Ecosystem management for sustainability: principles and practices illustrated by a regional biosphere reserve cooperative. Boca Raton, FL: CRC Press, Lewis Publishers: 187-208.(Editor's note: Kay Franzreb, SRS scientist, co-authored this chapter.)

9 The Role of Indicator Species: Neotropical Migratory Song Birds

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INTRODUCTION

Southern Appalachian forests support some of the richest avian diversity in North America, including some 75 species of neotropical migrants, birds that perform the remarkable feat of making much of the Western Hemisphere their home. This diverse group includes the swallows, kingbirds, and other flycatchers that feed in the air on flying insects. The Eastern Kingbird is a typical species. It breeds in forested areas, primarily in the Eastern U.S. and winters in Central America and Northern South America (Figure 1). Species such as tanagers glean insects from forest foliage and also feed extensively on fruit. Other groups include the vireos, orioles, thrushes, and even the tiny hummingbirds.

But the largest and most striking members of this group of birds are the wood warblers, some 50 closely related species of what can best be referred to as "quintessential" songbirds. These brightly colored songsters occupy an astonishing diversity of habitats. The Blackbumian Warbler inhabits the spruce-fir forests as far north as boreal Canada. Black and White Warblers glean insects from branches of the tallest trees in mature deciduous forests but nest on the ground. Worm-eating Warblers are specialists at prying insects out of the protective covering of curled up leaves, while Chestnut-sided Warblers are shrub nesting specialists of disturbed sites and forest edges.

Neotropical migrants predominate in the breeding bird community of eastern deciduous forests. In some parts of the southern Appalachians, up to 80% of the breeding bird community is comprised of these species (Figure 2). These approximately 75 species use ground, shrub, and especially canopy nests, and about 80% of them are insectivores (Figure 3). Recent concern over the status of these birds has been prompted by surveys showing widespread population declines.

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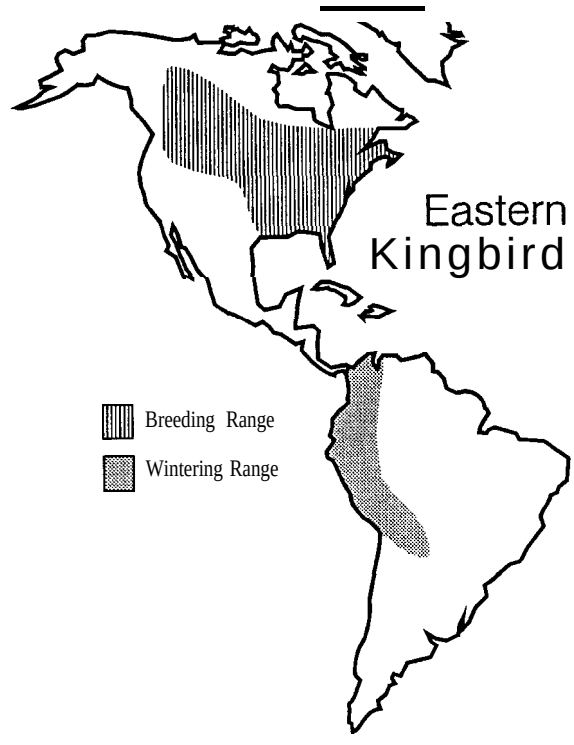

FIGURE 1 Breeding and wintering ranges of the Eastern Kingbird, a typical neotropical migratory passerine. (From Rappole, J.H. et al. USDI/FWS, U.S. Government Printing Office, Washington, D.C., 1983.)

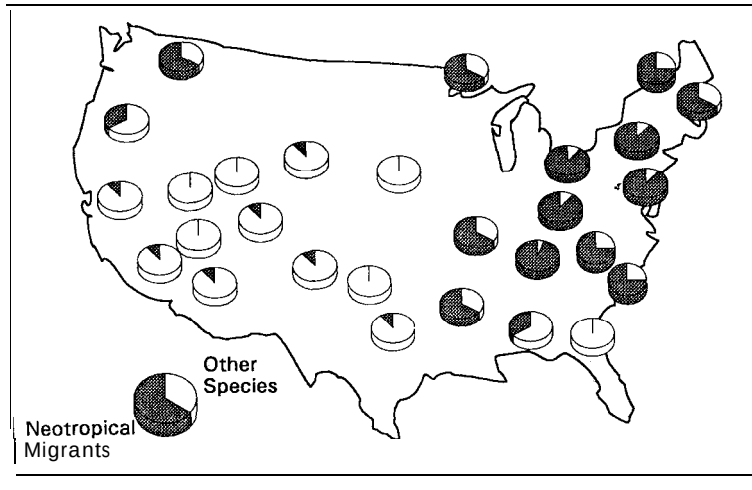

FIGURE 2 Proportion of neotropical migrants in the breeding bird community. (From MacArthur, R.H., *Proc. Natl. Acad. Sci. U.S.A., 43, 293-295, 1957.)*

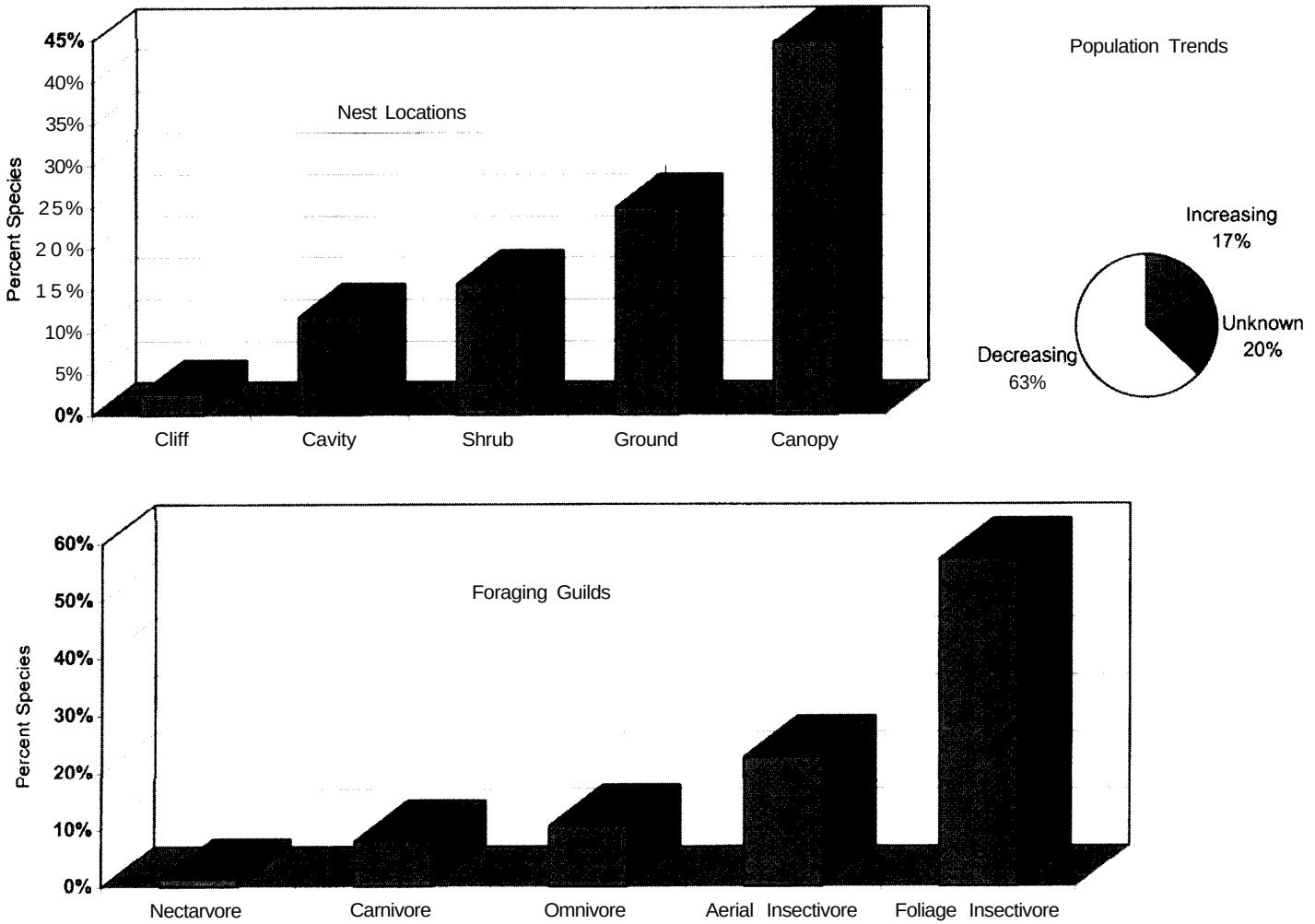

FIGURE 3 Population trends, nest locations, and foraging ecology of southern Appalachian neotropical migrants.

IMPORTANCE OF THE SOUTHERN APPALACHIANS

The southern Appalachian region is significant to forest birds for a variety of reasons:

- It is a an internationally recognized refugium of temperate forest biodiversity. Great Smoky Mountains National Park (GSMNP) is a designated World Heritage Site and an International Biosphere Reserve, recognized primarily for its biological diversity. The steep, complex topography harbors species richness along extreme temperature and moisture gradients.
- It contains the largest remaining stands of virgin forests in the eastern U.S. Over 30% of the forests of GSMNP are considered to be high in primary forest attributes, representing perhaps as much as 80% of the primary forest remaining in the eastern U.S. (Davis 1993). These forests provide a rare opportunity to study the unique characteristics of undisturbed forest ecosystems.
- A substantial number of ecosystems and species are at risk The most threatened ecosystem is the high elevation spruce-fir forests that have been decimated by exotic insects and air pollution. There are 120 species of vascular plants recognized as rare enough to be of managerial concern. A similar number of bryophytes, lichens, and fungi are also considered rare at the regional, national, or global level. At least 22 species of breeding birds are considered of serious management concern due to significant reductions in populations or habitats (Hunter 1993).
- The region contains the largest block of protected forested landscape in the eastern U.S. Over five million acres of protected lands in the region include a matrix of National Forests, federally designated wilderness areas, state lands, Tennessee Valley Authority reservoirs, and National Park Service lands (Figure 4).

EVIDENCE AND CAUSES OF DECLINING SONGBIRD POPULATIONS

We know that several species have been in decline for some time. In the western U.S., Golden-cheeked Warblers and Black-capped Vireos, and in the east Bachman's and Kirtland's Warblers are listed as endangered species. In these birds, population problems could usually be traced to extremely limited and specialized breeding and/or wintering habitat, and it is generally believed that their populations have historically always been low.

More recently, a larger problem has been detected. The U.S. Fish and Wildlife Service has conducted the Breeding Bird Survey in the U.S. since 1966. A survey consists of 50 3-minute point counts (censuses from a fixed point in which an observer records all the birds seen or heard during a set period of time) along a 25-mile roadside route. Routes are randomly assigned and run once each year during the peak of the breeding season. Using an all-volunteer force, the program conducts 2000 to 3000 surveys a year along some 50,000 miles of secondary roads. Population trends for neotropical migrants from 1978 to 1987 are summarized in Figure 5 (Robbins et al. 1989b). Of the species classified as neotropical migrants, 71% declined during the period. Of the 44 species showing negative trends, 20 exhibited statistically significant declines. Declines for some species, such as the Bay-breasted Warbler, were precipitous, averaging 16% per year. More typical are species like the Kentucky Warbler whose populations decreased at rates of 2 to 3% per year.

A more recent analysis of data from the Breeding Birds Survey from 1966 to 1992 (Peterjon et al. 1995) indicates that, continent-wide, as many species of neotropical migrants have shown increasing as decreasing populations. Nevertheless, widespread population declines were evident in many species over the past 15 years, particularly in the eastern U.S. (Askins et al. 1990). The southern Appalachians have shown consistent negative trends for both neotropical migrants and woodland birds over the 26 year period (Figure 6).

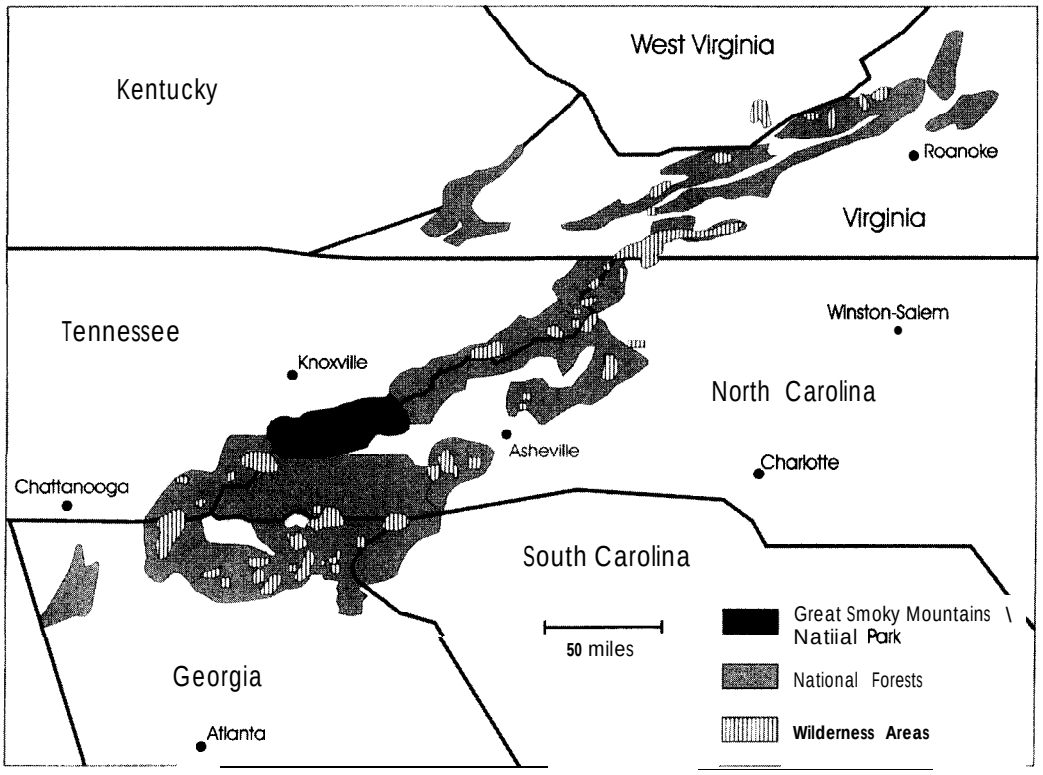

FIGURE 4 Protected areas in the southern Appalachians.

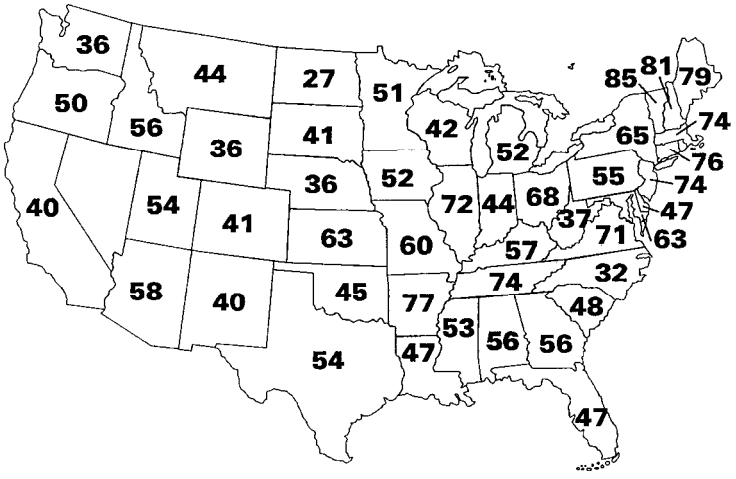

FIGURE 5 Percent of migratory bird species showing population declines from 1978 to 1987. (From Robbins, C.S. et al., *Wildl.Monogr.,* 103, 1989.)

Habitat changes on both the breeding and wintering grounds are thought to be responsible (Sherry and Holmes 1995). In the tropics, logging and land clearing for agriculture and ranching are reducing habitats at rates of 1 to 4% per year and, in some countries, these rates are rising.

The effects of winter habitat loss on population are amplified due to the simple fact that tropical wintering habitats comprise but a fraction of the land area available in North America for breeding.

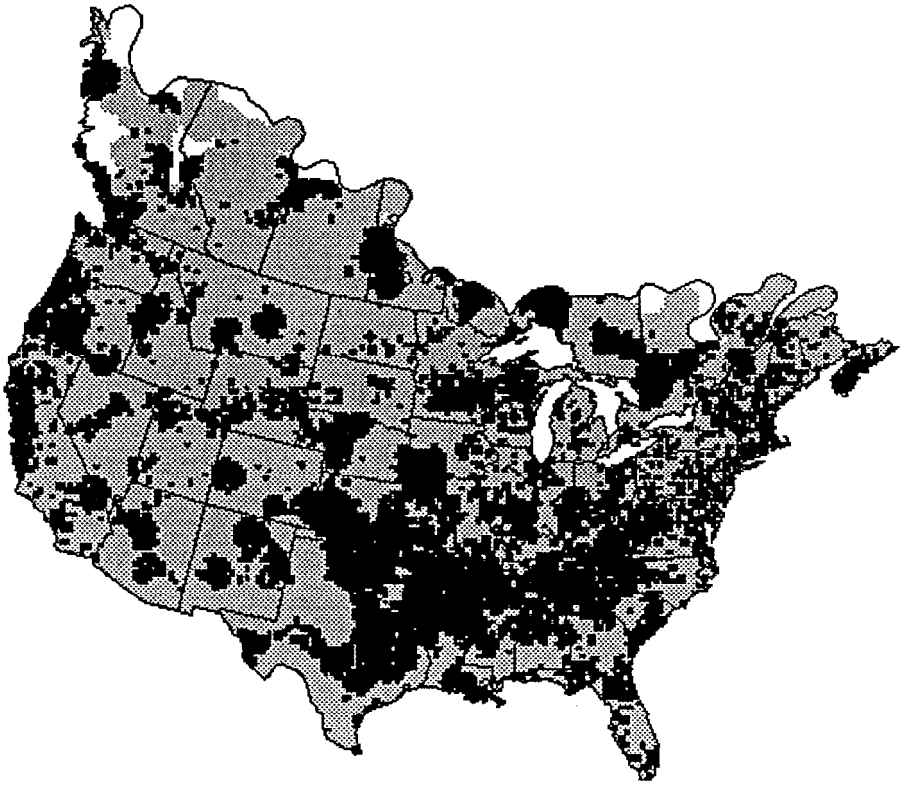

FIGURE 6 Mean trends for populations of neotropical migrant bird species during the period 1966 to 1992, based on the Breeding Bird Survey. Dark areas indicate negative population trends, light areas indicate positive population trends. (From Peterjon, B.J. et al., in Our Living Resources: a Report to the Nation of the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C., 1995.)

Nevertheless, it is important to keep in mind that forested habitats on the breeding grounds have also changed enormously over the past 3 centuries. Most of the bottomland hardwood forest of the Mississippi Valley and old growth forest in the east and west are gone. As managed forests become less diverse, they provide reduced habitat for forest birds (Thompson et al. 1995). Many of the remaining forested habitats have been severely fragmented by human activities. This has created additional pressures on many woodland birds that historically nested in the interior of large forest tracts.

The Wood Thrush, a so-called "area-sensitive" species (Robbins et al. 1989a), is a good example. The southern Appalachians are the center of abundance for the species which breeds in deciduous forests throughout the eastern U.S. (Figure 7). Populations have shown a steady decline over much of the species range during the past 20 years, based on a variety of indices (Figure 7). Research on the breeding and wintering grounds points to several consequences of habitat fragmentation that may explain these trends. Temple and Cary (1988) and Robinson et al. (1995) have shown that nest parasitism by Brown-headed Cowbirds is higher in fragmented forests. Small patches also harbor more potential predators such as squirrels, raccoons, and crows that generally avoid forest interiors. Wilcove et al. (1985) have shown that birds nesting in large contiguous forests suffered lower rates of nest predation than those nesting in forest fragments.

Much of this research, has been coordinated under the Partners in Flight Program (Finch and Stangel1993), a cooperative interagency effort involving state, private, and federal land management and conservation organizations in the U.S. and Latin America. The program has focused attention on these birds in a hemisphere-wide effort to stop population declines.

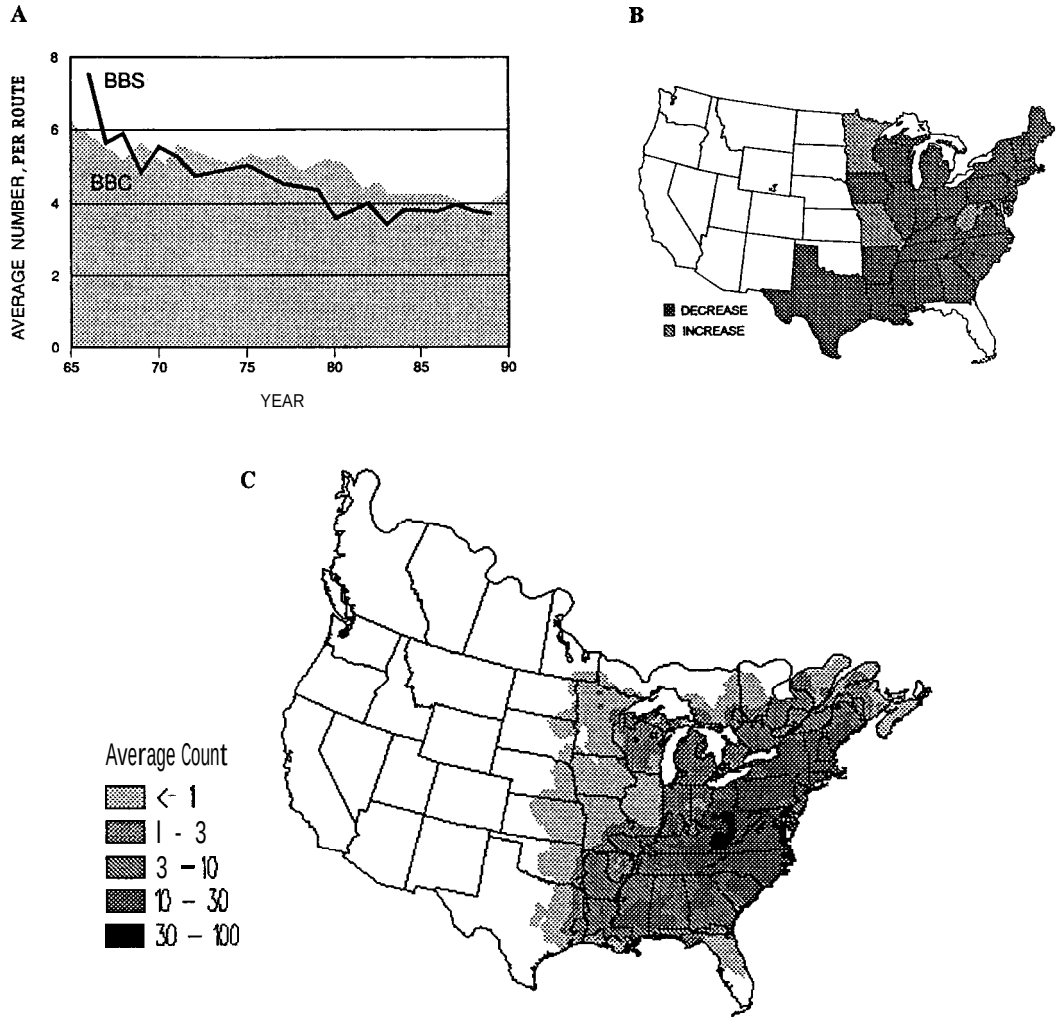

FIGURE 7 Status of breeding wood thrush populations in the U.S. Data from the Breeding Bird Census (BBC) and Breeding Bird Survey (BBS) indicate declining population trends (A) across most of the species breeding range in the eastern U.S. (B). Population densities reach their maximum in the southern Appalachians, based on BBS census data (C).

It is becoming clear that the population declines shown by many neotropical migrants and other forest birds are probably the result of a combination of factors. A wide variety of research efforts are underway in the southern Appalachians to help conserve forest bird populations (Table 1, Figure 8). These research projects were initiated independently, but efforts have been made to share data through Partners in Flight and use standardized methodologies where possible. These studies could serve as a framework for an ecosystem-scale program to address the conservation needs of forest birds across the southern Appalachians.

AN ECOSYSTEM APPROACH TO FOREST BIRD CONSERVATION

These collaborations have resulted in some standardization of methods and objectives, but they have also highlighted the need for a regional-scale approach to understanding the overall importance of the southern Appalachians to forest birds and the effect that land use practices are having on

TABLE 1
On-Going Avian Research in the Southern Appalachians

Principal investigator	Project title	Location	Partners
Buehler (UT)	Forest Avian Diversity	Cherokee N.F.	USFS
Collazo (NBS)	Forest Bird Productivity	Nantalahala N.F.	USFWS, USFS
Franzreb (USFS)	Effects of Timber Harvest on Cove Hardwood Birds	North Carolina National Forests	USFS, NC
Simons (NBS) Rabenlod (Purdue)	Old Growth Bird Community Studies	Great Smoky Mountains NP	NPS Purdue
Simons (NBS)	Wood Thrush Productivity	Great Smoky Mountains NP	NPS

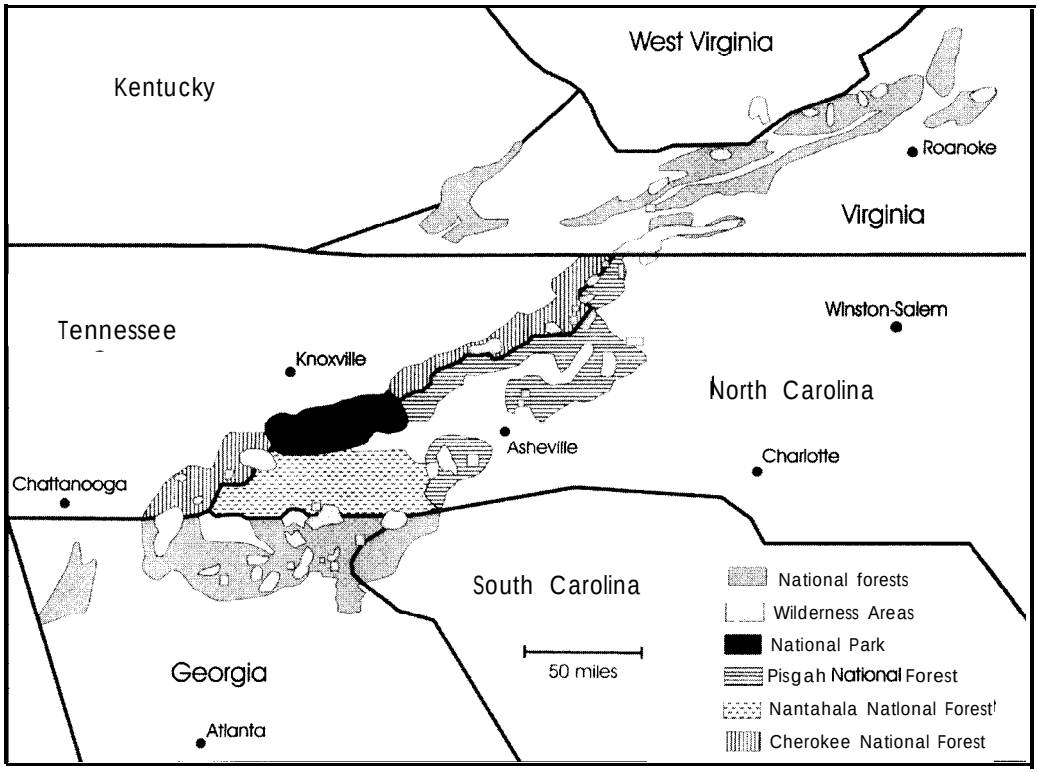

FIGURE 8 Forest bird study sites in the southern Appalachians.

their populations. An approach (Simons et al. 1995) for an ecosystem-scale research program has been developed that could serve as a model for understanding a number of important land management issues in the region. The proposed program would consist of two components:

- The establishment of standardized population and productivity monitoring protocols on "control" sites within GSMNP to allow comparisons to regional and national monitoring programs such as the Breeding Bird Survey
- A landscape scale "case study" to develop landscape models of how habitat conditions on protected and managed, public and private lands in the southern Appalachian region are affecting forest bird populations

A review of the objectives of the proposed ecosystem program and some of the findings to date will illustrate how an ecosystem-scale study of forest bird populations could enhance conservation efforts in the future.

Simons et al. (1995) have examined several questions related to the establishment of a population monitoring program within GSMNP, which would serve as a control site for comparison to more disturbed sites in the region. Because forest habitats in the Park are older and relatively more stable than surrounding areas, understanding bird population trends in the Park would provide important insights into larger-scale population trends and the relative significance of factors affecting populations on the wintering grounds, such as habitat loss, vs. those affecting populations on the breeding grounds, such as forest fragmentation. Some of the questions such an approach could address include:

- Do changes in bird populations within GSMNP mirror those observed on a regional scale (suggesting that populations are responding to conditions on the wintering grounds)?
- Do populations within the National Parks remain stable while regional populations decline (suggesting that populations are responding to conditions on the breeding grounds)?
- Does the productivity of neotropical migrants within these protected areas exceed that required for population stability (suggesting that the National Parks may serve as population "source" areas at a local or regional scale) (Simons and Farnsworth 1995)?

Work to establish GSMNP as a control site for regional scale studies began in 1991. Initial efforts were focused on calibrating and testing methodologies for long-term population monitoring to determine the costs and benefits of various population monitoring techniques, the appropriate scale for a Park-based monitoring program, and the relationship between bird population and habitat variability. We initially looked at three common methods of quantifying breeding bird populations; point counts, spot mapping, and mist netting. Based on the results of that calibration (Figure 9), we selected lo-minute fixed radius point counts as the primary sampling method. We then used point counts to estimate the breeding bird populations at five pairs of old growth-second-growth cove hardwood sites in the vicinity of Gatlinburg, TN. Permanent census points were established at each of the sites, and replicated censuses were conducted in May and June from 1992 to 1994. Results provided estimates of the relative abundance of 56 species of breeding birds at these sites and the sampling variability inherent in those estimates. Old growth sites showed higher breeding bird species diversity than second growth sites, presumably a reflection of the more even distribution of a larger number of species at old growth sites and the structural complexity caused by the large trees and tree-fall gaps characteristic of old growth forests (Figure 10). An analysis of the natural annual variability of census data (Figure 11) was used to evaluate the trade-off between statistical error rates and sample size requirements for a range of species (Figure 12). This approach can be used to ensure that future monitoring programs will be capable of meeting their objectives.

Forest breeding bird communities could serve as one of several models to examine how land use patterns and land management practices are affecting biological diversity in the southern Appalachians. Other potential indicators of regional forest health include the black bear, which is recognized as a management indicator species by the U.S. Forest Service (Clark and Pelton, Chapter 10 this volume) and salamanders, whose diversity in the southern Appalachians exceeds that anywhere else in North America (Duellman and Treub 1986). Clearly no one species or community can serve as a reliable indicator of ecosystem health, and legitimate questions have been raised concerning the management indicator concept (Doak and Mills 1994, Harrison 1994). Nevertheless, by carefully selecting a balanced sample of indicator species and communities, land managers should be able to track changes in biotic diversity and abundance that are being driven by changes in land use.

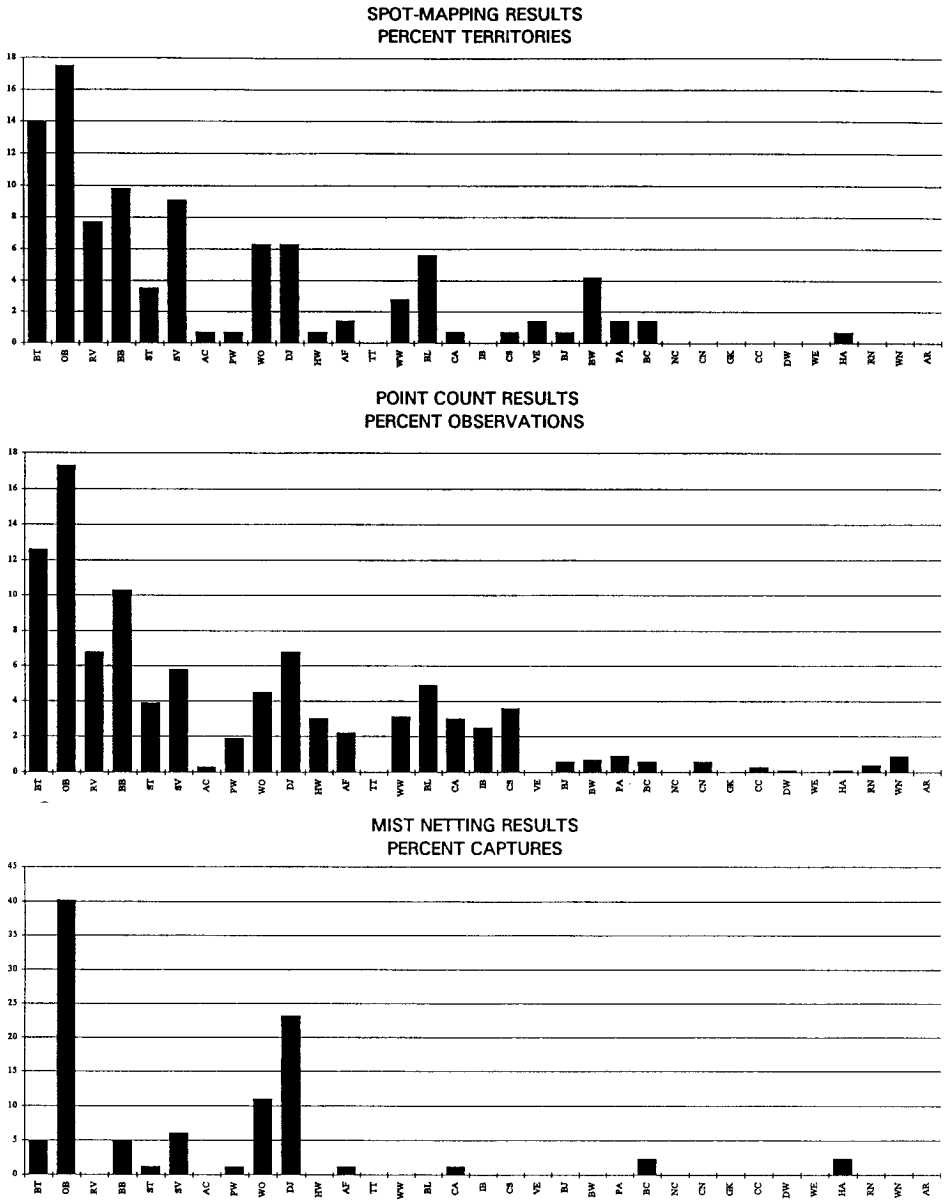

FIGURE 9 A comparison of census results from the Roaring Fork study site in Great Smoky Mountains National Park; 10-min, 50-m radius point counts proved to be the most efficient method for sampling forest bird communities in these habitats. (From Simons T.R. et al., Characterization of deciduous forest breeding bird communities of Great Smoky Mountains National Park. Final Report to the National Park Service, 1995.)

Accomplishing that goal for forest birds will require a coordinated landscape scale program focused on two major questions.

- How is the diversity, abundance, and productivity of avian populations related to habitat features such as habitat abundance, structural complexity, and the spatial arrangement of habitat types?
- How are these habitat features affected by land use and management?

Bird species codes used in Figures 9 through 11

Code	Species	Scientific name
AC	American Crow	*Corvus brachyrhynchos*
AF	Acadian Flycatcher	*Empidonax virescens*
AR	American Redstart	*Setophaga ruticilla*
BB	Black-throated Blue Warbler	*Dendroica caerulescens*
BC	Black-capped chickadee	*Parus atricapillus*
BG	Blue-gray Gnatcatcher	*Polioptila caerulea*
BH	Broad-winged Hawk	*Buteo platypterus*
BJ	Blue Jay	*Cyanocitta cristata*
BL	Black-and-white Warbler	*Mniotilta varia*
BN	Brown Thrasher	*Toxostoma rufum*
BO	Barred Owl	*Strix varia*
BR	Brown Creeper	*Certhia familiaris*
BT	Black-throated Green Warbler	*Dendroica virens*
BW	Blackburnian Warbler	*Dendroica fusca*
CA	Carolina Wren	*Thryothorus ludovicianus*
CB	Brown-headed Cowbird	*Molothrus ater*
c c	Carolina Chickadee	*Parus carolinensis*
CE	Cedar Waxwing	*Bombycilla cedrorum*
CG	Common Grackle	*Quiscalus quiscalus*
CH	Chestnut-sided-Warbler	*Dendroica pennsylvanica*
CN	Canada Warbler	*Wilsonia canadensis*
c o	Cooper's Hawk	*Accipiter cooperii*
CS	Chimney Swift	*Chaetura pelagica*
c u	Black-billed Cuckoo	*Coccyzus erythropthalmus*
c w	Cerulean Warbler	*Dendroica cerulea*
DJ	Dark-eyed Junco	*Junco hyemalis*
DW	Downy Woodpecker	*Picoides pubescens*
EK	Eastern Kingbird	*Tyrannus tyrannus*
EP	Eastern Phoebe	*Sayornis phoebe*
ES	Starling	*Sturnus vulgaris*
EW	Eastern Wood-pewee	*Contopus virens*
GC	Gray Catbird	*Dumetella carolinensis*
GF	Great Crested Flycatcher	*Myiarchus crinitus*
GK	Golden-crowned Kinglet	*Regulus satrapa*
GO	American Goldfinch	*Carduelis tristis*
HA	Hairy Woodpecker	*Picoides villosus*
HB	Ruby-throated Hummingbird	*Archilochus colubris*
HO	House Wren	*Troglodytes aedon*
HT	Hermit Thrush	*Catharus guttatus*
HW	Hooded Warbler	*Wilsonia citrina*
IB	Indigo Bunting	*Passerina cyanea*
KW	Kentucky Warbler	*Oporonis formosus*
LF	Least Flycatcher	*Empidonax minimus*
LW	Louisiana Waterthrush	*Seiurus motacilla*
MD	Mourning Dove	*Zenaida macroura*
MW	Magnolia Warbler	*Dendroica magnolia*
NC	Northern Cardinal	*Cardinalis cardinalis*
NF	Northern Flicker	*Colaptes auratus*
NO	Northern Oriole	*Icterus galbula*
NR	Northern Raven	*Corvus corax*
NW	Nashville Warbler	*Vermivora ruficapilla*
OB	Ovenbird	*Sieurus aurocapillus*
0 0	Orchard Oriole	*Icterus spurius*
PA	Parula Warbler	*Parula Americana*
PI	Pine Siskin	*Carduelis pinus*
PW	Pileated Woodpecker	*Dryocopus pileatus*
RB	Red-bellied Woodpecker	*Melanerpes carolinus*
RC	Red Crossbill	*Laxia curvirostra*
RG	Rose-Breasted Grosbeak	*Pheucticus ludovicianus*
RK	Red-Tailed Hawk	*Buteo jamaicensis*
RN	Red-breasted Nuthatch	*Sitta canadensis*
RO	American Robin	*Turdus migratorius*
RT	Rufous-sided Towhee	*Pipilo erythropthalmus*
RU	Ruffed Grouse	*Bonasa umbellus*
RV	Red-eyed Vireo	*Vireo olivaceus*
SA	Swainson's Warbler	*Limnothlypis swainsonii*
SI	Swainson's Thrush	*Catharus ustalatus*
S S	Song Sparrow	*Melospiza melodia*
ST	Scarlet Tanager	*Piranga olivacea*
s u	Summer Tanager	*Piranga rubra*
s v	Solitary Vireo	*Vireo solitarius*
TT	Tufted Titmouse	*Parus bicolor*
TW	Tennessee Warbler	*Vermivora peregrina*
VE	Veery	*Catharus fuscescens*
WE	Worn-eating Warbler	*Helmitheros vermivorus*
WI	White-eyed Vireo	*Vireo griseus*
WN	White-breasted Nuthatch	*Sitta carolinensis*
w o	Wood Thrush	*Hylocichla mustelina*
WT	White-throated sparrow	*Zonotrichia albicollis*
WV	Warbling Vireo	*Vireo gilvis*
w w	Winter Wren	*Troglodytes troglodytes*
YB	Yellow-billed Cuckoo	*Coccyzus americanus*
YC	Yellow-breasted Chat	*Icteria virens*
YR	Yellow-rumped Warbler	*Dendroica coronata*
YS	Yellow-bellied Sapsucker	*Sphyrapicus varius*
YT	Yellow-throated Warbler	*Dendroica dominica*
YV	Yellow-throated Vireo	*Virea flavifrons*
YW	Yellow Warbler	*Dendroica petechia*

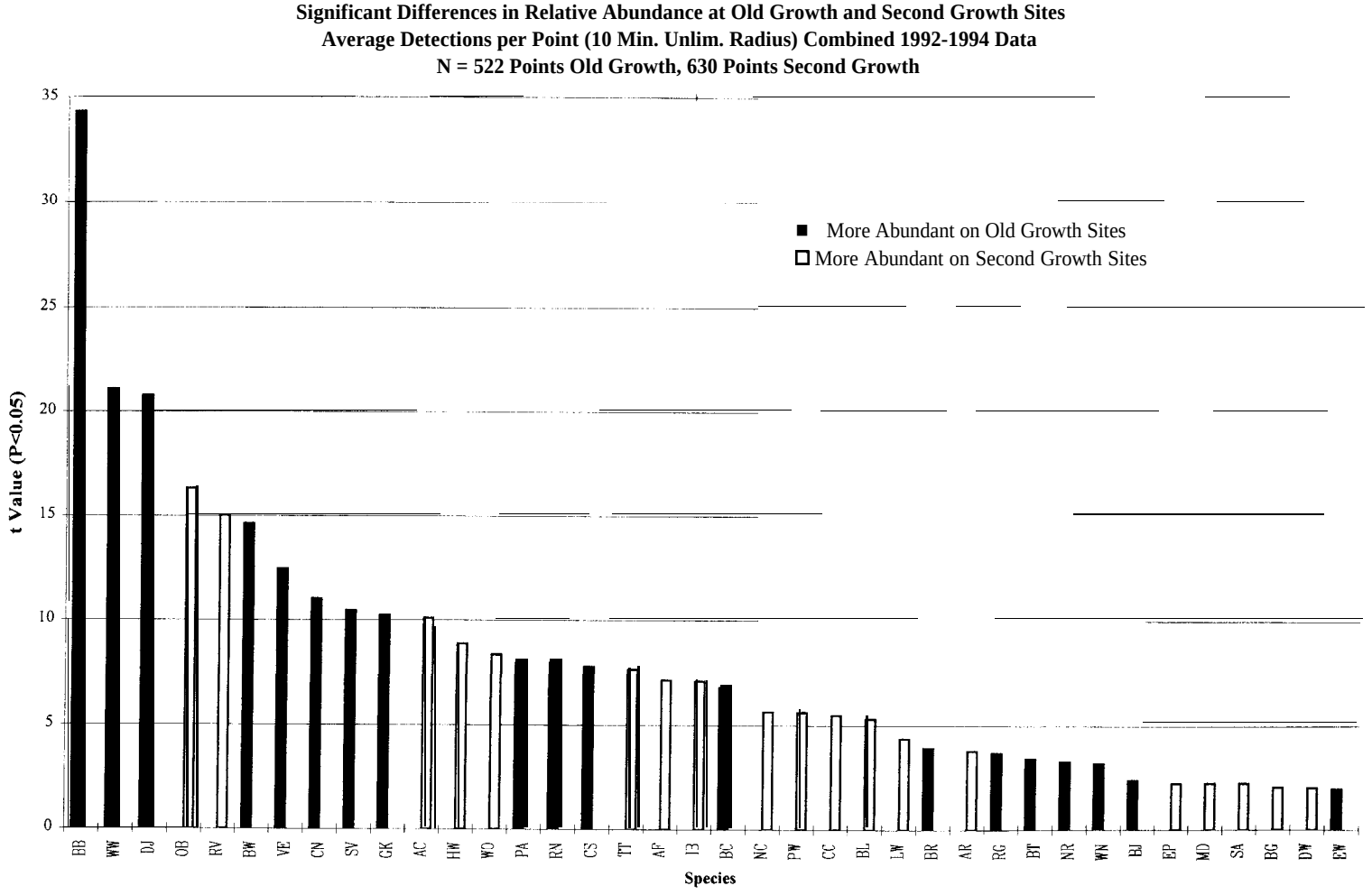

FIGURE 10 Significant differences in relative abundance at old growth and second growth sites. Average detections per point (10 min. unlim. radius) combined 1992-1994 data. N = 522 points old growth, 630 points second growth.

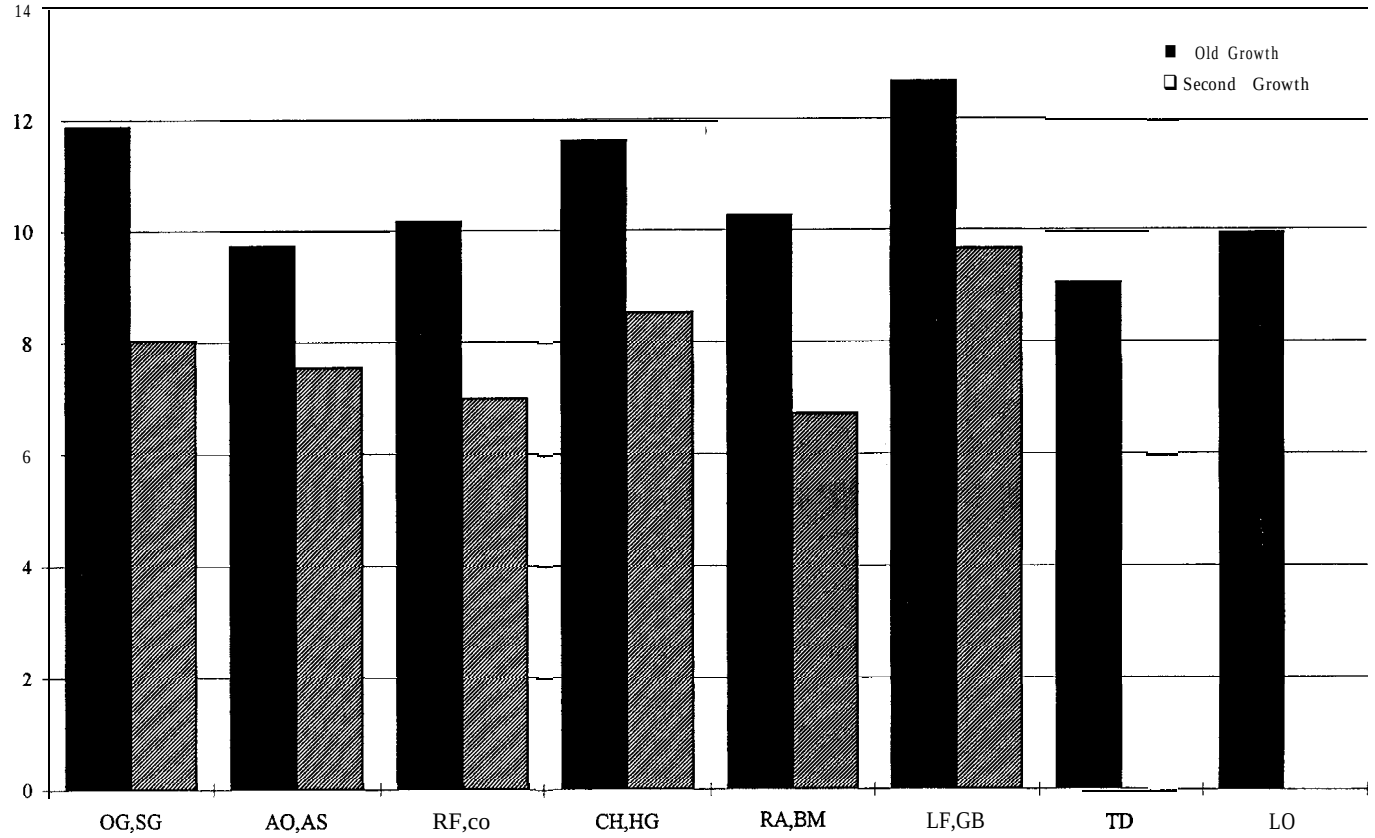

FIGURE 11 Comparison of bird species. Simpson diversity indices calculated from old growth and second growth study sites in Great Smoky Mountains National Park. Sites: (OG) combined old growth sites, (SG) combined second growth sites, (AO) Albright Grove old growth, (AS) Albright Grove second growth, (RF) Roaring Fork, (CO) Cherokee Orchard, (CH) Chimneys, (HG) Husky Gap, (RA) Ramsay Cascade, (BM) Brushy Mountain, (LF) Laurel Falls, (GB) Grassy Branch, (TD) Thomas Divide, (LO) Laurel Falls old growth.

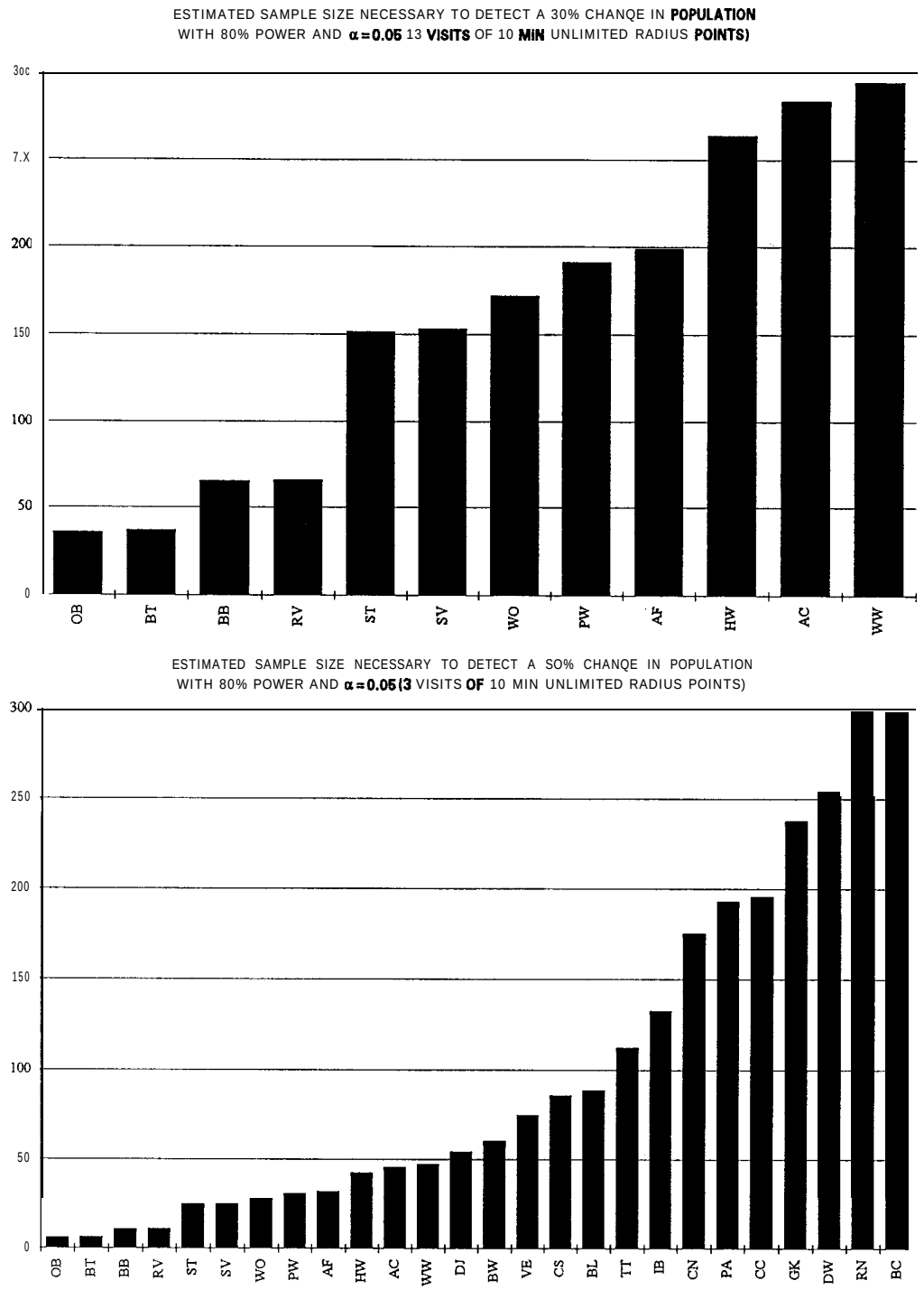

FIGURE 12 Estimated sample sizes (number of point counts) required to detect population changes from one year to another. Estimates based on point counts from 1992 to 1994 in Great Smoky Mountains National Park.

Some of the hypotheses to be tested through such a program might include:

- Old-growth forests support higher levels of breeding bird diversity, abundance, and productivity than younger but floristically similar stands
- Differences in habitat suitability between old growth and younger stands can be attributed to the greater structural complexity of old growth forests
- Breeding bird diversity and productivity are correlated with the abundance and connectivity of suitable habitat in southern Appalachian landscapes
- Rates of productivity will be lower and Brown-headed Cowbird nest parasitism will be higher in landscapes characterized by small, isolated habitat patches and patches with high edge-to-area ratios
- Local trends in bird abundance, diversity, productivity, and parasitism within patches of contiguous forest will be associated with distance to the patch boundary

INSIGHTS FROM ON-GOING RESEARCH

A comparison of preliminary results from our adjacent study sites provides a glimpse of the insights that such an ecosystem-scale approach might provide. The Southeastern Working Group of Partners in Flight has identified 22 high priority species in the region (Hunter 1993) (Table 2). These species were identified based on evidence of declining populations, specialized habitat requirements, or regional trends in habitat loss.

Preliminary results from our study sites indicate some differences between the bird communities on managed and unmanaged forests in the region. For example, comparison of spot-mapping results from cove hardwood/oak-hickory forests in GSMNP and adjacent North Carolina National Forests indicate that breeding bird densities for most high priority species are higher in the Park. The patterns were apparent for both old growth (Figure 13) and second growth (Figure 14) sites. A comparison of point count censuses from each of our study sites presents a more complex picture. (Figure 15). About half of the high priority species found on each of the sites showed higher indices of abundance within the Park, which may reflect higher habitat quality on less-disturbed sites. Populations of other species, such as Worm-eating and Hooded Warblers, appear to fare better on more disturbed sites where forest management practices presumably create preferred habitats.

Nesting productivity is another measure of habitat quality. The Wood Thrush has become a model species whose nesting success appears to be closely linked to levels of forest fragmentation (Robinson et al. 1995). On-going studies of Wood Thrush nesting success in GSMNP indicate relatively high levels of productivity, suggesting that the contiguous forests in the Park may be serving as a regional population source (Pulliam 1988) for the species (Simons and Farnsworth 1995). Data from 1993 indicate slightly higher Wood Thrush productivity in the Park than on the Cherokee National Forest (Table 3). Similar monitoring at a regional scale will be necessary to determine relationships between forest management practices and the diversity and abundance of forest birds.

The message from our preliminary research is clear: an effective program for conserving avian diversity in the southern Appalachians must be based on ecosystem-scale data that integrate a variety of influences across the regional landscape. A successful landscape scale program must include: (1) a commitment to long-term studies, (2) a standardized regional-scale habitat map, (3) fully standardized sampling protocols for birds and their habitats, and (4) controlled, hypothesis-driven studies of bird/habitat relationships that will provide an understanding of how habitat quality, the spatial characteristics of habitats, and land management practices influence habitat suitability for forest birds. The results of this program could serve as one of several complementary indicators of the health of southern Appalachian ecosystems.

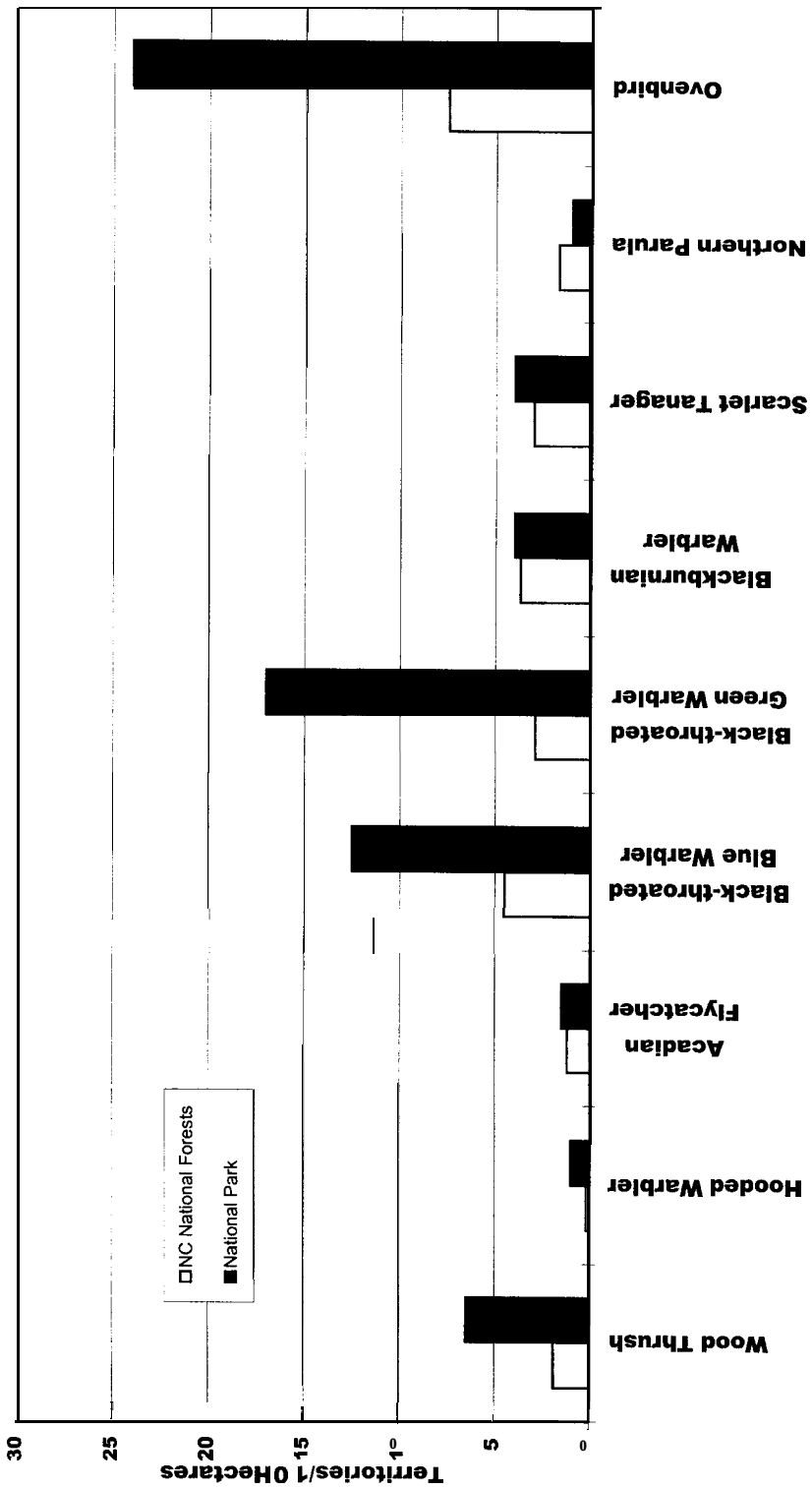

FIGURE 13 Comparison of breeding bird territory spot-mapping results from mature forest sites on North Carolina National Forests and old growth sites in Great Smoky Mountains National Park.

TABLE 2
High Priority Southern Appalachian Bird Species, Based on Analysis by Hunter (1993)

Rank	Species	Rank	Species
1	Chestnut-sided Warbler	12	Eastern Wood-Pewee
2	Swainson's Warble	13	Yellow-throated Vireo
3	Louisiana Waterthrush	14	Black-throated Green Warbler
4	Wood Thrush	15	Blackburnian Warbler
5	Golden-winged Warbler	16	Kentucky Warbler
6	Cerulean Warbler	17	Scarlet Tanager
7	Worn-eating Warbler	18	Gray Catbird
8	Hooded Warbler	19	Blue-winged Warbler
9	Acadian Flycatcher	20	Northern Parula
10	Black-throated Blue Warbler	21	Prairie Warbler
11	Canada Warbler	22	Ovenbird

TABLE 3
Wood Thrush Productivity on Study Sites in Great Smoky Mountains National Park and the Cherokee National Forest in 1993

Site	# Active nests 1993	# Successful nests	# Chicks fledged	Fledglings/successful nest
National Park	54	26	95	3.65
Cherokee National Forest	13	7	23	3.30

The components of such a program are beginning to take shape. Prioritization of species and habitats through Partners in Flight has greatly refined our ability to set appropriate research and conservation priorities. Numerous smaller studies such as ours have helped determine the relevant questions and methods to apply to a regional-scale study. Finally, digital map and information databases generated through the Southern Appalachian Assessment (see Berish et al., Chapter 7 of this volume) are providing an information base at an appropriate scale for ecosystem research and monitoring.

CONCLUSIONS

The diversity of southern Appalachian forest birds creates a dilemma for land managers seeking to conserve declining or sensitive species. The difficulty stems from the need to set objectives in an appropriate management context. Species of concern occur across a wide range of forest successional stages and management regimes, so that simple prescriptions are usually not possible. Protecting old growth, managing for snags, reducing clearcuts, or preserving large forest tracts will benefit some species, while management that creates edge and early successional habitats will benefit others.

Thompson et al. (1992, 1995) have discussed these trade-offs and the need to develop a hierarchical approach to management that scales down from the continental to the habitat-stand level. Large scale assessments of population trends and habitat requirements provided through programs such as Partners in Flight (Hunter 1993) and the Breeding Bird Survey (Peterjon et al. 1995) provide the best guidelines for evaluating regional and continental priorities. Because land use practices on private land tend to favor early successional and edge species, the best opportunities to manage for

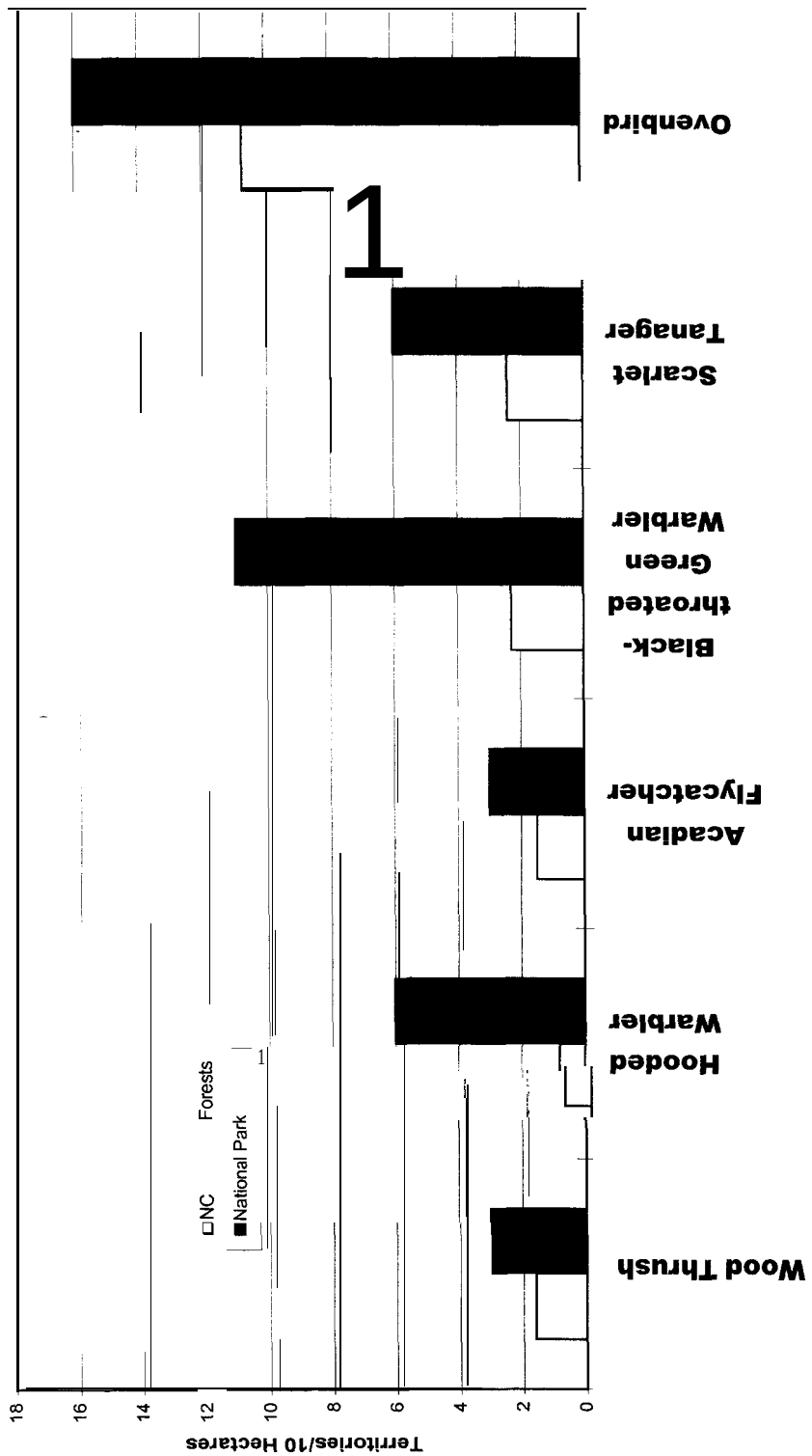

FIGURE 14 Comparison of breeding bird territory spot-mapping results from second growth sites on North Carolina National Forests and second growth sites in Great Smoky Mountains National Park.

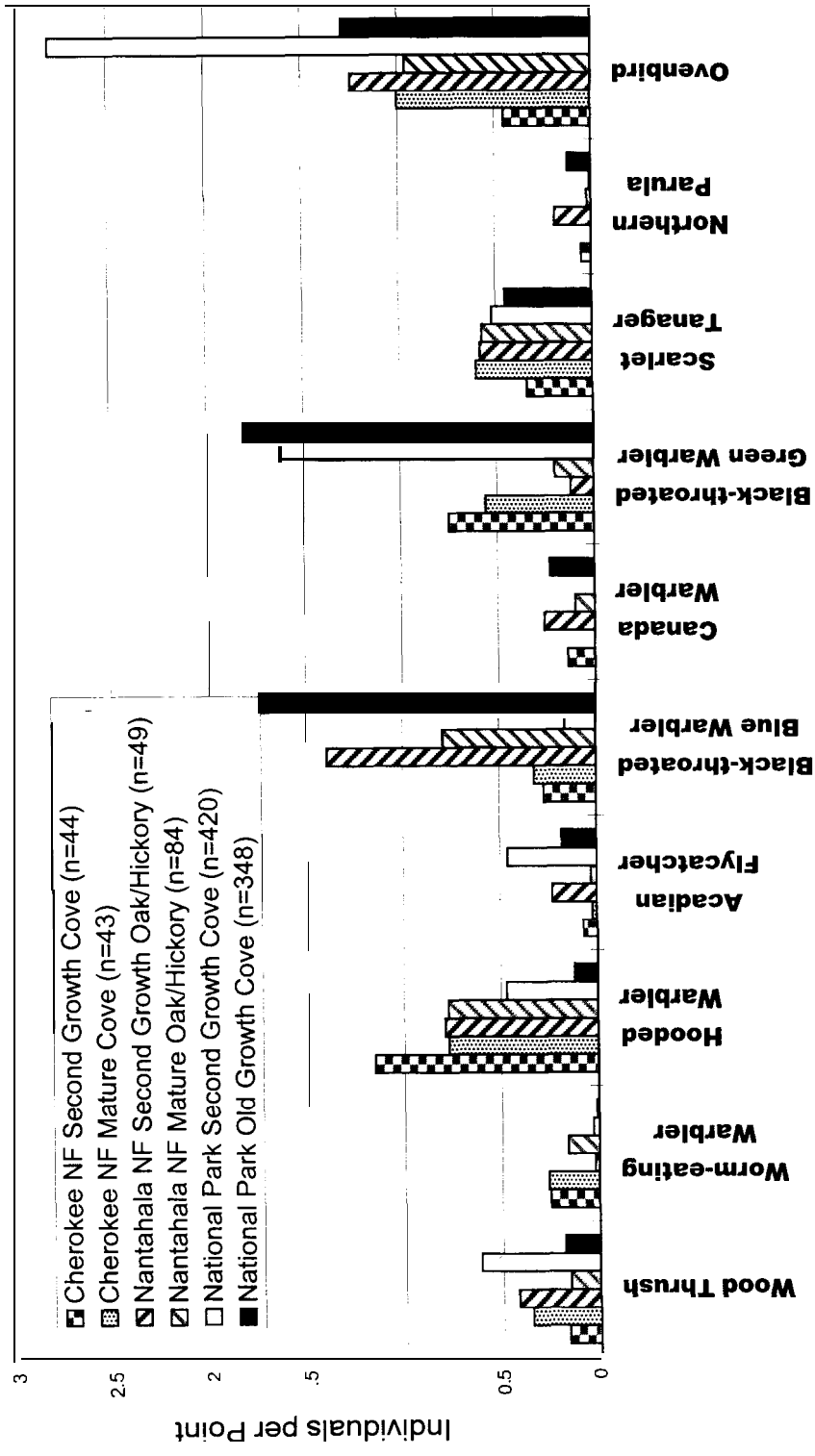

FIGURE 15 Comparison of breeding bird point count censuses on southern Appalachian National Forest sites and Great Smoky Mountains National Park.

late successional and forest interior species may often occur on public lands. The extent to which public lands should be managed to buffer or compensate for land use practices on private lands remains a major unanswered question of land management policy.

Finally, a successful ecosystem-scale program to conserve avian diversity in the southern Appalachians must have a strong public education component. The challenge of conserving these birds is shaped by their complex life histories and a web of interrelated social, economic, and ecological factors. Given the numerous environmental threats facing the region, one might legitimately ask, why worry about forest birds? Certainly we could invoke the "canary in the coal mine" argument and point to migratory bird population declines as a symptom of the impending free-fall in global biodiversity resulting from the unprecedented destruction of natural habitats that is currently taking place world-wide.

We could also argue that these birds perform an important ecological function. Warblers and related species have, in some circumstances, been shown to be important regulators of forest insects (Holmes 1990), but we would be hard pressed to convince anyone that loss of these birds will trigger an ecological collapse, even in an area as threatened by exotic insects as the southern Appalachians.

We believe that one of the most important reasons for directing conservation efforts toward these birds is their tremendous capacity to educate and inspire. A Black Poll Warbler, weighing less than a 25 cent piece, can fly from New England to Venezuela in 60 hours (McNair and Post 1993). The trip can include a 2000-km over-water flight at an altitude of 5000 meters, the metabolic equivalent of a person running 4 minute miles for 80 hours straight (Nisbet et al. 1963, Greenberg and Lumpkin 1991). The compelling stories these birds tell about the interconnection and interdependence of ecosystems ultimately provides the best incentive for preserving the southern Appalachian habitats on which they depend. Public education may well be the most important component of any strategy to protect the ecosystem because, ultimately, the political will to protect habitat for these birds will not derive from a wealth of ecological data but from their simple beauty, their remarkable life histories, and because knowing about them, enriches our lives.

RISK ASSESSMENT REPORT CARD

[Editor's note: The risk to managers taking action to enhance habitat for neotropical migratory birds centers around the lack of understanding of why some species are in such dramatic decline. Since their life cycle is so complex, it is difficult to ascertain the crux of the problem and how relevant breeding habitat is to the big picture. The Partners in Flight program provides a key focal point for understanding the context for taking action.]

Vision: B

Development of a hierarchical approach to management that evaluates management needs from the continental to the habitat-stand level is in its very early stages. Land management policies that relate management priorities on public lands to land use trends on private lands are lacking.

Resource risk: D

Several neotropical migrant species, particularly those associated with mature forests, are experiencing serious decline in the eastern U.S.

Socioeconomic conflicts: C–

Natural resource utilization versus conservation conflicts on public lands and private property remain unresolved although the value of old growth forest is becoming more accepted.

Procedural protocols: B+

Protocols for large-scale monitoring are available.

Scientific validity: A–

Understanding of species biology and habitat requirements exceeds that for most other groups of vertebrates.

Legal jeopardy: C

Legal challenges via the Endangered Species Act and Migratory Bird Treaty Act likely.

Public support: A

Public interest and support in bird conservation has historically always been high.

Adequacy of funding: B

Commitments of research funding through land management agencies, states, and Partners in Flight have been adequate. Funding for land management and conservation have been limited.

Policy precedent: C

Land management policies that relate management priorities on public lands to land use trends on private lands are lacking.

Administrative support: B+

Land management agencies participating in Partners in Flight have been strongly supportive of program objectives.

Transferability: B+

Research and monitoring techniques are broadly transferable. Necessary land management practices are often site and species specific.

[*Editor's note:* Here's hoping that stewards of forests are as inspired as the author by the beauty and courage of these magnificent creatures and gain resolve from the haunting calls of the wood thrush and oven bird while visiting an eastern forest.]

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