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DECREASES IN MIGRATING SHARP-SHINNED HAWKS (*ACCIPITER STRIATUS*) AT TRADITIONAL RAPTOR-MIGRATION WATCH SITES IN EASTERN NORTH AMERICA

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ABSTRACT.—Each fall, migrating Sharp-shinned Hawks (*Accipiter striatus*) are counted at traditional raptor-migration watch sites in eastern North America. During the 1980s and early 1990s, declines in the numbers of Sharp-shinned Hawks sighted at many of these sites raised concerns about the population status of the species. Using count data from Hawk Mountain Sanctuary, Pennsylvania, and Cape May Point, New Jersey, we offer additional evidence that the reported decline is greater at raptor-migration watch sites along the Atlantic coast than at sites farther inland. Band-recovery data for fall migrants indicate that Hawk Mountain Sanctuary and Cape May Point count birds that essentially are from the same eastern population. An analysis of Christmas-bird-count data for easternmost North America during the 1980s indicates significant increases in the numbers of Sharp-shinned Hawks observed north of the two sites. We suggest that at least part of the decline in numbers of Sharp-shinned Hawks sighted at traditional watch sites in eastern North America may result from migratory short stopping. *Received 29 September 1994, accepted 18 March 1995.*

EARLIER THIS CENTURY, declines in the numbers of birds of prey at traditional raptor-migration watch sites were correctly interpreted as signals of the widespread impact of DDT and other organochlorine pesticides on raptors (Hickey 1969, Cade et al. 1988). After a ban on the widespread use of DDT in the United States in 1972, increases in numbers of migrating raptors at these same sites were heralded as indications of a recovery from this impact (Bednarz et al. 1990).

In eastern North America, Sharp-shinned Hawks (*Accipiter striatus*) breed in forested areas south to the Pennsylvania-Maryland state line (i.e. 39°40'N), and in Appalachian Mountain forests south to northern Mississippi and Alabama (Clark 1985, Palmer 1988). A continental analysis of Christmas bird counts for 1962–1963 through 1971–1972 (i.e. the end of the DDT Era sensu Bednarz et al. 1990) indicated relatively small early-winter populations throughout the region, with peak populations in portions of eastern New England, the Delmarva Peninsula, the coastal plains of Virginia and North Carolina, and southern Alabama (Root 1988).

Eastern populations of Sharp-shinned Hawks migrate south each fall across a broad front, except as diverted by wind drift, leading-line phenomenon, and weather (Murray 1964, Mueller and Berger 1967, Palmer 1988). In Pennsylvania and New Jersey, migration begins in mid-August and ends in mid-November (Palmer 1988). Sharp-shinned Hawks concentrate on migration both along the easternmost ridge of the Appalachian Mountains of eastern Pennsylvania, and the Atlantic Coast of New Jersey, where they have been counted since the 1930s at Hawk Mountain Sanctuary, Pennsylvania (Broun 1948, Bednarz et al. 1990), and Cape May Point, New Jersey (Allen and Peterson 1936, Stone 1937, Clark 1985, Dunne and Sutton 1986). Banding-recovery data for birds trapped during migration at Cape May Point suggest that birds using the coastal flyway overwinter in the southeastern United States (Clark 1985).

Because Sharp-shinned Hawks are secretive, forest-dwelling birds that are difficult to census (Fuller and Titus 1990), many estimates of regional populations of the species result from inferences drawn from the numbers of individuals seen migrating past raptor-migration watch sites each fall (Titus and Mosher 1982, Bednarz et al. 1990, Titus and Fuller 1990, Kellog 1993).

In the 1980s and early 1990s, numbers of Sharp-shinned Hawks sighted at migration watch sites began to decline (Kellogg 1993, Kerlinger 1993; Fig. 1). The decline first appeared in coastal data sets (Sutton 1988). More recently, less substantial declines also have been sug-

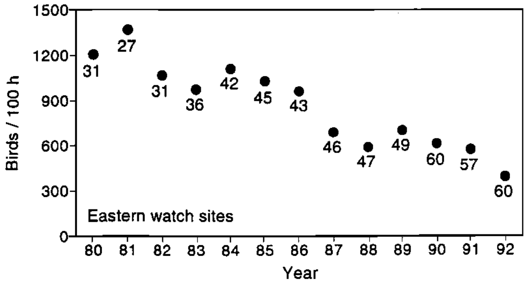

Fig. 1. Numbers of Sharp-shinned Hawks counted per 100 h at migration watch sites in eastern North America 1980–1989 (Kellog 1993). Values below dots indicate number of count sites reporting each year. For purpose of this data set, eastern North America includes Canada east of 80°W (i.e. eastern Ontario), New England, the Middle Atlantic states (except for portions of Pennsylvania and New York adjacent to Great Lakes), and southeastern states west to include Virginia, West Virginia, extreme eastern Tennessee, Georgia, and southern Alabama. Note that the number of sites reporting data increased between 1980 and 1989 and that part of the "decline" shown here may represent the addition of sites with lower hourly passage rates.

gested for inland sites in eastern North America (Laura 1992). Declines have not been reported west of the Great Lakes (Chartier 1994).

Although initial reports of the decline offered relatively benign explanations for the reductions (e.g. a return to the long-term carrying capacity for the region following a rebound from pesticide-era lows, natural population cycles, shifts in wintering populations to areas farther north, other changes in migration routes, a non-conducive weather pattern at watch sites, and declines in breeding populations as a result of forest maturation; Sutton 1988, 1989; I. Newton, J. C. Bednarz pers. comm.), more recent accounts have focused on more ominous scenarios (e.g. pesticide contamination, acid precipitation, and forest losses—both in North America, where the species breeds, and in the Neotropics, where much of the species' prey base overwinters; Dodge 1992, Kerlinger 1993, Viverette et al. 1994).

Here, we use data from Hawk Mountain Sanctuary and Cape May Point Bird Observatory, along with published and unpublished band-recovery data and coinciding Christmas-bird-count data from eastern North America, to: (1) document the extent of the declines at these two watch sites; (2) document the breeding and wintering areas of birds counted at these sites; and (3) assess the hypothesis that at least some of the decline in numbers counted results from shifts in the distribution of overwintering populations of the species to sites north of the two raptor-migration watch sites, rather than to changes in overall abundance.

Methods

Migration watch-site data.—Except for the "war years" of 1943–1945, fall raptor migration has been counted at Hawk Mountain's North Lookout (40°40′N, 75°55′W), near Kempton in eastern Pennsylvania, since 30 September 1934. Almost continual daily counts have occurred each fall between early September and late November. Seasonal coverage has expanded in recent years, and today counts are made each day (weather permitting) between 15 August and 15 December. Binoculars and, occasionally, telescopes are used to locate and identify 14 species of migrating raptors, including Sharp-shinned Hawks. Typically, one or two experienced counters record the numbers of migrating raptors. Daily observations usually begin before 0800 EST, and end at 1600 or later (For details, see Broun 1948, Bednarz et al. 1990, and Brett 1991). For our analyses, we used Hawk Mountain data collected between 1979 and 1992, a period during which the numbers of Sharp-shinned Hawks counted at many eastern watch sites declined (Kellog 1993).

Counts of migrating raptors at Cape May Point, New Jersey (38°50′N, 74°55′W), began in 1931 (Dunne and Sutton 1986). Counts usually are conducted by a single observer from an established fixed location at the Point for at least 8 h daily, weather permitting, from 1 September (15 August beginning in 1979) through late November or early December (Dunne and Sutton 1986). We used Cape May Point data collected between 1979 and 1992.

Band-recovery data.—To determine the breeding and wintering areas of Sharp-shinned Hawks counted at Hawk Mountain Sanctuary, we analyzed U.S. Fish and Wildlife Service recovery data for 212 Sharp-shinned Hawks banded between 1935 and 1989 within the Central Appalachian Mountains of eastern and central Pennsylvania, northwestern New Jersey, and southern New York west of the Hudson River (i.e. area bounded by 39°40′N, 78°00′W; 41°30′N, 78°00′W; 42°00′N, 74°00′W; and 39°40′N, 74°00′W). The region was selected to include birds from the population using the central Appalachian flyway, and to exclude migrants trapped along the eastern coastal flyway (see below). In addition to a banding station along the Kittatinny Ridge near Hawk Mountain, other stations along the ridge (and within the area mentioned above) include those at Little Gap, Pennsylvania, and Sussex County, New Jersey. Banding and recovery data are accurate to within 10′ of latitude and longitude (U.S. Fish and Wildlife Service 1976).

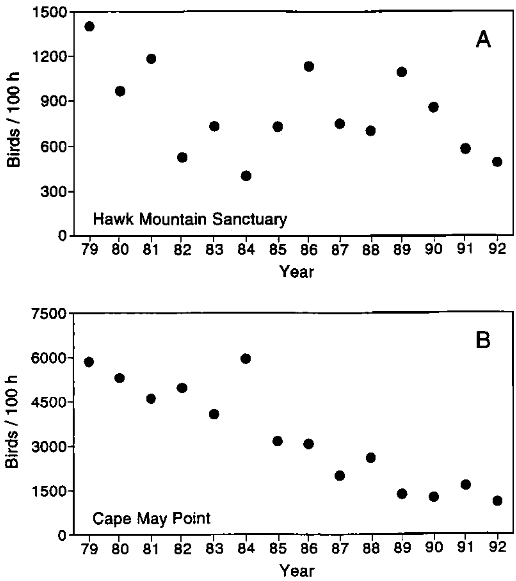

Fig. 2. Numbers of Sharp-shinned Hawks counted per 100 h at (A) Hawk Mountain Sanctuary, Pennsylvania, and (B) Cape May Point, New Jersey. Spearman rank correlation analyses indicate a significant decline ($P < 0.05$) at Cape May Point, but not at Hawk Mountain Sanctuary.

Similarly, 337 recoveries of mainly juvenile Sharp-shinned Hawks banded between 1967 and 1982, while migrating at Cape May Point, were used to determine the breeding and wintering areas of birds counted at Cape May Point (Clark 1985). Breeding and wintering areas for birds banded on migration were inferred from spring and summer (15 March-31 August) recoveries of birds north of the banding stations, and winter (1 December-15 March) recoveries of birds south of the banding stations, respectively.

Christmas-bird-count data.—Christmas bird counts (CBCs), which occur from 11 December through 8 January, are conducted by observers ranging from untrained novices to avid birders and professional ornithologists. The day-long counts are conducted within established 25-km-diameter circles. Effort varies among circles and among years within circles (Root 1988). Arbib (1981) and Butcher (1990) have described the counts and their limitations.

We obtained the following Christmas-bird-count data for Sharp-shinned Hawks for the eastern United States and eastern Canada for the years 1979 through 1989 (1990-1992 were not yet available on the computerized database at the time of our analysis): (1) name of count; (2) state; (3) count effort, including numbers of party hours (where a party is one or more observers traveling together) and party miles (1 mi = 1.6 km) traveled; and (4) numbers of Sharp-shinned Hawks sighted. Our analysis was limited to the 275 counts that were in operation for at least 8 of the 11 years (Appendix). Data are presented both in terms of numbers of birds sighted per 100 party-h and numbers sighted per 100 party-mi.

Statistical analyses.—We used Spearman rank correlation coefficients to determine if counts of Sharp-shinned Hawks changed with time at raptor-migration watch sites, and to examine relationships between counts at migration watch sites and numbers of hawks sighted at Christmas bird counts in states north of the two sites. Analyses of Christmas-bird-count and band-recovery data were conducted using SYSTAT (Wilkinson 1990). Other analyses were conducted using PC SAS (SAS Institute 1988).

RESULTS

Between 1979 and 1992, observation efforts at Hawk Mountain Sanctuary averaged 883 ± SD of 74.0 h and 111 ± 9.05 days per year, and at Cape May Point 916 ± 105 h and 101 ± 12.3 days per year. During this period, hourly passage rates for Sharp-shinned Hawks counted at Hawk Mountain Sanctuary and Cape May Point declined by 23% ($r_s = -0.41$, $P = 0.15$, $n = 14$ years) and 92% ($r_s = -0.91$, $P < 0.05$, $n = 14$ years), respectively (Fig. 2).

Winter recovery data for birds banded at Cape May Point indicate that most birds migrating past the site each fall overwinter on the Atlantic coastal plain of the southeastern United States and peninsular Florida, and that adults may overwinter farther north than juveniles (Clark 1985). Summer and spring-migration banding-station data indicate that Cape May Point migrants breed in the northeastern United States and eastern Canada (Clark 1985; Fig. 3).

Winter recovery data for birds banded along the central Appalachian flyway indicate that most birds trapped on fall migration in the central Appalachians also overwinter in the southeastern United States. Furthermore, summer and spring migration recovery data for birds banded in the region indicate that the birds breed in the mid-Atlantic and northeastern United States and in eastern Canada (Fig. 3). Thus, the breeding and wintering ranges of Sharp-shinned Hawks migrating past Cape May Point and Hawk Mountain Sanctuary overlap extensively (Fig. 3).

During the 11 years sampled (1979-1989), numbers of Sharp-shinned Hawks counted on 147 Christmas bird counts north of the two raptor-migration watch sites (Appendix) exhibited annual increases of 7.7% per party-h ($r = 0.25$,

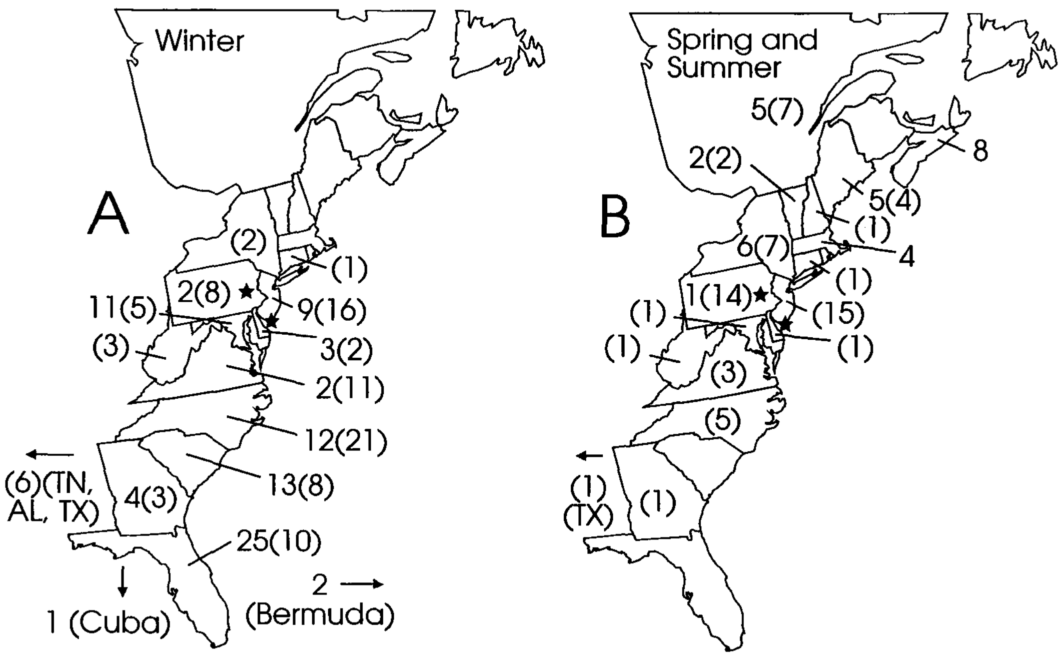

Fig. 3. Numbers of (A) winter and (B) spring-summer recoveries of Sharp-shinned Hawks banded at Cape May Point, New Jersey, and near Hawk Mountain Sanctuary, Pennsylvania (in parentheses). Stars show locations of Hawk Mountain Sanctuary and Cape May Point.

$P < 0.001$, $n = 1{,}474$) and 5.7% per party-mi ($r = 0.19$, $P < 0.001$, $n = 1{,}475$; Fig. 4). Except for nonsignificant decreases in birds per party-mi on the seven Nova Scotian counts, and for birds per party-mi and birds per party-h on the single Newfoundland count, the numbers of birds per party-mi and per party-h were higher in year 11 than in year 1 in all 13 northern states and provinces surveyed. Significant changes ($P < 0.05$) in states with 10 or more counts include annual per party-h increases of 17.8% in Connecticut, 11.7% in New York, 10.2% in New Jersey, and 4.0% in Pennsylvania.

The numbers of Sharp-shinned Hawks counted on 128 Christmas bird counts south of the two watch sites (Appendix) did not change significantly during the same 11-year period (per party-h, $r = 0.006$, $P < 0.82$, $n = 1{,}307$; per party-mi, $r = 0.035$, $P < 0.21$, $n = 1{,}307$; Fig. 4). A significant change ($P < 0.05$) in southern states with 10 or more counts occurred only in Florida (−4.0% annually, per party-h).

Spearman rank correlations indicated significant negative relationships between numbers of Sharp-shinned Hawks sighted per 100 h at Cape May Point and numbers of hawks sighted per 100 party-h ($r_s = -0.68$, $P = 0.021$, $n = 11$) and per 100 party-mi ($r_s = -0.66$, $P = 0.026$, $n = 11$) on Christmas bird counts north of Cape May Point (Fig. 5). The same relationships were not significant using Hawk Mountain Sanctuary data (per party-h, $r_s = -0.24$, $P = 0.48$, $n = 11$; per party-mi, $r_s = -0.28$, $P = 0.40$, $n = 11$).

Discussion

Our comparison of counts at Hawk Mountain Sanctuary with those at Cape May Point supports the notion that declines in the numbers of Sharp-shinned Hawks seen on fall migration are greater at watch sites along the Atlantic coast than at sites farther inland (Laura 1992). Our analysis of band-recovery data for birds migrating in the central Appalachians and a comparison of the resulting data with band-recovery information presented in Clark (1985) suggest that observers at Hawk Mountain Sanctuary and Cape May Point are counting birds that essentially are from the same regional population. Our analyses of Christmas-bird-count data from the 1980s indicate significant increases in the numbers of birds observed north of the two count sites. Finally, the numbers of Sharp-shinned hawks sighted at Cape May Point

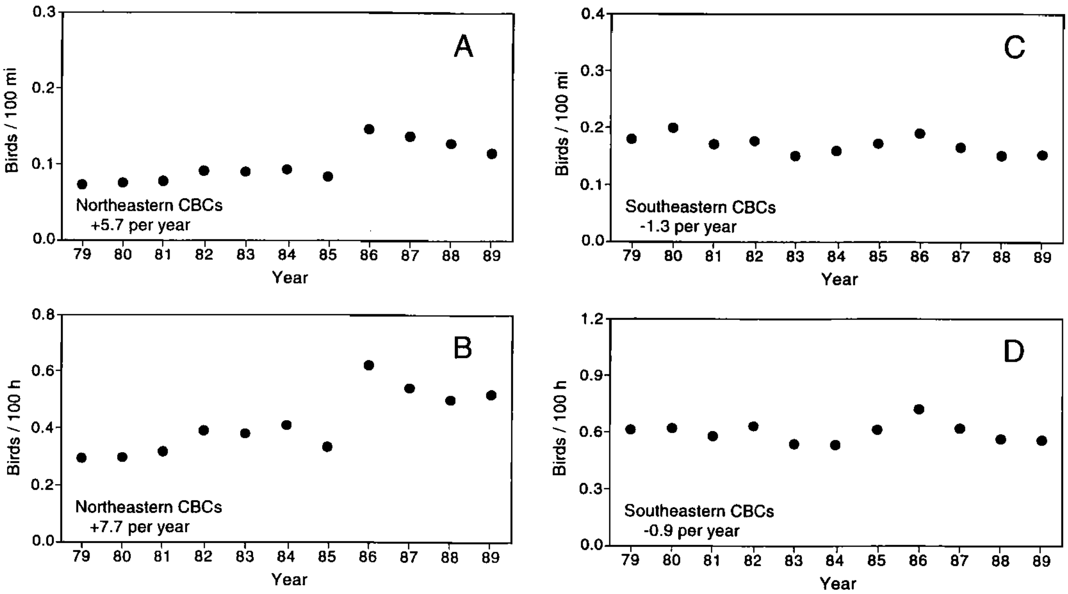

Fig. 4. Numbers of Sharp-shinned Hawks counted per (A and C) 100 party-mi and (B and D) 100 party-h on northeastern and southeastern Christmas bird counts, respectively, from 1979 through 1989.

between 1979 and 1989 are inversely correlated with numbers sighted on Christmas bird counts north of the site (Fig. 5).

The use of Christmas Bird Counts as population indexes remains controversial (Stewart 1954, Hickey 1955, Kenaga 1965, Robbins and Bystrak 1974, Berry 1992, Peterson 1995), especially for species like the Sharp-shinned Hawk that visit bird feeders (Dunn 1995), and are reported on counts in low numbers (Bock and Root 1981). Nevertheless, when considered on regional through continental scales, CBCs appear to provide useful information regarding the distribution and abundance of surveyed species (Root 1988, Butcher 1990, Hagan 1993). The constancy with which the Sharp-shinned Hawk counts we analyzed shifted in concert within groups of contiguous states suggests that, at the scale of our analysis, CBC data adequately reflect shifts in population distribution and abundance.

The data summarized above were not collected for the purpose of simultaneous comparisons, and considerable caution is warranted in drawing conclusions based on the significant negative correlation between the numbers of birds sighted at Cape May Point and the numbers of birds seen on Christmas bird counts north of the count site. Even so, the correlation suggests that Sharp-shinned Hawks may be altering their migratory behavior in eastern North America, and that the change may be affecting the numbers of birds counted at traditional raptor-migration watch sites in the region (Kellogg 1993). Below we explore this possibility, as well as several others mentioned above, for which our data are applicable.

Several populations of raptors have shifted migratory patterns in recent years. Merlins (*Falco columbarius*) breeding in the Canadian Great Plains recently have expanded their overwintering areas northward to include several Canadian cities where populations of potential avian prey now overwinter more regularly than they did a half century ago (Kerlinger 1989). Juillard (1977) reported a northward shift the overwintering area of Red Kites (*Milvus milvus*) in Switzerland, possibly in response to an increase in garbage dumps there. Throughout much of North America, Bald Eagle (*Haliaeetus leucocephalus*) migration appears to be influenced by local resource availability (McClelland et al. 1994, Bryan et al. in press). In eastern North America, the migratory habits of Broad-winged Hawks (*Buteo platypterus*) may have undergone several recent changes (Brown and Amadon 1968, Goodrich 1986). Finally, a recent analysis of Sharp-shinned Hawk num-

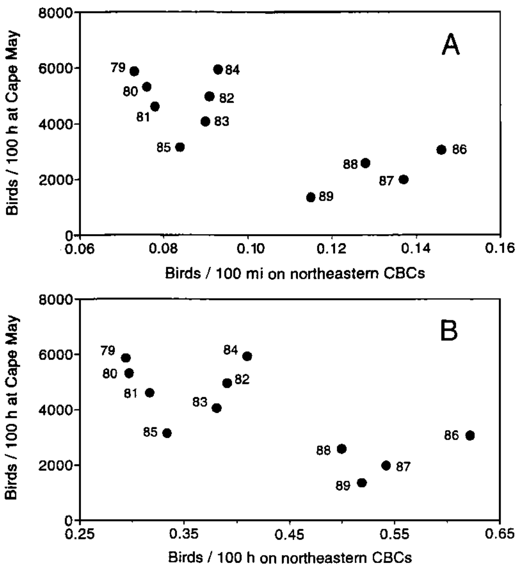

Fig. 5. Relationships between numbers of Sharp-shinned Hawks counted at Cape May Point and those counted (A) per 100 party-mi and (B) per 100 party-h on Christmas bird counts north of Cape May Point, 1979-1989. Numbers next to circles indicate year.

bers sighted on Christmas bird counts in New England states indicates a 500% increase between 1975 and 1992 (Duncan in press).

A report by the Intergovernmental Panel on Climate Change (IPCC 1992) indicates that a series of especially warm years beginning in 1980 and extending into the early 1990s has produced eight of the hottest years on record since the middle of the last century. Recent data from the Cornell Laboratory of Ornithology's Project FeederWatch indicate that Sharp-shinned Hawks rank above domestic cats (*Felis catus*) as the most frequent predator of small birds at bird feeders (Dunn and Tessaglia 1994). Although wintering Sharp-shinned Hawks have been hunting passerines attracted to human habitation for most of this century (Stone 1937), recently increased numbers of bird feeders may be enhancing the current attractiveness of the region (see also Dunn and Tessaglia 1994).

The numbers of Sharp-shinned Hawks reported at bird feeders in the northeastern United States apparently declines after December (Dunn and Tessaglia 1994), and it remains possible that the higher numbers of Sharp-shinned Hawks recorded on Christmas bird counts north of the two watch sites reflects a more protracted migration on the part of the birds, with some individuals remaining in New England and the Middle Atlantic states into early winter, after counts have ceased at migration watch sites.

That migrant numbers decreased more abruptly at Cape May Point, where most migrating Sharp-shinned Hawks are juveniles (Clark 1985), and less so at Hawk Mountain, where adults are more common (Goodrich 1989, Laura 1992), may reflect the fact that juvenile Sharp-shinned Hawks are more likely to be affected by local prey availability than are adults (Rosenfield and Evans 1980).

Nevertheless, except for the apparent shifts in numbers of Sharp-shinned Hawks seen on Christmas bird counts north of the two watch sites, the data we present also are consistent with a scenario of declining reproductive success in the species (i.e. a rapid and substantial decline in numbers of individuals seen along the predominant "juvenile" flyway, while, at least initially, numbers remain relatively high along the "adult" flyway). Sharp-shinned Hawks typically nest in relatively dense stands of young conifers near forest openings (Palmer 1988). As forests in the eastern United States continue to age (Marquis 1989), the species may be encountering reduced breeding opportunities. Indeed, researchers have suggested that recent shifts in the ratios of Sharp-shinned Hawks to Cooper's Hawks (*A. cooperii*) sighted at traditional migration watch sites may reflect this ongoing habitat change (J. C. Bednarz, I. Newton pers. comm.). This suggestion, together with several others mentioned above (i.e. the potential impacts of declines in the Sharp-shinned Hawk's Neotropical songbird prey base [Hagan and Johnston 1992] and of environmental contaminants on the species' reproductive success) deserve further study.

One suggestion to explain the decline in numbers of Sharp-shinned Hawks sighted is that weather patterns conducive to large raptor migrations at traditional watch sites did not exist in the latter half of the 1980s and early 1990s. The data at hand do not support this contention. Recent analyses of Hawk Mountain Sanctuary's long-term data set (i.e. 1934-1991) indicate that annual passage rates of cold fronts, a synoptic weather pattern frequently linked to "good flights" of Sharp-shinned Hawks, did not decline during the latter half of the 1980s and early 1990s, nor do the analyses suggest that annual counts of Sharp-shinned Hawks fluctuate in response to annual variability in such weather variables (Allen et al. 1996).

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APPENDIX. Numbers and names of Christmas Bird Counts in eastern United States, Washington, D.C., and Canadian provinces used in analysis.[a]

Canadian provinces. **Quebec,** 1 (Hudson); **Newfoundland,** 1 (Saint John's); **New Brunswick,** 3 (Grand Manan Island, Moncton, Sackville); **Nova Scotia,** 7 (Amherst, Broad Cove, Economy, Halifax East, Halifax West, Port Hebert, Yarmouth).

Northern United States.[b] **Connecticut,** 11 (Greenwich-Stamford, Hartford, Lakeville-Sharon, New Haven, New London, Old Lyme-Saybrooke, Quinnipiac Valley, Salmon River, Storrs, Westport, Woodbury-Roxbury); **Massachusetts,** 15 (Buzzards Bay, Cape Ann, Cape Cod, Concord, Greater Boston, Mid Cape Cod, Marshfield, Martha's Vineyard, Millis, Nantucket, Northampton, Plymouth, Springfield, Tauton-Middleboro, Worcester); **Maine,** 6 (Augusta, Bath-Phippsburg-Georgetown-Woolwich, Biddeford-Kennebunkport, Farmington, Greater Portland, Mount Desert Island); **New Hampshire,** 2 (Baker Valley, Coastal New Hampshire); **New Jersey,** 24 (Assunpink, Barnegat, Boonton, Cape May, Elmer, Cumberland County, Great Swamp-Watchung Ridges, Hackensack-Ridgewood, Lakehurst, Long Branch, Marmora, Northwestern Gloucester County, Northwestern Hunterdon County, Oceanville, Pinelands, Princeton, Ramsey, Raritan Estuary, Salem, Sandy Hook, Somerset County, Sussex County, Trenton Marshes, Walnut Valley); **New York,** 41 (Beaver Meadow, Binghamton, Brooklyn, Buffalo, Captree, Catskill-Coxsackie, Central Suffolk County, Chatham, Clinton, Conesus-Hemlock-Honeoye Lakes, Dunkirk-Fredonia, Dutchess County, East Orange County, Elmira, Geneva, Hamburg-East Aurora, Ithaca, Jamestown, Letchworth-Silver Lake, Lower Hudson, Montauk, Montezuma, Monticello, Northern Nassau County, Oak-Orchard Swamp, Orient, Peekskill, Putnam County, Queens, Quogue-Watermill, Rochester, Rockland County, Scio, Skaneateles, Smithtown, Southern Nassau County, Southern Rennselear County, Staten Island, Syracuse, Troy, Watkins Glen); **Pennsylvania,** 29 (Bethlehem-Easton, Bushy Run State Park, Central Bucks County, Chambersburg, Dallas Area, Elverson, Erie, Glenolden, Hamburg, Harrisburg, Lancaster, Lehigh Valley, Lewisburg, Linesville, Lititz, Lock Haven-Jersey Shore, Lower Bucks County, New Bloomfield, Reading, Rector, Southeastern Bradford County, Southern Lancaster County, State College, Upper Bucks County, Warren, West Chester, Williamsport, Wyncote, York); **Rhode Island,** 3 (Block Island, Newport County-Westport, South Kingstown); **Vermont,** 4 (Ferrisburg, Burlington, Rutland, Springfield).

APPENDIX. Continued.

Southern United States and District of Columbia.[b] **Delaware,** 5 (Bombay Hook National Wildlife Refuge, Cape Henlopen-Prime Hook, Middleton, Rehoboth, Wilmington); **District of Columbia,** 1 (Washington, D.C.); **Florida,** 39 (Bay County, Brooksville, Cedar Key, Cocoa, Choctawhatchee Bay, Coot Bay-Everglades National Park, Corkscrew Swamp Sanctuary, Dade County, Fort Lauderdale, Fort Myers, Fort Pierce, Gainesville, Jacksonville, Key Largo-Plantation Key, Kissimmee Valley, Lake Wales, Lakeland, Lower Keys, Marianna, Meritt Island National Wildlife Refuge, Mount Dora, Myakka River State Park, Naples, New Port Richey, North Pinellas, Pensacola, Perdido Bay, Port Saint Joe, Saint Augustine, Saint Marks, Saint Petersburg, Sanibel-Captiva, Sarasota, South Brevard County, Stuart, Tampa, Venice-Englewood, West Palm Beach, West Valusia County); **Georgia,** 8 (Athens, Atlanta, Columbus, Dublin, Glynn County, Macon, Sapelo Island, Thomasville); **Maryland,** 19 (Allegany County, Annapolis-Gibson Island, Baltimore Harbor, Bowie, Crisfield, Denton, Elkton, Liberty Reservoir, Lower Kent County, Ocean City, Point Lookout, Port Tobacco, Rock Run, Saint Michaels, Salisbury, Seneca, Southern Dorchester County, Triadelphia Reservoir, Washington County); **North Carolina,** 14 (Bodie-Pea Island, Brevard, Cape Hatteras, Central Beaufort County, Chapel Hill, Charlotte, Durham, Greensboro, Jordan Lake, Morehead City, Raleigh, Southern Pines, Wilmington, Winston-Salem); **South Carolina,** 8 (Carolina Sandhills National Wildlife Refuge, Charleston, Clemson, Columbia, Hilton Head Island, Litchfield-Pawleys Island, McClellanville, Savannah River Plant); **Virginia,** 29 (Augusta County, Back Bay National Wildlife Refuge, Blacksburg, Brooke, Calms Neck, Cape Charles, Charlottesville, Chincoteague National Wildlife Refuge, Danville, Fincastle, Fort Belvoir, Glade Spring, Gordonsville, Hopewell, Lexington, Little Creek, Lynchburg, Matthews, Newport News, Nickelsville, Northern Shenandoah Valley, Rockingham County, Roanoke, Shenandoah National Park-Luray, Wachapreague, Warren, Waynesboro, Williamsburg, Wise County); **West Virginia,** 5 (Charles Town, Charleston, Hampshire, Huntington, Lewisburg).

[a] Christmas bird counts conducted at leat 8 of 11 years (1979–1989) used in analysis.

[b] Northern states are wholly or mostly north of Pennsylvania-Maryland state line (i.e. latitude 39°40′N); southern states and the District of Columbia are wholly or mostly south of Pennsylvania-Maryland state line.