds of other migrants, on the deck of a fishing vessel in the Gulf of Mexico (26° 54.6'N 97° 3.4'W) at 2130 CST, 18 April 1952 (Bullis 1954). Crawford's (1980) examination of tower kills suggests a pattern typical of trans-Gulf migrants. Loetscher (1955) considered the species "probably a rare or casual transient" in Veracruz, Mexico, with two records; one in "deep woods" at 1370m (4500 ft; Jalapa) and the other at 76m (250 ft; San José del Carmen). Russell (1964) notes the birds at lowland localities in Belize in both spring and fall as well. One specimen he listed weighed 8.9 g, a rather low weight. Petit (pers. comm., 8 Jul 1997) observed a ♂ at 20 m (65 ft) elevation in late March within 19 km (12 mi) of Belize City, Belize. Bonhote (1903) noted two individuals of unknown sex having struck the lighthouse at Cay Lobos in the Bahamas, on 26 April 1901.

The birds arrive on the northern coast of the Gulf of Mexico from late March through early May. High concentrations of the birds are subsequently noted at certain inland

locations such as Kennesaw Mountain, Cobb County, Georgia (Giff Beaton, pers. comm.), and Sharps Ridge, Knox County, Tennessee (Robinson 1990). It is uncertain whether the large numbers reported from these inland North American sites represent specific staging areas for the birds or locations where conditions are favorable for observing these canopy birds as they move.

Fall migration is not as well understood as that in the spring. Presumably, the birds reverse the spring path, moving south through the Ohio and Mississippi River Valleys beginning in July and extending into October. Throughout this period, the birds depart the north Gulf Coast for Central America. Few data exist on concentrations of the birds in Central America in fall.

Very early arrival on the wintering grounds is demonstrated by two August records from Ecuador (Ridgely and Greenfield, in press; Amer. Mus. Nat. Hist. Specimens 180648, 180649, 10 Aug 1923, D. Pashley, American Bird Conservancy, pers. comm., 24 July 1996). Another individual, Field Museum of Natural History specimen 60022, was collected in Peru on 30 Sept 1922 (D. Pashley, American Bird Conservancy, pers. comm., 24 July 1996). Nevertheless, singing males have been recorded on breeding grounds as late as 21 August in Tennessee (C. Woodson, pers. comm. 22 August 1996) and 28 August in Michigan (Brodkorb 1929).

Fjeldså and Krabbe (1990) notes that during migration, in addition to the tropical and lower subtropical zones, cerulean warblers also occur (although rarely) in the lower temperate zone in the Andes.

A summary of listed migration dates by province, state, and region is presented in Table 7.

5.3. Food Habits

Cerulean warblers are insectivores, taking their foods from leaf bases and foliage of a great variety of trees using a variety of techniques, including gleaning, hover-gleaning, and sallying. Greenberg (1979) suggested that the species was specialized for foraging on insects in foliage, based on the small body size. More recently, Greenberg (pers. comm., February 1997) has noted that the birds also eat small amounts of plant material, as small fatty masses attached to fruits of some tropical trees that the birds encounter in migration.

Howell (1924) reported on contents of stomachs of four birds taken in Alabama in 1912. Hymenoptera (42%); Coleoptera, including weevils (23%); and Lepidoptera (35%) were commonly found. Sample et al. (1993) reported on differences in diet among birds taken during studies of gypsy moth invasion of West Virginia forests.

6. HABITAT

Conventional wisdom holds that cerulean warblers occupy large tracts of deciduous forest composed of large trees and an open understory during the breeding season. Migratory and winter season habitats are poorly known.

6.1. Breeding Season Habitat

6.1.1. General Descriptive Information

Breeding season habitat for the species is almost exclusively in forests of broadleaved, deciduous trees. These forests may be in wet bottomlands, mesic slopes, or upland situations. Although breeding season use of baldcypress (*Taxodium distichum*) has been recorded (Hamel, unpubl. data), and a nest located in a shortleaf pine (*Pinus echinata*; G. C. Vanderah, pers. comm.), most observations and reports of habitats indicate that they breed in hardwood forests.

Our capacity to measure habitats in detail at present creates an opportunity for detailed analyses of the current conditions of breeding habitats. Unfortunately, the sorts of habitats where the species was especially abundant in the past, e.g. the old-growth bottomland forests of the Mississippi Alluvial Valley (Widmann 1895a, 1895b, 1897), no longer exist. Earlier observers did not take the quantitative measurements that would be necessary for detailed empirical analyses. Nevertheless, these earlier accounts are particularly instructive descriptive accounts of habitat.

Unfortunately, mesic upland forests of the type the birds use are all too often no longer present, because the land use of mesic upland forests is most often farmland in the breeding range of the species. Occurrence in floodplains thus may be an artifact, rather than a preference, of the birds. One view is that ideal habitat for the birds includes extensive stands of large trees on rolling uplands in the upper Ohio River valley. Much of this landscape is now dominated by agricultural lands on which grow few such tracts.

Brandt (1947) associated the species with extensive oak-hickory woodland on the Edwin S. George Reserve, Michigan. Peterjohn and Rice (1991) associate these birds with "a variety of wooded communities including dry oak-hickory woodlots ..., extensive mixed mesophytic forests ..., wet beech-maple woodlands ..., and extensive floodplain woods" in Ohio. Brooks (1908) indicated that the birds were "Wonderfully abundant in Wood County in the hills just back from the Ohio River" in West Virginia, where the birds bred in the open oak woods on the top of the hills. In western Kentucky the species occurs "chiefly in mature, relatively undisturbed deciduous forest" (Mengel 1965). Mengel (1965) goes on to mention "mature swamp and lowland forests" where the birds were quite numerous. There it tends to avoid upland oak-hickory communities; near Cincinnati it was the most common nesting bird of deep woodlands, particularly beech-maple associations, but also other forests, often associated with

steep slopes. Along the Cumberland Plateau the birds occurred in a variety of mixed mesophytic forest, especially on mesic sites, where it was sometimes the most numerous warbler (Mengel 1965). Mengel (1965) expressed confusion about the elevational range of the species in Kentucky, where on Pine Mountain he found it only to 700 m (2300 ft), while on Black Mountain it was found to 1100 m (3600 ft). Palmer-Ball (1996) also associates the species with a range of deciduous forest habitats, perhaps "most frequently in mesic situations." In southwestern Michigan, Adams (1991) notes tree species associated with occurrence of the birds to be silver maple, ash, sycamore, American elm in bottomlands, and beech-maple, oak, black walnut, and black locust in uplands. Cadman et al. (1987) associate the species with "the upper canopy of large deciduous trees within extensive blocks of woodland." Andrle and Carroll (1988) identify a number of nesting habitats for New York birds, including wooded swamps, deciduous forest in stream bottoms, tall trees along water bodies, tall cottonwoods on islands in the Hudson River, as well as open, upland forest of oak, oak and maple, silver maple, and even black locust. Bystrak (pers. comm. April 1985) provided an interesting association of cerulean warblers with habitats in which small wads of material, such as dead leaves, were lodged in the trees. These "festoons" indicate situations in which flooding takes place.

Students of the species frequently refer to it as using floodplain forests. Rhoads and Pennock (1903) identify the species as associated with the "heavily timbered" bottomlands of the Choptank River in Delaware, indicating that the birds avoided the adjacent uplands. Gray (1924) found several nests in New York, all along streams or over swampy ground. He noted "The presence of water is probably more than a coincidence and seems to indicate a preference for such conditions." Robinson (1996) associated the birds in Illinois primarily with forested areas of large trees, in bottomlands as well as uplands. From reports such as these, it appears that this species prefers bottomlands in many areas.

This situation is likely an artifact of the distribution of forests, and that the birds are able to utilize both upland and bottomland forests. For example, Torrey (1896) noted the birds to be "moderately common" and breeding in old deciduous forest on several hilltops at Natural Bridge, Virginia. Todd (1893) was surprised to find the birds "quite common, ..., in the dry, open, oak woods of the uplands." Kirkwood (1901) found the birds nesting in an area dominated by chestnuts (*Castanea dentata*), with oaks, hickories, and tulip trees (*Liriodendron tulipifera*). Hann (1937) listed the species as 15th among the 25 "more common birds given in the general order of their frequency." His study area was a mesic stand of white oak (*Quercus alba*), black oak (*Q. velutina*), sugar maple (*Acer saccharum*), shagbark hickory (*Carya ovata*), and basswood (*Tilia americana*). The tract described by Maxon (1903) also indicates an upland situation. Schorger (1927) succinctly states "The Cerulean Warbler is found mainly in moist rich woodlands containing tall, dense timber, in both the uplands and river bottoms."

Additional descriptors of habitats or breeding locations include riparian areas or strips, as well as upland forests in West Virginia, New Jersey, Pennsylvania, Ohio,

Tennessee, and North Carolina (Kenneth Rosenberg, Northeast Regional Coordinator, Partners in Flight, pers. comm., 25 September 1996).

6.1.2. Summary of Preferred Microhabitats

Cerulean warblers are routinely identified with large tracts, tall trees, and mature forest. For example, Lynch (1981) indicates minimum habitat requirements of the birds along the Roanoke River in North Carolina to "include: (1) a closed canopy, (2) presence of scattered, very tall, old-growth canopy trees, and (3) good development of vegetation strata, i.e., distinct zonation of canopy, subcanopy, shrub, and ground-cover layers. Floodplain areas of even-aged timber with no old-growth trees contain few, if any, breeding pairs." Measurements of heights and diameters of trees from one area may not accurately reflect the birds' habitat in another area because maximum tree heights and diameters are a function of the specific topography, soil type, and site on which the forest grows (Table 5). This makes it difficult to extrapolate results of modeling efforts in one area to other areas.

6.1.3. Tree Species

Nesting has been recorded in a wide array of tree species. Bent (1953) includes "elm" [probably *Ulmus americana*], "soft maple" [probably *Acer rubrum*], oaks (*Quercus* sp.), maples, basswoods (*Tilia* sp.), tulip tree (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), "rock" maple (*A. rubrum*), sugar maple (*A. saccharum*), and white oak (*Q. alba*). Gray (1924) lists "buttonwood" [probably *Platanus occidentalis*]. Saunders (1900) noted nests of the birds in an Ontario woods where the birds were "exceedingly common," in basswood (N=4), oak (N=2), and maple (N=2); he avoided looking for nests in elms, which were too tall for him to feel safe climbing them. Harrison (1984) adds shagbark hickory (*Carya ovata*) to the list, noting that most nests he found were in oaks. Oliarnyk (1996) found a nest in an ironwood (*Ostrya virginiana*). Griscom (in Griscom and Sprunt 1979) notes without elaboration that coniferous trees are also used. Glendy Vanderah (Illinois Natural History Survey, pers. comm., May 1993) has located nests in pine trees in southern Illinois. Salzman (1983) adds black locust (*Robinia pseudo-acacia*) to the list from New York.

Published nest site information, data from the Cornell Laboratory of Ornithology Nest Record Program, and egg sets in the collections of the Western Foundation for Vertebrate Zoology (Table 3) indicate that a wide variety of trees are used for nesting throughout the range of the species. Without information on the abundance of different trees in the vicinity of the nest sites, however, it is impossible to determine whether the birds prefer to use trees of a certain size, certain species, or certain position in the canopy. Analyses of data from three sites in the Mississippi Alluvial Valley (Hamel, unpubl. data) may clarify that point in one area of the range. A tentative conclusion, based upon the variety of nest sites listed in Table 3 and observed in Mississippi Alluvial Valley and other localities (Hamel, unpubl. data; Oliarnyk and Robertson 1996; Vanderah, 1993 and pers. comm.), is that cerulean warblers do not prefer any particular

species or species group across the breeding range, although certain trees or trees of certain crown classes may be frequently used in particular localities. This is a tentative refutation of one conclusion of Robbins et al. (1992a).

Diseases of particular tree species do not appear to pose a serious general threat to the populations of this bird species. However, where diseases such as Dutch elm disease eradicate substantial populations of trees this may become a local problem (Scheider 1959; Kendeigh 1982), if reforestation is not pursued to replace the diseased trees, or if harvesting diseased trees leads to land use changes that eliminate forest from the site. In either of these cases, it is the deforestation, not the elimination of a particular species of tree, that is the problem for cerulean warblers. Kendeigh (1982: 65) presents data showing cerulean warbler density as 11.3 pairs/40 ha (/100 acres; n=3 years) before, and 12.0 pairs/40 ha (/100 acres; n=2 years) after the loss of American elms from one of his Illinois study sites, Robert Allerton Park.

6.1.4. Tree Size

Breeding habitats for this species are routinely described as including tall trees, though few workers provide specific information on tree height. Robbins et al. (1992a) indicate that in a sample of all behaviors taken from Tennessee, the birds were found at an average height of 17 m (56 ft) in a tree of average height of 22 m (72 ft). A much more extensive data set from Arkansas and Tennessee bottomland hardwood forests indicates an average perching and foraging height of 15 m (49 ft) in a tree of average height of 22 m (72 ft; Hamel, unpubl. data).

Habitats are usually described as also including large trees. Even Wilson (1811, p. 119) associated the birds with "high branches of the tallest trees." Robbins et al. (1992a) provide the only quantification to date of the habitats, from two study regions in Tennessee. In both locations, cerulean warblers preferentially used large trees, and areas with large trees, at three scales; the birds were found (1) to perch in trees whose diameters were significantly larger than average trees available to males in their territories, (2) the territories contained trees with significantly larger diameters than average for the stands in which the territories were located, and (3) those stands were dominated by trees with larger diameters than the dominants of the average stand in the study region.

More detailed examinations of habitats in the bottomlands of the Mississippi Alluvial Valley (Hamel et al. 1994) indicate that while the birds occur in areas dominated by large trees, within those areas the locations at which the birds spend their time may not be predictable by tree diameters alone.

In a detailed study of cerulean warblers in extensive forest in Ontario, Oliarnyk (1996) noted: "To determine structural features necessary for successful reproduction in this species, I related success or failure of a nest to habitat surrounding the nest site. Within a territory, habitat surrounding successful nests was significantly more likely to

contain larger than average trees and a dense upper canopy, while unsuccessful nests were associated with a dense understory."

6.1.5. Canopy Cover

Kahl et al. (1985) provide instructive data on the extent of canopy cover in breeding habitats in Missouri, indicating that these habitats include canopy cover averaging 85%, with a minimum value of 65%. Work in the Mississippi Alluvial Valley (Hamel, unpubl. data) indicates that the canopy cover of the habitat cannot be constrained to a single value, but that the vertical distribution of foliage in the canopy is important.

Numerous observers, including Bent (1953), Harrison (1984), Oliarnyk (1996), Oliarnyk and Robertson (1996), indicate that gaps in the canopy, or openings, are important to the distribution of the birds. Robinson (1996) indicated that the birds also occur in certain forests where disturbance has opened the canopy. Emily Jo Williams (Georgia Dept. of Natural Resources, pers. comm., 26 Sept. 1996) pointed out that the birds persisted in stands on the Chattahoochee National Forest in Georgia after Hurricane Opal had extensively damaged the forest. Nonetheless, Bannon and Robert (in Gauthier and Aubry 1995, p. 910-911) noted that a hailstorm in the beginning of the 1980's modified the habitat on Mont Saint-Hilaire (a regular breeding site for the species in Quebec in the 1960's-1970's). After that storm, the birds were rarely seen there. On a Mississippi Alluvial Valley site in Desha Co., AR, a severe ice storm was followed by a decline in the population (Chris Woodson, USDA Forest Service, Stoneville, MS, pers. comm., November 1996). Characterizing what are appropriate ways to measure these "openings" is an important research need.

6.1.6. Tract Size

The cerulean warbler is usually considered to be an area-sensitive species, but the minimum tract size to which the species is sensitive varies from region to region, e.g. from 700 ha (1730 acres; Robbins et al. 1989) in the Middle Atlantic States to 1600 ha (3950 acres) in the Mississippi Alluvial Valley of Tennessee (Robbins et al. 1992a).

Blincoe (1925) was among the earliest workers to note changes in abundance in response to changes in local habitat conditions. Bond (1957) noted birds in tracts larger than 16 ha (40 acres) more frequently than in smaller ones in Wisconsin. In a follow-up study, Ambuel and Temple (1982) found the birds on 2 of 14 tracts in 1979, significantly fewer than the 10 of 19 sites on which Bond (1957) had found them (Fisher's Exact Test, P=0.014). Only four of Bond's (1957) and three of Ambuel and Temple's (1982) tracts exceeded 100 ha (250 acres). Peterjohn and Rice (1991) indicated the birds prefer tracts at least 20-30 ha (50-75 acres) in extent, and avoid isolated tracts of less than 8-10 ha (20-25 acres) in Ohio. These tract sizes may be similar to those used in New York, which are not as large as those in the Midwest and Mississippi Alluvial Valley (Kenneth Rosenberg, Northeast Regional Coordinator, Partners in Flight, pers. comm., 25 September 1996). Robbins et al. (1989) estimated

the minimum area requirement for the birds in the Middle Atlantic States to be 700 ha (1730 acres), with occasional individuals occurring in smaller tracts. The birds occurred in only a small proportion of the tracts studied by Robbins et al. (1989). Hamel (1992) listed the bird as area-sensitive with minimal tract size of 1750 ha (4325 acres). Robbins et al. (1992a) only found birds in west Tennessee bottomlands in tracts larger than 1600 ha. Recent planning work (Mueller et al. in press) in the Mississippi Alluvial Valley suggests tracts in excess of 8000 ha (20,000 acres) may be required to support stable breeding populations. More research on this topic is needed.

In an alternative approach to looking at fragment size, Castrale et al. (1987) compared numbers of birds counted in nearly equivalent-length segments of two southern Indiana rivers with nearly equivalent flow and upstream water control conditions. The two streams differed in extent and kind of habitats in the floodplain. Salt Creek had less forest within 0.4 km (0.25 mi) of the stream channel than Patoka River (38% vs 78%), narrower median perpendicular width of continuous woodland [117 m vs 844 m (384 ft vs 2768 ft)], and shorter perpendicular distance from channel to nonforested habitat [42 m vs 319 m (138 ft vs 1046 ft)]. Salt Creek had significantly fewer cerulean warblers as well [0.4 singing males/10 km, range 0-1.1; vs 9.1 singing males/10 km, range 7.1-12.6 (0.6/10 mi vs 14.6/10 mi), $P < 0.01$].

In a detailed study of cerulean warblers in extensive forest in Ontario, Oliarnyk (1996) noted "This study furthers the recommendations of earlier work suggesting Cerulean Warblers require large tracts of mature forest by identifying tree size and relative canopy density as specific features of a mature forest related to successful reproduction." These determinations resulted from detailed, well-executed multivariate analyses of measurements of vegetation in 0.04-ha (0.1-acre) circular plots (James and Shugart 1970; Martin and Conway 1994).

Interestingly, in the report on terrestrial wildlife prepared for the Southern Appalachians Assessment, in which the cerulean warbler is listed first among area-sensitive, mid- to late-successional deciduous forest species (Southern Appalachian Man and the Biosphere Program 1996: 70), large tracts of forest believed to be suitable for this species are most abundant in the Southern Appalachians in the Blue Ridge Mountains, the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Mountains. Authors of the report project, using past trends in land use, that in "the next 15 years, suitable acreage in large tract sizes and associated forest interior habitats will continue to decrease due to loss of forestland to other land uses such as agricultural pasture and development," primarily in parts of the Appalachians currently with less than 70 percent forested landscapes (Southern Appalachian Man and the Biosphere Program 1996: 70-72).

The expanding populations of these birds in the northeastern part of the range, where they now occupy landscapes that were formerly cleared for agriculture, indicate that the birds are not restricted to certain localities, but will occupy areas in which habitat is

created, either by direct or natural reforestation of agricultural land as well as by maturation of previously harvested forests.

All observers have not agreed on area-sensitivity. Brooks (1934) believed a male had bred in the "grove of the Presbyterian Church" at French Lick, West Virginia, in 1925. Jason Jones (pers. comm. September 1996) noted the birds occurring in tracts as small as 10 ha (25 acres) during field surveys of Ontario habitats in the breeding season in 1996. He was not able to assess breeding success during that survey.

The mechanism of this area-sensitivity has not been determined. What constitutes fragmented habitat in one physiographic region, for example a highly agricultural area, probably does not adequately reflect the situation in a different, predominantly forested physiographic region. Response of this species to habitat fragmentation may, like that of other species, relate to other factors that co-vary with fragment size, such as intensity of cowbird parasitism and predation, rather than particular behavioral aversion to small fragment size or to edges (Robinson et al. 1995b; Hamel et al. in press).

6.1.7. Topography

That cerulean warblers occupy so many different habitats from level floodplains in river bottoms to steep slopes in Cumberland Mountain forests indicates that no particular terrain is preferred.

6.2. Non-breeding Season Habitat

6.2.1. Winter Habitats

Winter habitat for this species has not been studied in detail. Published and unpublished observations indicate that the birds occupy broadleaved, evergreen forests at middle and lower elevations on the east slopes of the Andes from Colombia to Peru and possibly Bolivia, as well as montane forests of Venezuela (Salvin and Godman 1879-1904; Allen 1907; Robbins et al. 1992a; Ridgely and Tudor 1989; de Schauensee 1966). Ridgely and Tudor (1989) list the species as an uncommon winter resident (October-March) in canopy and borders of forest and woodland, usually singly, in company of mixed flocks of insectivores. However, they suggest that the birds may be overlooked because they forage high in the canopy and are mostly silent.

Some observers, such as Terborgh (1989), Robbins et al. (1992a), and DeGraaf and Rappole (1995), believe that the birds are confined to areas of old-growth native forest, and that primary forest is thus a habitat requirement. Others (P. Greenfield, pers. comm.; W. P. Smith and Hamel, unpubl. obs.), however, have observed the birds in areas of second-growth, or disturbed forests within the same elevational band in Ecuador. It is unknown how important primary forest is to these birds on the wintering grounds. Research is needed to quantify the habitat requirements of the species in winter.

Fjeldså and Krabbe (1990) associate the birds with the tropical and lower subtropical zones in the Andes. Winter distribution is believed to be confined to 500-1500 m elevations in these forests (Robbins et al. 1992a). DeGraaf and Rappole (1995) agree with this view, giving the winter elevation range as 620-1300 m (2000-4300 ft).

Jones and Robertson (1997) note that the birds in Merida and Balinas states, Venezuela, associate with shade-coffee plantations and second-growth forest. Brief reconnaissance (Hamel and W. P. Smith, unpubl. obs., 1992) of habitats in which the species is routinely seen at the Cascada de San Rafael, on Rio Quijos, Prov. Oriente, Ecuador, indicates that considerable variation in canopy structure occurs at the site. It remains to be determined whether architecture of forest canopies in wintering areas is similar to, or differs from, that in breeding areas.

Cerulean warblers usually occur in mixed-species flocks of canopy-dwelling species, primarily tanagers. Winter habitat for the species thus consists not only of geographical, elevational, and vegetational structure components, but may include specific avifaunal components as well. Little information has been published on occurrence of cerulean warblers with mixed-species flocks of tanagers (but see Robbins et al. 1992a). The ongoing work of Jones and Robertson (1997) indicates that more than 90% of cerulean warblers associate with mixed-species canopy flocks in Venezuela. Research on this topic will be important to determine whether the cerulean warbler is an obligate flock follower in the nonbreeding season. Such research will also permit collaboration between North American investigators interested primarily in cerulean warblers and South American investigators interested primarily in the flock-forming species whose conservation may be essential to the conservation of the cerulean warbler.

6.2.2. Migration Stopover Habitats

Migration stopover habitats have not been identified. Concentration areas occur where strong vertical elevational relief rises abruptly from more gentle topography, as at Kennesaw Mountain, Georgia, Sharp's Ridge, Tennessee, and the highlands of Belize. Observers of the birds in migration note that they use tree canopies on migration as they do in both breeding and winter seasons.

Virtually nothing is known of the stopover ecology of cerulean warblers, other than the work of Parker (1994) in Belize, Beaton (pers. comm.) in Georgia, and the brief notes of James (1956) and Wiedenfeld and Wiedenfeld (1995). The works by James (1956) and Wiedenfeld and Wiedenfeld (1995) indicate clearly the difficulty that migrants of this and other species face during overwater flights across the Gulf of Mexico. Unless migrating individuals are adequately fat, adverse conditions may exhaust their fat reserves, resulting in increased chances of predation or death by drowning. Among six individuals examined by Wiedenfeld and Wiedenfeld (1995), prepared by the same individual (Donna L. Dittmann), and placed in the collections of the Louisiana State University Museum of Natural Science, six were males listed as having "heavy fat;" the

lone female had "moderate fat." This group of birds makes clear that migrants may carry much greater fat loads than are necessary to make the overwater crossing; these birds also make clear that adverse weather may kill large numbers of birds that are otherwise well-prepared for the journey.

Kopman (1907) compared migratory avifaunas of the deciduous forests of the Mississippi River delta of southeastern Louisiana with the adjacent uplands of the Coastal Plain, dominated primarily by longleaf pine (*Pinus palustris*). In this area, he noted that cerulean warblers migrated in greater numbers through the Coastal Plain than the delta, where they use broad-leaved trees.

During migration, particularly in South America, habitats for the species are poorly known and described. Chapman (1917) collected two specimens at 1370 m (4500 ft) on steep, heavily wooded slopes of a *posada* at the eastern edge of the Colombian llanos.

Fjeldså and Krabbe (1990) associate the birds with the tropical and lower subtropical zones, noting that during migration, the birds rarely occur also in the lower temperate zone in the Andes.

7. POPULATION TRENDS AND ESTIMATES

Historical data on the occurrence and abundance of the species are sketchy. However, it is clear from accounts such as those of Audubon (1856), Brewster (1875), Ridgway (1889), and Widmann (1907), that the cerulean warbler was a conspicuous and abundant species throughout the Ohio and Mississippi River valleys in the past century. Coues (1878), in summarizing knowledge of the distribution of the species to that time, noted that the birds' main area of distribution was the Mississippi Valley, broadly defined, "where only is it at all abundant." He notes that others found it breeding in abundance in the Indian Territory [presumably eastern Oklahoma] and common at Fort Leavenworth, Kansas. Currently the birds are much less numerous; they are absent from some areas where formerly they were abundant.

7.1. North American Breeding Bird Survey

The Breeding Bird Survey (BBS) is a cooperative volunteer program of the Canadian Wildlife Service and the Biological Resources Division of the U.S. Geological Survey. The survey consists of a number of randomly located routes on which volunteer observers count birds during a morning in the breeding season, usually in June. A route is a set of 50, 3-min counts of all birds heard or seen from predetermined stopping locations 0.8 km (0.5 mi) apart along a moderately traveled road. In this status assessment, the terms relative abundance, trend, and N will appear numerous times. Relative abundance, R. A., is the mean number of birds recorded per route. It is thus the number of birds/50 stops, and may reflect the annual mean for routes within a

physiographic area or state. Trend is the calculation of mean annual percentage change in numbers of birds per route over a certain time period. N is the number of routes on which a particular relative abundance or trend estimate is based. Calculation of trend is based upon the BBS statistical protocol, termed the route-regression method (Geissler and Noon 1981, Geissler 1984, Geissler and Sauer 1990, Sauer and Droege 1992). The BBS protocol permits estimation of standard error of trend, as well as the probability of observing a trend of a given magnitude. Where this probability is less than 0.05, the trend is usually termed "significant."

Breeding Bird Survey estimates for population trend for this species were calculated by the BBS office for the entire survey period, 1966-1998. For comparative purposes, trends have been calculated separately for the first 15 years of the BBS, 1966-1979, and the second half of the survey period, 1980-1998. Information on each of these periods is presented here (Tables 8, 9), so the reader can compare the trends between the separate parts of the survey period. Population trend estimates are significantly downward for the period 1966-1998 (Table 8). Sample size of routes on which the trends were based is large enough for confident interpretation of trends for the continent (U.S. and Canada) for all three periods of estimate, for the entire US for all three periods, as well as for the eastern U.S. for 1966-1998 and 1980-1998. Unfortunately, for the eastern U.S. for 1966-1979, the sample size of 101 routes is close to the 100-route minimum suggested by the BBS office (Bruce Peterjohn letter, 24 Jan 1995). Sauer (1993) indicated that, while sufficient sampling intensity in the BBS existed to detect a 50% decline in population of the species over a 25-year period with probability 0.9, low relative abundance of this species mandated caution in interpretation of trend results.

In the following section BBS trend data are summarized and projected in some detail. Before discussing the information, it is important to review the methodological and logistical limitations of the data set, so that some perspective on the BBS data can be brought to their interpretation (Bruce Peterjohn, pers. comm. 9 Sept. 1996). Summaries of BBS numbers reflect all routes in the relevant state or physiographic region (Figure 2, Table 10), not simply routes on which cerulean warblers have been recorded. The adequacy of the BBS as a method to monitor forest birds such as cerulean warblers has been questioned. Concerns focus on changes in habitats along roadside routes, which would reduce detectability of the birds potentially more than their numbers, and the fact that because BBS routes are along roadsides to begin with, BBS coverage may be biased against forest birds like cerulean warblers. Unfortunately, initial placement of routes in some states, including Kentucky, Ohio, Pennsylvania, and West Virginia, was along relatively more highly developed state highways than desirable (Bruce Peterjohn, pers. comm. 9 Sept. 1996). These are states with relatively numerous populations of cerulean warblers. Readers can bear these methodological concerns in mind.

Additional logistical concerns about the BBS make interpretation of some of the results more tentative as well (Bruce Peterjohn, pers. comm. 9 Sept. 1996). These concerns

result from the nature of the BBS as a volunteer program. BBS routes in eastern Kentucky and West Virginia, particularly in the more remote parts of those states where cerulean warblers are numerous, were not uniformly covered throughout the period of the BBS, and hence trend calculations cannot utilize effectively the data from some of these routes. The net effect of these differences in coverage is to introduce an unknown amount of uncertainty into the BBS trend estimates, particularly in some of the areas central to the range.

Some biologists believe that an additional problem with BBS data on cerulean warblers is the potential for unfamiliarity with the song of this species among BBS observers (K. G. Smith, pers. comm., 18 Oct. 1996; J. W. Davis, pers. comm., 10 Sept. 1996).

BBS estimates of trend for the continent, the U.S. as a whole, and the Eastern U.S. are based upon samples of similar size and, as each covers virtually the same area, they will be treated as a unit. The BBS estimate of the average annual trend 1966-1998 -3.6%/yr, is based on 246 routes. Trend for 1966-1979 (-4.4%/yr, n=110) indicates a significant decline over the first half of the survey period. The nonsignificant trend for the second half of the period, 1980-1998 (-0.7%/yr, n=201) suggests a stable population over the second half of the survey period. These trend estimates suggest that the population declined most dramatically prior to 1980. Whether this represents the primary period of decline, or perhaps indicates that populations were reduced to the point by 1980 that the BBS became a less useful monitoring tool rangewide, is not clear. [See earlier concerns of Peterjohn (pers. comm. 9 Sept. 1996) concerning logistical limitations of BBS coverage.] Certainly, in some parts of the range where formerly the birds were very numerous, such as the Mississippi Alluvial Valley, BBS trend estimates can no longer be calculated with any statistical confidence (Smith et al. 1996). Trend estimates in other areas, particularly the Northeast, may not reflect adequately the apparently increasing populations there. Mean relative abundance for the continent was 0.45 birds/route over the entire survey period.

Whenever BBS trend estimates can confidently be calculated, they show declining populations. Even trend estimates that are not significantly different from zero are negative, with the exception of the Ridge and Valley physiographic strata. BBS estimates for individual states and physiographic strata are presented within the assessment of status for the individual states.

An appropriate way to examine trends and other information from the BBS is to view the data for different physiographic regions, or strata as they are called in the BBS (Figure 2). Sufficient data to estimate annual trends from the BBS are available for five physiographic strata. Relative abundance information for the species indicates a range of more than an order of magnitude among estimates within the strata (from 0.24 birds/route in the Allegheny Plateau of Pennsylvania and New York to 4.14 birds/route in the Ohio Hills stratum of West Virginia and southeastern Ohio). These five strata lie adjacent to each other in the upper reaches of the Ohio River system and adjacent glaciated areas of the drainages of the lower Great Lakes. In short they represent the

upstream core of the range of the species. Four of the five strata show significant downward trends for the species 1966-1998, from -1.9%/yr (Ohio Hills, n=62, P<0.05) to -5.1%/yr (Highland Rim, n=26, P<0.05). Only the Ridge and Valley stratum (1.5%/yr, n=30, P>0.10), with a relative abundance of 0.78 birds/route, shows any indication of a non-decreasing trend.

Villard and Maurer (1996) conducted a separate geostatistical analysis of BBS data to assess changes in cerulean warbler numbers over the period of the BBS. Their analysis was not based on the physiographic strata, but on the entire range of the birds. Nevertheless, an important conclusion of their analysis was "spatial pattern of variation in Cerulean Warbler abundance thus appears to be characterized by declines concentrated in the areas of high abundance within the breeding range."

Using the trend estimates presented in Table 8, projections of the current population of cerulean warblers have been calculated as a proportion of 1966 population. These values, expressed as projections of the estimated trends to the entire BBS period, are presented in Table 11. Current rangewide breeding populations are projected to be 31% or 49% of those present in 1966. Projections of current populations within subregions of the range vary from 8% (Indiana) to 161% (Ridge and Valley strata) of initial numbers. Projections based upon separate trend determinations for the two parts of the survey agree closely for most of the subregions estimated. In 13 of 18 cases, projections based upon the separate trends for 1966-1979 and 1980-1998 lie within the range of the projections for the 95% confidence limits of the 1966-1998 trend estimate. In the Eastern U.S., the composite projection is 3% higher than the value projected from the upper 95% confidence limit of the 1966-1998 trend estimate; this is little different from the first 13 cases. In West Virginia, the Cumberland Plateau, and FWS Region 5, the two population projections disagree. The 1998 populations for these areas were projected to be between 30% and 47% of 1966 populations, based upon 1966-1998 trends. Projections based upon composite of 1966-1979 and 1980-1998 trends, however, indicate 70% of the 1966 population in the Cumberland Plateau, and an increase to at least 120% of 1966 population in West Virginia and FWS Region 5. Thus, it is possible, based upon the BBS, that a population of cerulean warblers in one part of the range may have maintained itself over the survey period.

Interpretation of BBS trend information has come under some controversy in the past few years, with alternative estimation procedures offered as potentially superior to the standard techniques used by the BBS office (Peterjohn et al. 1995). In particular James et al. (1996) presented alternative approaches. Irrespective of differences in techniques and philosophies represented by the different approaches, cerulean warbler populations are estimated by each of the competing techniques to have declined substantially over the period of BBS sampling. The agreement between these competing approaches to analysis lends even greater support to an interpretation of the BBS data that indicates that cerulean warbler populations have indeed declined, and that these declines are a reasonable cause for concern and conservation action, as Robbins et al. (1992a) have urged.

These trends are cause for concern. The portion of the species range within which BBS trends can be estimated is less than half of the entire breeding range of the species. The numbers of survey routes recording cerulean warblers within the rest of the range are too low to estimate trends. Within the restricted portion of the range in which trends can be estimated, populations have plummeted during the period sampled by the BBS. These numbers led to the concern expressed by Robbins et al. (1992a) for the future of the species.

7.1.1. Physiographic Area Summaries

BBS trend estimates could be calculated with adequate sample sizes for several physiographic areas. The numbers reflecting the actual trends are in Table 8. A brief summary of these findings is presented here. The areas for which trend estimates could be calculated with confidence might usefully be considered the important parts of the birds' breeding range. They are:

1. Ridge and Valley, BBS Stratum 13, where the relative abundance estimate is 0.78 birds/route over the entire survey period. The trend for this area is apparently stable over the BBS period.

2. Highland Rim, BBS Stratum 14, where the relative abundance estimate is only 0.43 birds/route. The trend for early part of the BBS period was a steep decline; that for the latter part was stable. Perhaps the numbers in this area declined to the point where BBS can no longer adequately monitor them.

3. Cumberland Plateau, BBS Stratum 21, where the relative abundance estimate is 3.22 birds/route, a large value. Trend information is conflicting, as that for the entire BBS period is significantly declining, while trends for portions of the period do not differ from zero. A more specific monitoring design may be required to assess the status of the species in this important physiographic area.

4. Ohio Hills, BBS Stratum 22, where the relative abundance estimate of 4.14 birds/route is the highest for any physiographic area, is perhaps the most important physiographic area in the birds' range. Here the trend over the entire BBS period is a significant decline, principally during the first part of the BBS period, with a stable trend since 1980. Here again, interpretation of the trends is problematical, as it is not certain whether the population stabilized at a level lower than at the beginning of the BBS period, or that the BBS is no longer adequate to measure trend in this species in this physiographic area.

5. Allegheny Plateau, BBS Stratum 24, has a low relative abundance estimate of 0.24 birds/route over the entire survey period. This low relative abundance may be inadequate for measuring trends in this area as estimates are not significantly different from zero for any of the periods. The non-significant

trends suggest a decline over the entire period, but the trend before 1980 is declining, while that since 1980 suggests a stable or increasing population.

While trends cannot confidently be estimated from BBS data for other strata (Table 9), relative abundance information is a useful indicator of occurrence of cerulean warblers in other strata. Relative abundance data, expressed as average number of birds/route, are available for ten other physiographic strata. These are Upper Atlantic Coastal Plain (BBS stratum 4, 0.13 birds/route), Northern Piedmont (BBS stratum 10, 0.14 birds/route), Southern Piedmont (BBS stratum 11, 0.02 birds/route), Southern New England (BBS stratum 12, 0.01 birds/route), Lexington Plain (BBS stratum 15, 0.18 birds/route), Great Lakes Plain (BBS stratum 16, 0.10 birds/route), Wisconsin Driftless Plain (BBS stratum 17, 0.02 birds/route), Ozark-Ouachita Plateau (BBS stratum 19, 0.06 birds/route), Great Lakes Transition (BBS stratum 20, 0.08 birds/route), and the Till Plains (BBS stratum 31, 0.02 birds/route). Two physiographic areas are not included in the tabulations of the BBS data set because the numbers of birds recorded there are too low to include, yet the areas are of importance to the range of cerulean warblers. First, the Mississippi Alluvial Valley (BBS stratum 5) was formerly one of the most populous parts of the range of the species. Second, the St. Lawrence Plain (BBS stratum 18) presently supports a small population of the species, which is reproducing at well-above replacement levels (Oliarnyk and Robertson 1996).

7.2. Breeding Bird Census

Although not designed to determine rangewide population trends or estimate the relative abundance of the species across the entire range, the Breeding Bird Census (BBC) is instructive of population density. This program, coordinated by the Cornell Lab of Ornithology in cooperation with the Association of Field Ornithologists, provides a mechanism for spot-map census work to be summarized. A BBC is a plot study in which maps of locations of singing, and presumed territorial, males are summarized into numbers of territories believed to be on the plot. Numbers of territories divided by area of the plot form the estimate of breeding density that is reported. Specific protocols for BBC work are outlined in Anonymous (1970) and James and Shugart (1970).

Cerulean warblers have been recorded on 332 BBCs (J. Lowe, Cornell Lab of Ornithology, pers. comm., 14 August 1996; B. Hoover, National Biological Service, 10 Feb 1995, pers. comm.). These censuses represent studies of 133 plots in 15 states and provinces. Studies of individual plots continued from 1 to 49 years between 1932 and 1993. Mean density does not differ significantly by state in the initial analysis of these data, in which average values for individual plots were used. Mean recorded density was 43 pairs (± 42 pairs std. dev.)/100 ha (/250 acres). Hamel (1992) reported a mean density of 24.2 ± 3.5 pairs/100 ha (/250 acres) from a more restricted data set. These numbers are much lower than the maximal densities reported by Robbins et al. (1992a) from individual years on individual plots. They reported maximal densities of 82-290 pairs/100 ha (/250 acres) from 11 different BBC plots, eight in West Virginia and

one each in Indiana, Michigan, and Ohio. These BBCs were conducted between 1949 and 1971, and most of them were conducted on upland sites.

When consideration of the data is confined to those 14 plots each censused at least 5 times, representing 141 censuses from 5 states, no changes from year to year are found in analysis of variance after the effect of plot is removed (Figure 3). Significant differences exist in density among the plots, however, in this analysis ($F_{,14,126\ d.f.}$ = 13.19, P=0.0001, R^2 = 0.59). One Ohio plot was censused 47 times between 1940-1991. When these censuses were grouped into 10-year periods, analysis of variance revealed significant differences in density among decades ($F_{,5,41\ d.f.}$ = 8.88, P=0.0001, R^2 = 0.52). These differences indicate that density on that plot was lowest in the 1940's and highest in the 1960's.

7.3. Breeding Bird Atlases

Breeding Bird Atlas (BBA) projects are area searches in which observers attempt to gather evidence that proves breeding by bird species within specific mapped areas. These areas, or atlas "blocks," are usually areas of 5x5 km (3.1x3.1 mi), or 1/6 of a USGS standard topographic map. As birds are observed during the breeding season, each species located is given a code that indicates the most clear evidence of breeding that was observed. These codes usually fall within one of three or four categories, indicating whether it was Possible that the species bred within the block, Probable that the species bred within the block, or that breeding was Confirmed within the block. Atlas data are usually presented in terms of the numbers and percentages of blocks in states or particular physiographic divisions of the states, in which the species was found. In the following sections, Atlas data are presented as a part of the account for each political division in the species range.

A project has been initiated during the 1997 breeding season to attempt to identify all known breeding sites for the species in the northeastern states (Fish and Wildlife Service Region 5: CT, DE, ME, MD, MA, NH, NY, PA, RI, VT, VA, WV). After establishment, the project has been extended to attempt to identify the locations at which the birds breed throughout their range. Protocols (Barker and Rosenberg 1997) are available from the Cerulean Warbler Atlas Project, Cornell Laboratory of Ornithology (159 Sapsucker Woods Road, Ithaca, NY 14850; Phone: 607/254-2446; E-mail: forest_birds@cornell.edu).

7.4. Geographical Area Summaries

In order to facilitate comparison of the different political divisions in which cerulean warbler occurs, a standard set of 8 topics is covered in each of the following accounts. The topics are **Summary, BBS, BBA, Research/monitoring, Major Populations, State[Provincial] Status, Natural Heritage Rank,** and **Habitat Condition**. Where no information on a particular category was discovered during this project, that category is omitted from the account.

7.4.1. Central and South America

Little information on population trends in the countries of the non-breeding range exists. Please see accounts in the section on **RANGE** (p. 2).

7.4.2. Canada

Nova Scotia

Summary: Cerulean warblers have been observed on islands off Nova Scotia during migration (McLaren 1981).

Ontario

Summary: A regular migrant and breeding species in small numbers on the northern edge of the species' range.
BBS: No confident estimate of trend is available from the BBS.
BBA: Cadman et al. (1987) list the species as uncommon, noting that 80% of abundance estimates indicated fewer than 11 pairs/atlas square (= atlas blocks). Cerulean warblers were found on 16% of 137 10x10 km atlas squares province-wide, although they were only on 108 (6%) of 1824 5x5 km (3.1x3.1 mi) squares in southern Ontario (Cadman et al. 1987).
Research/monitoring: Biologists at Queen's University in Kingston, Ontario, are conducting a cerulean warbler monitoring project of areas in Eastern Ontario studied by Oliarnyk (1996; Oliarnyk and Robertson 1996). Raleigh Robertson is the coordinator of the project.
Provincial Status: Listed as Vulnerable by the Committee on Status of Species at Risk in Ontario (COSSARO), a committee of the Ontario Ministry of Natural Resources (Don Sutherland, Zoologist, Natural Heritage Information Center, Peterborough, Ontario, pers. comm., 6 April 1998). Listed as Rare by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; cf. Austen et al. 1995; a group intended to raise awareness of issues of wildlife conservation; C. Oliarnyk, pers. comm., 11 September 1996). See Table 12.
Natural Heritage Rank: Tracked by the Ontario Natural Heritage program. See Table 12.

Quebec

Summary: Information on the birds in Quebec comes from Ouellet (1966, 1967, 1974) who summarized records for the province. The birds first were detected in the province in 1950 (Pierre Aquin, Biologiste, Direction de la faune et des habitats, Ministère de l'Environnement et de la Faune, Gouvernement du Québec, pers. comm., 25 September 1996). Additional information on the birds in Quebec is provided by Cyr and Larivée (1995) and Gauthier and Aubry (1995).
BBA: The species was observed in 6 blocks of the Quebec Breeding Bird Atlas, and confirmed as a breeder in 3 of those (Pierre Aquin, Biologiste, Direction de la faune et

des habitats, Ministère de l'Environnement et de la Faune, Gouvernement du Québec, pers. comm., 25 September 1996).
Research/monitoring: The first confirmed nest was found in 1989 (Pierre Aquin, Biologiste, Direction de la faune et des habitats, Ministère de l'Environnement et de la Faune, Gouvernement du Québec, pers. comm., 30 August 1996). Current population is estimated at a few tens of pairs.
Cerulean warblers showed no significant population trend in the checklist survey of Cyr and Larivée (1993), which was due to inadequate sample size of checklists for consideration.
Major Populations: Primary locations for the birds are in the Monteregian Hills near Montreal, and all in southern Quebec.
Provincial Status: The species has no formal legal protection in Quebec. However, the Ministère de l'Environnement et de la Faune, Gouvernement du Québec, has determined that the species is "Susceptible of Designation as Threatened or Vulnerable (SDMV), " pending further evaluation (Pierre Aquin, Biologiste, Direction de la faune et des habitats, Ministère de l'Environnement et de la Faune, Gouvernement du Québec, pers. comm., 30 August 1996).
Natural Heritage Rank: See Table 12. The species is tracked by the Quebec Natural Heritage program, which currently has 10 records in its data base.
Habitat Condition: Ouellet (1966, 1967, 1974) noted that the birds use the upper parts of the tallest trees in mature stands of sugar maple, northern red oak, and American beech on rather damp sites. The birds did not occur on areas that had been logged. He collected two males, mean mass 10.3 g, with little fat.

7.4.3. United States

U. S. Fish and Wildlife Service Region 1

Identified as a regular migrant in California and an irregular migrant in Nevada by the West Working Group, Partners in Flight (Carter and Barker 1993). Austin (1971) listed two October records for southern California.

Nevada

State Status: No special protection other than that accorded all migratory birds listed under the Nevada Wildlife Laws by the Nevada Department of Wildlife.
Natural Heritage Rank: See Table 12.

U. S. Fish and Wildlife Service Region 2

Identified as an irregular migrant in Arizona and New Mexico by the West Working Group, Partners in Flight (Carter and Barker 1993). No confident trend estimate is available from the BBS.

Oklahoma

Summary: Sutton (1967) considered this species a transient and summer resident in eastern Oklahoma. Baumgartner and Baumgartner (1992) list the birds as local and rare summer residents.
BBS: No confident trend estimate is available from the BBS.
Research/monitoring: The species is very rare in the state, but has shown no change in status.
Major Populations: Currently found in four counties in the Ouachita and Ozark Mountains in eastern Oklahoma, where the species is associated with bottomland hardwood forests (M. Howery, Oklahoma Dept. of Wildlife Conservation, 12 August 1996, personal communication).
State Status: Cerulean warblers have no official legal status in Oklahoma.
Natural Heritage Rank: See Table 12. Tracked by the Oklahoma Natural Heritage Program.
Habitat Condition: Carter (1967) studied the birds in three plant communities near Bethel in southeastern Oklahoma in 1961-1962. The old-growth bottomland forest there, later inundated by the Broken Bow Reservoir, supported 7.2 pairs/100 ha; the birds were not found in stream bottom or upland communities. On the Ouachita National Forest in LeFlore Co., the birds are found in upland hardwood forests at relatively high elevations, on north slopes in cove hardwood situations near the tops of ridges. Greater numbers of individuals apparently occur in upland than in riparian forests there (Jerry W. Davis, Larry Hedrick, pers. comm., Sept. 1996).

Texas

Summary: Migrant through the state, primarily in the eastern part.
BBS: No BBS information is available.
Research/monitoring: Forsyth and James (1971) tallied an average of 0.05 birds/census on 207 spring censuses of three 8 ha (20 acre) sites on the Texas Gulf Coast in the spring.
State Status: Cerulean warblers have no official legal status in Texas.
Natural Heritage Rank: See Table 12. Tracked by the Texas Natural Heritage Program.

U. S. Fish and Wildlife Service Region 3

Among 110 Neotropical migrants evaluated by Thompson et al. (1993), cerulean warbler ranked behind only Kirtland's warbler (*Dendroica kirtlandii*) and Bachman's warbler (*Vermivora bachmanii*) as the third highest rated species of management concern in the Midwest. Rosenberg and Wells (1995) estimate that 19% of the species population breeds in the Midwest.

BBS trend estimate 1966-1998 is -4.6%/yr, $P<0.01$, based on 76 routes. Trend for 1966-1979 (-9.3%/yr, n=28, $P<0.01$) and that for 1980-1998 (-3.7%/yr, n=67, $P<0.10$)

both indicate significant declines as well. Relative abundance estimate of 0.35 birds/route over the entire survey period is the lowest for a FWS region for which an estimate could be calculated.

Illinois

Summary: Ridgway (1889) listed cerulean warbler as the most abundant wood warbler in Illinois. Graber et al. (1983) point out that earlier observers had noted this to be the most abundant breeding species in the lower Wabash River Valley, and more abundant than the northern parula. However, the species were found to be equally abundant in surveys conducted by Graber et al. (1983). Surely, as Graber et al. (1983) point out, huge areas of bottomland forest habitats, that supported substantial populations of both species before the turn of the century, were eradicated in the interim. The earlier work of Graber and Graber (1963) might be expected to clarify this issue. Unfortunately, the comparison study of Forbes, conducted in 1906-1909 by A. O. Gross, H. A. Ray, and S. F. Forbes did not sample forest habitats to the extent that Graber and Graber (1963) did, and quantitative comparison of cerulean warbler numbers are not possible.
BBS: No confident trend estimate is available from the BBS; mean relative abundance is 0.01 birds/route.
BBA: Cerulean warblers were recorded on 89 of 1287 Breeding Bird Atlas blocks in Illinois 1985-1991 (Illinois Dept. of Natural Resources, unpubl. data; Sue Lauzon, Executive Director, Illinois Endangered Species Protection Board, pers. comm., 21 October 1996). Of the 89 blocks, the birds were confirmed breeders on 11, probable breeders on 33, possible breeders on 41, and observed in inappropriate habitat on 4 blocks.
Research/monitoring: Graber et al. (1983) summarize extensive surveys made 1967-1970, which indicate that in Illinois the birds have historically and continue to be more common in the southern part of the state than farther north, that they occur in bottomland forests more frequently and more extensively than in upland forests, and at higher densities (mean of 1.2 birds/40.5 ha [/100 acres] in upland forest vs. 4.1 in bottomland forest statewide).

Brodkorb (1927) noted a female and a juvenile from Kouts, near Chicago, 29 June 1895. Stine (1959) repeated work done by Ridgway 1908-1915 on a 7 ha (18 acre) woodlot on a 40 ha (100 acre) farm near Olney in Richland Co. Cerulean warblers had bred on the farm in the earlier period, but were no longer breeders in the 1950's.

Cerulean warblers were observed during a 1993 survey at Midewin National Tallgrass Prairie, near Chicago, in 1993, and in Cook County during Cook County Nesting Bird Census 1995 (Amelia Orton-Palmer, U.S. Fish and Wildlife Service, 30 July 1996, pers. comm.). Mlodinow (1984) notes the birds were locally common in the southern Chicago area and locally fairly common in the northern Chicago area. Favored nesting localities in the Chicago area are reported to be along the Des Plaines and Kankakee Rivers in Illinois, and the Galien River nearby in Michigan; as well as in the Indiana Dunes National Lakeshore nearby in Indiana (Mlodinow 1984).

An intensive study of the birds in the southern part of Illinois was conducted by Vanderah and Robinson (1995) who found the birds in bottomland and upland habitats. Knutson et al. (1996) report 0.47 cerulean warblers per 10, 70-m (230-ft) radius, 6-min point counts in bottomland habitats on the Cache River vs 0.21 birds in upland habitats at Trail of Tears State Forest.
State Status: None.
Natural Heritage Rank: See Table 12. Tracked informally by the Illinois Natural Heritage Program.

Indiana

Summary: Regular breeder and migrant through the state. Butler (1898) considered the species a common migrant and summer resident.
BBS: BBS trend estimate 1966-1998 is -7.7%/yr, $P<0.01$, based on 14 sample points. The trend for 1966-1979 (-9.1%/yr) was non-significant, but it showed a significant decline for 1980-1998 (-8.8%/yr, $P<0.05$). Relative abundance estimate of 0.29 birds/route over the entire survey period is lowest for any state for which an estimate could be calculated.
BBA: Recorded on 647 atlas blocks statewide, 21% of the total, throughout the state. Bruner (1998) indicates that this was a moderate number of blocks, and that occurrences were much more numerous in the southeastern and south-central portions of the state.
Research/monitoring: Castrale et al. (1987) pioneered a technique for surveying for these birds along river corridors.
State Status: Listed by the Indiana Department of Natural Resources as a species of Special Concern, a designation that offers no specific added protection to a species, but which does indicate a need for funding and research attention (John Castrale, letter, 22 July 1996).
Natural Heritage Rank: See Table 12. Tracked by the Indiana Natural Heritage Program.

Iowa

Summary: Regular; uncommon migrant that breeds locally in southern and eastern Iowa (Dinsmore et al. 1984). Kent and Dinsmore (1996) consider the bird a "rare summer resident." This status is similar to that reported in the last and early in the present century (Cecil 1996).
BBS: No confident trend estimate is available from the BBS. Cerulean warbler has been reported from only a single BBS route in the state (Cecil 1996).
BBA: Found on 44 atlas blocks (6%) in 28 counties in the state, primarily in priority blocks selected for their large proportions of forest land. Reports were concentrated in the eastern quarter of Iowa, with additional observations in the floodplain of the Des Moines River farther west. (Cecil 1996)
State Status: None.
Natural Heritage Rank: See Table 12.

Michigan

Summary: Regular migrant that breeds in the state (Adams in Granlund et al. 1994).
BBS: No confident trend estimate is available from the BBS; mean relative abundance is 0.13 birds/route. Found on 4 of 72 BBS routes surveyed in Michigan 1983-1988 (Adams in Granlund et al. 1994).
BBA: Breeding was confirmed in 16 townships of 155 where located 1983-1988. Occurrence in 1% of Upper Peninsula and Northern Lower Peninsula townships, 20.5% of Southern Lower Peninsula townships; aggregate of 8.2% of 1896 townships statewide (Adams in Granlund et al. 1994). All observations, save one, were made in "mature forest": 13 in wet, 6 in mesic, 1 in dry forest; only one was not in purely deciduous forest, that in "mixed mesic forest."
Research/monitoring: Adams (Granlund et al. 1994) reports surveys of 8 km of Galien River in Berrien Co., 1988-1989, which revealed 1.6-2.1 territories/km.
State Status: Listed as a species of Special Concern by the Michigan Department of Natural Resources 11 Nov. 1991 (John Legge, Michigan Dept. Nat. Resources, 13 Aug 1996, pers. comm.).
Natural Heritage Rank: See Table 12. Tracked by the Michigan Natural Heritage Program. Heritage has nine records, from Alger, Kalamazoo, Calhoun, Washtenaw, Jackson, Livingston, and Oakland counties. Records in Heritage data base do not reflect the full range of occurrence of species in state.

Minnesota

Summary: Migrant that breeds in the state (Janssen 1987).
BBS: No confident trend estimate is available from the BBS.
Research/monitoring: Knutson et al. (1996) report 0.26 cerulean warblers per 10, 50-m (164-ft) radius, 10-min point counts in bottomland habitats vs 1.01 birds in upland habitats on the Upper Mississippi River in Minnesota and Wisconsin. "Since 1988, the Minnesota County Biological Survey (MCBS) has surveyed 22 counties within the range of Cerulean Warbler. As a result of this effort, singing males were observed at 103 'locations' (or element occurrences) which can be grouped into 42 'local populations.' These consist of 8 local populations in floodplain forest and 34 local populations in upland forest. Seven of the 8 largest local populations were in upland forest." (Steve Stucker and Richard Baker, Minnesota County Biological Survey, pers. comm. to Steve Lewis, 27 March 1998).
State Status: Listed as a species of Special Concern by the Minnesota Department of Natural Resources.
Natural Heritage Rank: See Table 12. Tracked by the Minnesota Department of Natural Resources' Natural Heritage data base.
Habitat Condition: Warner (1950) described the habitat of the species in remnant forests along the south branch of the Root River, Fillmore County, MN: "In the forest above the river where the valley sides break away to upland a few old, white pines still stand. In that narrow strip and only near the pines I found the Cerulean Warbler a

locally common species. Males, as many as four at one time, sang early in the mornings between rains."

Missouri

Summary: Widmann (1907; p.225) listed this species as "a common summer resident in high trees of bottom land along water-courses in all parts of the state, but disappearing with the trees, not accepting the conditions imposed by civilization. It may be found in orchards and like places during migration, but for its nests it wants high trees near water, building far out on horizontal or drooping branches, much to the disgust of the egg collector. The species is especially numerous in the southeast, where it arrives as early as April 10, 1893. The magnificent forests in the flood plains of the Mississippi and Missouri Rivers afford homes for a large number of these diligent songsters." Robbins and Easterla (1991) consider the bird presently to be an uncommon summer resident in the Ozarks and Mississippi lowlands, rare in the Glaciated and Osage Plains regions of the state, and note that substantial declines have occurred, particularly in the Mississippi lowlands portion of the state. John Faaborg (pers. comm., 17 Sept 1996) indicated that the birds are sparsely distributed on upland study sites in the Missouri Ozarks.
BBS: No confident trend estimate is available from the BBS; mean relative abundance 0.04 birds/route.
BBA: Reported from 81 (7%) of 1,207 atlas blocks in Missouri (Jacobs and Wilson 1997). Most of the nine blocks where breeding was confirmed were associated with the Black, Current, and Jack's Fork rivers.
Research/monitoring: Surveys of baseline populations done by boat on Jack's Fork, Current, and Eleven Point Rivers in Natural Scenic Riverway in the Ozarks by M. Robbins (P. McKenzie, pers. comm. 18 July 1997), recorded 73 singing males in 31.5 river miles.
Major Populations: Some Missouri occurrences in uplands, but the major numbers are associated with riparian corridors and other areas near rivers, particularly the Current, Jack's Fork, and Eleven Point rivers in the Ozarks in southern Missouri.
State Status: Maintained on Watch List by Missouri Department of Conservation and Missouri Natural Heritage Program.
Natural Heritage Rank: See Table 12. Maintained on Watch List by Missouri Department of Conservation and Missouri Natural Heritage Program.
Habitat Condition: P. McKenzie (pers. comm. 18 July 1997) believes that habitat fragmentation is a major determinant of the distribution of this species in Missouri. In areas where the landscape is predominantly forested the birds are found, whereas in areas where river corridors are surrounded primarily by agricultural land, the birds are absent from otherwise apparently suitable habitat. McKenzie's opinion (pers. comm. 18 July 1997) is that the mechanism for this fragmentation effect is parasitism by brown-headed cowbirds.

Ohio

Summary: Occurrence in Ohio in the past was more widespread and in greater numbers than at present. Scott (1914) noted the birds as rare at Cambridge. Hicks (1935) [not seen, *fide* Peterjohn and Rice (1991)] noted the birds as common on the Allegheny Plateau where they were frequently the "most numerous woodland warbler." Brooks (1940) indicated that cerulean warbler was a species characteristic of the counties along the Ohio River. Peterjohn (1989) considers that the bird's fortune has improved in the southern and southeastern parts of the state as a result of maturation of woodlands there. The birds are now "fairly common to common summer residents in southern and eastern Ohio west to the glacial boundary" and are "fairly common residents" also in parts of southwestern Ohio.

BBS: BBS trend estimate 1966-1998 is -3.0%/yr, P<0.10, based on 40 routes. Trend for 1966-1979 (-9.4%/yr, n=17, P<0.01) was steep decline, while that for 1980-1998 (+1.9%/yr) was not statistically significant. Mean relative abundance estimate of 1.57 birds/route over the entire survey period is second highest for any state for which an estimate could be calculated. Earnst and Andres (1996) summarize Ohio BBS data in a different way than the BBS office. Their analyses indicate that the birds are more common in eastern Ohio (0.8 birds/route) than in western Ohio (0.1 birds/route, P<0.001). They indicate a relative abundance of 0.4 birds/route, on 28 routes. They question the utility of BBS routes for surveying the interior of large tracts of forest where cerulean warblers are more likely found, thus suggesting that the birds may be more numerous in Ohio than BBS data indicate. Their analyses indicate a trend of -0.1 ± 1.2%/yr (P=0.91) for 1966-1995. The approach of Earnst and Andres (1996) to trend analysis of BBS data would not be recommended by the BBS office (Bruce Peterjohn, pers. comm., 9 Sept. 1996).

BBA: Peterjohn and Rice (1991) relate the occurrence and abundance of cerulean warblers in Ohio to the occurrence and abundance of hardwood forests. The birds occurred on 51% of priority blocks statewide. They were very frequent in physiographic areas of the state with relatively large amounts of forest, e.g. 67-89% of blocks in the different portions of the Allegheny Plateau. In the heavily farmed Till and Lake Plain regions, they were encountered in only 21-24% of blocks.

State Status: Listed as a species of Special Interest in Ohio (Patrick M. Ruble, Ohio Department of Natural Resources, 29 July 1996, pers. comm.).

Natural Heritage Rank: See Table 12.

Habitat Condition: Beissinger and Osborne (1982) compared populations of birds in Hueston Woods, an old-growth mesic forest, with those in the town of Miami, Ohio. Cerulean warblers occurred at average density of 131 pairs/100 ha (/250 acres) in Hueston Woods, where brown-headed cowbirds were present; neither species was found on similar-sized plots in the town. Declines documented by Peterjohn and Rice (1991) include extirpation from areas cleared of forest as well as reductions in numbers in suitable habitats, where they are no longer the most common woodland warbler.

Wisconsin

Summary: Robbins (1991) listed the species as an uncommon migrant and summer resident in the southern and central portions of the state, and rare in the north. Flaspohler (1993) summarized the status of the species in Wisconsin. First recorded in 1872, the birds were reported common or abundant in restricted localities during the first half of this century. Apparently the birds have extended their range into the state during this period. Ironically, geographic extensions in Wisconsin have occurred during the period of documented declines in population of the species rangewide. Flaspohler (1993) points out that it is unclear whether the expansion is due primarily to the birds or to the more effective work of observers searching for them. Flaspohler's (1993) report is a thorough plan for conservation of the species at the state level.
BBS: No confident trend estimate is available from the BBS; mean relative abundance 0.02 birds/route. Cerulean warblers were recorded on 16 of Wisconsin's 71 BBS routes between 1966-1991 (Flaspohler 1993). Robbins et al. (1996) further evaluate Wisconsin Breeding Bird Survey results, noting that of 38 BBS routes within the species' Wisconsin range, only 16 routes recorded the birds, only two routes recorded them in at least three years, and only 31 individuals were recorded on Wisconsin BBS routes during 1966-1991.
BBA: Field work for the Wisconsin Breeding Bird Atlas was conducted between 1995 and 1999. Breeding cerulean warblers were recorded as confirmed, probable, or possible in 3.8% of 3,084 blocks (5 km x 5 km each) surveyed throughout the state, with most birds being found in the southern half of the state in upland hardwood oak-hickory or maple-beech-birch forests (Jennifer Davis, 15 March 2000, pers. comm. to Stephen Lewis).
Research/monitoring: In areas where the birds have been studied, such as the Baraboo Hills in Sauk and Columbia Counties, declines in numbers have been recorded in the past 25 years, in spite of range increases and assumed maturation of habitats. Hinebaugh (1994) searched for breeding cerulean warblers in 15 localities near La Crosse, found the birds at five localities, and documented breeding at four spots in three of the localities. All breeding sites were in floodplain conditions, although one was in a relatively high spot next to the bluff of the Mississippi River.
State Status: Listed as Threatened by the Wisconsin Department of Natural Resources.
Natural Heritage Rank: See Table 12. Cerulean warblers are tracked by Wisconsin Natural Heritage Program.
Habitat Condition: Bond (1957) detected Wisconsin birds in a greater proportion of medium (16-32 ha; 40-80 acres) and large tracts (>32 ha; >80 acres) than in tracts of smaller size, and the birds occurred in smaller tracts in mesic habitats than in xeric habitats. Mike Mossman (pers. comm. 16 October 1996) observes that a paucity of early records from the state reflects limited numbers of observers or at least of observers knowledgeable of the species. He believes that substantial amounts of habitat were eliminated for a period of time by logging in the latter part of the past century. Apparent increases in 1910-1960's likely reflect increased observer effort and familiarity with the species, maturation of forest after harvest in the last century, fire

suppression which allowed forest to occupy former savannah, and increase of hardwood proportion in forests of central and northern Wisconsin resulting from selective harvest of pine. Mossman indicates that increases in Wisconsin are occurring in a small population, and that the birds have declined in some areas, e.g. within the Baraboo Hills, where formerly they were more abundant and where the habitat has matured, hence becoming potentially better for the species. His impression is that the birds may be more restricted to large forest tracts now than during 1930-1960. Concise statement of the birds' biology in Wisconsin is found in Mossman and Hoffman (1989): "Large trees. Large tracts. Prefers mesic sites." (p. 350), and "The cerulean warbler is more dependent on mature trees than is any other species of southern upland and lowland forests." (p. 351). Occurrence of the birds in the state is further illustrated by modest numbers in floodplain forests in the southern part of the state (Mossman 1988), where the birds routinely occur in stands at least 21 m (70 ft) tall, and in the Baraboo Hills (Mossman and Lange 1982) where the birds continue to be present, in numbers less than early in the century and fewer than in the mid-century work of Bond (1957).

U. S. Fish and Wildlife Service Region 4

Hunter et al. (1993) ranked Neotropical migrants in the Southeast according to criteria accepted by Partners in Flight. Among the 46 species treated in their work as worthy of conservation attention, cerulean warbler (with a concern score of 30) was the highest ranked species with a wide distribution across the physiographic areas of the Southeast. Rosenberg and Wells (1995) estimated that 51% of the species population breeds in the Southeast. Evans and Fisher (1997) reviewed the status of the cerulean warbler on military installations in the Southeastern U. S.

BBS trend estimate 1966-1998 is -5.7%/yr, $P<0.01$, based on 45 routes. Trend for 1966-1979 (-6.8%/yr, n=29) indicated steep decline during the period, while that for 1980-1998 (-0.8%/yr, n=30) was not statistically significant. Mean relative abundance estimate of 0.55 birds/route over the entire survey period is the median for a FWS region for which an estimate could be calculated.

Alabama

Summary: Howell (1924) identified the bird as a moderately common summer resident in the northern half of Alabama, with migration dates from 26 March 10 May in spring, and 8 August to 9 September in fall. Imhof (1976) considered the birds to be locally common summer residents, more numerous in the western part of the state.
BBS: No confident trend estimate is available from the BBS; relative abundance 0.07 birds/route.
State Status: See Table 12.
Natural Heritage Rank: See Table 12. Cerulean warblers are tracked by the Alabama Natural Heritage program.
Habitat Condition: Imhof (1976) indicated their habitats to be river and creek valleys and mountain coves. Howell (1924) noted the birds as "common [at Guntersville] in

heavy deciduous timber along Short Creek, but at the other localities [Erin, Monte Sano, Squaw Shoals, Tuscaloosa, Autaugaville] was rather rare."

Arkansas

Summary: Baerg (1951) noted the species was "probably a common summer resident in all heavy deciduous woodland." James and Neal (1986) list the species as a summer resident occurring in areas with extensive tracts of tall mature deciduous trees.
BBS: No confident trend estimate is available from the BBS; relative abundance 0.08 birds/route.
Research/monitoring: On the Ouachita National Forest, the birds occur in several situations. Monitoring of some small groups of the birds is on-going; in certain cases, the numbers of the birds have remained more or less constant over the past few years (Larry Hedrick, pers. comm., Sept. 1996). The birds occur in both upland and bottomland situations in that National Forest.
State Status: See Table 12.
Natural Heritage Rank: See Table 12.
Habitat Condition: Shugart and James (1973) located one bird on a 3 ha (7 acre) 100 yr old mesic oak forest plot in the Ozarks. James and Neal (1986) make no distinction between the birds' use of floodplain and upland areas. They cite Holder (1970) and Howell (1911), in indicating that the birds were widespread before the major deforestation events of the Mississippi Alluvial Valley and adjacent areas.

Howell (1911) wrote: "its distribution is apparently limited only by the occurrence of heavy deciduous woodland, for the bird is equally common in the river bottoms of the Mississippi and on the slopes of the mountains."

Seventy-five years later, Neal and Mlodinow (1988) noted the birds to be regular summer residents in small numbers in moist, mature forests with large trees in the western Ozarks. Li (1994) mentions that cerulean warblers are common in the Ozarks, but presents no quantitative data on these birds.

Florida

Summary: Stevenson and Anderson (1994) note the bird as an occasional to rare migrant most frequently recorded in NW Florida. The birds usually show up in Florida in spring when a strong front pushes them farther east than they otherwise would go. The occurrence in early fall is believed to be more common than in spring (Jim Cox, Florida Game and Fresh Water Fish Commission, pers. comm., 29 Aug 1996). Crawford (1978), in a small sample of individuals, reported a relatively equal age and sex ratio among TV tower casualties of this species in Tallahassee. Howell (1932) considered the species to be a rare spring and fall migrant, providing dates from 23 March to 29 April in the spring, and 15 July to 10 August in the fall.
State Status: Cerulean warblers are not listed on the Florida list of rare and endangered species (Wood 1994).

Natural Heritage Rank: See Table 12. Cerulean warblers are not tracked by the Florida Natural Heritage Program.

Georgia

Summary: Greene et al. (1945) listed these birds as scarce spring and fall migrants north of the fall line. Breeding is suspected in the Georgia Mountains where the birds are found throughout the breeding season on the Chattahoochee National Forest (Eddie Morris and Chuck Hunter, pers. comm.).
BBS: No confident trend estimate is available from the BBS.
Research/monitoring: An intensive spring and fall monitoring of these and other birds is carried out by volunteers at Kennesaw Mountain (Giff Beaton, pers. comm.).
Major Populations: Most notable information about cerulean warblers in Georgia comes from Kennesaw Mountain, in Cobb County NW of Atlanta, where the species is dependably recorded in some numbers in spring and fall migration (Giff Beaton and Chuck Hunter, pers. comm.).
State Status: See Table 12.
Natural Heritage Rank: See Table 12. Cerulean warblers are tracked by the Georgia Natural Heritage Program.
Habitat Condition: These birds continued to use the stands on the Chattahoochee National Forest subsequent to extensive wind damage from Hurricane Opal (Emily Jo Williams, Georgia Dept. of Natural Resources, pers. comm., 26 Sept. 1996).

Kentucky

Summary: Former occurrence in the state stands in stark contrast to the situation today. Blincoe (1925) compared occurrence of birds in Nelson County, including the Bardstown area, from 1885-1921. In 1885, Beckham (List of birds of Nelson County. Kentucky Geol. Surv. 1885; cited in Blincoe 1925) indicated that the cerulean warbler was "A common summer resident." By 1911-1921 the species was "Found only in a few localities" 24 April - 19 August. Blincoe noted that "such great changes, brought on by the advances of civilization, have come over the country ..." in the intervening years that "everywhere the big timber has been cut."

Mengel (1965) says "fairly common to common in western and central Kentucky, somewhat less numerous and more local eastward," "almost undoubtedly breeds in every county in the state," "quite numerous," "most common nesting bird," and "most numerous warbler" in different locations in the state. He also lists the species as "rare in the inner Bluegrass," "irregular and ... somewhat perplexing" in the Cumberland Plateau and Mountains, "rare and local" in the southern Cumberland Plateau. Nevertheless, Palmer-Ball (1996) now lists the species as "very locally distributed in summer over much of Kentucky" and "fairly widespread" only in the Cumberland Plateau and Mountains.
BBS: BBS trend estimate 1966-1998 is -6.2%/yr, $P>0.10$, based on 23 routes. Trend for 1966-1979 (-7.1%/yr, $n=14$, $P<0.05$) was declining, while that for 1980-1998 (-1.8%

/yr) was not significantly different from zero. Relative abundance estimate of 1.01 birds/route over the entire survey period is third highest for any state for which an estimate could be calculated. Please see earlier concerns of Peterjohn (pers. comm. 9 Sept. 1996) concerning logistical limitations of BBS coverage in Kentucky. Palmer-Ball (1996) believes the BBS does not adequately represent populations in the state.
BBA: Atlas results indicated a frequency of but 16% of priority blocks statewide, and barely 13% in the central and western parts of the state.
Major Populations: Palmer-Ball (1996) notes that the most substantial populations of these birds in Kentucky are located in the Cumberland Plateau and Mountains.
State Status: Cerulean warblers have no official legal status in Kentucky.
Natural Heritage Rank: See Table 12. Tracked by Kentucky Nature Preserves Commission.

Louisiana

Summary: Beckham (1887) found only a single individual, in the "top of a sycamore," in Bayou Sara. Oberholser (1938) believed that the birds bred in the state, noting it as "rare, locally fairly common, summer resident ... in northern, central, and southeastern Louisiana." He further believed the birds bred in the "heavy bottomland forest along the Tensas River on the Singer Preserve 13 miles southwest of Tallulah," near the present Tensas National Wildlife Refuge where a female with brood patch was mist-netted in 1993 (Dan Twedt, pers. comm.)

Remsen et al. (in prep.) consider the species to be an uncommon spring migrant and rare to very rare fall migrant, mainly near the coast. Earlier, Lowery (1974) had considered the birds to be "widespread and fairly common, occasionally abundant" in the spring, and "much more regular in occurrence in fall." Decline in numbers appears to be greater in fall than in spring.
BBS: No confident trend estimate is available from the BBS.
BBA: The single record of probable breeding in the state in Tensas NWR in 1993 (Bill Vermillion, Nongame Biologist, Louisiana Natural Heritage Program, pers. comm., 23 August 1996) is the only such record during the atlas period. No additional records of probable breeding were made during the Louisiana Breeding Bird Atlas field seasons 1994-1996, although some of these birds were present in East Carroll and Tensas Parishes in 1982 and 1983 (Bill Vermillion, Nongame Biologist, Louisiana Natural Heritage Program, pers. comm., 23 August 1996).
State Status: Louisiana Natural Heritage Program considers the species of Special Concern, a designation that carries no legal protection beyond that of the Migratory Bird Treaty Act of 1933.
Natural Heritage Rank: See Table 12. Tracked by the Louisiana Natural Heritage Program, which has a single record of probable breeding in the state in Tensas NWR in 1993 (Bill Vermillion, Nongame Biologist, Louisiana Natural Heritage Program, pers. comm., 23 August 1996).

Mississippi

Summary: Regular migrant and breeder in small numbers in the state, principally in the largest tracts of forest in the Mississippi Delta and the batture lands of the Mississippi River.
BBS: No confident trend estimate is available from the BBS.
State Status: See Table 12.
Natural Heritage Rank: See Table 12. Listed as a Species of Special Concern by the Mississippi Natural Heritage Program.

North Carolina

Summary: Pearson et al. (1942) considered the birds to be transients primarily, with a small number of breeding records. LeGrand (1979) summarized records of the birds in the state as a rare and local summer resident at the lower elevations in the mountains, and also along the Roanoke River in the coastal plain.
BBS: No confident trend estimate is available from the BBS.
Research/monitoring: Current distributional study of the birds in the southern Appalachians is being conducted by David Buehler and Chuck Nicholson (Chris McGrath, North Carolina Wildlife Resources Commission, pers. comm., 4 September 1996).
State Status: Cerulean warbler has no specific legal designation by the North Carolina Wildlife Resources Commission.
Natural Heritage Rank: See Table 12. Listed as Significantly Rare and tracked by the North Carolina Natural Heritage Program. The Heritage data base contains 35 records from 13 counties, 16 of which records have been verified in the past 10 years (Chris McGrath, North Carolina Wildlife Resources Commission, pers. comm., 4 September 1996). Populations along the Roanoke River are located in three counties, and the remaining occurrences identify populations in the mountains of western North Carolina.
Habitat Condition: LeGrand (1979) suggested that observers search for the birds in areas between 600-750 m (2000-2500 ft) on steep slopes with mature, somewhat open hardwoods. Lynch (1981) reported the birds in mature floodplain forest, where 28 of 33 birds he found were in a 60-km (37-mi) stretch of Roanoke River. This approximates 1.2 territories/km (0.8 territories/mi) of river.

South Carolina

Summary: Summer records exist from Caesar's Head State Park in the northwest part of the state during late May and early June in 1987, 1988, and 1995, but breeding has not been confirmed there (I. Pitts, SC Dept. of Parks, Recreation and Tourism, pers. comm., 15 August 1996).
State Status: Cerulean warblers have no official status in the state.
Natural Heritage Rank: See Table 12.

Habitat Condition: Habitat similar to the North Carolina site at Roanoke River exists in Congaree Swamp National Monument, Richland Co., but no birds have been found there.

Tennessee

Summary: Robinson (1990) lists the species as an uncommon migrant and summer resident that occurs in the state on a regular basis.
BBS: BBS trend estimate 1966-1998 is -4.8%/yr, P<0.05, based on 13 routes. Trend for 1966-1979 (-5.0%/yr, n=10, P<0.05) was a decline, while that for 1980-1998 (-0.6% /yr) was not significantly different from zero. Relative abundance estimate of 0.89 birds/route over the entire survey period is fourth highest for any state for which an estimate could be calculated.
BBA: Species was found on 14% of priority atlas blocks in the state (Ford and Hamel 1997). Located on 6% of miniroutes at average abundance of 2.1 stops/route. Only in Cumberland Mountains were the birds reasonably common, occurring on 62% of miniroutes, at average abundance of 3.8 stops/route. Atlas results from Tennessee graphically depict the reduction of the population of this species in the past century.
Research/monitoring: Tennessee Wildlife Resources Agency has contract with David Buehler of Univ. of Tennessee to develop habitat models of the species occurrence in the Cumberland Mountains of the state, as well as the Southern Blue Ridge. Chuck Nicholson of the Tennessee Valley Authority is working on the project as well (Robert M. Hatcher, Tennessee Wildlife Resources Agency, 12 August 1996, personal communication). In these investigations, the birds have been found on nearly 30% of point counts in the Cumberland Mountains, a frequency ranking third among species recorded (D. Buehler, University of Tennessee, pers. comm., 13 August 1996). A survey of the birds' occurrence is being conducted in middle Tennessee as part of the Interior Low Plateaus project of the Tennessee Wildlife Resources Agency in conjunction with Partners in Flight (M. Welton, pers. comm., June 1997).
Major Populations: A substantial population of these birds has been known for a number of years in the cove and upland hardwood forests of Frozen Head State Natural Area in Morgan County.
State Status: Species has no official status in the state.
Natural Heritage Rank: See Table 12. Cerulean warblers are tracked by the Tennessee Natural Heritage Program.

U. S. Fish and Wildlife Service Region 5

Smith et al. (1993) evaluated conservation concern for Neotropical migrants in the Northeast. With a score of 28 (out of 35) in the Partners in Flight prioritization scheme, cerulean warbler was tied with golden-winged warbler (*Vermivora chrysoptera*) as the species of highest concern in the Northeast.

BBS trend estimate 1966-1998 is -2.4%/yr, P<0.05, based on 122 routes. Trend for 1966-1979 (0.6%/yr, n=51) and that for 1980-1998 (0.6%/yr, n=103) were not statistically significant. Mean relative abundance estimate of 0.83 birds/route over the entire survey period is the highest for a FWS region for which an estimate could be calculated.

Rosenberg and Wells (1995) developed concern scores for Neotropical migratory bird species in the Northeast based upon population trend, relative size of population in the Northeast, and proportion of the species' range in the Northeast. Cerulean warbler had the fourth highest concern score among migrants in the Northeast. They stressed the importance of the Ohio Hills and Cumberland Plateau physiographic strata to the conservation of the species. They provide an estimate that 30% of the total population of the species breeds in the Northeast. The Cerulean Warbler Atlas Project (Barker and Rosenberg 1997), an attempt to involve volunteers in a rangewide project to determine the distribution of the species, was first developed and applied in the Northeast in 1997.

Connecticut

Summary: Regular migrant and breeding species in small numbers in the state.
BBS: No confident trend estimate is available from the BBS; relative abundance 0.01 birds/route.
BBA: Breeding was confirmed on 9 of 39 blocks where located in the state, in two populations established in the 1970s, in the Housatonic Valley and at East Haddam. Occurrence on 6.5% of blocks in the state, representing all counties (Ellison in Bevier 1994, p.322-323).
State Status: The species has no legal status other than that afforded by the Migratory Bird Treaty Act. The avian selection committee did not feel it met listing criteria in Connecticut (J. Dickson, Connecticut Dept. of Environmental Protection, pers. comm., 12 August 1996).
Natural Heritage Rank: See Table 12. Tracked by the Connecticut Natural Heritage Program.

Delaware

Summary: Linehan (1973) summarized status of the species in the Atlantic Piedmont as "rare, but locally fairly common." Two nests discovered in 1972 were the first found in Delaware, culminated a 10 year search (Linehan 1973). The agitated behavior of the ♀ cerulean warbler at the presence of a brown-headed cowbird nearby led to the discovery of the first Delaware nest.
BBS: No confident trend estimate is available from the BBS.
BBA: Preliminary results from the Delaware breeding bird atlas indicate the birds were found in two blocks in the northern part of the state (Lisa Gelvin-Innvaer, pers. comm., 18 Sept. 1996).

State Status: See Table 12. Listed as a Threatened Species by the Delaware Division of Fish and Wildlife.
Natural Heritage Rank: See Table 12. Tracked by the Delaware Natural Heritage Program.

Maryland and District of Columbia

Summary: The species has been recorded in Maryland and the District of Columbia on a regular basis in the past (e.g., Ball 1932, 1948), including Rock Creek Park in the District of Columbia (e.g., Ball 1927), although it does not breed there.
BBS: BBS trend estimate 1966-1998 is 1.3%/yr, P>0.10, based on 14 routes. Trends for 1966-1979 (-4.7%/yr, n=5, P>0.10) and 1980-1998 (-1.7%/yr) were not significantly different from zero. Relative abundance estimate of 0.32 birds/route over the entire survey period was the second lowest for any state for which an estimate could be calculated.
State Status: See Table 12.
Natural Heritage Rank: See Table 12. Maintained on Watch List by the Maryland Natural Heritage Program.

Massachusetts

Summary: Cerulean warbler is primarily a migrant in the state, as well as a rare and local breeding summer resident (Bradford G. Blodget, State Ornithologist, Commonwealth of Massachusetts, Division of Fisheries & Wildlife, pers. comm., 23 August 1996). Veit and Petersen (1993) indicate that the species is a rare and local breeder; rare but regular visitor or migrant, more frequently encountered in spring. Birds had been recorded at several locations in apparently suitable breeding habitat during May-July for a number of years before adults feeding young were first encountered in the state in 1989. Presently, "total Massachusetts breeding population probably does not exceed 5 to 10 pairs" (Veit and Petersen 1993, p. 403).
BBS: No confident trend estimate is available from the BBS.
State Status: The species is not currently a listed species in the state.
Natural Heritage Rank: See Table 12.

New Hampshire

Summary: Possibly cerulean warblers breed in New Hampshire in very low numbers.
BBS: No confident trend estimate is available from the BBS.
BBA: Janeway (1994) notes that the birds have not yet been confirmed to breed in the state, although an unverified report of a young bird in 1982 suggests that possibility. A single record was made during the atlas project, and records in 3 additional years since.
State Status: See Table 12.
Natural Heritage Rank: See Table 12. Tracked by New Hampshire Natural Heritage Program.

Habitat Condition: Harding (1930) noted the bird "in the tops of the tallest deciduous trees," where it "flitted restlessly in and out of the dense foliage maintaining a height of from [*sic* 9-18 m] thirty to sixty feet."

New Jersey

Summary: Stone (1937) considered the species an "exceedingly rare bird" in the state. Moulding (1976) found the birds breeding in 100-yr-old second-growth mixed upland oak forest.
BBS: No confident trend estimate is available from the BBS; relative abundance 0.49 birds/route.
Natural Heritage Rank: See Table 12. Tracked by New Jersey Natural Heritage Program.

New York

Summary: A locally common breeding species in the central and western parts of the state in the past century (Blake 1907). Populations in New York are believed to have resulted from dispersal of birds from western Ontario (Bull 1974). Currently the species is rare in most counties in New York although some local populations are fairly large. The birds appear to be more numerous in western New York than in the east, although breeding habitats have been destroyed on some historical locations in western New York and these are no longer occupied (R. Miller, New York State Department of Environmental Conservation, pers. comm., Species Dossier, 22 August 1996).
BBS: No confident trend estimate is available from the BBS; relative abundance 0.02 birds/route.
BBA: The species was recorded on 279 5x5-km atlas blocks in the state, approximately 5% of the blocks in the state. The distribution of records indicates a range expansion in the state, in western New York, in the Allegany Hills, the upper Mohawk Valley, in the Indian River Lakes area near Ontario, and along the west side of the Hudson River (Andrle and Carroll 1988). Andrle and Carroll (1988) expect further increases.
State Status: See Table 12.
Natural Heritage Rank: See Table 12.
Habitat Condition: The breeding record of Salzman (1983) in Suffolk Co., on Long Island, indicates that the birds had begun to occupy an area in advanced secondary succession from a previous old-field condition, based upon their use of Black Locust (*Robinia pseudo-acacia*) trees. Allen and Belknap (1964) found a nest in an elm tree in a stand of mixed upland hardwood forest in Jefferson County. Lindsay and Vezo (1992, 1994) demonstrated breeding on eastern Long Island.

Pennsylvania

Summary: Burleigh (1923) considered the birds to be common summer residents, restricted to stretches of woods along the Allegheny River, in Allegheny County, in the early decades of the 20th century. Daniel Brauning (Wildlife Biologist, Pennsylvania Game Commission, pers. Comm., 3 September 1996) pointed out that "Although the Cerulean Warbler is detected at such low rates on BBS routes, making trend analysis questionable, patterns of forest cover in the state might suggest why Ceruleans are not declining here. Pennsylvania both has more forest area and the forests are more mature than any time this century, providing more potential habitat for forest species such as Cerulean Warbler."
BBS: BBS trend estimate 1966-1998 is -1.2%/yr, P>0.10, based on 39 routes. Trend for 1966-1979 (-3.3%/yr) and that for 1980-1998 (2.2%/yr) were not statistically significant. Mean relative abundance estimate of 0.33 birds/route over the entire survey period is third lowest for any state for which an estimate could be calculated.
BBA: Reported in 836 (17%) of Pennsylvania's atlas blocks, widely scattered across the state. Confirmed breeding in 10% of blocks. The largest concentration of cerulean warbler blocks were in the southwestern corner of the state, in the Pittsburgh Plateau physiographic section (equivalent to Ohio Hills in BBS). Habitats referred to include tall oaks on slopes or ridge tops in Ridge & Valley physiographic section, as well as riparian woodland (Ickes 1992).
State Status: See Table 12.
Natural Heritage Rank: See Table 12.

Rhode Island

Summary: Richard L. Ferren (pers. comm., October 1996) provided a summary of occurrence of the birds in Rhode Island from his manuscript on the birds of Rhode Island. Formerly a very rare spring vagrant before the turn of the century, the species has greatly increased in recent decades as a May transient, and was located as a breeding species on the Rhode Island Atlas project. Fall records continue to be very rare. From a high of 5 localities known during the Rhode Island Atlas project, the species currently occurs only at a single breeding locality in the state (C. Raithel, Rhode Island Division of Fish, Wildlife, and Estuarine Resources, pers. comm. 13 August 1996).
BBS: No confident trend estimate is available from the BBS.
BBA: Cerulean warblers were identified on 3 blocks in the state, at five localities, including one confirmed nesting. Scattered summer records were reported beginning in the early 1960's, but only a single locality currently exists (Rhode Island Atlas; C. Raithel, Rhode Island Division of Fish, Wildlife, and Estuarine Resources, pers. comm. 13 August 1996).
State Status: Listed as State Threatened by Rhode Island Division of Fish and Wildlife, a designation that confers no additional legal protection (C. Raithel, Rhode Island Division of Fish, Wildlife, and Estuarine Resources, pers. comm. 13 August 1996).

State Status: See Table 12.
Natural Heritage Rank: See Table 12. Tracked by Rhode Island Natural Heritage Program.

Vermont

Summary: Migrant and extremely rare breeding species, known from a single locality in Vermont.
BBS: No confident trend estimate is available from the BBS.
BBA: Ellison (1985) indicates that the species was found on two, non-priority blocks in the state. Breeding was first confirmed in 1977.
State Status: Listed as Species of Special Concern, an unofficial listing, by the Vermont Department of Fish and Wildlife.
Natural Heritage Rank: See Table 12. Tracked by the Vermont Natural Heritage Program.
Habitat Condition: A single occurrence in the state, in tall cottonwood-silver maple forest in the floodplain of the Lamoille River (S. Parren, Vermont Department of Fish and Wildlife, pers. comm., 22 August 1996). A single singing male was noted at the site in 1994.

Virginia

Summary: Bailey (1913) listed the species as "hypothetical," while speculating "I have no doubt but that they breed sparingly all along the Allegheny Ridge." Recent monitoring efforts have clarified the distribution and status of the species in Virginia, as a locally common to uncommon species in the Ridge and Valley and Piedmont.
BBS: BBS trend estimate 1966-1998 is -18.0%/yr, P>0.10, based on 14 routes. Trends for 1966-1979 (-9.9%/yr) and 1980-1998 (1.6%/yr) were not significantly different from zero. Relative abundance estimate is 0.72 birds/route over the entire survey period.
BBA: Cerulean warblers were recorded on 88 blocks during the Virginia Breeding Bird Atlas Project, primarily in the western and northern mountains and Shenandoah Valley; a small number of records were made in the Coastal Plain as well (Rick Reynolds, Virginia Department of Game and Inland Fisheries, pers. comm., 24 September 1996).
State Status: While the species is monitored by both the US Forest Service and Virginia Department of Game and Inland Fisheries, it has no specific legal status in the state.
Natural Heritage Rank: See Table 12.
Habitat Condition: "The general impression we have is that where you find cove hardwoods you find cerulean warblers. This appears to be true throughout the mountains of Virginia." (Rick Reynolds, Virginia Department of Game and Inland Fisheries, pers. comm., 20 August 1996 and 24 September 1996).

West Virginia

Summary: Brewster (1875) found cerulean warbler to be the most abundant *Dendroica* sp. in Ritchie Co. Brooks (1940) indicated that cerulean warbler was a species characteristic of the counties along the Ohio River which reached its maximum abundance in the southern mixed hardwoods and oak-hickory forests in west central West Virginia. Furthermore, among "warblers rare east of the Alleghenies" he notes that this species is among a group of Mississippi River Valley migrants that breed in the Allegheny Plateau but are "uncommon as nesting birds east of the Backbone" of the Alleghenies (Brooks 1952).

BBS: BBS trend estimate 1966-1998 is -2.3%/yr, $P<0.05$, based on 43 routes. Trend for 1966-1979 (1.9%/yr, n=23) and that 1980-1998 (-0.1%/yr, n=35) were not significantly different from zero. Relative abundance estimate of 3.50 birds/route over the entire survey period is highest for any state for which an estimate could be calculated. Peterjohn (24 Jan 1995 letter) explains that the trends for the three time intervals may be very different in cases where substantial changes to the population occurred in the vicinity of 1980. Please see earlier concerns of Peterjohn (pers. comm. 9 Sept. 1996) concerning logistical limitations of BBS coverage in West Virginia.

BBA: Atlas work shows the birds to be widespread and common in the Western Hills, scarce or missing in the Allegheny Mountains Region, and to occur sparingly in the Ridge and Valley Region. In the Ridge and Valley Region of West Virginia, the birds are limited to river valleys. Birds were recorded on 258 atlas blocks in West Virginia (Buckelew and Hall 1994).

Research/monitoring: Ongoing work by West Virginia University is discussed below under **Habitat Condition**.

State Status: The species has no specific legal designation in West Virginia, although it is ranked the second bird of conservation priority by the West Virginia working group of the Partners in Flight *ad hoc* network (A. Jones, West Virginia Division of Natural Resources, pers. comm., 12 August 1996).

Natural Heritage Rank: See Table 12.

Habitat Condition: Jennifer Bell and Robert Whitmore (pers. comm., 17 September 1996), provided the following information on work they have done in West Virginia (Figure 4): "Cerulean Warbler density estimates from 42 fixed plots show a nonsignificant increasing trend from 1984-1996 at the Sleepy Creek Public Hunting and Fishing Area in the eastern panhandle of West Virginia. This area was severely defoliated by the gypsy moth in 1987-1988 and suffered heavy tree mortality. Gypsy moth impact resulted in a patchy habitat, where numerous overstory gaps and thick understory are interspersed with tree canopy. Despite preferences of the gypsy moth for *Quercus* spp., oaks still remain the dominant tree species in the area. Despite heavy tree mortality, sufficient canopy was left after defoliation to support populations of Cerulean Warblers. Although we have no data on Cerulean Warbler nesting success, data on four low-nesting species from the same study plots show that cowbird parasitism is not particularly high in the area."

U. S. Fish and Wildlife Service Region 6

Colorado

Summary: Identified as an irregular migrant in Colorado by the West Working Group, Partners in Flight (Carter and Barker 1993).

Kansas

Summary: Thompson and Ely (1992) consider the species a rare transient and summer resident in the east and a casual transient in western Kansas. First nest was discovered in 1985 near the Marais des Cygnes Refuge in Linn County.
BBS: No confident trend estimate is available from the BBS.
State Status: Listed as Species in Need of Concern by Kansas Department of Wildlife and Parks, a status that conveys no additional protection beyond that of the Migratory Bird Treaty Act (K. Brunson, Kansas Department of Wildlife and Parks, pers. comm. 13 August 1996).
Natural Heritage Rank: See Table 12. Species is tracked by Kansas Natural Heritage Program.
Habitat Condition: Schukman (1996) censused a population in bottomland hardwood forest along the Missouri River on Fort Leavenworth Military Reservation. Cerulean warblers arrived later in the season than northern parulas and yellow-throated warblers (*Dendroica dominica*), and were less numerous than the other species. Nearest neighbor analysis indicated that territories of the three species were distributed at random with respect to each other.

Nebraska

Summary: Agersborg (1885) corrected an earlier record by stating a report from South Dakota was actually from Dakota Co., Nebraska. Records of occurrence of the bird include a single individual at Fairbury on 12 May 1923 (Anonymous 1923). Ducey (1988) shows current distribution in the state to be in Sarpy Co., considers the species an occasional nester along the Missouri River valley.
BBS: No confident trend estimate is available from the BBS.
State Status: See Table 12.
Natural Heritage Rank: See Table 12. Tracked by the Nebraska Natural Heritage Program.

South Dakota

Summary: Peterson (1995) reviews several breeding season records from Newton Hills State Park and some from Roberts Co.; he concludes that the species status is uncertain in the state. Agersborg (1885) corrected an earlier record by stating a report from South Dakota was actually from Dakota Co., Nebraska.
BBS: No confident trend estimate is available from the BBS.

State Status: See Table 12.
Natural Heritage Rank: See Table 12. Tracked by South Dakota Natural Heritage Program.

8. THREATS

In accordance with the Endangered Species Act of 1973, five factors are used to determine whether a species is endangered or threatened:

(A) the present or threatened destruction, modification, or curtailment of the species' habitat or range;

(B) overutilization for commercial, recreational, scientific, or educational purposes;

(C) disease or predation;

(D) the inadequacy of existing regulatory mechanisms;

(E) other natural or manmade factors affecting its continued existence.

Based on literature available on the species and input provided by the states, known threats to the cerulean warbler will be summarized according to these listing factors.

The most extensive, direct listing of potential threats facing cerulean warblers was presented by Robbins et al. (1992a), and included six items which they listed as constraints on the breeding grounds as well as treatment of non-breeding season constraints.

8.1. Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range

The land use changes brought about by increasing human population in the breeding, migratory, and winter range of this species are the underlying cause of the population decline of the bird in this century. Humans occupy habitats in which the birds have occurred, clear the habitats for other land uses, and replace mature and old-growth stands with shorter rotation stands.

Most of the breeding habitat destruction for this species took place earlier in this century and at the end of the last century. Currently, breeding habitat modification results from clearing of extensive tracts of forest. In predominantly agricultural landscapes, occurrence of the birds is related to fragment size and to proportion of agricultural land use in the landscape (Hamel et al. in press). However, in areas where the landscape is predominantly forested, cerulean warbler breeding populations appear

to be able to coexist with forest management activities (Oliarnyk 1996; D. Buehler pers. comm. Oct. 1996).

The threat of habitat destruction may be related to the proportion of the landscape that is forested. This is a testable hypothesis. The following is a statement of that hypothesis. The hypothesis has not been verified by specific research. It is important enough to state, however, as a suggestion available for future test. In largely forested areas, perhaps extensive areas of many tens of thousands of hectares, which exceed 60-70% forested (cf. percolation theory, Milne 1991, p. 220), forest harvest activities appear not to affect the birds (Oliarnyk 1996). In areas in which the landscape is primarily agricultural, forest clearing may present a serious threat to the birds (Hamel et al. in press). The effect of harvest activities in largely agricultural landscapes is an important research topic. Much more research is needed 1) to identify at what point a landscape becomes fragmented for these birds (see Hamel et al. in press); 2) to compare reproductive success and other demographic parameters in different areas of the range representing different levels of fragmentation; and 3) to determine the intensity and types of land management activities that are compatible with producing source populations of the birds.

Winter habitat destruction is a very important concern for these birds. No extensive studies of the birds' winter habitats have been conducted. Present understanding of habitat modification in the montane subtropical forest suggests that habitat modification is ongoing rapidly and that it is largely a process of conversion of primarily forested landscapes to primarily anthropogenic landscapes of pastures and farms. The paucity of information on cerulean warblers in winter suggests that these birds may not persist when the great majority of their limited winter habitat has been converted to other land uses. Research on the birds' use of winter habitats is a critical need.

Habitat along migratory routes has been identified in a number of locations, e.g. Belize Highlands (Parker 1994), coastal cheniers (Moore and Simon 1992), and convenient promontories inland in North America (Giff Beaton, pers. comm.). No evaluation of the relative use of different migration habitats by cerulean warblers has been conducted. Research in this area will be very useful.

Rappole and McDonald (1994) present 14 predictions based on the hypothesis that populations of Nearctic avian migrants are declining as a result of events during the breeding season. These 14 predictions are particularly well-suited to evaluate the locations and causes of decline of populations of neotropical migratory birds, including cerulean warbler. The predictions, as they apply to cerulean warbler biology, are discussed in an appendix. When listed as (+) prediction of breeding season limitation verified, (-) prediction refuted, (0) insufficient data to evaluate prediction, results of this preliminary evaluation of the predictions of Rappole and McDonald (1994) are: (+) 1, (+?) 3, (0) 10, (-?) 1, (-) 1. The substantial number of "insufficient data to evaluate" -- indicates the need for detailed quantitative work on the biology of this species in several areas each on the breeding and winter grounds. Some reviewers of this document

suggested removing mention of the Rappole and McDonald (1994) discussion from this report. It is briefly included because it provides a useful structure for thinking about limitation of populations of migratory birds. Latta and Baltz (1997) question the analyses of Rappole and McDonald (1994) on the grounds that evidence exists that breeding season limitation is important to many species populations, as are events throughout the annual cycle.

8.1.1. Present and Historical Breeding Habitat Loss

A most obvious correlate and possible cause, on the breeding grounds, for the observed historical change in the abundance of the cerulean warbler is land use change involving the clearing of forest land in favor of agricultural and urban/suburban land uses. Numerous papers have identified this factor, calling it forest fragmentation, which is most obvious in the western and southwestern parts of the species range in the agricultural areas of the Midwest and Mississippi Alluvial Valley (e.g., Moseley 1947, Robbins et al. 1992a, papers in Hagan and Johnston 1992). The mechanism by which fragmentation of habitats affects populations in these areas is not precisely known and deserves further study (Robinson et al. 1995a, 1995b). How the populations of this species fluctuated in response to wholesale logging of large areas of the mountainous areas of the east during the period 1880-1930 is not documented. A valuable contribution to the biology of the species will come from historical research designed to examine this issue.

The breeding season constraints on cerulean warblers listed by Robbins et al. (1992a) are six. Four of them relate to breeding season habitat. The other two are listed in other parts of this section.

> "loss of mature deciduous forest, especially along stream valleys"

This is clearly the most serious long-term problem facing the species on the breeding grounds. It is likely important to distinguish land-use changes from forest management practices in this regard. Large areas of potential breeding terrain are no longer inhabitable by this species because they lie in urban areas or because they have been converted to agriculture. Forests managed with long rotations, however, represent potential habitat for the species. Long rotations are those sufficient to produce large sawtimber trees; the specific age in the rotation at which the habitat would become useful to cerulean warblers cannot yet be specified. Recent range extensions in the north and east indicate that the cerulean warbler is capable of reoccupying areas once unsuitable because of the structural stage of stand development. Uneven-age management systems (i.e., single tree and group selection) may maintain acceptable habitat throughout management cycle. Research on this topic is necessary.

"fragmentation and increasing isolation of remaining mature deciduous forest"

For reasons yet to be determined, cerulean warblers do not occur in small forest tracts. Minimum tract size in the western part of the breeding range (Hamel et al. in press) is apparently larger than that in the eastern portion (Oliarnyk 1996; Jennifer Bell and Robert Whitmore pers. comm., 17 September 1996). What constitutes a "small tract" is similarly undetermined at present. Perhaps more than most North American species, the cerulean warbler is sensitive to landscape-level characteristics (e.g. Hamel et al. in press). Hamel et al. (in press) were able to distinguish breeding sites for the species in the Mississippi Alluvial Valley from sites on which the birds did not occur on the basis of proportion of cropland at distances of 2.4-8 km from the breeding habitat. Occupied forest patches had lower proportions of surrounding cropland than did patches on which the birds did not occur.

"change to shorter rotation periods and even-aged management, so that less deciduous forest habitat reaches maturity"

As land uses become more competitive with each other on a regional scale, pressure is brought to bear on individual land owners and managers to achieve particular rates of return on investment in order to maintain their holdings in specific land uses. Pressure from more lucrative uses, either suburban development or agricultural activities, has caused many forest landowners to intensify their management activities by shortening rotations. To an unknown extent this factor has taken some potential habitat out of the pool of breeding habitat, at least in the intermediate term. While regenerating forests do not contribute to fragmentation of breeding habitats directly, management practices that do not include some large sawtimber production as part of the later structural stages of stand development, will not provide habitats for cerulean warblers.

"loss of key tree species, especially oaks from oak wilt and gypsy moths, sycamores from a fungus, elms from Dutch elm disease, and American chestnuts from chestnut blight"

The wide variety of habitats in which cerulean warblers breed, and the high densities apparently present in the past in the Mississippi Alluvial Valley on flat terrain at low elevation and the Cumberland Mountains at considerably higher elevation and steeper terrain suggests that these birds are able to utilize a great variety of tree species for their breeding habitats. Unpublished work in the Mississippi Alluvial Valley indicates that the birds nest in virtually every tree species available in their habitats (Hamel, unpubl. data). The relative preference of the species for certain tree species is a topic worthy of more research. Based upon an assumption that the species prefers older, large tree stages, potentially reaching high densities in old-growth forests dominated by gap-phase dynamics, a testable hypothesis arises that the birds will show greater preference for shade tolerant tree species than for shade intolerants. Among the trees listed in this constraint, elms and chestnuts are shade tolerant, sycamores are intolerant, and oaks show intermediate tolerance. The birds appear able to use a

variety of tree species, and the loss of a particular species is not likely to be detrimental to their populations, unless the loss of the species means the permanent loss of forest from that landscape. David Buehler (pers. comm. Oct. 1996) suggests that "some limited opening of the canopy in heavily forested areas may improve habitat, rather than degrade habitat. It all depends on the degree to which gypsy moth or oak decline or whatever kills overstory trees." The research question here is the explicit definition of "limited opening" of the canopy.

8.1.2. Present and Potential Non-breeding Habitat Loss

Winter Habitat

Robbins et al. (1992a) and Terborgh (1989) summarized current data on the loss of non-breeding habitat. Substantial amounts of non-breeding habitat have been converted from native forest to more intensive land uses of greater short-term economic value. Further conversion of primary forest lands to other uses is inevitable. Unfortunately, cerulean warblers occur in winter at the same elevation in which coca is grown (Robinson et al. 1988). This fact will interfere with future winter habitat of the species and it will make studies of the winter distribution of the birds in the northern part of the winter range, particularly in Colombia, problematic. Whether landscapes in which coca is grown are poorer habitats for cerulean warblers than are those in which forests are converted entirely to pastures and other agricultural crops is uncertain.

Constraints on the winter grounds are much less certain than those on the breeding grounds. The major threat is loss of primary forest to other land uses. As on the breeding ground, the most important factor affecting the population of this species appears to be permanent land-use change from forested to non-forested land uses.

Migratory Stopover Habitat

Parker (1994) provided the clearest description of migratory stopover habitat when he wrote of the birds' use of montane forests in Belize. North American habitats or, more specifically, localities where the birds are especially easily observed include forested slopes of ridges in the southern Appalachians such as Kennesaw Mountain in Georgia (Giff Beaton, pers. comm.), and Sharp's Ridge outside Knoxville, TN (Bob Ford, pers. comm.).

Concerns voiced by Moore and Simon (1992) and others concerning the availability of suitable woodlots close to the landfalls of the birds on both north and south shores of the Gulf of Mexico are likely of importance. Resting locations close to the coast may provide the measure of difference in survivorship for inexperienced migrants or for more experienced birds that encounter adverse weather while *en route* over the Gulf. Extensive deforestation, such as has happened over the past 100 years in the Mississippi Alluvial Valley, has reduced the availability of *en route* habitat. The extent to which the species is limited by migratory stopover habitats is unclear.

8.2. Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Cerulean warblers have never been of commercial value, although their consumption of insects may provide some commercial benefit. Their use for recreational, scientific and educational purposes does not pose a threat to the populations at this time.

8.3. Disease or Predation

Disease problems have not been investigated in the species. Robbins et al. (1992a) suggest "Pollution and disease problems certainly are not specific to Cerulean Warblers, but these problems seem to be especially severe on the major breeding areas of this warbler (Cowling 1983, Husar and Holloway 1983)." No published analyses of cerulean warbler tissues were discovered in preparation of this report; probably none have been conducted for contaminant loads. Gard et al. (1993) suggest that birds may be exposed to contaminants during migration and that additional work on the topic is warranted. Exposure to contaminants is also possible on the winter grounds, where some pesticides no longer available in the U.S., such as DDT, are used.

Predation problems are possible for this species as is nest parasitism by brown-headed cowbirds. No specific study of either predation on the birds or nest parasitism has been conducted. Study of nest parasitism and predation is part of the protocol in studies in Ontario (Oliarnyk 1996), the Mississippi Alluvial Valley (Hamel, unpubl. obs.), the Cumberland Plateau in Tennessee (Buehler, pers. comm.), and Illinois (Vanderah, pers. comm.).

Robbins et al. (1992a) list "nest parasitism by the Brown-headed Cowbird" as an important factor in the decline of the species.

Friedmann's (1963, Friedmann et al. 1977) records of parasitism by cowbirds are taken from virtually throughout the range of the species, however, suggesting that range overlap between the species has been of relatively long duration, and that the incidence of nest parasitism results from the changes in habitat configuration brought about by human intervention rather than changes in breeding ranges.

Because cerulean warblers nest high in the canopy of forests, where their nests are difficult for humans to find, only detailed and intensive searches for nests can be expected to provide even minimal estimates of the actual rates of parasitism experienced by populations of cerulean warblers in different habitats. Cerulean warblers are susceptible to parasitism by brown-headed cowbirds, at rates as high as those reported by Peck and James (18%; 1987) as discussed by Robbins et al. (1992a). In the Midwest and the Mississippi Alluvial Valley, where forest patches of all sizes are surrounded by a matrix of agricultural lands, most potential breeding habitats for cerulean warblers also support breeding cowbirds, and parasitism on cerulean

warbler nests has been observed in all study sites in the lower Mississippi Alluvial Valley (Hamel, unpubl. data). Robinson et al. (1995b) convincingly demonstrate a relationship between cowbird parasitism rates of migratory birds and regional forest fragmentation levels. Whether their results apply to cerulean warblers is an important research question. In other areas where cowbird abundance is low, parasitism rates on cerulean warblers are also low (David Buehler, pers. comm., Oct. 1996; Oliarnyk 1996). Continuing work will reveal the actual rates of parasitism experienced by the birds, and more importantly, the effect of the cowbird parasitism on the reproductive success of the cerulean warblers.

The effect of this factor must not be overlooked in understanding the population dynamics of cerulean warblers. Much more research on reproductive success of the species is required before an evaluation of that effect is possible. Brown-headed cowbirds are known to be serious threats to the existence of certain species, such as Kirtland's warbler (*Dendroica kirtlandii*), golden-cheeked warbler (*D. chrysoparia*), black-capped vireo (*Vireo atricapillus*), least Bell's vireo (*V. bellii arizonae*), and California populations of willow flycatcher (*Empidonax traillii extimus, E. t. brewsteri,* and *E. t. adastus*) (Robinson et al. 1995a).

Studies of cowbirds have focused on host birds of relatively open habitats, such as those listed above. Cowbirds are notoriously effective parasites of some forest birds, such as wood thrushes (*Hylocichla mustelina*), as well (Robinson et al. 1995b). It is possible that female cowbirds concentrate their nest searching on the understory and midstory of the forest, and that parasitism is most intense near prominent ecological edges between forest and agricultural landscapes. Conversely, cowbirds have been observed parasitizing cerulean warbler nests constructed over flooded bottomlands at least 1.6 km (1 mi) from upland habitats, and nests as high as 25 m (82 ft) above the ground in continuous forest (Hamel, unpubl. data).

More work on this issue is pertinent to understanding whether cowbird parasitism is a threat, whether it is exacerbated by forest fragmentation, and how its impact varies across the range of the species. Such research will be a logical part of studying reproductive success of the species.

8.4. Inadequacy of Existing Regulatory Mechanisms

In 1987, the U.S. Fish and Wildlife Service identified cerulean warbler as one of 30 "migratory nongame birds of management concern in the United States" (USFWS 1987). Cerulean warbler was also included when the list was revised in 1995 (USFWS 1995). Cerulean warbler was a Category 2 candidate for review for possible addition to the Federal endangered or threatened species list from 1991 (USFWS 1991a), until use of the Category 2 list was discontinued in 1996 (USFWS 1996).

The Lacey Act, Convention for the Protection of Migratory Birds, Migratory Bird Treaty Act of 1918 (MBTA), and Convention on Nature Protection and Wildlife Preservation in

the Western Hemisphere were attempts to halt the unregulated killing, import, and/or sale of migratory birds (USFWS 1991b). The MBTA established Federal responsibility for protection of the international migratory bird resource. The MBTA makes it "unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill ... any migratory bird, any part, nest, or egg of any such bird ... included in the terms of the conventions ... ."

The MBTA provides cerulean warbler protection from direct take throughout its breeding range; however, current regulatory mechanisms are inadequate to protect the breeding and wintering habitats on which the species depends. Section 404 of the Clean Water Act and the National Environmental Policy Act of 1969 (NEPA) may, in some cases, provide protection for breeding habitats used by cerulean warblers.

Wetlands are regulated by the U.S. Army Corps of Engineers (COE) under Section 404 of the Clean Water Act. Section 404 prohibits the discharge of dredged or fill materials into waters of the United States, including wetlands. Any activity that involves placement of dredge or fill material in a wetland requires a permit from the COE. Some forested wetlands may be used by breeding and migrating cerulean warblers, thus Section 404 probably results in the protection of a limited amount of habitat for the species.

NEPA requires all Federal agencies to consult with each other on proposals for legislation or other major Federal actions significantly affecting the quality of the human environment. Significant fish and wildlife habitats, including some cerulean warbler breeding habitats, are afforded some protection through NEPA.

Protection by the Endangered Species Act would perhaps protect breeding habitats of the birds in more restrictive ways than are currently available. The poor understanding of the birds' use of forest structure for breeding may be an indication that better understanding of the management of forests to promote habitat for these birds is more important than the protection of the habitats. Only through specific experimental manipulation of the stands will the proper silvicultural practices to promote habitat become known.

Existing incentive programs such as the Conservation Reserve Program are unlikely to benefit cerulean warblers because the enrollment periods of 10 or even 30 years are not long enough for forests to develop the characteristics that cerulean warblers require. The Wetland Reserve Program offers slightly more opportunity, however, because of provisions that do permit easements in perpetuity under certain conditions.

In addition to the protection afforded this and other species under the general wildlife laws of the states, at least fourteen states and two provinces in the breeding range of the species list it as a species of special concern, as threatened or endangered, or in some other protected status. Heritage Program lists of species routinely include it as well. Table 12 presents a summary of the legal status of the species in the countries,

states and provinces within its range, as well as the global, national, and state/province ranks of the species from the Conservation Science Division of The Nature Conservancy. The Migratory Bird Treaty between Canada, Mexico, and the United States offers a modicum of international recognition and protection to the species.

Existing regulatory mechanisms may not be sufficient to ensure that the population will persist at the current level or increase to a previous level, especially on the winter grounds. Legal protections in the U.S. are available, while in other countries, especially in the nonbreeding range, such protections are less specific. Relating the conservation of this species to efforts to protect native species (such as the tanagers with whose flocks wintering cerulean warblers travel) will be a useful method to take advantage of such protections as are available in the countries of the nonbreeding range.

8.5. Other Natural or Man-made Factors Affecting its Continued Existence

Robbins et al. (1992a) list "environmental degradation from acid rain and stream pollution" as a potential factor causing decline in the species.

9. SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION FOR POPULATIONS

Current numbers and distribution of the species are such that no summary of this type can be prepared, other than to state that the birds are found on public lands, industrial forest lands, and other private lands. In short, they are found on at least examples of all sorts of land ownerships.

10. MANAGEMENT ACTIVITIES

Management activities can be directed at the species, at its habitat, and at people and their interactions with the species or its habitat. In the following discussion, management in each of these areas is considered. For purposes of this section, management actions include restoration of lands to habitat for the species, protection of existing habitats where appropriate, as well as silvicultural manipulation of forest stands where appropriate.

What steps need to be implemented to protect, restore, and manage essential cerulean warbler habitat? Developing an understanding of the land management activities that create the appropriate vegetation structure in which cerulean warblers can successfully breed, as well as overwinter, is a critical step in the process. What these activities are is not at present known with certainty. Success in this endeavor will depend on non-regulatory, rather than regulatory, mechanisms in North America and probably in the more southerly winter grounds as well. Non-regulatory mechanisms are available to undertake this work, including the Partners in Flight program (discussed in a

subsequent section), application of best management practices to forest harvest and other land management activities, North American Waterfowl Management Plan land protection, and others. Critical to the process is the research to develop a clear understanding of the silviculture required to produce habitats for cerulean warblers.

10.1. General Management Approach

Management of cerulean warblers at present is an incidental by-product of forest management for sawtimber products on public and private forest lands. The presumed steep decline in the species' population in the past 100 years, and particularly the detailed documentation of the decline in the past 30 years, indicates that specific habitat management involving increasing the availability or the quality of existing breeding habitats is advisable. Production of this future condition on the breeding grounds, in which stands of large trees with heterogeneous, 3-dimensional canopy structure exist in context of extensively forested matrix, seems distinctly possible. Partners in Flight brings biologists and land managers together in a forum through which management activities can be disseminated and subsequently implemented.

Land managers of breeding habitats can potentially affect the survivorship of fledglings. This can be done by attempting specifically to produce habitats for the species to the extent practicable within the forest manager's management strategy. The challenge to managers of breeding habitats is to produce a sufficiently large number of fledglings such that low survival rates in winter do not reduce the population below the level that it can maintain itself.

The status and management of winter habitats is less clear. Cerulean warblers are not as high a priority for the managers and conservationists of the Central and South American non-breeding grounds as are the endemic species there. A combination effort in which protection of endemic species, management of second-growth forest lands to promote habitats for tanager flocks, and substantial ecotourism directed toward endemic species, as well as migratory forms, would appear to be an appropriate approach.

10.1.1. Silviculture of Breeding Habitat

Some guidelines for land managers on effective silviculture of breeding habitat have been suggested by Hands et al. (1989), Kahl et al. (1985), Hamel (1992) and Robbins et al. (1992a). No specific experimentation on silviculture for the species has been attempted. Current work in the Mississippi Alluvial Valley and the Cumberland Mountains of Tennessee is likely to result in some suggestions.

In a detailed study of cerulean warblers in extensive forest in Ontario, Oliarnyk (1996) noted "Selective cutting at one of the sites has not significantly altered the forest structure, or Cerulean Warbler reproductive success, relative to the two unmanaged sites. Continued monitoring of the population at this site is required to further determine

management effects on this species, however it is possible that certain forest management activities may be compatible with the conservation of Cerulean Warblers."

Silviculture of breeding habitat is the primary tool available to an individual land manager. For cerulean warblers, silviculture of breeding habitat means management for sawtimber products. It likely means management for premium quality sawtimber products, involving long rotations with intermediate treatments directed toward fostering long boles, large diameters, and full canopies of dominant trees. It likely means strategies to produce a varied 3-dimensional stand with extensive development of vertical diversity, such as tall canopies of dominants and canopy emergents towering above midstory or intermediate trees. Conditions such as these can be produced by uneven-age management of extensive stands, and by old-growth or wilderness management techniques that foster an extensive network of canopy gaps. Other strategies are likely to work as well.

An important consideration in the process of developing strategies for silviculture of breeding habitats involves the landscape context of the managed stands. The species is area-sensitive, being found only in the largest available tracts. Future policy and land use planning decisions that favor the existence of large tracts of forest, or landscapes that are primarily forested will be useful to these birds. One speculative view is that a primarily forested landscape would consist of perhaps 70% of the land in a 30,000 ha landscape forested; these numbers reflect the results of Robinson et al. (1995b). Where these landscapes can be self-sustaining, that is maintained by their own production, cerulean warblers will likely prosper. Where extensive economic subsidy is required to maintain the landscape in primarily forested condition, the future of the species would seem more tenuous.

It is not possible at present to state specific forest management plans for the species. Forest stand management techniques that result in "ideal" or even "high quality" cerulean warbler habitat cannot yet be stated. When developed and tested, they will include parameters like length of rotations, average height, diameter, and density of canopy trees, tree species composition, extent of ground and mid-story vegetative cover, minimum forest tract size, and amount of canopy closure. Kahl et al. (1985) have made specific proposals, applicable in Missouri. Because of the variety of deciduous forest habitats occupied by the birds, it is premature to assume that the correlates of occurrence found by Kahl et al. (1985) in Missouri apply to the habitats of the birds throughout the range, or that these are the values that will provide habitat in which the birds reproduce most successfully. Specific manipulative research on habitats is necessary to make such determinations with assurance.

10.1.2. Winter Habitat Management

Little is known of forest management to promote the habitats of this species in the non-breeding season. Research on this topic is essential. Current suggestions that only primary forest is adequate for the birds, if correct, mean that only protection of intact

ecosystems will assure the future of the species. Intense pressure from growing human populations limits the extent of forest in the winter grounds. Consequently, efforts to reforest now and in the future will likely be required to maintain non-breeding habitats for the species. Encouragement of economically viable crops from primary or "altered" primary forest may offer a means to maintain forest cover useful as habitats to these birds. Such an approach has been successful in maintaining habitats for other species elsewhere in the tropics, i.e., where brazil nuts, shade coffee, or other crops have been grown.

10.1.3. Other Management Considerations and Opportunities

Opportunities abound to increase the consideration received by cerulean warblers and other species in forest management decisions at several levels. At the stand level, detailed understanding of habitat used by cerulean warblers under a variety of physiographic situations will enable development of useful silvicultural guidelines for the species in different forest types. Research on these topics is continuing at present in several parts of the breeding range.

At the landscape level, current understanding of the area-sensitivity of the cerulean warbler is sufficient to use the species as a planning tool (e.g., Mueller et al. in press; D. Pashley, Summarizing "Midwest and Southern Great Plains: Setting Population and Habitat Objectives," meeting of 8 April 1996, pers. comm.). Partners in Flight appears to provide a mechanism by which conservation policy makers and forest land use policy makers can usefully interact. That interaction may provide the leadership that implements management appropriate to maintain adequate habitat for cerulean warblers into the future.

10.2. Monitoring Effects of Management Activities

Understanding of cerulean warbler habitats and the silvicultural manipulations necessary to promote them is primitive. Rapid improvement of that understanding will perhaps be an essential ingredient in assuring the future persistence of the species. Detailed monitoring of the abundance and response of the species to habitat manipulations in both the short and long term is indicated. Monitoring activities will require moderate expenditures of resources, but can be expected to yield precisely the sorts of information useful to adaptive management of natural resources, including cerulean warblers and likely other forest canopy bird species as well. Otherwise, as Robbins et al. (1992a) wrote, *Dendroica cerulea* will increasingly become "A warbler in trouble."

11. PAST AND CURRENT CONSERVATION ACTIVITIES UNDERTAKEN TO BENEFIT THE SPECIES

Current conservation activities underway for cerulean warblers include activities designed originally as research as well as activities directed specifically at conservation practice. Among the research projects are those in southern Illinois managed by scientists at the Illinois Natural History Survey, principally Scott Robinson; in the Cumberland Plateau managed by scientists at the University of Tennessee, Knoxville, principally David Buehler; in southern Ontario managed by scientists at Queen's University in Kingston, principally Raleigh Robertson; and in the lower Mississippi Alluvial Valley in Tennessee, Arkansas, and Mississippi managed by scientists at the USDA Forest Service, Southern Hardwoods Lab., principally the author of this assessment.

Among important conservation projects are the Interior Low Plateaus project managed by the Tennessee Wildlife Resources Agency and the Southeast Partners in Flight Working Group, principally Bob Ford; the Mississippi Alluvial Valley migratory bird conservation plan, an activity of the U.S. Fish and Wildlife Service, Vicksburg, Mississippi, that brings together numerous collaborators (Mueller et al. in press); and the Cerulean Warbler Atlas Project, managed by scientists at the Cornell Laboratory of Ornithology, principally Sarah Barker and Ken Rosenberg.

Deanna Dawson of Patuxent Wildlife Research Center conducted a survey for cerulean warblers in 1997 on West Point Military Academy property in New York (D. Dawson, pers. comm., 30 Jul 1997). Birds were recorded on approximately 5% of over 400 10-min point counts distributed throughout forest lands on the 6500 ha (16,000 acre) tract.

Perhaps indicative of work being done by land managers to inventory and monitor the populations of these birds on their lands is that of the Wayne National Forest in Ohio (L. Andrews, pers. comm. 3 Jul 1997). Point count surveys are being conducted throughout the forest to identify the locations at which the birds occur. Results indicate that on that forest, cerulean warbler is most numerous in upland habitats. Other managers (cf. Staten and Hamel 1996) conduct inventory work on their lands as part of the management process, and thereby track the occurrence and distribution of the birds on their lands.

11.1. Partners in Flight

Partners in Flight appears to provide a mechanism by which conservation policy makers and forest land use policy makers can usefully interact. Partners in Flight is a volunteer organization with minimal formal structure designed to bring together agencies, organizations, companies, and individuals interested in the perpetuation of neotropical migratory birds and their breeding, winter, and migratory stopover habitats. It has proved to be a very useful forum in which entities with disparate interests in land use and the management of lands can cooperate in the development of mutual trust and

understanding as well as joint activity to assure the continued existence and abundance of migratory birds. Cerulean warbler is a species that will require considerable concerted attention and effort from Partners in Flight to maintain and increase its numbers.

Among the activities in which Partners in Flight is involved, Wm. C. Hunter, Southeast Regional Partners in Flight Coordinator (pers. comm., memo of 24 June 1997) visited several sites on the Chattahoochee National Forest with Forest biologists in search of the species. They found the birds in some of the stands impacted by Hurricane Opal, leading to information that may be of use to the management of the species on that National Forest. The Cerulean Warbler Atlas Project of Cornell University Laboratory of Ornithology (Barker and Rosenberg 1997) is a Partners in Flight endorsed project. Other activities through Partners in Flight, formal as well as informal, will be of use in the conservation of cerulean warblers.

12. SURVEYS, MONITORING, AND RESEARCH NEEDS

Cerulean warbler information needs fall under 3 categories: surveys, monitoring, and research. Survey information is potentially easiest to acquire, and becomes the basis for the others. Monitoring activities follow upon surveys and lead to identification and clarification of new research issues and questions. This section begins with a list of the necessary activities in a chronological sequence, and concludes with a list of research activities in priority sequence.

12.1. Surveys

1. Conduct rangewide survey to identify current occurrence. Robbins et al. (1992a) summarized the occurrence based upon atlas results through 1989. This assessment summarizes breeding bird atlas results as well. The Cerulean Warbler Atlas Project of Barker and Rosenberg (1997) may provide the most up-to-date distribution information possible. This project began in the Northeast in 1997. Extending it to the remainder of the species' range will provide useful information and allow increased numbers of interested citizens to participate in the conservation of the species. Innovative techniques, such as the canoe surveys of rivers conducted by Merrill Lynch in North Carolina, John Castrale in Indiana, and Mark Robbins in Missouri likely will be required to implement this survey as well.

2. A similar survey in winter will be extremely useful. Only anecdotal information is currently available. The one current study (J. Jones, Queens University, pers. comm. Aug 1996) is taking place in only a single country, Venezuela, in the northern part of the winter range.

3. Surveys of migratory stopover locations in North, Middle, and South America, perhaps patterned after the work of Parker (1994) in Belize and Beaton in Georgia (pers. comm. Jul 1997), will clarify the need for conservation action directed toward stopover sites.

12.2. Monitoring

Subsequent to survey identification of breeding, migratory stopover, and winter habitats and sites, regular monitoring of the numbers of birds using these areas, and the demographic parameters of the populations, will be an important part of the conservation of the cerulean warbler.

Issues in monitoring involve the adequacy of the existing Breeding Bird Survey network and appropriate means to improve coverage of areas likely to be inhabited by cerulean warblers. In many areas, BBS routes, designed as a continent-wide network, are too thinly spread to monitor adequately the numbers of this bird in physiographic areas where the birds are rare. More routes may be needed. BBS was designed as a roadside survey, and cerulean warblers appear to occur predominantly in interior of forest tracts, relatively removed from roads. A test of the occurrence of the birds on roadside vs. off-road counts in the same tracts would clarify this issue. Currently, extensive networks of off-road point counts are being conducted on certain National Forests, National Wildlife Refuges, and other properties in the range of the species. These counts can form the basis for such tests of occurrence of the birds on off-road vs. roadside counts. Should the birds be less likely to be found on roadside counts, for example, then a strategy to survey likely off-road habitats will be necessary for adequate monitoring of the species.

Additional population monitoring techniques may be necessary in certain situations. Where the birds occur in river floodplains, a water-based survey technique such as that employed by Castrale et al. (1987) and Robbins (Robbins et al. 1992b; P. McKenzie, pers. comm. 18 July 1997; M. Robbins, pers. comm. 5 August 1997) may be effective. This technique involves tallying the number of singing males recorded during float surveys of standard fixed stream reaches. An important feature of developing such techniques will be to quantify the relationship between numbers of birds as determined by newer techniques and numbers of birds as reported by BBS and other techniques.

Monitoring the demographic characteristics of populations is necessary in this species. The extreme difficulty of finding the nests of cerulean warblers, and of capturing adults, especially females, make determination of reproductive success problematical. Assessing survivorship of eggs, nestlings, and fledglings; and age-specific winter and annual survivorship of older individuals is also very difficult. Until such survivorship and reproductive success information is available, the actual dynamics of populations, as well as identification of source and sink populations of this species will continue to be unknown. Accurate interpretation of patterns of population change in different physiographic areas is not possible without such information.

Information on relative abundance by habitat is vital to the development of silvicultural prescriptions for the species in different areas. Responses to silvicultural treatments will be difficult to interpret without information on the demographic parameters of the populations in the treated areas.

Monitoring efforts will provide useful information about the size, distribution and trend of breeding and wintering populations. More importantly, the act of monitoring the birds by those directly responsible for the management of the land will bring information about the occurrence of the birds into the decision-making process at the local scale of the individual timber sale.

12.3. Research Needs

In no fewer than 30 locations in the foregoing has it been pointed out that more information and research activity is needed on this species. The research priorities presented below reflect needs for information related to conservation and management action. Numerous other biologically interesting and relevant questions remain about the species. Pursuing these activities first will develop an understanding of the conservation of the species such that its likelihood of persistence can be enhanced. The other important research questions can then be addressed.

12.3.1. High Priority Activities

Research is critically needed in the following areas:

> *Winter survivorship, habitat distribution, and relative abundance by habitat in the forests of the east slope of the Andes and elsewhere in northern South America:* Information on the land use change in the winter range as it relates to specific habitats for the species is also vital. Winter occurrence is essentially unknown at the geographic as well as habitat scales. So little is known about the birds in the non-breeding season that no meaningful comparison of winter with breeding limitation can yet be attempted, or even credibly speculated. Because of the occurrence of the birds frequently in association with canopy flocks of resident species in the winter range, a likely mechanism to conduct research on cerulean warbler biology in the winter grounds will be to enlist partners whose interest lies in the study of the biology of the flock forming species. These animals are probably of greater conservation concern to workers in the countries in which cerulean warbler winters than are the cerulean warblers. By working together on the associated issues of canopy flock species and cerulean warbler association with these species, the research will benefit not only curiosity about cerulean warblers and their associates, but further elucidate the importance of events in the winter range outside the times at which cerulean warblers are there. It is likely that such information will be essential to management of winter habitats for cerulean warblers.

Demography or population dynamics of the species in different parts of the range and under different silvicultural treatments of the breeding habitats.
Such research must include determination of location-specific differences in (a) survivorship and productivity, (b) predation rates on nests and adults, and (c) nest parasitism rates by brown-headed cowbirds.

Landscape characteristics of cerulean warbler occurrence, area-sensitivity, and distribution in relation to forest fragmentation.
Monitoring the occurrence of the species in relation to landscape characteristics (e.g., proportion of agricultural vs. forested land use, tract shape and connectivity) will be extremely useful. Such monitoring will aid in determining priorities for additional research because it will enable comparison of relative abundance of the birds with landscape features. Understanding the relationship of relative abundance to landscape features will make obvious the level of detail needed to characterize population size, productivity, and survivorship within tracts.

Preferred vegetation structure within habitats.
In addition to taking usual measures of vegetation structure, investigating vertical distribution of vegetation and horizontal distribution of canopy gaps will clarify the habitat requirements of the species.

Response of populations to land management activities.
Intensive monitoring of known populations and their responses to management treatments will provide invaluable information about management activities appropriate to the perpetuation of the species.

12.3.2. Moderate Priority Activities

Research is urgently needed in the following areas:

Silvicultural activities that create cerulean warbler habitat.
This will involve development of specific activities rather than a determination simply of response of the birds to particular existing treatments.

Applicability of habitat models developed in one area to cerulean warbler habitats in another part of the breeding or winter range.
Applying habitat models developed in one area of the species range to other areas is an important part of the research on habitat requirements and silviculture of habitats of the species. Because the physical stature of the habitats varies extensively within the range of the species, coordination of efforts among scientists in different parts of the species' range will be very useful to developing and testing habitat models.

Testing hypothesis that cerulean warblers are better censused by off-road than roadside counts.
Concern over the forest interior occurrence of the species suggests that surveys into the occurrence of the species on roadside vs. off-road counts in the same areas will be important.

Development of survey techniques applicable in different physiographic situations.
Occurrence of the birds in montane as well as riverine forest situations suggests that different techniques may enable more efficient and precise determination of population levels and trends.

Summarizing existing Breeding Bird Census data.
This will provide a useful initial indication of the physical structure of cerulean warbler habitat across the breeding range. Further study of the BBC data will be a useful part of understanding the status of this species. Potentially useful in that regard will be summary of the vegetation measurements on the sites and comparison of upland with bottomland situations.

12.3.3. Low Priority Activities

Research is also needed in the following areas:

Migratory movements, stopover sites, stopover biology, and timing of migration.
Clearer understanding of the early migration of the species will provide insight into potential means to improve survivorship of the species at this season.

Breeding social system and local distribution of individuals.
Addressing this issue will assist in understanding observed patterns of habitat use and may explain the absence of the species from some ostensibly suitable habitats.

Historical distribution of known breeding habitats.
Clearer understanding of the historical dynamics of habitats across the landscape will enable a more informed interpretation of current population trends among physiographic areas.

13. LITERATURE CITED

Adams, R. J., Jr. 1991. Cerulean Warbler (*Dendroica cerulea*). *In* Brewer, R., G. A. McPeek, and R. J. Adams, Jr., eds. The Atlas of Breeding Birds of Michigan, pp. 424-425. Michigan State Univ. Press, East Lansing, MI.

Agersborg, G. S. 1885. The birds of southeastern Dakota. Auk 2:276-289.

Allen, A. W. and J. B. Belknap. 1964. Cerulean Warbler (*Dendroica cerulea*) nesting in Jefferson County. Kingbird 14(4):215.

Allen, J. A. 1879. Nest and eggs of the Cerulean Warbler. Bull. Nutt. Orn. Club 4:25-27.

Allen, J. A. 1907. Berlepsch and Stolzmann on birds from Peru. Auk 24:361.

Amadon, D. 1950. The species -- then and now. Auk 67:492-498.

Ambuel, B. and S. A. Temple. 1982. Songbird populations in southern Wisconsin forests: 1954 and 1979. J. Field Ornithol. 53:149-158.

American Ornithologist's Union (A.O.U.). 1998. Check-list of North American Birds, 7th ed. Allen Press, Lawrence, KS. 829 pp.

Andrle, R. F. and J. R. Carroll. 1988. The atlas of breeding birds in New York state. Cornell Univ. Press, Ithaca, NY.

Anonymous. 1923. Minutes of the twenty-fourth annual meeting of the Nebraska Ornithologists' Union. Auk 35:102-105.

Anonymous. 1970. Recommendations for an international standard for a mapping method in bird census work. Aud. Field Notes 24:723-726.

Audubon, J. J. 1856. The birds of America. Vol. II. V. G. Audubon, New York, NY.

Austen, M., R. Pratt, M. Cadman, D. Cuddy, and R. Knapton. 1995. national recovery plan for Henslow's sparrow. Final Report for the Canadian Wildlife Service, Ontario Region and the Endangered Species Recovery Fund.

Austin, G. T. 1971. On the occurrence of eastern wood warblers in western North America. Condor 73:455-462.

Averill, C. K. 1920. Migration and physical proportions. A preliminary study. Auk 37:572-579.

Baerg, W. J. 1951. Birds of Arkansas. Univ. Ark. Agric. Exp. Sta., Bull. No. 258(rev.).

Bagg, A. C. and S. A. Eliot, Jr. 1937. Birds of the Connecticut Valley in Massachusetts. The Hampshire Bookshop, Northampton, MA.

Bagg, E. 1900. Bird news from central New York. Auk 17:177-178.

Baicich, P. J. and C. J. O. Harrison. 1997. A guide to the nests, eggs, and nestlings of North American birds. Academic Press, San Diego, CA.

Bailey, A. M. and E. G. Wright. 1931. Birds of southern Louisiana. Wilson Bull. 43:114-142, 190-219.

Bailey, H. H. 1913. The birds of Virginia. J. P. Bell, Lynchburg, VA.

Ball, W. H. 1927. Notes from Washington, DC. Auk 44:257-259.

Ball, W. H. 1932. Notes from the Washington, DC Region. Auk 49:362.

Ball, W. H. 1948. Cerulean Warbler in the District of Columbia, Maryland, and Virginia. Auk 65:307-308.

Banks, R. C., and J. Baird. 1978. A new hybrid warbler combination. Wilson Bull. 90:143-144.

Barker, S. and K. Rosenberg. 1997. Cerulean Warbler Atlas project (CEWAP). Cornell Lab. of Ornithology, Ithaca, NY. 4 pp., data forms, and audio cassette.

Baumgartner, F. M. and A. M. Baumgartner. 1992. Oklahoma bird life. Univ. of Oklahoma Press, Norman, OK.

Beckham, C. W. 1887. Additions to the avifauna of Bayou Sara, LA. Auk 4:299-306.

Beissinger, S. R., and D. R. Osborne. 1982. Effects of urbanization on avian community organization. Condor 84:75-83.

Bent, A. C. 1953. Life histories of North American wood warblers. Part 1. U.S. Nat. Mus. Bull. 203. (Dover Reprints, New York, 1963).

Beyer, G. E., A. Allison, and H. H. Kopman. 1906. List of the birds of Louisiana. Part II. Preliminary sketch, concluded. Auk 23:275-282.

Blake, M. C. 1907. Notes from western New York. Auk 24:224-226.

Blincoe, B. J. 1925. Birds of Bardstown, Nelson County, Kentucky. Auk 42:404-420.

Bohlen, H. D. 1989. The birds of Illinois. Bloomington, IN: Indiana Univ. Press. 221 p.

Bond, J., and R. M. de Schauensee. 1941-1942. The birds of Bolivia. Part 1. Proc. Acad. Nat. Sci. Phila. 94:307-391.

Bond, R. R. 1957. Ecological distribution of breeding birds in the upland forests of southern Wisconsin. Ecol. Monogr. 27:351-384.

Bonhote,. J. L. 1903. Bird migration at some of the Bahama lighthouses. Auk 20:169-179.

Boulton, R. 1924. The Cerulean Warbler (*Dendroica cerulea*) in Central Park, New York City. Auk 41:348.

Brandt, A. E. 1947. The rearing of a cowbird by Acadian flycatchers. Wilson Bull. 59:79-82.

Brauning, D. W., ed. 1992. Atlas of Breeding Birds in Pennsylvania. Univ. of Pittsburgh Press, Pittsburgh, PA.

Brewster, W. 1875. Some observations on the birds of Ritchie County, West Virginia. Ann. Lyc. Nat. Hist. New York 11:129-146.

Brimley, C. S. 1917. Thirty-two years of bird migration at Raleigh, North Carolina. Auk 34:296-308.

Brodkorb, P. 1927. Notes on some uncommon birds in the Chicago region. Auk 44:259-260.

Brodkorb, P. 1929. Notes from Berrien County, Michigan. Auk 46:397-398.

Brooks, E. A. 1908. Notes from West Virginia. Auk 25:235-238.

Brooks, M. 1934. Some changes in the breeding birds of Upshur County, West Virginia. Wilson Bull. 46:243- .

Brooks, M. 1940. The breeding warblers of the central Allegheny Mountain region. Wilson Bull. 52:249-266.

Brooks, M. 1952. The Allegheny Mountains as a barrier to bird movement. Auk 69:192-198.

Bruner, A. W. 1998. Cerulean Warbler (Dendroica cerulea). Pages 260-261 *in* Castrale, J. S., E. M. Hopkins, and C. E. Keller, eds. Atlas of Breeding Birds of Indiana. Nongame and Endangered Wildlife Program, Indiana Department of Natural Resources, Indianapolis, IN.

Buckelew, A. R. and G. A. Hall. 1994. The West Virginia breeding bird atlas. Univ. of Pittsburgh Press, Pittsburgh, PA.

Bull, J. 1974. Birds of New York state. Doubleday, Garden City, NY.

Bullis, H. R., Jr. 1954. Trans-Gulf migration, Spring 1952. Auk 71:298-305.

Burleigh, T. D. 1923. Notes on the bird life of Allegheny County, Pennsylvania. Wilson Bull. 35:79-99, 138-147.

Butler, A. W. 1898. Birds of Indiana. Indiana Dept. Geol. and Nat. Resources. Annual Rept. 22:515-1187.

Cadman, M. D., P. F. J. Eagles, F. M. Helleiner, compilers. 1987. Atlas of the breeding birds of Ontario. Univ. of Waterloo Press, Waterloo, Ont..

Carter, M. F., and K. Barker. 1993. An interactive database for setting conservation priorities for western Neotropical migrants. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 120-143. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Carter, W. A. 1967. Ecology of the nesting birds of the McCurtain Game Preserve, Oklahoma. Wilson Bull. 79:259-272.

Castrale, J. S., S. E. Backs, and D. Howell. 1987. Avian Surveys along two river segments in southern Indiana. Indiana Academy of Science 96:223-229.

Cecil, R. 1996. Cerulean Warbler *Dendroica cerulea*. *In* Jackson, L. S., C. A. Thompson, and J.J. Dinsmore, eds. The Iowa Breeding Bird Atlas, pp. 322-323. Univ. of Iowa Press, Iowa City, IA.

Chapman, F. M. 1917. The distribution of birdlife in Colombia: A contribution to a biological survey of South America. Bull. Amer. Mus. Nat. Hist. 36:1-729.

Coues, E. 1878. Birds of the Colorado valley. U. S. Geol. Surv. Territ. Misc. Publ. 11:1-807.

Cowling, E. B. 1983. The North American acid rain situation. *In* Ecological Effects of Acid Deposition, pp. 53-73. National Swedish Environment Protection Board Report PM 1636. Solna, Sweden.

Crawford, R. L. 1978. Autumn bird casualties at a northwest Florida TV tower: 1973-1975. Wilson Bull. 90:335-345.

Crawford, R. L. 1980. Wind direction and the species composition of autumn TV tower kills in northwest Florida. Auk 97:892-895.

Crosby, M. S. 1923. Supplementary notes on the birds of Dutchess County, N.Y. Auk 40:94-105.

Cyr, A. and J. Larivée. 1993. A checklist approach for monitoring Neotropical migrant birds: Twenty-year trends in birds of Québec using ÉPOQ. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 229-236. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Cyr, A. and J. Larivée. 1995. Atlas saisonnier des oiseaux du Québec. Les Presses de l'Université de Sherbrooke et la Société de Loisú Ornithologique de l'Estrie, Inc.

Dater, E. E. 1951. First successful nesting of the Cerulean Warbler in New Jersey. Wilson Bull. 61(2):115-116.

DeGraaf, R. M. and J. H. Rappole. 1995. Neotropical migratory birds: Natural history, distribution, and population change. Comstock Publ. Assoc., Ithaca, NY.

DeSante, D. and P. Pyle. 1986. Distributional checklist of North American birds. Volume 1. United States and Canada. Artemisia Press, Lee Vining, CA.

de Schauensee, R. M. 1951. The birds of the republic of Colombia. Caldasia 5(25):873-1112.

de Schauensee, R. M. 1966. The species of birds of South America and their distribution. Academy of Natural Sciences of Philadelphia, Philadelphia, PA.

Dickey, S. S. 1920. Nests in Greene Co., PA. Oologist 37:88.

Dinsmore, J. J., t. H. Kent, D. Koenig, P. C. Petersen, and D. M. Roosa. 1984. Iowa birds. Iowa State Univ. Press, Ames, IA.

Dott, H. E. M. 1985. North American migrants in Bolivia. Condor 87:343-349.

Ducey, J. E. 1988. Nebraska birds: breeding status and distribution. Simmons-Boardman Books, Omaha, NE.

Earnst, S. L., and B. A. Andres. 1996. Population trends of breeding birds in Ohio. Columbus, Ohio, Ohio Biological Survey, Misc. Contr. 3.

Edwards, E. P. 1972. A field guide to the birds of Mexico. Lynchburg, VA.

Ellison, W. G. 1985. Cerulean Warbler. *In* Laughlin, S., ed. Atlas of the Breeding Birds of Vermont Atlas, pp. 308-309. Vermont Inst. for Natural Science, Woodstock, VT.

Ellison, W. G. 1994. Cerulean Warbler. *In* Bevier, L. D. , ed. Atlas of Breeding Birds in Connecticut, pp. 322-323. Conn. Dept. of Environ. Protection, Hartford, CT.

Evans, D. E., and R. A. Fischer. 1997. Species profile: cerulean warbler (Dendroica cerulea) on military installations in the southeastern United States. Technical Report SERDP-97-12, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Fjeldså, J. and N. Krabbe. 1990. Birds of the High Andes. Zool. Mus., Univ. Copenhagen and Apollo Books, Svendborg, Denmark.

Flaspohler, D. 1993. Wisconsin cerulean warbler recovery plan. Wisconsin Endangered Resources Report 101. Madison, Wisconsin Dept. of Natural Resources.

Ford, R. P. and P. B. Hamel. 1997. Cerulean Warbler. *In* Nicholson, C. P., ed. Tennessee Breeding Bird Atlas. Univ. of Tennessee Press, Knoxville, TN.

Forsyth, B. J., and D. A. James. 1971. Springtime movements of transient nocturnally migrating landbirds in the Gulf Coastal Bend region of Texas. Condor 73:193-207.

Friedmann, H. 1963. Host relations of the parasitic cowbirds. U. S. Nat. Mus. Bull. 233, 276 p.

Friedmann, H., L. F. Kiff, and S. I. Rothstein. 1977. A further contribution to knowledge of the host relations of the parasitic cowbirds. Smithsonian Contributions to Zoology, No. 235, 75 p.

Gard, N. W., M. J. Hooper, and R. S. Bennett. 1993. Effects of pesticides and contaminants on neotropical migrants. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 310-314. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Gauthier, J. and Y. Aubry (sous le direction de). 1995. Les oiseaux nicheurs du Québec: Atlas des oiseaux nicheurs du Québec meridional. Association québécoise des groupes d'ornithologues, Société cubitus de protection des oiseaux, Service canadien de la faune.

Geissler, P. H. 1984. Estimation of animal population trends and annual indices from a survey of call-counts or other indications. Proc. Am. Stat. Assoc., Section on Surv. Res. Methods 1984:472-477.

Geissler, P. H. and B. R. Noon. 1981. Estimates of avian population trnds from the North American Breeding Bird Survey. *In* C.J. Ralph and M. J. Scott, eds. Estimating numbers of terrestrial birds, pp. 42-51. Studies in Avian Biology No. 6.

Geissler, P. H. and J. R. Sauer. 1990. Topics in route-regression analyses. *In* J. R. Sauer and S. Droege, eds. Survey designs and statistical methods for the estimation of avian population trends, pp. 54-57. U.S. Fish and Wildlife Service Biol. Rept. 90(1).

Godfrey, W. E. 1986. The birds of Canada. National Museums of Canada, Ottawa, Ont.

Graber, J. W., R. R. Graber, and E. L. Kirk. 1983. Illinois Birds: Wood Warblers. Illinois Natural History Survey, Biological Notes No. 118.

Graber, R. R., and J. W. Graber. 1963. A comparative study of bird populations in Illinois, 1906-1909 and 1956-1958. Illinois Natural History Survey Bull. 28, Article 3.

Granlund, J., G. A. McPeek, R. J. Adams, P. C. Chu, J. Reinoehl, C. Nelson, R. Schinkel, M. Kielb, S. Allen, A. Trautman. 1994. The Birds of Michigan. Indiana Univ. Press, Bloomington, IN.

Gray, G. W. 1924. The Cerulean Warbler in Dutchess County, NY. Auk 41:161-162.

Greenberg, R. 1979. Body size, breeding habitat, and winter exploitation systems in *Dendroica*. Auk 96:756-766.

Greene, E. R., W. W. Griffin, E. P. Odum, H. L. Stoddard, I. R. Tomkins. 1945. Birds of Georgia. Ga. Ornithol. Soc. Occas. Publ. No. 2. Univ. of Georgia Press, Athens, GA.

Griscom, L. and A. Sprunt, Jr. 1979. The warblers of America. Rev. and updated by E. M. Reilly, Jr. Doubleday and Co, Garden City, NY.

Hagan, J. M. III and D. W. Johnston, eds. Ecology and conservation of Neotropical migrant landbirds. Smithsonian Inst. Press, Washington, DC.

Hamel, P. B. 1992. Cerulean warbler, *Dendroica cerulea*. *In* Schneider, K. J., and D. M. Pence, eds. Migratory nongame birds of management concern in the Northeast, pp. 385-400. U.S. Dep. Inter., Fish and Wildl. Serv., Newton Corner, Massachusetts.

Hamel, P. B., R. J. Cooper, and W. P. Smith. in press. The uncertain future of Cerulean Warblers in the Mississippi Alluvial Valley. Proc. of The Delta Conference, Memphis, Tennessee, 13-16 August 1996.

Hamel, P. B., W. P. Smith, R. J. Cooper, and C. A. Woodson. 1994. Empirical prediction of habitat variables of cerulean warblers in bottomland hardwood forests. ABSTRACT. Paper presented at First North American Ornithological Conference, Missoula, MT, June 1994.

Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the Cerulean Warbler in the northcentral United States. U.S. Department of the Interior, Fish and Wildlife Service. Twin Cities, MN.

Hann, H. W. 1937. Life history of the Oven-bird in southern Michigan. Wilson Bull. 49:145-237.

Harding, K. C. 1930. Cerulean Warbler in Holderness, New Hampshire. Auk 47:90.

Harrison, H. H. 1984. Wood warblers' world. Simon and Schuster, New York, NY.

Helms, C. W. and W. H. Drury. 1960. Winter and migratory weight and fat: Field studies on some North American buntings. Bird-Banding 31:1-40.

Hicks, L. E. 1935. Distribution of the breeding birds of Ohio. Ohio Biol. Surv., 6(3):125-190.

Hinebaugh, D. M. 1994. 1994 Cerulean Warbler study. Unpubl. Report to Wisconsin Dept. of Natural Resources.

Holder, T. 1970. Disappearing wetlands in eastern Arkansas. Little Rock, Arkansas Planning Commission.

Howell, A. H. 1911. Birds of Arkansas. USDA Bur. Biol. Surv. Bull. 38.

Howell, A. H. 1924. Birds of Alabama. Dept. of Game and Fisheries of Alabama, Montgomery, AL.

Howell, A. H. 1932. Florida bird life. Florida Dept. of Game and Freshwater Fish, Tallahassee, FL.

Hunter, W. C., D. N. Pashley, and R. E. F. Escano. 1993. Neotropical migratory landbird species and their habitats of special concern within the Southeast region. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 159-171. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Husar, R. B., and J. M. Holloway. 1983. Sulfur and nitrogen over North America. *In* Ecological Effects of Acid Deposition, pp. 95-115 . National Swedish Environment Protection Board Report PM 1636. Solna, Sweden.

Ickes, R. 1992. Cerulean Warbler. *In* Brauning, D. ed. Atlas of Breeding Birds in Pennsylvania, pp. 328-329. Univ. of Pittsburgh Press, Pittsburgh, PA.

Imhof, T. A. 1976. Alabama birds, 2nd ed. Univ. of Alabama Press, Tuscaloosa, AL.

Jackson, J. A., ed. 1981. The "Mid-South Bird Notes" of Ben B. Coffey, Jr. Spec. Publ. No. 1, Mississippi Ornithol. Soc., Mississippi State, MS.

Jacobs, B. and J. D. Wilson. 1997. Missouri breeding bird atlas 1986-1992. Natural History Series, No. 6, Missouri Department of Conservation, Jefferson City, MO.

James, D. A. and J. C. Neal. 1986. Arkansas birds: Their distribution and abundance. Univ. of Arkansas Press, Fayetteville, AR.

James, F. C., C. E. McCulloch, and D. A. Wiedenfeld. 1996. New approaches to the analysis of population trends in land birds. Ecology 77:13-27.

James, F. C. and H. H. Shugart. 1970. A quantitative method of habitat description. Aud. Field Notes 24:727-737.

James, P. 1956. Destruction of warblers on Padre Island, Texas, in May, 1951. Wilson Bull. 68(3):224-227.

Janeway, E. C. 1994. Cerulean Warbler *Dendroica cerulea*. *In* Foss, C. R., K. C. Elkins, D. Miller, E. Miller, T. Richards, eds. Atlas of Breeding Birds in New Hampshire, pp. 385-386. Arcadia Press, Dover, NH.

Janssen, R. B. 1987. Birds in Minnesota. Univ. of Minnesota Press, Minneapolis, MN.

Jehl, J. R., Jr. 1974. The near-shore avifauna of the Middle American West Coast. Auk 91:681-699.

Jones, J., and R. J. Robertson. 1997. ABSTRACT 75: Winter ecology of the Cerulean Warbler in modified Venezuelan landscapes. Presented to the 115th stated meeting of the American Ornithologists' Union, 13-16 August 1997. Minneapolis-St. Paul, MN.

Jones, L. 1914. Nineteen years of bird migration at Oberlin, Ohio. Wilson Bull. 88:198-205.

Kahl, R. B., T. S. Baskett, J. A. Ellis, and J. N. Burroughs. 1985. Characteristics of summer habitats of selected nongame birds in Missouri. Univ. Missouri-Columbia Agric. Exp. Sta. Res. Bull. 1056.

Kendeigh, S. C. 1982. Bird populations in east central Illinois: Fluctuations, variations, and development over a half-century. Illinois Biological Monographs, No. 52.

Kent, T. H., and J.J. Dinsmore. 1996. Birds in Iowa. Published by the authors, Iowa City and Ames, IA.

Kirkwood, F. C. 1901. The Cerulean Warbler (*Dendroica cærulea*) as a summer resident in Baltimore County, Maryland. Auk 18:137-142.

Knutson, M. G., J. P. Hoover, and E. E. Klaas. 1996. The importance of floodplain forests in the consrvation and management of Neotropical migratory birds in the Midwest. *In* Thompson, F. M., ed. Management of midwestern landscapes for the conservation of neotropical migratory birds, pp. 168-188. Gen. Tech. Rep. NC-187. USDA, Forest Service, North Central Forest Expt. Stn., St. Paul, MN.

Koenig, D. 1976. Some unusual nest discoveries. Iowa Bird Life 46:19-20.

Kopman, H. H. 1907. Aspects of bird distribution in Louisiana and Mississippi. Auk 24:169-181.

Land, H. C. 1970. Birds of Guatemala. Livingston Publ. Co., Wynnewood, PA.

Latta, S. C. and M. E. Baltz. 1997. Population limitation in neotropical migratory birds: Comments. Auk 114:754-762.

Leberman, R. C., and M. H. Clench. 1975. Bird-banding at Powdermill, 1974. Powdermill Nature Reserve, Research Rep. No. 35.

LeGrand, H. E., Jr. 1979. Cerulean Warbler colony in Graham County, N.C. Chat 43:20.

Li, P. 1994. Breeding productivity, microhabitat requirements, and parental care of Neotropical migrant birds in the Ozarks of Arkansas. Publication No. 21, Arkansas Cooperative Fish and Wildlife Research Unit, Fayetteville, AR.

Lindsay, P., and T. Vezo. 1992. Probable breeding of Cerulean Warbler on eastern Long Island. Kingbird 42:213-215.

Lindsay, P., and T. Vezo. 1994. Cerulean Warbler confirmed breeding and Acadian Flycatcher probable breeding on eastern Long Island. Kingbird 44:108.

Linehan, J. T. 1973. Nest records of Cerulean Warbler in Delaware. Wilson Bull. 85(4):482-483.

Loetscher, F. W., Jr. 1955. North American migrants in the state of Veracruz, Mexico: A summary. Auk 72:14-54.

Lowery, G. H., Jr. 1974. Louisiana birds, 3rd ed. Louisiana State Univ. Press, Baton Rouge, LA.

Lynch, J. M. 1981. Status of the Cerulean Warbler in the Roanoke River basin of North Carolina. Chat 45:29-35.

Macoun, J. and J. M.Macoun. 1909 . Catalogue of Canadian birds. Government Printing Bureau, Ottawa, Ont.

Martin, T. E. and C. J. Conway. 1994. Breeding Bird (BBIRD) field protocol. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, MT.

Maurer, B. A. 1994. Geographical Population Analysis: Tools for the analysis of biodiversity. Blackwell Scientific Publications, Oxford, UK.

Maxon, W. R. 1903. Notes on the birds of Madison County, New York, with especial reference to Embody's recent list. Auk 20:262-266.

McLaren, I. 1981. The incidence of vagrant landbirds on Nova Scotia islands. Auk 98:243-257.

Mengel, R. M. 1965. The Birds of Kentucky. Ornithological Monogr. 3.

Middleton, D. S. 1957. Notes on the summering warblers of Bruce Township, Macomb County, Michigan. Jack-Pine Warbler 35:71-77.

Milne, B. T. 1991. Chapter 9. Lessons from applying fractal models to landscape patterns. *In* Turner, M. G. and R. H. Gardner, eds. Quantitative methods in landscape ecology, pp. 199-235. New York: Springer-Verlag.

Mlodinow, S. 1984. Chicago Area Birds. Chicago Review Press, Chicago, IL.

Monroe, B. L., Jr. 1968. A distributional survey of the birds of Honduras. Ornithological Monogr. 7.

Moore, F. R., and T. R. Simon. 1992. Habitat suitability and stopover ecology of Neotropical landbird migrants. *In* Hagan, J. M. III and D. W. Johnston, eds. Ecology and conservation of Neotropical migrant landbirds, pp. 345-355. Smithsonian Inst. Press, Washington, D.C.

Moseley, E. L. 1947. Variations in the bird population of the North-Central states due to climatic and other changes. Auk 64:15-35.

Mossman, M. J. 1988. Birds of southern Wisconsin floodplain forests. Passenger Pigeon 50(4):321-337.

Mossman, M. J., and R. M. Hoffman. 1989. Birds of southern Wisconsin upland forests. Passenger Pigeon 51(4):343-358.

Mossman, M. J., and K. I. Lange. 1982. Breeding birds of the Baraboo Hills, Wisconsin: Their history, distribution, and ecology. Wisconsin Dept. of Natural Resources and Wisconsin Society for Ornithology, Madison, WI.

Moulding, J. D. 1976. Effects of a low persistence insecticide on forest bird populations. Auk 93:692-708.

Mueller, A. J., C. R. Loesch, and D. J. Twedt. in press. Developoment of management objectives for breeding birds in the Mississippi Alluvial Valley. Proc. Partners in Flight International Workshop, Cape May, N.J., 1-5 October 1995.

Mumford, R. E. and C. E. Keller. 1984. The birds of Indiana. Bloomington: Univ. Indiana Press.

Murray, B. G., Jr., and F. B. Gill. 1976. Behavioral interactions of Blue-winged and Golden-winged Warblers. Wilson Bull. 88:231-254.

Neal, J. C., and M. A. Mlodinow. 1988. Birding in the western Arkansas Ozarks. J. C. Neal and M. A. Mlodinow, Fayetteville, AR.

Norris, R. T. 1947. The cowbirds of Preston Frith. Wilson Bull. 59:83-103.

Norris, R. A., and D. W. Johnston. 1958. Weights and weight variations in summer birds from Georgia and South Carolina. Wilson Bull. 70:114-129.

Oberholser, H. C. 1938. The bird life of Louisiana. Louisiana Dept. of Conservation, Bull. 28.

Oliarnyk, C. J. 1996. Habitat selection and reproductive success in a population of Cerulean Warblers in southeastern Ontario. M. S. Thesis, Queen's University, Kingston, Ontario, Canada.

Oliarnyk, C. J., and R. J. Robertson. 1996. Breeding behavior and reproductive success of Cerulean Warblers in southeastern Ontario. Wilson Bull. 108(4):673-684.

Ouellet, H. 1966. Histoire et dispersion de la fauvette azurée *Dendroica cerulea* (Wilson) dans la Province de Québec, Canada. Naturaliste Can., 93:335-337.

Ouellet, H. 1967. The distribution of the Cerulean Warbler in the Province of Quebec, Canada. Auk 84:272-274.

Ouellet, H. 1974. Les oiseaux des collines montérégiennes et de la région de Montréal, Québec, Canada. Mus. National des Sciences naturelles, Ottawa, Publ. de Zoologie, no. 5.

Palmer-Ball, B. L., Jr. 1996. The Kentucky breeding bird atlas. The Univ. Press of Kentucky, Louisville, KY.

Parker, T. A. III. 1994. Habitat, behavior, and spring migration of Cerulean Warbler in Belize. Am. Birds 48(1):70-75.

Parker, T. A. III, S. A. Parker, and M. A. Plenge. 1982. An annotated checklist of Peruvian birds. Buteo Books, Vermillion, SD.

Parkes, K. C. 1978. Still another parulid intergeneric hybrid (*Mniotilta* x *Dendroica*) and its taxonomic and evolutionary implications. Auk 95:682-690.

Pearson, T. G., C. S. Brimley, and H. H. Brimley. 1942. Birds of North Carolina. N. C. Dept. Agric., Raleigh, NC.

Peck, G. K. and R. D. James. 1987. Breeding birds of Ontario: Nidiology and distribution. Vol. 2: Passerines. Toronto: Royal Ontario Museum.

Peterjohn, B. G. 1989. The birds of Ohio. Indiana Univ. Press, Bloomington, In.

Peterjohn, B. G., and D. L. Rice. 1991. The Ohio Breeding Bird Atlas. Ohio Dept. of Natural Resources, Division of Natural Areas and Preserves, Columbus, OH.

Peterjohn, B. G., J. R. Sauer, and C. S. Robbins. 1995. Population trends from the North American Breeding Bird Survey. *In* Martin, T. E., and D. M. Finch, eds. Ecology and Management of Neotropical Migratory Birds, pp. 3-39. Oxford Univ. Press, New York, NY.

Peterson, R. A. 1995. The South Dakota Breeding Bird Atlas. South Dakota Ornithologists' Union.

Phelps, W. H. and W. H. Phelps, Jr.. 1950. Lista de las aves de Venezuela con su distribucion. Bol. Sociedad Venezolana de Ciencias Naturales 12(75).

Pyle, P., S. N. G. Howell, R. P. Yunick, D. F. DeSante. 1987. Identification guide to North American Passerines. Slate Creek Press, Bolinas, CA.

Raffaele, H. 1998. Guide to the Birds of the West Indies. Princeton Univ. Press, Princeton, NJ.

Rappole, J. H. and M. V. McDonald. 1994. Cause and effect in population declines of migratory birds. Auk 111(3):652-660.

Remsen, J. V., S. W. Cardiff, D. L. Dittmann, D. A. Wiedenfeld, and M. M. Swan. in preparation. Status and distribution of Louisiana birds. Unpubl. manuscript.

Rhoads, S. N. and C. J. Pennock. 1905. Birds of Delaware: A preliminary list. Auk 22:194-205.

Ridgely, R. S. and P. J. Greenfield. in press. The Birds of Ecuador. Vol. I. Status, distribution and taxonomy. Cornell Univ. Press, Ithaca, NY.

Ridgely, R. S. and G. Tudor. 1989. The Birds of Northern South America. I. The Oscine Passerines. Univ. of Texas Press, Austin, TX.

Ridgway, R. R. 1889. The Ornithology of Illinois. Part I. Descriptive catalogue. State Laboratory of Natural History, Natural History Survey of Illinois, Springfield, IL.

Ridgway, R. R. 1896. Manual of NorthAmerican Birds, 2nd ed. J. B. Lippincott, Philadelphia, PA.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The Breeding Bird Survey: Its first fifteen years, 1965-1979. US Dep. Interior, Fish and Wildlife Service. Resource Publ. 157. Washington, D.C.

Robbins, C. S., D. K. Dawson, and B. A. Dowell. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic states. Wildl. Monogr. 103.

Robbins, C. S., J. W. Fitzpatrick, and P. B. Hamel. 1992a. A warbler in trouble: *Dendroica cerulea*. *In* Hagan, J. M. III and D. W. Johnston, eds. Ecology and conservation of Neotropical migrant landbirds, pp. 549-562. Smithsonian Inst. Press, Washington, D.C.

Robbins, M. B., and D. A. Easterla. 1991. Birds of Missouri: Their distribution and abundance. Univ. of Missouri Press, Columbia, MO.

Robbins, M. B., D. A. Easterla, and D. Mead. 1992b. Avian census of the Nodaway River, northwestern Missouri. Bluebird 59:105-107.

Robbins, S. D. 1991. Wisconsin Birdlife: Population and Distribution Past and Present. Univ. of Wisconsin Press, Madison, WI.

Robbins, S. D., D. W. Sample, P. W. Rasmussen, and M J. Mossman. 1996. the Breeding Bird Survey in Wisconsin: 1966-1991. Passenger Pigeon 58(2):81-178.

Robinson, J. C. 1990. An annotated checklist of the birds of Tennessee. Univ. of Tennessee Press, Knoxville, TN.

Robinson, S. K., S. I. Rothstein, M. C. Brittingham, L. J. Petit, and J. A. Grzybowski. 1995a. Chapter 15. Ecology and behavior of cowbirds and their impact on host populations. *In* Martin, T. E., and D. M. Finch, eds. Ecology and Management of Neotropical Migratory Birds, pp. 428-460. Oxford Univ. Press, New York, NY.

Robinson, S. K., J. Terborgh, and J. W. Fitzpatrick. 1988. Habitat selection and relative abundance of migrants in southeastern Peru. *In* H. Ouellet, ed. Acta XIX Congressus Internationalis Ornithologici, pp. 2298-2307. Univ. of Ottawa Press, Ottawa, Ont., Canada.

Robinson, S. K., F. R. Thompson III, T. M. Donovan, D. R. Whitehead, and J. Faaborg. 1995b. Regional forest fragmentation and the nesting success of migratory birds. Science 267:1987-1990.

Robinson, W. D. 1996. Southern Illinois Birds. Southern Illinois University Press, Carbondale and Edwardsville, IL.

Rosenberg, K. V., and J. V. Wells. 1995. Importance of geographic areas to Neotropical migrant birds in the Northeast. Report submitted to U.S. Fish and Wildlife Service, Hadley, Mass., by Cornell Lab of Ornithology, Ithaca, NY.

Russell, S. M. 1964. Distributional study of the birds of British Honduras. Ornithological Monogr. 1.

Salvin, O. and F. D. Godman. 1879-1904. Biologia Centrali-Americana. Aves. Vol. 1.

Salzman, E. 1983. Cerulean Warbler breeding in Suffolk County. Kingbird 33:105.

Sample, B. E., R. J. Cooper, and R. C. Whitmore. 1993. Dietary shifts among songbirds from a diflubenzuron-treated forest. Condor 95:616-624.

Sauer, J. R. 1993. Monitoring goals and programs of the U.S. Fish and Wildlife Service. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 245-251. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Sauer, J. R. and S. Droege. 1992. Geographic patterns in population trends of neotropical migrants in North America. *In* Hagan, J. M. III and D. W. Johnston, eds. Ecology and conservation of Neotropical migrant landbirds, pp. 26-42. Smithsonian Inst. Press, Washington, D.C.

Saunders, W. E. 1900. Nesting habits of the cerulean warbler. Auk 17:358-362.

Scheider, F. 1959. Warblers in southern sic [central] New York. Kingbird 9:13-19.

Schukman, J. M. 1996. Temporal and spatial relationships of three canopy-dwelling warblers in a Missouri River bottomland forest. Kansas Ornithological Society Bulletin 47(4):37-40.

Schorger, A. W. 1927. Notes on the distribution of some Wisconsin birds. I. Auk 44:235-240.

Scott, [Mrs.] R. T. 1914. Field notes from Cambridge, Ohio. Wilson Bull. 26:214-216.

Simmons, G. F. 1914. Spring migration at Houston, Texas. Wilson Bull. 88:128-140.

Shugart, H. H., Jr., and D. A. James. 1973. Ecological succession of breeding bird populations in northwestern Arkansas. Auk 90:62-77.

Smith, C. R., D. M. Pence, and R. J. O'Connor. 1993. Status of neotropical migratory birds in the Northeast: A preliminary assessment. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 172-188. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Smith, W. P., P. B. Hamel, and R. P. Ford. 1996. Mississippi Alluvial Valley Forest Conversion: Implications for eastern North American avifauna. Proc. 1993 Annu. Conf. Southeast Assocn. Fish and Wildl. Agencies 47:460-469.

Snedecor, G. W., and W. G. Cochran. 1967. Statistical methods, 6th edition. Iowa State Univ. Press, Ames, IA.

Southern Appalachian Man and the Biosphere (SAMAB), coordinator. 1996. The Southern Appalachian Assessment Terrestrial technical report. Report 5 of 5. U.S. Dep. Agric., Forest Service, Southern Region, Atlanta, GA.

Speirs, J. M. 1985. Birds of Ontario. Natural Heritage/Natural History, Toronto, Ont.

Staten, M. and P. Hamel. 1996. Anderson Tully Company's breeding bird field manual: Its contribution to the focus on forest management for the future. *In* Hubbard, B., ed. Proceedings: Education and Communication Applications in Natural Resource Management, pp. 101-103. Georgia Cooperative Extension Service, Athens, GA.

Stephens, L. and M. A. Traylor. 1983. Ornithological gazetteer of Peru. Museum of Comparative Zoology, Harvard Univ., Cambridge, MA.

Stevenson, H. M.,and B. Anderson. 1994. The Birdlife of Florida. Univ. Press of Florida, Gainesville, FL.

Stewart, P. A. 1937. A preliminary list of bird weights. Auk 54:324-332.

Stine, P. M. 1959. Changes in the breeding birds of Bird Haven Sanctuary over a period of forty-five years. Wilson Bull. 71:372-380.

Stone, W. 1937. Bird Studies at old Cape May. Vol. 2. Dover reprints; New York, NY (1965).

Sutton, G. M. 1928. The birds of Pymatuning Swamp and Conneaut Lake, Crawford Co., Pennsylvania. Ann. Carnegie Mus. 18:19-239.

Sutton, G. M. 1967. Oklahoma birds. Univ. of Oklahoma Press, Norman, OK.

Taylor, W. K. and B. H. Anderson. 1973. Nocturnal migrants killed at a central Florida TV tower; autumns 1969-1971. Wilson Bull. 85:42-51.

Terborgh, J. 1989. Where have all the birds gone? Princeton Univ. Press, Princeton, NJ.

Thompson, F. R., S. J. Lewis, J. Green, and D. Ewert. 1993. Status of neotropical migrant landbirds in the Midwest: Identifying species of management concern. *In* Finch, D. M., and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds, pp. 145-158. Gen. Tech. Rep. RM-229. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Thompson, M. C., and C. A. Ely. 1992. Birds in Kansas, vol. 2. Univ. of Kansas, Museum of Natural History, Public Education Series No. 12.

Todd, W. E. C. 1893. Summer birds of Indiana and Clearfield Counties, Pennsylvania. Auk 10:35-46.

Todd, W. E. C. 1940. Birds of Western Pennsylvania. Univ of Pittsburgh Press, Pittsburgh, PA.

Torrey, B. 1896. Virginia notes. Auk 13:179.

Trapp, J. 1967. Observations at a Cerulean Warbler nest during early incubation. Jack-Pine Warbler 45(2):42-49.

U.S. Fish and Wildlife Service. 1987. Migratory nongame birds of management concern in the United States: The 1987 list. U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Washington, D.C.

U.S. Fish and Wildlife Service. 1991a. Endangered and threatened wildlife and plants; animal candidate review for listing as endangered or threatened species, proposed rule. Federal Register 56(25):58804-58836.

U.S. Fish and Wildlife Service. 1991b. Plan for conservation of nongame birds in the northcentral United States. U.S. Fish and Wildlife Service, Fort Snelling, MN.

U.S. Fish and Wildlife Service. 1995. Migratory nongame birds of management concern in the U.S.: the 1995 list. U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Washington, D.C.

U.S. Fish and Wildlife Service. 1996. Endangered and threatened wildlife and plants; review of plant and animal taxa that are candidates for listing as endangered and threatened. Federal Register 61(40):7596-7693.

Vanderah, G. C. 1993. Habitat preferences of the declining cerulean warbler. Illinois Natural History Survey Reports 320:3-4.

Vanderah, G. C., and S. K. Robinson. 1995. Habitat selection of Cerulean Warblers in Illinois. ABSTRACT. Presented at 113th Stated Meeting, American Ornithologists' Union, Cincinnati, Ohio, 15-19 August 1995.

Veit, R. R., and W. R. Petersen. 1993. Birds of Massachusetts. Mass. Audubon Society, Boston, MA.

Villard, M.-A., and B. A. Maurer. 1996. Geostatistics as a tool for examining hypothesized declines in migratory songbirds. Ecology 77:59-68.

Walkinshaw, L. H. 1968. Observations of summering and migrating wood warblers in Muskegon County. Jack-Pine Warbler 46(2):42-56.

Warner, D. W. 1950. Summer bird life of Carimona Woods Fillmore County, Minnesota. The Flicker 22:27-34.

Wetmore, A., et al. 1964. Song and Garden birds of North America. National Geographic Society, Washington, D.C.

Wetmore, A., R. F. Pasquier, and S. L. Olson. 1984. Birds of the Republic of Panama, part 4. Passeriformes: Hirundinidae (Swallows) to Fringillidae (Finches). Smithsonian Misc. Coll. 150(4):1-670.

Widmann, O. 1895a. Swainson's Warbler an inhabitant of the swampy woods of southeastern Missouri. Auk 12:112-117.

Widmann, O. 1895b. The Brown Creeper nesting in the cypress swamp of southeastern Missouri. Auk 12:350-355.

Widmann, O. 1897. The summer home of Bachman's Warbler no longer unknown. Auk 14:305-309.

Widmann, O. 1907. A preliminary catalog of the birds of Missouri. Trans. Acad. Sci. St. Louis, 17:1-296.

Wiedenfeld, D. A. and M. G. Wiedenfeld. 1995. Large kill of Neotropial migrants by tornado and storm in Louisiana, April, 1993. Journ. Field Ornithol. 66:70-80.

Willson, M. F., J. R. Karr, and R. R. Roth. 1975. Ecological aspectss of avian bill-size variation. Wilson Bull. 87:32-44.

Wilson, A. 1810. American Ornithology, vol. 2. Bradford and Inskeep, Philadelphia, PA.

Wilson, A. 1811. American Ornithology, vol. 3. Bradford and Inskeep, Philadelphia, PA.

Wood, D. A. 1994. Official lists of Endangered & potentially endangered fauna and flora in Florida. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Wood, N. A. 1951. The birds of Michigan. Univ. of Michigan Mus. of Zool. Misc. Publ. No. 75:1-559.

Zimmer, J. T. 1949. Studies of Peruvian birds. No. 54. Amer. Mus. Novitates No. 1428, 1-59.

Table 1.a. List of measurements of cerulean warbler specimens, from a sample of 45 specimens in various plumages in the collections of the U.S. National Museum, and banding records from two locations. Measurements in mm (1mm = 0.039 in).

Measurement[a]	Females			Males		
	Mean		S.E.	Mean		S.E.
Specimens in US National Museum						
	N = 22			N = 23		
Wing Chord[b]	62.3	±	0.29	64.5	±	1.26
Tail ***	40.9	±	0.27	42.4	±	0.25
Exposed Culmen	9.56	±	0.10	9.62	±	0.13
Bill Width	3.57	±	0.06	3.62	±	0.03
Bill Height	3.52	±	0.04	3.43	±	0.04
Diagonal of Tarsus[c] *	14.8	±	0.20	15.7	±	0.14
Middle Toe	11.1	±	na	11.5	±	0.38
Birds Banded at Univ. Southern Mississippi Banding Station						
	N = 33			N = 36		
Wing Chord[b] ***	62.4	±	0.28	65.2	±	0.26
Tarsus[d] (N=16 in each)	16.9	±	0.30	16.6	±	0.16
Birds Banded at Powdermill Nature Reserve, Pennsylvania						
	N = 32			N = 47		
Wing Chord[b] ***	62.2	±	0.34	64.6	±	0.24

[a] Mean values for males and females differ at * - P=0.05, ** - P=0.01, *** - P=0.001

Table 1.a, continued

[b] Pyle et al. (1987) suggest sex differences in wing chord measurements as ♀ 58-64, n=26, and ♂ 62-70, n=30. The data set from Univ. Southern Mississippi includes ♀ 60-66, n=33, and ♂ 62-68, n=36; that from Powdermill Nature Reserve includes ♀ 58.5-68.5, n=32, and ♂ 61.5-68.5, n=47. Thus, substantial overlap occurs between the sexes in wing chord measurement, although males have longer wings on average.

[c] Diagonal of tarsus measured from intertarsal joint to end of last undivided tarsal scute.

[d] Tarsus measurements made from intertarsal joint to the end of the folded joint of the toes (J. Clark, pers. comm., 3 March 1996)

Table 1.b. Weights of cerulean warblers, from various sources. Measurements in g (1g = 0.036 oz).

Source	N	Age and Sex	Weight ($\bar{x} \pm$ S. E.)	Fat Class[a]
Stewart (1937)	1	adult ♂	8.5	?
Norris and Johnson (1958)	1	adult ♂	12.4	5
	5	immature ♀	10.8 ± 0.7	4
	1	immature ♂	9.4	2
Ouellet (1967)	2	adult ♂	10.3	"little"
M.A.P.S.[b] Data set (Feuss, pers. comm. 15 Jan 1997)	23	unspecified	9.07 ± 0.21	≤ 2
Univ. Southern Mississippi Banding Station (J. Clark, pers. comm., 3 March 1996)	33[c]	unspecified ♀	8.04 ± 0.16	any
	(17)	unspecified ♀	7.59 ± 0.13	0
	(7)	unspecified ♀	7.86 ± 0.11	1
	(1)	unspecified ♀	10.4	4
	36	unspecified ♂	8.35 ± 0.19	any
	(19)	unspecified ♂	8.03 ± 0.21	0
	(7)	unspecified ♂	8.33 ± 0.25	1
	(1)	unspecified ♂	13.4	4
Powdermill Nature Reserve Banding Station (M. Niedermeier, pers. comm., 11 October 1996)	34[d]	unspecified ♀	8.83 ± 0.10	any
	(29)	unspecified ♀	8.80 ± 0.11	0
	(4)	unspecified ♀	8.85 ± 0.19	1
	47	unspecified ♂	9.28 ± 0.09	any
	(36)	unspecified ♂	9.19 ± 0.10	0
	(10)	unspecified ♂	9.57 ± 0.19	1

[a] Fat class is an ordinal measure of the amount of fat stored by an animal. Several scales are used in bird banding activity. Pyle et al. (1987) present one such scheme. Helms and Drury (1960) present another. In all schemes, birds with more fat have higher scores. Scores listed indicate fat class for all individuals in that sample.

[b] M.A.P.S. is the Monitoring Avian Productivity and Survivorship project of the Institute for Bird Population Studies, P.O. Box 1346, Pt. Reyes Station, CA 94956 (Feuss, pers. comm., 15 Jan 1997)

[c] Initial row for each gender in the Univ. of Southern Mississippi data set indicates the entire data set for that gender, without regard to fat class or age. Subsequent rows indicate the subsamples for particular fat classes. Birds in other fat classes, e.g., 2 and 3, in the data set are excluded from the table. Difference between the genders in mean value for mass is not significant at p=0.05, by t-test (t=-1.18, df=67, P=0.24).

[d] Initial row for each gender in the Powdermill Nature Reserve data set indicates the entire data set for that gender, without regard to fat class or age. Subsequent rows indicate the subsamples for particular fat classes. Birds in other fat classes, e.g., 2 and 3, in the data set are excluded from the table. Genders differ in mean value for mass, by t-test (t=-3.32, df=79, P<0.001).

Table 2. Synopsis of the distribution of cerulean warblers in North America, from DeSante and Pyle (1986).

Status Distribution
Fairly Common Summer Resident and Confirmed Breeder
Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, West Virginia
Uncommon Summer Resident and Confirmed Breeder
Alabama, Arkansas, Iowa, Louisiana [*sic*], Maryland, Michigan, Minnesota, Missouri, New Jersey, New York, Virginia, Wisconsin
Uncommon Summer Resident and Confirmed Breeder with Limited Distribution
Delaware, Ontario, Texas
Rare Summer Resident and Confirmed Breeder
Connecticut, Georgia [*breeding assumed*], Mississippi [*breeding assumed*]
Rare Summer Resident and Confirmed Breeder with Limited Distribution
Nebraska, North Carolina, Oklahoma, Québec, Vermont
Extremely Rare Summer Resident and Confirmed Breeder
Kansas
Rare Non-breeding Summer Resident with Limited Distribution
Rhode Island
Extremely Rare Non-breeding Summer Resident
Massachusetts, North Dakota
Frequent Transient
Louisiana, Mississippi

Table 2, continued

Status	Distribution
Uncommon Transient	Dist. of Columbia, Georgia, North Carolina, Oklahoma, Texas
Rare Transient	Delaware, Florida, Kansas, Massachusetts, Nebraska, South Carolina
Rare Vagrant	California, Maine
Extremely Rare Vagrant	Arizona, Colorado, Manitoba, not observed for 50 yrs, Nevada, New Brunswick, New Hampshire, North Dakota, Nova Scotia, South Dakota

Table 3.a. Tree species of published nest sites of the cerulean warbler. Sources as in Table 3.b.

Tree Species common name	N	Nest Height [in m], $\bar{x}$ ± s.e., range (ft ± s.e., range)
Acer rubrum red maple	1	10.7 (35)
Acer saccharum sugar maple	1	15.8 (52)
Acer sp. all maples	3	13.2 ± 1.01, 12.2-15.2 (43 ± 3.3, 40-50)
Fagus grandifolia American beech	1	14.0 (46)
Fraxinus americana white ash	1	9.1 (30)
Fraxinus sp. ash species, nonspecified	1	9.1 (30)
Juglans nigra black walnut	1	12.2 (40)
Liriodendron tulipifera tulip poplar	1	14.8 (48)
Quercus alba white oak	8	13.7 ± 1.39, 5.5-18.3 (45 ± 4.6, 18-60)
Quercus macrocarpa bur oak	3	8.6 ± 0.71, 7.9-10.1 (28 ± 2.3, 26-33)
Quercus prinus chestnut oak	1	12.2 (40)
Quercus sp. oak species, nonspecified	9	10.2 ± 1.2, 6.1-16.5 (33 ± 3.9, 20-54)
Quercus rubra northern red oak	1	18.3 (60)
Tilia americana basswood	2	8.7 ± 0.15, 8.5-8.8 (28 ± 0.5, 28-29)
Ulmus sp., probably *Ulmus americana* elms, probably American elm	9	13.3 ± 0.91, 10.7-18.3 (44 ± 3.0, 35-60)
Total	43	12.1 ± 0.54, 5.5-18.3 (39.7 ± 1.8, 18-60)

Table 3.b. Published nest heights of cerulean warbler.

Locality	Low[a]	High[a]	N	Source
Alabama	12 (40)	15 (50)	?	Howell 1924
Alabama	6 (20)	18 (60)	?	Imhof 1976
Delaware	5 (17)	12 (40)	2	Linehan 1973
Illinois	8 (25)	8 (25)	1	Allen 1879
Indiana	6 (20)	15 (50)	?	Butler 1898
Indiana	4.5 (15)	24 (80)	11	
mean	14 (45)			Mumford and Keller, 1984
Iowa	?	?	1	Koenig 1976
Maryland	15 (48.5)	15 (48.5)	1	Bent 1953
Massachusetts	8 (25)	13 (42)	2	Bagg and Eliot 1937
Michigan	4.5 (15)	24 (80)	?	Granlund et al. 1994
Michigan	14 (47)	14 (47)	1	Wetmore et al. 1964
Michigan	8 (26)	8 (26)	1	Walkinshaw 1968
Michigan	9 (29)	9 (29)	1	Trapp 1967
Michigan	18 (60)	18 (60)	1	Middleton 1957
New Jersey	11 (36)	11 (36)	1	Dater 1951
New York	8 (25)	15 (50)	3	Gray 1924
New York	8 (25)	13 (42)	2	Crosby 1923
New York	17 (55)	17 (55)	1	Bent 1953
New York	6 (20)	6 (20)	1	Allen 1879
New York	8 (25)	18 (60)	?	Bent 1953
New York	9 (30)	9 (30)	1	Bent 1953
New York	14 (45)	14 (45)	1	Bent 1953
New York	9 (30)	9 (30)	1	Allen and Belknap 1964
Ohio	9 (30)	30 (100)	?	Peterjohn 1989
Oklahoma	7 (23)	7 (23)	1	Sutton 1967
Ontario	5 (17)	5 (17)	1	Saunders 1900
Ontario	9 (30)	9 (30)	1	Saunders 1900
Ontario	12 (40)	12 (40)	1	Saunders 1900
Ontario	7 (23)	7 (23)	1	Saunders 1900
Ontario	11 (35)	11 (35)	1	Saunders 1900
Ontario	15 (50)	15 (50)	1	Saunders 1900
Ontario	14 (45)	14 (45)	1	Saunders 1900
Ontario	15 (50)	15 (50)	1	Allen 1879
Ontario	7 (23)	18.6 (61)	27	
mean	11.8 (36) ± 0.56 (1.8)			Oliarnyk and Robertson 1996
Ontario	8 (25)	18 (60)	?	Macoun and Macoun 1909
Ontario	8 (25)	18 (60)	6	Speirs 1985
Ontario	5 (17)	15 (50)	4	Bent 1953

Table 3.b, continued

Locality	Low[a]	High[a]	N	Source
Ontario	7.5 (25)	18 (60)	?	Godfrey 1986
Ontario	6 (20)	6 (20)	1	Bent 1953
Ontario	7 (23)	7 (23)	1	Bent 1953
Ontario	9 (30)	9 (30)	1	Bent 1953
Ontario	11 (35)	11 (35)	1	Bent 1953
Ontario	4.5 (15)	20 (66)	38	Peck and James 1987
Ontario	9 (30)	12 (40)	19	Peck and James 1987
Pennsylvania	8 (25)	most above 14 (45)		Brauning 1992
Pennsylvania	12 (40)	12 (40)	1	Burleigh 1923
Pennsylvania	15 (50)	15 (50)	1	Todd 1940
Pennsylvania	5.5 (18)	?	?	Dickey 1920
Pennsylvania	6 (20)	15 (50)	?	Sutton 1928
Rangewide	5 (17)	20 (66)	?	Hamel 1992
Rangewide	12 (40)	18 (60)	12	Harrison 1984
Rangewide	4.5 (15)	27 (90)	?	Griscom and Sprunt 1979
Rangewide	4.5 (15)	27 (90)	?	
majority	9 (30) - 12 (40)			Robbins et al. 1992a
Rangewide	6 (20)	15 (50)	?	Ridgway 1896
Unknown	14 (45)	14 (45)	1	Norris 1947
Wisconsin	4.5 (15)	11 (35)	2	Robbins 1991

[a] Heights in m (ft)

Table 4. Summary of historical nest site and clutch size data for cerulean warblers, including clutch records from the collections of the Western Foundation for Vertebrate Zoology and nest record cards from Cornell Laboratory of Ornithology and other published sources. Heights and dimensions of nests from literature sources cited in Table 3.b.

Locality	N[a]	Height[b], m [ft]	Distance From[b] Bole, m [ft]	Clutch Size[b]
Illinois	2	9.60 ± 2.0 (2; 7.6-11.6) [31 ± 6.6 (2; 25-38)]	-	5.00 ± 0 (1)
Iowa	2	12.20 ± 0 (2; 12.2-12.2) [40 ± 0 (2; 40-40)]	-	-
Maryland	1	14.79 (1) [48]	-	-
Massachusetts	2	10.21 ± 2.59 (2; 7.6-12.8) [33 ± 8.5 (2; 25-42)]	-	-
Michigan	10	12.90 ± 1.23 (10; 7.6-18.3) [42 ± 4.0 (10; 25-60)]	2.44 ± 0.39 (6; 1.2-3.6) [8 ± 1.3 (6; 3.9-11.8)]	4.33 ± 0.21 (6; 4-5)
New Jersey	1	10.98 (1) [39]	-	-
New York	21	11.86 ± 0.87 (21; 6.1-18.3) [39 ± 2.8 (21; 20-60)]	2.44 ± 0.66 (4; 1.2-4.3) [8 ± 2.2 (4; 3.9-14.1)]	3.58 ± 0.15 (12; 3-4)

Table 4, continued

Locality	N[a]	Height[b], m [ft]	Distance From[b] Bole, m [ft]	Clutch Size[b]
Ohio	1	7.62 (1) [25]	-	2.00 (1)
Oklahoma	1	7.01 (1) [23]	-	-
Ontario[c]	22	9.40 ± 0.60 (22; 5.2-15.2) [31 ± 2.0 (22; 17-50)]	1.65 ± 0.31 (5; 0.9-2.7) [5.4 ± 1 (5; 3-8.8)]	3.67 ± 0.17 (9; 3-4)
Ontario[d]	51	median 9-12 (38; 4.5-20) [30-40 (38; 15-66)]	median 1.5-2.4 (24; 1.2-6) [2.3-7.9 (24; 3.9-20)]	3.25, median 4 (36; 1-4)
Pennsylvania	14	13.81 ± 0.73 (14; 9.1-18.3) [45 ± 2.4 (14; 30-60)]	5.18 ± 0.42 (10; 3.0-7.3) [17 ± 1.4 (10; 10-24)]	3.82 ± 0.12 (11; 3-4)
Wisconsin	2	7.62 ± 3.05 (2; 4.6-10.7) [25 ± 1.1 (2; 15-35)]	-	-
Unknown	1	13.72 (1) [45]	-	-

Table 4, continued

Locality	N[a]	Height[b], m [ft]	Distance From[b] Bole, m [ft]	Clutch Size[b]
Rangewide	80	11.35 ± 0.41 (80; 4.6-18.3) [37 ± 1.3 (80; 15-60)]	3.38 ± 0.37 (25; 0.9-7.3) [11 ± 1.2 (25; 3-24)]	3.78 ± 0.10 (40; 2-5)

[a] Number of nest sites examined or reported in the literature. Heights and dimensions of nests from literature sources cited in Table 3.b. Clutch sizes from records of Western Foundation for Vertebrate Zoology and Cornell Laboratory of Ornithology Nest Record Card Program.

[b] Expressed as Mean ± standard error (sample size on which mean is based; range)

[c] These values do not include the data of Oliarnyk (1996); see Table 5.

[d] From Peck and James (1987)

Table 5. Summary of recent observations of nest sites from study sites at edges of range of cerulean warblers, with reference to data from Table 4.

Site and Sample Size, (Source)			
Tree Dimensions[a]		Nest Site Measurements[a]	
Height m [ft]	Diameter at Breast Height, cm [in]	Height m [ft]	Distance from bole m [ft]
Chickasaw National Wildlife Refuge, Tennessee, n=15 nests, (Hamel, unpubl.)			
29.5 ± 1.4 (19-38) [97 ± 4.6 (62-125)]	62.3 ± 6.6 (21-108) [24.5 ± 2.6 (8-42)]	19.3 ± 1.1 (13-27) [63 ± 3.6 (43-89)]	6.8 ± 1.0 (2.3-12) [22 ± 3.3 (7.5-39)]
Desha Delta Hunt Club, Arkansas, n=19 nests, (Hamel, unpubl.)			
27.3 ± 2.0 (13-43) [90 ± 6.6 (43-141)]	52.9 ± 4.8 (24-87) [20.8 ± 1.9 (9-34)]	17.0 ± 1.1 (9-25) [56 ± 3.6 (30-82)]	3.5 ± 0.5 (0.8-7) [11.5 ± 1.6 (2.6-23)]
Meeman Shelby Forest State Park, Tennessee, n=16 nests, (Hamel, unpubl.)			
31.9 ± 1.7 (22-49) [105 ± 5.6 (72-161)]	44.4 ± 3.2 (29-74) [17.5 ± 1.3 (11-29)]	22.8 ± 1.7 (12-36) [75 ± 5.6 (39-118)]	3.2 ± 0.4 (1-6.5) [10.5 ± 1.3 (3.3-21)]
All nests from Mississippi Alluvial Valley above, 1992-1995, n=50 nests, (Hamel, unpubl.)			
29.4 ± 1.0 (13-49) [79 ± 3.3 (43-161)]	53.2 ± 3.0 (21-108) [20.9 ± 9.8 (8-42)]	19.5 ± 0.8 (9-36) [64 ± 2.6 (30-118)]	4.4 ± 0.4 (0.8-12) [14.4 ± 1.3 (2.6-39)]
Ontario, 1994-1995, n=27 nests, (Oliarnyk and Robertson 1996)			
17.7 ± 0.7 [58 ± 2.3]	40.2 ± 5.1 [15.8 ± 2.0]	11.8 ± 0.6 [39 ± 2.0]	3.6 ± 0.3 [11.8 ± 1.0]
Literature and Collection Data, n=80 nests (see Table 4)			
-	-	11.4 ± 0.4 (4-18, n=80) [37 ± 1.3 (13-60, n=80)]	3.4 ± 0.4 (0.9-7.3, n=25) [11.1 ± 1.3 (3-24, n=25)]

Table 5, continued

Site and Sample Size, (Source)	Tree Dimensions[a]		Nest Site Measurements[a]	
	Height m [ft]	Diameter at Breast Height, cm [in]	Height m [ft]	Distance from bole m [ft]
Published Ranges of Nest Heights[b], n=15 ranges, (see Table 3.b)				
	-	-	13.0 (median) (4-31) [43 (median) (13-102)]	-

[a] Entries are listed as Mean ± S. E. (Range)

[b] A number of authors present only the minimum and maximum height of nests reported to them. These data represent the summary of the median values from those reports.

Table 6. Cerulean warbler bandings by locality, from the records of the Bird Banding Laboratory, 1955-1995[a].

Nation	Province/State	Number of Birds				
		Dec-Feb	Mar-Apr	May-Jul	Aug-Nov	Total
Bahama Islands		.	.	.	1	1
Belize		.	1	.	1	2
Bermuda		.	.	.	1	1
Canada	New Brunswick	.	.	1	1	2
	Ontario	.	1	63	4	68
Costa Rica		.	.	.	4	4
Cuba		.	.	.	2	2
USA	Alabama	.	18	4	9	31
	Arkansas	.	2	.	.	2
	California	.	.	2	1	3
	Connecticut	.	.	8	3	11
	Delaware	.	.	.	1	1
	Florida	.	4	.	2	6
	Georgia	.	.	1	.	1
	Illinois	.	2	30	8	40
	Indiana	.	.	18	1	19
	Iowa	.	.	10	.	10
	Kansas	.	.	16	.	16

Table 6, continued

Nation	Province/State	Number of Birds				
		Dec-Feb	Mar-Apr	May-Jul	Aug-Nov	Total
	Kentucky	.	1	.	.	1
	Louisiana	.	32	10	.	42
	Maine	.	.	1	6	7
	Maryland	.	.	13	12	25
	Massachusetts	.	.	.	9	9
	Michigan	.	1	42	6	49
	Minnesota	.	.	8	2	10
	Mississippi	.	24	1	1	26
	Missouri	.	.	5	.	5
	Nebraska	.	.	1	.	1
	Nevada	.	.	1	.	1
	New Jersey	.	1	14	3	18
	New York	.	.	32	11	43
	North Carolina	.	.	1	1	2
	Ohio	.	8	213	7	228
	Oklahoma	.	.	1	.	1
	Pennsylvania	.	4	111	53	168
	Rhode Island	.	.	2	2	4
	South Carolina	.	.	.	1	1

Table 6, continued

Nation	Province/State	Number of Birds				
		Dec-Feb	Mar-Apr	May-Jul	Aug-Nov	Total
	Tennessee	.	2	20	6	28
	Texas	1	62	12	.	75
	Virginia	.	1	19	7	27
	West Virginia	.	6	86	28	120
	Wisconsin	.	1	22	7	30
Venezuela		.	.	.	2	2
Total		1	171	768	203	1143

[a] As of August 1999, the total reported bandings was 1399 individuals (K. Klimkiewicz, Biologist, Bird Banding Laboratory, pers. comm., September 1999).

Table 7. Summary of migration information on the cerulean warbler.

Nation / Province/State	SEASON
SPRING MIGRATION	
Canada	
Ontario	
Banding records from Long Point Bird Observatory (J. McCracken, Long Point Bird Observatory, pers. comm. 21 August 1996) indicate that most movement of cerulean warblers through the observatory is in the spring (27 of 28 records), from 18 April to 25 May.	
Quebec	
Earliest arrival 1 May (Cyr and Larivée 1995).	
United States	
Alabama	
Late March arrival in both coastal and mountain localities in the state (Imhof 1976); migrants have left coastal situations by 21 April.	
Arkansas	
Statewide arrive very late March, becoming more numerous in 3rd-4th wk of April, widespread after that (James and Neal 1986). Northeastern Arkansas - occur 2nd wk April - 2nd wk of May, recently as transient only. Neal and Mlodinow (1988) note the birds arrive in the Ozarks in mid-April, leave in the latter half of August, and that status in late summer and early fall is poorly known.	
Florida	
Specimen dates: 23 March - 1 May and 15 July - 5 October. Sight records 1 April - 21 May and 11 July - 15 October. As many as 141 have been found as casualties at Florida TV towers (Stevenson and Anderson 1994).	

Table 7, continued

SEASON

Nation

Province/State

SPRING MIGRATION, continued

Georgia

Perhaps the most dependable location to observe numbers of migrating cerulean warblers is Kennesaw Mountain, where as many as 19/day have been recorded during nearly daily visits to the site during the migration period (Giff Beaton, pers. comm.) Data from Kennesaw Mountain, reflecting cumulative numbers observed by year, 1995-1997:

Year	Date at which percentile of observations occurred 25%	50%	75%	Total Range of Dates Observed
	April	April	April	April to May
1995	19	25	28	15 7
1996	20	27	28	14 2
1997	16	22	26	8 12

Illinois

Usually arrive about 15 April, arrivals continuing throughout late April (Robinson 1996, Bohlen 1989).

Iowa

Usual arrival after mid-April, most commonly in May (Kent and Dinsmore 1996).

Kansas

Usual arrival 24 April, most migrants gone by 10 May (Thompson and Ely 1992).

Kentucky

Usually arrives in mid-April, attaining maximum numbers by 1 May (Mengel 1965).

Table 7, continued

SEASON

Nation
Province/State

SPRING MIGRATION, continued

Louisiana

Beyer et al. (1906) indicate arrival about 4 April on a warm spell, rare in southeastern Louisiana in spring. Frank Moore (unpubl. report, Bill Vermillion, Louisiana Dept. of Wildlife and Fisheries, pers. comm., 24 Sept. 1996), in a 1988 study, first encountered a bird on 13 April at Peveto Beach Woods, Cameron Parish. Bailey and Wright (1931) considered the birds to be "Not Abundant" in southeastern Louisiana, where they arrive rather early in the spring and depart early in the fall.

Massachusetts

108 records 1954-1981, 20 April - early June, almost all single individuals (Veit and Petersen 1993).

Michigan

Arrive in southern Lower Peninsula in first or 2nd wk of May, maybe late April, peaking about mid-May (Adams in Granlund et al. 1994).

Mississippi

Frank Moore (unpubl. report, Bill Vermillion, Louisiana Dept. of Wildlife and Fisheries, pers. comm., 24 Sept. 1996), in a 1988 study, first encountered a bird on 11 April at East Ship Island, Harrison Co.

Missouri

Early April arrival, peak migration in early May (Robbins and Easterla 1991).

New York

27 April, more usually mid-May arrival (Bull 1974).

Table 7, continued

SEASON

Nation
Province/State

SPRING MIGRATION, continued

North Carolina

Brimley (1917) lists species as transient, 8 May 1893 is his only spring record.

Ohio

Jones (1914) lists earliest of 19 appearances as 29 April, median first date as 4 May at Oberlin. Peterjohn (1989) lists 25-30 April arrival, few migrants detected after 20 May.

Oklahoma

Usual arrival in late April, early date 27 March (Baumgartner and Baumgartner 1992).

Rhode Island

Ferren (pers. comm. Oct 1996) lists 58 May records, 2-31 May, 55% between 12-23 May.

Tennessee

Repeatedly in first week of April at Memphis (Jackson 1981). Typically arrives by mid-April (Robinson 1990), with early dates of 29 Mar in middle Tennessee, 5 April in west Tennessee, and 11 April in east Tennessee.

Texas

Simmons (1914) lists the migratory period as 28 March - 21 April at Houston.

Virginia

Last week in April to May 1 (Bailey 1913).

Table 7, continued

Nation / Province/State	SEASON
FALL MIGRATION	
Canada	
Quebec	
Latest departure 22 August (Cyr and Larivée 1995).	
United States	
Alabama	
Coastal records 18 July - 16 Sept, Coastal Plain records to 24 Sept (Imhof 1976).	
Arkansas	
Statewide seen with regularity thru July, poorly known later, with few reports in August and September, latest a single bird in Chicot Co. in 2nd week of Sept. (James and Neal 1986).	
Florida	
Taylor and Anderson (1973) note TV tower kills from late August - late September.	
Georgia	
As in the spring, Kennesaw Mountain is a dependable place to observe migrants in the fall (Giff Beaton and Chuck Hunter, pers. comm.).	
Illinois	
Few birds encountered after singing ends in June (Graber et al. 1983), late dates 28 September in north and central regions and 30 September in the St. Louis area.	

Table 7, continued

SEASON

Nation
Province/State

FALL MIGRATION, continued

Iowa

Usual departure apparently in August, with fewer than 10 records after July (Kent and Dinsmore 1996).

Kansas

Usual departure August, late date 13 September (Thompson and Ely 1992).

Kentucky

Poorly known after early August, majority of birds apparently gone by early September, late date 20 October 1886 (Mengel 1965).

Louisiana

23 July (1959) - 21 October (1984). Beyer et al. (1906) note that an occasional individual is seen with the first migrating Yellow Warblers and Black-and-white Warblers around 15 July (Remsen et al. in preparation).

Massachusetts

Much rarer than in spring, 10 August - 29 September, including one record from bird aboard ship in Georges Bank (Veit and Petersen 1993).

Michigan

Apparent departure as early as late July, perhaps through August and into early September (Adams in Granlund et al. 1994). Fall migration poorly documented (Wood 1951; Adams 1991).

Missouri

Mid-August-early September departure, late dates 28 Sept 1897, 26 Sept 1968 (Robbins and Easterla 1991).

Table 7, continued

Nation / Province/State	SEASON
FALL MIGRATION, continued	
New York	
As late as 5 October, but rarely reported in the fall (Bull 1974). Boulton (1924) noted a female feeding with Palm Warblers and Black-throated Green Warblers at 6m (20 ft) in Central Park on 15 Sept. 1923.	
North Carolina	
Transient 29 August - 16 September (Brimley 1917).	
Ohio	
August-early September peak, ending usually by 25 September, perhaps as late as 9 October (Peterjohn 1989).	
Oklahoma	
Usually depart late July, records extend through August to 1 Sept (Baumgartner and Baumgartner 1992).	
Rhode Island	
Ferren (pers. comm. Oct 1996) lists 4 fall records 17 Aug - 16 Sept.	
South Carolina	
Occasional to uncommon during late August (17th) to the first week in September (4th) at Caesar's Head State Park (I. Pitts, SC Dept. Parks, Recreation, and Tourism, pers. comm., 26 August 1996), when the birds are more numerous than in the spring.	
Tennessee	
Robinson (1990) reports that the birds depart usually by early Sept., with late dates of 1 Sept. in west Tennessee, 4 Oct in east Tennessee, and 6 Oct in middle Tennessee.	

Table 7, continued

Nation / Province/State	SEASON
FALL MIGRATION, continued	
Caribbean Islands	
Very rare migrant, primarily in western islands, in September and October (Raffaele 1998).	

Table 8. Breeding Bird Survey trend data for the cerulean warbler, current through June 1998. Areas for which trends could confidently be estimated, using criteria of adequate sample size provided by the BBS office, minimally 10 routes/interval.

Area	Periods and Trends[a]								
	1966-1998					1966-1979		1980-1998	
	R.A.	N	Trend	(95% C. I.)		N	Trend	N	Trend
States									
IN	0.29	14	-7.7***	-11.6	-3.8	--	--	14	-8.8
KY	1.01	23	-6.2	-14.7	2.2	14	-7.1**	14	-1.8
MD	0.32	14	1.3	-3.0	5.7	6	-4.7	14	-1.7
OH	1.57	40	-3.0 *	-6.4	0.4	17	-9.4***	36	1.9
PA	0.33	39	-1.2	-4.5	2.0	14	-3.3	32	2.2
TN	0.89	13	-4.8**	-7.9	-1.7	10	-5.0**	10	-0.6
VA	0.72	14	-18.0	-45.9	9.9	5	-9.9	12	1.6
WV	3.50	43	-2.3**	-4.2	-0.3	23	1.9	35	-0.1
BBS Strata[b]									
S13	0.78	30	1.5	-4.7	7.7	8	11.6	27	4.5
S14	0.43	26	-5.1**	-9.6	-0.7	15	-7.3 **	20	-0.6
S21	3.22	22	-3.7***	-5.2	-2.3	9	-1.8	17	-0.7
S22	4.14	62	-1.9**	-3.5	-0.3	28	-4.2 **	56	0.2
S24	0.24	42	-3.7	-8.5	1.0	24	-5.3	31	2.9
US Fish and Wildlife Service Regions[c]									
Re3	0.35	76	-4.6***	-6.8	-2.4	28	-9.3***	67	-3.7*
Re4	0.55	45	-5.7***	-9.1	-2.4	29	-6.8***	30	-0.8
Re5	0.83	122	-2.4**	-4.3	-0.6	51	0.6	103	0.6
Entire BBS by portion of Continent[d]									
Eas	0.52	233	-3.5***	-4.8	-2.1	101	-3.8***	195	-0.6
US	0.53	244	-3.6***	-5.0	-2.2	109	-4.5***	200	-0.7
SUR	0.45	246	-3.6***	-5.1	-2.2	110	-4.4***	201	-0.7

Table 8, continued

[a] Trend information is presented as: R.A. - relative abundance over the period, expressed as mean number of birds recorded per route per year; N - the number of routes on which R.A. and Trend are based for the particular period; and Trend, which is the average annual percentage change in population over the period, based upon the BBS route-regression protocol. 95% C.I. is the lower and upper limits of the confidence interval in which 95% of mean values for trend are expected to fall, given the variability of trends calculated for the several routes in the area during the period. Asterisks indicate probabilities that the trend is equal to zero, as * - P<0.10, ** - P<0.05, and *** - P<0.01.

[b] BBS Strata are as follows: 13 - Ridge and Valley; 14 - Highland Rim; 21 - Cumberland Plateau; 22 - Ohio Hills; 24 - Allegheny Plateau.

[c] Regions include states as follows: Region 3 (IL, IN, IA, MI, MN, MO, OH, WI); Region 4 (AR, AL, FL, GA, KY, LA, MS, NC, SC, TN, PR); Region 5 (CT, DE, ME, MD, MA, NH, NY, PA, RI, VT, VA, WV).

[d] Eas - Eastern half of Continent; US - United States; SUR - Entire Breeding Bird Survey area (United States and Canada).

Table 9. Breeding Bird Survey trend data for the cerulean warbler, current through 1998. Areas for which trends could not confidently be estimated, primarily because of small sample sizes of routes, minimally 10 routes/interval.

Area	Trend 1966-1998[a]		
	Relative Abundance	N	Trend
States			
Alabama	0.07	2	-10.4
Arkansas	0.08	6	-21.3
Connecticut	0.01	2	13.3
Illinois	0.01	2	-9.6
Michigan	0.13	8	-4.4
Missouri	0.04	5	-1.4
New Jersey	0.49	2	36.6
New York	0.02	7	5.2
Wisconsin	0.02	6	-7.6
Physiographic Strata[b]			
S04	0.13	5	-9.1
S10	0.14	5	2.4
S11	0.02	2	-42.2
S12	0.01	2	13.3
S15	0.18	5	-13.9
S16	0.10	13	-2.4
S17	0.02	3	-6.1
S19	0.06	9	-13.8
S20	0.08	6	-6.6
S31	0.02	6	-13.0
1CE	0.05	13	-12.4

[a] Trend information is presented as: R.A. - relative abundance over the period, expressed as mean number of birds recorded per route per year; N - the number of routes on which R.A. and Trend are based for the particular period; and Trend, which is the average annual percentage change in population over the period, based upon the BBS route-regression protocol. P is the probability that the trend estimate is zero, based upon the N and Variance observed.

Table 9, continued

[b] Physiographic Strata are as follows: 04 - Upper Coastal Plain; 10 - Northern Piedmont; 11 - Southern Piedmont; 12 - Southern New England; 15 - Lexington Plain; 16 - Great Lakes Plain; 17 - Wisconsin Driftless Area; 19 - Ozark-Ouachita Plateau; 20 - Great Lakes Transition; 31 - Till Plains; 1CE - Central Region.

Table 10. Physiographic areas, or strata, employed in the North American Breeding Bird Survey and mapped in Figure 2, from Robbins et al. (1986).

Stratum	Name
Atlantic Coastal Plain	
01	Subtropical
02	Floridian section
03	Lower Coastal Plain
04	Upper Coastal Plain
05	Mississippi Alluvial Plain
06	East Texas Prairies
07	South Texas Brushlands
08	Glaciated Coastal Plain
Eastern Piedmont Plateau	
10	Northern Piedmont
11	Southern Piedmont
12	Southern New England
13	Ridge and Valley
14	Highland Rim
15	Lexington Plain
16	Great Lakes Plain
17	Wisconsin Driftless Area
18	St. Lawrence Plain
19	Ozark-Ouachita Plateau
20	Great Lakes Transition
Appalachian Mountains and Boreal Forest	
21	Cumberland Plateau
22	Ohio Hills
23	Blue Ridge Mountains
24	Allegheny Plateau
25	Open Boreal Forest
26	Adirondack Mountains
27	Central New England
28	Spruce-Hardwood Forest
29	Closed Boreal Forest
30	Aspen Parklands
Great Plains	
31	Till Plains
32	Dissected Till Plains
33	Osage Plains
34	High Plains Border
35	Staked and Pecos Plains

Table 10, continued

Stratum	Name
36	High Plains
37	Drift Prairie
38	Missouri Plateau-Glaciated
39	Missouri Plateau-Unglaciated
40	Black Prairie
53	Edwards Plateau
54	Colorado and Uinta Basins
Western Mountains	
61	Black Hills
62	Southern Rocky Mountains
63	High Plateaus of Utah
64	Central Rocky Mountains
65	Dissected Rocky Mountains
66	Sierra-Trinity Mountains
67	Cascade Mountains
68	Canadian Rocky Mountains
Arid Interior	
81	Mexican Highlands
82	Sonoran Desert
83	Mojave Desert
84	Pinyon-Juniper Woodland
85	Pitt-Klamath Plateau
86	Wyoming Basin
88	Great Basin
89	Columbia Plateau
Pacific Slope	
91	Central Valley
92	California Foothills
93	Southern Pacific Rain Forest
94	Northern Pacific Rain Forest
95	Los Angeles Ranges

Table 11. Current population estimates of cerulean warblers as proportion of 1966 populations, estimated from trend data in Table 8. These are projections of mean annual trends to the entire survey period.

Locality	1998 Population Estimate as Percent of 1966 estimate, based on trend estimates		
	1966-1998 Trend[a]	1966-1998 95% Conf. Interval[b]	Composite of 1966-1979 and 1980-1998 Trends[c]
States			
Indiana	8	2 - 29	.
Kentucky	13	0.6 - 200	28
Maryland	151	38 - 589	39
Ohio	38	12 - 114	39
Pennsylvania	68	23 - 188	96
Tennessee	21	8 - 58	46
Virginia	0.2	0 - 2050	34
West Virginia	47	25 - 91	125
Physiographic Areas			
Ridge and Valley	161	21 -1074	920
Highland Rim	19	4 - 80	33
Cumberland Plateau	30	19 - 47	70
Ohio Hills	54	32 - 91	59
Allegheny Plateau	30	6 - 137	82
Fish & Wildlife Service Regions			
FWS Region 3	22	11 - 46	54
FWS Region 4	15	5 - 46	35
FWS Region 5	46	25 - 82	120
Larger areas			
Eastern U.S.	32	21 - 51	54
U.S.	31	19 - 49	48
Entire BBS	31	19 - 49	49

Table 11, continued

[a] 1998 Estimate calculated as $(1966\text{-}1998\ \text{Trend})^{32}$

[b] Lower and Upper Limits on the 1966-1998 Estimate of Trend calculated as (Lower 95% Conf. Limit of $1966\text{-}1998\ \text{Trend})^{32}$ and (Upper 95% Conf. Limit of $1966\text{-}1998\ \text{Trend})^{32}$

[c] 1998 Estimate as Composite of 1966-1979 Trend and 1980-1998 Trend, calculated as $(1966\text{-}1979\ \text{Trend})^{13} * (1980\text{-}1998\ \text{Trend})^{18}$

Table 12. Legal status and Heritage Program rank of cerulean warbler in the political divisions of its range.

Nation Province/State	Legal Status[a]	Heritage Program[b] Rank	Track[b]
Global or Rangewide		G	
Netherlands Antilles		NAN	
Bolivia		N1N2N	
Brazil		NAN	
Bahamas		NAN	
Belize		NN	
Canada		N?B, NZN	
Manitoba		S?	N
Ontario	Vulnerable	S3B, SZN	Y
Quebec		S1B	Y
Colombia		N3N	
Cali		S?	I
Costa Rica		NN	
Cuba		NAN	
Ecuador		N2N	
Guatemala		NN	
Honduras		NN	
Jamaica		NAN	
Cayman Islands		NAN	
Mexico		NZN	
Nicaragua		NN	
Panama		N2N3N	
Peru		N1N2N	
Surinam		NAN	
United States		N4B, NZN	
Alabama		S3	Y
Arizona		SAN	N
Arkansas		S4	N
California		SA	N
Connecticut		S3B,SZN	Y
Delaware	Threatened	S1B	Y
District of Columbia		S?	N
Florida		S?	N
Georgia		S3?	Y

Table 12, continued

Nation Province/State	Legal Status[a]	Heritage Program[b] Rank	Track[b]
United States, continued			
Great Smoky Mountains National Park		P1B, PZN	W
Illinois		S3	W
Indiana	Special Concern	S2	Y
Iowa		S2B	N
Kansas	Species in Need of Concern	S1B	Y
Kentucky		S4	Y
Louisiana	Special Concern	S1B	Y
Maine		S?	
Maryland	Watch List	S3S4B	W
Massachusetts		S?	N
Michigan	Special Concern	S3	Y
Minnesota	Special Concern	S?	Y
Mississippi	Special Concern	S?B, SZN	N
Missouri	Watch List	S?	W
Nebraska		S2	Y
Nevada		SA	N
New Hampshire		S1B	Y
New Jersey		S3	Y
New Mexico		S1N	N
New York	Special Concern	S4B	N
North Carolina	Significantly Rare	S3B, SZN	Y
North Dakota		S?	N
Ohio	Special Interest	S?	N
Oklahoma		S2B	Y
Pennsylvania		S4B	N
Rhode Island	Threatened	S1B,S2N	Y
South Carolina		S?	N
South Dakota		S?	Y
Tennessee		S3	Y
Tennessee Valley Authority		S?	N
Texas		S3B	Y
Vermont	Special Concern	S1B, SZN	Y

Table 12, continued

Nation Province/State	Legal Status[a]	Heritage Program[b] Rank	Track[b]
United States, continued			
Virginia		S4	N
Wisconsin	Threatened	S2S3B, SZN	Y
West Virginia		S4B	N
Venezuela		N2N	

[a] Legal protection designation or status within the statutes of the political entity. Designations listed here are those specifically indicating protection of cerulean warblers. Legal recognition under the general wildlife laws of the several states is not indicated here; rather it is assumed.

[b] Element Rank and Tracking status from the relevant office of the Natural Heritage network of Biological and Conservation Data Centers, a program initiated by The Nature Conservancy. Information courtesy of the Conservation Science Division, The Nature Conservancy (Kelley Watson, pers. comm., 5 Aug 1995, amended). Ranks are listed as @#$, where @ is N - nation, S - state or province, or P - park; # is 1 - critically imperiled within the geographic area (typically fewer than 5 occurrences), 2 - imperiled within the geographic area (usually 6 to 20 occurrences), 3 - either very rare and local throughout its range or found only in restricted range within the geographic area (usually 21 to 100 occurrences), 4 - widespread, abundant, and apparently secure within the geographic area (usually more than 100 occurrences), 5 - demonstrably widespread, abundant, and secure within the geographic area, A - accidental, Z - of regular temporal occurrence within the geographic area, but not at a specific, permanently dependable site, as a migratory bird, ? - not ranked; $ is B - breeding season, N - nonbreeding period. Tracking status is N - not tracked by the data center, Y - actively tracked by the data center, W - watch list, or occurrences noted and monitored informally, [blank] indicates no information.

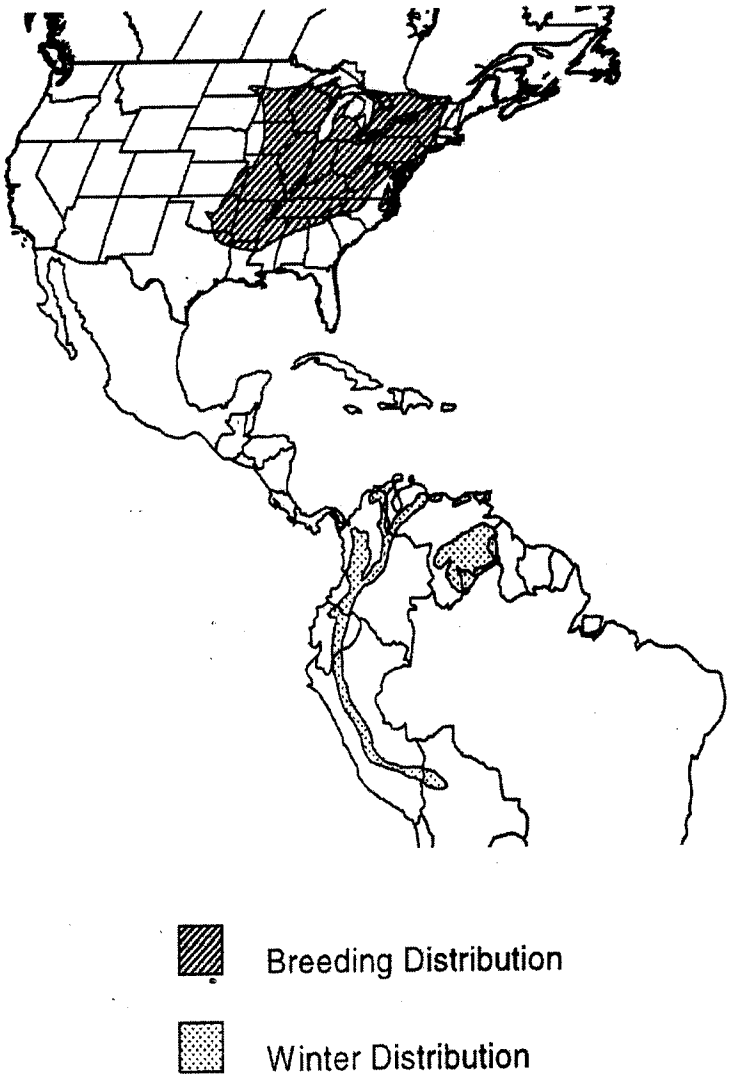


Figure 1. Geographic range of the cerulean warbler. Sources are as listed in the section on **Range**. Winter range includes specimen and sight records from Robbins et al. (1992a).

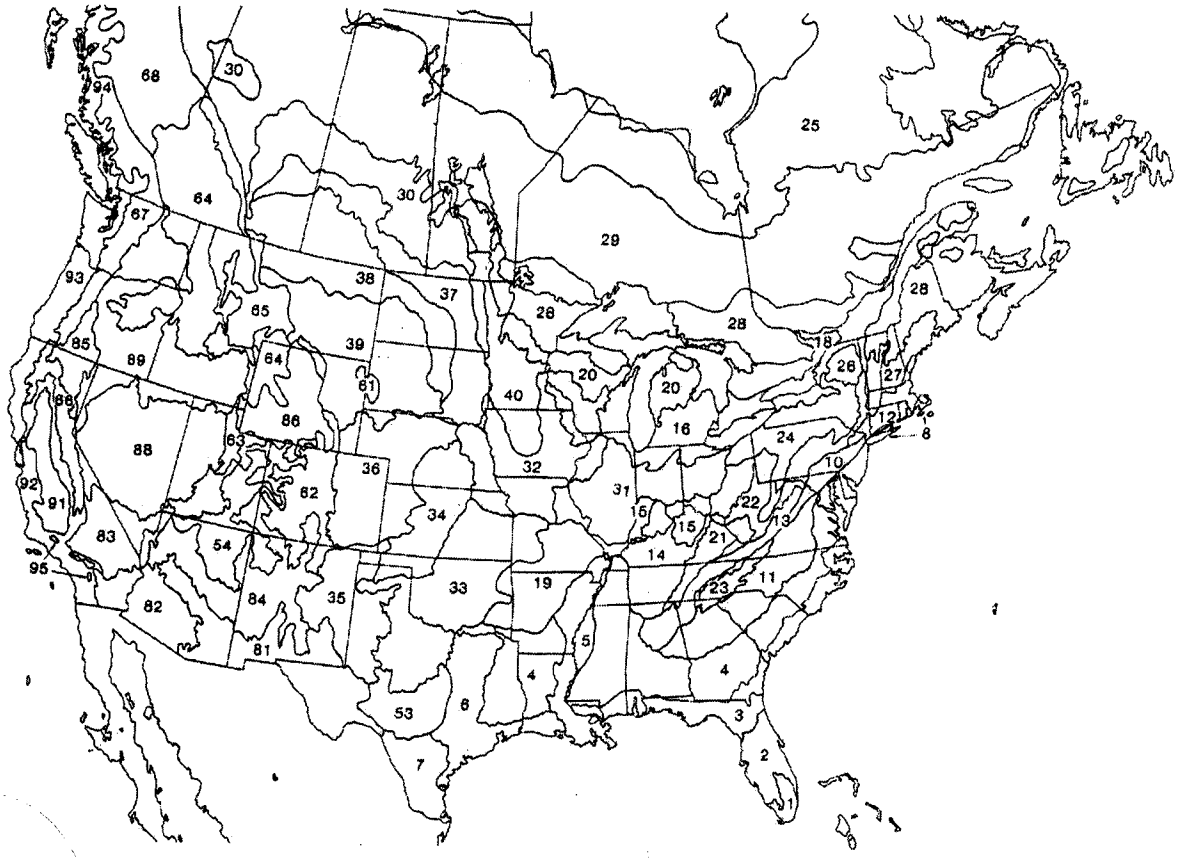


Figure 2. Physiographic areas, or strata, used in the North American Breeding Bird Survey, from Robbins et al. (1986). Stratum numbers and names are included in Table 10.

Cerulean Warbler densities on Breeding Bird Census Plots censused at least 5 times, 1932-1993

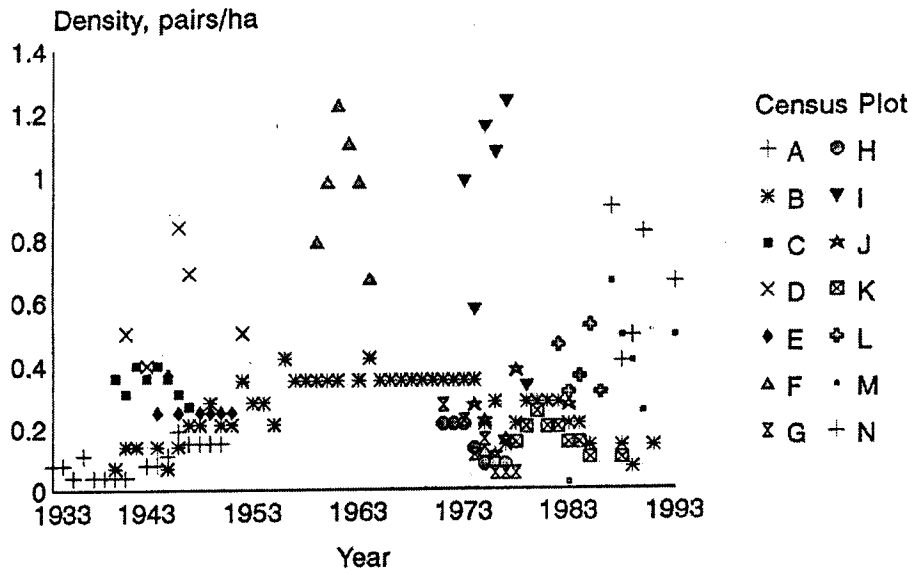


Figure 3. Cerulean warbler breeding density as recorded on Breeding Bird Census plots. Only plots censused at least 5 times between 1932 and 1993 are included. Plots designated in figure, (Site reference number from Breeding Bird Census files), State, mean ± standard deviation of density in pairs/ha (1 pr/ha = 0.4 pr/acre), sample size of years recorded, early and late years recorded on plot, are as follows: **A** (32001), OH, 0.10 ± 0.05, N=16, 1932-1950; **B** (37200), OH, 0.26 ± 0.10, N=47, 1940-1991; **C** (40030), OH, 0.35 ± 0.05, N=8, 1940-1947; **D** (41037), OH, 0.58 ± 0.18, N=5, 1941-1952; **E** (44027), VA, 0.26 ± 0.05, N=7, 1944-1951; **F** (59010), IN, 0.84 ± 0.36, N=7, 1959-1975; **G** (71035), MD, 0.13 ± 0.09, N=7, 1971-1978; **H** (71036), MD, 0.14 ± 0.06, N=7, 1971-1977; **I** (73092), OH, 0.89 ± 0.36, N=6, 1973-1979; **J** (74131), PA, 0.24 ± 0.10, N=6, 1974-1983; **K** (78237), OH, 0.16 ± 0.05, N=9, 1978-1987; **L** (82314), PA, 0.39 ± 0.09, N=5, 1982-1986; **M** (83031), VA, 0.38 ± 0.22, N=6, 1983-1993; **N** (87013), VA, 0.66 ± 0.21, N=5, 1987-1993.

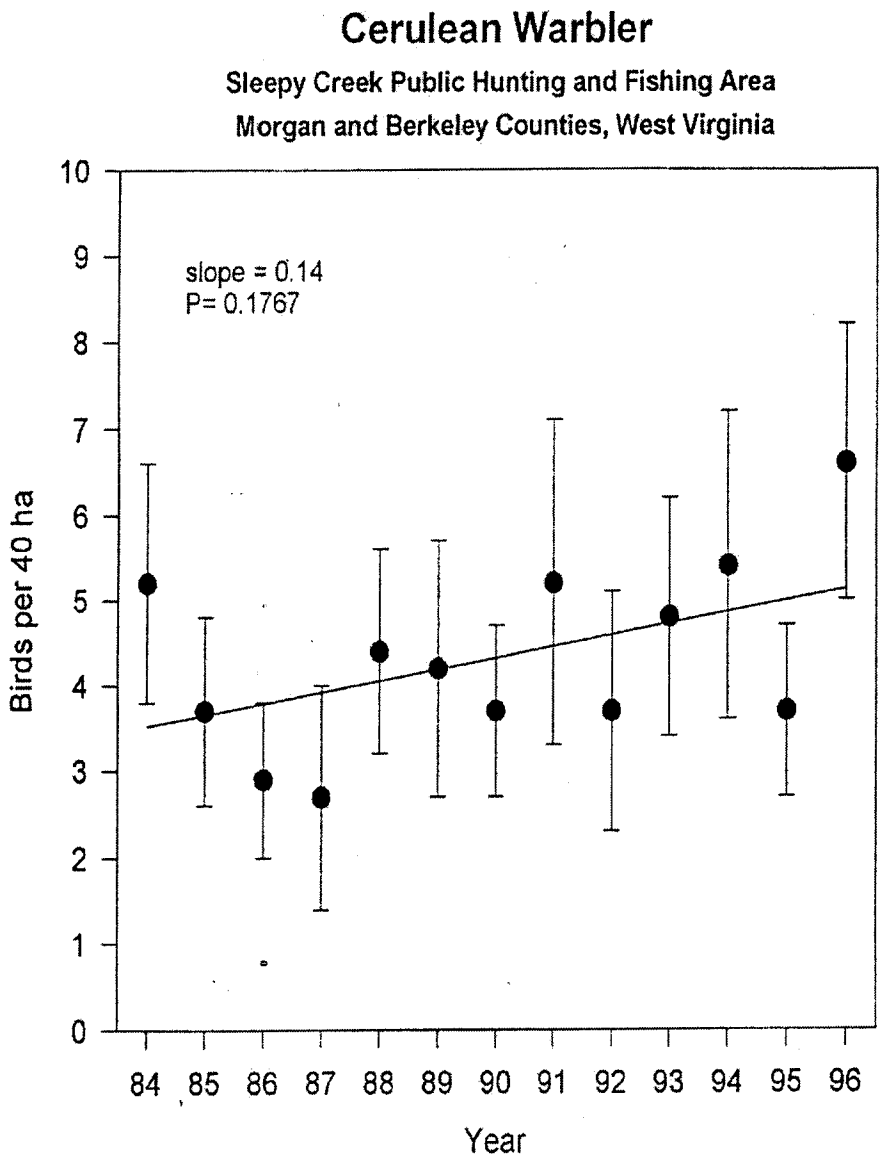


Figure 4. Numbers of cerulean warblers on a study area in Morgan and Berkeley Counties, West Virginia (personal communication of Jennifer Bell and Robert Whitmore, 17 September 1996).

14. APPENDIX

Rappole and McDonald (1994) present 14 predictions based on the hypothesis that populations of Nearctic avian migrants are declining as a result of events during the breeding season. Application of the predictions to evaluate the locations and causes of decline of cerulean warbler populations; summarized as (+) prediction of breeding season limitation verified, (-) prediction refuted, (0) insufficient data; follows.

> 1. "Wintering sites for migrants should not be limited. Migrants should have their choice of optimal winter habitat sites, and should not occupy suboptimal sites." (0)

Detailed information concerning the actual distribution of cerulean warblers among a variety of sites and habitats must be gathered to assess this prediction. Current data are not sufficient to make a conclusive statement about this prediction, because no study capable of distinguishing optimal from suboptimal sites has been conducted. No work on the actual change in abundance of these habitats over time has been conducted either. The work cited by Robbins et al. (1992a) on loss of forest habitats at 400-1400m elevations on the eastern slopes of the Andes is suggestive, however. Gross extent of montane forests is declining as previously forested areas are converted to a more varied landscape of agricultural and other land uses in response to rising human populations in the winter range of the species. Decline in available habitat is related to the increase in abundance of the cultivation of coca in the northern Andes in South America.

> 2. "If breeding habitats are limiting, apparently suitable but marginal breeding habitats (i.e. lower in relative fitness than optimal breeding habitats) should appear filled with individuals of both sexes attempting to breed, regardless of the pressure from nest predation, parasitism, or similar fragmentation effects, since the principal alternative would be to forego breeding altogether (zero fitness)." (-)

Full assessment of this prediction cannot be made at the present time, because too few detailed studies of the breeding biology of cerulean warblers have been conducted. However, the great variety of forest types in which the birds occur, and the varied flora of their breeding sites, would suggest that potentially suitable breeding habitats are not filled. Indeed, it may be that many such localities are now devoid of the birds. If such is the case, then nonbreeding habitat limitation may be indicated.

> 3. "Migratory bird declines should not be observed in breeding habitats that are undisturbed, and presumably optimal." (+?, 0)

Undisturbed, presumably optimal breeding habitats currently are concentrated in the upper Ohio River valley in eastern Kentucky, eastern Tennessee, southeastern Ohio, and West Virginia. Even in these areas, however, "undisturbed" habitats are not truly

numerous. BBS trend data indicate declining populations in these areas in the center of the range, however (Peterjohn, pers. comm., 24 June 1996; Maurer 1994).

4. "Declines should not occur in species where no apparent change has occurred in breeding habitat." (0)

This prediction cannot be assessed with respect to cerulean warbler because it is obvious that enormous areas formerly occupied at high density by the species are no longer available as breeding habitat because of land conversion from forest to agricultural and suburban/urban land uses.

5. "Spring return rates by adults to unaltered, optimal breeding sites should be higher than return rates by adults to unaltered winter sites in optimal habitat." (0)

Two studies of return rates of birds to breeding localities are currently underway, in the Mississippi Alluvial Valley (Hamel, unpubl. data), and in Ontario (Oliarnyk, pers. comm. 10 June 1996). Too few data exist at present to estimate spring return rates. No data exist on return rates to unaltered winter sites. This sort of work is a high priority activity for future work on the species.

6. "The proportion of young birds allowed to enter the breeding population should decrease as the amount of quality breeding habitat decreases relative to quality winter habitat." (0)

No work on this prediction has yet been done. One possible approach to this question would be work on relative abundance of SY vs ASY males and females in the breeding populations sampled by collections in the past, compared to relative abundance of SY vs ASY birds in current breeding populations. Comparison of proportion of young entering the breeding population will likely require assessment of survivorship of fledglings. No existing work provides the opportunity to estimate fledgling survivorship.

7. "The number of nonbreeding males in the breeding population should be high." (0)

Extensive work on breeding populations, including colormarking individuals, should provide data on the numbers of breeding and nonbreeding, or at least territorial and nonterritorial individuals in local populations. Whether the numbers of nonbreeders is actually "high" will probably be a matter of subjective judgment at such time as the numbers of breeders and nonbreeders can be identified in several populations. At present, it is premature to evaluate this prediction.

8. "There should be little or no evidence of floaters (wanderers) in wintering populations." (0)

No work has been done on aspects of winter occurrence other than the distribution of birds in qualitative surveys. Detailed work on winter populations should provide a test of this prediction. No winter capturing of cerulean warblers has been conducted, although individuals have been captured in general netting work (P. Mena, Ecociencia, pers. comm., 10 August 1995).

9. "The number of breeding individuals in populations of migrants in optimal habitats should not fluctuate appreciably with predator/prey and climatic cycles on the breeding ground because they will be buffered by the effect of having excess numbers of potential breeders in the population." (+?)

Current work on populations in the Mississippi Alluvial Valley has been conducted for five years, which is sufficient to permit tentative estimates of the number of breeding territories in several localities. Whether these estimates of occupied territories are sufficiently precise and occupy sufficiently wide areas to be estimates of the numbers of individuals in breeding populations is not clear. Potentially, at least, data exist to assess this prediction in a limited way, and they suggest that the prediction may be verifiable.

10. "The numbers of territorial individuals in optimal winter habitat should show sharp annual fluctuations." (0)

No demonstration of territoriality among winter cerulean warblers has yet been made. Numbers of individuals reported in mixed species flocks, as usually single birds, suggests that territoriality may in some sense occur in cerulean warblers in winter. If so, then this prediction is susceptible of test. No test of this prediction has yet been attempted.

11. "Alteration of breeding habitat could bring some species with similar ecological requirements into competition, forcing genetic or competitive replacement of one of the species." (+)

Studies of breeding canopy warblers in the Mississippi Alluvial Valley have the potential of testing this prediction (Hamel, unpubl. data). Over a five-year period, we have conducted detailed work on cerulean warblers, as well as mapping territories of other breeding warblers, northern parula , yellow-throated warbler, and American redstart, may provide some insight into this question in one locality. We have observed apparent countersinging between cerulean warblers and northern parulas on certain occasions. We have also seen a small number of physical aggressive encounters between female cerulean warblers, American redstarts, and blue-gray gnatcatchers over nesting material, particularly the spider webs and coccoons used by each of these species to attach their nests to the supporting twigs. Ironically, Kirkwood (1901) noted

an American redstart pulling nesting material from a non-redstart nest very similar to a cerulean warbler nest he later found; he also observed a male cerulean warbler attack a female American redstart. Kirkwood (1901) made his observations in forest near his home, in an area possibly altered by clearing for orchard and grazing by hogs. However, his locale also included "considerable woods in its original state, on one side."

Ontario workers have observed aggressive interactions between cerulean warblers and red-eyed vireos (*Vireo olivaceus*) and least flycatchers (*Empidonax minimus*; Jason Jones, pers. comm., September 1996.). Lynch (1981) describes similar interactions between the warbler and the same vireo, but concludes that the species coexist peacefully. Murray and Gill (1976) noted both blue- and golden-winged warblers chasing cerulean warblers.

> 12. "Declines in Nearctic migrants should be paralleled by changes in temperate, nonmigrant populations occupying the same breeding habitats." (+?)

This prediction, which assumes that factors on the breeding ground affect all species in the fauna equally, will be a relatively easy prediction to test. However, because the number of cerulean warblers on BBS data sets is small, some of these tests may not fully examine the prediction. Smith et al. (1996) discovered significant declines in breeding birds in forest habitats in the Mississippi Alluvial Valley, but because the numbers of all forest breeding birds in the Mississippi Alluvial Valley BBS data sets were small, the tests, while instructive, were not especially satisfactory.

> 13. "Declines in Nearctic migrants should not be paralleled by changes in nonmigrant populations occupying the same wintering habitats." (0, -?)

Unfortunately, inasmuch as few data on trends of populations of cerulean warblers in the wintering grounds exist, similarly few data exist on the numbers of nonmigrant species. Because of wholesale changes in forested environments brought about by human colonization of habitats between 400-1400m in the eastern Andes, this prediction would appear to be false.

> 14. "The ratio of songbirds migrating in fall compared to spring should increase over time." (0)

This prediction is potentially a very powerful one, and potentially susceptible of test. No satisfactory data on this prediction yet exist. Numbers of birds captured at traditional banding stations are potentially instructive. Migration is notoriously variable, and slight changes in wind patterns may create conditions that move the stream of migrants toward, or away from, traditional banding locations. Banding results for cerulean warblers suggest that this ratio will be difficult to test, based upon the much greater capture rates of the birds in the spring, when they are apparently easier to capture than in the fall.

Summary of the results of this preliminary evaluation of the predictions of Rappole and McDonald (1994)-- (+) 1, (+?) 3, (0) 10, (-?) 1, (-) 1 -- indicates the need for detailed quantitative work on the biology of this species in several areas each on the breeding and winter grounds.

15. LIST OF CONTACTS

Information Requests

Information on the status of the cerulean warbler was requested from the following people in the summer of 1996:

Mr. Pierre Aquin
Ministry of Environment and Wildlife
Service des Habitats
150 Rene Levesque Blvd. E.
5th floor
Quebec City, QUE G1R 4Y1
CANADA

Mr. Roger L. Banks, Field Supervisor
Charleston Field Office
U.S. Fish and Wildlife Service
P. O. Box 12559
Charleston, SC 29422-2559

Mr. Lee Barclay, Field Supervisor
Cookeville Field Office
U.S. Fish and Wildlife Service
446 Neal St.
Cookeville, TN 38501

Dr. Jonathan Bart
Dept. of Zoology
1735 Neill Ave.
Ohio State Univ.
Columbus, OH 43210

Mr. Robert G. Bowker, Field Supervisor
Jackson Field Office
U.S. Fish and Wildlife Service
6578 Dogwood View Parkway, Suite A
Jackson, MS 39213

Mr. Allen Boynton
North Carolina Wildlife Resources
Commission
161 Frank Allman Rd.
Morgantown, NC 28655-9023

Mr. Dan Brauning
Pennsylvania Game Commission
RD 2, Box 484
Montgomery, PA 17752

Mr. Ken Brunson, Coordinator
Nongame Program
Kansas Department of Wildlife and
Parks
RR 2, Box 54A
Pratt, KS 67124-9599

Dr. David Buehler
Dept. of Forestry, Wildlife, and Fisheries
P.O. Box 1071
Knoxville, TN 37901-1071

Ms. Dorothy Butler
Missouri Dept. of Conservation
P.O. Box 180
2901 W. Truman Blvd.
Jefferson City, MO 65102-0180

Ms. Gail A. Carmody, Field Supervisor
Panama City Field Office
U.S. Fish and Wildlife Service
1612 June Ave
Panama City, FL 32405-3721

Ms. Catherine Carnes
U.S. Fish and Wildlife Service
1015 Challenger Court
Green Bay, WI 54311

Mr. Denis Case
Ohio Department of Natural Resources
Fountain Square, Bldg. C-4
Columbus, OH 43224

Mr. John Castrale
Indiana Department of Natural Resources
Rural Route #2, Box 477
Mitchell, IN 47446

Mr. John Cely
South Carolina Dept. of Wildlife and Marine Resources
Nongame and Heritage Trust Section
P.O. Box 167
Columbia, SC 29202

Mrs. Jeannie Clark
Mountwood Park
2620 27th Ave.
Parkersburg, WV 26101

Mr. Patrick O. Corr, Bird Group Leader
Maine Dept. of Inland Fisheries and Wildlife
650 State St.
Bangor, ME 04401-5654

Mr. Ralph Costa, Field Supervisor
Clemson Field Office
U.S. Fish and Wildlife Service
Dept. of Forest Resources
Clemson University
261 Lehotsky Hall, Box 341003
Clemson, SC 29634-1003

Mr. Jim Cox
Florida Game and Fresh Water Fish Commission
320 South Meridian St.
Tallahassee, FL 32399-1600

Mr. Jerry Davis
USDA Forest Service
Ouachita National Forest
P.O. Box 1270
Hot Springs, AR 71902

Mr. Mike DeCapita
U.S. Fish and Wildlife Service
302 Manly Miles Building
1405 South Harrison Rd.
East Lansing, MI 48823

Dr. David F. DeSante
Institute for Bird Populations
P. O. Box 1346
Pt. Reyes Station, CA 94956-1346

Ms. Jenny Dickson
Wildlife Division
Connecticut Dept. of Environmental Protection
Sessions Woods WMA
P.O. Box 1550
Burlington, CT 06013

Mr. John Dinan
Nongame Bird Program Manager
Nebraska Game and Parks Commission
2200 N. 33rd St.
P.O. Box 30370
Lincoln, NE 68503-0370

Dr. Douglas D. Dow
P. O. Box 557
Harbor Springs, MI 49740

Ms. Bonita Eliason
Minnesota Department of Natural Resources
Box 7, 500 Lafayette Rd.
St. Paul, MN 55155

Mr. Buddy Fazio
U.S. Fish and Wildlife Service
6950-H Americana Parkway
Reynoldsburg, OH 43068

Dr. Thomas French
Natural Heritage & Endangered Species Program
Massachusetts Division of Fisheries and Wildlife
Route 135
Westborough, MA 01581-3337

Mr. David Fruge, Field Supervisor
Lafayette Field Office
U.S. Fish and Wildlife Service
Brandywine II, Suite 102
825 Kaliste Saloom Road
Lafayette, LA 70508

Ms. Lisa Gelvin-Innvaer
Division of Fish and Wildlife
Delaware Dept. of Natural Resources and Environmental Control
4876 Hay Point Landing Rd.
Smyrna, DE 19977

Mr. Larry E. Goldman, Field Supervisor
Daphne Field Office
U.S. Fish and Wildlife Service
Daphne E. Office Plaza
2001 Hwy 98, Suite A
P. O. Drawer 1190
Daphne, AL 36526

Dr. Russ Greenberg
Smithsonian Migratory Bird Center
National Zoological Park
Washington, DC 20008

Mr. J. A. Grom
North Park, 575 Brown Rd.
Wexford, PA 15090

Dr. George A. Hall
Rt. 12, Box 89
Morgantown, WV 26505

Mr. Dave Hankla, Field Supervisor
Jacksonville Field Office
U.S. Fish and Wildlife Service
6620 Southport Drive, S
Suite 310
Jacksonville, FL 32216-0912

Mr. John Harcus
Ministry of Natural Resources
6th Floor, ICI Bldg.
90 Sheppard Ave. East
North York, Ontario
CANADA M2N 3A1

Mr. Robert M. Hatcher
Tennessee Wildlife Resources Agency
Nongame Program
P.O. Box 40747
Nashville, TN 37214

Mr. Ronnie Haynes, Field Supervisor
Brunswick Field Office
U.S. Fish and Wildlife Service
4270 Norwich St.
Brunswick, GA 31520-2523

Mr. John Hefner, Field Supervisor
Raleigh Field Office
U.S. Fish and Wildlife Service
551-F Pylon Drive
P.O. Box 33726
Raleigh, NC 27636-3726

Ms. Lisa Hemesath
Iowa Department of Natural Resources
1436 255th St.
Boone, IA 50036

Mr. W. H. Hoover
6220 Gum Street
Alexandria, VA 22310

Mr. Mark Howery
Oklahoma Dept. of Wildlife Conservation
1801 North Lincoln
Oklahoma City, OK 73105

Mr. Keith Hudson
Alabama Department of Conservation and Natural Resources
Division of Game and Fish
309 Knightsbridge Rd.
Florence, AL 35631

Mr. Brad Jacobs
Missouri Dept. of Conservation
P.O. Box 180
2901 W. Truman Blvd.
Jefferson City, MO 65102-0180

Mr. L. G. Johnson
10217 Yale Bridge Road
Rockton, IL 61072

Mr. John Kanter, Coordinator
Nongame & Endangered Wildlife Program
2 Hazen Drive
Concord, NH 03301

Mr. Chuck Kjos
U.S. Fish and Wildlife Service
4101 East 80th Street
Bloomington, MN 55425-1665

Mr. Vernon Kleen
Illinois Department of Conservation
Lincoln Tower Plaza
524 S. Second Street
Springfield, IL 62706

Mr. C. H. Knight
8400 Clear Vista Place
Apt. Coventry,Room 105
Indianapolis, IN 46256-3741

Dr. Melinda Knutson
Upper Mississippi Science Center
P. O. Box 818
National Biological Service
La Crosse, WI 54602

Ms. Suni Lawless, Coordinator
Nongame Program
Kentucky Department of Fish and Wildlife
#1 Game Farm Road
Frankfort, KY 40601

Ms. Kathleen Leo, Project Leader
West Virginia Department of Commerce, Labor
and Environmental Resources
Nongame Wildlife Program
P.O. Box 67
Elkins, WV 26241

Mr. John McCracken
Long Point Bird Observatory
P. O. Box 160
Port Rowan, ON N0E 1M0
CANADA

Mr. Sumner Matteson
Wisconsin Department of Natural Resources
Bureau of Endangered Resources, Box 7921
Madison, WI 53707

Dr. Paul McKenzie
U.S. Fish and Wildlife Service
608 East Cherry Street, Room 207
Columbia, MO 65201

Mrs. M. E. Miller
3354 Canacee Drive
Mobile, AL 36693

Mr. Robert Miller
Wildlife Resources Center
New York State Department of
Environmental Conservation
Game Farm Rd.
Delmar, NY 12054-9767

Dr. Frank R. Moore
Dept. Biological Sciences
Univ. of Southern Mississippi
Box 5018
Hattiesburg, MS 39406-5018

Mr. Allen Mueller, Field Supervisor
Vicksburg Field Office
U.S. Fish and Wildlife Service
2524 S. Frontage Rd., Suite B
Vicksburg, MS 39180-5269

Mr. Chuck Nicholson, WT8C
Tennessee Valley Authority
400 West Summitt Hill Drive
Knoxville, TN 37902-1499

Dr. F. O. Novy,
John J. Flora
3636 Williams
Dearborn, MI 48124

Ms. Amelia Orton-Palmer
U.S. Fish and Wildlife Service
1000 Hart Road, Suite, 180
Barrington, IL 60010

Dr. Kenneth C. Parkes
Carnegie Museum of Natural History
4400 Forbes Ave.
Pittsburgh, PA 15213

Mr. Steve Parren
Vermont Department of Fish and
Wildlife
103 South Main St.
Waterbury, VT 05671-0501

Mr. E. W. Peartree
713 Madison St.
Apartment 205
Sauk City, WI 53583

Dr. Bruce Peterjohn
Breeding Bird Survey
Patuxent Environmental Science Center
12100 Beech Forest Rd.
Laurel, MD 20708

Dr. Dan Petit
Office of Migratory Bird Management
634 Arlington Square
Washington, DC 20240

Mr. Scott Pruitt
U.S. Fish and Wildlife Service
620 S. Walker
Bloomington, IN 47403

Mr. Chris Raithel
Rhode Island Division of Fish and
Wildlife
P.O. Box 218
West Kingston, RI 02892

Dr. John H. Rappole
Conservation & Research Center
Front Royal, VA 22630

Mr. Rick Reynolds
Virginia Dept. of Game and Inland
Fisheries
Nongame and Endangered Species Unit
P.O. Box 996
Verona, VA 24482

Ms. Cecilia M. Riley
Gulf Coast Bird Observatory
9800richmond Ave., #150
Houston, TX 77042

Dr. Scott Robinson
Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820

Ms. Karen Rowe, Nongame Wildlife Biologist
Arkansas Game and Fish Commission
Hampton Waterfowl Research Center
Route 1, Box 188-A
Humphrey, AR 72073

Mr. Ray Rustem
Michigan Department of Natural Resources
Box 30028
Steven T. Mason Bldg.
Lansing, MI 48909

Mr. David P. Scott
Ohio Division of Wildlife
8589 Horseshoe Rd.
Ashley, OH 43003

Mr. M. C. Shieldcastle
5939 Bodi Rd.
Oak Har bor, OH 43449

Mr. Don Sutherland
NHIC
P.O. Box 7000
300 Water St.
Peterborough, Ontario K9J 8M5
Canada

Mr. Glenn D. Therres, Supervisor
Nongame and Urban Wildlife Program
Maryland Department of Natural Resources
P. O. Box 68
Wye Mills, MD 21679

Dr. Frank Thompson
U.S. Forest Service
I-26 Agricultural Bldg.
University of Missouri
Columbia, MO 65211

Mr. L. J. Trott, Jr.
The Madeira School
8328 Georgetown Pike
McLean, VA 22102

Mr. Bill Vermillion
Louisiana Natural Heritage Program
Department of Wildlife and Fish
P. O. Box 98000
Baton Rouge, LA 70898-9000

Dr. Donald Whitehead
Dept. of Biology
Indiana University
Bloomington, IN 47405

Dr. Bob Whitmore
Division of Forestry and Wildlife Biology
West Virginia University
P.O. Box 6125
Morgantown,WV 26506-6125

Ms. E.J. Williams
Georgia Dept. of Natural Resources
Nongame Wildlife Program
Route 5, Box 180
Forsyth, GA 31029

Mr. Jim D. Wilson
Missouri Department of Conservation
P.O. Box 180
Jefferson City, MO 65102-0180

Dr. Mark Woodrey
Mississippi Department of Wildlife, Fisheries and Parks
Museum of Science
111 North Jefferson St.
Jackson, MS 39202

Requests for Review

The following people were contacted asking for a review of the status assessment based on their response to the earlier requests or my specific intention to ask them for help.

Mr. Ray Adams
Kalamazoo Nature Center
7000 N. Westnedge Ave.
Kalamazoo, MI 49007

Mr. Pierre Aquin
Ministry of Environment and Wildlife
Service des Habitats
150 Rene Levesque Blvd. E.
5th floor
Quebec City, QUE G1R 4Y1
CANADA

Mr. Gerry Bade
U.S. Fish and Wildlife Service
4469-48th Avenue Court
Rock Island, IL 61201

Mr. Lee Barclay, Field Supervisor
Cookeville Field Office
U.S. Fish and Wildlife Service
446 Neal St.
Cookeville, TN 38501

Dr. Jerry Bartelt
Wisconsin DNR
1350 Fem??te Drive
Monona, WI 53716

Mr. Dan Brauning
Pennsylvania Game Commission
RD 2, Box 484
Montgomery, PA 17752

Dr. Jeff Brawn
Illinois Natural History Survey
607 East Peabody
Champaign, IL 61820

Mr. Ken Brunson, Coordinator
Nongame Program
Kansas Dept. of Wildlife and Parks
RR 2, Box 54A
Pratt, KS 67124-9599

Dr. David Buehler
Dept. of Forestry, Wildlife, and Fisheries
P.O. Box 1071
Knoxville, TN 37901-1071

Ms. Catherine Carnes
U.S. Fish and Wildlife Service
1015 Challenger Court
Green Bay, WI 54311

Mr. John Castrale
Indiana Department of Natural
Resources
Rural Route #2, Box 477
Mitchell, IN 47446

Mr. John Cely
South Carolina Dept. of Wildlife and
Marine Resources
Nongame and Heritage Trust Section
P.O. Box 167
Columbia, SC 29202

Dr. Richard Coon
U.S. Fish and Wildlife Service - Refuges
1875 Century Blvd.
Atlanta, GA 30345

Mr. Jerry Davis and Mr. Larry Hedrick
USDA Forest Service
Ouachita National Forest
P.O. Box 1270
Hot Springs, AR 71902

Ms. Jenny Dickson
Wildlife Division
Connecticut Dept. of Environmental Protection
Sessions Woods WMA
P.O. Box 1550
Burlington, CT 06013

Ms. Bonita Eliason
Minnesota DNR, Box 7
500 Lafayette Road
St. Paul, MN 55155

Dr. John Faaborg
University of Missouri
106 Tucker Hall
Columbia, MO 65211

Mr. Buddy Fazio
U.S. Fish and Wildlife Service
6950-H Americana Parkway
Reynoldsburg, OH 43068

Mr. Richard Ferren
17 Hubbard St.
Lenox, MA 01240

Dr. John Fitzpatrick
Cornell Lab of Ornithology
159 Sapsucker Woods Rd.
Ithaca, NY 14850

Mr. Bob Ford
Tennessee Conservation League
300 Orlando Ave.
Nashville, TN 37209

Ms. Lisa Gelvin-Innvaer
Division of Fish and Wildlife
Delaware Dept. of Natural Resources and Environmental Control
4876 Hay Point Landing Rd.
Smyrna, DE 19977

Dr. Russ Greenberg
Smithsonian Migratory Bird Center
National Zoological Park
Washington, DC 20008

Mr. Robert M. Hatcher
Tennessee Wildlife Resources Agency
Nongame Program
P.O. Box 40747
Nashville, TN 37214

Ms. Lisa Hemesath
Iowa Dept. of Natural Resources
Wildlife Research Station
1436 255th Street
Boone, IA 50036

Mr. Bill Howe
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, NM 87103

Daryl Howell
IADNR Bureau of Preserves & Ecology
Henry Wallace Bldg.
Des Moines, IA 50319

Mr. Mark Howery
Oklahoma Dept. of Wildlife Conservation
1801 North Lincoln
Oklahoma City, OK 73105

Mr. Keith Hudson
Alabama Department of Conservation and Natural Resources
Division of Game and Fish
309 Knightsbridge Rd.
Florence, AL 35631

Mr. Chuck Hunter
U.S. Fish and Wildlife Service
1875 Century Blvd., Suite 200
Atlanta, GA 30345

Mr. Brad Jacobs
Missouri Dept. of Conservation
P.O. Box 180
2901 W. Truman Blvd.
Jefferson City, MO 65102-0180

Mr. Andrew Jones
West Virginia Department of
Commerce, Labor
and Environmental Resources
Nongame Wildlife Program
P.O. Box 67
Elkins, WV 26241

Ms. Stephanie Jones
U.S. Fish and Wildlife Service
P.O. Box 25486, DFC
Denver, CO 80225

Mr. Chuck Kjos
U.S. Fish and Wildlife Service
4101 East 80th Street
Bloomington, MN 55425-1665

Dr. Melinda Knutson
Upper Mississippi Science Center
P. O. Box 818
National Biological Service
La Crosse, WI 54602

Ms. Sue Lauzon
Illinois DNR
Endangered Species Protection Board
Div. Natural Heritage
524 So. 2nd Street
Springfield, IL 62706-1787

Dr. Stephen J. Lewis
U.S. Fish & Wildlife Service
Great Lakes - Big Rivers Region
Federal Bldg, 1 Federal Drive
Fort Snelling, MN 55111 - 4056

Sumner Matteson
Wisconsin Department of Natural
Resources
Bureau of Endangered Resources, Box
7921
Madison, WI 53707

Dr. Mary Victoria McDonald
Dept. of Biology
Lewis Science Center 105
University of Central Arkansas
Conway, AR 72035-5003

Mr. Chris McGrath
315 Morgan Branch Rd.
Leicester, NC 28748

Dr. Paul McKenzie
U.S. Fish and Wildlife Service
608 East Cherry Street, Room 200
Columbia, MO 65201

Mr. Robert Miller
Wildlife Resources Center
New York State Department of
Environmental Conservation
Game Farm Rd.
Delmar, NY 12054-9767

Ms. Nora Murdock for Mr. Brian P. Cole
Field Supervisor
Asheville Field Office
U.S. Fish and Wildlife Service
160 Zillicoa St.
Asheville, NC 28801

Mr. Chuck Nicholson, WT8C
Tennessee Valley Authority
400 West Summitt Hill Drive
Knoxville, TN 37902-1499

Ms. Catherine Oliarnyk
Dept. of Biology
Queen's University
Kingston, Ontario K7L 3N6

Ms. Amelia Orton-Palmer
U.S. Fish and Wildlife Service
1000 Hart Road, Suite, 180
Barrington, IL 60010

Dr. L. Karolee Owens
U.S. Fish and Wildlife Service
6620 Southpoint Drive South, Suite 310
Jacksonville, FL 32216-0912

Ms. Diane Pence
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035-9589

Mr. Bruce Peterjohn
Breeding Bird Survey
Patuxent Environmental Science Center
12100 Beech Forest Rd.
Laurel, MD 20708

Dr. Dan Petit
Office of Migratory Bird Management
634 Arlington Square
Washington, DC 20240

Mr. Scott Pruitt
U.S. Fish and Wildlife Service
620 South Walker Street
Bloomington, IN 47403-2121

Mr. Chris Raithel
Rhode Island Division of Fish and Wildlife
P.O. Box 218
West Kingston, RI 02892

Mr. Ron Refsnider
U.S. Fish and Wildlife Service
Federal Bldg., 1 Federal Drive
Fort Snelling, MN 55111 - 4056

Ms. Virginia Rettig
Lafayette Field Office
U.S. Fish and Wildlife Service
Brandywine II, Suite 102
825 Kaliste Saloom Road
Lafayette, LA 70508

Mr. Rick Reynolds
Virginia Dept. of Game and Inland Fisheries
Nongame and Endangered Species Unit
P.O. Box 996
Verona, VA 24482

Dr. Chan Robbins
Patuxent Wildlife Research Center
Laurel, MD 20708

Dr. Scott Robinson
Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820

Dr. Ken Rosenberg
Cornell Lab of Ornithology
159 Sapsucker Woods Rd.
Ithaca, NY 14850

Ms. Karen Rowe
Arkansas Game and Fish Commission
Hampton Waterfowl Research Center
Route #1, Box 188-A
Humphrey, AR 72073

Mr. Patrick Ruble
Ohio Department of Natural Resources
1840 Belcher Drive
Columbus, OH 43224-1329

Mr. John Schukman
14207 Robin Rd.
Leavenworth, KS 66048

Dr. Kim Smith
Dept. of Biological Sciences
University of Arkansas
Fayetteville, AR 72701

Mr. Mike Staten
Mr. Tony Parks
Anderson Tully Co.
P.O. Box 761
Lake Village, AR 71653

Mr. Glenn D. Therres, Supervisor
Nongame and Urban Wildlife Program
Maryland Department of Natural Resources
P. O. Box 68
Wye Mills, MD 21679

Dr. Frank Thompson
U.S. Forest Service
I-26 Agricultural Bldg.
University of Missouri
Columbia, MO 65211

Mr. John Trapp
U.S. Fish and Wildlife Service
4401 North Fairfax Drive, Room 634
Arlington, VA 22203

Mr. Bill Vermillion
Louisiana Natural Heritage Program
Department of Wildlife and Fish
P. O. Box 98000
Baton Rouge, LA 70898-9000

Dr. Bob Whitmore
Division of Forestry and Wildlife Biology
West Virginia University
P.O. Box 6125
Morgantown,WV 26506-6125

Ms. E.J. Williams
Georgia Department of Natural Resources
Nongame Wildlife Program
Route 5, Box 180
Forsyth, GA 31029

Dr. Mark Woodrey
Mississippi Department of Wildlife, Fisheries and Parks
Museum of Science
111 North Jefferson St.
Jackson, MS 39202