# FIVE YEARS POST-HARVEST:

# BREEDING BIRD POPULATION SURVEY AND HABITAT ASSESSMENT

for the

# KENSAN-DEVAN WILDLIFE SANCTUARY

Prepared for:
New Hampshire Audubon

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*Cover photo: Vegetation resulting from a canopy gap opening at Kensan-Devan Wildlife Sanctuary (S. Lamonde).*

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## Summary

Throughout New Hampshire, 42% of the State's 193 documented breeding species exhibit declining population trends. Habitat degradation and loss contribute significantly to these worrying trends, yet not all forms of habitat alteration are detrimental. By the late 20th century conservation-minded groups began promoting wildlife and forest management as a means of preserving, or even improving, native biodiversity and healthy ecosystems. The creation of numerous management plans, often species- or property-specific, helped spur this movement on and Audubon Vermont's *Foresters for the Birds* project was born in 2008. This novel approach to forest management sought to help keep common forest birds common by melding traditional forestry techniques with current science on habitat preferences of twelve representative forest birds in New England.

In 2015, New Hampshire Audubon worked with consulting foresters to create the *Kensan-Devan Wildlife Sanctuary Forest Management Plan*, a comprehensive strategy for managing this 570-acre woodland with a specific focus on improving habitat for nine target bird species: Black-throated Blue Warbler, Black-throated Green Warbler, Blue-headed Vireo, Canada Warbler, Chestnut-sided Warbler, Eastern Towhee, Eastern Wood-Pewee, Scarlet Tanager, and Wood Thrush. To track bird populations and habitats in response to forest management over time, skilled biologists conducted repeated point-count surveys at designated locations distributed across the sanctuary. At each station, all detected birds were recorded by species, and these counts were analyzed between seasons. With six years of data collected by 2021, a number of trends emerged, some clear and some uncertain.

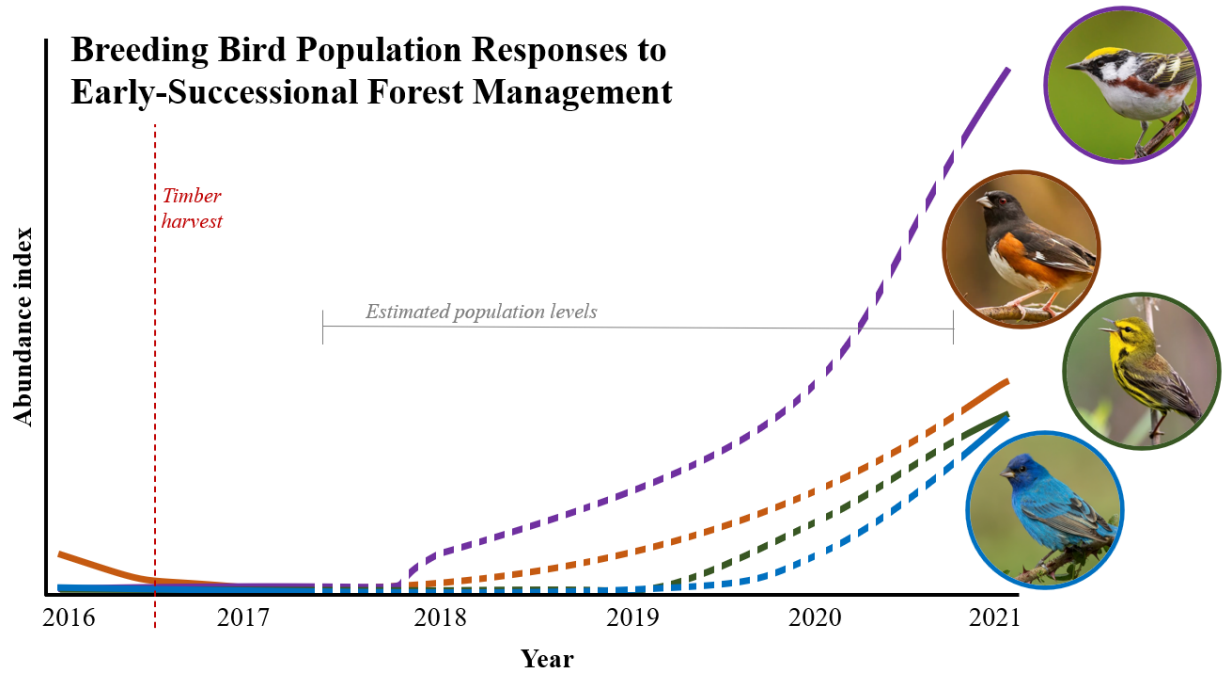


Figure 1. Graph of species abundance at Kensan-Devan Wildlife Sanctuary for New Hampshire Audubon's four early-successional forest birds: Chestnut-sided warbler (purple), Eastern Towhee (orange), Prairie Warbler (green), and Indigo Bunting (blue).

First and foremost, the creation of early-successional forest habitat within the timber harvest area of Kensan-Devan's Meetinghouse Pond section was widely successful. Newly-present and abundant counts of Prairie Warblers, Indigo Buntings, Chestnut-sided Warblers, and Eastern Towhees underscored how beneficial the seed tree and overstory removal treatments were for early-successional forest birds by the fifth-year post-harvest. Second, some mature-forest species including Blue-headed Vireo appeared to decline after the harvest, especially within the overstory removal and seed tree treatment zones due to loss of canopy cover. This tradeoff between early-successional species population increases and mature-forest species decreased was expected.

Third, several species, including Eastern Wood-Pewee and Black-throated Green Warbler exhibited mixed trends, thereby indicating a potentially stable population. Future data will help paint a clearer picture of populations in this category. Fourth, Ovenbird and Red-eyed Vireo remained the most abundant birds on the property despite an initial population decline immediately following the harvest, which suggests a satisfactory amount of mature forest exists at Kensan-Devan and within the surrounding landscape.

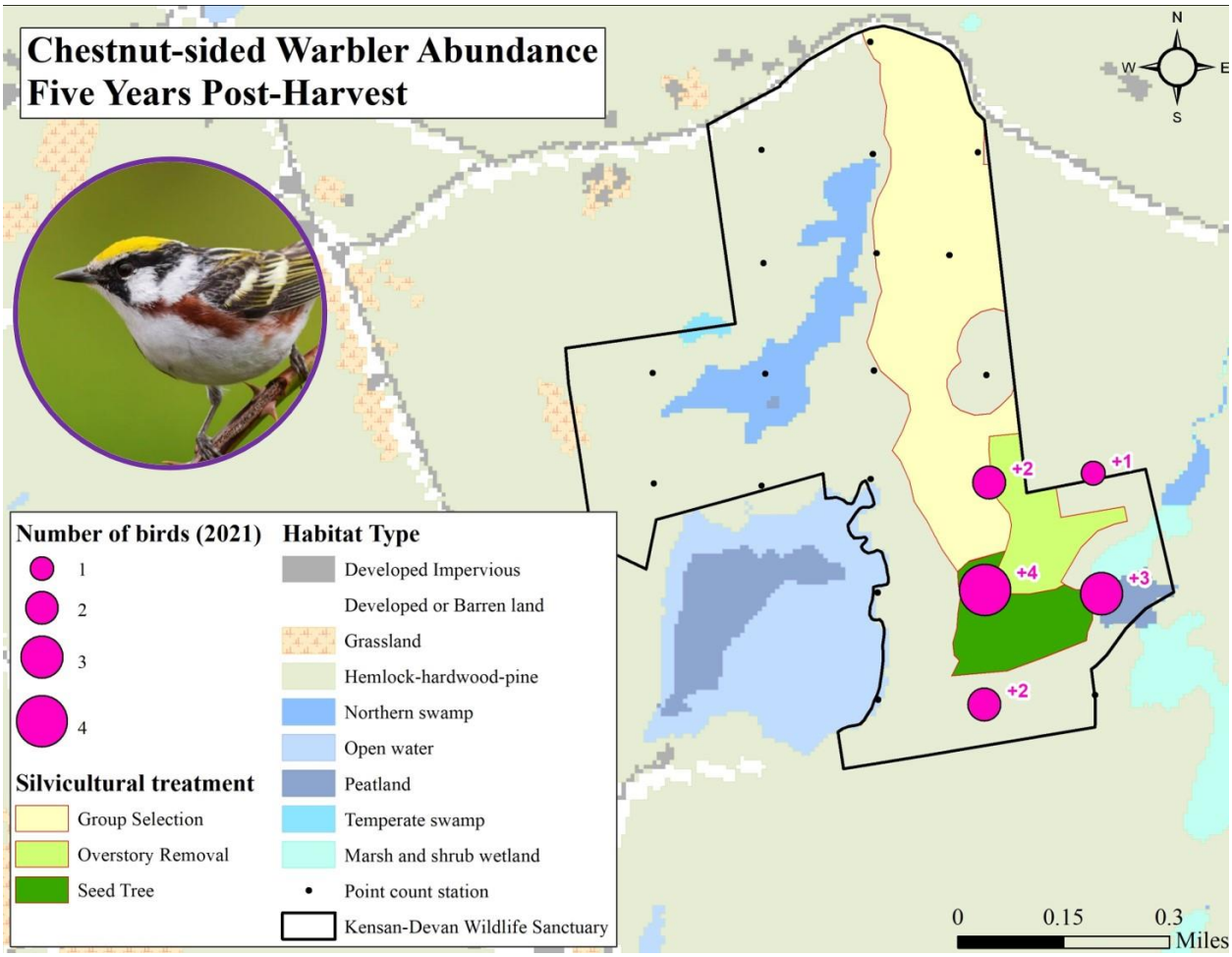


Figure 2. Map of Chestnut-sided Warbler abundance (maximum number of individuals detected on a single survey in 2021 with points labeled by change in abundance since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

# Introduction

## Overview

During March 2021 New Hampshire Audubon contracted Moosewood Ecological, LLC to conduct breeding bird surveys (May-June) and a vegetation-based habitat assessment at Kensan-Devan Wildlife Sanctuary (Kensan-Devan) in Marlborough, New Hampshire to better measure responses to forest management. Five years had passed since the pre-harvest surveys took place in 2016 and four years since the first and only post-harvest surveys were conducted. The specific objectives of this project were to:

1. Conduct three replicate breeding bird surveys during the months of May, June, and July mimicking the same methodology as the 2016 and 2017 surveys.
2. Conduct a single round of vegetation surveys, also using the same methodology.
3. Analyze measured responses in bird populations and forest communities.
4. Compare these findings to data from previous years.

## Background

In 2016 a pre-forestry breeding bird survey was conducted at Kensan-Devan to establish a baseline for forest bird populations breeding on the property. This largely forested property had not been managed specifically for birds, but New Hampshire Audubon identified several opportunities to improve bird habitat for a suite of forest species in decline. New Hampshire Audubon worked with consulting foresters at Meadowsend Consulting Company to develop a forest management plan for Kensan-Devan (see TEMC 2015). Part of this plan identified nine species for targeted habitat management: Eastern Wood-Pewee (*Contopus virens*), Blue-headed Vireo (*Vireo solitarius*), Wood Thrush (*Hylocichla mustelina*), Eastern Towhee (*Pipilo erythrophthalmus*), Chestnut-sided Warbler (*Setophaga pensylvanica*), Black-throated Blue Warbler (*Setophaga caerulescens*), Black-throated Green Warbler (*Setophaga virens*), Canada Warbler (*Cardellina canadensis*), and Scarlet Tanager (*Piranga olivacea*).

Following completion of the Kensan-Devan forest management plan, New Hampshire Audubon partnered with Chad Witko, a then graduate student from Antioch University and now Conservation Biologist with the National Audubon Society, who, for his Master's Thesis, established and surveyed 45 points across the 570-acre property for the breeding bird counts before and after the first timber harvest. Foresters from Meadowsend carried out the first round of forest management actions from the management plan over the winter of 2016-17. These took place in the western section of the property (referred to as the Meetinghouse Pond section). During the following breeding bird season of 2017, a second round of surveys was completed to measure the breeding bird response to the forest management. A report was written summarizing these findings (see Witko 2019). In 2021, New Hampshire Audubon restored an older trail system to highlight various forest management practices that conserve and support priority bird species in forested settings in New Hampshire. The goal of the trail system is to provide an educational and recreational experience across several habitat types that were created in conjunction with the forest management carried out in 2016-17.

In 2021, Meadowsend conducted a second timber harvest at Kensan-Devan, this time to support key breeding bird species in the eastern section of the property (referred to as the Hunt Road section). This multi-treatment harvest aimed to create new patches of early successional forest, tailor mixed-canopy communities for Canada Warbler habitat, and foster multi-aged hardwood stands (Appendix A) and was completed between August and December.

# Methods

## Study Area

Located in Marlborough, New Hampshire, Kensan-Devan's 570 acres of mostly-forested land is divided into two incontiguous properties, the western Meetinghouse pond section (274 acres) and eastern Hunt Road section (296 acres). Red oak, eastern white pine, and red maple dominate much of the overstory, with American beech and eastern hemlock frequent in the midstory and understory (TEMC 2015). Several scrub-shrub and forested wetlands are scattered throughout, and Meetinghouse Pond lies to the west of the Meetinghouse Pond section of Kensan-Devan.

## Data Collection

Prior to field surveys, a GIS shapefile containing the 45 point count stations was uploaded to a handheld Garmin eTrex30 GPS unit that is accurate to five meters in open canopy and sunny skies. All 45 points were navigated to using this GPS unit and reflagged with two-inch orange flagging, regardless if flagging from 2017 was still present. Approximately one-half to two-thirds of flagging from 2017 had either fallen to the ground in pieces or was undetectable, leading to spatial differences in some point count centers between the 2017 and 2021 surveys.

Avian point counts were conducted during the 2021 breeding season in accordance with Witko's (2019) methodology. Three replicate surveys were conducted on each of the 45 point count stations, and each round of surveys was separated by about three weeks. Three mornings of surveys were required for each round and 15 points were covered each morning, totaling nine visits to the sanctuary for avian surveys. Surveys were conducted on relatively calm mornings with no precipitation, and if unfavorable weather forced postponement of a survey, it was rescheduled for within three days of the original date. At each station, following a two-minute waiting period, all detected birds within a five-minute count period were counted by species, detection type (call, song, drumming, flyover, visual), and detection distance (within or beyond 50 meters of the point count center) (Appendix F).

Additional data on weather were recorded at the start and end of each survey, and all birds observed during the study (both official point count data and incidental observations) were entered into eBird. For continuity, all checklists were submitted to one of two eBird hotspots (Witko 2019): "Kensan-Devan Wildlife Sanctuary – Hunt Road Section" or "Kensan-Devan Meetinghouse Pond Wildlife Sanctuary, Marlborough".

For measuring changes to Kensan-Devan's natural communities, each of the 45 point count stations were assessed using the *Foresters for the Birds* protocol (Appendix E), also per Witko's (2019) methodology. These vegetation assessments took place in August and September, prior to the autumn timber harvest and before leaves began falling to reduce differences in canopy coverage estimates. North-facing photos were taken at each point for

comparison to photos taken in the same direction in previous survey years. Metrics on vegetation composition and distribution were measured categorically, and presence data was collected on soft mast, invasive, plants, leaf litter, and coarse and fine wood material. Lastly, using a 10-basal area factor Bitterlich wedge prism, all trees were tallied by species using the variable radius plot method.

Data Analysis

Total detections and relative abundance were calculated for all bird species at three spatial scales (Kensan-Devan, each section, and each timber harvest treatment zone within the Meetinghouse Pond section) and compared to values from the 2016 and 2017 survey seasons (Witko 2019). To help assess changes in species populations over time percentage change in total relative abundance (ΔRA) was also calculated. Similarly, to assess changes in species composition over time, Simpson's Diversity Index values were computed for all point count stations and for each treatment type. Special attention was paid to the nine target species and the two most-abundant species at Kensan-Devan, Ovenbird (*Seiurus aurocapilla*) and Red-eyed Vireo (*Vireo olivaceus*). Additionally, the locations of each target species were mapped by point across Kensan-Devan to visualize abundance during the 2021 breeding season (maximum number of individuals detected during a single survey) and change in abundance since pre-harvest conditions in 2016.

Habitat data was summarized as percent frequency or averaged across each of the thee spatial scales used for avian surveys and compared to previous years. For each tree species, basal area, relative basal area, frequency, relative frequency, and species importance values were also calculated. In addition to Witko's (2019) methodology, a simple comparison of observer and avian survey effort was conducted to assess potential factors that influenced differences in total detections between years. Calculations of mean travel time (mT) were calculated as mT = mD/mP – (pcp + wp), where mD = mean survey duration, mP = mean number of points per survey, pcp = point count period (five minutes), and wp = waiting period (two minutes).

# Results

Field season surveys in 2016, 2017, and 2021 detected 76 species of birds at Kensan-Devan. This included 987 individual detections of 54 species in 2016, 806 individual detections of 49 species in 2017, and 1,718 individual detections of 69 species in 2021 (Table 1). Of these 76 species, 42 were detected in each of the three survey years.

Twelve species of greatest conservation need (SGCN) (NHFG 2015) were detected among the three survey years: Black-billed Cuckoo (*Coccyzus erythropthalmus*), Bobolink (*Dolichonyx oryzivorous*; flyover on 6/15/2016), Canada Warbler, Chimney Swift (*Chaetura pelagica*), Common Loon (*Gavia immer*), Eastern Towhee, Prairie Warbler (*Setophaga discolor*), Purple Finch (*Haemorhous purpureus*), Ruffed Grouse (*Bonasa umbellus*), Scarlet Tanager, Veery (*Catharus fuscescens*), and Wood Thrush. Of special note is the Common Loon, a State Threatened species that is a confirmed breeder on Kensan-Devans' neighboring Meetinghouse Pond.

Table 1. Alphabetical list of all bird species identified at Kensan-Devan Wildlife Sanctuary during each survey season. Numbers for each year represent total number of detections across all points (n = 45) for a given year and relative abundance (%).

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Alder Flycatcher | 6 (0.61) | 7 (0.87) | 9 (0.52) |
| American Crow | 14 (1.42) | 7 (0.87) | 16 (0.93) |
| American Goldfinch | 2 (0.20) | 11 (1.36) | 4 (0.23) |
| American Robin | 4 (0.41) | 3 (0.37) | 3 (0.17) |
| Barn Swallow | 5 (0.51) | 2 (0.25) | 4 (0.23) |
| Barred Owl | 1 (0.10) | 1 (0.12) | 6 (0.35) |
| Black-and-white Warbler | 8 (0.81) | 5 (0.62) | 23 (1.34) |
| Black-billed Cuckoo* | 0 (0.00) | 1 (0.12) | 1 (0.06) |
| Blackburnian Warbler | 3 (0.30) | 1 (0.12) | 81 (4.71) |
| Black-capped Chickadee | 70 (7.09) | 47 (5.83) | 104 (6.05) |
| **Black-throated Blue Warbler** | 22 (2.23) | 20 (2.48) | 63 (3.67) |
| **Black-throated Green Warbler** | 56 (5.67) | 52 (6.45) | 64 (3.73) |
| Blue Jay | 70 (7.09) | 62 (7.69) | 59 (3.43) |
| **Blue-headed Vireo** | 34 (3.44) | 33 (4.09) | 25 (1.46) |
| Bobolink* | 1 (0.10) | 0 (0.00) | 0 (0.00) |
| Broad-winged Hawk | 3 (0.30) | 3 (0.37) | 1 (0.06) |
| Brown Creeper | 1 (0.10) | 1 (0.12) | 17 (0.99) |
| Canada Goose | 0 (0.00) | 0 (0.00) | 4 (0.23) |
| **Canada Warbler*** | 1 (0.10) | 3 (0.37) | 7 (0.41) |
| Cedar Waxwing | 2 (0.20) | 0 (0.00) | 16 (0.93) |
| **Chestnut-sided Warbler** | 0 (0.00) | 0 (0.00) | 29 (1.69) |
| Chimney Swift* | 0 (0.00) | 0 (0.00) | 1 (0.06) |
| Chipping Sparrow | 0 (0.00) | 0 (0.00) | 3 (0.17) |
| Common Loon*[T] | 6 (0.61) | 1 (0.12) | 5 (0.29) |
| Common Raven | 14 (1.42) | 0 (0.00) | 3 (0.17) |
| Common Yellowthroat | 30 (3.04) | 17 (2.11) | 76 (4.42) |
| Downy Woodpecker | 2 (0.20) | 2 (0.25) | 5 (0.29) |
| Eastern Kingbird | 3 (0.30) | 2 (0.25) | 9 (0.52) |
| Eastern Phoebe | 0 (0.00) | 1 (0.12) | 4 (0.23) |
| **Eastern Towhee*** | 1 (0.10) | 0 (0.00) | 8 (0.47) |
| **Eastern Wood-Pewee** | 14 (1.42) | 13 (1.61) | 38 (2.21) |
| Golden-crowned Kinglet | 1 (0.10) | 0 (0.00) | 0 (0.00) |
| Gray Catbird | 0 (0.00) | 0 (0.00) | 10 (0.58) |
| Great Blue Heron | 0 (0.00) | 0 (0.00) | 2 (0.12) |
| Great Crested Flycatcher | 0 (0.00) | 0 (0.00) | 6 (0.35) |
| Green Heron | 1 (0.10) | 0 (0.00) | 0 (0.00) |
| Hairy Woodpecker | 16 (1.62) | 10 (1.24) | 12 (0.70) |
| Hermit Thrush | 69 (6.99) | 66 (8.19) | 90 (5.24) |
| House Wren | 1 (0.10) | 0 (0.00) | 0 (0.00) |
| Indigo Bunting | 0 (0.00) | 0 (0.00) | 7 (0.41) |
| Killdeer | 0 (0.00) | 0 (0.00) | 5 (0.29) |
| Least Flycatcher | 0 (0.00) | 1 (0.12) | 0 (0.00) |
| Mallard | 1 (0.10) | 1 (0.12) | 11 (0.64) |
| Mourning Dove | 7 (0.71) | 17 (2.11) | 19 (1.11) |
| Northern Flicker | 1 (0.10) | 2 (0.25) | 6 (0.35) |
| Northern Parula | 3 (0.30) | 0 (0.00) | 0 (0.00) |
| Northern Waterthrush | 0 (0.00) | 3 (0.37) | 2 (0.12) |
| Ovenbird | 154 (15.60) | 89 (11.04) | 222 (12.92) |
| Pileated Woodpecker | 6 (0.61) | 8 (0.99) | 10 (0.58) |
| Pine Warbler | 18 (1.82) | 20 (2.48) | 48 (2.79) |
| Prairie Warbler* | 0 (0.00) | 0 (0.00) | 6 (0.35) |
| Purple Finch* | 4 (0.41) | 11 (1.36) | 7 (0.41) |

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Red Crossbill | 0 (0.00) | 0 (0.00) | 6 (0.35) |
| Red-bellied Woodpecker | 1 (0.10) | 0 (0.00) | 2 (0.12) |
| Red-breasted Nuthatch | 56 (5.67) | 26 (3.23) | 33 (1.92) |
| Red-eyed Vireo | 97 (9.83) | 85 (10.55) | 193 (11.23) |
| Red-shouldered Hawk | 0 (0.00) | 1 (0.12) | 1 (0.06) |
| Red-winged Blackbird | 12 (1.22) | 19 (2.36) | 11 (0.64) |
| Rose-breasted Grosbeak | 1 (0.10) | 0 (0.00) | 2 (0.12) |
| Ruby-throated Hummingbird | 0 (0.00) | 0 (0.00) | 2 (0.12) |
| Ruffed Grouse* | 1 (0.10) | 0 (0.00) | 0 (0.00) |
| **Scarlet Tanager*** | 14 (1.42) | 18 (2.23) | 60 (3.49) |
| Song Sparrow | 13 (1.32) | 17 (2.11) | 28 (1.63) |
| Swamp Sparrow | 16 (1.62) | 11 (1.36) | 27 (1.57) |
| Tree Swallow | 9 (0.91) | 0 (0.00) | 10 (0.58) |
| Tufted Titmouse | 17 (1.72) | 11 (1.36) | 36 (2.10) |
| Veery* | 15 (1.52) | 6 (0.74) | 21 (1.22) |
| White-breasted Nuthatch | 20 (2.03) | 5 (0.62) | 22 (1.28) |
| White-throated Sparrow | 0 (0.00) | 0 (0.00) | 1 (0.06) |
| Wild Turkey | 0 (0.00) | 0 (0.00) | 3 (0.17) |
| Winter Wren | 15 (1.52) | 15 (1.86) | 12 (0.70) |
| Wood Duck | 0 (0.00) | 14 (1.74) | 12 (0.70) |
| **Wood Thrush*** | 0 (0.00) | 0 (0.00) | 1 (0.06) |
| Yellow-bellied Sapsucker | 10 (1.01) | 15 (1.86) | 38 (2.21) |
| Yellow-billed Cuckoo | 0 (0.00) | 2 (0.25) | 13 (0.76) |
| Yellow-rumped Warbler | 35 (3.55) | 38 (4.71) | 33 (1.92) |

Species listed in **bold** represent target species. * = NH species of greatest conservation Need (n = 12), NH Wildlife Action Plan 2015. T = NH Threatened (List revised in 2017).

Relative abundance

**Kensan-Devan Wildlife Sanctuary**

As with both prior survey seasons, Ovenbird and Red-eyed Vireo remained the two most abundant species, with relative abundance slightly increasing since 2017. Rounding out the top ten most-abundant species at Kensan-Devan in order of decreasing abundance were: Black-capped Chickadee (*Poecile atricapillus*), Hermit Thrush (*Catharus guttatus*), Blackburnian Warbler (*Setophaga fusca*), Common Yellowthroat (*Geothlypis trichas*), Black-throated Green Warbler (*Setophaga virens*), Black-throated Blue Warbler, Scarlet Tanager, and Blue Jay (*Cyanocitta cristata*) (Table 1). Missing from this top-ten list were three species present on it in 2017: Red-breasted Nuthatch (*Sitta canadensis*) (ΔRA = -67%, Δdetections = +21%), Blue-headed Vireo (ΔRA = -181%, Δdetections = -32%), and Yellow-rumped Warbler (*Setophaga coronata*) (ΔRA = -145%, Δdetections = -15%). In many instances, individual detections increased or remained about the same between 2021 and 2017, yet the greater number of detections and higher species diversity in 2021 contributed to general decreases in relative abundance on a per species basis.

All nine target species were detected during the 2021 season (Table 2), although the one Wood Thrush detected on 26 May 2021 may have moved elsewhere to breed as it was not detected during subsequent surveys. With the exception of Blue-headed Vireo, total detections of all target species increased at Kensan-Devan since 2017, with marked increases in the relative

abundance of Black-throated Blue Warbler (ΔRA = +32%), Chestnut-sided Warbler (ΔRA >100%), Eastern Towhee (ΔRA >100%), Eastern Wood-Pewee (ΔRA = +27%) and Scarlet Tanager (ΔRA = +36%). While one Eastern Towhee was observed in 2016, both Chestnut-sided Warbler and Eastern Towhee were not detected in 2017.

Table 2. Alphabetical list of target species determined by New Hampshire Audubon that were identified at Kensan-Devan Wildlife Sanctuary along with total detections and relative abundance (%) for all three survey seasons.

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Black-throated Blue Warbler | 22 (2.23) | 20 (2.48) | 63 (3.67) |
| Black-throated Green Warbler | 56 (5.67) | 52 (6.45) | 64 (3.73) |
| Blue-headed Vireo | 34 (3.44) | 33 (4.09) | 25 (1.46) |
| Canada Warbler | 1 (0.10) | 3 (0.37) | 7 (0.41) |
| Chestnut-sided Warbler | 0 (0.00) | 0 (0.00) | 29 (1.69) |
| Eastern Towhee | 1 (0.10) | 0 (0.00) | 8 (0.47) |
| Eastern Wood-Pewee | 14 (1.42) | 13 (1.61) | 38 (2.21) |
| Scarlet Tanager | 14 (1.42) | 18 (2.23) | 60 (3.49) |
| Wood Thrush | 0 (0.00) | 0 (0.00) | 1 (0.06) |

### Hunt Road and Meetinghouse Pond Sections

The 2021 surveys within the Hunt Road section (unmanaged as of 2021 breeding season) yielded 50 species, an increase from 39 species in 2016 and 36 species in 2017. This total included 12 new additions, including Yellow-billed Cuckoo (*Coccyzus americanus*), Indigo Bunting (*Passerina cyanea*), Chestnut Sided Warbler, and flyover Red Crossbills (*Loxia curvirostra*), and Common Loon (Table 3). Similar to property-wide relative abundance, Ovenbird and Red-eyed Vireo remained the most abundant species within the Hunt Road section. Ovenbird relative abundance increased by 41%, virtually making up the negative change in relative abundance between 2016 and 2017. Red-eyed Vireos experienced a minor increase in relative abundance (+5%), despite a 182% jump in total detections.

Seven of nine target species were observed within the Hunt Road section, an increase from five target species in 2016 and six in 2017. Chestnut-sided Warbler was the sole new addition in 2021, with one singing male detected >50m from point 26 and two singing males detected >50m away from point 35. Both these points fall close to the eastern boundary line of the Hunt Road section, beyond which the adjacent landowner conducted a forest thinning in 2014 or 2015 (Google Earth 2015).

Compared to 2016, eight species experienced at least a doubling of relative abundance: Blackburnian Warbler, Cedar Waxwing (*Bombycilla cedrorum*), Northern Flicker (*Colaptes auratus*), Pine Warbler (*Setophaga pinus*), Mourning Dove (*Zenaida macroura*), Black-throated Blue Warbler, Black-and-white Warbler (*Mniotilta varia*), and Scarlet Tanager. During this same five-year time period, relative abundances of White-breasted Nuthatch (*Sitta carolinensis*), Winter Wren (*Troglodytes hiemalis*) and Common Raven (*Corvus corax*) declined by more than 70%, and six species escaped detection or were not present in 2021: Bobolink, Eastern Kingbird (*Tyrannus tyrannus*), Green Heron (*Butorides virescens*), House Wren (*Troglodytes aedon*), Red-winged Blackbird (*Agelaius phoeniceus*), and Tree Swallow (*Tachycineta bicolor*).

Table 3. Alphabetical list of bird species detected within the Hunt Road section in all three survey seasons, showing total detections and relative abundance (%).

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Alder Flycatcher | 4 (0.81) | 5 (1.34) | 7 (0.94) |
| American Crow | 6 (1.21) | 1 (0.27) | 3 (0.40) |
| American Goldfinch | 0 (0.00) | 0 (0.00) | 2 (0.27) |
| American Robin | 0 (0.00) | 3 (0.80) | 0 (0.00) |
| Barred Owl | 0 (0.00) | 0 (0.00) | 1 (0.13) |
| Black-and-white Warbler | 3 (0.61) | 3 (0.80) | 10 (1.34) |
| Black-billed Cuckoo | 0 (0.00) | 0 (0.00) | 1 (0.13) |
| Blackburnian Warbler | 2 (0.40) | 0 (0.00) | 36 (4.83) |
| Black-capped Chickadee | 45 (9.09) | 26 (6.97) | 52 (6.98) |
| **Black-throated Blue Warbler** | 8 (1.62) | 12 (3.22) | 27 (3.62) |
| **Black-throated Green Warbler** | 21 (4.24) | 25 (6.70) | 35 (4.70) |
| Blue Jay | 42 (8.48) | 25 (6.70) | 21 (2.82) |
| **Blue-headed Vireo** | 16 (3.23) | 13 (3.49) | 11 (1.48) |
| Bobolink | 1 (0.20) | 0 (0.00) | 0 (0.00) |
| Broad-winged Hawk | 2 (0.40) | 1 (0.27) | 1 (0.13) |
| Brown Creeper | 0 (0.00) | 0 (0.00) | 7 (0.94) |
| **Canada Warbler** | 0 (0.00) | 2 (0.54) | 1 (0.13) |
| Cedar Waxwing | 2 (0.40) | 0 (0.00) | 8 (1.07) |
| **Chestnut-sided Warbler** | 0 (0.00) | 0 (0.00) | 4 (0.54) |
| Common Loon | 0 (0.00) | 0 (0.00) | 3 (0.40) |
| Common Raven | 11 (2.22) | 0 (0.00) | 2 (0.27) |
| Common Yellowthroat | 11 (2.22) | 10 (2.68) | 27 (3.62) |
| Downy Woodpecker | 1 (0.20) | 1 (0.27) | 3 (0.40) |
| Eastern Kingbird | 2 (0.40) | 2 (0.54) | 0 (0.00) |
| **Eastern Wood-Pewee** | 6 (1.21) | 3 (0.80) | 16 (2.15) |
| Gray Catbird | 0 (0.00) | 0 (0.00) | 3 (0.40) |
| Great Crested Flycatcher | 0 (0.00) | 0 (0.00) | 1 (0.13) |
| Green Heron | 1 (0.20) | 0 (0.00) | 0 (0.00) |
| Hairy Woodpecker | 8 (1.62) | 4 (1.07) | 7 (0.94) |
| Hermit Thrush | 38 (7.68) | 42 (11.26) | 40 (5.37) |
| House Wren | 1 (0.20) | 0 (0.00) | 0 (0.00) |
| Indigo Bunting | 0 (0.00) | 0 (0.00) | 2 (0.27) |
| Least Flycatcher | 0 (0.00) | 1 (0.27) | 0 (0.00) |
| Mourning Dove | 2 (0.40) | 2 (0.54) | 7 (0.94) |
| Northern Flicker | 1 (0.20) | 0 (0.00) | 4 (0.54) |
| Ovenbird | 86 (17.37) | 44 (11.80) | 124 (16.64) |
| Pileated Woodpecker | 2 (0.40) | 4 (1.07) | 4 (0.54) |
| Pine Warbler | 6 (1.21) | 14 (3.75) | 24 (3.22) |
| Purple Finch | 0 (0.00) | 2 (0.54) | 4 (0.54) |
| Red Crossbill | 0 (0.00) | 0 (0.00) | 5 (0.67) |
| Red-bellied Woodpecker | 1 (0.20) | 0 (0.00) | 1 (0.13) |
| Red-breasted Nuthatch | 27 (5.45) | 12 (3.22) | 15 (2.01) |
| Red-eyed Vireo | 49 (9.90) | 54 (14.48) | 114 (15.30) |
| Red-shouldered Hawk | 0 (0.00) | 1 (0.27) | 1 (0.13) |
| Red-winged Blackbird | 3 (0.61) | 4 (1.07) | 0 (0.00) |
| **Scarlet Tanager** | 5 (1.01) | 2 (0.54) | 16 (2.15) |
| Song Sparrow | 0 (0.00) | 2 (0.54) | 9 (1.21) |
| Swamp Sparrow | 9 (1.82) | 6 (1.61) | 14 (1.88) |
| Tree Swallow | 1 (0.20) | 0 (0.00) | 0 (0.00) |
| Tufted Titmouse | 10 (2.02) | 5 (1.34) | 8 (1.07) |
| Veery | 7 (1.41) | 6 (1.61) | 7 (0.94) |
| White-breasted Nuthatch | 18 (3.64) | 3 (0.80) | 8 (1.07) |
| White-throated Sparrow | 0 (0.00) | 0 (0.00) | 1 (0.13) |

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Wild Turkey | 0 (0.00) | 0 (0.00) | 3 (0.40) |
| Winter Wren | 8 (1.62) | 9 (2.41) | 3 (0.40) |
| Yellow-bellied Sapsucker | 10 (2.02) | 12 (3.22) | 22 (2.95) |
| Yellow-billed Cuckoo | 0 (0.00) | 0 (0.00) | 6 (0.81) |
| Yellow-rumped Warbler | 19 (3.84) | 12 (3.22) | 14 (1.88) |

Species listed in **bold** represent target species.

Within the Meetinghouse Pond section, which received a multi-treatment timber harvest during the 2016-2017 nonbreeding season, both Ovenbird and Red-eyed Vireo maintained their status as the two most abundant species (Table 4). Ovenbirds experienced a minor decrease in abundance from 2017 to 2021 (ΔRA = -3%) following a sharper decline from 2016 to 2017 (ΔRA = -24%) (Table 4). Red-eyed Vireo relative abundance grew by 13% from 2017 to 2021, which partially offsets a decline of 26% from 2016 to 2017 (Table 4). All nine of the target species were detected in the Meetinghouse Pond section during 2021, seven of which had been detected in prior surveys. Wood Thrush and Chestnut-sided Warbler were new additions with one and 25 detections, respectively.

Similar to the Hunt Road section, ten species experienced at least a doubling of relative abundance since 2016: Blackburnian Warbler, Mallard (*Anas platyrhynchos*), Brown Creeper (*Certhia americana*), Eastern Kingbird, Eastern Towhee, White-breasted Nuthatch, Canada Warbler, Barred Owl (*Strix varia*), Scarlet Tanager, and Tufted Titmouse (*Baeolophus bicolor*). At the other end of the spectrum, both Common Loon and Common Raven suffered >80% decreases in relative abundance and four previously-documented species lacked detection during five-minute point count periods in 2021: Broad-winged Hawk (*Buteo platypterus*), Golden-crowned Kinglet (*Regulus satrapa*), Northern Parula (*Setophaga americana*), and Ruffed Grouse. However, a single Ruffed Grouse was noted while walking between points 18 and 21 in the Meetinghouse Pond section on 7 July 2021, and an independent observer flushed a female from a nest with eggs in May 2021 (personal communication).

Table 4. Alphabetical list of bird species detected within the Meetinghouse Pond section in all three survey seasons, showing total detections and relative abundance (%).

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Alder Flycatcher | 2 (0.41) | 2 (0.46) | 2 (0.21) |
| American Crow | 8 (1.63) | 6 (1.39) | 13 (1.34) |
| American Goldfinch | 2 (0.41) | 11 (2.54) | 2 (0.21) |
| American Robin | 4 (0.81) | 0 (0.00) | 3 (0.31) |
| Barn Swallow | 5 (1.02) | 2 (0.46) | 4 (0.41) |
| Barred Owl | 1 (0.20) | 1 (0.23) | 5 (0.51) |
| Black-and-white Warbler | 5 (1.02) | 2 (0.46) | 13 (1.34) |
| Black-billed Cuckoo | 0 (0.00) | 1 (0.23) | 0 (0.00) |
| Blackburnian Warbler | 1 (0.20) | 1 (0.23) | 45 (4.62) |
| Black-capped Chickadee | 25 (5.08) | 21 (4.85) | 52 (5.34) |
| **Black-throated Blue Warbler** | 14 (2.85) | 8 (1.85) | 35 (3.60) |
| **Black-throated Green Warbler** | 35 (7.11) | 27 (6.24) | 30 (3.08) |
| Blue Jay | 28 (5.69) | 37 (8.55) | 38 (3.91) |
| **Blue-headed Vireo** | 18 (3.66) | 20 (4.62) | 14 (1.44) |
| Broad-winged Hawk | 1 (0.20) | 2 (0.46) | 0 (0.00) |
| Brown Creeper | 1 (0.20) | 1 (0.23) | 10 (1.03) |
| Canada Goose | 0 (0.00) | 0 (0.00) | 4 (0.41) |
| **Canada Warbler** | 1 (0.20) | 1 (0.23) | 6 (0.62) |

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Cedar Waxwing | 0 (0.00) | 0 (0.00) | 8 (0.82) |
| **Chestnut-sided Warbler** | 0 (0.00) | 0 (0.00) | 25 (2.57) |
| Chimney Swift | 0 (0.00) | 0 (0.00) | 1 (0.10) |
| Chipping Sparrow | 0 (0.00) | 0 (0.00) | 3 (0.31) |
| Common Loon | 6 (1.22) | 1 (0.23) | 2 (0.21) |
| Common Raven | 3 (0.61) | 0 (0.00) | 1 (0.10) |
| Common Yellowthroat | 19 (3.86) | 7 (1.62) | 49 (5.04) |
| Downy Woodpecker | 1 (0.20) | 1 (0.23) | 2 (0.21) |
| Eastern Kingbird | 1 (0.20) | 0 (0.00) | 9 (0.92) |
| Eastern Phoebe | 0 (0.00) | 1 (0.23) | 4 (0.41) |
| **Eastern Towhee** | 1 (0.20) | 0 (0.00) | 8 (0.82) |
| **Eastern Wood-Pewee** | 8 (1.63) | 10 (2.31) | 22 (2.26) |
| Golden-crowned Kinglet | 1 (0.20) | 0 (0.00) | 0 (0.00) |
| Gray Catbird | 0 (0.00) | 0 (0.00) | 7 (0.72) |
| Great Blue Heron | 0 (0.00) | 0 (0.00) | 2 (0.21) |
| Great Crested Flycatcher | 0 (0.00) | 0 (0.00) | 5 (0.51) |
| Hairy Woodpecker | 8 (1.63) | 6 (1.39) | 5 (0.51) |
| Hermit Thrush | 31 (6.30) | 24 (5.54) | 50 (5.14) |
| Indigo Bunting | 0 (0.00) | 0 (0.00) | 5 (0.51) |
| Killdeer | 0 (0.00) | 0 (0.00) | 5 (0.51) |
| Mallard | 1 (0.20) | 1 (0.23) | 11 (1.13) |
| Mourning Dove | 5 (1.02) | 15 (3.46) | 12 (1.23) |
| Northern Flicker | 0 (0.00) | 2 (0.46) | 2 (0.21) |
| Northern Parula | 3 (0.61) | 0 (0.00) | 0 (0.00) |
| Northern Waterthrush | 0 (0.00) | 3 (0.69) | 2 (0.21) |
| Ovenbird | 68 (13.82) | 45 (10.39) | 98 (10.07) |
| Pileated Woodpecker | 4 (0.81) | 4 (0.92) | 6 (0.62) |
| Pine Warbler | 12 (2.44) | 6 (1.39) | 24 (2.47) |
| Prairie Warbler | 0 (0.00) | 0 (0.00) | 6 (0.62) |
| Purple Finch | 4 (0.81) | 9 (2.08) | 3 (0.31) |
| Red Crossbill | 0 (0.00) | 0 (0.00) | 1 (0.10) |
| Red-bellied Woodpecker | 0 (0.00) | 0 (0.00) | 1 (0.10) |
| Red-breasted Nuthatch | 29 (5.89) | 14 (3.23) | 18 (1.85) |
| Red-eyed Vireo | 48 (9.76) | 31 (7.16) | 79 (8.12) |
| Red-winged Blackbird | 9 (1.83) | 15 (3.46) | 11 (1.13) |
| Rose-breasted Grosbeak | 1 (0.20) | 0 (0.00) | 2 (0.21) |
| Ruby-throated Hummingbird | 0 (0.00) | 0 (0.00) | 2 (0.21) |
| Ruffed Grouse | 1 (0.20) | 0 (0.00) | 0 (0.00) |
| **Scarlet Tanager** | 9 (1.83) | 16 (3.70) | 44 (4.52) |
| Song Sparrow | 13 (2.64) | 15 (3.46) | 19 (1.95) |
| Swamp Sparrow | 7 (1.42) | 5 (1.15) | 13 (1.34) |
| Tree Swallow | 8 (1.63) | 0 (0.00) | 10 (1.03) |
| Tufted Titmouse | 7 (1.42) | 6 (1.39) | 28 (2.88) |
| Veery | 8 (1.63) | 0 (0.00) | 14 (1.44) |
| White-breasted Nuthatch | 2 (0.41) | 2 (0.46) | 14 (1.44) |
| Winter Wren | 7 (1.42) | 6 (1.39) | 9 (0.92) |
| Wood Duck | 0 (0.00) | 14 (3.23) | 12 (1.23) |
| **Wood Thrush** | 0 (0.00) | 0 (0.00) | 1 (0.10) |
| Yellow-bellied Sapsucker | 0 (0.00) | 3 (0.69) | 16 (1.64) |
| Yellow-billed Cuckoo | 0 (0.00) | 2 (0.46) | 7 (0.72) |
| Yellow-rumped Warbler | 16 (3.25) | 26 (6.00) | 19 (1.95) |

Species listed in **bold** represent target species.

## Forestry Treatments

Four treatment types were implemented as part of the 2016-2017 timber harvest within the Meetinghouse Pond section: group selection, seed tree, overstory removal, and no treatment. Since zero points fell within the overstory treatment, relative abundances were not calculated (Witko, 2019).

### *No Treatment*

Most of the Meetinghouse Pond section's 22 points fell into the no treatment category (n=16; points 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 19, 20, 21, and 22). Within this treatment type, Ovenbird (ΔRA = -24.6%) and Red-eyed Vireo (ΔRA = -21.0%) declined within one year after the harvest, and by five years post-harvest both populations appeared to stabilize with Ovenbird and Red-eyed Vireo both registering a -22.7% decline in relative abundance since 2016 (Table 5). Among target species, Chestnut-sided Warblers leapt from no prior detections in 2016 and 2017 to ten detected songs in 2021 (Table 5). All 2021 detections of Chestnut-sided Warbler within the no treatment zone were from three points close to the group selection treatment. Similarly, Eastern Wood-Pewee went from absent in 2016 to nine detections in 2021 (Table 5).

Table 5. Alphabetical list of bird species detected within the No Treatment Zone of meetinghouse Pond section across all three survey years, showing total detections and relative abundance (%).

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Alder Flycatcher | 2 (0.55) | 2 (0.61) | 2 (0.28) |
| American Crow | 7 (1.91) | 4 (1.22) | 9 (1.27) |
| American Goldfinch | 2 (0.55) | 11 (3.36) | 2 (0.28) |
| American Robin | 3 (0.82) | 0 (0.00) | 2 (0.28) |
| Barn Swallow | 5 (1.37) | 2 (0.61) | 4 (0.56) |
| Barred Owl | 1 (0.27) | 1 (0.31) | 4 (0.56) |
| Black-and-white Warbler | 2 (0.55) | 2 (0.61) | 9 (1.27) |
| Black-billed Cuckoo | 0 (0.00) | 1 (0.31) | 0 (0.00) |
| Blackburnian Warbler | 1 (0.27) | 0 (0.00) | 33 (4.65) |
| Black-capped Chickadee | 17 (4.64) | 13 (3.98) | 36 (5.07) |
| **Black-throated Blue Warbler** | 12 (3.28) | 7 (2.14) | 19 (2.68) |
| **Black-throated Green Warbler** | 28 (7.65) | 24 (7.34) | 24 (3.38) |
| Blue Jay | 22 (6.01) | 30 (9.17) | 30 (4.23) |
| **Blue-headed Vireo** | 9 (2.46) | 14 (4.28) | 13 (1.83) |
| Brown Creeper | 1 (0.27) | 0 (0.00) | 4 (0.56) |
| Canada Goose | 0 (0.00) | 0 (0.00) | 2 (0.28) |
| **Canada Warbler** | 1 (0.27) | 1 (0.31) | 5 (0.70) |
| Cedar Waxwing | 0 (0.00) | 0 (0.00) | 7 (0.99) |
| **Chestnut-sided Warbler** | 0 (0.00) | 0 (0.00) | 10 (1.41) |
| Chimney Swift | 0 (0.00) | 0 (0.00) | 1 (0.14) |
| Chipping Sparrow | 0 (0.00) | 0 (0.00) | 2 (0.28) |
| Common Loon | 5 (1.37) | 1 (0.31) | 1 (0.14) |
| Common Raven | 3 (0.82) | 0 (0.00) | 1 (0.14) |
| Common Yellowthroat | 19 (5.19) | 7 (2.14) | 42 (5.92) |
| Downy Woodpecker | 1 (0.27) | 0 (0.00) | 1 (0.14) |
| Eastern Kingbird | 1 (0.27) | 0 (0.00) | 9 (1.27) |
| Eastern Phoebe | 0 (0.00) | 1 (0.31) | 4 (0.56) |
| **Eastern Towhee** | 1 (0.27) | 0 (0.00) | 4 (0.56) |
| **Eastern Wood-Pewee** | 0 (0.00) | 3 (0.92) | 9 (1.27) |
| Gray Catbird | 0 (0.00) | 0 (0.00) | 7 (0.99) |
| Great Blue Heron | 0 (0.00) | 0 (0.00) | 2 (0.28) |

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| Great Crested Flycatcher | 0 (0.00) | 0 (0.00) | 4 (0.56) |
| Hairy Woodpecker | 3 (0.82) | 3 (0.92) | 3 (0.42) |
| Hermit Thrush | 21 (5.74) | 17 (5.20) | 33 (4.65) |
| Indigo Bunting | 0 (0.00) | 0 (0.00) | 2 (0.28) |
| Killdeer | 0 (0.00) | 0 (0.00) | 5 (0.70) |
| Mallard | 1 (0.27) | 1 (0.31) | 11 (1.55) |
| Mourning Dove | 4 (1.09) | 11 (3.36) | 11 (1.55) |
| Northern Flicker | 0 (0.00) | 0 (0.00) | 1 (0.14) |
| Northern Parula | 3 (0.82) | 0 (0.00) | 0 (0.00) |
| Northern Waterthrush | 0 (0.00) | 3 (0.92) | 1 (0.14) |
| Ovenbird | 46 (12.57) | 31 (9.48) | 69 (9.72) |
| Pileated Woodpecker | 3 (0.82) | 2 (0.61) | 4 (0.56) |
| Pine Warbler | 8 (2.19) | 4 (1.22) | 15 (2.11) |
| Prairie Warbler | 0 (0.00) | 0 (0.00) | 2 (0.28) |
| Purple Finch | 4 (1.09) | 8 (2.45) | 3 (0.42) |
| Red-bellied Woodpecker | 0 (0.00) | 0 (0.00) | 1 (0.14) |
| Red-breasted Nuthatch | 21 (5.74) | 10 (3.06) | 15 (2.11) |
| Red-eyed Vireo | 34 (9.29) | 24 (7.34) | 51 (7.18) |
| Red-winged Blackbird | 9 (2.46) | 15 (4.59) | 11 (1.55) |
| Rose-breasted Grosbeak | 1 (0.27) | 0 (0.00) | 0 (0.00) |
| Ruby-throated Hummingbird | 0 (0.00) | 0 (0.00) | 2 (0.28) |
| Ruffed Grouse | 1 (0.27) | 0 (0.00) | 0 (0.00) |
| **Scarlet Tanager** | 7 (1.91) | 14 (4.28) | 33 (4.65) |
| Song Sparrow | 13 (3.55) | 15 (4.59) | 19 (2.68) |
| Swamp Sparrow | 7 (1.91) | 5 (1.53) | 13 (1.83) |
| Tree Swallow | 8 (2.19) | 0 (0.00) | 8 (1.13) |
| Tufted Titmouse | 6 (1.64) | 4 (1.22) | 25 (3.52) |
| Veery | 6 (1.64) | 0 (0.00) | 9 (1.27) |
| White-breasted Nuthatch | 1 (0.27) | 1 (0.31) | 8 (1.13) |
| Winter Wren | 6 (1.64) | 2 (0.61) | 7 (0.99) |
| Wood Duck | 0 (0.00) | 14 (4.28) | 12 (1.69) |
| Yellow-bellied Sapsucker | 0 (0.00) | 2 (0.61) | 13 (1.83) |
| Yellow-billed Cuckoo | 0 (0.00) | 2 (0.61) | 5 (0.70) |
| Yellow-rumped Warbler | 10 (2.73) | 15 (4.59) | 16 (2.25) |

Species listed in **bold** represent target species.

*Group Selection Treatment*

Across the five points (points 1, 2, 6, 7, and 15) located within the group selection treatment, both Ovenbird and Red-eyed Vireo remained the two most abundant species. While Ovenbirds declined in the first year following the harvest (ΔRA = -28.5%) and stabilized within five years post-harvest (ΔRA = -27.6%), Red-eyed Vireos experienced an initial one-year decline (ΔRA = -38.2%) before rebounding (ΔRA = +40.2%) after five years (Table 6). Among target species, Black-throated Blue Warbler (ΔRA = +180%), Scarlet Tanager (ΔRA = +155%), and Eastern Wood-Pewee (ΔRA = +27.4%) appeared to benefit the most by the fifth-year post-harvest (Table 6). Single detections of Canada Warbler, Eastern Towhee, and Wood Thrush also occurred during the 2021 surveys, each of which were not recorded in prior surveys. Chestnut-sided Warbler demonstrated the strongest response, with an increase from zero detections in 2016 and 2017 to six detections in 2021 (Table 6). On the flip side, Blue-headed Vireo (ΔRA = -93.6%) and Black-throated Green Warbler (ΔRA = -56.3%) declined in the five years following the harvest.

Table 6. Alphabetical list of bird species detected within the Group Selection Treatment of the Meetinghouse Pond section across all three survey years, showing total detections and relative abundance (%).

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| American Crow | 1 (0.95) | 2 (2.35) | 2 (0.97) |
| American Robin | 1 (0.95) | 0 (0.00) | 0 (0.00) |
| Black-and-white Warbler | 2 (1.90) | 0 (0.00) | 2 (0.97) |
| Blackburnian Warbler | 0 (0.00) | 1 (1.18) | 12 (5.83) |
| Black-capped Chickadee | 6 (5.71) | 8 (9.41) | 15 (7.28) |
| **Black-throated Blue Warbler** | 2 (1.90) | 1 (1.18) | 11 (5.34) |
| **Black-throated Green Warbler** | 7 (6.67) | 3 (3.53) | 6 (2.91) |
| Blue Jay | 6 (5.71) | 5 (5.88) | 7 (3.40) |
| **Blue-headed Vireo** | 8 (7.62) | 6 (7.06) | 1 (0.49) |
| Broad-winged Hawk | 0 (0.00) | 2 (2.35) | 0 (0.00) |
| Brown Creeper | 0 (0.00) | 1 (1.18) | 5 (2.43) |
| Canada Goose | 0 (0.00) | 0 (0.00) | 2 (0.97) |
| **Canada Warbler** | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| Cedar Waxwing | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| **Chestnut-sided Warbler** | 0 (0.00) | 0 (0.00) | 6 (2.91) |
| Chipping Sparrow | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| Common Loon | 1 (0.95) | 0 (0.00) | 0 (0.00) |
| Common Yellowthroat | 0 (0.00) | 0 (0.00) | 4 (1.94) |
| Downy Woodpecker | 0 (0.00) | 1 (1.18) | 0 (0.00) |
| **Eastern Towhee** | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| **Eastern Wood-Pewee** | 4 (3.81) | 5 (5.88) | 10 (4.85) |
| Golden-crowned Kinglet | 1 (0.95) | 0 (0.00) | 0 (0.00) |
| Great Crested Flycatcher | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| Hairy Woodpecker | 5 (4.76) | 3 (3.53) | 0 (0.00) |
| Hermit Thrush | 10 (9.52) | 6 (7.06) | 16 (7.77) |
| Indigo Bunting | 0 (0.00) | 0 (0.00) | 2 (0.97) |
| Mourning Dove | 1 (0.95) | 2 (2.35) | 1 (0.49) |
| Northern Flicker | 0 (0.00) | 2 (2.35) | 1 (0.49) |
| Northern Waterthrush | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| Ovenbird | 19 (18.10) | 11 (12.94) | 27 (13.11) |
| Pileated Woodpecker | 1 (0.95) | 1 (1.18) | 0 (0.00) |
| Pine Warbler | 3 (2.86) | 1 (1.18) | 9 (4.37) |
| Prairie Warbler | 0 (0.00) | 0 (0.00) | 2 (0.97) |
| Red Crossbill | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| Red-breasted Nuthatch | 8 (7.62) | 4 (4.71) | 3 (1.46) |
| Red-eyed Vireo | 8 (7.62) | 4 (4.71) | 22 (10.68) |
| **Scarlet Tanager** | 2 (1.90) | 1 (1.18) | 10 (4.85) |
| Tree Swallow | 0 (0.00) | 0 (0.00) | 2 (0.97) |
| Tufted Titmouse | 1 (0.95) | 0 (0.00) | 1 (0.49) |
| Veery | 1 (0.95) | 0 (0.00) | 4 (1.94) |
| White-breasted Nuthatch | 0 (0.00) | 0 (0.00) | 5 (2.43) |
| Winter Wren | 1 (0.95) | 4 (4.71) | 2 (0.97) |
| **Wood Thrush** | 0 (0.00) | 0 (0.00) | 1 (0.49) |
| Yellow-bellied Sapsucker | 0 (0.00) | 0 (0.00) | 3 (1.46) |
| Yellow-billed Cuckoo | 0 (0.00) | 0 (0.00) | 2 (0.97) |
| Yellow-rumped Warbler | 6 (5.71) | 11 (12.94) | 3 (1.46) |

Species listed in **bold** represent target species.

*Seed Treatment*

Despite the small sample size of points (n=1; point 18) within the seed treatment zone, some post-harvest trends emerged from the data. Ovenbirds (ΔRA = -75%) and Red-eyed Vireos (ΔRA = -63%) declined for the second survey season in a row, despite total detections remaining about the same (Table 7). However, all species detected in 2016 experienced declines ranging from -26% to -100% over five years, possibly stemming from an increase in species diversity (+160%) during this same five-year period.

Among target species, Black-throated Blue Warbler, Chestnut-sided Warbler, and Eastern Towhee appeared to benefit the most from the seed treatment. Total detections for each of these three species went from zero in 2016 and 2017 to at least three in 2021 (Table 7). Blue-headed Vireo declined from the presence of one individual in 2016 to zero individuals in 2017 and 2021, whereas Eastern Wood-Pewee and Scarlet Tanager total detections remained about the same (Table 7).

Table 7. Alphabetical list of bird species detected within the Seed Treatment Zone of the Meetinghouse Pond section in all three survey seasons, showing the total detections and relative abundance (%).

| Species | 2016 | 2017 | 2021 |
|---|---|---|---|
| American Crow | 0 (0.00) | 0 (0.00) | 2 (3.51) |
| American Robin | 0 (0.00) | 0 (0.00) | 1 (1.75) |
| Barred Owl | 0 (0.00) | 0 (0.00) | 1 (1.75) |
| Black-and-white Warbler | 1 (4.76) | 0 (0.00) | 2 (3.51) |
| Black-capped Chickadee | 2 (9.52) | 0 (0.00) | 1 (1.75) |
| **Black-throated Blue Warbler** | 0 (0.00) | 0 (0.00) | 5 (8.77) |
| Blue Jay | 0 (0.00) | 2 (9.52) | 1 (1.75) |
| **Blue-headed Vireo** | 1 (4.76) | 0 (0.00) | 0 (0.00) |
| Broad-winged Hawk | 1 (4.76) | 0 (0.00) | 0 (0.00) |
| Brown Creeper | 0 (0.00) | 0 (0.00) | 1 (1.75) |
| **Chestnut-sided Warbler** | 0 (0.00) | 0 (0.00) | 9 (15.79) |
| Common Loon | 0 (0.00) | 0 (0.00) | 1 (1.75) |
| Common Yellowthroat | 0 (0.00) | 0 (0.00) | 3 (5.26) |
| Downy Woodpecker | 0 (0.00) | 0 (0.00) | 1 (1.75) |
| **Eastern Towhee** | 0 (0.00) | 0 (0.00) | 3 (5.26) |
| **Eastern Wood-Pewee** | 4 (19.05) | 2 (9.52) | 3 (5.26) |
| Hairy Woodpecker | 0 (0.00) | 0 (0.00) | 2 (3.51) |
| Hermit Thrush | 0 (0.00) | 1 (4.76) | 1 (1.75) |
| Indigo Bunting | 0 (0.00) | 0 (0.00) | 1 (1.75) |
| Mourning Dove | 0 (0.00) | 2 (9.52) | 0 (0.00) |
| Ovenbird | 3 (14.29) | 3 (14.29) | 2 (3.51) |
| Pileated Woodpecker | 0 (0.00) | 1 (4.76) | 2 (3.51) |
| Pine Warbler | 1 (4.76) | 1 (4.76) | 0 (0.00) |
| Prairie Warbler | 0 (0.00) | 0 (0.00) | 2 (3.51) |
| Purple Finch | 0 (0.00) | 1 (4.76) | 0 (0.00) |
| Red-eyed Vireo | 6 (28.57) | 3 (14.29) | 6 (10.53) |
| Rose-breasted Grosbeak | 0 (0.00) | 0 (0.00) | 2 (3.51) |
| **Scarlet Tanager** | 0 (0.00) | 1 (4.76) | 1 (1.75) |
| Tufted Titmouse | 0 (0.00) | 2 (9.52) | 2 (3.51) |
| Veery | 1 (4.76) | 0 (0.00) | 1 (1.75) |
| White-breasted Nuthatch | 1 (4.76) | 1 (4.76) | 1 (1.75) |
| Yellow-bellied Sapsucker | 0 (0.00) | 1 (4.76) | 0 (0.00) |

Species listed in **bold** represent target species.

Overall, the group selection treatment exhibited a net positive impact over five years on Black-throated Blue Warbler, Canada Warbler, Chestnut-sided Warbler, Eastern Towhee, Eastern Wood-Pewee, Scarlet Tanager, and Wood Thrush (Figure 3; Table 8). Conversely, group selection had a net negative impact on Black-throated Green Warbler and especially Blue-headed Vireo (Figure 3; Table 8). Within the seed tree treatment zone, Black-throated Blue Warbler, Chestnut-sided Warbler, and Eastern Towhee benefitted, whereas Blue-headed Vireo, Eastern Wood-Pewee, and Scarlet Tanager declined (Figure 3; Table 8). While not a target species, Prairie Warblers and Indigo Buntings were also detected within the group selection and seed tree treatment zones during the 2021 surveys. Both species were not present in either prior survey.

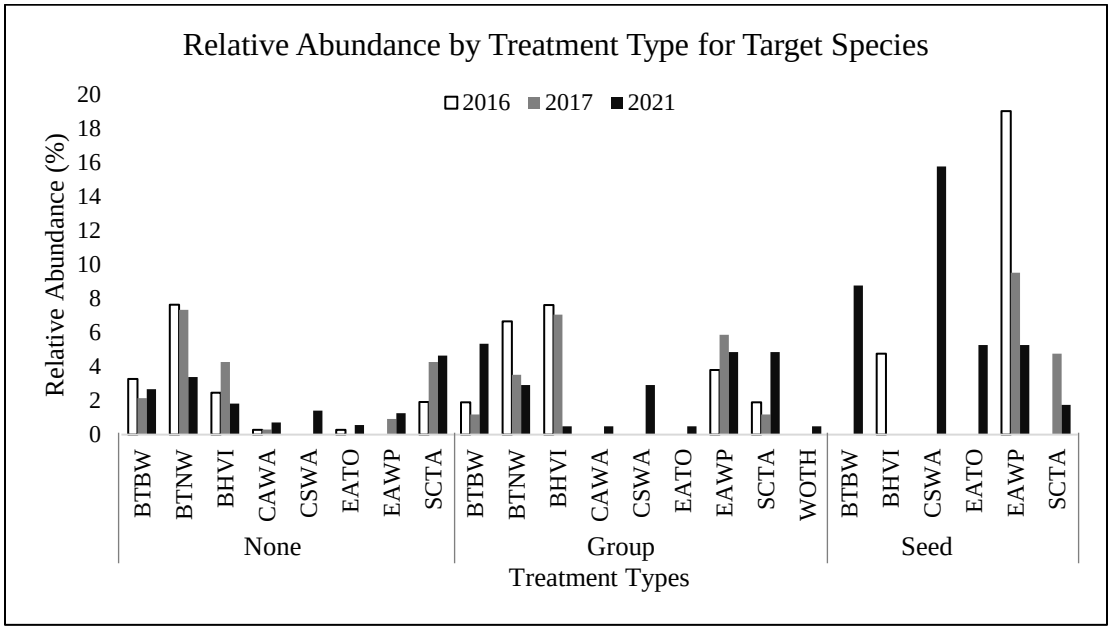


Figure 3. Relative avian abundance of target species for all treatment types within the Meetinghouse Pond section across all three survey years. See Appendix B for four letter alpha codes for all species.

Table 8. Target species detected within all treatment types in the Meetinghouse Pond section for all three survey years, showing the total detections and relative abundance (%). Impacts of treatment type on the target species is represented as percent change in relative abundance (ΔRA) both one year and five years post-harvest.

| Treatment | Species | 2016 | 2017 | 2021 | ΔRA 1-yr | ΔRA 5-yr |
|---|---|---|---|---|---|---|
| None | Black-throated Blue Warbler | 12 (3.28) | 7 (2.14) | 19 (2.68) | -35% | -18% |
| None | Black-throated Green Warbler | 28 (7.65) | 24 (7.34) | 24 (3.38) | -4% | -56% |
| None | Blue-headed Vireo | 9 (2.46) | 14 (4.28) | 13 (1.83) | 74% | -26% |
| None | Canada Warbler | 1 (0.27) | 1 (0.31) | 5 (0.70) | 12% | 158% |
| None | Chestnut-sided Warbler | 0 (0.00) | 0 (0.00) | 10 (1.41) | 0% | + |
| None | Eastern Towhee | 1 (0.27) | 0 (0.00) | 4 (0.56) | -100% | 106% |
| None | Eastern Wood-Pewee | 0 (0.00) | 3 (0.92) | 9 (1.27) | + | + |
| None | Scarlet Tanager | 7 (1.91) | 14 (4.28) | 33 (4.65) | 124% | 143% |
| Group | Black-throated Blue Warbler | 2 (1.90) | 1 (1.18) | 11 (5.34) | -38% | 180% |
| Group | Black-throated Green Warbler | 7 (6.67) | 3 (3.53) | 6 (2.91) | -47% | -56% |
| Group | Blue-headed Vireo | 8 (7.62) | 6 (7.06) | 1 (0.49) | -7% | -94% |
| Group | Canada Warbler | 0 (0.00) | 0 (0.00) | 1 (0.49) | 0% | + |
| Group | Chestnut-sided Warbler | 0 (0.00) | 0 (0.00) | 6 (2.91) | 0% | + |
| Group | Eastern Towhee | 0 (0.00) | 0 (0.00) | 1 (0.49) | 0% | + |
| Group | Eastern Wood-Pewee | 4 (3.81) | 5 (5.88) | 10 (4.85) | 54% | 27% |

| Treatment | Species | 2016 | 2017 | 2021 | ΔRA 1-yr | ΔRA 5-yr |
|---|---|---|---|---|---|---|
| Group | Scarlet Tanager | 2 (1.90) | 1 (1.18) | 10 (4.85) | -38% | 155% |
| Group | Wood Thrush | 0 (0.00) | 0 (0.00) | 1 (0.49) | 0% | + |
| Seed | Black-throated Blue Warbler | 0 (0.00) | 0 (0.00) | 5 (8.77) | 0% | + |
| Seed | Blue-headed Vireo | 1 (4.76) | 0 (0.00) | 0 (0.00) | -100% | -100% |
| Seed | Chestnut-sided Warbler | 0 (0.00) | 0 (0.00) | 9 (15.79) | 0% | + |
| Seed | Eastern Towhee | 0 (0.00) | 0 (0.00) | 3 (5.26) | 0% | + |
| Seed | Eastern Wood-Pewee | 4 (19.05) | 2 (9.52) | 3 (5.26) | -50% | -72% |
| Seed | Scarlet Tanager | 0 (0.00) | 1 (4.76) | 1 (1.75) | + | + |

+ indicates a calculated "null" percent change in relative abundance only because this species had not been detected in 2016 (pre-harvest).

## Avian Diversity

Comparable to previous survey seasons, Simpson's Diversity Index (SDI) values remained relatively similar among the 45 points, ranging from 0.80 to 0.97 (Table 9), where values closer to one are more diverse. By 2021, five years after the timber harvest, avian diversity increased across 89% of points at Kensan-Devan. This follows an increase in diversity at 64% of points just one-year post-harvest. Looking at changes in SDI within specific treatment zones, diversity generally increased across each treatment type. At point 18, within the seed tree treatment (n=1), diversity increased from 0.88 pre-harvest to 0.95 one-year post-harvest and remained stable at 0.95 five-years post-harvest (Table 10). Avian diversity within the group selection (n=5) saw slight increases in both survey intervals, first from 0.93 in 2016 to 0.94 in 2017 and then marginally higher to 0.95 in 2021. Contrary to original calculations of SDI within the no treatment zone (Witko 2019), SDI remained level at 0.95 from pre-harvest to one-year post-harvest before marginally increasing to 0.96 five-years post-harvest.

Table 9. Total avian diversity for all 45 points in all three survey years as well as the percent change at the one-year interval (1yr) and five-year interval (5yr) post-harvest. Values closer to 1 indicate greater species diversity.

| Section | Point | 2016 | 2017 | 2021 | % change (1yr) | % change (5yr) | Treatment |
|---|---|---|---|---|---|---|---|
| Meetinghouse Pond | 1 | 0.913 | 0.905 | 0.946 | -0.91% | 3.63% | Group |
| Meetinghouse Pond | 2 | 0.933 | 0.890 | 0.902 | -4.63% | -3.41% | Group |
| Meetinghouse Pond | 3 | 0.890 | 0.948 | 0.962 | 6.43% | 8.00% | None |
| Meetinghouse Pond | 4 | 0.933 | 0.886 | 0.943 | -5.10% | 1.02% | None |
| Meetinghouse Pond | 5 | 0.882 | 0.890 | 0.952 | 0.83% | 7.84% | None |
| Meetinghouse Pond | 6 | 0.879 | 0.947 | 0.957 | 7.78% | 8.94% | Group |
| Meetinghouse Pond | 7 | 0.929 | 0.939 | 0.931 | 1.13% | 0.22% | Group |
| Meetinghouse Pond | 8 | 0.916 | 0.936 | 0.941 | 2.17% | 2.80% | None |
| Meetinghouse Pond | 9 | 0.921 | 0.936 | 0.956 | 1.59% | 3.84% | None |
| Meetinghouse Pond | 10 | 0.923 | 0.938 | 0.953 | 1.59% | 3.20% | None |
| Meetinghouse Pond | 11 | 0.912 | 0.908 | 0.959 | -0.43% | 5.07% | None |
| Meetinghouse Pond | 12 | 0.927 | 0.963 | 0.963 | 3.88% | 3.90% | None |
| Meetinghouse Pond | 13 | 0.940 | 0.950 | 0.972 | 1.09% | 3.45% | None |
| Meetinghouse Pond | 14 | 0.954 | 0.841 | 0.961 | -11.78% | 0.72% | None |
| Meetinghouse Pond | 15 | 0.933 | 0.960 | 0.953 | 2.93% | 2.15% | Group |
| Meetinghouse Pond | 16 | 0.847 | 0.892 | 0.946 | 5.23% | 11.59% | None |
| Meetinghouse Pond | 17 | 0.949 | 0.963 | 0.963 | 1.55% | 1.56% | None |
| Meetinghouse Pond | 18 | 0.881 | 0.952 | 0.951 | 8.11% | 7.97% | Seed |
| Meetinghouse Pond | 19 | 0.932 | 0.958 | 0.957 | 2.80% | 2.67% | None |
| Meetinghouse Pond | 20 | 0.948 | 0.922 | 0.955 | -2.69% | 0.77% | None |
| Meetinghouse Pond | 21 | 0.847 | 0.917 | 0.932 | 8.18% | 10.03% | None |
| Meetinghouse Pond | 22 | 0.853 | 0.892 | 0.943 | 4.59% | 10.54% | None |
| Hunt Road | 23 | 0.858 | 0.905 | 0.873 | 5.39% | 1.70% | None |

| Section | Point | 2016 | 2017 | 2021 | % change (1yr) | % change (5yr) | Treatment |
|---|---|---|---|---|---|---|---|
| Hunt Road | 24 | 0.850 | 0.972 | 0.902 | 14.38% | 6.13% | None |
| Hunt Road | 25 | 0.954 | 0.944 | 0.922 | -1.12% | -3.44% | None |
| Hunt Road | 26 | 0.926 | 0.895 | 0.897 | -3.35% | -3.20% | None |
| Hunt Road | 27 | 0.879 | 0.846 | 0.911 | -3.71% | 3.65% | None |
| Hunt Road | 28 | 0.791 | 0.835 | 0.903 | 5.56% | 14.07% | None |
| Hunt Road | 29 | 0.868 | 0.883 | 0.949 | 1.69% | 9.33% | None |
| Hunt Road | 30 | 0.909 | 0.895 | 0.948 | -1.52% | 4.27% | None |
| Hunt Road | 31 | 0.910 | 0.982 | 0.943 | 7.95% | 3.66% | None |
| Hunt Road | 32 | 0.939 | 0.953 | 0.946 | 1.40% | 0.71% | None |
| Hunt Road | 33 | 0.893 | 0.860 | 0.895 | -3.68% | 0.25% | None |
| Hunt Road | 34 | 0.862 | 0.917 | 0.870 | 6.44% | 0.93% | None |
| Hunt Road | 35 | 0.867 | 0.825 | 0.922 | -4.86% | 6.41% | None |
| Hunt Road | 36 | 0.821 | 0.883 | 0.872 | 7.66% | 6.25% | None |
| Hunt Road | 37 | 0.905 | 0.912 | 0.932 | 0.77% | 2.94% | None |
| Hunt Road | 38 | 0.901 | 0.931 | 0.936 | 3.28% | 3.86% | None |
| Hunt Road | 39 | 0.856 | 0.939 | 0.920 | 9.72% | 7.45% | None |
| Hunt Road | 40 | 0.929 | 0.957 | 0.925 | 3.03% | -0.44% | None |
| Hunt Road | 41 | 0.875 | 0.857 | 0.800 | -2.04% | -8.57% | None |
| Hunt Road | 42 | 0.901 | 0.758 | 0.922 | -15.94% | 2.30% | None |
| Hunt Road | 43 | 0.838 | 0.800 | 0.930 | -4.56% | 10.97% | None |
| Hunt Road | 44 | 0.867 | 0.939 | 0.909 | 8.39% | 4.91% | None |
| Hunt Road | 45 | 0.924 | 0.810 | 0.929 | -12.37% | 0.61% | None |

Table 10. Total avian diversity for each of the three treatment types (Meetinghouse Pond) in all three survey years that avian point count circles fell within. Values closer to 1 indicate greater species diversity.

| Treatment | 2016 | 2017 | 2021 |
|---|---|---|---|
| Group (n=5) | 0.93 | 0.94 | 0.95 |
| None (n=16) | 0.95 | 0.95 | 0.96 |
| Seed (n=1) | 0.88 | 0.95 | 0.95 |

## Natural communities

Across all 45 points at Kensan-Devan, 14 tree species were identified using the variable radius plot sampling method (Table 11). Point 38, located in a sphagnum-dominated forested wetland, contained a species of spruce tree (either red spruce or black spruce) that could not be confidently identified in the field. Relative to 2016, no significant changes were made to the overall forested community by the timber harvest as evidenced by only modest adjustments in tree species composition and distribution for the property (Table 11). Eastern hemlock, eastern white pine, red maple, and red oak remain the most important, or dominant, species across the property (Table 12).

Table 11. Alphabetical list (common name) of tree species measuring >10" diameter-at-breast-height and present at Kensan-Devan Wildlife Sanctuary's 45 avian point count stations. Frequency (percentage of points detected) is also included for both the 2016 and 2021 surveys.

| Species | Latin name | Points present (%) 2016 | Points present (%) 2021 |
|---|---|---|---|
| American beech | *Fagus grandifolia* | 28.89 | 22.22 |
| American chestnut | *Castanea dentata* | 2.22 | 0.00 |
| Balsam fir | *Abies balsamea* | 2.22 | 4.44 |
| Black birch | *Betula lenta* | 17.78 | 17.78 |
| Black cherry | *Prunus serotina* | 6.67 | 4.44 |

| Species | Latin name | Points present (%) 2016 | Points present (%) 2021 |
|---|---|---|---|
| Eastern hemlock | *Tsuga canadensis* | 71.11 | 55.56 |
| Eastern white pine | *Pinus strobus* | 53.33 | 73.33 |
| Paper birch | *Betula papyrifera* | 35.56 | 20.00 |
| Red maple | *Acer rubrum* | 88.89 | 80.00 |
| Red oak | *Quercus rubra* | 64.44 | 64.44 |
| Red spruce | *Picea rubens* | 11.11 | 15.56 |
| Spruce sp. | *Picea* | 0.00 | 2.22 |
| Sugar maple | *Acer saccharum* | 0.00 | 4.44 |
| White ash | *Fraxinus americana* | 4.44 | 6.67 |
| Yellow birch | *Betula alleghaniensis* | 11.11 | 17.78 |

Table 12. Alphabetical list (common name) of tree species measuring >10" diameter-at-breast-height and present at the Kensan-Devan Wildlife Sanctuary along with their importance value across all point count stations for the 2021 survey season.

| Species | Total count | Stand BA(ft2/A) | Rel. BA | # of occ. | Freq. | Rel. freq. | Importance value |
|---|---|---|---|---|---|---|---|
| American beech | 19 | 4.22 | 3.30 | 10 | 0.22 | 5.71 | 4.51 |
| Balsam fir | 2 | 0.44 | 0.35 | 2 | 0.04 | 1.14 | 0.75 |
| Black birch | 10 | 2.22 | 1.74 | 8 | 0.18 | 4.57 | 3.15 |
| Black cherry | 3 | 0.67 | 0.52 | 2 | 0.04 | 1.14 | 0.83 |
| Eastern hemlock | 163.5 | 36.33 | 28.39 | 25 | 0.56 | 14.29 | 21.34 |
| Eastern white pine | 128 | 28.44 | 22.22 | 33 | 0.73 | 18.86 | 20.54 |
| Paper birch | 12.5 | 2.78 | 2.17 | 9 | 0.20 | 5.14 | 3.66 |
| Red maple | 106.5 | 23.67 | 18.49 | 36 | 0.80 | 20.57 | 19.53 |
| Red oak | 94 | 20.89 | 16.32 | 29 | 0.64 | 16.57 | 16.45 |
| Red spruce | 14.5 | 3.22 | 2.52 | 7 | 0.16 | 4.00 | 3.26 |
| Spruce sp. | 3.5 | 0.78 | 0.61 | 1 | 0.02 | 0.57 | 0.59 |
| Sugar maple | 6.5 | 1.44 | 1.13 | 2 | 0.04 | 1.14 | 1.14 |
| White ash | 3 | 0.67 | 0.52 | 3 | 0.07 | 1.71 | 1.12 |
| Yellow birch | 10 | 2.22 | 1.74 | 8 | 0.18 | 4.57 | 3.15 |

Habitat metrics were categorized for height, percent cover, and uniformity of distribution. Across all habitat characteristics, variation in collected data values between surveys was high, with the pre-harvest and five-years post-harvest surveys being most similar. Within the overstory, Kensan-Devan continued to exhibit a mostly-closed canopy of generally patchy distribution (Table 13). In few (n=1-3) instances, canopy height was estimated as less than 20 feet. Kensan-Devan's midstory remained mostly a mixture of hardwoods and softwoods, with more points trending towards hardwood dominated than softwood dominated (Table 14). Percent midstory cover appeared to increase since the harvest, and midstory distribution likely remained patchy. Midstory composition consisted of a variety of trees species, nine of which occurred at more than one-fifth of points: eastern hemlock, red maple, American beech, eastern white pine, balsam fir, black birch, paper birch, red oak, and red spruce (Table 16).

Table 13. Yearly overstory habitat for points at Kensan-Devan summarized first by total count (number of point count stations that have listed habitat characteristics) and then relative frequency (percentage of point count stations) in parentheses.

| | | 2016 | 2017 | 2021 |
|---|---|---|---|---|
| Height | < 20 | 3 (6.67) | 1 (2.22) | 1 (2.22) |
| | 20-60 | 38 (84.44) | 3 (6.67) | 42 (93.33) |
| | >60 | 4 (8.89) | 41 (91.11) | 2 (4.44) |
| Percent cover | 0-25 | 1 (2.22) | 3 (6.67) | 1 (2.22) |
| | 26-50 | 4 (8.89) | 2 (4.44) | 14 (31.11) |
| | 51-75 | 24 (53.33) | 33 (73.33) | 19 (42.22) |
| | 76-100 | 16 (35.56) | 7 (15.56) | 11 (24.44) |
| Distribution | Patchy | 30 (66.67) | 7 (15.56) | 35 (77.78) |
| | Uniform | 15 (33.33) | 38 (84.44) | 10 (22.22) |

Table 14. Yearly midstory habitat for points at Kensan-Devan summarized first by total count (number of point count stations that have listed habitat characteristics) and then relative frequency (percentage of point count stations) in parentheses.

| | | 2016 | 2017 | 2021 |
|---|---|---|---|---|
| Type | Hardwood | 3 (6.67) | 0 (0.00) | 4 (8.89) |
| | Mixed | 34 (75.56) | 41 (91.11) | 40 (88.89) |
| | None | 1 (2.22) | 1 (2.22) | 1 (2.22) |
| | Softwood | 7 (15.56) | 3 (6.67) | 0 (0.00) |
| Percent Cover | 0 | 1 (2.22) | 1 (2.22) | 1 (2.22) |
| | 25 | 15 (28.89) | 13 (33.33) | 3 (6.67) |
| | 50 | 22 (40.00) | 18 (48.89) | 15 (33.33) |
| | 75 | 7 (28.89) | 13 (15.56) | 23 (51.11) |
| | 100 | 0 (0.00) | 0 (0.00) | 3 (6.67) |
| Distribution | Patchy | 38 (84.44) | 14 (31.11) | 36 (80.00) |
| | Uniform | 7 (15.56) | 31 (68.89) | 9 (20.00) |

Within the understory, mixed hardwood – softwood communities were most common, followed by hardwood- and softwood-dominant communities (Table 15). While distribution of understory cover appeared to remain equal to pre-harvest conditions, percentage of understory cover appeared to generally decrease. Soft mast presence, namely lowbush blueberry and rubus species, increased in the five years following the timber harvest, and leaf litter appeared to decline. Understory hardwood species were diverse, with American beech, eastern hemlock, red maple, red oak, balsam fir, eastern white pine, striped maple, and red spruce located at more than one-fifth of points (Table 16).

Table 15. Yearly understory habitat for points at Kensan-Devan summarized first by total count (number of point count stations that have listed habitat characteristics) and then relative frequency (percentage of point count stations) in parentheses.

| | | 2016 | 2017 | 2018 |
|---|---|---|---|---|
| Type | Hardwood | 5 (11.11) | 3 (6.67) | 10 (22.22) |
| | Mixed | 30 (66.67) | 38 (84.44) | 32 (71.11) |
| | None | 2 (4.44) | 1 (2.22) | 0 (0.00) |
| | Sedge | 1 (2.22) | 1 (2.22) | 1 (2.22) |

| | | 2016 | 2017 | 2018 |
|---|---|---|---|---|
| | Softwood | 7 (15.56) | 2 (4.44) | 2 (4.44) |
| Percent Cover | 0 | 2 (4.44) | 1 (2.22) | 12 (26.67) |
| | 25 | 32 (71.11) | 16 (35.56) | 25 (55.56) |
| | 50 | 7 (15.56) | 9 (20.00) | 5 (11.11) |
| | 75 | 3 (6.67) | 17 (37.78) | 1 (2.22) |
| | 100 | 1 (2.22) | 2 (4.44) | 2 (4.44) |
| Distribution | Patchy | 40 (88.89) | 23 (51.11) | 36 (80.00) |
| | Uniform | 5 (11.11) | 22 (48.89) | 9 (20.00) |
| Soft mast | Absent | 34 (75.56) | 32 (71.11) | 17 (37.78) |
| | Present | 11 (24.44) | 13 (28.89) | 28 (62.22) |
| Leaf litter | Adequate | 43 (95.56) | 44 (97.78) | 33 (73.33) |
| | Inadequate | 2 (4.44) | 1 (2.22) | 12 (26.67) |

Table 16. Total count of points (out of 45) at which hardwood plant species were detected during the 2021 habitat surveys.

| | Overstory | Midstory | Understory |
|---|---|---|---|
| American Beech | 3 | 29 | 32 |
| American Hop-Hornbeam | 0 | 3 | 0 |
| Balsam Fir | 0 | 10 | 13 |
| Beaked Hazelnut | 0 | 1 | 0 |
| Black Birch | 3 | 10 | 1 |
| Black Cherry | 1 | 4 | 2 |
| Common Witch-hazel | 0 | 2 | 3 |
| Eastern Hemlock | 17 | 35 | 29 |
| Eastern White Pine | 38 | 11 | 11 |
| Glossy Buckthorn | 0 | 3 | 8 |
| Hawthorn sp. | 0 | 0 | 1 |
| Hazelnut sp. | 0 | 0 | 1 |
| Highbush Blueberry | 0 | 3 | 6 |
| Hobblebush | 0 | 0 | 7 |
| Paper Birch | 6 | 10 | 0 |
| Red Maple | 35 | 33 | 23 |
| Red Oak | 31 | 10 | 22 |
| Red Spruce | 6 | 10 | 10 |
| Spruce sp. | 1 | 1 | 1 |
| Striped Maple | 0 | 3 | 11 |
| Sugar Maple | 0 | 8 | 2 |
| White Ash | 1 | 0 | 1 |
| Winterberry Holly | 0 | 0 | 2 |
| Yellow Birch | 6 | 8 | 1 |

Survey differences

In addition to natural avian population fluctuations, annual variation in survey effort may have contributed to seasonal differences in the number of birds and which species were detected, thereby affecting total detections and calculations of relative abundance. Several effort metrics related to survey effort were compared between years to hint at potential correlations to differences in total detections within and across species. On average, the 2021 avian surveys began 25 minutes closer to sunrise than the 2016 surveys and 63 minutes closer to sunrise when compared to 2017 surveys (Table 17). Similarly, the 2021 surveys ended closer to sunrise on average (224 minutes past sunrise) than the 2016 surveys (261 minutes) and 2017 surveys (229 minutes). Fewer visits (n=9) to Kensan-Devan were required to conduct three replicate surveys during the 2021 season to reduce budget cost, hence a faster walking pace was necessary to visit all points before four hours past sunrise (Table 17). These factors, as well as time of year, weather, observer abilities, attention to double-counting, and forest condition may have contributed to differences in the total detections and species diversity across all three survey years. For example, from 2016 to 2021, total species increased by 28%, total visual detections within 50 meters increased by 57%, total song detections over 50 meters away increased by 156%, and detections of flyovers increased by (58%) (Table 18).

Table 17. Summary of breeding bird survey start and end times relative to sunrise for all three survey seasons as well as dates of first and last surveys. Earliest, mean, and latest times are represented in minutes after sunrise.

| Effort Metric | 2016 | 2017 | 2021 |
|---|---|---|---|
| Earliest start time | 19 | 34 | -10 |
| Mean start time | 29 | 69 | -4 |
| Latest start time | 48 | 100 | 0 |
| Earliest end time | 208 | 222 | 184 |
| Mean end time | 229 | 261 | 202 |
| Latest end time | 265 | 300 | 224 |
| First visit | 8-Jun | 9-Jun | 26-May |
| Last visit | 14-Jul | 17-Jul | 10-Jul |
| Number of visits | 12 | 12 | 9 |
| Mean travel time between points | 10m 41s | 10m 4s | 6m 40s |

Table 18. Summary of categorized total detections and species between all three survey years.

| Category | 2016 | 2017 | 2021 |
|---|---|---|---|
| Total species | 54 | 49 | 69 |
| Total detections | 987 | 806 | 1718 |
| Calls ≤50 m | 148 | 80 | 172 |
| Songs ≤50 m | 271 | 198 | 377 |
| Visual ≤50 m | 11 | 21 | 33 |
| Drums ≤50 m | 0 | 1 | 7 |
| Calls > 50 m | 178 | 156 | 183 |
| Songs > 50 m | 360 | 337 | 862 |
| Visual > 50 m | 11 | 2 | 19 |
| Drums > 50 m | 0 | 6 | 31 |
| Flyovers | 8 | 5 | 34 |

# Discussion

Despite a decline in total avian abundance across the Kensan-Devan Wildlife Sanctuary in the first-year post-harvest, total avian abundance nearly doubled from pre-harvest condition by the fifth-year post-harvest. During the same one-year and five-year intervals, species diversity across the entire sanctuary increased equally, perhaps indicating that property-wide diversity is leveling off. Future effects of the timber harvest completed in 2021 may contribute to another change in property-scale species diversity. The magnitude of increase in total detections from 2016 to 2021 may stem from a variety of factors (e.g., survey timing, weather, observer differences) in addition to changes in forest communities, so it remained unclear exactly how some bird populations on the property were faring relative to forest management. However, multiple helpful and informative trends were still apparent.

First and foremost, the creation of early-successional forest habitat within the overstory removal and seed tree treatment zones was widely successful. While no point count station fell within the overstory removal treatment zone, singing birds from this zone were detected from nearby point count stations. The new breeding presence of multiple Prairie Warblers, Indigo Buntings, Chestnut-sided Warblers and greatly increased abundance of Eastern Towhee and Black-throated Blue Warbler underscore how beneficial these treatments were for the early-successional forest bird community.

Second, some mature-forest species, but not all, appeared to decline after the harvest especially within the overstory removal and seed tree treatment zones. Blue-headed Vireo suffered a notable decline in the first-year post-harvest, virtually disappearing from the seed tree treatment and gently declining the group selection treatment zone, yet the population generally stabilized by the fifth-year post harvest. Eastern Wood-Pewee and Black-throated Green Warbler also declined in the group selection and seed tree treatment zones but remained stable in the untreated areas.

Third, Ovenbird and Red-eyed Vireo remained the most abundant birds on the property, both in terms of total detections and relative frequency. This comes after Ovenbird experienced statistically significant declines across Kensan-Devan in the first-year post-harvest and Red-eyed Vireo declined significantly in the Meetinghouse Pond section only (Witko 2019). By the 2021 survey, both Ovenbird and Red-eyed Vireo populations appeared to recover some of their original pre-harvest population size.

Fourth, while long-term population impacts for some species remain unclear, enough data has been collected to present the following trends for each of New Hampshire Audubon's nine target species at Kensan-Devan.

Black-throated Blue Warbler

One of the top-ten most abundant species at Kensan-Devan, the population of Black-throated Blue Warblers increased throughout the entire sanctuary following the harvest. However, the timing of population change was different in each section. Within the Hunt Road section, total detections increased by 50% in the first-year post-harvest despite no forest management taking place in this section. Relative abundance stabilized and total detections continued to increase by the fifth year, aligning with Hunt's (2020) determination that the New Hampshire population of Black-throated Blue Warblers is generally increasing.

Contrary to an increase and subsequent stabilization of Black-throated Blue Warblers in the Hunt Road section, this species experienced a substantial drop in total detections and relative abundance in the Meetinghouse Pond section during the first-year post-harvest surveys. Yet, due to significant, forestry-induced understory generation at five-years post-harvest, Black-throated Blue Warblers have rebounded back to, and beyond, their pre-harvest abundance (Figure 4). Population growth of this species was most concentrated within the seed tree and overstory removal treatment zones, where maximum detections of individual birds during a single survey increased by two to three birds per point (Figure 5). Even with the property-wide population increase factored in, the direct boost to Black-throated Blue Warbler abundance from targeted forest management actions is clearly evident.

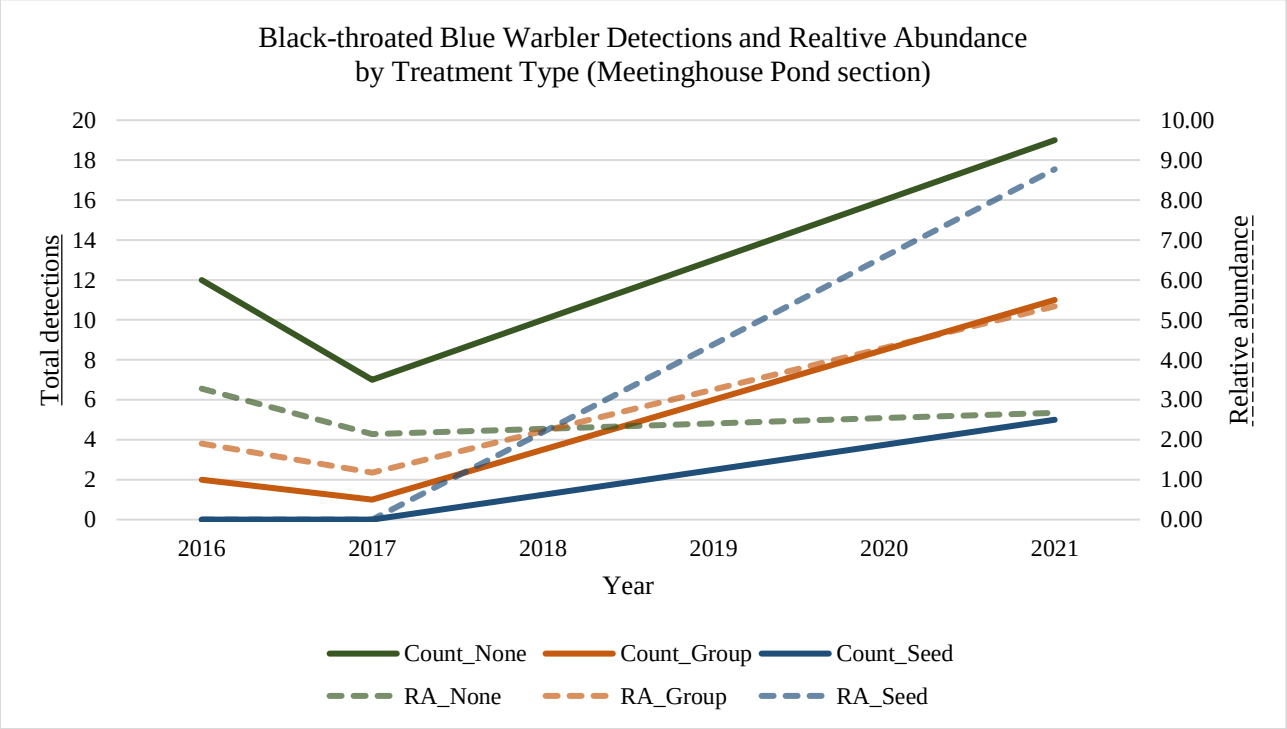


Figure 4. Total detections and relative frequency of Black-throated Blue Warblers in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

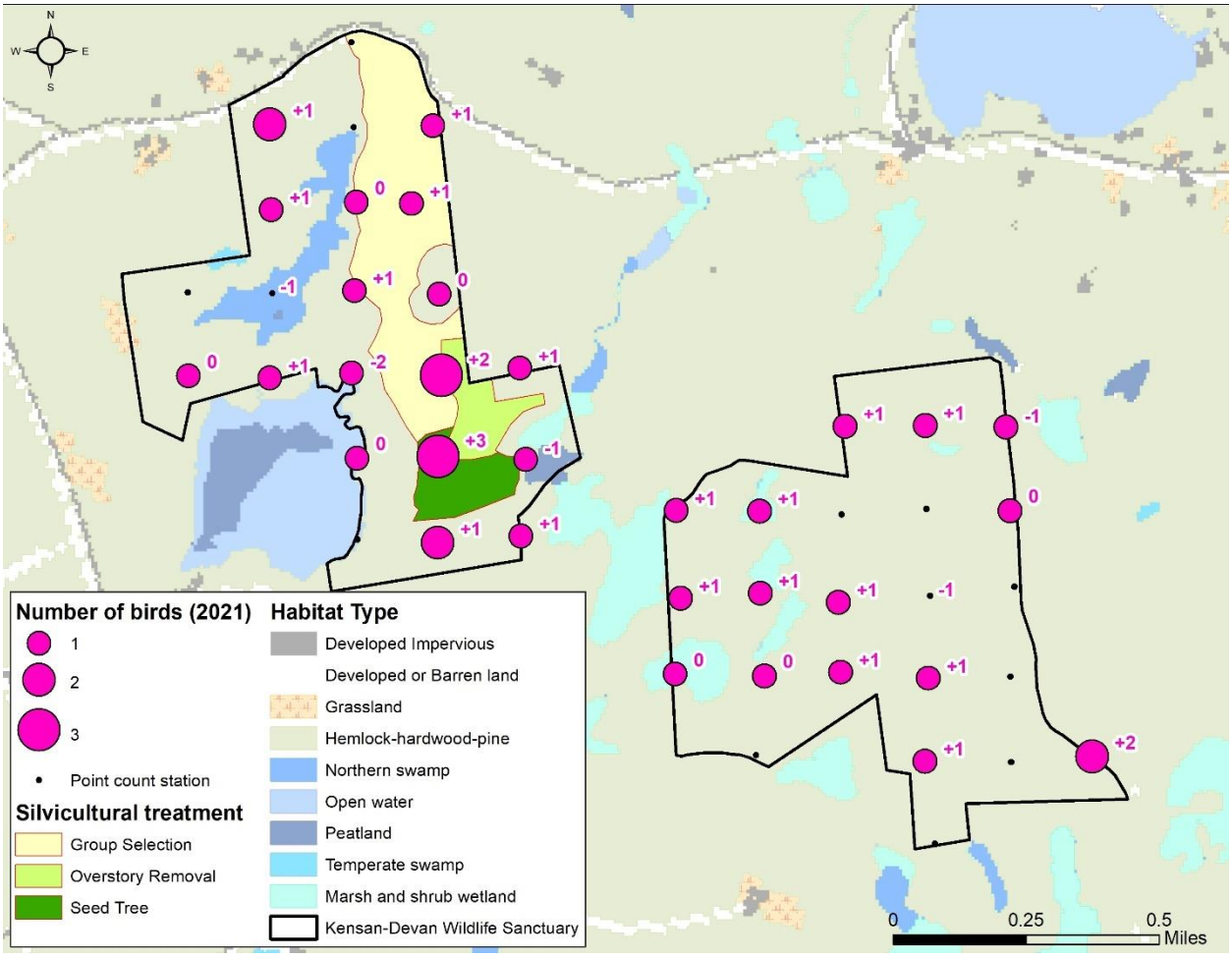


Figure 5. Maximum number of individual Black-throated Blue Warblers detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

## Black-throated Green Warbler

Even more abundant than the Black-throated Blue Warbler at Kensan-Devan is the Black-throated Green Warbler. Overall, population trends for this species were a mixture of increases, decreases, and no change. Across the sanctuary total detections of Black-throated Green Warblers were highest five-years post-harvest, yet relative abundance was lower in 2021 than prior surveys. At first glance this opposite relationship between total detections and relative abundance appeared counterintuitive. However, this pattern directly stemmed from greater species diversity recorded during the 2021 surveys, which increased the denominator in relative abundance calculations and led to lower relative abundances shared among more species. Roughly a quarter of the 42 species detected in all three survey years experienced an increase in total detections alongside a decrease in relative abundance, likely indicating either a generally stable or slightly larger population relative to pre-harvest levels.

For Black-throated Green Warblers in the Hunt Road section, data revealed higher total detections and a near-equal relative abundance compared to pre-harvest conditions. Since no forest management actions were taken in the Hunt Road section prior to the 2021 surveys, this pattern aligned with the property-wide sense of a stable population. Yet within the Meetinghouse Pond section, lower total detections and a much lower relative abundance five-years post-harvest hinted at a net negative impact of forest management on Black-throated Green Warblers. Indeed, relative abundance decreased sharply within the group selection treatment zone and this species continued to be absent in the seed tree treatment zone (Figure 6). However, a less dire story was told by a spatial investigation of changes in abundance. Comparing the maximum number of Black-throated Green Warbler detections during a single survey, points adjacent to the seed tree treatment zone lost one individual, on average, between pre-harvest and five-years post-harvest, and maximum counts of this species remained fairly stable in the no treatment and group selection treatment zones with the exception of Point 2 (Figure 7).

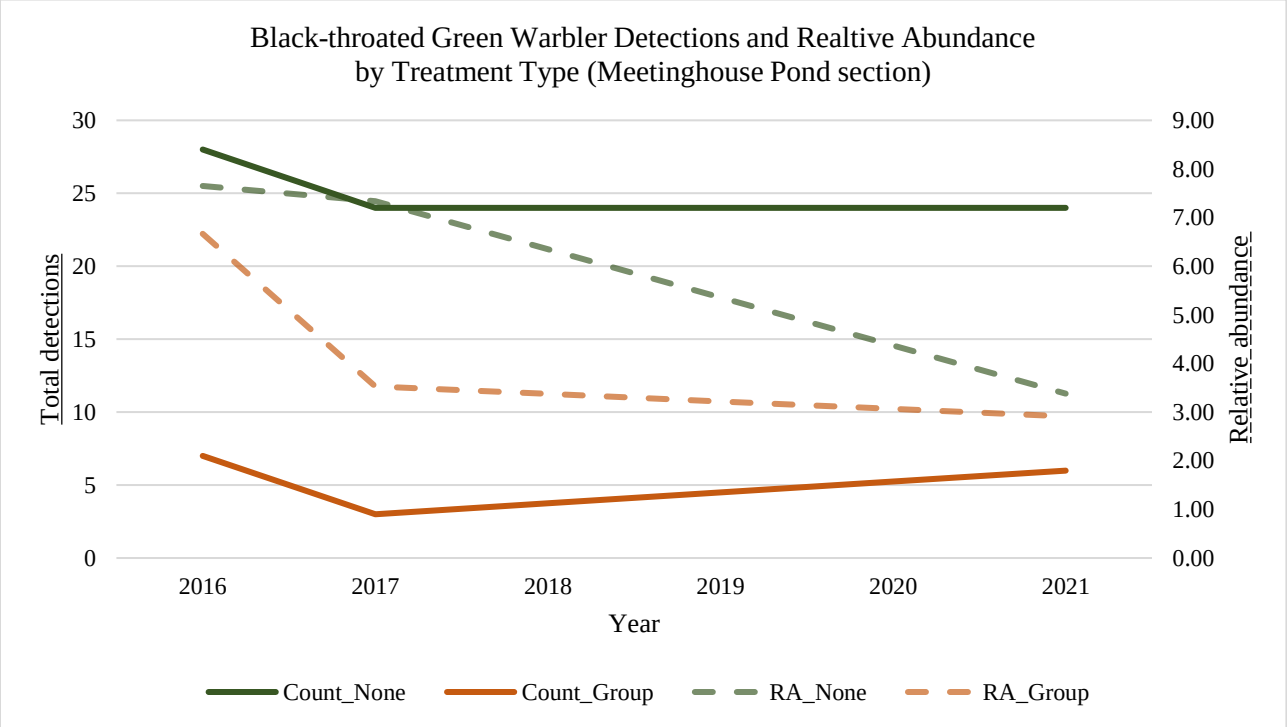


Figure 6. Total detections and relative frequency of Black-throated Green Warblers in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

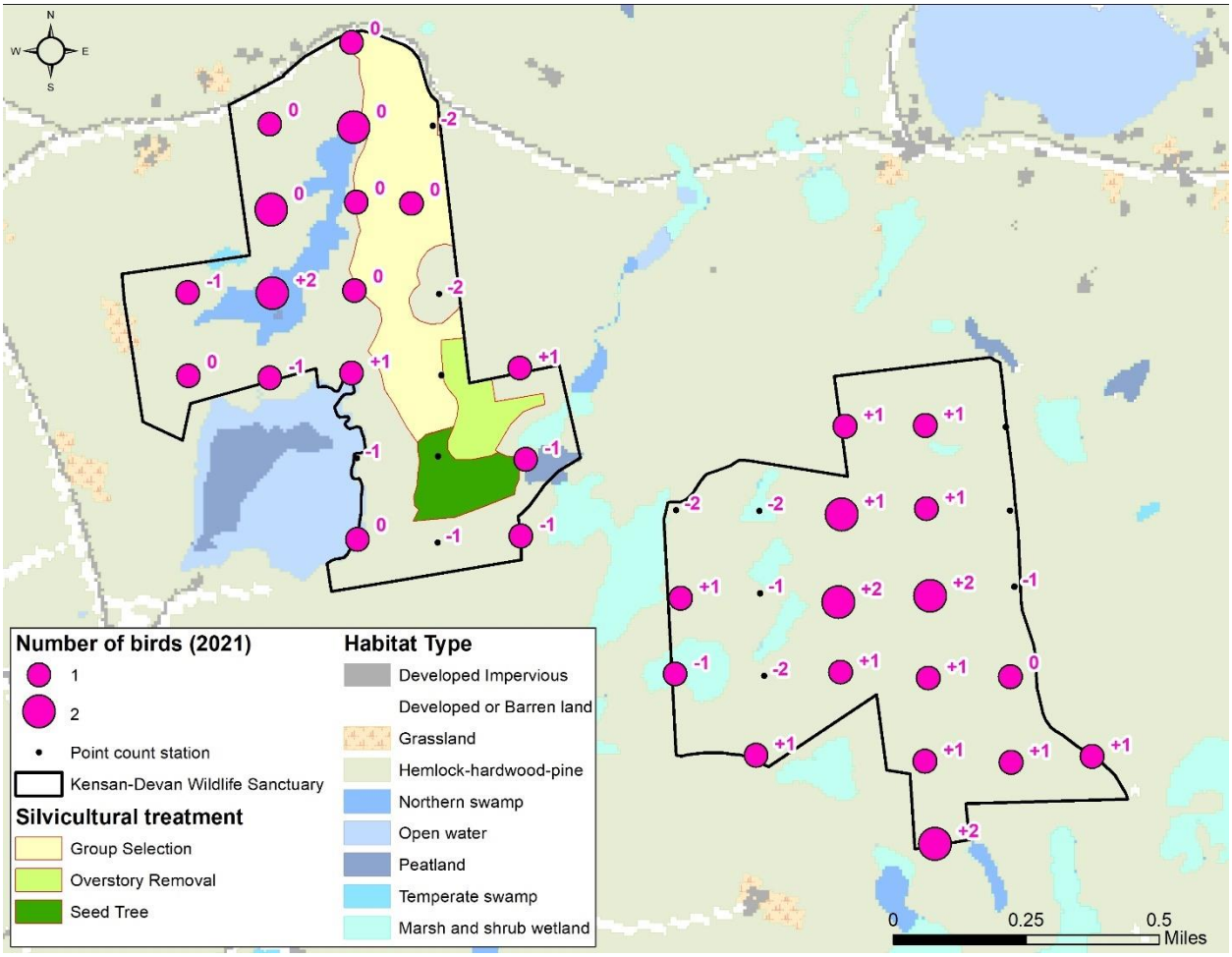


Figure 7. Maximum number of individual Black-throated Green Warblers detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

As a species that prefers closed canopy stands (>80% cover) within coniferous or mixed coniferous-deciduous forests in southwestern New Hampshire, future survey data may capture the expected population boost in Black-throated Green Warblers within the group selection treatment. Additionally, while the creation of small forest gaps (24-40 meters) detracts from Black-throated Green Warbler breeding habitat (Hagan *et al*. 1996; Audubon Vermont 2011), the early-successional forest and forest edges created within the seed tree and overstory removal treatment zones may still benefit this species during migration (Morse and Poole 2020).

Blue-headed Vireo

Among the nine target species identified for habitat stewardship at Kensan-Devan, Blue-headed Vireo is the only species that significantly declined in the five years following the initial timber harvest. Both total detections and relative abundance for this species decreased across the entire property and within the Hunt Road section, possibly indicating a regional population decline or simply variation in local annual population size. Within the Meetinghouse Pond section, despite an initial population increase (Witko 2019), Blue-headed Vireo abundance decreased more sharply here by the fifth-year post harvest relative to the Hunt Road section, thereby indicating a net-negative reaction to the timber harvest at this point in time.

Blue-headed Vireos abandoned the seed tree treatment zone entirely within one year of the harvest and nearly disappeared from the group selection treatment zone with just one detection in 2021 (Figure 8). This decline in the group selection treatment zone came as somewhat of a surprise since Blue-headed Vireos favor closed-canopy forests with mixed hardwoods and softwoods (Audubon Vermont 2011) and generally respond well to single-tree and small-group selection treatments. Although the maximum number of Blue-headed Vireo detections in a single survey decreased at 80% of the group selection points, is worthwhile noting that, by the same metric, Blue-headed Vireos increased at points within the no treatment zone that were adjacent to the group selection treatment zone (Figure 9). Perhaps the group selection treatment opened the canopy too much for short-term recolonization while adding value to adjacent habitat with denser canopy coverage. Additionally, it may take more than five years for Blue-headed Vireos to respond positively to the type of group selection implemented at Kensan-Devan.

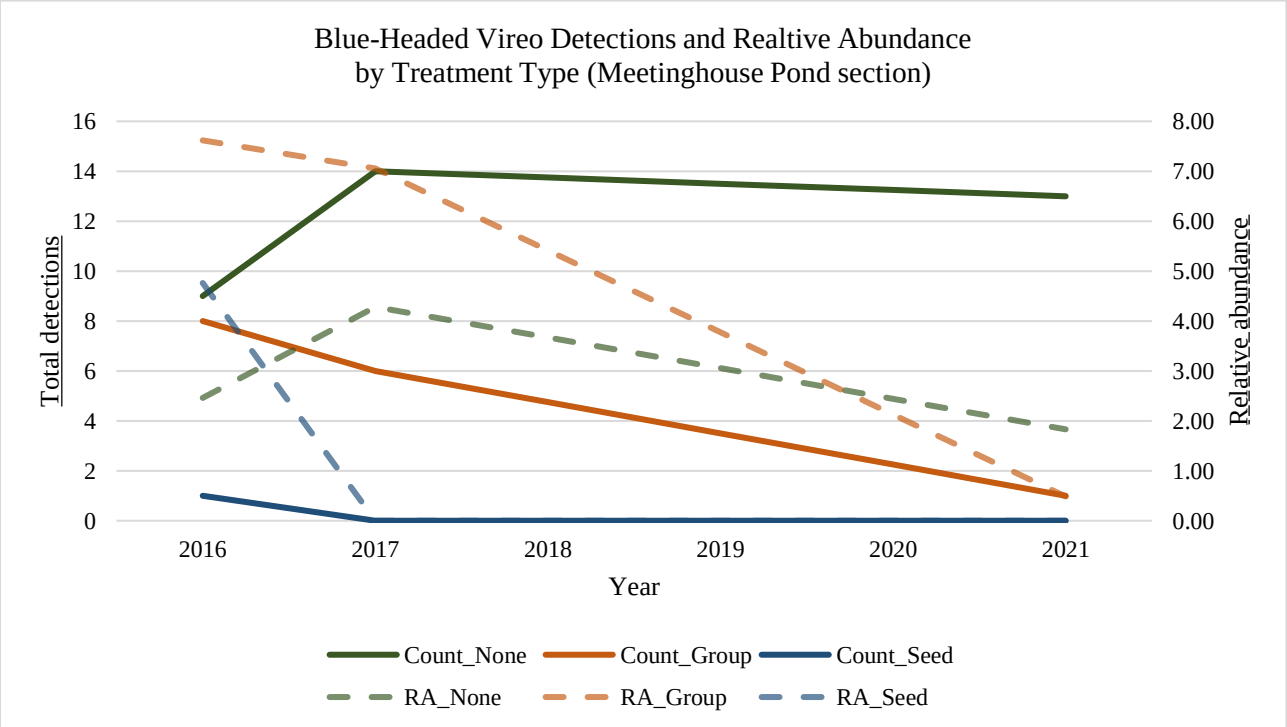


Figure 8. Total detections and relative frequency of Blue-headed Vireos in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

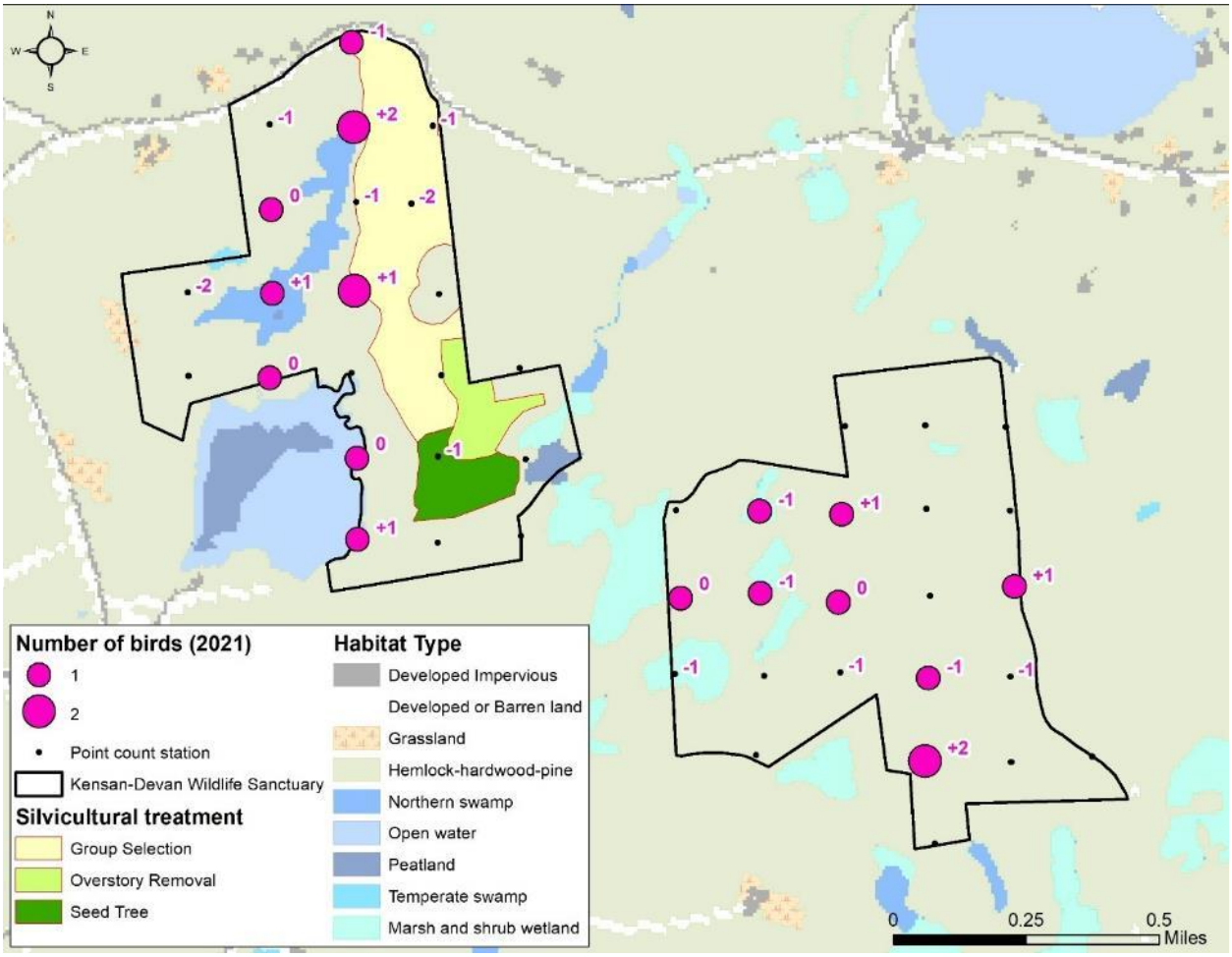

Figure 9. Maximum number of individual Blue-headed Vireos detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

Canada Warbler

Relative to other target species, the Canada Warbler is the second-least abundant species at Kensan-Devan and likely the least populous breeding target species. Canada Warblers are closely associated with moist, mixed forests with dense understory and often standing water (Reitsma *et al*. 2009), and at Kensan-Devan this species resides within and adjacent to large forested or shrub wetlands at the sanctuary (Figure 10). During the six-year study period, total detections of Canada Warblers throughout Kensan-Devan increased each survey year whereas relative abundance increased one-year post-harvest and then stabilized by the fifth year. The Hunt Road section continued to host few individual birds, with a maximum of two detections in any one survey year. In contrast, relative abundance of Canada Warblers in the Meetinghouse Pond section tripled in the five years following the harvest, and total detections were six times higher than counts from 2017 and 2016. This points to the possibility of a locally increasing Canada Warbler population, which may help colonization of new treatment zones aimed at improving habitat for this species in the Hunt Road section. Within the Meetinghouse Pond section's treatment zones, relative abundance increased in the no treatment zone and detections

remained at zero within the seed tree treatment zone (Figure 11). In 2021, this species was newly detected within the group selection treatment zone, although this observation was of a single male singing more than 50 meters away from Point 6 and was probably more associated with the large wetland west of this point than the group selection treatment area itself.

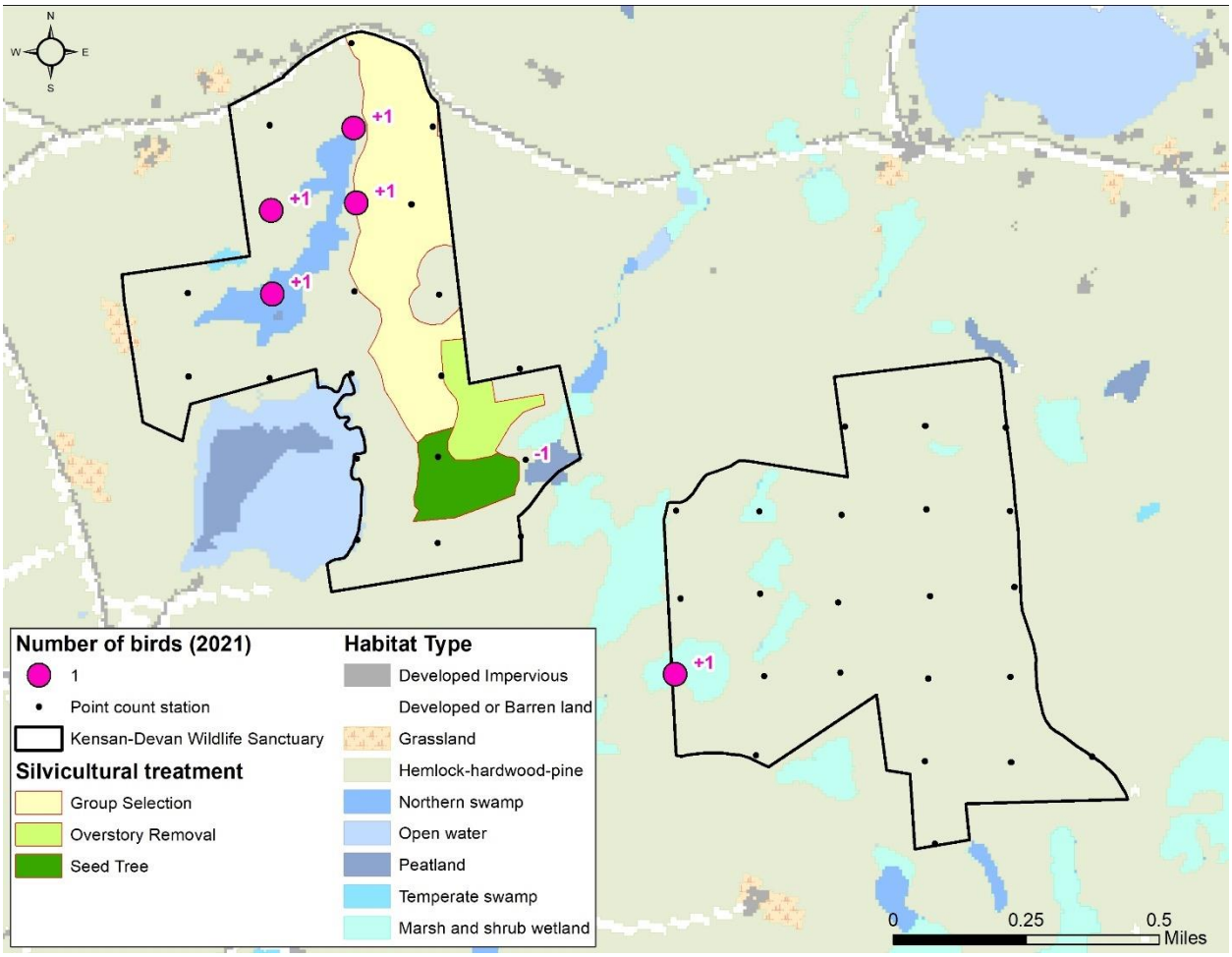


Figure 10. Maximum number of individual Canada Warblers detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

Given the relatively few total detections of Canada Warblers in all three survey years, these increasing populations trends should be interpreted with caution. Since Canada Warbler habitat was not altered during the 2016-2017 timber harvest, fewer detections of this species in earlier years may possibly stem from late-migrating individuals, annual population variability, or variation in survey timing. To this latter point, one New Hampshire-based study found that the dawn chorus of Canada Warblers typically ends no later than 30 minutes after sunrise, after which paired males will fall silent with the exception of intermittent song and only two-thirds of unpaired males will continue singing 0-4.5 hours after sunrise and (Demko 2013). Due to these various sources of uncertainty in population estimates, settling on a population trend of stable, rather than increasing, may be more appropriate. Considering that Canada Warblers are thought to be strongly decreasing throughout New Hampshire (Hunt 2020), a cautiously optimistic stable population trend for this species at Kensan-Devan is an encouraging sign.

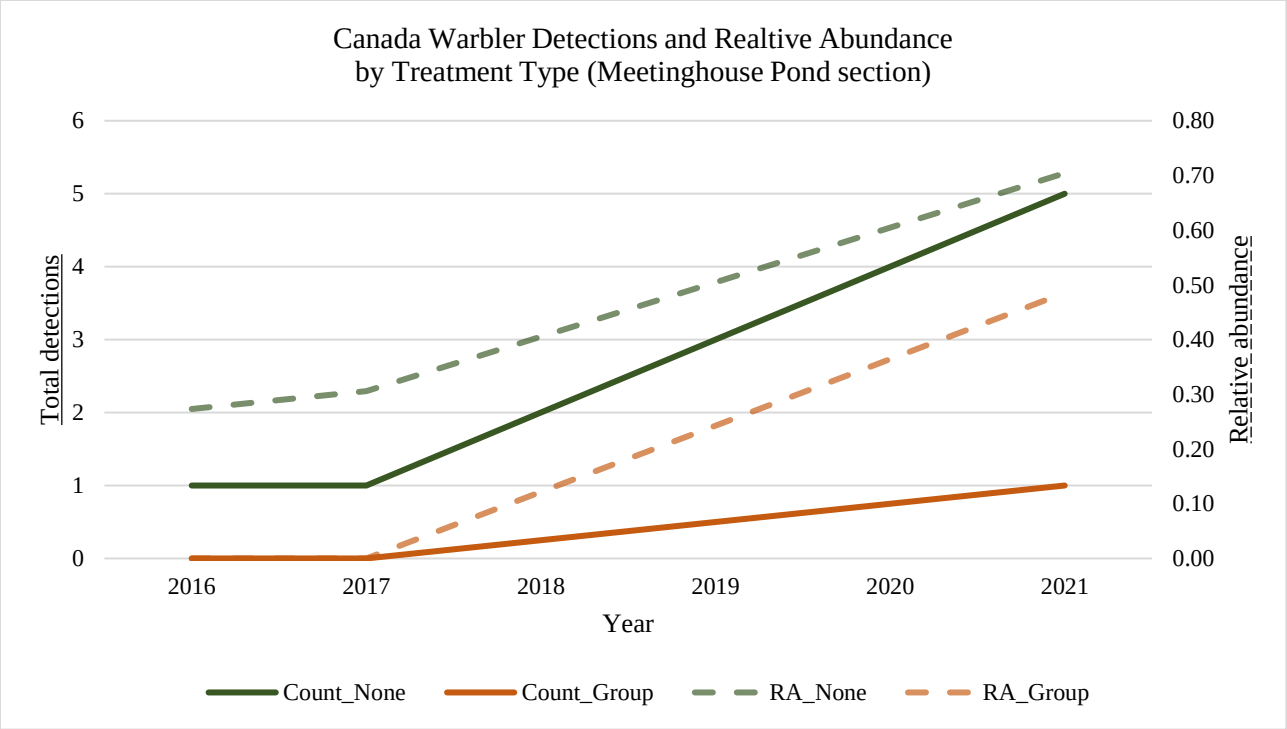


Figure 11. Total detections and relative frequency of Canada Warblers in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

Chestnut-sided Warbler

Perhaps the clearest choice of a target species to demonstrate forest management successes at Kensan-Devan, survey data on Chestnut-sided Warblers revealed an impressive story. Prior to the 2016-2017 timber harvest, virtually all upland forests at the sanctuary consisted of mature second-growth stands and were therefore unsuitable habitat for the early-successional forest preferences of Chestnut-sided Warblers. Accordingly, no individuals were detected in this pre-harvest condition (Figure 12). One-year following the harvest, understory regeneration lacked enough growth to attract Chestnut-sided Warblers and total detections remained at zero. Yet by the fifth-year post-harvest, the quality of early-successional habitat had improved significantly and nearly 30 detections of Chestnut-sided Warblers were made across the property.

Roughly 86% of these observations came from the Meetinghouse Pond section, all within or adjacent to the overstory removal and seed tree treatment zones. The sharply defined spatial correlation between Chestnut-sided Warbler abundance and these two treatment zones points directly to the positive impact of a well-designed timber harvest on early-successional habitat (Figure 13). Additionally, data revealed that it takes two to five years for Chestnut-sided Warblers to colonize seed tree and overstory removal treatments. This timeline can be further refined with data from the Hunt Road section, where three individual singing males were observed in 2021. All three birds were heard singing from the adjacent, off-site, timber harvest that was performed in 2014 or 2015. The lack of Chestnut-sided Warbler detections in 2017 suggests that early-successional forest generation in the nearby cut had not progressed enough in two to three years to attract this species. Hence, it may take three or four years for understory regeneration following a timber harvest to attract Chestnut-sided Warblers. This colonization timeline of two to five years for Chestnut-sided Warblers aligns with other studies of breeding birds in regenerating forest stands that also describe abundance peaking five to 15 years post-harvest (Chizinski *et al*. 2011, Tozer *et al*. 2010).

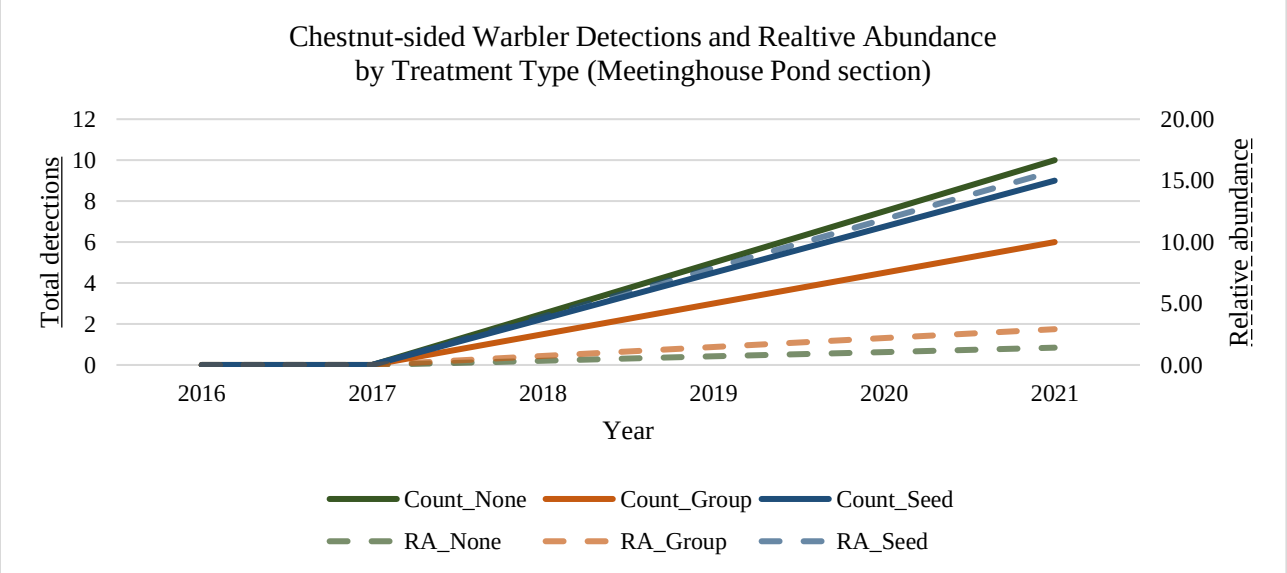


Figure 12. Total detections and relative frequency of Chestnut-sided Warblers in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

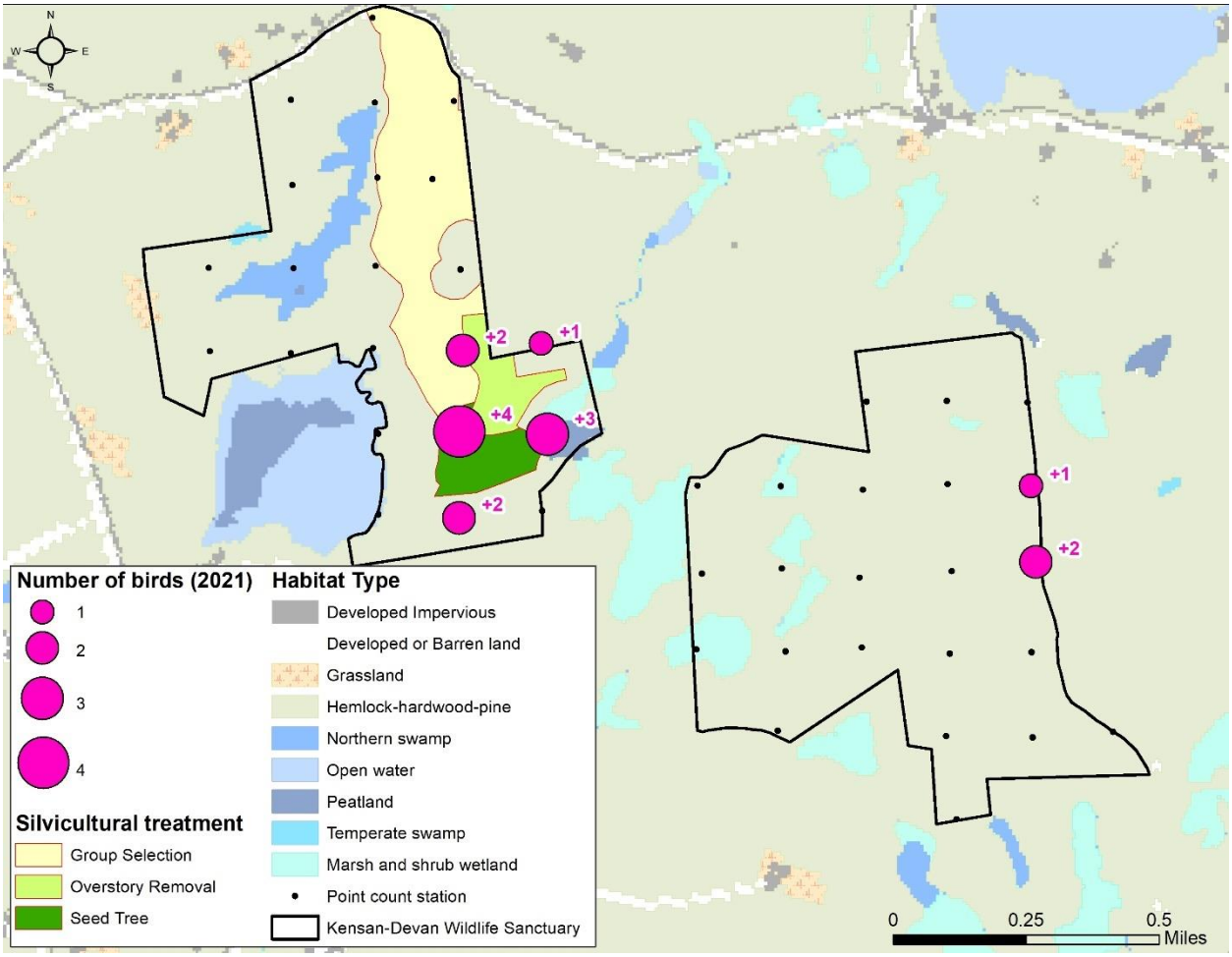


Figure 13. Maximum number of individual Chestnut-sided Warblers detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

Eastern Towhee

While not as abundant as Chestnut-sided Warblers, Eastern Towhees also demonstrated a strong, positive response to forest management at Kensan-Devan. After being virtually absent both pre-harvest and one-year post-harvest, with the exception of an unexpected single observation at Point 8 in 2016, Eastern Towhee numbers jumped from zero detections in 2017 to eight detections in 2021 (Figure 14). This species exhibited a strong spatial correlation with silvicultural treatments, with presence limited to points within or adjacent to the seed tree or overstory removal treatment zones (Figure 15). All birds detected from within the no treatment zones were vocalizing from within the developing early-successional forest.

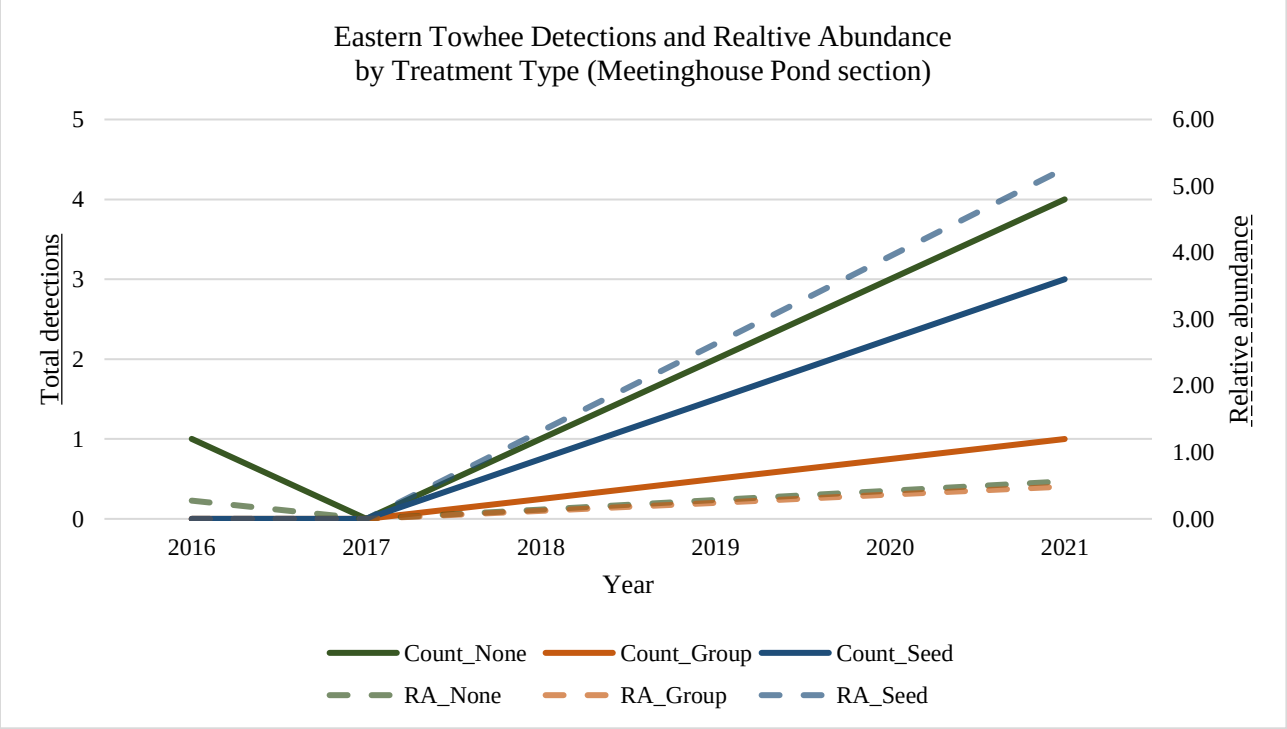


Figure 14. Total detections and relative frequency of Eastern Towhees in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

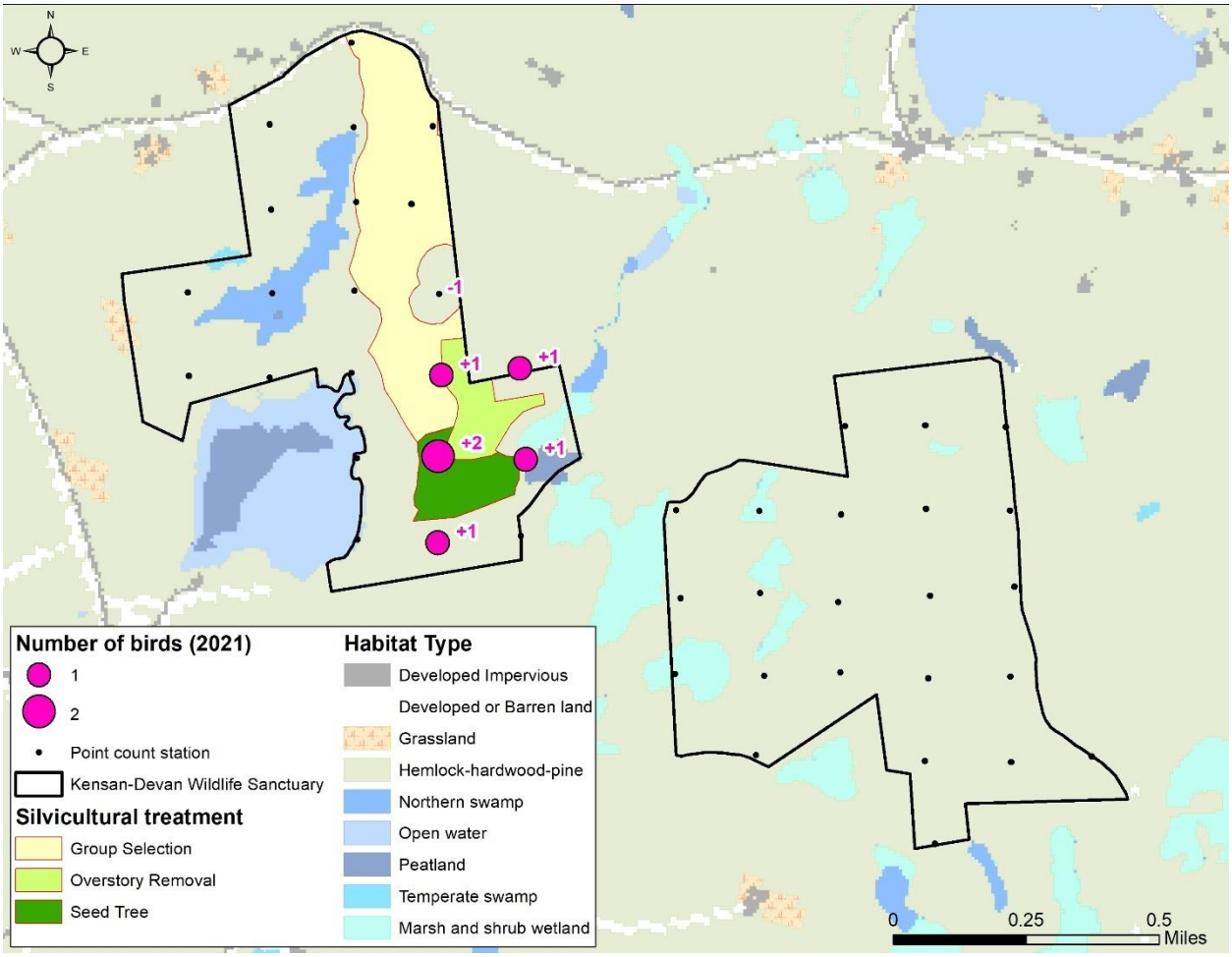


Figure 15. Maximum number of individual Eastern Towhees detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

Eastern Wood-Pewee

Compared to pre-harvest conditions, both total detections and relative abundance of Eastern Wood-Pewees increased across Kensan-Devan. A near doubling of pewee relative abundance in the Hunt Road Section during the six-year study period, where no timber harvests were conducted, points to a potential local population increase despite a general sense of statewide population decline (Hunt 2020). Within the Meetinghouse Pond section, Eastern Wood-Pewees exhibited a strong increase in the first-year post-harvest, which seemed to stabilize by the fifth-year post-harvest. A likely increase in the of abundance flying insects and exposed perches in the year following the harvest may have contributed to this pattern. Indeed, there is a weak spatial correlation between treatment zone edges and Eastern Wood-Pewee abundance (Figure 16).

Five years after the timber harvest, total detections of Eastern Wood-Pewee increased in the no treatment zone and even more so in the group selection zone (Figure 17). Total detections remained generally stable within the seed tree treatment zone, despite a drop in relative abundance as other species colonized the area one- to five-years post-harvest. Overall, among the

treatment types, it appears the group selection may have weakly benefitted Eastern Wood-Pewees on top of a potential local population increase. This species prefers closed canopy (<80%) forests with an open midstory near opening and edges (Audubon Vermont 2011), which supports the hypothesis that the creation of forest openings and edges improved Eastern Wood-Pewee habitat within the Meetinghouse Pond section. Future surveys may collect data that more conclusively demonstrates an impact on pewee population.

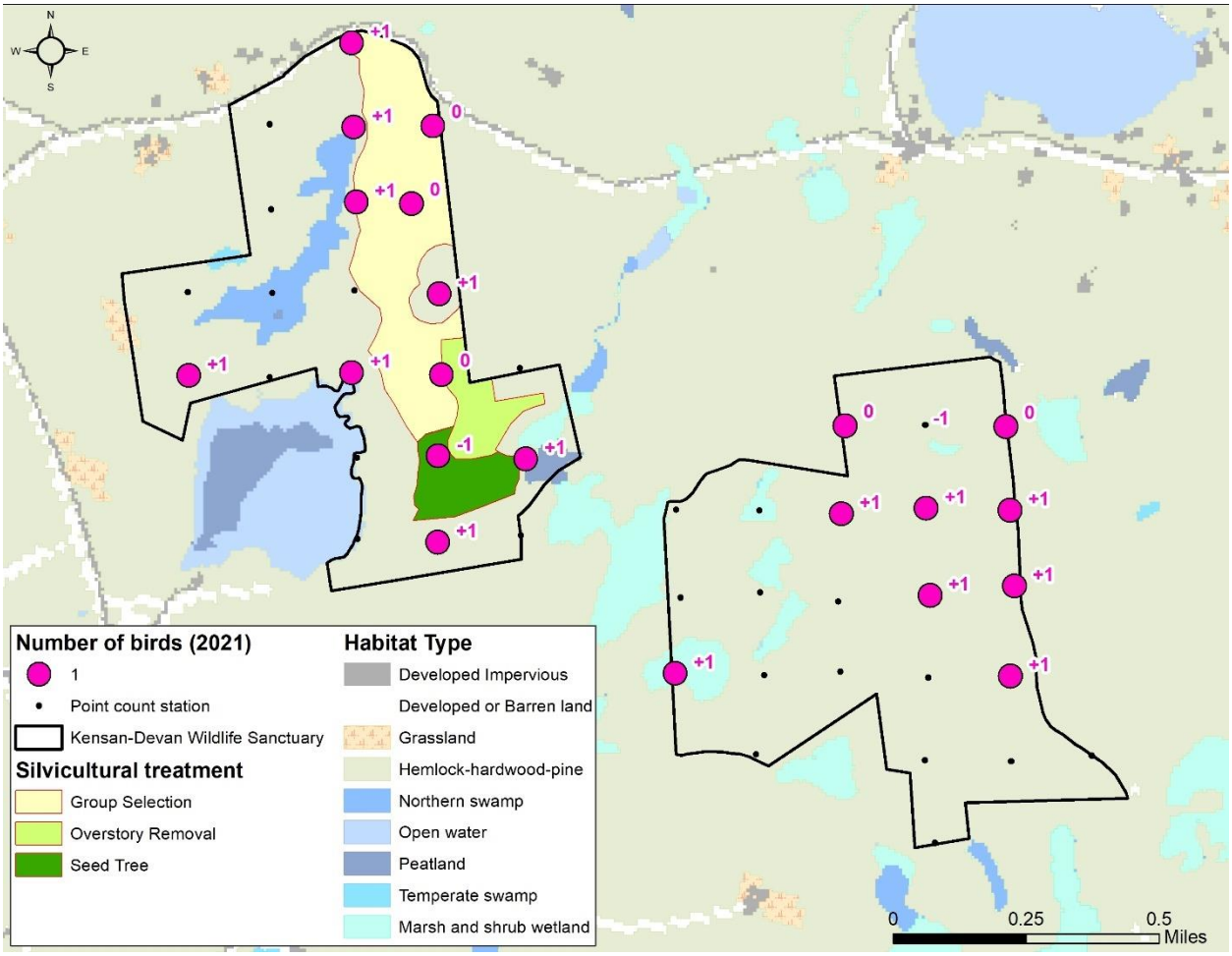


Figure 16. Maximum number of individual Eastern Wood-Pewees detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

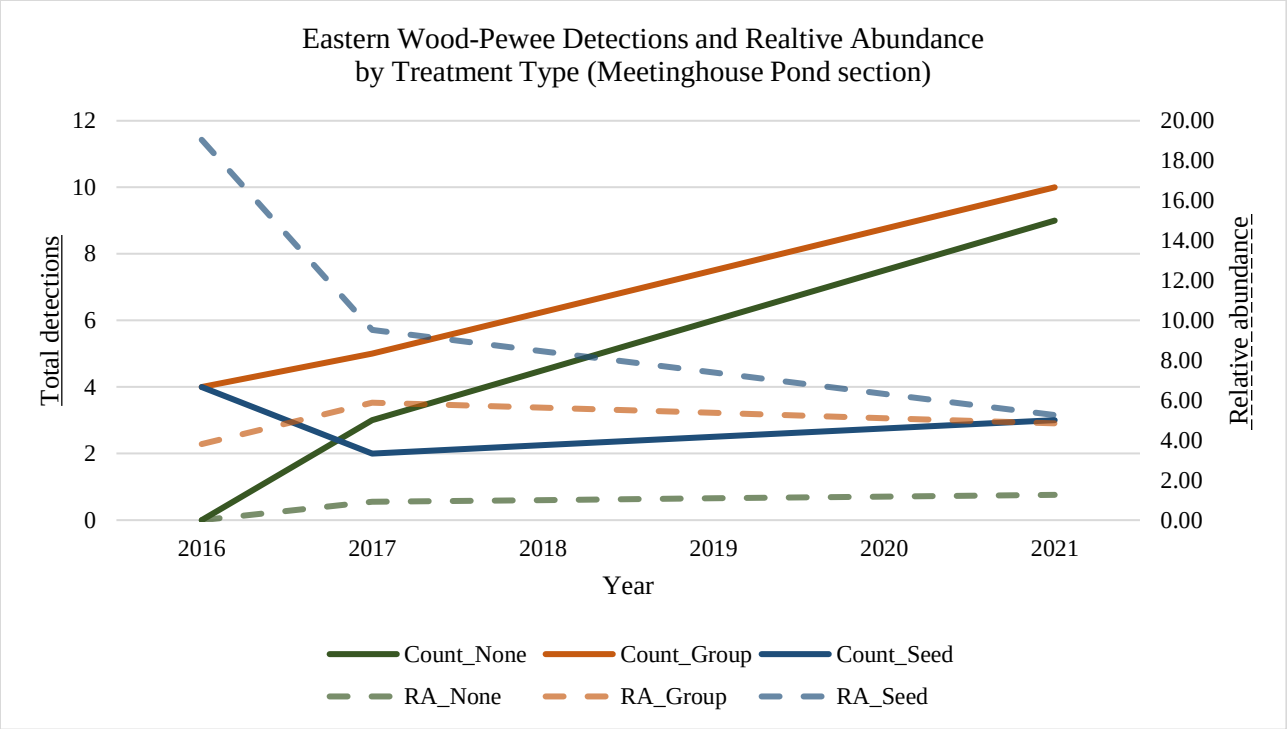


Figure 17. Total detections and relative frequency of Eastern Wood-Pewees in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

Scarlet Tanager

The eighth-most common species at Kensan-Devan in 2021, Scarlet Tanagers were detected from all but nine of the 45 point count stations. This species appeared to be equally distributed throughout the property, with maximums of one or two individuals detected where present (Figure 18). In the first-year post-harvest, Scarlet Tanagers experienced a property-wide increase in relative abundance, which was followed by increased total detections and greater relative abundance by the fifth-year post-harvest. Two pieces of evidence suggest forest management at Kensan-Devan had little to do with this population increase. First, total detections and relative abundance of Scarlet Tanagers more than doubled within the Hunt Road section in the fifth-year post-harvest. No forest management activities were conducted within this section of the sanctuary during the study period. Second, Scarlet Tanagers prefer large tracts of interior hardwood forests with closed canopies (Audubon Vermont 2011). As three of the silvicultural treatments (group selection, seed tree, and overstory removal) reduced the amount of closed canopy, one would expect a decline of Scarlet Tanagers within these treatment zones. However, within the Meetinghouse Pond section, Scarlet Tanager abundance appeared to increase equally in both the no treatment and group selection treatment zones by the fifth-year post-harvest despite a potential decline one-year post-harvest within the group selection treatment zone (Figure 19). Additionally, within the seed tree treatment zone, single detections of Scarlet Tanagers were made in both 2017 and 2021 – opposite the expected negative trend since no birds were detected at this location during pre-harvest conditions when the forest was intact. However, these single detections, only one of which was detected within 50 meters of Point 18, do not

indicate that Scarlet Tanagers are breeding within the seed tree treatment zone. More likely, these birds were singing from nearby undisturbed habitat (i.e., no treatment zone) when they were detected.

The dramatic increase in both total detections and relative abundance of Scarlet Tanager across Kensan-Devan was thought to have been potentially caused by migratory individuals flooding the first round of avian surveys, which took place in late May 2021. However, total Scarlet Tanager detections remained even across all three surveys with 20 tanager detections made during the first round of surveys, 19 detections during the second round in June, and 21 detections during the third round in July. While distant birds may have been double-counted in the 2021 surveys, there were still three times more detections of Scarlet Tanagers within 50 meters of point count centers in 2021 than in 2016. Alternative explanations for the significant increase in Scarlet Tanager abundance include variability in observer abilities or annual population size. Regardless, Kensan-Devan and the surrounding region clearly supports enough interior hardwood forest to locally stave off a statewide, strongly-decreasing population trend for this species (Hunt 2020).

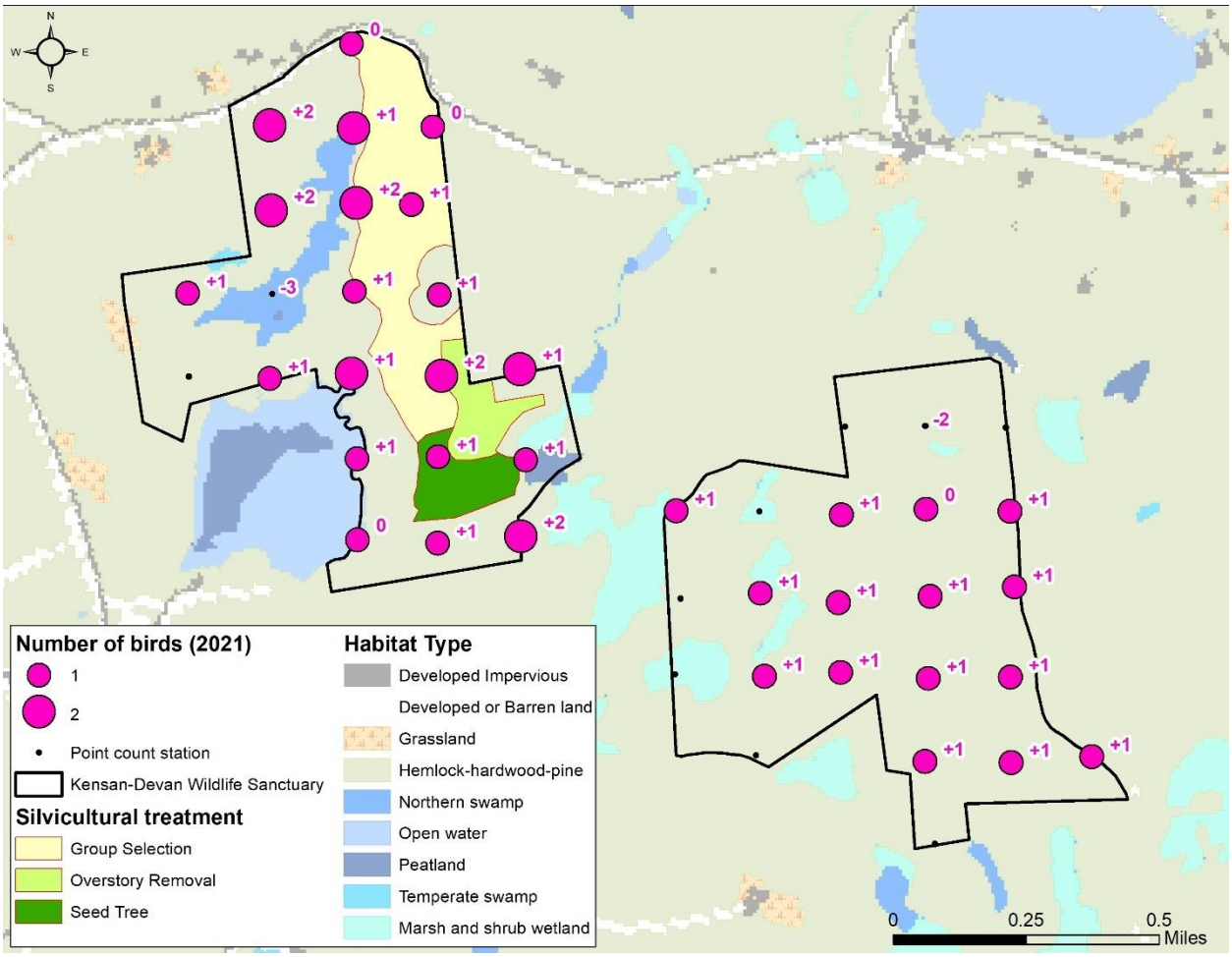


Figure 18. Maximum number of individual Scarlet Tanagers detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

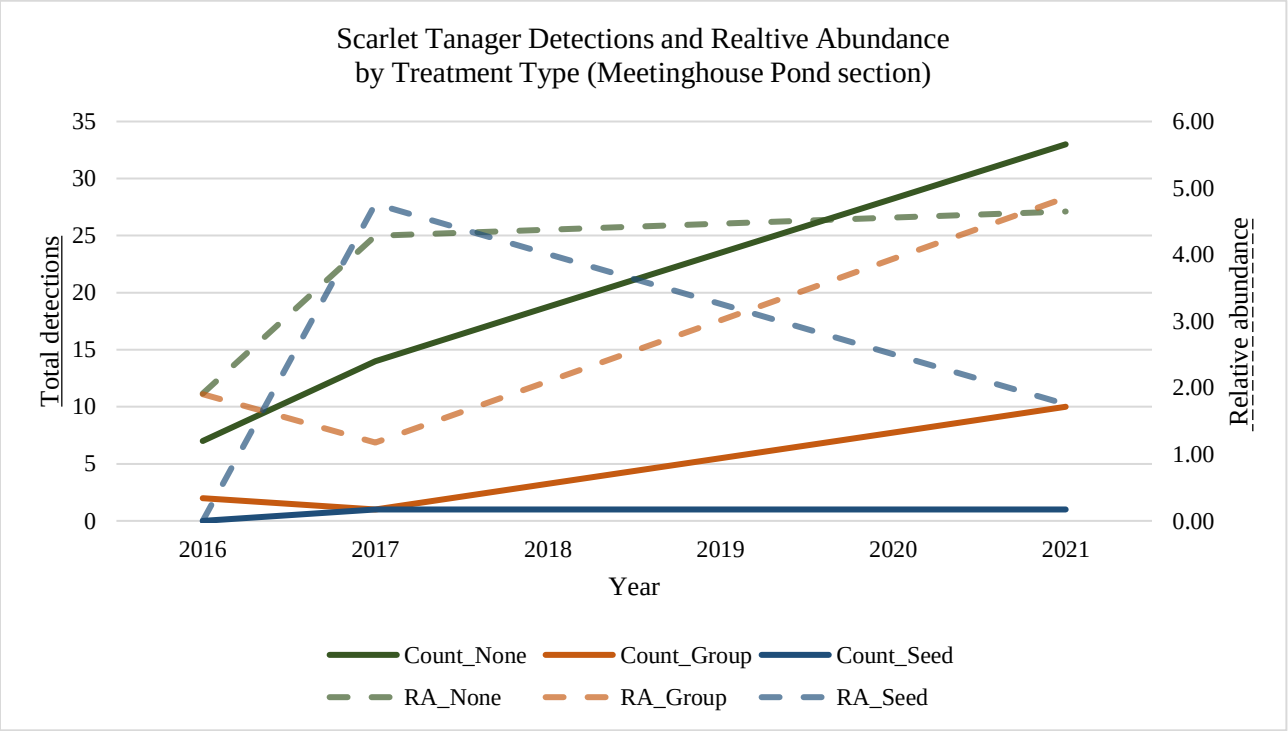


Figure 19. Total detections and relative frequency of Scarlet Tanagers in each of the treatment types within the Meetinghouse Pond section across the study period. Values for 2018, 2019, and 2020 were estimated using a linear equation and do not reflect actual values as no surveys were conducted during these three years.

Wood Thrush

At the conclusion of this six-year study, Wood Thrush remained an uncertain breeding species at Kensan-Devan. Only three individual birds were detected in more than 109 hours of point count surveys during the study. One Wood Thrush was heard calling from within 50 meters of Point 1 during an official five-minute point count period on 26 May 2021 (Figure 20), and two birds were incidentally noted on 27 May 2021 while walking between Points 21 and 22 (not mapped). Both observations may have been of migrating individuals as this species was not detected during latter surveys. Additional observations of Wood Thrush at Kensan-Devan are limited, with an eBird checklist containing one Wood Thrush (1 July 2019) and an anecdotal observation of unknown certainty listing three Wood Thrushes made on 15 July 2017 (Witko 2019). To date, no known occurrences of Wood Thrush exist for the Hunt Road section.

Wood Thrush populations are rapidly declining in New Hampshire (Hunt 2020) and throughout this species' entire geographic range (Evans *et al*. 2010). Healthy hardwood stands with a moist leaf litter layer in the northeastern part of the sanctuary offers potential for breeding Wood Thrush in future years. To this effect, the 2021 timber harvest created a new group selection treatment zone where more mature hardwood forest cover remains dominant relative to the surrounding area. However, heavy, constant deer browse may hinder understory hardwood

growth that would eventually mature into the moderately dense midstory that Wood Thrush prefer (Evans *et al*. 2011; NHFG 2015).

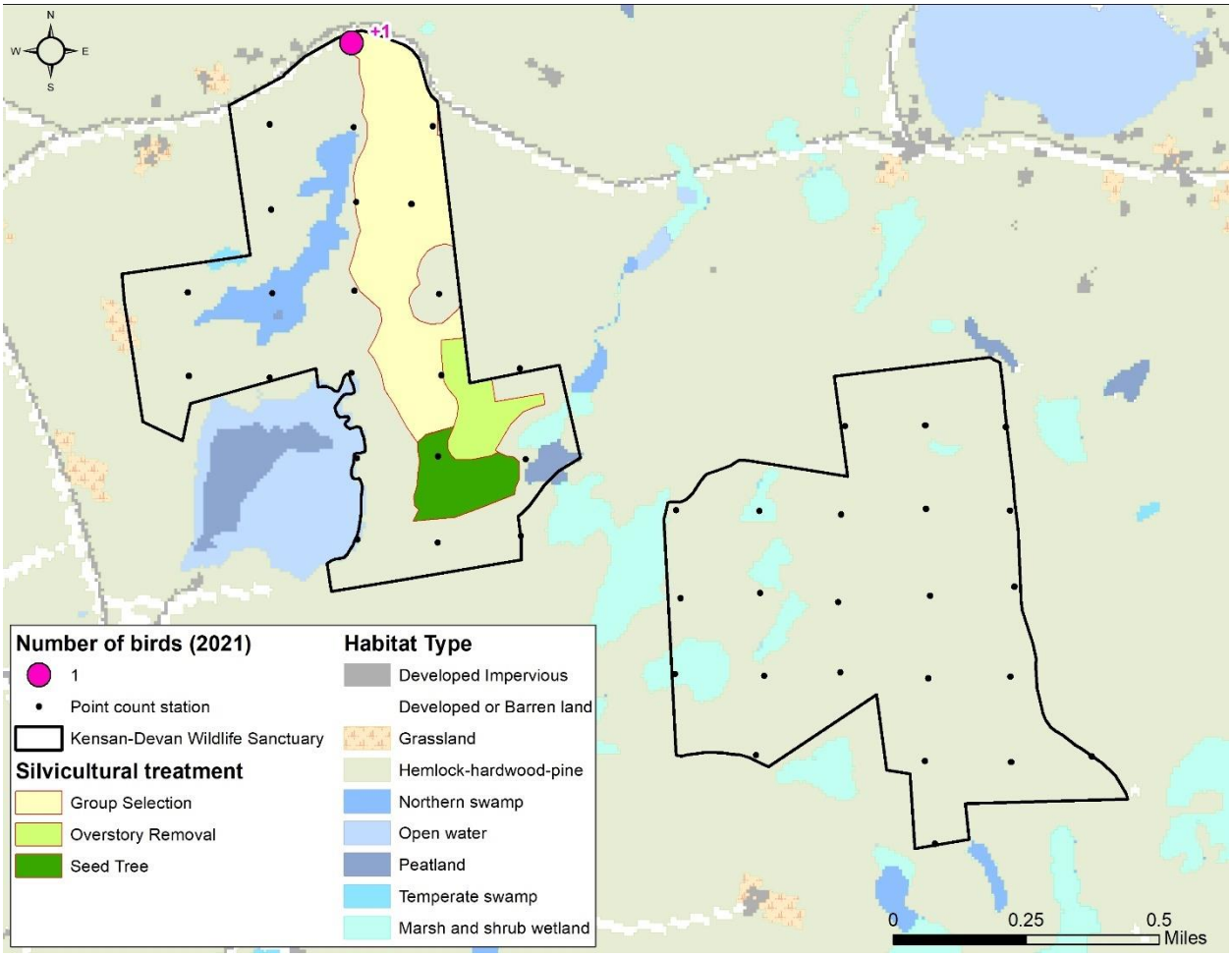


Figure 20. Maximum number of individual Wood Thrushes detected on a single survey in 2021with points labeled by the change in maximum number of individual birds since 2016 (pre-harvest). Silvicultural treatment zones and Wildlife Action Plan habitat (NHFG 2015) displayed for context.

## Recommendations

Rather than make new and potentially conflicting recommendations concerning forest management for birds, the following suggestions focus on ways to improve survey accuracy and analysis, clarifying property boundaries, and promoting general forest health. In case New Hampshire Audubon wants to modify their list of target species for forest management, Appendix G synthesizes numerous bird conservation plans and reports to identify species of varying local, regional, and national conservation concern.

1. Echoing an earlier recommendation (Witko 2019), upgrading the marking of point count stations with brightly painted iron rebar or another durable marker will ensure that point count centers do not change from year to year. Depending on flagging, which degrades over time, leads to reduced accurate replication of surveys, particularly the vegetation-based habitat surveys.

2. Several of the Kensan-Devan boundaries are unclear, and a handful of point count stations may actually be located on adjacent property owned by the Monadnock Conservancy (see GIS data from Witko 2019 for spatial discrepancies). Boundaries should be resurveyed to create a more accurate, official shapefile. Additionally, if long-term markers are established at point-count centers, GPS points for each point center should be waypoint-averaged for greater locational accuracy.

3. Due to the subjective estimates of forest characteristics that The Foresters for the Birds protocol uses, this remains a large source of error when comparing habitat assessments over time. Retaining the same observer for follow-up surveys will reduce variation of collected data yet creating a more standardized data collection methodology would be more powerful approach. Fortunately, the variable radius plot method that uses a 10 basal area factor prism is standardized, these data will become more accurate if point count centers are standardized with a long-term marking solution.

4. From an analysis standpoint, it may be worthwhile to explore calculating relative abundance from the maximum number of detections at a single point during a single survey (i.e., the maximum number of individual birds detected at one time), rather than the total number of detections from three replicate surveys. This approach may reduce statistical noise, allowing for more meaningful interpretation and application.

5. Similarly, to nullify any potential effect of double-counting distant birds (i.e., the same bird is counted at more than one point), relative abundance could be calculated from only detections within 50 meters. However, since most birds detected were more than 50 meters away from point count centers, this would lead to a significantly reduced dataset and this approach may only be useful for abundant species (e.g., Ovenbird, Red-eyed Vireo) or those with far-carrying vocalizations (e.g., Ovenbird, cuckoos, Mourning Dove).

6. Theoretically, when species abundance remains relatively stable, relative abundance calculations should cancel out some differences in observer abilities and effort, yet other factors (e.g., time of year, weather, forest condition) likely contributed to the nearly doubling of total detections in 2021 compared to previous surveys. Timing the avian surveys to start as close to sunrise as possible will reduce the effect time of day has on bird detectability

7. In accordance with recommendations from Witko (2019), the impact of forest management on bird populations would be best monitored with field surveys repeated every 2-3 years. This calls for the next round of avian surveys and habitat assessments in the year 2023 or 2024.

8. Fortunately points located within the group selection and seed tree treatment zones lacked evidence of invasive species, although these areas should be checked more thoroughly to document any potential colonization. If desired, to better document existing patches of invasive species and design a plan for invasive species management, a more detailed invasive species inventory could be conducted on the property. Glossy buckthorn is currently of particular concern near wetlands within both the Hunt Road and Meetinghouse Pond sections.

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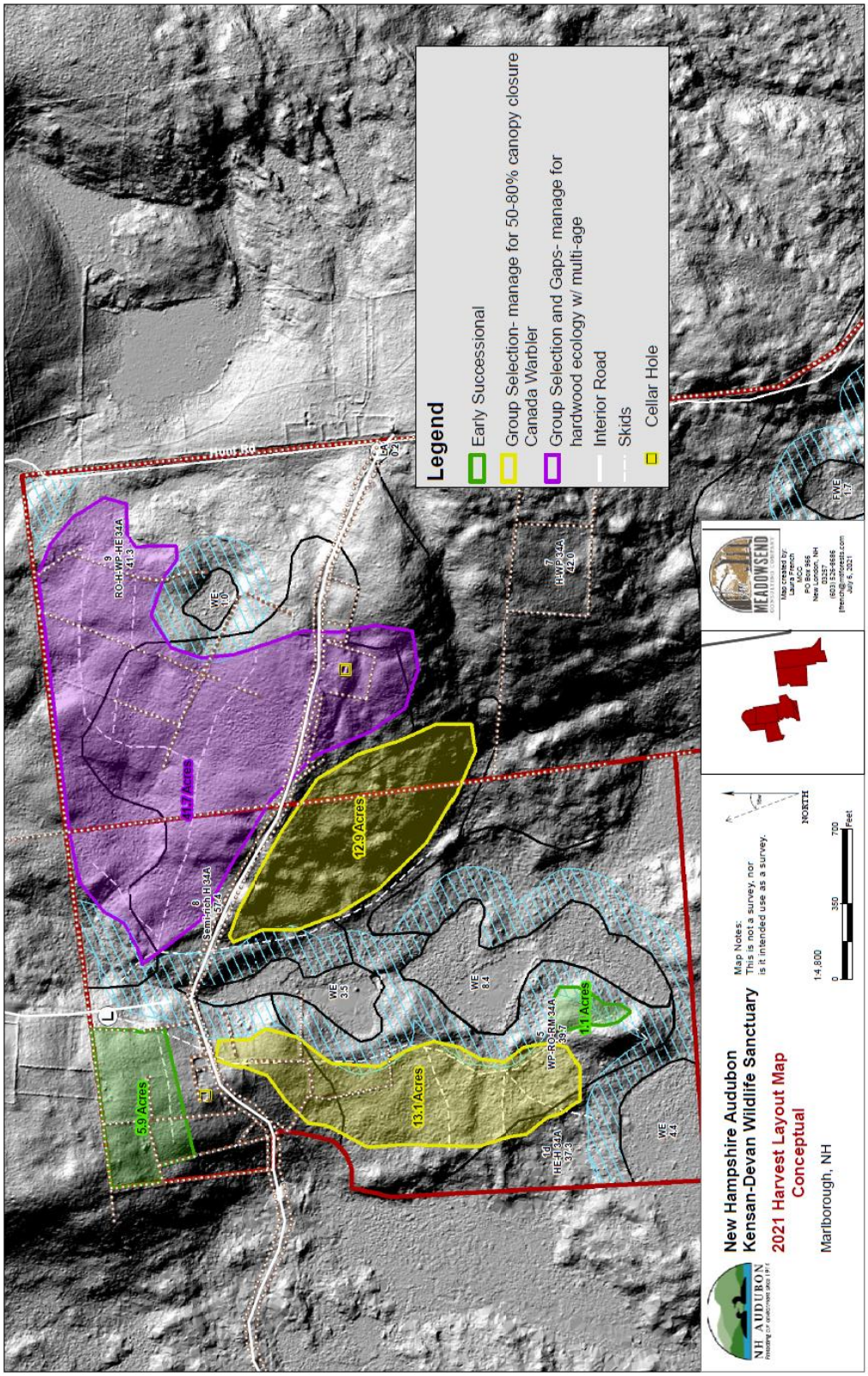
# Appendices

## Appendix A. Treatment map for 2021 timber harvest.



**Appendix B. Key for the American Ornithological Society (AOS) designated alpha codes**

| Common Name | Scientific Name | Alpha Code |
|---|---|---|
| Alder Flycatcher | *Empidonax alnorum* | ALFL |
| American Crow | *Corvus brachyrhynchos* | AMCR |
| American Goldfinch | *Spinus tristis* | AMGO |
| American Robin | *Turdus migratorius* | AMRO |
| Barn Swallow | *Hirundo rustica* | BARS |
| Barred Owl | *Strix varia* | BADO |
| Black-and-white Warbler | *Mniotilta varia* | BAWW |
| Black-billed Cuckoo | *Coccyzus erythropthalmus* | BBCU |
| Blackburnian Warbler | *Setophaga fusca* | BLBW |
| Black-capped Chickadee | *Poecile atricapillus* | BCCH |
| Black-throated Blue Warbler | *Setophaga caerulescens* | BTBW |
| Black-throated Green Warbler | *Setophaga virens* | BTNW |
| Blue Jay | *Cyanocitta cristata* | BLJA |
| Blue-headed Vireo | *Vireo solitarius* | BHVI |
| Bobolink | *Dolichonyx oryzivorus* | BOBO |
| Broad-winged Hawk | *Buteo platypterus* | BWHA |
| Brown Creeper | *Certhia americana* | BRCR |
| Canada Goose | *Branta canadensis* | CANG |
| Canada Warbler | *Cardellina canadensis* | CAWA |
| Cedar Waxwing | *Bombycilla cedrorum* | CEDW |
| Chestnut-sided Warbler | *Setophaga pensylvanica* | CSWA |
| Chimney Swift | *Chaetura pelagica* | CHSW |
| Chipping Sparrow | *Spizella passerina* | CHSP |
| Common Loon | *Gavia immer* | COLO |
| Common Raven | *Corvus corax* | CORA |
| Common Yellowthroat | *Geothlypis trichas* | COYE |
| Downy Woodpecker | *Picoides pubescens* | DOWO |
| Eastern Kingbird | *Tyrannus* | EAKI |
| Eastern Phoebe | *Sayornis phoebe* | EAPH |
| Eastern Towhee | *Pipilo erythrophthalmus* | EATO |
| Eastern Wood-Pewee | *Contopus virens* | EAWP |
| Golden-crowned Kinglet | *Regulus satrapa* | GCKI |
| Gray Catbird | *Dumatella carolinensis* | GRCA |
| Great Blue Heron | *Ardea herodias* | GBHE |
| Great Crested Flycatcher | *Myiarchus crinitus* | GCFL |
| Green Heron | *Butorides virescens* | GRHE |
| Hairy Woodpecker | *Leuconotopicus villosus* | HAWO |
| Hermit Thrush | *Catharus guttatus* | HETH |
| House Wren | *Troglodytes aedon* | HOWR |
| Indigo Bunting | *Passerina cyanea* | INBU |
| Killdeer | *Charadrius vociferus* | KILL |
| Least Flycatcher | *Empidonax minimus* | LEFL |
| Mallard | *Anas platyrhynchos* | MALL |

| Common Name | Scientific Name | Alpha Code |
|---|---|---|
| Mourning Dove | *Zenaida macroura* | MODO |
| Northern Flicker | *Colaptes auratus* | NOFL |
| Northern Parula | *Setophaga americana* | NOPA |
| Northern Waterthrush | *Parkesia noveboracensis* | NOWA |
| Ovenbird | *Seiurus aurocapilla* | OVEN |
| Pileated Woodpecker | *Hylatomus pileatus* | PIWO |
| Pine Warbler | *Setophaga pinus* | PIWA |
| Prairie Warbler | *Setophaga discolor* | PRAW |
| Purple Finch | *Haemorhous purpureus* | PUFI |
| Red Crossbill | *Loxia curvirostra* | RECR |
| Red-bellied Woodpecker | *Melanerpes carolinus* | RBWO |
| Red-breasted Nuthatch | *Sitta canadensis* | RBNU |
| Red-eyed Vireo | *Vireo olivaceus* | REVI |
| Red-shouldered Hawk | *Buteo lineatus* | RSHA |
| Red-winged Blackbird | *Agelaius phoeniceus* | RWBL |
| Rose-breasted Grosbeak | *Pheucticus ludovicianus* | RBGR |
| Ruby-throated Hummingbird | *Archilochus colubris* | RTHU |
| Ruffed Grouse | *Bonasa umbellus* | RUGR |
| Scarlet Tanager | *Piranga olivacea* | SCTA |
| Song Sparrow | *Melospiza melodia* | SOSP |
| Swamp Sparrow | *Melospiza georgiana* | SWSP |
| Tree Swallow | *Tachycineta bicolor* | TRES |
| Tufted Titmouse | *Baeolophus bicolor* | TUTI |
| Veery | *Catharus fuscescens* | VEER |
| White-breasted Nuthatch | *Sitta carolinensis* | WBNU |
| White-throated Sparrow | *Zonotrichia albicollis* | WTSP |
| Wild Turkey | *Meleagris gallopavo* | WITU |
| Winter Wren | *Troglodytes hiemalis* | WIWR |
| Wood Duck | *Aix sponsa* | WODU |
| Wood Thrush | *Hylocichla mustelina* | WOTH |
| Yellow-bellied Sapsucker | *Sphyrapicus varius* | YBSA |
| Yellow-billed Cuckoo | *Coccyzus americanus* | YBCU |
| Yellow-rumped Warbler | *Setophaga coronata* | YRWA |

**Appendix C. Species codes for trees.**

| Common Name | Scientific Name | Code |
|---|---|---|
| American Beech | *Fagus grandifolia* | AMBE |
| American Chestnut | *Castanea dentata* | AMCH |
| American Hop-Hornbeam | *Ostrya virginiana* | AHHO |
| Balsam Fir | *Abies balsamea* | BAFI |
| Beaked Hazelnut | *Corylus cornuta* | BEHA |
| Black Birch | *Betula lenta* | BLBI |
| Black Cherry | *Prunus serotina* | BLCH |
| Common Witch-hazel | *Hamamelis virginiana* | COWI |
| Eastern Hemlock | *Tsuga canadensis* | EAHE |
| Eastern White Pine | *Pinus strobus* | EAWP |
| Glossy Buckthorn | *Frangula alnus* | GLBU |
| Hawthorn sp. | *Crataegus* | HAWT |
| Hazelnut sp. | *Corylus* | HAZE |
| Highbush Blueberry | *Vaccinium corymbosum* | HIBL |
| Hobblebush | *Viburnum lantanoides* | HOBB |
| Paper Birch | *Betula papyrifera* | PABI |
| Red Maple | *Acer rubrum* | REMA |
| Red Oak | *Quercus rubra* | REOA |
| Red Spruce | *Picea rubens* | RESP |
| Spruce sp. | *Picea* | SPRU |
| Striped Maple | *Acer pensylvanicum* | STMA |
| Sugar Maple | *Acer saccharum* | SUMA |
| White Ash | *Fraxinus americana* | WHAS |
| Winterberry Holly | *Ilex verticillata* | WIHO |
| Yellow Birch | *Betula alleghaniensis* | YEBI |

## Appendix D. Photos of point count stations (facing north from point count center)

Figure D1. Point count station 01 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D2. Point count station 02 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D3. Point count station 03 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D4. Point count station 04 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D5. Point count station 05 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D6. Point count station 06 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D7. Point count station 07 in the Meetinghouse Pond section; A) July 26, 2016, B) June 25, 2017 C) September 15, 2021.

Figure D8. Point count station 08 in the Meetinghouse Pond section; A) July 28, 2016, B) July 15, 2017 C) September 14, 2021.



Figure D9. Point count station 09 in the Meetinghouse Pond section; A) July 28, 2016, B) July 15, 2017 C) September 14, 2021.

Figure D10. Point count station 10 in the Meetinghouse Pond section; A) July 28, 2016, and B) September 14, 2021. Point count photo from 2017 is missing.

Figure D11. Point count station 11 in the Meetinghouse Pond section; A) July 28, 2016, B) June 25, 2017, and C) September 14, 2021.

Figure D12. Point count station 12 in the Meetinghouse Pond section; A) July 28, 2016, B) June 25, 2017, and C) September 14, 2021.

Figure D13. Point count station 13 in the Meetinghouse Pond section; A) July 28, 2016, B) June 25, 2017, and C) September 14, 2021.

Figure D14. Point count station 14 in the Meetinghouse Pond section; A) July 28, 2016, B) July 15, 2017, and C) September 14, 2021.

Figure D15. Point count station 15 in the Meetinghouse Pond section; A) July 27, 2016, and B) September 14, 2021. Photo missing for point count station 15 in 2017.

Figure D16. Point count station 16 in the Meetinghouse Pond section; A) July 27, 2016, B) July 15, 2017, and C) September 14, 2021.

Figure D17. Point count station 17 in the Meetinghouse Pond section; A) July 27, 2016, B) July 15, 2017, and C) September 14, 2021.

Figure D18. Point count station 18 in the Meetinghouse Pond section; A) July 27, 2016, and B) September 14, 2021. Photo of point count 18 is missing from 2017.

Figure D19. Point count station 19 in the Meetinghouse Pond section; A) July 27, 2016, B) July 15, 2017, and C) September 14, 2021.


Figure D20. Point count station 20 in the Meetinghouse Pond section; A) July 27, 2016, and B) September 10, 2021. Photo for point count 20 is missing from 2017.

Figure D21. Point count station 21 in the Meetinghouse Pond section; A) July 27, 2016, B) July 15, 2017, and C) September 10, 2021.

Figure D22. Point count station 22 in the Meetinghouse Pond section; A) July 27, 2016, B) July 15, 2017, and C) September 10, 2021.

Figure D23. Point count station 23 in the Hunt Road section; A) October 17, 2016, B) June 10, 2017, and C) August 2, 2021.

Figure D24. Point count station 24 in the Hunt Road section; A) October 17, 2016, and B) August 2, 2021. Photo for point 24 is missing from 2017.

Figure D25. Point count station 25 in the Hunt Road section; A) October 17, 2016, B) June 10, 2017, and C) August 2, 2021.

Figure D26. Point count station 26 in the Hunt Road section; A) October 11, 2016, B) June 10, 2017, and C) August 2, 2021.

Figure D27. Point count station 27 in the Hunt Road section; A) October 17, 2016, B) June 10, 2017, and C) August 2, 2021.

Figure D28. Point count station 28 in the Hunt Road section; A) October 16, 2016, B) June 11, 2017, and C) August 2, 2021.

Figure D29. Point count station 29 in the Hunt Road section; A) October 17, 2016, B) June 11, 2017, and C) August 3, 2021.

Figure D30. Point count station 30 in the Hunt Road section; A) October 17, 2016, B) June 11, 2017, and C) August 3, 2021.

Figure D31. Point count station 31 in the Hunt Road section; A) October 17, 2016, B) June 11, 2017, and C) August 3, 2021.

Figure D32. Point count station 32 in the Hunt Road section; A) October 16, 2016, B) June 11, 2017, and C) August 3, 2021.

Figure D33. Point count station 33 in the Hunt Road section; A) October 17, 2016, B) June 11, 2017, and C) August 2, 2021.

Figure D34. Point count station 34 in the Hunt Road section; A) October 17, 2016, B) June 10, 2017, and C) August 2, 2021.

Figure D35. Point count station 35 in the Hunt Road section; A) October 11, 2016, B) June 10, 2017, and C) August 2, 2021.

Figure D36. Point count station 36 in the Hunt Road section; A) October 12, 2016, B) June 10, 2017, and C) September 10, 2021.

Figure D37. Point count station 37 in the Hunt Road section; A) October 11, 2016, B) June 10, 2017, and C) September 10, 2021.

Figure D38. Point count station 38 in the Hunt Road section; A) October 11, 2016, B) June 11, 2017, and C) September 10, 2021.

Figure D39. Point count station 39 in the Hunt Road section; A) October 11, 2016, B) June 11, 2017, and C) August 3, 2021.

Figure D40. Point count station 40 in the Hunt Road section; A) October 12, 2016, B) June 11, 2017, and C) August 3, 2021.

Figure D41. Point count station 41 in the Hunt Road section; A) October 11, 2016, B) June 11, 2017, and C) August 3, 2021.

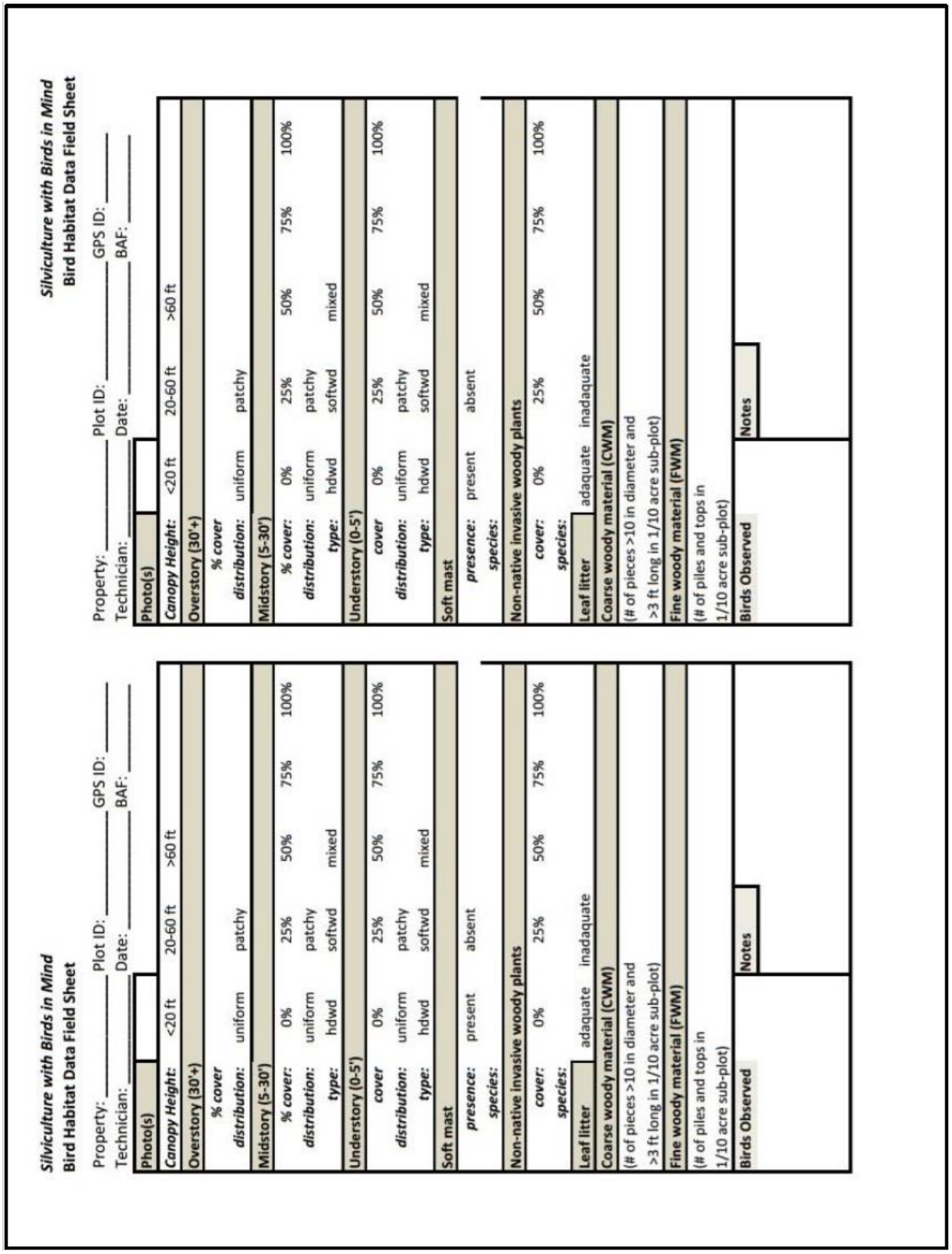
Figure D42. Point count station 42 in the Hunt Road section; A) October 11, 2016, B) June 10, 2017, and C) September 10, 2021.

Figure D43. Point count station 43 in the Hunt Road section; A) October 11, 2016, and B) September 10, 2021. Photo for point 43 is missing from 2017.

Figure D44. Point count station 44 in the Hunt Road section; A) October 11, 2016, B) June 10, 2017, and C) September 10, 2021.

Figure D45. Point count station 45 in the Hunt Road section; A) June 11, 2016, and B) September 10, 2021. Photo for point 45 is missing from 2017.

## Appendix E: Bird habitat data field sheet (by Audubon Vermont)



**Silviculture with Birds in Mind**
**Bird Habitat Data Field Sheet**

Property: _____ Plot ID: _____ GPS ID: _____
Technician: _____ Date: _____ BAF: _____

| Photo(s) | | | | | |
|---|---|---|---|---|---|
| **Canopy Height:** | <20 ft | 20-60 ft | >60 ft | | |
| **Overstory (30'+)** | | | | | |
| **% cover** | | | | | |
| **distribution:** | uniform | patchy | | | |
| **Midstory (5-30')** | | | | | |
| **% cover:** | 0% | 25% | 50% | 75% | 100% |
| **distribution:** | uniform | patchy | | | |
| **type:** | hdwd | softwd | mixed | | |
| **Understory (0-5')** | | | | | |
| **cover** | 0% | 25% | 50% | 75% | 100% |
| **distribution:** | uniform | patchy | | | |
| **type:** | hdwd | softwd | mixed | | |
| **Soft mast** | | | | | |
| **presence:** | present | absent | | | |
| **species:** | | | | | |
| **Non-native invasive woody plants** | | | | | |
| **cover:** | 0% | 25% | 50% | 75% | 100% |
| **species:** | | | | | |
| **Leaf litter** | adaquate | inadaquate | | | |
| **Coarse woody material (CWM)** | | | | | |
| (# of pieces >10 in diameter and >3 ft long in 1/10 acre sub-plot) | | | | | |
| **Fine woody material (FWM)** | | | | | |
| (# of piles and tops in 1/10 acre sub-plot) | | | | | |
| **Birds Observed** | **Notes** | | | | |

Data sheet available at: https://vt.audubon.org/sites/default/files/birdhab_field_sheet.pdf

## Appendix F: Kensan-Devan Wildlife Sanctuary Point Count Data Sheet

**Kensan-Devan Wildlife Sanctuary Point Count Data Form** Page____of_____

**Start Weather Information** (to be taken at first point count station)
**Temp**:_____° F or ° C (circle one) **Cloud Cover**_____% **Wind Speed**_____mph, knots, or kmph (circle one)

Month Day Year Visit # Observer Name Phone Number

| Point # | Time | Species | ≤ 50 m | > 50 m | Fly-overs | Breed? |
|---|---|---|---|---|---|---|
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**End Weather Information** (to be taken at last point count station)
**Temp**:_____° F or ° C (circle one) **Cloud Cover**_____% **Wind Speed**_____mph, knots, or kmph (circle one)

**Data Entry** (Initial): Entered: _____Proofed: _____eBird:_____

## Appendix G: NH Conservation Status and Trends of Bird Species Observed at Kensan-Devan Wildlife Sanctuary

Bolded species represent those tracked by at least one of the following conservation plans and lists.

Key to status codes:

1 = New Hampshire Fish and Game Wildlife Action Plan species of conservation concern
2 = Partners in Flight Watch List or Stewardship List for Eastern and Northern Forest biomes
3 = Atlantic Northern Forest Bird Conservation region (BCR 14)

General population trends were taken from Hunt (2020).

| Common Name | Status | General trend |
|---|---|---|
| **Alder Flycatcher** | **2** | **Strongly increasing** |
| American Crow | | Increasing |
| American Goldfinch | | Stable |
| American Robin | | Stable |
| **Barn Swallow** | **3** | **Strongly decreasing** |
| Barred Owl | | Increasing |
| Black-and-white Warbler | | Strongly decreasing |
| **Black-billed Cuckoo** | **1; 3** | **Decreasing** |
| **Blackburnian Warbler** | **2; 3** | **Stable** |
| Black-capped Chickadee | | Increasing |
| **Black-throated Blue Warbler** | **3** | **Increasing** |
| **Black-throated Green Warbler** | **2; 3** | **Increasing** |
| Blue Jay | | Decreasing |
| **Blue-headed Vireo** | **2** | **Increasing** |
| **Bobolink** | **1; 3** | **Strongly decreasing** |
| **Broad-winged Hawk** | **3** | **Increasing** |
| **Brown Creeper** | **3** | **Increasing** |
| **Canada Goose** | **3** | **Strongly increasing** |
| **Canada Warbler** | **1; 2; 3** | **Strongly decreasing** |
| Cedar Waxwing | | Stable |
| **Chestnut-sided Warbler** | **2; 3** | **Strongly decreasing** |
| **Chimney Swift** | **1; 3** | **Strongly decreasing** |
| Chipping Sparrow | | Increasing |
| **Common Loon** | **1; 3** | **Strongly increasing** |
| Common Raven | | Increasing |
| Common Yellowthroat | | Stable |
| Downy Woodpecker | | Strongly increasing |
| **Eastern Kingbird** | **3** | **Strongly decreasing** |

| Common Name | Status | General trend |
|---|---|---|
| Eastern Phoebe | | Stable |
| **Eastern Towhee** | **1; 2; 3** | **Strongly decreasing** |
| **Eastern Wood-Pewee** | **3** | **Decreasing** |
| Golden-crowned Kinglet | | Increasing |
| **Gray Catbird** | **3** | **Stable** |
| Great Blue Heron | | Increasing |
| **Great Crested Flycatcher** | **3** | **Stable** |
| Green Heron | | Strongly decreasing |
| Hairy Woodpecker | | Increasing |
| Hermit Thrush | | Stable |
| House Wren | | Decreasing |
| **Indigo Bunting** | **2** | **Stable** |
| **Killdeer** | **3** | **Strongly decreasing** |
| Least Flycatcher | | Strongly decreasing |
| Mallard | | Increasing |
| Mourning Dove | | Increasing |
| **Northern Flicker** | **3** | **Decreasing** |
| **Northern Parula** | **3** | **Strongly increasing** |
| Northern Waterthrush | | Strongly decreasing |
| **Ovenbird** | **3** | **Stable** |
| Pileated Woodpecker | | Strongly increasing |
| **Pine Warbler** | **2** | **Strongly increasing** |
| **Prairie Warbler** | **1; 2** | **Increasing** |
| **Purple Finch** | **1; 3** | **Strongly decreasing** |
| Red Crossbill | | Unknown |
| **Red-bellied Woodpecker** | **2** | **Strongly increasing** |
| Red-breasted Nuthatch | | Increasing |
| Red-eyed Vireo | | Increasing |
| **Red-shouldered Hawk** | **2** | **Increasing** |
| Red-winged Blackbird | | Decreasing |
| **Rose-breasted Grosbeak** | **3** | **Strongly decreasing** |
| Ruby-throated Hummingbird | | Increasing |
| **Ruffed Grouse** | **1; 3** | **Decreasing** |
| **Scarlet Tanager** | **1** | **Strongly decreasing** |
| Song Sparrow | | Decreasing |
| **Swamp Sparrow** | **2** | **Stable** |
| Tree Swallow | | Decreasing |
| Tufted Titmouse | | Strongly increasing |
| **Veery** | **1; 3** | **Decreasing** |

| Common Name | Status | General trend |
|---|---|---|
| White-breasted Nuthatch | | Strongly increasing |
| **White-throated Sparrow** | **2** | **Strongly decreasing** |
| Wild Turkey | | Strongly increasing |
| Winter Wren | | Unknown |
| **Wood Duck** | **3** | **Increasing** |
| **Wood Thrush** | **1; 2; 3** | **Strongly decreasing** |
| **Yellow-bellied Sapsucker** | **2; 3** | **Increasing** |
| Yellow-billed Cuckoo | | Decreasing |
| Yellow-rumped Warbler | | Stable |