**SUPPLEMENTAL MATERIAL**

Observations by E.E. Smith (Smith 1948):

*“This area is mostly concentrated in the town of Petersham but a small area lies in the adjoining town of Phillipstown to the northeast. The main area is included in three separate tracts consisting of approximately equal areas. The Tom Swamp Tract containing Harvard Pond [not surveyed as part of the 1993-2016 study] has been set aside since 1922 as a sanctuary in cooperation with the Massachusetts Conservation Commission.*

*The Forest consists of several types…(and) vary from the marshy borders of Harvard, Conner’s and Riceville Ponds through the spruce swamps, red maple swales, coniferous stands and plantations to deciduous stands. These types are again broken down into other habitats by the inclusion of many age classes.*

*The hurricane of 1938 destroyed most of the old growth but left in its wake large areas of blowdown which are restocking with a dense covering of hardwood and some coniferous growth, but there are scattered dead and living trees of greater height throughout these areas. This type of habitat attracts many species such as the Olive-sided Flycatcher, Chestnut-sided Warbler and the White-throated Sparrow.”*

**Table S1**. Summary of breeding landbird species, 1948 – present. Status in 1993-2016 is given as a frequency of points where detected (presence/absence) for years indicated (Zone A, June only). Several species mentioned as occurring by Smith in 1948 and Hopkins and Hopkins in 1970 were omitted unless breeding behavior was mentioned. “BCC” (after name) indicates a Bird Species of Special Concern[[1]](#footnote-1) for Bird Conservation Regions 14 and/or 30, which cover central Massachusetts. “WB” = “whispering bird” (in “Change/Notes on habitat”), refers to species showing increases in range (by atlas block occupancy) yet with population declines noted by regional BBS trends, so deserving of population monitoring. Correlations with tree species from this study, referring to values >0.3. Species order follows most recent AOU taxonomy (Chesser et al. 2024).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **1948 (Smith)** | **1993** | **2011 – 2016** | **Change/Notes on habitat** |
| Wild Turkey (*Meleagris gallopavo*) | - | Incidental | Incidental | Colonized; since 1948 detected incidentally in open areas/clearings; not reported by either Smith nor Hopkins and Hopkins. |
| Ruffed Grouse (*Bonasa umbellus*) BCC | “Many of these fine birds are present on the Forest and rarely is a trip in the field concluded without seeing or hearing several. Three broods flushed in the summer.” | Incidental | Incidental | Declined since 1948; rarely encountered 2011-2016, never on point counts, and not found on surveys at Petersham CC (pers. obs.). |
| Mourning Dove (*Zenaida macroura*) | 1 bird, August | Incidental | 0.014 |  |
| Yellow-billed Cuckoo (*Coccyzus americanus*) | - | Incidental | 0.018 | Irregular; could have been missed in 1948 |
| Black-billed Cuckoo (*Coccyzus erythropthalmus*) BCC | - | Incidental | 0.018 | Irregular; could have been missed in 1948 |
| Eastern Whip-poor-will (*Caprimulgus vociferus*) BCC | “Heard throughout the summer” | - | - | Extirpated after 1948 |
| Red-shouldered Hawk (*Buteo lineatus*) | - | Incidental | Incidental | Colonized since 1948; pair present at main bog and at Petersham CC; not reported by either Smith nor Hopkins and Hopkins. |
| Broad-winged Hawk (*Buteo platypterus*) | “Found throughout the summer in several parts of the forest.” | 0.012 | 0.009 |  |
| Red-tailed Hawk (Buteo jamaicensis) | “Two adults were observed with a young bird…in a wild tangle of bog and scattered large trees. Another pair with one young bird was found in a large hurricane blow-down area.” | - | - | Extirpated after 1948 |
| Ruby-throated Hummingbird (Archilochus colubris) | - | 0.024 | 0.022 | Colonized after 1948 |
| Yellow-bellied Sapsucker (Sphyrapicus varius) | - | - | 0.118 | Colonized after 1993 |
| Red-bellied Woodpecker (Melanerpes carolinus) | - | - | 0.005 | Colonized; 2016 survey only |
| Downy Woodpecker (Picoides pubescens) | “Observed throughout the Forest” | 0.073 | 0.053 | Corr.: Shadbush |
| Hairy Woodpecker (Picoides villosus) | “Observed throughout the forest” | 0.012 | 0.076 | Corr.: ash sp. |
| Northern Flicker (Colaptes auratus) | “Common summer resident throughout the Forest.” | Incidental | 0.004 | Declined after 1948; present in open areas today (e.g. Petersham CC; pers. obs.) |
| Pileated Woodpecker (Dryocopus pileatus) | “2 were observed on the Forest, one in mid-July in Tom Swamp and one in a restricted area of Prospect Hill.” | 0.012 | 0.014 |  |
| Great Crested Flycatcher (Myiarchus crinitus) | - | - | 0.031 | Colonized after 1993 |
| Eastern Kingbird (*Tyrannus tyrannus*) | “Summer resident around the ponds and marshes” | Incidental | Incidental |  |
| Olive-sided Flycatcher (*Contopus cooperi*) BCC | “The large slash filled areas with scattered larger trees left by the hurricane of 1938 made an ideal habitat for this flycatcher. Five singing males were observed during the nesting season in the Tom Swamp Block.” | - | - | Extirpated after 1948. |
| Eastern Wood-pewee (*Contopus virens*) | “Common summer resident throughout the Forest” | 0.256 | 0.193 | Corr.: Red oak |
| Alder Flycatcher (*Empidonax alnorum*) | - | - | 0.009 | Marginal? 2011 and 2013 only. |
| Least Flycatcher (*Empidonax minimus*) | “Summer resident throughout the Forest” | - | 0.036 | Re-colonized recently? Missed in 1993. |
| Eastern Phoebe (*Sayornis phoebe*) | “Summer resident of the Forest” | 0.012 | 0.040 |  |
| Yellow-throated Vireo (*Vireo flaviformes*) | - | - | 0.009 | Marginal? 2013 only |
| Blue-headed Vireo (*Vireo solitarius*) | “Common summer resident throughout the Forest” | 0.390 | 0.160 | Corr.: Eastern hemlock |
| Red-eyed Vireo (*Vireo olivaceus*) | “Common summer resident” | 0.451 | 0.648 | Corr.: Red maple, paper birch, witch-hazel, ash sp. |
| Blue Jay (*Cyanocitta cristata*) | “Permanent resident throughout the Forest” | 0.122 | 0.144 |  |
| American Crow (*Corvus brachyrhynchos*) | “Permanent resident throughout the Forest” | Incidental | 0.005 | Declined since 1948 on forest; still common in open areas (e.g., Petersham CC) |
| Common Raven (*Corvus corax*) | - | Incidental | Incidental | Colonized after 1948 |
| Black-capped Chickadee (*Poecile atricapillus*) | Permanent resident throughout the Forest” | 0.415 | 0.261 |  |
| Tufted Titmouse (*Baeolophus bicolor*) | - | 0.073 | 0.049 | Colonized after 1948; not reported by either Smith nor Hopkins and Hopkins; Corr.: slippery elm |
| Golden-crowned Kinglet (*Regulus satrapa*) | Fall only | 0.037 | 0.027 | Colonized as a breeder since 1948. Corr.: Black gum, black spruce |
| Cedar Waxwing (*Bombycilla cedrorum*) | “Common summer resident” | 0.037 | 0.080 | Still common in open areas (e.g., Petersham CC; pers. obs.) |
| Red-breasted Nuthatch (*Sitta canadensis*) | Fall only | 0.244 | 0.148 | Colonized after 1948; reported to 1 May (1969) by Hopkins and Hopkins but apparently not breeding; Corr.: black spruce |
| White-breasted Nuthatch (*Sitta carolinensis*) | - | 0.073 | 0.070 | Colonized after 1948, though possibly overlooked by Smith; termed “abundant” by Hopkins and Hopkins. |
| Brown Creeper (*Certhia americana*) | Fall only | 0.195 | 0.189 | Colonized as a breeding resident between 1970 and 1993 (Oct. only by Hopkins and Hopkins 1970). Corr.: Red pine, larch, black spruce |
| Northern House Wren (*Troglodytes aedon*) | “Rare summer resident…one was observed nesting in a hollow tree near Riceville pond” | - | 0.004 |  |
| Winter Wren (*Troglodytes hiemali*s) | “2 singing males were present during the breeding season in a wild area of spruce swamp in the Prospect Hill Tract.” | 0.134 | 0.076 | Corr.: American beech, eastern hemlock |
| Gray Catbird (*Dumetella carolinensis*) | “Common summer resident” | 0.049 | 0.072 | Declined after 1948; still common in open areas (e.g., Petersham CC) |
| Brown Thrasher (*Toxostoma rufum*) | “Rare summer resident on the Forest. Only one pair were observed.” | - | 0.005 |  |
| European Starling (*Sturnus vulgaris*) | “Not common in the forested areas. Several have been observed around the Forest headquarters” | Incidental | Incidental |  |
| Eastern Bluebird (*Sialia sialis*) | “Not so common summer resident on the forest due to lack of suitable area.” | Incidental | 0.004 |  |
| Veery (*Catharus fuscescens*) BCC | “Common summer resident” | 0.171 | 0.147 | Corr.: Bigtooth aspen |
| Hermit Thrush (*Catharus guttatus*) | “Summer resident of the Forest” | 0.134 | 0.133 | Corr.: White pine |
| Wood Thrush (*Hylocichla mustelina*) BCC | “Summer resident of the Forest” | Incidental | 0.013 | Declined after 1948 |
| American Robin (*Turdus migratorius*) | “Common summer resident of the Forest” | Incidental | 0.009 | Declined after 1948; still common in open/residential areas |
| House Sparrow (*Passer domesticus*) | “Rather rare resident about the forest headquarters” | - | - | (overlooked?) |
| Evening Grosbeak (*Coccothraustes vespertinus*) | - | 0.024 | 0.004 |  |
| House Finch (*Haemorhous mexicanus*) | - | Incidental | Incidental | Colonized after 1948 |
| Purple Finch (*Haemorhous purpureus*) | “Common summer resident of the coniferous plantations throughout the forest” | 0.061 | 0.018 | Declined after 1948; Corr.: red spruce |
| American Goldfinch (*Spinus tristis*) | “Resident of the few open fields in the forest” | 0.024 | 0.023 |  |
| Chipping Sparrow (*Spizella passerina*) | “Summer resident of the open areas around the forest” | 0.024 | 0.049 |  |
| Field Sparrow (*Spizella pusilla*) | “Summer resident in a few of the open fields of the forest area. | - | - | May not have occurred on Prospect Hill Tract |
| White-throated Sparrow (*Zonotrichia albicollis*) | “Common in the moist brush and shrub filled areas” | Incidental | 0.005 | Presumably declined, but unclear if 1948 status pertained to winter or summer. |
| Song Sparrow (*Melospiza melodia*) | “Found throughout the forest where there are openings in the forest canopy but only common near the ponds and swamps” | 0.073 | 0.036 |  |
| Swamp Sparrow (*Melospiza georgiana*) | “Common summer resident of the marshes and pond borders” | 0.037 | 0.036 |  |
| Eastern Towhee (*Pipilo erythrophthalmus*) | “Common summer resident of the brushy openings” | 0.049 | 0.059 | Declined after 1948 |
| Baltimore Oriole (*Icterus galbula*) | “Summer resident at scattered localities” | - | 0.013 |  |
| Red-winged Blackbird (*Agelaius phoeniceus*) | “Common summer resident of the swampy tracts and around the ponds” | 0.037 | 0.014 |  |
| Brown-headed Cowbird (*Molothrus ater*) | “Common summer resident of the vicinity occasionally seen in the forest” | 0.012 | 0.023 | Corr.: Yellow birch, witch-hazel |
| Common Grackle (*Quiscalus quiscula*) | “Summer resident about the town and occasionally seen on the forest” | - | 0.014 |  |
| Ovenbird (*Seiurus aurocapilla*) | “Common summer resident of the deciduous hardwood stands of the forest” | 0.780 | 0.910 | Corr.: Gray birch, red maple, red oak, paper birch |
| Northern Waterthrush (*Parkesia noveboracensis*) | - | 0.073 | 0.028 | Colonized after 1948; Corr.: Black spruce, highbush blueberry |
| Black-and-white Warbler (*Mniotilta varia*) | “Common summer resident of the deciduous hardwood areas of the forest” | 0.378 | 0.149 | Corr.: Red pine |
| Common Yellowthroat (*Geothlypis trichas*) | “Common summer resident of the lower moist areas throughout the forest” | 0.159 | 0.148 |  |
| American Redstart (*Setophaga ruticilla*) | “Common summer resident throughout the forest” | 0.012 | 0.014 | Declined after 1948; widely-scattered pairs in open areas. |
| Northern Parula (*Setophaga americana*) | - | - | 0.005 |  |
| Magnolia Warbler (*Setophaga magnolia*) | “Common summer resident in the coniferous plantations of the forest” | 0.049 | - | Extirpated after 1993. Corr.: Black spruce, highbush blueberry |
| Blackburnian Warbler (*Setophaga fusca*) | “A summer resident of the tops of the older conifers” | 0.195 | 0.244 | Corr.: Red pine |
| Yellow Warbler (*Setophaga petechia*) | - | - | 0.005 |  |
| Chestnut-sided Warbler (*Setophaga pensylvanica*) | “The most common warbler of the forest. The large areas of brush which cover the blow-down of the hurricane make an ideal habitat for this species.” | 0.085 | 0.122 | Declined between 1948 and 1993, then increased slightly, but not the “most common warbler of the forest” |
| Black-throated Blue Warbler (*Setophaga caerulescens*) | “Summer resident of the cooler areas of the Forest usually with heavy understory” | 0.256 | 0.373 | Corr.: Red maple |
| Pine Warbler (*Setophaga pinus*) | - | 0.122 | 0.425 | Colonized after 1948; Corr.: cherry sp., red pine, larch, black spruce |
| Yellow-rumped Warbler (*Setophaga coronata*) | “Like the Magnolia this is a bird of the coniferous plantations of the Forest” | 0.293 | 0.188 |  |
| Prairie Warbler (*Setophaga discolor*) BCC | - | - | 0.031 | Colonized after 1993 |
| Black-throated Green Warbler (*Setophaga virens*) | “This is the characteristic bird of the older growth coniferous stands throughout the Forest” | 0.293 | 0.257 | Corr.: Eastern hemlock |
| Canada Warbler (*Cardellina canadensis*) BCC | “Summer resident of the deciduous undergrowth throughout the Forest” | 0.134 | 0.072 |  |
| Scarlet Tanager (*Piranga olivacea*) BCC | “Summer resident throughout the forest in the older hardwood stands” | 0.220 | 0.318 | Corr.: snag (dead tree) |
| Northern Cardinal (*Cardinalis cardinalis*) | - | Incidental | 0.005 | Colonized after 1948 |
| Rose-breasted Grosbeak (*Pheucticus ludovicianus*) BCC | “Summer resident in the deciduous stands near the ponds and swamps” | - | 0.004 | Declined after 1948; like American Redstart, scattered pairs in open areas. |
| Indigo Bunting (*Passerina cyanea*) | - | 0.012 | 0.044 | Colonized after 1948 |

**Table S2**. Species turnover at Harvard Forest since 1948 (see also Table S1). Abbreviations include “BBA” [Massachusetts Breeding Bird Atlas, indicating % change between BBA1 (1974-1979) and BBA2 (2007-2011) (MAS 2008)], and “BBS” (Breeding Bird Survey Results, available in MAS 2008). Range and habitat based on Craig et al. (2022). Migratory Status abbreviations are based on various sources, and include long-distance migrant (LDM) and short-distance migrant (SDM). Parentheses indicate species not treated by Craig et al. 2022 nor McNulty et al. 2008, or where information seems inaccurate, so determination made using Veit and Petersen (1993) and other sources[[2]](#footnote-2).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **BBA** | **BBS** | **Range/Migratory Status** | **Habitat** | **Notes (from BBA unless indicated)** |
| **COLONIZED SINCE 1948** |  |  |  |  |  |
| Wild Turkey (*Meleagris gallopavo*) | 97.9 | + | Core/Resident | Edge/successional | Human-assisted (population driven by released game birds) |
| Red-shouldered Hawk (*Buteo lineatus*) | 29.2 | + | Northern limit/ Resident | Forest interior (Generalist) | Decline in the mid-1900s, followed by slow recovery, aided by beaver increase and forest maturation. |
| Ruby-throated Hummingbird (*Archilochus colubris*) | 41.7 | + | Core/LDM | Generalist | “The proliferation of natural beaver clearings and cultivated suburban gardens during Atlas 2 provided ideal conditions for Ruby-throated Hummingbirds” |
| Common Raven (*Corvus corax*) | 70.8 | + | Southern limit/Resident | Generalist |  |
| Tufted Titmouse (*Baeolophus bicolor*) | 60.4 | + | Northern limit/ Resident | Generalist | Continued invasion (east to west) through late 1900s. |
| Red-breasted Nuthatch (*Sitta canadensis*) | 33.3 | + | Southern limit/ Resident | Forest interior |  |
| White-breasted Nuthatch (*Sitta carolinensis*) | 16.7 | + | Core/ Resident | Forest interior |  |
| Brown Creeper (*Certhia americana*) | 33.3 | + | Southern limit/ Resident | Forest interior |  |
| Golden-crowned Kinglet (*Regulus satrapa*) | 10.4 | + | (Southern limit)/ Resident | (Forest interior) |  |
| House Finch (*Haemorhous mexicanus*) | 52.1 | + | (Northern limit)/Resident | (Generalist) | “…rapidly increasing abundance, followed by a fairly steep decline since the early 1990s…(which could) possibly be driven by a mycoplasmal conjunctivitis epidemic that appeared in House Finches during that decade.” |
| Northern Waterthrush (*Parkesia noveboracensis*) | 29.2 | + | Southern limit/LDM | Forest interior |  |
| Pine Warbler (*Setophaga pinus*) | 81.3 | + | Core/SDM | Forest interior | “…stands of maturing pasture pines and abandoned pine plantations across the state, almost certainly contributed in part to the extraordinary success of this species” |
| Northern Cardinal (*Cardinalis cardinalis*) | 56.3 | + | Northern limit/ Resident | Edge/successional | “Throughout the 1960s, the species continued its northward expansion in the eastern half of the country.” |
| Indigo Bunting (*Passerina cyanea*) | 12.5 | n/a | (Core)/LDM | (Edge/successional) |  |
| **COLONIZED SINCE 1993** |  |  |  |  |  |
| Yellow-bellied Sapsucker (*Sphyrapicus varius*) | 66.7 | + | Southern limit/SDM | Generalist (Forest interior) | Expanding eastward; “The species’ growth into the Worcester Plateau, where it had only a small foothold, was the most remarkable change in its distribution (i.e., from BBA1 to BBA2)”. |
| Red-bellied Woodpecker (*Melanerpes carolinus*) | 66.7 | + | Northern limit/ Resident | Forest interior (Generalist) | “Other than the Wild Turkey (which received considerable direct assistance from humans), no breeding bird species in Massachusetts shows a greater increase in occupied blocks across the state than the Red-bellied Woodpecker.” (starting mid-1990s) |
| Great Crested Flycatcher (*Myiarchus crinitus*) | 37.5 | n/a | Core/LDM | Generalist |  |
| Prairie Warbler (*Setophaga* discolor) | 35.4 | - | (Northern limit)/LDM | (Edge/successional) | “Because they require what is usually an ephemeral habitat for breeding…generally not reliably persistent in any one area, appearing and disappearing across the state as the landscape shifts.” |
| **DECLINED SINCE 1948** |  |  |  |  |  |
| Ruffed Grouse (*Bonasa umbellus*) | 39.6 | - | Southern limit/ Resident | Edge/successional | “Prefer a middle ground disallowed by either managed farmland or mature woods…In central and western Massachusetts, where old farmlands are returning to forests more than they are becoming parking and housing lots, the species is holding on.” |
| Red-tailed Hawk (*Buteo jamaicensis*) | 31.3 | + | Core/ Resident | Edge/successional | Declines noted in w. MA, contrary to statewide trends. |
| Eastern Whip-poor-will (*Caprimulgus vociferus*) | 4.2 | - | Core/LDM | Edge/successional | “Concern over this decline resulted in the species being listed as a Species of Special Concern in Massachusetts in 2011. Efforts are currently underway to create more suitable habitat for the species in Massachusetts.” |
| Northern Flicker (*Colaptes auratus*) | 6.3 | - | Core/SDM | Edge/successional |  |
| Olive-sided Flycatcher (*Contopus cooperi*) | -2.1 | - | (Southern limit)/LDM | (Edge/successional) | “Olive-sided Flycatchers moved further toward extirpation in Massachusetts by Atlas 2. Not a single Confirmed instance of breeding was reported anywhere in the state.” |
| Least Flycatcher (*Empidonax minimus*) | 6.3 | - | Southern limit/LDM | Edge/successional |  |
| American Crow (*Corvus brachyrhynchos*) | 12.5 | + | (Core)/ Resident | (Generalist) |  |
| Gray Catbird (*Dumetella carolinensis*) | 0 | + | Core/SDM | Edge/successional |  |
| Wood Thrush (*Hylocichla mustelina*) | -4.2 | - | Core/LDM | Forest interior (Edge/successional) |  |
| American Robin (*Turdus migratorius*) | 2.1 | - | Core/SDM | Edge/successional |  |
| Purple Finch (*Carpodacus purpureus*) | 8.3 | - | Southern limit/ Resident | Edge/successional | “There has been a remarkable decline in the distribution of the Purple Finch, reducing this once fairly common breeder to a fraction of its range in a mere 35 years.” |
| Eastern Towhee (*Pipilo eurythrophthalmus*) | 0 | - | Northern limit/SDM | Edge/Successional | “Maturing forests – former farmlands that have already passed through the early successional shrubland stage – have now become inhospitable to this species, forcing it to look for homes elsewhere.” |
| American Redstart (*Setophaga ruticilla*) | -10.5 | n/a | Core/LDM | Edge/successional |  |
| Magnolia Warbler (*Setophaga magnolia*) | 4.2 | + | Southern limit/LDM | Generalist (Forest interior) |  |
| Chestnut-s, Warbler (*Setophaga pensylvanica*) | 2.1 | - | Southern limit/LDM | Edge/Successional |  |
| Rose-br. Grosbeak (*Pheucticus ludovicianus*) | 18.8 | - | Core/LDM | Edge/successional |  |

1. https://www.fws.gov/sites/default/files/documents/birds-of-conservation-concern-2021.pdf [↑](#footnote-ref-1)
2. White-throated Sparrow may be included as a declining species, as it was noted as occurring in brushy habitats by Smith in 1948, and was found marginally during modern surveys. While it is believed to be declining regionally (MAS 2008), confusing over late spring migrants and actual nesters confounds interpretation of its true breeding status. [↑](#footnote-ref-2)