Relative Abundance and Diversity of Bird Species across Habitat Types at the Hiroshi Land, Peterborough, New Hampshire

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Introduction

A Natural Resource Inventory (NRI) is an important tool, and is used by many biologists and ecologists to learn about how different species of biota are utilizing landscapes and as a way to create a baseline for management decisions (Van de Poll 1997). Inventories can be all-encompassing or focus in on one particular plant or animal group (Van de Poll 1997). One method of environmental assessment or NRI is through bird surveys. Birds can be assessed within a landscape through a variety of methods, but point count surveys are a popular and frequently used form of assessment. Birds are often used as a proxy and bio-indicator group for many reasons: their ecology is well understood, they play large and important roles in the ecosystem covering multiple layers of the ecological hierarchy, and they are relatively easy to identify through both sight and sound (Padoa-Schioppa et al. 2005).

Point count surveys are easy to conduct and provide information on habitat relationships, species diversity and abundance, and the effects of management and environmental change on bird populations over a specific time frame (Pacifici et al. 2008). The Hiroshi Land and the surrounding area have very little biological data, especially in terms of bird counts, collected on them. However, the birds of the similarly composed hardwood forest within the White Mountains, NH were surveyed by Welsh and Healy (1993). Welsh and Healy (1993) found that a greater number of bird species were present on land that was managed for quality saw-logs than land that was reserved from timber management (53 species compared to 33). The Hiroshi Land has similar early-successional areas that have been recently logged and are directly adjacent to areas that were less disturbed. Another study in New Hampshire by King and DeGraaf (2000) also indicated that habitat structure has an effect on bird species diversity and richness.

Similar to these studies, the Hiroshi Land was assessed for not only diversity of species, but also species association to different habitat types across points. All species have a range of tolerance towards chemical, physical, and biological conditions, which can be studied and evaluated to assess the quality of natural systems (Holt and Miller 2010). Through inventorying the birds of a particular property, one can gain a better understanding of what is present and/or absent on the land and through that information guide conservation strategies for the future.

Goals and objectives.— Our objective was to determine species diversity and richness of the birds on the Hiroshi Land. This information was compared across habitat types present on the property. The NRI of the birds on the Hiroshi Land has provided valuable information on both the wintering and early breeding avifauna of the property. Data collected may provide property owners with information regarding what bird species are using their land, which can guide future strategies for both management and conservation.

Methods

Study area.— Located approximately six miles northwest of Peterborough, NH along Brush Brook Road (Route 137), the 109-acre Hiroshi Land is a recent acquisition of the Harris Center for Conservation Education (Harris Center). The Hiroshi Land is a part of the Contoocook River Watershed, within the greater Merrimack River Watershed. With nine acres of open wetland and a border along Nubanusit Brook (2/3 mile in length), the property is primarily upland and riparian forest with modest slopes containing habitats that are ranked by the New Hampshire Wildlife Action Plan as "highest" value wildlife habitat. The topographical contours of the area run north to south with the west edge at around 1000 feet in elevation and the east edge at around 940 feet in elevation (Appendix 1A). The majority of the Hiroshi Land is made up of hemlock-hardwood-pine forest, with a little bit of marsh and shrub wetland and northern or temperate swamp (Appendix 1B). There has been some recent logging activity on the land, so early successional habitat is associated with a portion of the property. Indicator plant species located on the site include: white ash (*Fraxinus americana*), indicating rich, wet, and moist soil and substrate, and yellow birch (*Betula alleghaniensis*), indicating wet and moist soil and substrate. According to the New Hampshire Soil Survey for Cheshire County (1994), the area is within the Marlow-Berkshire-Tunbridge soil series, which is classified as having very deep and moderately deep, gently sloping to very steep, well-drained, loamy soils that formed a glacial till. The property has a 1.9 mile trail loop that has easy road access and its own parking lot, making the trail fairly busy with hikers.

Data collection.— For our inventory of the avifauna at the Hiroshi Land we utilized the Variable Circular Plot (VCP) point count method as established by PRBO Conservation Science (California Avian Data Center 2003). We visited the Hiroshi Land for a total of five visits during the late winter and early spring (February 28, March 5, March 26, April 13, and April 17), beginning 15 minutes after local sunrise and lasting approximately three hours. Observations took place at eight previously mapped point count stations that are located more than 250 meters apart throughout the property (Appendix 1C). We selected the stations from a matrix of 52 points given to us from a representative from the Harris Center with the intention of maximizing the number of points within the property while still maintaining a large enough distance between points to reduce the potential for double counting birds. Upon the first visit, we marked all point count stations with bright pink vinyl flagging at eye-level to assure accuracy of location for future studies. We used a Garmin GPS e Trek to navigate to each point while in the field.

We surveyed each point for a total of 10 minutes per visit (the one deviation we took from the PRBO method, which calls for 5 minute surveys) with each visit starting at a random point to remove early or late morning bias. At each point, we tallied all birds that were detected (unique individuals), paying special attention to avoid double counting individuals along the way. This gave us the number of species and abundance for each point. Aside from a tally (count) of each bird/species, we marked each unique individual with a behavior code to denote how it was first detected (e.g., C=Call, S=Song, V=Visual, D=Drumming). We paid special attention to note whether each bird was inside or outside of a 50-meter radius originating from the center of the point count station. For the habitat inventory we employed the variable radius plot sampling method to tally all trees by species at each of the eight points with a 10 meter Bitterlich wedge prism.

Data analysis.— We used bird species observed during the bird counts and their abundance to calculate the relative abundance of species for all of the Hiroshi Land and for each habitat type within it. We used the Shannon diversity index to score the bird species richness, diversity, and evenness of each habitat type. We decided the habitat type of each point based on forest cover and the dominant tree species with the greatest importance value. We used relative basal area and relative frequency to calculate the importance values, and based the different forest covers on the Eastern forest cover types established by the Society of American Foresters (SAF) (Eyre 1980). We then summarized and presented the estimated values for bird species and their habitat types into tables and figures. We accompanied averages that were generated for comparative values with standard deviation, calculated as the square root of the variance.

Results

Habitat inventory.— The results reflected the differences in tree composition and distribution across habitat types. We separated the habitat types of the eight bird count points into three forest cover types based on SAF guidelines. We categorized five of the points into a white pine – northern red oak – red maple forest cover type, two into an eastern hemlock forest cover type, and one into a red maple forest cover type that had experienced a recent logging event likely in the last 30 years. The eastern hemlock forest type had the greatest average basal area (175 ft^2/acre ±7.07 SD), while the disturbed red maple forest type had the lowest (120 ft^2/acre ±0.00 SD) (Fig. 1). Tree species found across all eight points of the Hiroshi Land include, in decreasing order of importance value: red maple (*Acer rubrum*), white pine (*Pinus strobus*), eastern hemlock (*Tsuga canadensis*), red oak (*Quercus rubra*), American beech (F*agus grandifolia*), black birch (*Betula lenta*), and paper birch (*Betula papyrifera*) (Fig. 2). The species of greatest importance within the white pine – northern red oak – red maple forest type were white pine (34.6%) and red maple (28.1%) (Fig. 3). Within the eastern hemlock forest type, the species of greatest importance were eastern hemlock (38.2%) and red maple (23.9%) (Fig. 4). Finally, the species of greatest importance within the recently disturbed red maple forest type were red maple (45.8%) and black birch (20.8%) (Fig. 5).

Wildlife inventory.— The results of the bird count surveys reflected how the differences in habitat type related to the distribution and abundance of the various species of birds. The eastern hemlock forest cover type had the greatest average abundance of birds per 10 minute sampling session (9.2 ±4.16 SD), while the white pine – northern red oak – red maple forest type had the lowest (7.1 ±3.33 SD) (Fig. 6). The white pine – northern red oak – red maple forest type did, however, have the greatest species richness, which was 26.9% greater than the eastern hemlock forest type and 94.1% greater than the red maple forest type (Table 1). The white pine – northern red oak – red maple forest type also had the greatest Shannon species diversity of 3.110, while the red maple forest type had the lowest of 2.600 (Table 1). The red maple forest type had the greatest Shannon equitability score (0.918), while the eastern hemlock forest type had the lowest (0.843) (Table 1).

The total abundance of birds at the Hiroshi Land with all eight points combined was mostly made up of Black-capped Chickadees (*Poecile atricapillus*) (19.8%), White-breasted Nuthatches (*Sitta carolinensis*) (8.0%), and American Crows (*Corvus brachyrhynchos*) (7.3%) (Fig. 7). The white pine – northern red oak – red maple forest cover type had a similar bird species composition and was made up of mostly Black-capped Chickadees (16.9%), White-breasted Nuthatches (7.9%), and Hairy Woodpeckers (*Leuconotopicus villosus*) and Yellow-bellied Sapsuckers (*Sphyrapicus varius*) (both 6.8%) (Fig. 8). The relative abundance of bird species for the eastern hemlock forest type was mostly made up of Black-capped Chickadees (25.0%), American Crows (9.8%), and Tufted Titmice (*Baeolophus bicolor*) (7.6%) (Fig. 9). Finally, the recently disturbed red maple forest type mostly consisted of Black-capped Chickadees (20.5%), White-breasted Nuthatches (11.4%), and Downy Woodpeckers (*Picoides pubescens*) (9.1%) (Fig. 10). Bird species in Fig. 7-10 are labeled in the format of the American Ornithologists' Union designated four-letter codes. A key for interpreting these four-letter codes is provided in the appendix section (Appendix 2).

Table 1. Shannon species diversity scores of different forest cover types at Hiroshi Land, Peterborough, NH.

Forest cover type	Species richness	Shannon species diversity (H)	Shannon species evenness (E_H)
Hiroshi Land (all points)	37	3.094	0.857
White pine – northern red oak – red maple	33	3.110	0.889
Eastern hemlock	26	2.747	0.843
Red maple	17	2.600	0.918

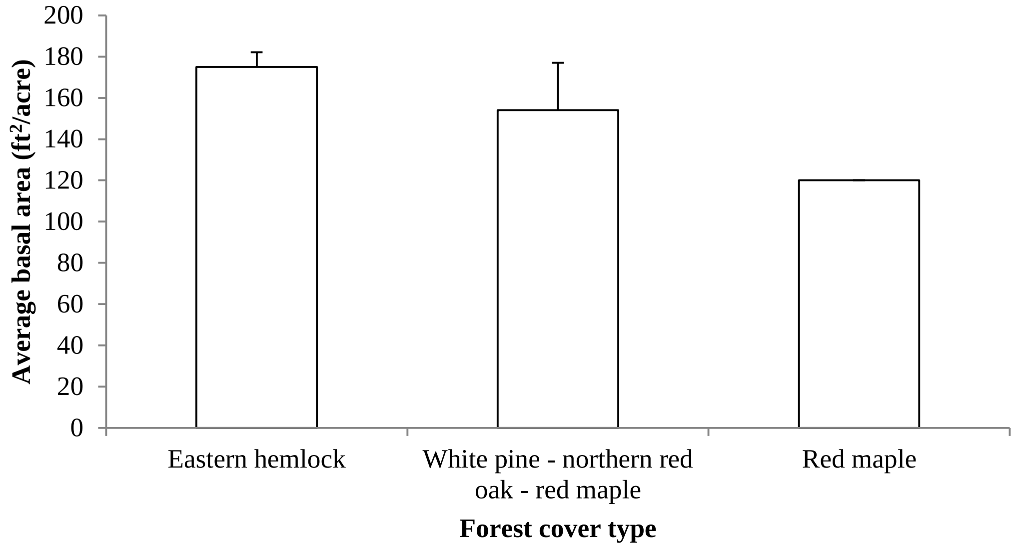

Figure 1. Average basal area (ft^2/acre) across forest cover types with error bars representing standard deviation at Hiroshi Land, Peterborough, NH.

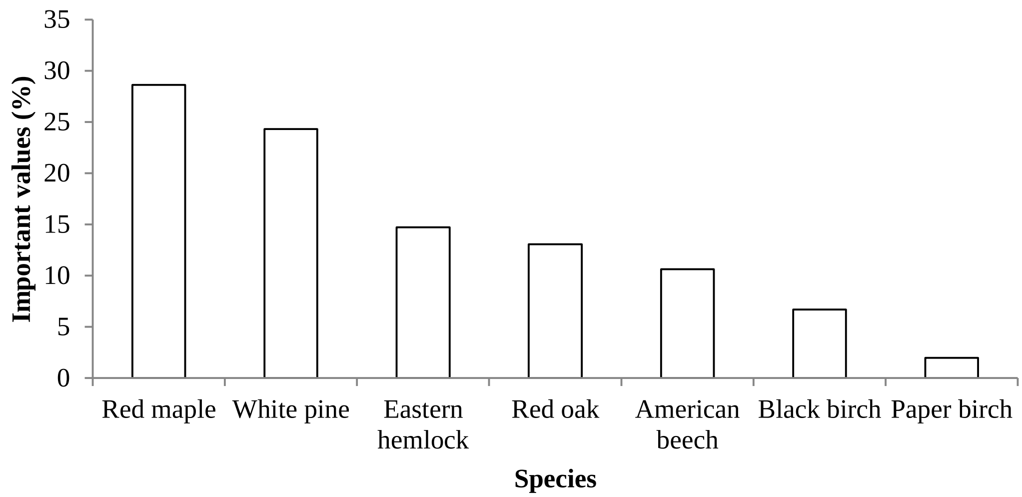

Figure 2. Important values (average of relative basal area and relative frequency) of tree species at Hiroshi Land, Peterborough, NH.

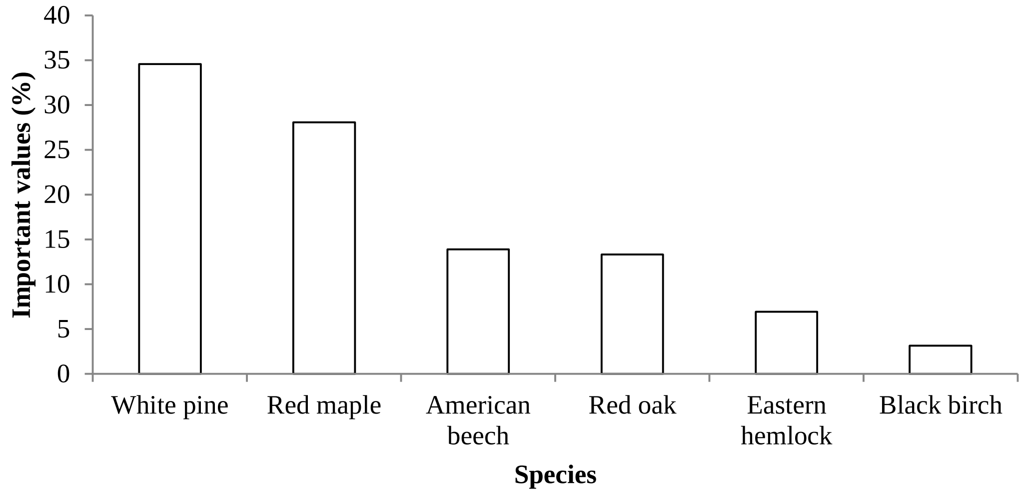

Figure 3. Important values (average of relative basal area and relative frequency) of tree species in white pine – northern red oak – red maple forest cover type at Hiroshi Land, Peterborough, NH.

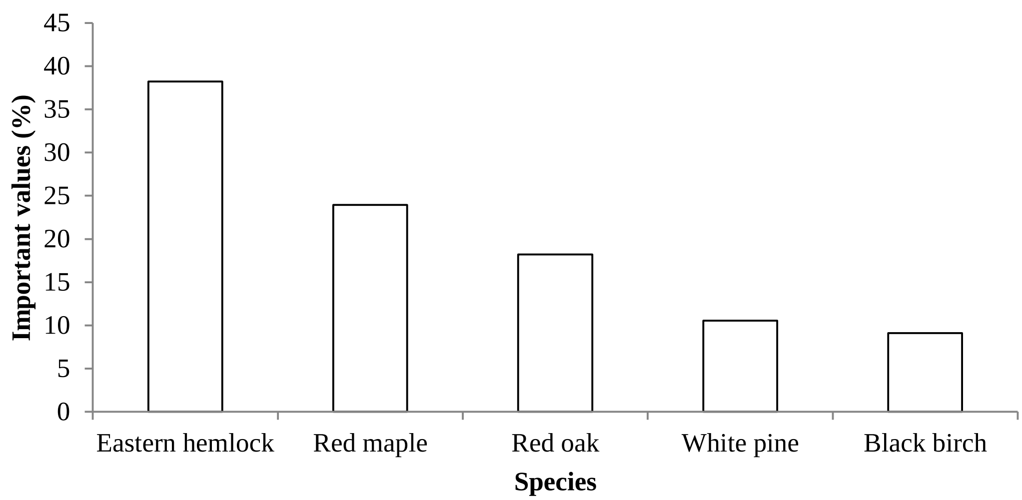

Figure 4. Important values (average of relative basal area and relative frequency) of tree species in eastern hemlock forest cover type at Hiroshi Land, Peterborough, NH.

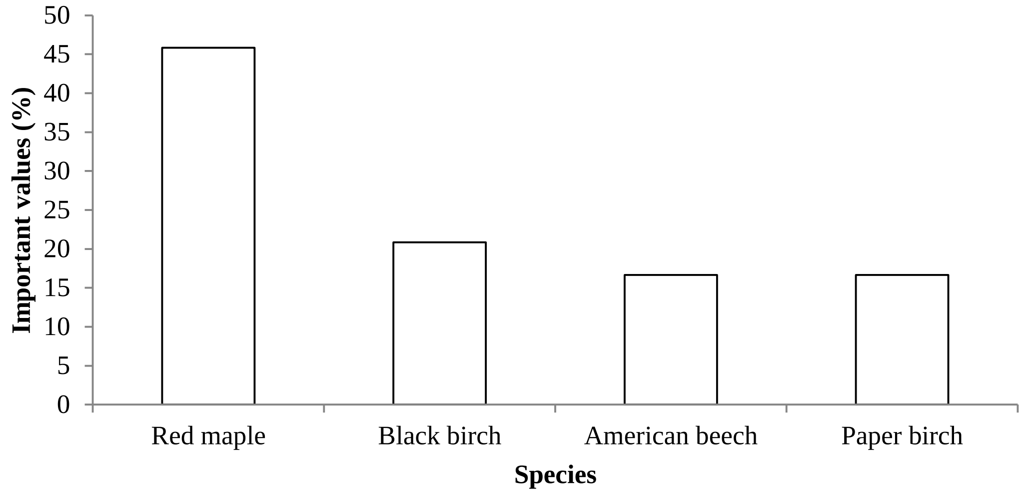

Figure 5. Important values (average of relative basal area and relative frequency) of tree species in the recently disturbed red maple forest cover type at Hiroshi Land, Peterborough, NH.

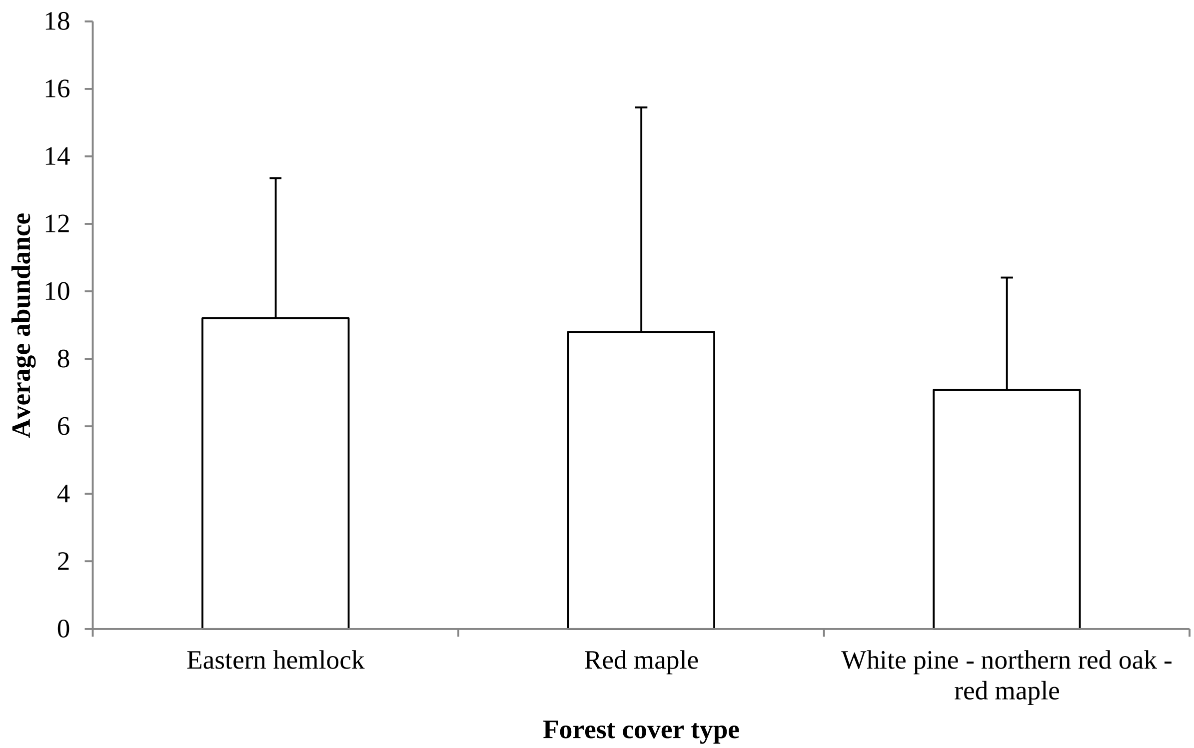

Figure 6. Average abundance of birds per 10 minute sampling session across different forest cover types at Hiroshi Land, Peterborough, NH. February-April 2016.

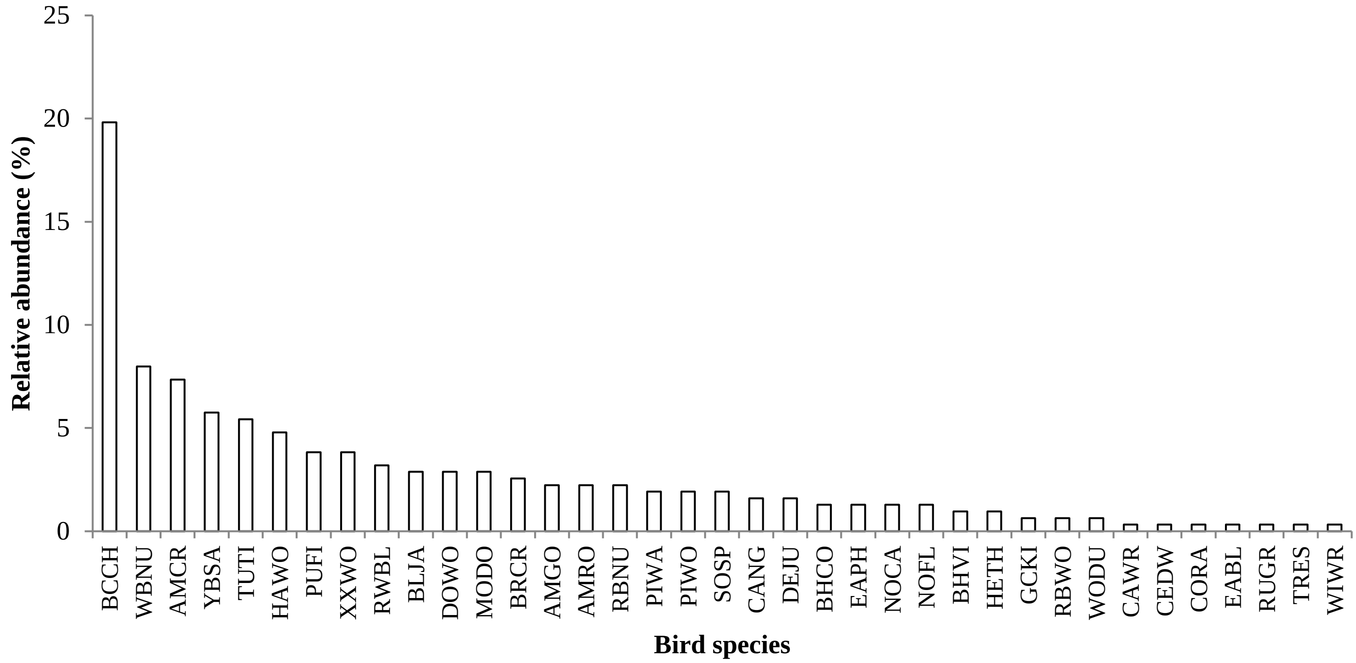

Figure 7. Relative abundance (%) of bird species observed during all bird count surveys at Hiroshi Land, Peterborough, NH. February-April 2016.

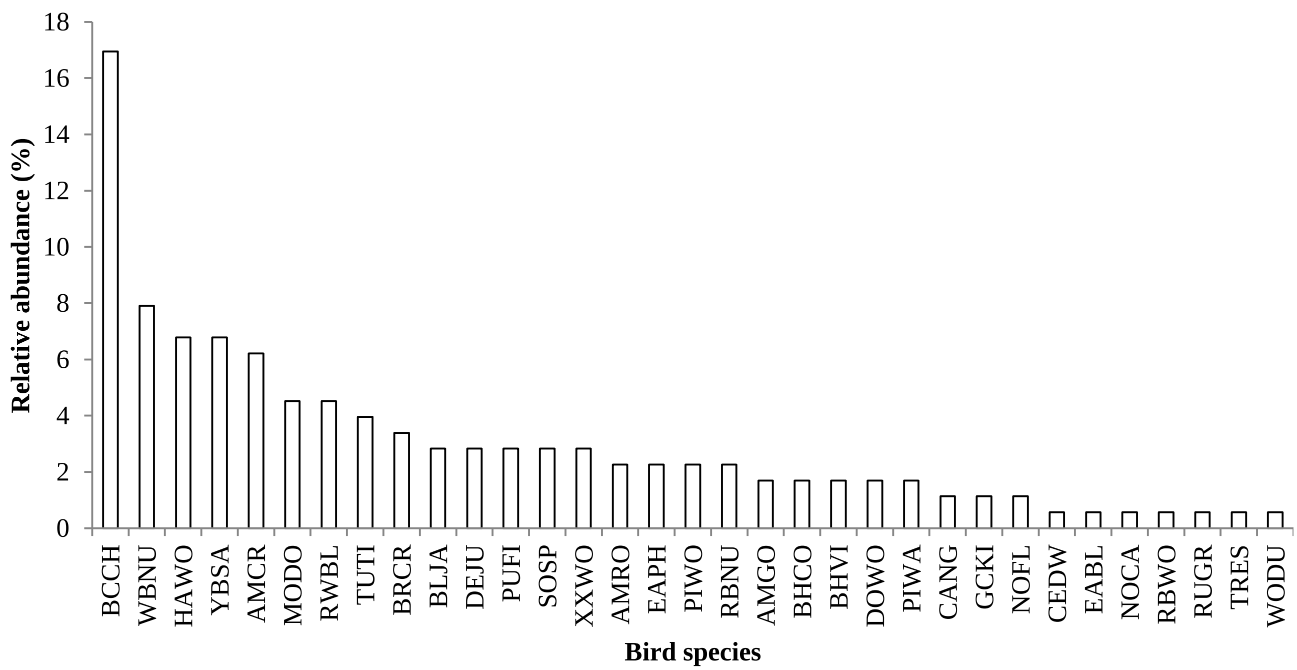

Figure 8. Relative abundance (%) of bird species observed in white pine – northern red oak – red maple forest cover type at Hiroshi Land, Peterborough, NH. February-April 2016.

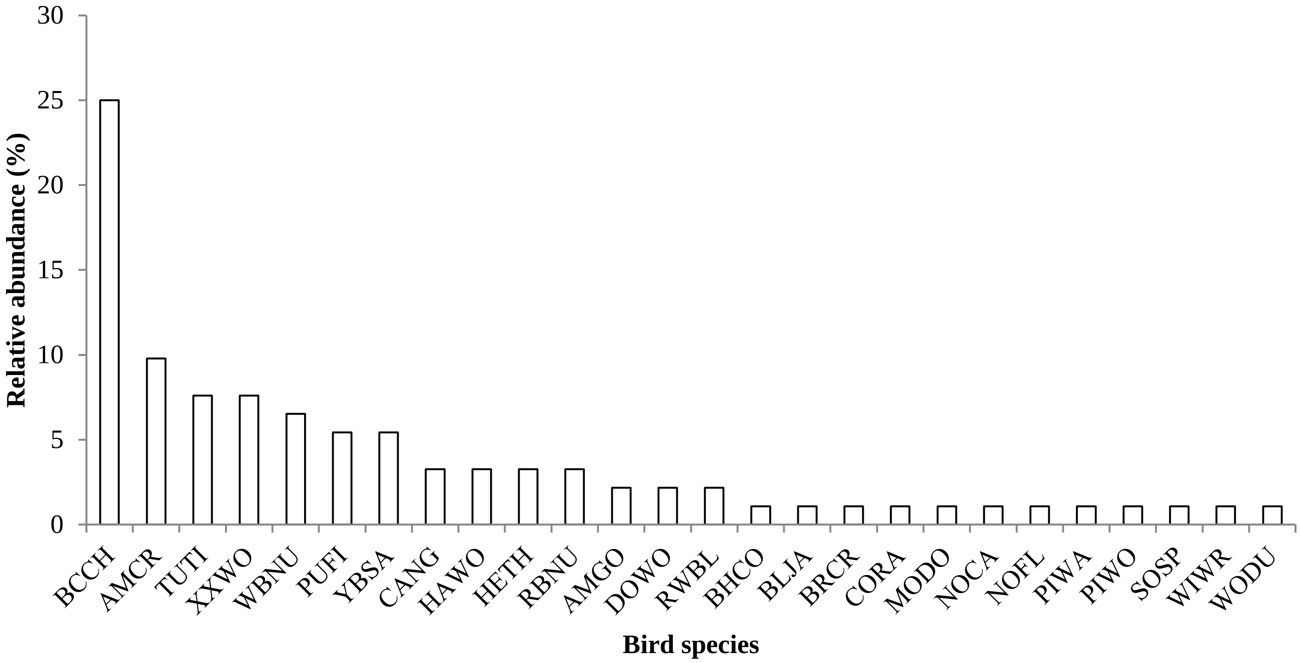

Figure 9. Relative abundance (%) of bird species observed in eastern hemlock forest cover type at Hiroshi Land, Peterborough, NH. February-April 2016.

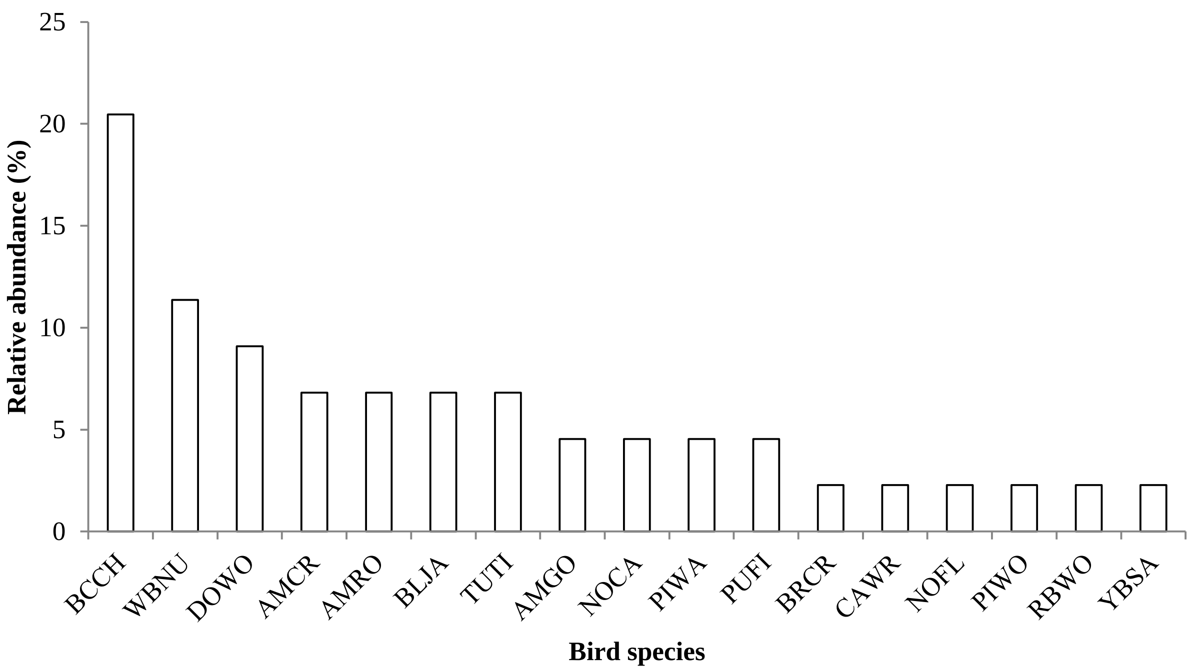

Figure 10. Relative abundance (%) of bird species observed in recently disturbed red maple forest cover type at Hiroshi Land, Peterborough, NH. February-April 2016.

Discussion

The results of this study suggest that birds utilize the various forest habitat types differently within the Hiroshi Land. The white pine – northern red oak – red maple forest cover type, which made up the majority of the sampled sites on the Hiroshi Land, had the lowest average abundance of birds, but was the most species rich and diverse of all of the forest cover habitat types. The eastern hemlock forest cover type, which had the greatest average basal area, also had the greatest average abundance of birds, but was the least species even (weighted heavily towards Black-capped Chickadees). Finally, the recently logged red maple forest type, which consequently had the lowest average basal area, was also the least species rich and diverse, but was the most species even. These results contrasted those found by Welsh and Healy (1993) in the White Mountains, NH, which indicated that land managed for logging should have a greater species richness than land that has not been recently disturbed.

After we inventoried the birds of the Hiroshi Land, we found that the most dominant species on the property were resident species, including the Black-capped Chickadee, White-breasted Nuthatch, and American Crow. It is important to note that the surveys began in February, before many of the spring migrants had arrived. However, several early spring migrants, which travel to the Northeast region to breed, were detected on the property including Yellow-bellied Sapsucker (*Sphyrapicus varius*), Blue-headed Vireo (*Vireo solitarius*), and Pine Warbler (*Setophaga pinus*). This may have skewed our abundance counts towards resident species. Perhaps if the survey had been conducted later in the year, the resident species (e.g., Black-capped Chickadee) would not have appeared as dominant. Whether these migratory birds are breeding on the Hiroshi Land or utilizing it as a stopover site, it is important to note that these species are using the property. We also documented two species of gamebird that are using the

Hiroshi Land; Wood Duck (*Aix sponsa*) and Ruffed Grouse (*Bonasa umbellus*) were observed and/or heard on the property. Migratory and game species documented on the property can help to inform management actions in the future, and their presence indicates that the Hiroshi Land is a property of ecological value.

The timeframe of the data collection was limiting, thus impacting our results based on the fact that data collection stopped before all migrants had returned from their wintering grounds. There could be other species of concern using the Hiroshi Land as both breeding grounds and a migratory pathway. For example, Black-throated Green Warbler (*Setophaga virens*), Red-eyed Vireo (*Vireo olivaceus*), Yellow Warbler (*Setophaga petechia*), Common Yellowthroat (*Geothlypis trichas*), and Black-and-white Warbler (*Mniotilta varia*), among others, could potentially use the Hiroshi Land based on their habitat requirements. This is an assumption however, and should not directly influence management strategies based on our study alone. A more extensive study of the Hiroshi Land over the course of several years and all seasons should be conducted to verify the above assumption if management is to be guided with any of the potential species in mind.

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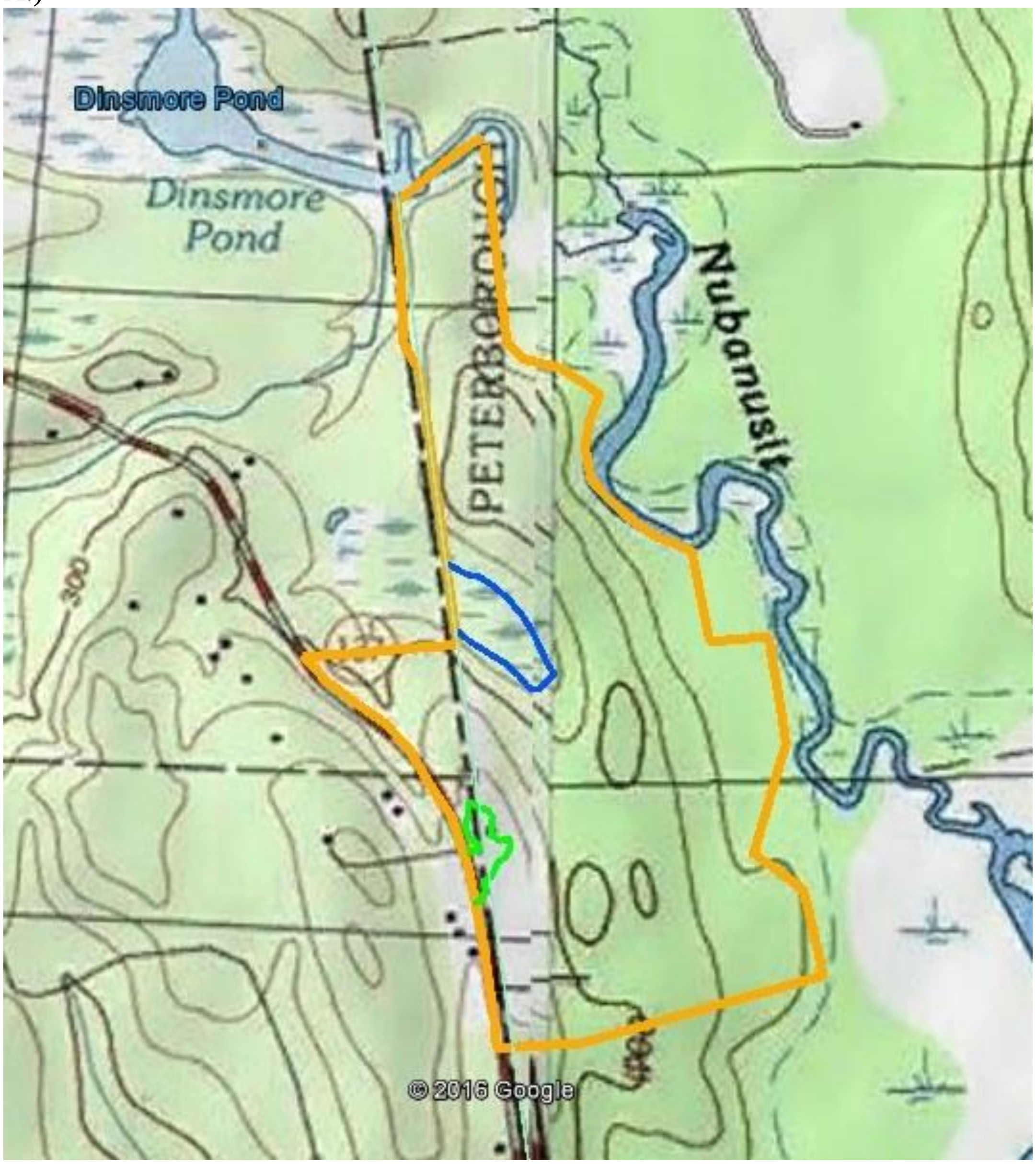
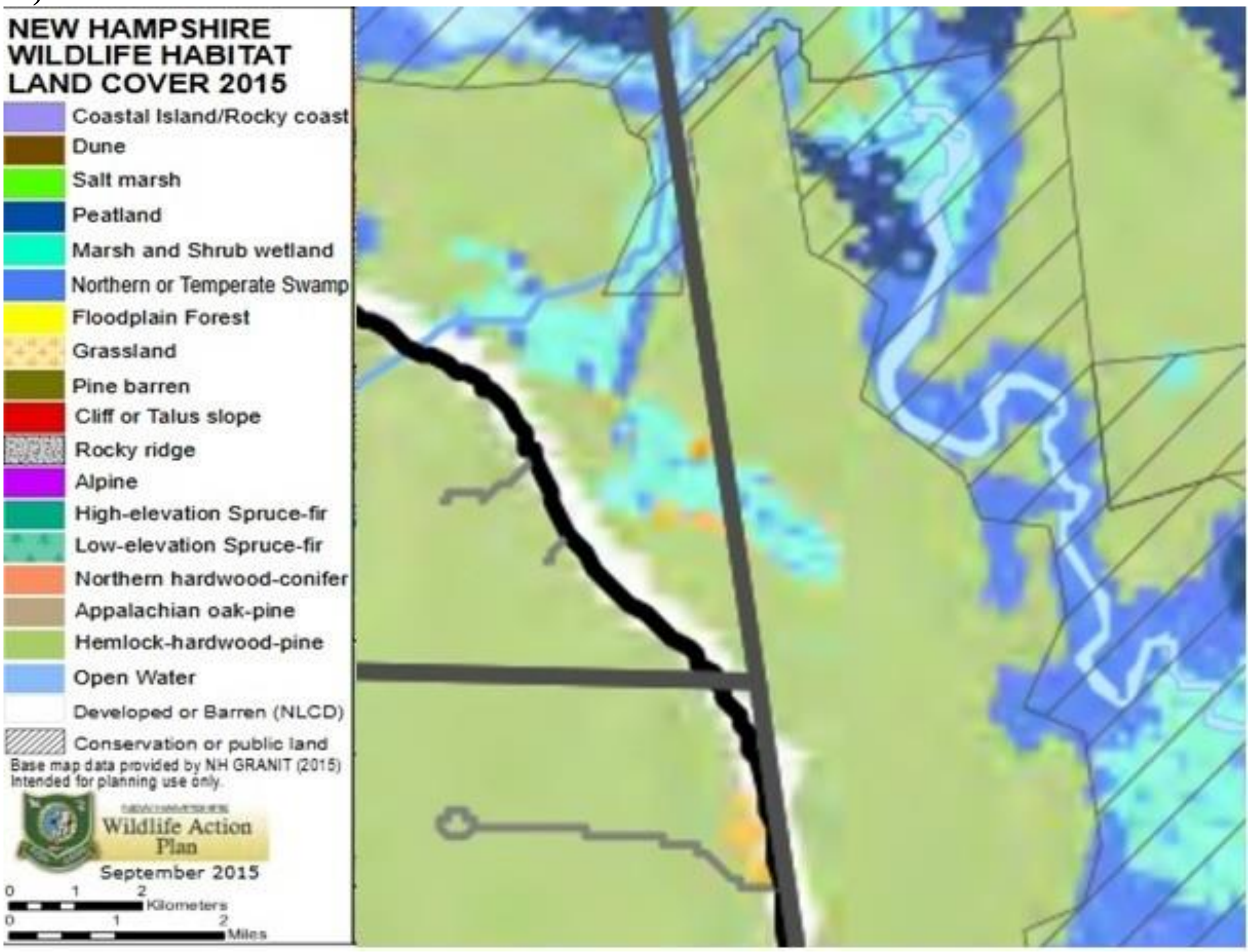
Appendix I

Maps describing the area within and surrounding the Hiroshi Land, Peterborough, NH, including A.) topographic map (Google Inc. 2016), B.) habitat map (New Hampshire Fish and Game Department 2016), and C.) point count locations (Google Inc. 2016)

A.)



B.)


NEW HAMPSHIRE
WILDLIFE HABITAT
LAND COVER 2015
Coastal Island/Rocky coast
Dune
Salt marsh
Peatland
Marsh and Shrub wetland
Northern or Temperate Swamp
Floodplain Forest
Grassland
Pine barren
Cliff or Talus slope
Rocky ridge
Alpine
High-elevation Spruce-fir
Low-elevation Spruce-fir
Northern hardwood-conifer
Appalachian oak-pine
Hemlock-hardwood-pine
Open Water
Developed or Barren (NLCD)
Conservation or public land
Base map data provided by NH GRANIT (2015)
Intended for planning use only.
Wildlife Action Plan
September 2015
0 1 2 Kilometers
0 1 2 Miles

C.)

Appendix II

Key for the American Ornithologists' Union (AOU) designated four-letter codes in Fig. 7-10.

AOU four-letter code	Common name	Scientific name
AMCR	American Crow	*Corvus brachyrhynchos*
AMGO	American Goldfinch	*Spinus tristis*
AMRO	American Robin	*Turdus migratorius*
BCCH	Black-capped Chickadee	*Poecile atricapillus*
BHCO	Brown-headed Cowbird	*Molothrus ater*
BHVI	Blue-headed Vireo	*Vireo solitarius*
BLJA	Blue Jay	*Cyanocitta cristata*
BRCR	Brown Creeper	*Certhia americana*
CANG	Canada Goose	*Branta canadensis*
CAWR	Carolina Wren	*Thryothorus ludovicianus*
CEDW	Cedar Waxwing	*Bombycilla cedrorum*
CORA	Common Raven	*Corvus corax*
DEJU	Dark-eyed Junco	*Junco hyemalis*
DOWO	Downy Woodpecker	*Picoides pubescens*
EABL	Eastern Bluebird	*Sialia sialis*
EAPH	Eastern Phoebe	*Sayornis phoebe*
GCKI	Golden-crowned Kinglet	*Regulus satrapa*
HAWO	Hairy Woodpecker	*Leuconotopicus villosus*
HETH	Hermit Thrush	*Catharus guttatus*
MODO	Mourning Dove	*Zenaida macroura*
NOCA	Northern Cardinal	*Cardinalis cardinalis*
NOFL	Northern Flicker	*Colaptes auratus*
PIWA	Pine Warbler	*Setophaga pinus*
PIWO	Pileated Woodpecker	*Hylatomus pileatus*
PUFI	Purple Finch	*Haemorhous purpureus*
RBNU	Red-breasted Nuthatch	*Sitta canadensis*
RBWO	Red-bellied Woodpecker	*Melanerpes carolinus*
RUGR	Ruffed Grouse	*Bonasa umbellus*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
SOSP	Song Sparrow	*Melospiza melodia*
TRES	Tree Swallow	*Tachycineta bicolor*
TUTI	Tufted Titmouse	*Baeolophus bicolor*
WBNU	White-breasted Nuthatch	*Sitta carolinensis*
WIWR	Winter Wren	*Troglodytes hiemalis*
WODU	Wood Duck	*Aix sponsa*
XXWO	Unknown woodpecker species	*Picidae* family
YBSA	Yellow-bellied Sapsucker	*Sphyrapicus varius*