CHANGES IN HABITAT AND BREEDING BIRDS IN A PITCH PINE OAK HEATH ROCKY SUMMIT COMMUNITY AT THE MOHONK PRESERVE, ULSTER COUNTY, NY

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Abstract—I studied changes in vegetation and breeding birds over 15 years in a Pitch Pine Oak Heath Rocky Summit community at the Mohonk Preserve, Ulster County, NY. Historical data from the Breeding Bird Census (BBC) were grouped into five-year periods of time from 1992 through 2007 and analyzed using geographic information system (GIS) methodology. In 2007, my colleagues and I collected two sets of BBC data, which were compared to the historical data and to each other, to assess variability among observers.

Changes in resident species were the inclusion of the Downy Woodpecker (*Picoides pubescens*), Northern Cardinal (*Cardinalis cardinalis*), and Tufted Titmouse (*Baeolophus bicolor*) in BBC data. Changes in short distance migrants included a decrease in Eastern Towhee (*Pipilo erythrophthalmus*) breeding territories, the absence of the Brown-headed Cowbird (*Molothrus ater*) since 1997, and a decrease in Hermit Thrush (*Catharus guttatus*). Changes in long distance (neotropical) migrants were increases in the Indigo Bunting (*Passerina cyanea*) and Red-eyed Vireo (*Vireo oliveaceus*). Climate data showed increased temperature and increased precipitation over 111 years of data at the Mohonk Lake Cooperative Weather Station. Habitat change has occurred in the study area from 1986 through 2007 associated with Gypsy Moth (*Lymantria dispar*) attack, drought, the absence of fire, and an ice storm in 2002. Observer variability needs to be taken into account when analyzing bird populations because there is potentially a high level of variance among different observers.

The Mohonk Preserve is the largest member-and-visitor-supported nature preserve in New York and has been conducting a Breeding Bird Census (BBC) annually since 1992. Five different habitats are censused on a rolling basis. Pitch Pine Oak Heath Rocky Summit has been censused in 1992, 1997, 2002, and 2007. BBC results from the Mohonk Preserve were published in the *Journal of Field Ornithology* in the 1993 annual supplement; all other results are kept at the Daniel Smiley Research Center at the Mohonk Preserve.

I participated in the Mohonk Preserve's BBC in 2007. At the end of each BBC, breeding territories are established for each breeding bird that uses the habitat. Besides delineating breeding territories for each species, little else has been done with the BBC results.

The BBC was established in 1914 by the U.S. Bureau of Biological Survey to collect long-term data on and improve our understanding of changes in

distribution and abundance patterns of avian communities (USGS 2007a). The BBC was sponsored by the National Audubon Society from 1937-1984 and results were published in *American Birds* and its predecessor publications (USGS 2007a). Since 1985, the BBC has been administered by the Cornell Laboratory of Ornithology and results have been published as an annual supplement in the *Journal of Field Ornithology*. A BBC is good for observing changes in bird communities in a single habitat over a period of time; however, it does not give trends for overall bird populations.

The North American Breeding Bird Survey (BBS) is one of the most commonly used surveys to determine information on overall bird populations in North America. It is a long-term, large-scale international avian monitoring program which began in 1966 and is now comprised of over 4,100 routes, of which about 2,900 are surveyed each year. In June, skilled observers survey a 24.5 mile route which consists of 50 stops at 0.5 mile intervals. Observers stop for three minutes at each stop and record any bird seen within a 0.25 mile radius or heard (USGS 2007b). The overall abundance of birds recorded in the Mississippi and Atlantic flyways of the BBS decreased by up to 18% between 1966 and 2005 (Valiela and Martinetto 2007). Furthermore, U.S. and Canadian resident species decreased by 30%, migrants within the U.S. and Canada (short distance migrants) decreased by 19%, while long distance (neotropical) migrants increased by up to 20% (Valiela and Martinetto 2007). Residents or migrants within the U.S. and Canada that preferred open or edge habitat showed the most rapid population decline since 1966, while residents and both short and long distance migrants associated with forest habitat increased in population size since 1966. Changes in northeastern North American bird populations have been associated with land cover changes such as the abandonment of agricultural areas, regrowth of forests, and the expansion of human development (Valiela and Martinetto 2007, Sibley 2001).

The Pitch Pine Oak Heath Rocky Summit habitat can be found on the southwest facing slopes of the slabrock at the Mohonk Preserve. Typical plants are Pitch Pine (*Pinus rigida*), Chestnut Oak (*Quercus prinus*), Scrub Oak (*Quercus ilicifolia*), Mountain Laurel (*Kalmia latifolia*), Low-bush Blueberry (*Vaccinium angustifolium*), and Black Huckleberry (*Gaylussacia baccata*) (Thompson 1996). These plants are adapted to climates where fire is a natural disturbance, but there has never been a fire documented in the study area (DSRC 1989). Studies show that fire maintains Pitch Pine and oak associated communities (Jordan et al. 2003, Rieske 2002). Fire alters growth and foliar chemistry of Chestnut Oak making it more vigorous after fire occurs (Gilbert et al. 2003, Rieske 2002).

The Gypsy Moth (*Lymantria dispar*), an introduced species, has quickly spread throughout the Northeast and portions of the Southeast, Midwest, and Canada (USDA Forest Service 2003). Gypsy Moth populations are irruptive and the larvae feed on the foliage of many types of North American vegetation. Chestnut Oak at the Mohonk Preserve has faced Gypsy Moth attacks over several decades (DSRC 1989). Heavy defoliation from 1986 through 1988 and drought in 1987 caused many mature stands of Chestnut Oak to die (DSRC

1989). An ice storm in November of 2002 caused heavy breakage and damage to trees and shrubs over a wide area at the Mohonk Preserve (Mohonk Preserve 2007). Gypsy Moth infestation, drought, an ice storm, and the absence of fire have caused habitat change in the Pitch Pine Oak Heath Rocky Summit at the Mohonk Preserve.

I determined if resident and migratory breeding birds of the Pitch Pine Oak Heath Rocky Summit had changed over 15 years. I used a geographic information system (GIS) to plot and analyze BBC results from this habitat. Breeding Bird Census information can help us determine general status in resident and migratory breeding bird populations in the Pitch Pine Oak Heath Rocky Summit and similar habitats, and because two sets of data were collected in 2007, variation between different observers can also be assessed.

METHODS

Study Area

The study area began at the intersection of Millbrook Trail and Trapps Road at the Mohonk Preserve in New Paltz, New York. Using a global positioning system (GPS) to define the study area, I and other observers followed Trapps Road 1,600 feet to the southwest. At this point, we went southeast up the Shawangunk Ridge to Millbrook Trail. The total distance to Millbrook Trail was about 850 feet. Orange ribbons were tied to tree branches every 100 feet in order to mark the path. We then followed Millbrook Trail heading northeast along the Shawangunk Ridge until we reached our starting point at Trapps Road. Directions were reversed each day. The coordinates of the site are 41˚44'N, 74˚12'W in the USGS Gardiner 7.5 minute quadrangle.

The study area is part of the Northern Shawangunk Mountains which stretch 20 miles from Rosendale, N.Y. to Ellenville, N.Y. in southeastern Ulster County. The two main types of rock found in the Shawangunk Mountains are Shawangunk conglomerate overlying Martinsburg shale. The soil formed on the conglomerate slabrock is acidic, shallow, droughty, and nutrient poor (Russell 2001, Kiviat 1988). The vegetation on the sloping area of the northern section is sparse and patchy with numerous rock outcrops while on the southern section, the vegetation is denser but also had rock outcrops.

In 1993, the open canopy was dominated by Pitch Pine (*Pinus rigida*), Chestnut Oak (*Quercus prinus*), and Black Birch (*Betula lenta*) estimated to be between 61 and 100 years of age (Larson and Cornwall 1993). The mean canopy height was five meters (range 3-10 meters). The understory was dominated by Mountain Laurel (*Kalmia latifolia*), Shadbush (*Amelanchier arborea*), and Scrub Oak (*Quercus ilicifolia*). Ground cover was dominated by Low-bush Blueberry (*Vaccinium angustifolium*), Black Huckleberry (*Gaylussacia baccata*), Wood Hairgrass (*Deschampsia flexuosa*), Sheep Laurel (*Kalmia angustifolia*), Cow-wheat (*Melampyrum lineare*), Wintergreen (*Gaultheria procumbens*), and lichens including *Cetraria arenaria* and *Cladonia* spp. (Thompson 1996, Larson and Cornwall 1993).

Plant species found in the study area during the 2007 BBC that were not listed previously included Red Maple (*Acer rubrum* L.), Eastern Hemlock (*Tsuga canadensis*), White Pine (*Pinus strobus* L.), Black Gum (*Nyssa sylvatica*), Witch Hazel (*Hamamelis virginiana* L.), Sassafras (*Sassafras albidum*), and Striped Maple (*Acer pensylvanicum* L.) which were mainly found in the southern half and/or around the edge of the study area (personal observation 2007).

Identification of Birds and Vegetation

I learned to identify the breeding birds by sight and sound using *Stokes Field Guide to Bird Song* (Elliot et al. 1997), *A Field Guild to the Birds of Eastern and Central North America* (Peterson 1980), *The Sibley Guild to Birds* (Sibley 2000), and The Birds of North America Online (BNA 2007). Beginning in January 2007, weekly, I walked from Trapps Road to Bayards Path and then back to Trapps Road along the Millbrook Trail, a route which encompassed the study area to become familiar with the habitat and species found there. On each walk I recorded any birds I observed and the arrival dates of some species of migratory birds. I also used the *National Audubon Society Field Guide to Trees – Eastern Region* (Little et al. 1980) to identify tree species. I learned to identify different types of vegetation best by communicating with people who were familiar with the study area.

Breeding Bird Census

Each census involved walking the study area on at least 12 mornings, between 6:00 A.M. and 9:00 A.M. from May to early July. There were three to four observers each morning with the exception of one morning when there were six. The estimated location of singing male birds and any sightings of birds in or around the study area were recorded on a map of the area. A separate map was used for each day (Map 1-13). Censuses in 2002 and 2007 included one evening walk each. The 2002 evening walk was on 24 June from 8:05 P.M to 9:30 P.M., the 2007 evening walk was on 26 June from 8:00 P.M. to 9:30 P.M. Temperature, wind speed, and any notes concerning the birds observed were recorded.

At the end of the BBC, the maps created from each day that censusing was done were used to create individual species maps so that breeding territories could be determined. This was done by designating a number for each map created on the 13 days censusing was done (Map 1-13). These numbered maps were reviewed and each species record was transferred to a new species map using the number (1-13) corresponding to the day the bird was observed. With each species map, breeding territories were delineated for each breeding bird based on aggregations of recordings from the BBC. Two sets of data were collected in 2007 so that the set of breeding territories determined by me could be compared with another determined by the other observers.

Breeding territories are used during the breeding season because they offer superior nest sites and food resources. Research on previously recorded breeding territory sizes and locations was obtained from *The Birds of North America*

Online, which I used for reference and comparison when determining breeding territories (BNA 2007). The recorded breeding territory size for many of the birds found in the study area ranged from 0.5 hectares to three hectares. The study area was 15.75 hectares. Recorded locations of breeding territories varied among species and there was variance in breeding territory size for each species.

Each species was assigned a habitat preference (edge or forest) based on the classification of Valiela and Martinetto (2007), and a migratory status (resident, short-distance migrant, or long-distance migrant). Resident species were defined as those living in the north temperate region of the U.S. or Canada throughout the year. Short-distance migrants spend their entire life in the U.S. and Canada and migrate within the north temperate region of the U.S. and Canada to the mid to southern U.S. Long-distance (neotropical) migrants winter outside of the U.S. and Canada in the West Indies, Mexico, or Central and South America.

Weather

Censuses were done when no inclement weather was forecast. Temperature and wind speed were recorded prior to each walk. Wind speed was recorded based on the Beaufort wind force scale.

The Mohonk Lake Cooperative Weather Station, located at the Mohonk Mountain House, completed its 112th year of continuous weather data during 2007. The annual summaries from 1992 through June 2007 were used to examine potential trends in weather data (DSRC 2007, Mohonk Preserve 2007).

Geographic Information Systems

I obtained orthoimagery of the study area from the New York State Geographic Information Systems Clearinghouse website (http://nysgis.state.ny.us) and imported images e_05731054, e_05731056, and e_05731058 from the 2001 State Plane Orthoimagery database to ArcGIS 9.0. Then, I created a shapefile in ArcCatalog which enabled me to digitize the BBC data gathered since 1992. A total of 2,705 points were plotted onto the orthoimagery of the study area and an attribute table was created which contained information gathered for each bird species observed. Attributes included the date of observation, time interval of observation, temperature, wind speed on a Beaufort wind force scale, and any notes listed for each bird.

ArcMap was used to analyze the BBC data by allowing me to produce maps which define the study area, breeding territories for each species, and a list of the total number of observations for each species in each year.

RESULTS

Breeding Bird Census

Table 1 summarizes the preferred habitat, migratory status, and frequency of occurrence (as a breeder or visitor) for each of the 70 species encountered.

A total of 39 species of birds have been identified as breeding in the Pitch Pine Oak Heath Rocky Summit at the Mohonk Preserve since 1992. Thirty-six of these birds were "perching birds" in the order Passeriformes, two were woodpeckers in the order Piciformes (family Picidae) and one species was in the order Columbiformes (family Columbidae), which includes pigeons and doves. Of the 36 passerines, 33 were "true songbirds" in the suborder Passeri and three were flycatchers in the suborder Tyranni (family Tyrannidae). Of the 33 "true songbirds", 10 were wood-warblers in the family Parulidae, four were thrushes in the family Turdidae, three were vireos in the family Vireonidae, three were finches in the family Fringillidae, three were in the sparrow family, or Emberizidae, three were in the cardinal family, or Cardinalidae, and two were in the nuthatches and allies family, or Paridae. There was also one species in each one of the following families: crows/jays (Corvidae), blackbirds (Icteridae), wrens (Troglodytidae), waxwings (Bombycillidae), and mimic thrushes (Mimidae).

Of the 39 species recorded as breeders, 22 were considered edge species because they are most commonly found along forest edges or in disturbed habitat, and 17 were considered forest species because they are most likely found in undisturbed or more forested habitat.

From 1992 through 2007, some breeding bird populations and/or territories remained stable, certain species did not appear in all BBCs, and some species showed observable increases or decreases in population size and/or breeding territories. The four most abundant birds in this BBC were the Chipping Sparrow and Eastern Towhee, both short-distance migrants, and the Black-and-white and Prairie Warblers, which are long-distance migrants. Eighteen species have appeared in all four BBCs, twelve species have been present in two to three BBCs, and nine species have only been recorded in one BBC. Total observations of long-distance migrants increased 45% between 1992 and 2007. Total observations of north temperate residents increased from 1992 until 2002, and then decreased by 24% in 2007. Short-distance migrants had the same trend as north temperate residents but decreased by 29% in 2007.

The total numbers of breeding territories and observations for each species are presented for each of the three migratory classes in Tables 2, 3, and 4 (Joseph Chernek's data). A value of 0.5 indicates that at least half of the breeding territory was found in the study area, and a positive value indicates that less than half of a breeding territory was found in the study area, the bird had a low number of total observations, or was recorded primarily while flying overhead.

Of 11 north temperate residents, nine were edge species and four had changed since 1992 (Table 2). The Downy Woodpecker, Northern Cardinal, and Tufted Titmouse were not included as breeders in the BBC until 2002 and 2007. The Downy Woodpecker and Northern Cardinal had low total observations. Total observations of the Tufted Titmouse increased. Total observations of the Mourning Dove doubled from the first two BBC years to the last two BBC years while breeding territories remained stable. The Dark-eyed Junco had three territories in 1992 but only one territory in each one of the following censuses.

Table 1. Preferred habitat, migratory status, and occurrence of 70 bird species at the Pitch Pine Oak Heath Rocky Summit of the Mohonk Preserve in New Paltz, NY. Res = north-temperate resident; SD = short-distance migrant; and LD = long-distance migrant. BBC = number of years recorded on Breeding Bird Census; Vis = number of years recorded as a non-breeding visitor to the study site.

Species	**Habitat**	**Migr**	**BBC**	**Vis**
Turkey Vulture *Cathartes aura*	open	SD	0	3
Sharp-shinned Hawk *Accipiter striatus*	forest	SD	0	1
Mourning Dove *Zenaida macroura*	edge	Res	4	-
Black-billed Cuckoo *Coccyzus erythropthalmus*	forest	LD	0	2
Yellow-billed Cuckoo *Coccyzus americanus*	forest	LD	0	2
Barred Owl *Strix varia*	forest	Res	0	1
Ruby-throated Hummingbird *Archilochus colubris*	edge	LD	0	3
Red-bellied Woodpecker *Melanerpes carolinus*	edge	Res	0	1
Downy Woodpecker *Picoides pubescens*	edge	Res	2	1
Hairy Woodpecker *Picoides villosus*	edge	Res	0	2
Northern Flicker *Colaptes auratus*	edge	Res	3	1
Pileated Woodpecker *Dryocopus pileatus*	forest	Res	0	1
Eastern Wood-Pewee *Contopus virens*	forest	LD	2	-
Eastern Phoebe *Sayornis phoebe*	edge	SD	4	-
Great Crested Flycatcher *Myiarchus crinitus*	edge	LD	4	-
Yellow-throated Vireo *Vireo flavifrons*	forest	LD	1	1
Blue-headed Vireo *Vireo solitarius*	forest	LD	1	2
Red-eyed Vireo *Vireo olivaceus*	forest	LD	4	-
Blue Jay *Cyanocitta cristata*	edge	Res	4	-
American Crow *Corvus brachyrhynchos*	edge	Res	0	3
Common Raven *Corvus corax*	open	Res	0	3
Barn Swallow *Hirundo rustica*	edge	LD	0	1
Black-capped Chickadee *Poecile atricapillus*	edge	Res	4	-
Tufted Titmouse *Baeolophus bicolor*	edge	Res	2	2
Red-breasted Nuthatch *Sitta canadensis*	forest	Res	0	2
White-breasted Nuthatch *Sitta carolinensis*	edge	Res	0	1
Brown Creeeper *Certhia americana*	forest	SD	0	1
Carolina Wren *Thryothorus ludovicianus*	edge	SD	1	-
Winter Wren *Troglodytes hiemalis*	edge	SD	0	2
Blue-gray Gnatcatcher *Polioptila caerulea*	edge	LD	0	1
Ruby-crowned Kinglet *Regulus calendula*	forest	SD	0	1
Eastern Bluebird *Sialia sialis*	edge	Res	1	-
Hermit Thrush *Catharus guttatus*	forest	SD	3	-
Wood Thrush *Hylocichla mustelina*	forest	LD	4	-

Species	Habitat	Migr	BBC	Vis
American Robin *Turdus migratorius*	edge	SD	4	-
Gray Catbird *Dumetella carolinensis*	edge	SD	1	2
Northern Mockingbird *Mimus polyglottos*	edge	Res	0	1
Cedar Waxwing *Bombycilla cedrorum*	edge	SD	4	1
Ovenbird *Seiurus aurocapilla*	forest	LD	2	1
Worm-eating Warbler *Helmitheros vermivorus*	forest	LD	1	2
Black-and-white Warbler *Mniotilta varia*	forest	LD	4	-
Nashville Warbler *Oreothlypis ruficapilla*	forest	LD	0	3
Common Yellowthroat *Geothlypis trichas*	edge	LD	4	-
Hooded Warbler *Setophaga citrina*	forest	LD	1	1
American Redstart *Setophaga ruticilla*	forest	LD	3	-
Northern Parula *Setophaga americana*	forest	LD	0	1
Magnolia Warbler *Setophaga magnolia*	forest	LD	0	1
Blackburnian Warbler *Setophaga fusca*	forest	LD	0	1
Chestnut-sided Warbler *Setophaga pensylvanica*	forest	LD	0	1
Blackpoll Warbler *Setophaga striata*	forest	LD	0	1
Black-thr. Blue Warbler *Setophaga caerulescens*	forest	LD	1	-
Pine Warbler *Setophaga pinus*	forest	SD	4	-
Yellow-rumped Warbler *Setophaga coronata*	edge	SD	3	2
Prairie Warbler *Setophaga discolor*	forest	LD	4	-
Black-throated Green Warbler *Setophaga virens*	forest	LD	0	3
Canada Warbler *Cardellina canadensis*	forest	SD	0	1
Eastern Towhee *Pipilo erythrophthalmus*	edge	SD	4	-
Chipping Sparrow *Spizella passerina*	edge	SD	4	-
Field Sparrow *Spizella pusilla*	edge	SD	0	1
Dark-eyed Junco *Junco hyemalis*	forest	Res	4	-
Scarlet Tanager *Piranga olivacea*	forest	LD	4	-
Northern Cardinal *Cardinalis cardinalis*	edge	Res	2	-
Rose-breasted Grosbeak *Pheucticus ludovicianus*	forest	LD	0	2
Indigo Bunting *Passerina cyanea*	edge	LD	4	-
Red-winged Blackbird *Agelaius phoeniceus*	edge	SD	0	1
Brown-headed Cowbird *Molothrus ater*	edge	SD	2	-
Baltimore Oriole *Icterus galbula*	edge	LD	0	3
Purple Finch *Carpodacus purpureus*	forest	Res	2	1
House Finch *Carpodacus mexicanus*	edge	Res	1	-
American Goldfinch *Spinus tristis*	edge	SD	2	3

Table 2. Total number of breeding territories and observations for north temperate resident species. Habitat preference can be found next to common names: E = edge species and F = forest species. Numbers in parentheses are total number of observations.

North temperate residents	**1992**	**1997**	**2002**	**2007**
Black-capped Chickadee (E)	2 (12)	2 (28)	2 (40)	2 (31)
Blue Jay (E)	2 (6)	2 (17)	1 (37)	0.5 (10)
Dark-eyed Junco (F)	3 (12)	1 (5)	1 (9)	1 (3)
Downy Woodpecker (E)	0	0	+	+ (3)
Eastern Bluebird (E)	0	0	+	0
House Finch (E)	1 (2)	0	0	0
Mourning Dove (E)	2 (13)	1 (17)	2 (34)	2 (30)
Northern Cardinal (E)	0	0	0.5	+ (3)
Northern Flicker (E)	1 (2)	1 (8)	+	+ (2)
Purple Finch (F)	0	1 (8)	0	+ (2)
Tufted Titmouse (E)	0	0	0.5 (6)	1 (12)

Of 12 short distance migrants, ten were edge species and six had changed since 1992 (Table 3). Breeding territories of the Eastern Towhee decreased by 50% between the first two BBC years and the last two BBC years; total observations varied over the four BBC years. The Brown-headed Cowbird was not recorded in the BBC after 1997. The Hermit Thrush had established breeding territories and more observations in 1992 and 1997 than the following two BBCs; it was not recorded in 2002 and was observed five times in 2007. The Chipping Sparrow had at least eight breeding territories in all BBCs and the number of observations steadily increased from 1992 to 2002. A visitor species was a bird observed during the BBC but was not specifically using the study area for breeding purposes. The American Goldfinch was listed as a visitor species in the 1992 and 1997 BBCs, as breeding in 2002, and as both in 2007. The Cedar Waxwing was listed as breeding until 2007, when it was listed as both breeding and visiting. The American Goldfinch and Cedar Waxwing recordings were mainly "fly-overs" or small feeding flocks. They were not singing as breeding male birds do in May and June. Cedar Waxwings are non-territorial and breed later in the summer when fruits are abundant (BNA 2007). The American Goldfinch also nests later in the breeding season with the appearance of flowering composites (BNA 2007).

Of 16 long distance migrants, 13 were forest species and six had changed since 1992 (Table 4). Total observations of the Indigo Bunting and Red-eyed Vireo increased steadily since 1992. Breeding territories for the Indigo Bunting were higher in 2002 and 2007 than in 1992 and 1997. The American Redstart was recorded in the first three BBCs but not in 2007. Breeding territories of the Common Yellowthroat decreased since 1997; total observations were stable. The Ovenbird was listed as a visitor in 1992 and then as a breeding bird in 1997, 2002, and 2007. In 1997 and 2007, the Ovenbird had recorded breeding territories and total observations while in 2002 a positive value was the only record. Breeding territories for the Wood Thrush decreased since 1992; total observations were fairly constant.

Table 3. Total number of breeding territories and observations for short-distance migrants. Habitat preference can be found next to common names: E = edge species and F = forest species. Numbers in parentheses are total number of observations.

Short distance migrants	1992	1997	2002	2007
American Goldfinch (E)	0	0	2 (33)	+ (17)
American Robin (E)	4 (20)	4 (36)	2 (63)	2 (23)
Brown-headed Cowbird (E)	2 (18)	2.5 (26)	0	0
Carolina Wren (E)	1 (2)	0	0	0
Cedar Waxwing (E)	5 (6)	2 (23)	2 (26)	+ (7)
Chipping Sparrow (E)	12 (55)	8 (76)	10 (141)	11 (136)
Eastern Phoebe (E)	1 (3)	1 (14)	1 (8)	+ (4)
Eastern Towhee (E)	11 (58)	13 (104)	6 (93)	4.5 (49)
Gray Catbird (E)	1 (2)	0	0	0
Hermit Thrush (F)	2 (10)	4 (21)	0	+ (5)
Pine Warbler (F)	4 (20)	3 (18)	2 (28)	2.5 (38)
Yellow-rumped Warbler (E)	1 (6)	2 (18)	0	+ (2)

Table 4. Total number of breeding territories and observations for long-distance migrants. Habitat preference can be found next to common names: E = edge species and F = forest species. Numbers in parentheses indicate total number of observations.

Long distance migrants	1992	1997	2002	2007
American Redstart (F)	3 (11)	1.5 (12)	1 (13)	0
Black-and-white Warbler (F)	7 (54)	8 (75)	5.5+ (69)	6.5 (57)
Black-thr. Blue Warbler (F)	0	0.5 (9)	0	0
Blue-headed Vireo (F)	0	0	+	0
Common Yellowthroat (E)	3 (10)	3 (15)	0.5 (8)	0.5 (16)
Eastern Wood-Pewee (F)	0	1 (7)	+	+ (2)
Great Crested Flycatcher (E)	2 (6)	1.5 (16)	2 (36)	1 (21)
Hooded Warbler (F)	0	0	0	+ (6)
Indigo Bunting (E)	2 (8)	2 (13)	6 (59)	3.5 (64)
Ovenbird (F)	0	2.5 (25)	+	1 (9)
Prairie Warbler (F)	6 (47)	8 (85)	4 (65)	6 (86)
Red-eyed Vireo (F)	1 (4)	2.5 (26)	1.5 (43)	6 (48)
Scarlet Tanager (F)	1 (3)	3 (15)	1.5 (25)	1 (16)
Wood Thrush (F)	3 (9)	1.5 (10)	+ (4)	+ (7)
Worm-eating Warbler (F)	0	0	0	0.5 (13)
Yellow-throated Vireo (F)	0	1 (3)	0	0

Several species were designated as breeders in at least one year and as visitors in at least one other year: American Goldfinch, Blue-headed Vireo, Cedar Waxwing, Downy Woodpecker, Gray Catbird, Hooded Warbler, Ovenbird, Purple Finch, Tufted Titmouse, and Worm-eating Warbler. The American Goldfinch and Cedar Waxwing were on both lists in 2007 because it could not

be determined if they were using the habitat for foraging or for breeding. Thirty-one species were recorded only as visitors.

Observer Variation

The observer difference in the number of breeding territories for 2007 between other observers and me is shown in Table 5. Most results were the same or had a difference up to one. The greatest differences in breeding territories were for the Red-eyed Vireo and the Prairie Warbler, which had a difference of -4.5 and +2.5, respectively.

Table 5. Variation in assessment of breeding territories for 2007 BBC in the Pitch Pine Oak Heath Rocky Summit at the Mohonk Preserve. J.C. = Joseph Chernek and O.O. = other observers.

Species	**J.C.**	**O.O.**	**Difference**
Chipping Sparrow	11	12	+1
Eastern Towhee	4.5	4.5	0
Black-and-white Warbler	6.5	6	-0.5
Prairie Warbler	6	8.5	+2.5
Cedar Waxwing	+	1+	+0.5
American Robin	2	1.5	-0.5
Pine Warbler	2.5	3	+0.5
Wood Thrush	+	0	
Common Yellowthroat	0.5	1	+0.5
Dark-eyed Junco	1	1	0
Mourning Dove	2	2	0
Great Crested Flycatcher	1	1	0
Blue Jay	0.5	0.5	0
Black-capped Chickadee	2	3	+1
Hermit Thrush	+	0	
Indigo Bunting	3.5	3.5	0
Northern Flicker	+	0	
Eastern Phoebe	+	0.5	
Red-eyed Vireo	6	2	-4.5
Yellow-rumped Warbler	+	0	
Scarlet Tanager	1	1	0
Ovenbird	1	0	-1
Purple Finch	+	0	
Eastern Wood-Pewee	+	0	
American Goldfinch	+	0	
Tufted Titmouse	1	1	0
Northern Cardinal	+	0	
Downy Woodpecker	+	0	
Hooded Warbler	+	0	
Worm-eating Warbler	0.5	0.5	0

Weather

Two mornings during 2007's BBC had cloud cover and two mornings were partly cloudy at the beginning and sunny at the finish. All other days were bright, clear, and calm. BBC morning temperatures have increased since 1997. In 1992 and 1997 the average temperature taken on census mornings was 10˚ C, in 2002 the average temperature was 18.5˚ C and in 2007 it was 14.9˚ C. Rainfall was below average in May and June of 1997 and 2007 and in June of 2002. However, data from the Mohonk Lake Cooperative Weather Station indicated no trend of below average rainfall for April, May, and June (Mohonk Preserve 2007). Dates, times, and weather data for all BBC visits in 1992, 1997, 2002, and 2007 are available on request.

Of the 111 years of weather data kept at the Mohonk Lake Cooperative Weather Station, eight of the ten warmest years on record have been since 1990. Since 1896, the average daily temperature had increased 2.3˚ F, the linear average of total precipitation per year had increased by 4.7 inches, and the linear average of total snowfall per season had increased by 21 inches. In addition the growing season was an average of eight days longer with the first frost in the fall three days later and the last frost in spring five days earlier (Smiley 2006).

DISCUSSION

Vegetation

Four distinct periods of vegetational change can be distinguished in the landscape of the Shawangunk Mountains: Pre-colonial period, early European settlement period, period of intensive forest use between 1850 and the early 20th century, and the mid-late 20th century forest recovery (Russell 2001).

Before human settlement of the northeastern United States, natural forces probably played the primary role in the formation of habitats. Major natural forces in the Shawangunk Mountains were probably the changing of seasons with warm summers, cool winters, and sufficient rainfall to support deciduous trees. Based on studies of pollen preserved in swamp sediments, oaks seem to have dominated the regional vegetation for at least 6000 years with various amounts of pine, hemlock, chestnut, beech, and other trees (Laing 1994). Pitch Pine and Chestnut Oak were probably found above the cliff line, with American Chestnut (*Castanea dentata*), Chestnut Oak, and White Pine dominating above 200m, and more Basswood, maple, beech, and Black Oak (*Quercus velutina* Lam.) found at lower elevations (Russell 2001).

During the early European settlement period (mid 17th century-1850) farmers cleared much of the forest of the lowlands but left some woodlots on the poor soils and hedgerows along property lines. At this time, hunting reduced deer, wolf, and panther populations, and livestock was allowed to roam freely. Fires used for agricultural purposes probably became more frequent in lowland forests and may have escaped to surrounding areas (Russell 2001).

Between 1850 and the early 20th century there was continued intensive forest use and it is likely that all extant forests were cut at least once for some use. The forests of the Shawangunk Mountains were used for lumber and

fuelwood. The bark of Eastern Hemlock was used for tanning leather because of its high tannin content. Eastern Hemlock tree saplings were used to make barrel hoops (Snyder and Beard 1981). Between 1900 and 1908, Chestnut Blight Fungus (*Cryphonectria parasitica*) was introduced to North America and by 1940 mature American Chestnut trees were virtually extinct (Wikipedia 2007). Fire frequency probably increased because it was thought to make conditions more favorable for blueberry and huckleberry, which were harvested. This time period came to an end when resources dwindled and the industries died out. Farms were abandoned and the forest was allowed to grow back to its current status (Russell 2001).

The habitat in the 1992 BBC was probably more open due to the heavy defoliation and death of many Chestnut Oaks during the drought and Gypsy Moth infestations observed from 1986 through 1988. Chestnut Oak will refoliate after a disturbance such as Gypsy Moth attack. When refoliation does occur, water needs to be available for growth. The drought in the growing season of 1987, followed by below average rainfall in the growing season of 1988, in combination with the stress of repeated Gypsy Moth infestation is the reason many Chestnut Oaks died (DSRC 1989).

Since the early 1990s Red Maple has become especially abundant in the southern section and along the edge of the study area. In addition, the vegetation became denser. Besides Red Maple, species that were not listed in earlier descriptions of the study area and were seen in 2007 included Eastern Hemlock, White Pine, Black Gum, Witch Hazel Sassafras, and Striped Maple. Most of these plants were less than three meters in height and were found around the perimeter of the study area. The northern section of the study area was more open and was dominated by Pitch Pine. The southern section was dominated by an understory of Mountain Laurel, and an open canopy of Chestnut Oak, Pitch Pine, Black Birch, and Red Maple. Blueberry and huckleberry were mixed in with the Mountain Laurel with an increase in elevation in the southern section. Red Maple is a shade tolerant tree which can survive in many different types of habitat, while Pitch Pine, Scrub Oak, Black Huckleberry, Low-bush Blueberry, and Chestnut Oak depend on partial to full sunlight for survival (Gilbert et al. 2003).

All of the species in the study area have adaptations to resist fire and survive afterwards. These characteristics include basal sprouting, root crown sprouting, rhizome sprouting, and fire resistant bark (Jordan et al. 2003). Red Maple is known to aggressively seed and sprout after fire occurs; it persisted after a single prescribed fire in an oak-pine forest on the Cumberland Plateau in Kentucky (USDA-NRCS 2006, Gilbert et al. 2003). Successive burns have been suggested as a method for controlling Red Maple populations (Gilbert et al 2003).

Fire has been used to maintain Pitch Pine and oak associated communities (Jordan et al. 2003, Rieske 2002). Rieske (2002) found that a series of wildfires over a one month period caused physiological changes in Chestnut Oaks leading to higher levels of foliar nitrogen, higher tannin levels early in the growing season, higher specific leaf mass later in the growing season, and higher leaf

water content. The absolute height growth of seedlings from burned sites was over four times greater than those from non-burned sites and seedlings from burned plots were more productive with respect to leaf area and leaf mass. Without fire, however, succession favors Red Maple, and the development of a denser habitat. The study area has never experienced a documented fire. The ice storm that occurred in November of 2002 did cause heavy breakage and damage to trees and shrubs over a wide area, but this happened five years before the next BBC in the study area, which would have allowed time for some recovery.

Birds

BBC results which show bird community changes corresponding to habitat succession include the absence of Brown-headed Cowbird since 1997, a decrease in Eastern Towhee breeding territories, and an increase in Red-eyed Vireo populations. Although the habitat has never been fragmented, earlier BBC results indicate the habitat was more open compared to the 2007 BBC.

In a more open habitat, bird populations may have been affected by nest predation and nest parasitism. Declines in neotropical migrant birds have been attributed to habitat fragmentation, which cause increased nest predation, nest parasitism by the Brown-headed Cowbird, and loss of habitat (Faaborg 2002, Bohning-Gaese et al. 1993, Robbins et al. 1989). Robbins et al. (1989) analyzed BBS data from 1966-1978 and from 1978-1987 and identified the principal winter habitat of 62 neotropical migrant species in Quintana Roo, Mexico. They found those which used forest habitat on their winter territories showed the greatest population decline. Bohning-Gaese et al. (1993) also studied BBS data during this time period and found that neotropical migrants that make low, open nests had declined the most.

Any animal may be a nest predator; however, Leimgruber (1994) found that Raccoon (*Procyon lotor*) and Striped Skunk (*Mephitis mephitis*) were the top nest predators in forests in Front Royal, VA. Corvids, such as the American Crow (*Corvus brachyrhyncos*) and Blue Jay are also known nest predators which were common in the study area. In a denser habitat, nests would less likely be found by predators and with the absence of Brown-headed Cowbirds, nest parasitism would decrease.

Brown-headed Cowbirds are short distance migrants and may be declining in the study area because of habitat change, but BBS data has shown a decrease of this species in N.Y. and in the eastern BBS region since 1992 (USGS 2007c). It is known that Brown-headed Cowbirds depend on large areas of land for breeding, feeding, and roosting (Gates and Evans 1998). They choose home ranges based on a hierarchy of categories: brush habitat, deciduous forest, and agricultural land were the top three. Developed land was their least favored site. Succession in the study area may be the reason for the absence of the Brown-headed Cowbird; habitat change outside of the study area may also be a factor.

The Eastern Towhee, a short distance migrant which breeds in open woody areas, has also decreased in N.Y. and in the eastern BBS region since 1992. Reasons for declines of this species may be similar to those of the Brown-

headed Cowbird: succession in the study area, habitat change outside the study area, overall population trends, or a combination of these factors.

Valiela and Martinetto (2007) suggested north temperate resident and short distance migratory bird populations have declined because of the development of natural habitat on their breeding grounds in North America. This is because neotropical migratory birds mainly use similar types of habitat on their winter territories as they do on their breeding territories. If tropical habitat is continuously being altered for human purposes and becoming less forested, then neotropical migratory birds which prefer open habitat would increase. Neotropical migratory birds which use open habitat decreased by 22% between 1966 and 2005 (Valiela and Martinetto 2007).

Increases in Red-eyed Vireo populations have been correlated with forest regrowth and fire suppression in eastern North America, both of which have happened in the study area (Sibley 2001).

Warming Temperatures and Observer Variation

Warming temperatures are apparent in the Mohonk Preserve weather data and the BBC temperature data. Global warming has caused avian distribution shifts, earlier migration and egg laying, or population changes in certain species found throughout the U.S. and Canada and as far south as the Antarctic (Bonfield 2007). The Christmas Bird Count (CBC) occurs within two weeks of December 25 and consists of counting all the birds seen in an area within a 15-mile diameter in a single day. The CBC data from 1930-2001 in Cape Cod, MA show that increases in local mean minimum winter temperature correlate with a significantly higher ratio of southern winter distribution bird species to northern winter distribution bird species (Valiela and Bowen 2003). Examples of birds observed in more northern areas include the Carolina Wren, Tufted Titmouse, Red-bellied Woodpecker (*Melanerpes carolinus*), and Cape May Warbler (*Dendroica tigrina*) (Bonfield 2007). The Black Vulture's (*Coragyps atratus*) northern limit of distribution used to be to southern PA. It is now a year-round resident at the Mohonk Preserve and successfully bred there for the first time in 1997. The American Robin, Turkey Vulture, and Song Sparrow are also year-round residents at the Mohonk Preserve (Smiley 2006).

Observer variation can be a problem in bird population studies (Sauer et al. 1994). Sauer et al. (1994) found evidence for observer differences in 50% of 369 bird species examined in the BBS from 1966 through 1991. Observer variation may have come from a number of factors such as a person's ability to detect birds, strategies for observing birds, estimating total numbers of birds, the number of observers participating in a group, and changes in observers over time. Observers tended to count more birds in later years than in earlier years which was attributed to observers becoming more skilled over time. There was a considerable increase in observations in this BBC with species such as the Chipping Sparrow, Indigo Bunting, Mourning Dove, and Red-eyed Vireo. Also, the main compilers of BBC data changed from 1992 to 1997.

When comparing my data with other observers' data in 2007, our results were similar but did have some differences. The location of birds recorded in the

field was similar for all species except the Red-eyed Vireo, for which many of my recordings were in the study area while other observers' data were outside of the study area. I declared breeding territories with my results three times: once after making my species maps, a second using ArcGIS, and a third after researching the recorded sizes of breeding territories for each species. Other BBC observers discussed their results together and decided on breeding territories together.

Further observer variation can be attributed to distinguishing the various species which have a trill-like song in the study area. The Chipping Sparrow, which seemed to be everywhere, Pine Warbler, and Dark-eyed Junco all have a similar song and cannot be distinguished at all times unless you are a very good bird observer or a visual sighting is made.

Partners in Flight

It is important that we ensure avifauna is conserved for generations to come. The practice of conservation, education, and research at the Mohonk Preserve is one way to fulfill this goal. Species such as the Prairie Warbler and Wood Thrush have had marked population declines on a large scale while other species such as the Black-and-white and Pine Warbler are specialized to pine forests. Thirty of the breeding birds in the Pitch Pine Oak Heath Rocky Summit were considered common or abundant and had populations that were stable or increasing (BNA 2007). In the future, we must ensure that common species remain common, that we protect species which have declined, and ensure that species with special needs are able to obtain them.

There is a plan for the conservation of North American landbirds. Partners in Flight (PIF) developed the North American Landbird Conservation Plan which provides a continental synthesis of priorities and objectives that will guide landbird conservation actions at national and international levels (PIF 2004). Of the 448 landbirds that regularly breed in the U.S. and Canada, 100 warrant inclusion on the PIF Watch List. Of these 100 species, 28 require immediate action to protect small remaining populations and 44 more are in need of management to reverse long-term declines. In this plan there is also a Stewardship Species List, which includes species that are characteristic of specific landscapes in each portion of the North American continent which need to be considered in conservation planning. Species found in the BBC at the Mohonk Preserve that are Watch List Species on the PIF Landbird Conservation Plan include the Worm-eating Warbler, Prairie Warbler, and Wood Thrush. Stewardship Species found at the Mohonk Preserve include the Eastern Towhee, Hooded Warbler, Pine Warbler, Carolina Wren, Indigo Bunting, and Yellow-throated Vireo. Five of these key species have been present in all of the BBCs in the Pitch Pine Oak Heath Rocky Summit.

The Mohonk Preserve was designated by The Nature Conservancy as one of Earth's "Last Great Places", and it truly is. It is critically important that we continue to monitor and conserve this natural area and natural areas worldwide, so that bird populations and wildlife will continue to survive for generations to come.

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