be aware of changes in range/distribution; to identify source and sink habitats/populations; to understand the factors contributing to the replacement of golden-winged warblers by blue-winged warblers; to detect colonization and abandonment of habitats/breeding areas; to determine population response to conservation action/inaction; to determine longevity of various habitat types created by particular techniques; and to assess overall values of particular conservation actions. Information gathered in pursuit of these objectives would be vital to adaptive management of the two species in Pennsylvania. Long-term monitoring plans should occur at the state level to maintain a general understanding of the status of golden-winged and blue-winged warblers in Pennsylvania. Monitoring should occur also at the site level to compile meaningful data sets that can be used to answer important questions about the ecology and long-term conservation of the species. Inclusion of genetic sampling during population monitoring would be extremely beneficial at any level.

Several lines of research are needed to identify suitable areas for long-term management and monitoring of breeding populations of golden-winged warblers in Pennsylvania. These include an extensive study that assesses population size and genetic purity of golden-winged and blue-winged warblers at all known breeding areas and identifies specific areas with the highest proportion of genetically pure golden-winged warblers; an intensive demographic study of multiple breeding populations of golden-winged warblers to identify the most productive breeding areas and habitat types (Kubel 2008); a field study that investigates what habitat conditions, if any, favor golden-winged warblers to the exclusion of blue-winged warblers and hybrids; a management study that experiments with different habitat creation/maintenance techniques (e.g., prescribed burning, clear-cutting) and monitors colonization and use of manipulated habitats by golden-winged and blue-winged warblers (and hybrids); and a study that identifies potential habitats (i.e., areas that do not currently support golden-winged warblers but could be converted to suitable habitat given proper management action) and investigates the feasibility of acquiring such habitats (if not already under state ownership).

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Cerulean Warbler

Order: Passeriformes
Family: Parulidae
Dendroica cerulea
(also *Responsibility Concern*)

The cerulean warbler (*Dendroica cerulea*) is a small, canopy-dwelling wood-warbler (fig. 5.35). In Pennsylvania it is listed as a Species of High-Level Concern. Because of severe population declines, it is currently being considered for listing as Threatened under the United States Endangered Species Act (U.S. Fish and Wildlife Service 2002a). It is considered a Species of Special Concern in Canada (McCracken 1993), and is a Partners in Flight Continental Watchlist species (Rich et al. 2004). It is included on the list of Species of Greatest Conservation Need throughout most of the Northeast. State and global populations are considered Apparently Secure (S4B, G4, NatureServe 2009).

GEOGRAPHIC RANGE

Ceruleans breed in deciduous forests through much of eastern Northern America, from eastern North and South Dakota, southern Minnesota, Wisconsin, Ontario, and Quebec south to eastern Oklahoma and northeastern Texas, east through the central Gulf States to central Georgia (American Ornithologists' Union 1998). Within most of this range they are rather sparse and locally distributed, except in the core of their range in the central Appalachians from southwestern Pennsylvania south to the Cumberland Plateau regions of Kentucky and Tennessee, where they can be the most common forest warbler (Hamel 2000).

Ceruleans winter in the lower to middle elevations (800–2,200 m; Stotz et al. 1996) of the Andes of

Fig. 5.35. The Cerulean Warbler, *Dendroica cerulean.* Photo courtesy of Frode Jacobsen.

South America from Venezuela and Columbia south to eastern Peru and northern Bolivia. Although migration routes remain poorly known, en route ceruleans have been reported primarily from the Greater Antilles and Caribbean slopes of Central America (American Ornithologists' Union 1998, Hamel 2000).

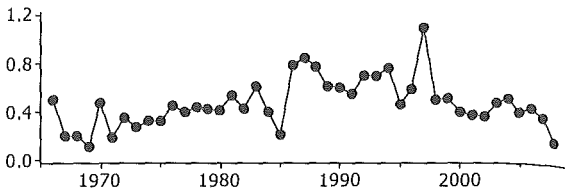

Fig. 5.37. Cerulean Warbler, *Dendroica cerulean*, population trends from the Breeding Bird Survey.

DISTRIBUTION AND RELATIVE ABUNDANCE IN PENNSYLVANIA

Cerulean warblers were reported from 17 percent of blocks in the first Pennsylvania Breeding Bird Atlas, but distribution was highly irregular. Fully 43 percent of the blocks documenting cerulean presence were located in seven southwestern counties, primarily in the Pittsburgh Plateau physiographic section. Elsewhere in the state, ceruleans were rather uncommon and local. Minor areas of concentration include the Lake Erie Coastal Plain and portions of the Allegheny, Susquehanna, and Delaware River valleys (Ickes 1992c, McWilliams and Brauning 2000). Their current distribution pattern is similar (fig. 5.36).

The overall range of the cerulean has been shifting northeastward over time (Hamel et al. 2004). Within Pennsylvania, this shift has been apparent as the species was once rare or absent from all but the southwestern part of the state (e.g., Harlow 1918, Todd 1940a), but seems to have expanded across much of the state since the Breeding Bird Surveys began. Whether this truly represents a northward shift in the species' range or a recolonization of maturing forests that have grown up since the extensive deforestation of the early 1900s is unclear. Breeding Bird Survey data indicate that the overall abundance of ceruleans has decreased significantly in Pennsylvania, at a rate of 3.0 percent per year (Sauer et al. 2005; fig. 5.37). However, that figure is probably driven by declines in the western third of the state; populations in central and eastern Pennsylvania have generally increased since the 1960s.

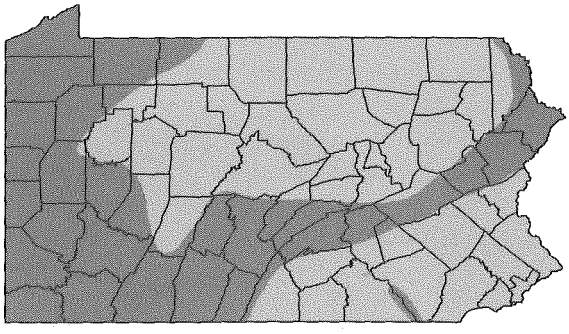

Fig. 5.36. Primary (darkened shading) and secondary (lighter shading) distribution of the Cerulean Warbler, *Dendroica cerulean.*

COMMUNITY TYPE/HABITAT USE

The cerulean warbler breeds in extensive tracts of tall, mature deciduous forest. Considered to be an area-sensitive species, ceruleans avoid forest tracts below a certain size (Robbins et al. 1989, Weakland and Wood 2005). That tract size threshold varies regionally, from as small as 10 ha in Ontario to 1,600 ha in the Mississippi Alluvial Valley (Hamel 2000). Within large forest tracts, ceruleans breed in two general topographic locations: ridge tops and riparian corridors along waterways (Dettmers and Bart 1999, Rosenberg et al. 2000). Ridge-top sites are almost exclusively in oak-hickory forests; ceruleans appear to be rare or absent in northern hardwood or mixed hardwood-conifer types (Rosenberg et al. 2000, Stoleson 2004). Valley bottom habitats may include sycamore or elm-dominated riparian forests (McWilliams and Brauning 2000, Inman et al. 2002). In either habitat type, ceruleans favor areas of broken canopy, widely spaced large trees, and dense foliage 12–18 m up, often with an open understory (Jones and Robertson 2001, Inman et al. 2002). Structural complexity may be a critical attribute of high-quality habitat for this species; unlike many other area-sensitive birds, ceruleans seem to have an affinity for internal gaps or other openings and have been described as a disturbance-dependent bird of mature forests (Hunter et al. 2001, Rodewald 2004). Growing evidence suggests that certain types of timber management (e.g., partial harvests) may increase habitat suitability for ceruleans by increasing structural heterogeneity within even-aged forest stands (Rodewald and Yahner 2000, Stoleson 2004).

LIFE HISTORY AND ECOLOGY

Cerulean warblers are insectivorous, catching prey primarily by gleaning from foliage high in the canopy (Hamel 2000). A study in Illinois found ceruleans to

be extremely selective in foraging substrate, preferring hickories and silver maple but avoiding red maple (Gabbe et al. 2002). What little is known of their diet indicates they feed primarily on lepidopteran larvae and homopterans (Sample et al. 1993, Hamel 2000).

The cerulean warbler is a long-distance Nearctic-Neotropical migrant that spends less than five months of the year on the breeding grounds in Pennsylvania. Spring migration peaks in Pennsylvania during the middle two weeks of May (McWilliams and Brauning 2000). Fall migration is less well documented, as the birds tend to disappear quietly from breeding grounds by late July or early August; ceruleans are rarely reported after early September.

Although a socially monogamous species, ceruleans often appear to breed semicolonially, occurring in loose aggregations of territories while seemingly identical habitat nearby remains unoccupied (Rosenberg et al. 2000). Territory size can range from <0.4 ha to several hectares per pair, and average territory density varies considerably as well. Hamel (2000) reports the average density among 332 Breeding Bird Censuses as 43 pair per 100 ha. Current densities on the Allegheny High Plateau in northwestern Pennsylvania reach 76 pair per 100 ha in preferred habitat (S. H. Stoleson, unpublished data).

Ceruleans arrive on the breeding grounds about the time when oaks begin to leaf out. Males arrive first. Females arrive a week or more later, choose a mate, and begin building nests without male assistance. Ceruleans typically place their nests rather high in the lower canopy on the lowest horizontal branch of a large tree, often where a small side branch joins, and usually with open space below the nest. Nests are often located near a canopy gap (Oliarnyk and Robertson 1996, Rogers 2006). They are usually single brooded but will renest after an initial failure.

THREATS

As an area-sensitive species, ceruleans are most threatened by the loss and fragmentation of its mature forest-breeding habitat, particularly in the densely populated southwestern Pittsburgh Plateau section, where historically the bird has been most abundant. Ceruleans are vulnerable to large-scale forest disturbances and fragmentation both directly through the loss of available habitat and indirectly through reduced densities in remaining forest (Robbins et al. 1989, Weakland and Wood 2005). Even natural disturbances affect populations; canopy damage from a large ice storm greatly diminished subsequent nesting success in an Ontario cerulean population (Jones et al. 2001). Actions or processes that reduce the structural complexity of forests are likely to also reduce their suitability for ceruleans. For example, ceruleans may be sensitive to the effects of deer overabundance on forest structure: in a controlled enclosure experiment, ceruleans occurred only in treatments with lower densities of deer (deCalesta 1994). In contrast, small-scale disturbances that increase structural complexity of forests, such as uneven-aged forestry techniques, may benefit ceruleans. Ross et al. (2001) documented successful breeding by ceruleans in partially harvested stands with as little as 12 m^2 basal area per hectare.

Although brown-headed cowbirds (*Molothrus ater*) parasitize cerulean nests, at least in some populations, they are unlikely to pose a significant threat, as ceruleans prefer extensively forested areas and nest very high (Hamel 2000). A Michigan study found relatively low rates of parasitism in ceruleans (<10%) in areas where understory-nesting hooded warblers (*Wilsonia citrina*) experienced rates in excess of 60 percent (Rogers 2006).

CONSERVATION AND MANAGEMENT NEEDS

Although cerulean warbler populations appear to be increasing in the eastern half of Pennsylvania, those in the western half, with the bulk of the state's birds, are declining rapidly. Therefore, the primary conservation focus for Pennsylvania should be to reverse population declines and develop and maintain high-quality breeding habitat. Specific conservation strategies for ceruleans (synthesized from Rosenberg et al. 2000, Robertson and Rosenberg 2003, and Rich et al. 2004) include maintaining current levels of forest coverage within the state and minimizing fragmentation of remaining, large contiguous forest tracts. In addition, it is important to develop guidelines for timber management that promote structural complexity and maintain mature stands, especially at topographically appropriate sites. Long-range forest management plans are needed at as large a scale as possible to designate tracts that will be mature at each stage of the plan and to maintain connections between existing mature forest patches. Surveys should be conducted to identify important populations and sites on public and private land. Once identified, these areas should be targeted for management practices that protect or enhance populations.

MONITORING AND RESEARCH NEEDS

Populations of cerulean warblers have been assessed primarily through standard survey methods, such as the Breeding Bird Survey. However, such standard methods may be biased for forest-interior species like the cerulean (Rosenberg et al. 2000). Therefore, a targeted monitoring program should be designed and conducted to better track population trends of ceruleans. Also, because seemingly healthy populations elsewhere appear to function as sink populations (Jones et al. 2004, Rogers 2006), monitoring of nest success at selected sites across Pennsylvania should be conducted to gauge the health of cerulean warbler populations in the state. As forest management guidelines are developed, their effects on both cerulean abundance and productivity should be assessed to better understand how forest structure interacts with demography to determine habitat quality and to provide input on refinement of those guidelines.

The top research needs for successful conservation of the cerulean warbler have been discussed extensively by Hamel et al. (2004), Rich et al. (2004), and Rosenberg et al. (2000). Those most relevant to Pennsylvania are summarized here. As the greatest threats to ceruleans in Pennsylvania are the loss and degradation of its mature forest habitat, a better understanding is needed of the bird's need for and response to landscape configuration, patch size and shape, structural complexity, gaps, and specific floral elements (e.g., American chestnut). Researchers need to identify critical habitat components for ceruleans at multiple spatial scales.

In addition, we need to better determine how forest harvest and other management practices (such as oil and gas development), natural forest maturation, forest pests and pathogens, and effects of deer overabundance affect breeding habitat quality for ceruleans. Activities that alter forest structure and composition have great potential to affect ceruleans either positively or negatively, yet very little is known about how these activities influence habitat quality for ceruleans or other forest species.

The few populations studied appear to be functioning as population sinks (Jones et al. 2004, Rogers 2006), yet our understanding of the species' demography remains poor. Determining what factors drive population declines at the local and larger levels is vital for developing management strategies for reversing those declines.

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Prothonotary Warbler

Order: Passeriformes
Family: Parulidae
Protonotaria citrea

The prothonotary warbler is a large, plump, and short-tailed warbler that dwells in swampy forests, primarily in the southeastern United States (fig. 5.38). It was selected as a Species of High-Level Concern and is currently listed as a Candidate Rare Species in Pennsylvania because of its limited distribution within the state. It is a Partners in Flight Priority Species. Global populations are Secure (G5), and Pennsylvania breeding populations are considered Imperiled or Vulnerable (S2S3B, NatureServe 2009).

GEOGRAPHIC RANGE

During the breeding season, the prothonotary warbler is found in appropriate habitats throughout most of the southeastern United States. Within the northern half of the eastern United States, this species is found locally in scattered populations as far north as Connecticut and New York, with a small population ranging into extreme southwestern Ontario, Canada. In the Midwest, this species' breeding range has been expanding northward, especially in the Mississippi Valley between Wisconsin and Minnesota. During the nonbreeding season, the bulk of the population winters in the coastal lowlands of Panama, northern Venezuela, and northern Colombia, concentrated particularly in mangrove forests (Petit 1999).

DISTRIBUTION AND RELATIVE ABUNDANCE IN PENNSYLVANIA

A rare, but apparently increasing, species in Pennsylvania, the prothonotary warbler was detected in <1 percent of the state's atlas blocks in the first Breeding Bird Atlas (1983–1989; Leberman 1992e). During this effort, individuals were observed summering in most major river drainage basins in the state; however, many of these observations were of single males and may not represent breeders (Leberman 1992e). In general, in Pennsylvania this species is a rare and local breeder in the southeastern Piedmont and Glaciated northwest regions and is accidental elsewhere (McWilliams and Brauning 2000). Small populations may be regularly found in the Conneaut and Pymatuning Swamps of Crawford County, and at a few points along the lower Susquehanna River in Lancaster County (McWilliams and Brauning 2000; fig. 5.39).

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