

Conservation Priorities for Terrestrial Birds in the Northeastern United States¹

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Abstract

As part of the Partners in Flight (PIF) bird-conservation planning process, we assessed breeding land bird species according to seven categories of population vulnerability to derive a priority species pool in each of 12 physiographic areas that overlap the northeastern U.S. We then grouped species into the following habitat-species suites: (1) boreal-mountaintop habitats (stunted conifers) that support a majority of the world's population of Bicknell's Thrush; (2) maritime marsh and ecotonal communities that support nearly all breeding Saltmarsh Sharp-tailed Sparrows, coastal populations of Nelson's Sharp-tailed Sparrows, Black Rail, Seaside Sparrow, and American Black Duck; (3) naturally disturbed and early-successional shrub-scrub habitats that support Appalachian Bewick's Wren (possibly extinct), Golden-winged Warbler, and American Woodcock; (4) natural and agricultural grasslands that support Henslow's Sparrow, Upland Sandpiper, eastern Grasshopper Sparrow, and Bobolink; (5) oak-dominated hardwood forests that support Cerulean Warblers, Worm-eating Warblers, and associated species; and (6) northern-hardwood and mixed coniferous forests that support Canada Warbler, Black-throated Blue Warbler, Bay-breasted Warbler and associated species. The value of these and other habitats (e.g. coastal concentration sites) to stopover migrants is also undoubtedly very high, although this remains largely unquantified. Within each habitat-species suite, we have identified population status, threats to habitats, and research needs, and recommended strategies for conservation action. Results of this PIF planning process will be integrated with objectives for waterbirds, shorebirds, and colonial waterbirds, as part of the North American Bird Conservation Initiative (NABCI) efforts.

Introduction

In 1990, Partners in Flight (PIF) was conceived as a voluntary, international coalition of government agencies, conservation organizations, academic institutions, private industry, and other citizens dedicated to reversing the downward trends of declining species with the purpose of "keeping common birds common." The foundation for PIF's long-term strategy for bird conservation is a series of Landbird Conservation Plans, which identify the highest priority bird species and habitats, set numerical population and habitat objectives, and outline an implementation strategy for achieving these objectives. The geographical context of these plans in the eastern United States is physiographic areas, modified from original strata devised by the Breeding Bird Survey (Robbins et al. 1986). Although priorities and biological objectives are identified at the physiographic area level, implementation of PIF objectives will take place at different scales, including individual states, federal agency regions, and conservation-partnership regions such as joint ventures.

The goal of each PIF Bird Conservation Plan is to ensure long-term maintenance of healthy populations of native landbirds. The conservation plans primarily address nongame landbirds, which have been vastly underrepresented in previous conservation efforts, and many of which are exhibiting significant declines that may be arrested or reversed if appropriate management actions are taken. The Partners in Flight approach differs from many existing federal and state-level listing processes in that it (1) is voluntary and nonregulatory, and (2) focuses proactively on relatively common species in areas where conservation actions can be most effective, rather than the frequent local emphasis on rare and peripheral populations. Partners in Flight landbird conservation planning, therefore, provides the framework to develop and implement habitat conservation actions on the ground that may prevent the need for future species listings. Additional details on PIF history, structure, and methodology can be found in Finch and Stangel (1993), Bonney et al. (1999), and <http://www.partnersinflight.org>.

In this paper we summarize the results of the PIF planning process for the 12 physiographic areas that comprise the northeastern United States. These results build on the regional assessment of Rosenberg and Wells (2000) by applying a nationally standardized approach and methodology to the planning process.

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Specifically, we (1) identify the highest priority bird species that are most vulnerable to regional population declines and require conservation attention, (2) identify the habitat types that support these high priority bird species and are therefore in greatest need of protection or management, and (3) discuss the conservation objectives, challenges, and threats to these priority species and habitats, including gaps in our current knowledge that point to specific future research needs. Our primary goal is to draw attention to these terrestrial bird-habitat priorities, so that they may be incorporated into existing and future habitat-based conservation initiatives.

Methods

Twelve physiographic areas overlap the northeastern United States (*fig. 1*); this area also corresponds to the administrative boundaries of USFWS Region-5. For each of these physiographic areas, a landbird conservation plan has been developed and is available at <http://www.partnersinflight.org>.

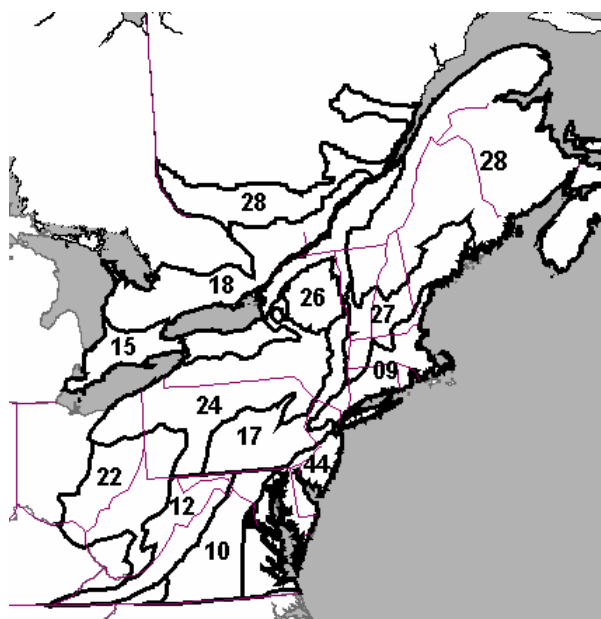


Figure 1—Partners in Flight physiographic areas overlapping the northeastern U.S. 9 = Southern New England; 10 = Mid-Atlantic Piedmont; 12 = Mid-Atlantic Ridge and Valley; 15 = Lower Great Lakes Plain; 17 = Northern Ridge and Valley; 18 = Saint Lawrence Plain; 22 = Ohio Hills; 24 = Allegheny Plateau; 26 = Adirondack Mountains; 27 = Northern New England; 28 = Eastern Spruce-Hardwood forest; 44 = Mid-Atlantic Coastal Plain.

Prioritizing Species

Within each plan, we follow a standardized procedure for identifying the pool of breeding species that represents priorities for conservation action within the physiographic area (modified from Carter et al. 2000). The different reasons for priority status (e.g., global threats, high concern for regional populations, large populations) are identified by levels or tiers in the species pool. The PIF species assessment process initially ranks species according to six measures of conservation vulnerability. These include four range-wide measures (i.e., they do not change from area to area), as well as two that are specific to each physiographic area. Although this process has been refined and improved to reflect the recent consensus of avian conservation biologists and land managers (Panjabi 2001), it remains conceptually very similar to that described in (Carter et al. 2000; reviewed by Beissinger et al. 2000).

For each factor contributing to conservation vulnerability (*table 1*), a species is scored on a scale of 1 to 5, as follows: "1" roughly represents *resistance to vulnerability* (positive association with human disturbance, significantly increasing populations, etc.); "2" represents *stability or lack of perceived vulnerability* due to that factor; "3" represents *moderate or unknown vulnerability* due to that factor; "4" represents *high vulnerability* leading to future danger of regional extirpation or significant population decline if not addressed; and "5" represents *imminent danger of regional extirpation or intolerable rates of population decline*, due to that factor. In addition to these measures of vulnerability, each species is given two scores to reflect the importance of each physiographic area to its overall conservation needs. The first is a 1-5 *Area Importance* score (AI), based on the relative abundance of a species in a physiographic area relative to the maximum abundance attained by that species in any area (see Carter et al. 2000). The second is an estimate of the percentage of the species' range-wide population that breeds in a physiographic area (see Rosenberg and Wells 2000). Both of these measures allow the incorporation of regional responsibility, as well as regional concern, into the overall conservation assessment for species, based on the rationale that conservation will be most effective where a species is most abundant or concentrated, rather than where it is rare or peripheral (Rosenberg and Wells 1995, 2000).

The primary source of information on species' abundances and population trends is the Breeding Bird Survey (BBS), a volunteer-based, standardized survey begun in 1966. The BBS is a cooperative effort between the U.S. Geological Survey's Patuxent Wildlife Research Center and the Canadian Wildlife Service's National Wildlife Research Centre to monitor the status and trends of North American bird populations (Sauer

Table 1—Conservation vulnerability and area importance parameters used in the Partners in Flight species assessment process (see Panjabi 2001 for details).

Assessment Parameter	Definition
Population Size (PS)	Estimated total population of a species throughout its range
Breeding Distribution (BD)	Size of breeding range for entire species
Nonbreeding Distribution (ND)	Size of smallest area of range used during all or part of the nonbreeding season.
Threats Breeding (TB)	Assessment of future threats to global or regional populations of a species during the breeding season
Threats Nonbreeding (TN)	Assessment of future threats to global or regional populations of a species during the nonbreeding season
Population Trend (PT)	Long-term (30-year) trend in population numbers, usually based on Breeding Bird Survey or other survey data
Area Importance (AI)	Relative abundance of a species in a region, compared with maximum abundance in any region.
Percent of Population (%pop)	Percentage of total population of a species occurring in a particular region.

et al. 2003; <http://www.mp2-pwrc.usgs.gov/bbs/>). For species lacking or poorly represented on BBS, individual scores were provided by a consensus of regional or species-group experts. A complete matrix of all vulnerability and area-importance scores for each species in each physiographic area is maintained in a database at Rocky Mountain Bird Observatory and can be accessed via <http://www.partnersinflight.org>.

Within regional bird conservation plans, categories of conservation status are determined by examining combinations of parameter scores, as well as the total rank score, which is a measure of overall conservation vulnerability. This process of identifying priority species has been standardized across all physiographic areas of North America (although application varies across regions). There are five entry levels into a priority species pool, as follows.

High Continental Importance

Species on the *PIF Continental Watch List* (see Rich et al. 2004) are those which are typically of conservation concern throughout their range. These are species showing high vulnerability in a number of factors, expressed as any combination of high global parameter scores, with AI > 2 (so that species without manageable populations in the region are omitted).

High Continental Concern - High Regional Responsibility

Species for which this region shares in major conservation responsibility; i.e., conservation in this region is critical to the overall health of this species. These are species with AI of 3 - 5, or a high percent population.

High Continental Concern - Low Regional Responsibility

Species that are uncommon, but for which this region can contribute to rangewide conservation objectives where the species occurs. Species with AI of 2.

High Regional Importance

Species that are of moderate continental priority (not on *Continental Watch List*), but are important to consider for conservation within a region because of various combinations of high parameter scores, as defined below; total of 7 parameter scores ≥ 19 .

High Regional Concern

Species that are experiencing declines in the core of their range and that require conservation action to reverse or stabilize trends. These are species with a combination of high area importance and declining (or unknown) population trend; total of 7 parameters ≥ 19 , with AI + PT ≥ 8 .

High Regional Responsibility

Species for which this region shares significant responsibility for long term conservation, even if they are not currently declining or threatened. These are species of moderate overall priority with a disproportionately high percentage of their total population in the region; total of 7 parameters ≥ 19 , with AI = 5 or percent population > threshold. These species require long-term planning to ensure healthy and sustainable populations in the region.

High Regional Threats

Species of moderate overall priority that are uncommon in a region and whose remaining populations are threatened, usually because of extreme threats to sensitive habitats. These are species with high breeding threats scores within the region (or in combination with high nonbreeding threats outside the region); total of 7 parameters ≥ 19 with TB + TN > 6 , or local TB or TN = 5.

Results

Regional priority species

Sixty-seven species were identified as being of conservation priority in at least one of the 12 physiographic areas of the northeastern United States (*table 2*). Of these, 24 species are on the PIF continental Watch List (Rich et al. 2004) and are considered of conservation importance in any region in which they have manageable populations. Note that Black Rail, Upland Sandpiper, and American Woodcock also meet criteria for the Continental Watch List, but are not listed by PIF. Continentally Important species for which portions of the Northeast support important populations (i.e. this region shares a major responsibility for their overall conservation) include American Woodcock, Bicknell's Thrush, Wood Thrush, Blue-winged Warbler, Golden-winged Warbler, Prairie Warbler, Cerulean Warbler, Kentucky Warbler, Canada Warbler, Henslow's Sparrow, Saltmarsh and Nelson's Sharp-tailed Sparrows, and Seaside Sparrow. These species may be considered of highest overall priority for conservation action wherever they occur throughout the Northeast region.

The remaining 40 species of regional importance represent a combination of species that either are declining in the core of their range, have disproportionately high populations in the Northeast (high responsibility), or whose smaller (often peripheral) populations are highly threatened in the region. Many of these species (e.g. Louisiana Waterthrush, Scarlet Tanager, and Field Sparrow) are widespread and are priority species in half or more of the physiographic areas, whereas others (e.g. Bewick's Wren, Yellow-throated Warbler, and Spruce Grouse) are priorities only in a small part of the region.

Regional Priority Habitats

Based on the primary habitats of the species identified above, seven broad habitat types are considered most in need of conservation attention in the northeastern

United States (*table 2*). Species of continental importance within each habitat suite that overlap in habitat requirements with other regional priority species are considered as focal species in the physiographic area plans (Lambeck 1996). Pine-savannah habitat is restricted to portions of the southernmost physiographic areas and is more characteristic of the southeastern U. S.. We do not consider this habitat-type further, but see (Watts 1999; Mid-Atlantic Coastal Plain PIF plan). Of the remaining habitat-types, grassland/agricultural and shrub-scrub/successional habitats are the most widespread, with representative, high-priority bird species occurring in virtually every physiographic area. Other important habitat types are restricted either to coastal physiographic areas (maritime salt-marsh) or to either northerly or southerly portions of the region. Below we synthesize information on each habitat type from the detailed accounts presented in the individual physiographic-area bird conservation plans.

Boreal-Mountaintop Conifer Woodland

The recognition of Bicknell's Thrush as a separate species (Ouellet 1993, AOU 1995) has elevated the importance of its primary habitat, high-elevation conifers, to a top regional conservation priority (Rosenberg and Wells 2000). Preferred habitat has been described as dense, stunted stands dominated by balsam fir, with varying amounts of white birch, mountain ash and sometimes red spruce and other species (Wallace 1939, Atwood et al. 1996). This habitat type occurs naturally at high elevations (approximately $>900\text{m}$ in U.S.; $>500\text{m}$ in Canada) from the Adirondack and Catskill Mountains of New York, northeastward through northern New England, western New Brunswick to the Gaspé Peninsula of Quebec. Its distribution is therefore naturally fragmented at the landscape level, with most patches estimated to be <1000 ha in extent (Atwood et al. 1996). The other bird species associated with Bicknell's Thrush, such as Blackpoll Warbler and Yellow-bellied Flycatcher, tend to be species of open coniferous and disturbed forests in the more northern portions of their range, but are specialists on mountaintop conifers in New England and New York.

Distribution and Populations

Bicknell's Thrush appears to be the only species that is restricted to this habitat nearly throughout its range. In Canada, additional populations of this species may occur locally in habitats of similar structure along the windswept coasts of the Maritime provinces and Quebec, and in some second-growth industrial forest habitats at lower elevations inland (Erskine 1992, Ouellet 1993, Gauthier and Aubry 1996, Nixon 1999). Thrushes were present on mountaintop islands as small

Table 2—High priority breeding landbird species in Northeast U.S. Physiographic areas, based on Partners in Flight species assessment process (see Panjabi 2001). Priority levels refer to tiers or entry levels into regional priority species pools as described in text: C-R = Continental concern-high regional responsibility; C-L = continental concern-low regional responsibility; R-C = High regional concern; R-R = High regional responsibility; R-T = High regional threats.

Species	Habitat	Physiographic area											
		44	9	10	12	15	17	18	22	24	26	27	28
<u>Boreal-mountaintop</u>													
Bicknell's Thrush, <i>Catharus bicknelli</i>											C-L	C-R	C-R
<u>Pine-savannah</u>													
Red-cockaded Woodpecker, <i>Picoides borealis</i>		C-L											
Brown-headed Nuthatch, <i>Sitta pusilla</i>		C-L		C-L									
Bachman's Sparrow, <i>Aimophila aestivalis</i>													
<u>Salt marsh</u>													
Black Rail, <i>Laterallus jamaicensis</i>		C-R	C-L										
Clapper Rail, <i>Rallus longirostris</i>		R-R											
Virginia Rail, <i>Rallus limicola</i>		R-C											
Marsh Wren, <i>Cistothorus palustris</i>		R-C											
Saltmarsh Sharp-tailed Sparrow, <i>Ammodramus caudacutus</i>		C-R	C-R									C-L	
Nelson's Sharp-tailed Sparrow, <i>Ammodramus nelsoni</i>												C-L	C-R
Seaside Sparrow, <i>Ammodramus maritimus</i>		C-R	C-R										
<u>Oak-hickory/deciduous forest</u>													
Chimney Swift, <i>Chaetura pelagica</i>		R-C	R-C	R-C					R-R				
Red-headed Woodpecker, <i>Melanerpes erythrocephalus</i>		C-L	C-L	C-L	C-L	C-L	C-L	C-L	C-L	C-L		C-L	
Acadian Flycatcher, <i>Empidonax virescens</i>		R-R	R-C	R-C	R-R				R-C				
Eastern Wood-Pewee, <i>Contopus virens</i>		R-C			R-C								
Yellow-throated Vireo, <i>Vireo flavifrons</i>		R-C			R-C				R-C				
Wood Thrush, <i>Hylocichla mustelina</i>		C-R	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C-L
Yellow-throated Warbler, <i>Dendroica dominica</i>													
Cerulean Warbler, <i>Dendroica cerulea</i>		C-L	C-L	C-L	C-R	C-L	C-L	C-L	C-R	C-L			
Black-and-white Warbler, <i>Mniotilta varia</i>			R-C								R-C		
American Redstart, <i>Setophaga ruticilla</i>											R-C		
Worm-eating Warbler, <i>Helminthos vermivorus</i>		C-R	C-R	C-L	C-R	C-L	C-R					C-L	
Swainson's Warbler, <i>Limnethlypis swainsoni</i>		C-L											
Louisiana Waterthrush, <i>Seiurus motacilla</i>		R-T	R-T	R-R	R-R	R-T	R-R	R-R	R-C			R-R	
Prothonotary Warbler, <i>Protonotaria citrea</i>		C-R	C-L	C-L	C-L	C-L			C-L				
Kentucky Warbler, <i>Oporornis formosus</i>		C-R	C-L	C-L	C-R				C-L				
Hooded Warbler, <i>Wilsonia citrina</i>					R-R								

Table 2 (contd.)

Species	Habitat	Physiographic area											28
		44	9	10	12	15	17	18	22	24	26	27	
Oak-hickory/deciduous forest (contd.)													
Scarlet Tanager, <i>Piranga olivacea</i>		R-C			R-R				R-R				
Baltimore Oriole, <i>Icterus galbula</i>		R-C				R-C	R-C	R-C					
Shrub-successional													
Northern Bobwhite, <i>Colinus virginianus</i>		R-C		R-C									
American Woodcock, <i>Scolopax minor</i>		C-R	C-R	C-R	C-L	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C-R
Whip-poor-will, <i>Caprimulgus vociferus</i>		R-C		R-R	R-C			R-T				R-T	
Willow Flycatcher, <i>Empidonax traillii</i>		C-L	C-L	C-L	C-L	C-R	C-R	C-R	C-R	C-R	C-L	C-L	C-L
Bewick's Wren (Appalachian), <i>Thryomanes bewickii altus</i>					C-R				C-R				
Brown Thrasher, <i>Toxostoma rufum</i>		R-C	R-C		R-C	R-C	R-C	R-C					
Blue-winged Warbler, <i>Vermivora pinus</i>		C-L	C-R		C-L	C-R	C-R	C-L	C-R	C-R		C-L	
Golden-winged Warbler, <i>Vermivora chrysoptera</i>			C-L		C-R	C-L	C-R	C-R	C-R	C-L	C-L	C-L	
Chestnut-sided Warbler, <i>Dendroica pennsylvanica</i>											R-C	R-C	R-C
Prairie Warbler, <i>Dendroica discolor</i>		C-R	C-R	C-R	C-R	C-L	C-R		C-R			C-L	
Yellow-breasted Chat, <i>Icteria virens</i>					R-C				R-C				
Indigo Bunting, <i>Passerina cyanea</i>					R-C				R-C				
Eastern Towhee, <i>Pipilo erythrophthalmus</i>		R-C	R-C	R-C	R-C				R-C	R-C			
Field Sparrow, <i>Spizella pusilla</i>		R-C	R-C	R-C	R-C	R-C							
Grassland-agriculture													
Northern Harrier, <i>Circus cyaneus</i>									R-T				
Upland Sandpiper, <i>Bartramia longicauda</i>		C-L	C-L	C-L		C-L	C-L	C-L	C-L	C-L	C-L	C-L	C-L
Short-eared Owl, <i>Asio flammeus</i>		C-L				C-L	C-L	C-L		C-L	C-L	C-L	C-L
Sedge Wren, <i>Cistothorus platensis</i>		R-T			R-T	R-T	R-T	R-T	R-T	R-T	R-T	R-T	R-T
Loggerhead Shrike, <i>Lanius ludovicianus</i>		R-T		R-T	R-T	R-T	R-T	R-T					
Grasshopper Sparrow, <i>Ammodramus saviannarum</i>		R-T	R-T	R-T	R-T	R-T	R-T	R-T		R-T			
Henslow's Sparrow, <i>Ammodramus henslowi</i>		C-L	C-L	C-L	C-L	C-L	C-L	C-L	C-R	C-R			
Bobolink, <i>Dolichonyx orizivorus</i>						R-C		R-C		R-T			R-C
Northern hardwood/coniferous forest													
Spruce Grouse, <i>Falcapennis canadensis</i>											R-T		R-C
Black-billed Cuckoo, <i>Coccyzus erythrophthalmus</i>			R-C			R-C		R-C	R-C	R-C	R-C	R-C	
Black-backed Woodpecker, <i>Picoides arcticus</i>											R-T	R-T	R-T
Least Flycatcher, <i>Empidonax minimus</i>											R-C	R-C	R-C
Olive-sided Flycatcher, <i>Contopus cooperi</i>					C-L						C-L	C-L	C-R
Veery, <i>Catharus fuscescens</i>											R-C	R-C	R-C

Table 2 (contd.)

Species	Habitat	Physiographic area											
		44	9	10	12	15	17	18	22	24	26	27	28
Northern hardwood/coniferous forest (contd.)													
Northern Parula, <i>Parula americana</i>					R-C								R-R
Black-throated Blue Warbler, <i>Dendroica caerulescens</i>					R-T						R-C	R-R	R-R
Bay-breasted Warbler, <i>Dendroica castanea</i>											C-L	C-L	C-R
Blackburnian Warbler, <i>Dendroica fusca</i>			R-T		R-T						R-R	R-C	R-R
Cape May Warbler, <i>Dendroica tigrina</i>													R-R
Ovenbird, <i>Seiurus aurocapillus</i>											R-R	R-R	R-R
Canada Warbler, <i>Wilsonia canadensis</i>					C-R	C-L	C-L	C-L	C-R	C-R	C-R	C-R	C-R
Rose-breasted Grosbeak, <i>Pheucticus ludovicianus</i>			C-L					R-C	R-R	R-C	R-C	R-C	R-C
Rusty Blackbird, <i>Euphagus carolinus</i>			R-C								C-L	C-L	C-L
Purple Finch, <i>Carpodacus purpureus</i>												R-C	R-C

as 1.5 ha (Atwood et al. 1996), and area of available habitat was not a significant predictor of occupancy (Atwood et al. 1996). Despite the small size of most available habitat patches, Bicknell's Thrush and other associated species occur there in high densities. Recent estimates of Bicknell's Thrush densities on Mt. Mansfield in Vermont range from about 40 to 60 pairs per 40 ha of continuous habitat (Rimmer et al. 1996), but these do not take into account more recent discoveries of highly skewed sex ratios (1.8 males:1 female) and very patchy distributions within suitable habitat. Using the most up-to-date GIS data available, K. McFarland (unpubl. data) estimates a maximum of 53,000 breeding Bicknell's Thrush occurring within the U.S. portion of the range, though the actual number could be as low as 15,000-30,000 individuals. Erskine (1992) estimated an additional 1000 pairs breeding in the Maritime provinces, although the number of birds in Canada remains highly uncertain (Nixon 1999).

Population trends for species in this habitat are difficult to assess, because BBS routes do not sample such high-elevation sites. Multi-year research in Vermont indicates that reproductive success is highly variable from year to year, with nest failure primarily attributed to predation by red squirrels and red-backed voles. Nest predation is highest in years following high spruce-cone abundance and may involve an upslope movement of predators from lower-elevation forests (K. McFarland, pers. com.). In addition, an unusual spacing and mating system in this species has been documented, including lack of male territoriality, high degree of promiscuity, and large movements of individuals within habitat patches. These factors contribute to the difficulty in monitoring population size and reproductive success.

Threats and Conservation Issues

Current threats to the habitat fall into three categories: (1) global climate change; (2) atmospheric pollution (including acid precipitation); and (3) recreational and other development. The first factor, a global warming trend resulting in the shrinkage or retraction of cool-temperate forests regionwide, has been postulated to influence bird distribution and abundance (Erskine 1992, Atwood et al. 1996). Indeed, recent models for change in CO₂ indicate that high elevation conifer habitat, especially fir, will eventually disappear from the region (<http://www.fs.fed.us/ne/delaware/atlas/>). Although such an effect cannot be controlled by bird-conservation efforts alone, we must make every effort to influence the larger factors that ultimately may determine the fate of this entire habitat-species suite. Atmospheric pollution in the form of acid rain has been shown to adversely influence the health of balsam fir and spruce-dominated communities in New York and New England, resulting in heavy mortality in some

areas (Miller-Weeks and Smoronk 1993). Although studies of the effects of acid rain on bird communities in these areas have just begun, a likely factor is the reduction of available calcium in the soil, ultimately reducing egg production and egg-shell thickness in nesting birds (Hames et al. 2002).

High elevation habitats are currently protected to some extent by existing laws in Vermont, New Hampshire, and Maine, but Bicknell's Thrush is listed as a species of Special Concern in only Maine and Massachusetts. Recreational development, primarily for ski resorts is a growing threat to high-elevation habitats in parts of New England, but is less of a factor in the Adirondack Mountains of New York. The effects of lighter recreation, such as hiking and camping, are not well known. In addition, the recent proliferation of communication towers on mountaintops may represent another potential threat.

Needs and Recommendations

A strategy for protecting high-elevation habitats and ensuring a stable population of Bicknell's Thrush and associated species should include the following elements (not necessarily sequential):

- identification and characterization (habitat size, quality, land ownership) of all potential habitat patches, using GIS (now complete for Vermont; K. McFarland unpubl. data);
- completion of on-the-ground inventories to determine numbers of breeding Bicknell's Thrushes at all sites;
- identification and designation of most important sites, through state Important Bird Area programs;
- identification of specific threats to particularly important sites;
- incorporation of research on reproductive success of Bicknell's Thrush and other species into ongoing studies of forest health, in relation to pollution and development;
- explicit and "official" recognition of Bicknell's Thrush and its associated habitat as a high conservation priority in public agency and private land-use planning efforts;
- if future declines in habitat availability or Bicknell's Thrush populations warrant, legal mandates for implementation of habitat-protection objectives.

Several ongoing research efforts are now focusing on mountaintop bird communities and the breeding bio-

logy of Bicknell's Thrush. These and additional studies should be supported at the highest level of conservation priority. Specific research and monitoring needs that are most relevant to implementation of this conservation plan include the following:

- application of GIS and GAP analyses to determine distribution and conservation status of all habitat patches;
- continued censuses of Bicknell's Thrush and other species at all sites;
- studies of Bicknell's Thrush demography, to be applied to source-sink dynamics modeling and meta-population analysis throughout this region;
- studies of calcium availability in relation to acid precipitation and avian reproductive success at high elevation sites;
- determination of potential limiting factors affecting Bicknell's Thrush on its nonbreeding grounds, in winter and at migration-stopover sites;
- development of efficient monitoring protocols for evaluating Bicknell's Thrush population trends.

Recommended protocols for surveying breeding Bicknell's Thrushes are now available (Rimmer et al. 1996). A potential technique for monitoring this species along its migration routes may employ the recording of distinct nocturnal flight calls (Evans 1994). Studies of Bicknell's Thrush on its wintering grounds and development of a conservation plan for this species in the Dominican Republic are also ongoing (C. Rimmer, pers. comm.).

Maritime Salt Marsh

Priority species for northeastern maritime salt marshes include Black Rail, Saltmarsh Sharp-tailed Sparrow, Nelson's Sharp-tailed Sparrow, and Seaside Sparrow. In the Northeast, all of these species occur only in this habitat. Virtually the entire world breeding range of Saltmarsh Sharp-tailed Sparrow occurs within northeastern salt marshes. This habitat occurs within the four physiographic areas of the northeast that contain coastal zones: Eastern Spruce-Hardwood, Northern New England, Southern New England, and the Mid-Atlantic Coastal Plain. Other bird species of regional priority that are dependent on salt marshes for at least part of their annual cycle include American Black Duck, Northern Harrier, Clapper Rail, Willet, Short-eared Owl, and Sedge Wren.

Distribution and Populations

The four focal species of maritime salt marsh occur in a narrow band along the coastline of the northeast U.S. Of the four, Nelson's Sharp-tailed Sparrow has the smallest distribution within the northeast, with the coastal subspecies (*A. n. subvirgata*) occurring entirely from the New England and Maine coasts north through the Maritime Provinces. In Maine, recent inventories show an estimated 1000 Nelson's Sharp-tailed Sparrow (Hodgman pers. comm.). Saltmarsh Sharp-tailed Sparrow breeds from southern Maine south to the northern part of coastal North Carolina so that its entire population is almost completely confined to the northeast U.S. during the breeding season. Surveys for Saltmarsh Sharp-tailed Sparrows have been undertaken in Maine, where there are an estimated 500 individuals (Hodgman pers. comm.), and parts of New England, but information is generally lacking over the remainder of the species range. Recent research in the contact zone between the two sharp-tailed sparrows has shown that the zone of overlap between the two species is three-times larger than previously documented (Hodgman et al. 2002). Seaside Sparrow has a more extensive breeding range along the Atlantic and Gulf coasts, but within the northeast occurs from Massachusetts south through the region. No information is available on estimated population sizes for Seaside Sparrow. Black Rail distribution and abundance is not well documented because of the species' secretive nocturnal habits, but the species does occur in isolated pockets extending from Connecticut and Long Island south through coastal Virginia. The species is not abundant anywhere but occurs in higher densities southward from southern New Jersey. Breeding Bird Survey data do not permit estimates of population trends for any of the four focal species in this region because of the general inaccessibility of salt marsh habitat.

Within this region, Black Rail, Nelson's Sharp-tailed Sparrow and Saltmarsh Sharp-tailed Sparrow show a preference for the higher marsh zone characterized especially by *Spartina patens*. In contrast, Seaside Sparrow prefers the lower marsh zone which is dominated by *Spartina alterniflora*. The three sparrows of salt-marshes show comparably rather short incubation and fledging periods that generally must be completed between high tide events, which are the biggest factor causing reproductive failure (Post and Greenlaw 1994).

Threats and Conservation Issues

Within the mid-Atlantic region, a substantial number of salt marshes have been lost over the past 200 years (Tiner 1984). Between 1954 and 1978, loss rates were extremely high, primarily due to urban and industrial development (Gosselink and Baumann 1980). However, since the passage of protective legislation, loss rates have declined dramatically. Many of the largest

marshes are also now part of federally-owned U.S. Fish and Wildlife Service Refuges.

Current threats to maritime salt marshes include habitat degradation from loss of buffer habitats along the upper margins of marshes and encroachments from roads and other development. In many areas, the invasion of *Phragmites*, which is not inhabited by salt marsh obligate species, has replaced large amounts of salt marsh habitat. In addition, the control of *Phragmites* through the manipulation of water levels, can itself destroy salt marsh habitats and is often carried out without consideration to the needs of salt marsh bird species. Similarly, projects to restore tidal flow to salt marshes to benefit some species are often done without consideration to the needs of the focal salt marsh bird species.

Current protection for this habitat type includes marshes existing within National Seashores, coastal National Wildlife Refuges, state-protected areas such as natural areas and wildlife management areas, and properties owned by conservation organizations or land trusts. Many of the most important sites have been or will soon be identified through state and national Important Bird Areas (Wells et al. this volume, Wells 1998). Fortunately, many of the remaining large marshes are already under some form of protection from development.

Needs and Recommendations

Bird species of these coastal marshes are not well monitored by standard programs such as the Breeding Bird Survey. Conservation needs of these birds therefore fall into two categories: implementation of targeted monitoring and inventory programs; and protection and management of high-marsh habitats that support populations of high-priority marsh birds. Specific recommendations are as follows:

- complete inventory for all four focal species, with particular attention to the northern range limit for Saltmarsh Sharp-tailed Sparrow and range-wide distribution of Black Rail;
- develop program (perhaps using volunteers) to monitor populations of focal species at five-year intervals at key sites.
- identify threats to the most important sites for salt-marsh sparrows and Black Rails and develop ways to diminish these threats;
- increase protection of high-marsh borders and buffers to maximize habitat availability for focal species;
- incorporate needs of these nongame focal species into management projects for waterfowl or marsh

restoration, especially for projects under the Atlantic Coast Joint Venture.

Grasslands and Agricultural Habitats

Priority species for grasslands and agricultural habitats include Upland Sandpiper, Sedge Wren, Henslow's Sparrow, Grasshopper Sparrow, and Bobolink. All have experienced significant declines in the region (Vickery 1992, Askins 1999, Wells and Rosenberg 1999). Most other grassland species are declining as well, and concern is high for these species throughout the region. For example, Eastern Meadowlark, Vesper Sparrow, and Horned Lark are declining rapidly, but do not rank highly in regional plans because of large populations remaining elsewhere in their large ranges (Wells and Rosenberg 1999). These species often are listed as threatened or endangered by individual states (Vickery 1992). Grassland and agricultural habitats occur in all 12 physiographic areas, though with restricted amounts in the northern forest areas such as the Adirondack Mountains and northwestern Maine.

Debate over whether native grasslands were a historically significant part of the landscape of the northeastern U. S. has tempered conservation efforts targeting grassland birds. There is evidence, however, that large native grasslands existed in the northeast U. S. in pre-colonial times (Askins 1999, 2000). Perhaps the most compelling evidence is the existence of certain subspecies of grassland birds native to the region, in particular the extinct Heath Hen (*Tympanuchus cupido cupido*) and the eastern subspecies of Henslow's Sparrow (*A. h. susurrans*) (Askins 1999, 2000). Natural fires and those set by native Americans (Vickery and Dunwiddie 1997), beaver activity, ice and wind storms all contributed to the creation and persistence of grassland habitats in the northeast U.S. Complicating the historical record though, much of the native grassland and heathland habitat was among the first to be lost to development. For example, more than 98 percent of the once vast Hempstead Plains on Long Island, New York has been lost (Noss et al. 1995).

Distribution and Populations

Grassland bird inventories have been completed throughout much of the northeast U.S., with especially thorough coverage in New England and New York (Shriver et al., this volume). This inventory work has shown that in much of the region, sites harboring the greatest abundance and diversity of grassland species are located at airfields, particularly on military installations (Shriver et al., this volume). Other important sites include some relict native sandplain grasslands, reclaimed strip mines, and less intensively-managed agricultural fields. In New England, there are 10-15 sites that harbor significant breeding populations of

Upland Sandpipers and/or Grasshopper Sparrows, the largest being those at Westover Airforce Base in western Massachusetts (Jones and Vickery 1997), the Elizabeth Islands in coastal southeastern Massachusetts, Rentschler Field and Bradley International Airport, Connecticut, the Champlain Valley of Vermont, the blueberry barrens of eastern Maine, and Kennebunk, Maine (Shriver et al., this volume; Comins et al. 2003).

Significant areas for Henslow's Sparrows include the St. Lawrence Plain of New York, grasslands in Otsego County, New York, and several large reclaimed strip mines in western Pennsylvania. In total there are thought to be fewer than ten sites in the northeast U.S. that have 50 or more pairs of Henslow's Sparrows. The areas supporting significant numbers of Henslow's Sparrows typically harbor even larger numbers of Grasshopper Sparrows. Knowledge of the habitat and area requirements of most grassland species is relatively well-known and several grassland management manuals have been produced for use in the northeast U. S. (e.g. Jones and Vickery 1997).

Threats and Conservation Issues

The greatest threats to grassland birds in the northeast U.S. are through the effects of habitat loss. This includes continued loss of remnant grassland sites to development, abandonment of dairy farms or switching from hay cultivation to growing row crops, and the more intensive modern management of hay crops with much earlier and multiple cuttings. The number of farms in the northeast has declined by 50 percent since 1950 (Comins et al. 2003), with much of this habitat lost to development. Loss of habitat to development is greatest in the coastal plain from New England south to Virginia and within commuting distance of major urban areas like New York, Philadelphia, Pittsburgh, etc., where urban sprawl has increased greatly in the last 20 years. In regions like the St. Lawrence Plains, Great Lakes Plain and Allegheny Plateau, most loss of grassland habitat is through the abandonment of farms and subsequent reversion of habitat to shrub and, later, forest.

In addition to the loss of habitat to development and succession of abandoned farmland, much current acreage of agricultural lands is being more intensively managed so that it is unsuitable for grassland birds. Hayfields that are converted to row crops are effectively lost as habitat for grassland birds. Fields managed for feed hay are now routinely harvested so early in the season and so frequently over the season (because of the development of new, faster-growing feed hay varieties) that birds that nest in those fields experience little or no nesting success.

Some of the largest remaining grasslands in the north-east U.S. are at commercial and military airports which are typically mowed annually to maintain maximum visibility for air safety. Mowing these sites during the breeding season is obviously detrimental to birds but still occurs at many airports, probably because managers are unaware that later mowing would benefit these birds. In addition, since the prevention of collisions between wildlife and airplanes is of high concern to airport managers, there is often a view that birds and other wildlife should be discouraged from using habitat near airstrips. Paradoxically, the short grass that remains after mowing is more likely to attract flocking species (e.g. European Starling) and large species (e.g. Canada Goose, Ring-billed Gull) that are a much greater hazard to airplanes than are the small, non-flocking, and low-flying species of breeding grassland birds that occur in taller grass.

In Maine, blueberry barrens support the greatest numbers of priority grassland birds and more than 90 percent of the state's commercial blueberry fields have been sprayed with herbicides (Vickery et al. 1999). Such herbicide treatment has been shown to result in decreased densities of Grasshopper Sparrow, Savannah Sparrow, Bobolink, and Eastern Meadowlark (Vickery et al. 1999). With continued regular herbicide treatment of these areas it is expected that these species will suffer large regional population declines (Vickery et al. 1999).

Needs and Recommendations

- Complete grassland bird inventories for states south of New York and especially document the current important remaining Henslow's Sparrow breeding populations in Pennsylvania and West Virginia.
- Study demographics of Henslow's Sparrow populations in the region.
- Protection and restoration of native, remnant grassland habitats should be a high priority of public agencies and conservation organizations that manage wildlife habitat.
- Direct acquisition of large blocks of these habitats should be a priority in places like central and eastern Maine, eastern Long Island, and in portions of the coastal plain of Delaware, Maryland, and Virginia.
- Develop a comprehensive grassland bird management plan for all commercial and military airfields that support significant grassland bird populations in the region.

- Develop a coordinated program to ensure that publications that provide private landowners with information on the status of grassland birds, ways to manage for grassland birds that are not incompatible with farming, and knowledge of government incentives are distributed to the hundreds of thousands of land managers and owners that have the ability to affect the long-term health of grassland bird habitats.
- Develop a comprehensive program to catalyze existing farmland protection and management initiatives at the state and local levels to focus on sites with significant grassland bird populations on private agricultural lands that are being heavily impacted by development.

Shrub-Scrub/Early Successional

The priority bird species of shrub-scrub/early successional habitats are American Woodcock, Golden-winged Warbler, Blue-winged Warbler, Prairie Warbler, as well as the Appalachian subspecies of the Bewick's Wren (*T. b. altus*). Other species of regional importance that show up on many northeastern physiographic area plans include Whip-poor-will, Brown Thrasher, Eastern Towhee, Field Sparrow, and Indigo Bunting. In addition Yellow-breasted Chat is important in more southerly areas, whereas Chestnut-sided Warbler represents this habitat suite in the northern forest areas.

In pre-settlement times, fire likely maintained successional areas along sandy portions of coastal areas (locations of some of today's pine barrens), while major weather events, such as hurricanes, tornadoes, and ice storms, along with beaver activity, generated scattered thickets of shrubby habitat further inland (Askins 1998). Human settlement, beginning with Native Americans and followed by European colonization, brought increased disturbance to the region. With European settlement, large-scale changes in land cover occurred, with widespread clearing of the inland forests for agriculture and wood products. By the mid 1800s, forest cover in New England had dropped from >90 percent to <50 percent (Litvaitis 1993, Litvaitis et al. 1999). During a subsequent period of farm abandonment and reforestation during the late 1800s and early 1900s, large amounts of early successional habitat became available, and the suite of early successional bird species experienced a population boom in the Northeast. In recent decades, as the resulting second-growth forests grew beyond the early seral stages used by shrubland birds, populations of these species began to decline again with the reduction in amount of habitat available to them.

Distribution and Populations

Most species of this habitat type are showing significant rangewide declines according to Breeding Bird Survey trend analyses, and often the species showing steepest population declines within an area are birds of early successional habitats. The most dramatic example is the Appalachian Bewick's Wren, which once occurred commonly across the Appalachian region from southeast New York to Georgia, but is now virtually eliminated from this entire range (Kennedy and White 1997). Golden-winged Warbler has experienced a range-wide decline of 2.5 percent per year from 1966-2002 (Sauer et al. 2003). The species has expanded its northern range limit into Canada, but has disappeared from much of its former range in New England and has declined sharply in New Jersey, New York, and Pennsylvania. Within the Northeast U.S., populations of Golden-winged Warblers remain in the Appalachians of West Virginia, Pennsylvania, the New York-New Jersey Highlands, and the St. Lawrence Valley of northern New York. The ongoing Golden-winged Warbler Atlas Project is currently documenting population concentrations of this species, as well as location of the current hybrid-zone with blue-winged Warblers (Rosenberg and Barker 2002). In areas where direct conflicts with Golden-wings are minimal, the Blue-winged Warbler is itself a high priority for conservation. This species too has expanded its range eastward and northward, but has also shown subsequent declines in southern New England and New Jersey. Prairie Warbler is another species experiencing widespread declines, while expanding at the northern edge of its range. In the Northeast, largest populations remain in the Mid-Atlantic Coastal Plain, Piedmont, and Ohio Hills physiographic areas.

Along with other species in this suite, American Woodcock has shown declines of 2.3 percent per year from 1968-2002 in the eastern U.S. according to USFWS singing-ground surveys (Kelley 2002). The species remains quite broadly distributed across the eastern U.S. with highest densities across the northern portion of the breeding range including the St. Lawrence Plain, Eastern Spruce-Hardwoods, and Adirondack Mountains physiographic regions. Other species, such as Brown Thrasher, Eastern Towhee, and Field Sparrow, remain abundant in many parts of the region, but continue to show troubling rangewide declines.

Habitats used by species within this group include successional shrublands resulting from natural disturbances (wind-storms, ice-storms, fires, landslides, beaver activity), and natural barrens and heathlands, as well as a variety of habitats created by human activities (e.g. forestry, agriculture, power-line cuts, mining). Habitat requirements for priority species in this habitat

suite are broadly similar, and there is overlap in management recommendations between species. In particular, management practices for American Woodcock, the only priority early-successional species that is extensively managed for, may have important benefits for Golden-winged Warbler and other focal species populations. Detailed habitat studies and recommendations for management of Golden-winged Warblers may be found in Confer (1992) and Confer et al. (1999).

Threats and Conservation Issues

Shrubland habitat has decreased significantly in the Northeast since the early 1900's for a variety of reasons, chief among them the reforestation of abandoned agricultural lands and lands previously cleared for timber harvest. In certain physiographic areas and near urban areas of the Northeast, the major threat to birds of this habitat type is now loss and fragmentation from urban development. Especially troubling, large acreages of natural pine barren habitat recently have been converted to housing lots. Remaining tracts of pine barrens, even if protected, are threatened by cessation of natural fire cycles.

In addition to outright loss of remaining habitats to development, lack of current management in regenerating forests also results in fewer opportunities for early successional bird species. Balancing the needs of both shrub- and forest-nesting species in the Northeast represents a major challenge for managers and conservation planners. For example, a forest can be cleared to make early successional habitat within a year or two of clearing but it may take dozens or even hundreds of years for the forest to grow back to a condition that is suitable for species dependent on large, mature forests. Deciding which areas and the size of areas to convert or maintain in early successional habitat and whether or not natural disturbance regimes are adequate to meet the needs of these species in some areas is difficult and requires a landscape level perspective.

For Golden-winged Warblers, the continued hybridization with and competitive exclusion by Blue-winged Warblers is a major threat that may be exacerbated by human-caused habitat changes that have allowed Blue-wings to inhabit higher elevation habitats than originally used. Therefore, habitat-based management plans to enhance Golden-wing populations must consider local interactions between the two species, and these may not succeed at all in regions where Blue-winged Warblers are common.

Needs and Recommendations

An overall strategy for conserving shrub-nesting species should start with assessment and protection of naturally disturbed habitats, such as pine- and other

barrens. Management to mimic or replicate natural disturbance processes, especially on public lands, should balance the needs of early- and late-successional species, in a landscape context. Conservation needs for shrub-nesting birds include a combination of habitat-based protection and management actions and basic research on the biology of high priority species, especially for the Golden-winged Warbler. Specific needs for this species on the breeding grounds include:

- determine range of suitable habitats and identify present breeding sites for Golden-winged Warbler in this region. (Present breeding sites are being surveyed through the Golden-winged Warbler Atlas Project by the Lab of Ornithology, with field work being conducted for this project continuing from 2000-2004);
- develop improved monitoring program for Golden-winged Warbler that considers their patchy distribution and low population size;
- identify sites where significant populations of Golden-winged Warblers coexist with Blue-winged Warblers; manage these sites as potential "safe havens" for sustaining Golden-wings within their historic range;
- compare early successional habitats resulting from natural disturbances vs. forestry and other management practices, with regard to suitability for high-priority species;
- determine effects of woodcock habitat management techniques on other priority, early-successional bird species;
- develop specific recommendations about burning regimes in managed or protected sites;
- develop management guidelines and policy for utility right-of-ways and other shrub habitats maintained in early-successional states;
- survey for any extant populations of Appalachian Bewick's Wren.

Oak-Hickory Deciduous Forests

Highest priority species for this habitat suite include Cerulean Warbler, Worm-eating Warbler, Kentucky Warbler, Louisiana Waterthrush and Wood Thrush. In addition, several widespread forest species are considered regional priorities in many physiographic areas, making this the largest habitat-species suite (21 species) of any considered (*table 2*). In many of the southern physiographic regions especially, this habitat makes up the highest proportion of the habitat in the landscape and often occurs in relatively large unbroken

forest blocks. The avifauna of these forests are also primarily southern, and some species are near the northern limit of their range.

Distribution and Populations

Cerulean Warbler had the greatest decline of any North American warbler between 1966 and 1982 (Degraaf and Rappole 1995) and the decline was estimated at 4.0 percent per year from 1966-2002 (Sauer et al. 2003). Although expansions into portions of the Northeast were documented through the 1900s, these populations do not appear to be expanding at present, and in some areas (e.g. New Jersey) subsequent declines have been noted. Largest populations in the Northeast region occur in the highlands of West Virginia but significant populations also occur in the Ridge and Valley and Lower Great lakes Plain physiographic areas. The recently completed Cerulean Warbler Atlas Project (Rosenberg et al. 2000) identified the most important sites for this species in each state. Cerulean Warbler populations occupy mature oak forests on dry ridge tops, mixed-mesophytic forests on slopes, and tall bottom-land forests of sycamore, cottonwood, or maples. The common feature of these habitats appears to be mature trees, a tall and uneven emergent canopy layer, and large tracts of land (Hamel 2000, Rosenberg et al. 2000).

Among the other focal species, Kentucky Warbler and Wood Thrush also are showing significant long-term declines, with losses of over 50 percent of the total population in the Northeast since 1966. Wood Thrush is the most widespread and abundant of the priority species of this habitat suite, with highest densities occurring in West Virginia (Sauer et al. 2003). In contrast, Kentucky Warbler is more abundant to the south of our region, with highest densities along the coastal plain and Piedmont regions.

Worm-eating Warbler is vulnerable to population declines because of its dependence on large tracts of forest for nesting and as a result of significant losses of over-wintering tropical broadleaf forest habitat (Petit et al. 1993). The BBS data show increasing populations in southern New England and the Mid-Atlantic Coastal Plain, whereas declines were noted in areas supporting the highest densities in south-central Pennsylvania and West Virginia (Sauer et al. 2003). Similarly, the Louisiana Waterthrush is believed to have relatively stable populations overall in Canada and the U. S., with local declines in high-abundance areas such as West Virginia perhaps offset by recent expansions at the northern edge of the range (Sauer et al. 2003).

Threats and Conservation Issues

The greatest threats to oak-hickory/deciduous forests of the Northeast include continued loss and fragmentation of forests near rapidly growing urban centers and degradation of forest habitat from excessive deer browse, disease, and invasive plants. In some areas there are specific threats, including the massive loss of habitat from mountaintop removal mining in West Virginia within the areas of highest density for breeding Cerulean Warblers. In addition to habitat loss, changing forest structure is of critical importance to many bird species. In particular, most priority species are associated with some form of forest disturbance, especially gaps and openings that create dense shrubby understory. Management to induce or replicate patterns of local disturbance may be important for sustaining forest bird populations, yet applying such management on public lands is often controversial. Furthermore, balancing the needs of species requiring small-scale local disturbance with those that need more extensive disturbance management remains one of the most challenging issues in bird conservation in the Northeast.

An estimated 80 percent of forest land in the eastern United States is privately owned. Outreach should be targeted at owners of private woodlots and large timber companies to manage (or not manage) their land for the benefit of priority forest birds. Proactive management on private lands would benefit conservation efforts and landowner interests. The largest tracts of oak-hickory dominated forests exist, however, on the relatively small amount of public lands in the region. These include several large National Forests in Virginia, West Virginia, and Pennsylvania, as well as numerous state parks and state-owned forests. These public lands are extremely important for the conservation of forest-dependent species in this region.

Needs and Recommendations

Implementing the broad objectives for this habitat-species suite will require a comprehensive forest management plan for the entire region that acknowledges the long-term importance of maintaining large source populations of priority forest birds. Elements of such a plan that are most relevant to the high-priority birds include:

- maintaining a balance of forest-age structures, including adequate amounts of mid-successional as well as late-successional forest;
- ensuring long-term tree-species composition; i.e. preventing loss of particular species, through disease or selective harvest;

- ensuring adequate structural diversity, especially regarding canopy and understory components (shrubs, treefalls); monitoring effects of natural disturbances (e.g. wind storms) as well as insect outbreaks, deer browsing, and forestry practices;
- setting maximum allowable levels of forest fragmentation due to forestry practices or planned development; e.g. do not allow any 10,000 km² landscape to fall below 70 percent forest cover.

Specific implementation strategy for the highest-priority species, Cerulean Warbler, includes:

- identify important populations and sites on public land; determine habitat needs and implement policy to protect or enhance populations;
- identify important populations and sites on private land; prioritize and target sites for easement, acquisition, or voluntary implementation of habitat protection or enhancement;
- monitor long-term use and suitability of key sites in relation to land use trends.
- determine best forest management practices for Cerulean Warblers to enhance populations.

Northern Hardwood and Coniferous Forest

Priority species for this habitat suite at the continental level include Olive-sided Flycatcher, Bay-breasted Warbler, Canada Warbler, and Rusty Blackbird, though the number of priority species that occupy this habitat is quite large (18 species - *table 2*). Additional species of regional concern or high responsibility include Black-billed Cuckoo, Yellow-bellied Sapsucker, Boreal Chickadee, Black-throated Blue Warbler, and Blackburnian Warbler. This habitat suite occurs in all 12 physiographic areas, though it is quite restricted in many of the southern regions. In many of the northern physiographic areas these habitats make up the highest proportion of the habitat in the landscape and often occur in relatively large unbroken forest blocks.

Distribution and Populations

Several priority species in this suite are at the southern limit of their range in the Northeast U. S. A majority of species are showing moderate to steep population declines in the Northeast and throughout their ranges. For example, Canada Warbler has shown a decline of -1.9 percent per year from 1966-2003, while Olive-sided Flycatcher has declined by an estimated -3.5 percent per year. Highest densities of both species in the region are in northwestern Maine (Sauer et al. 2003). Black-billed Cuckoo, Cape May Warbler, and

Rusty Blackbird are showing even steeper regional declines since 1966. In contrast, Northern Parula, Blackburnian, and Black-throated Blue Warblers have shown stable or increasing long-term trends (Sauer et al. 2003). Declining species are primarily those associated either with disturbance regimes within the forest (e.g. shrubby understory, edge), or with mature conifer stands (especially Bay-breasted and Cape May Warblers).

It is noteworthy that several of the species in this suite undergo marked population fluctuations in response to spruce-budworm outbreaks; these species exhibited large increases during the period 1966-1979 and then subsequent declines during the following decades. Setting population objectives for such species is extremely difficult.

Threats and Conservation Issues

Northern hardwood and mixed forests, usually dominated by sugar maple, beech, and birch, represent the most widely distributed habitat-type within the more northerly physiographic areas of the Northeast U. S. As mature softwoods (especially white pine) in these areas were extensively harvested in the past century, hardwood forests have regenerated over most of the region during the past 80 years. The major issues affecting this habitat suite today relate to trends in commercial timber production and management, forest habitat degradation (including effects of acid rain and deer over-browse), and, in some areas, loss and fragmentation of habitat from development.

Coniferous (i.e. softwood) tree species are currently preferred for commercial timber production (pulp and paper) in this region, and vast acreages of coniferous forest are under management for commercial forestry. In addition, because of shorter rotation cycles, age-class distribution of conifer forest is favoring younger and more even-aged stands. These trends suggest that a shortage of mature spruce-fir forest may exist in the near future. It is these mature coniferous forests that support a large number of high priority bird species, and if projections are accurate these species may decline throughout the region. Unlike the patchily distributed mountaintop communities, where protection of specific sites is critical, conservation strategies for mature coniferous forest will need to focus on maintenance of minimum percentages of the landscape mosaic to prevent local loss of this habitat type and its associated dependent species. This goal may best be achieved through cooperative agreements with large landowners.

For conservation lands that support coniferous forest, maintenance of considerably larger percentages of land area in mature or overmature age classes is desirable to

offset potential shortfalls or temporal bottlenecks. The shifting mosaic paradigm requires that no species be lost from a landscape unit over time (Hagan et al. 1997). To meet this seemingly simplistic objective requires maintenance of all habitat types in that landscape unit for a specified period. In the Adirondack Mountains, for example, vast areas are within state-owned forest preserve, whereas other large areas are under active timber management on private lands. This mosaic of ownership and land-use presents both a challenge and an opportunity for largescale bird conservation in the region.

Needs and Recommendations

General management guidelines for priority species in northern hardwood and coniferous forests do not exist at present, although much research has been conducted on habitat relationships and effects of silviculture in local areas. Many of the priority species have been shown to respond positively to various silvicultural practices. In particular, Canada and Black-throated Blue Warbler populations were enhanced by modest timber harvesting in Maine (Hagan and Grove 1995). Because songbirds have small area requirements and frequently dense populations, greater consideration should be given to the diversity and arrangement of habitats at the landscape-level rather than focusing on species abundance at the stand level (Hagan et al. 1997). No single silvicultural practice benefits all species of neotropical migrant birds (DeGraaf et al. 1993); rather, forest management activity can benefit most species at some time in the rotation cycle. Strong associations of dense understory to populations of Black-throated Blue and Canada Warbler (Holmes 1994, Conway 1999) suggests that certain forest harvesting practices (on appropriate sites), like selective cutting or group selection, could be especially useful at creating or maintaining suitable habitat.

Developing predictive habitat suitability models for priority species at landscape scales is a high priority in this forest type. This effort would benefit from research directed at the following specific needs:

- GIS analysis of public and private lands to identify, catalog, and prioritize forest stands in terms of species composition, age structure, and amount of understory;
- determine specific habitat needs (and causes of declines) for Canada Warbler; why, for example, is Canada Warbler declining while Black-throated Blue Warbler is stable, if both require shrubby understory of mature forest?
- better understanding of landscape-level effects of land-use practices on forest bird populations;

- better understanding of role of stand age and stand structure on habitat quality and ultimately survival and reproductive success of priority species;
- better methods for monitoring species that use patchily distributed components of the forest, such as treefall gaps, wetlands, peatlands, snags.

Conservation of birds in northern hardwood and coniferous forests will be best implemented in partnership with Canadian agencies and organizations. Recent efforts in the Atlantic Northern Forest Bird Conservation Region (BCR 14) through the Atlantic Coast and Eastern Habitat Joint Ventures represent an excellent beginning.

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