

**A Breeding Bird Survey of the
Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge
2001 Final Report**

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ABSTRACT

In 2000, I used point counts, area searches, and callback surveys to investigate the use of representative natural communities (RNC) by breeding landbirds in the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge (Lambert 2000). I repeated the point counts in 2001, adding road-based points in areas recently managed for timber production (timber harvest zone or THZ). Objectives in the second year were to further document the presence, relative abundance, and distribution of breeding birds, to measure between-year changes in bird abundance, and to evaluate effects of forest management on the local bird community. This report places emphasis on species identified as conservation priorities by the state of Vermont or Partners in Flight (PIF).

I detected 85 bird species during and between point counts in 2001, including 13 species not documented in the study area in 2000. After two years of breeding season surveys, the Nulhegan Basin Division's bird list stands at 103 species, of which 43 are neotropical migrants and 32 are considered conservation priorities. Breeding residents are uncommon compared to short- and long-distance migrants, however this group includes four conifer-dwelling species that occur in few other Vermont locations (Spruce Grouse, Gray Jay, Boreal Chickadee, Black-backed Woodpecker). RNC bird communities experienced very slight changes in composition and no change in overall abundance between years. The 75 species observed over the two years were divided evenly between those that decreased in abundance (37) and those that increased or were unchanged in number (38). No pattern related to habitat, guild, or migratory strategy was evident in these groups. Moderate changes in number (> 20%) were observed for two out of three species, however pronounced changes (> 40%) were uncommon.

The ten most abundant species in the THZ were also the ten most widespread in this management category. All are typical of northern New England forests where logging has created a mosaic of forest types and seral stages. Measures of overall abundance were similar in the THZ and RNC, although differences in other parameters were evident. Species richness and diversity were higher at THZ stations than at RNC stations, apparently due to the diversity of forest age-classes in the THZ. However, forests managed for timber production were less important than forest reserves to state- or PIF-listed species. Abundance of birds in the priority species class was 28% higher in undisturbed forests than in forests managed for timber production. Six forest-dwelling species, half of them listed as high regional priorities, were notably reduced in the THZ compared to the RNC. Five of the six exhibit a strong conifer association, and the same number require structural features of mature forests for nesting. Of the three species that showed a positive association with timber management, none are listed as conservation priorities by the state or PIF.

Preliminary indications suggest that efforts to restore the extent, continuity, and maturity of the Nulhegan Basin's conifer forests may reduce avian richness and diversity at the local scale. However, they will produce the greatest regional benefits to bird conservation by ensuring diversity at larger scales. This broad view of bird conservation is consistent with the founding principles of the Conte Refuge, which was established as a regional management effort (USFWS 1995).

BACKGROUND AND PURPOSE

In 1999, the U.S. Fish and Wildlife Service (the Service) established the Nulhegan Basin Division (NBD) of the Silvio O. Conte National Fish and Wildlife Refuge on 26,000 acres of former timberland in Essex County, Vermont. The property contains outstanding examples of woodland habitat, including lowland conifer forests of high regional significance to bird populations (Laughlin and Kibbe 1985, Lambert 2000). Several bird species that are uncommon in the Northeast occur here at the southern periphery of their breeding ranges. This group consists of year-round residents (Boreal Chickadee, Gray Jay, Spruce Grouse, Black-backed Woodpecker) and migratory species (e.g. Bay-breasted Warbler, Palm Warbler, Olive-sided Flycatcher, Rusty Blackbird, Philadelphia Vireo). In addition, productive wetland and upland sites provide stopover habitat for transient birds and wintering habitat for irruptive finch, crossbill, and grosbeak populations. The bird conservation value of the Nulhegan Basin is further enhanced by its location near the heart of the eastern spruce-hardwood forest. Partners in Flight describes this physiographic region as a breeding stronghold for neotropical migrants (Rosenberg and Hodgman 2000).

The Service's stewardship priorities demonstrate a commitment to protecting the area's extraordinary bird life. The Silvio O. Conte National Fish and Wildlife Refuge Act charged the Service "to conserve, protect and enhance the natural diversity and abundance of plant, fish, and wildlife species and the ecosystems upon which these species depend in the refuge." The Final Environmental Assessment for the Nulhegan Basin Division places strong emphasis on the protection of rare species and migratory bird habitat (USFWS 1995). Actions to conserve migratory bird habitat fulfill the federal government's obligations under the multi-national Migratory Bird Treaty Act.

During the 2000 landbird breeding season, I used point counts, area searches, and callback surveys to investigate avian use of representative natural communities in the Nulhegan Basin Division and the neighboring West Mountain Wildlife Management Area (Lambert 2000). Results showed locations and natural community associations of 103 bird species, including 23 listed as conservation priorities. Lowland spruce-fir forests emerged as the natural community of primary bird conservation value, due to a high diversity index and a high proportion of priority species. When combined with black spruce bogs, black spruce swamps, and northern white cedar swamps, these forests form a lowland softwood complex inhabited by half of the area's breeding bird species. In the uplands, red spruce-northern hardwood forests contained the greatest avian diversity, supporting both softwood and hardwood associates. The investigation also found that non-forested wetlands enrich the area's avifauna. Alluvial shrub swamps ranked high for diversity, while the dwarf shrub bog/poor fen complex contained three species found in no other natural community type.

Nulhegan Basin point counts were repeated in 2001, with a road-based survey added to complement the sampling of representative natural communities. My objective in the second year was to provide further documentation of the presence, relative abundance, and distribution of landbirds, with an emphasis on state- or PIF-listed species. Results establish a baseline for future monitoring and enable a preliminary assessment of timber management effects on the structure of bird communities in the Nulhegan Basin.

STUDY AREA

The Nulhegan Basin Division is located north of route 105 in Essex County, Vermont. Its 26,000 acres include parts of four towns: Lewis, Bloomfield, Ferdinand, and Brunswick. The

basin, itself, is a low-lying, circular area surrounded by prominent hills. It is drained by four tributaries of the Nulhegan River: the North Branch, the Logger Branch, the Yellow Branch, and the Black Branch. National Wetlands Inventory maps show close to 7,000 acres of wetlands within the Division's boundaries. These include boreal bogs, black spruce swamps, shrub swamps, and sedge meadows. Conifer and mixed forests predominate in the lowlands, while northern hardwoods ring the basin on upland slopes. Intensive logging in the 1970's, hastened by spruce budworm outbreaks (USFWS 1999), has resulted in an extensive matrix of young, regenerating cut-blocks and scattered remnants of older forest.

METHODS

Survey Procedures

I placed fifty-five point count stations within representative natural communities (RNC) mapped by Lapin et al. (2001). Only large, relatively intact, and mature natural communities qualified as representative. RNC points, separated by a minimum of 200 m, were situated 60-1,575 m from the nearest road and at least 50 m from natural community ecotones. The network of survey stations encompassed lowland conifer forest (n = 26 points), mixed-wood forest (n = 10), northern hardwood forest (n = 10), and non-forested wetland (n = 9). The last category consisted primarily of alluvial shrubland points (n = 6), but also included a single point each in an alder swamp, beaver meadow, and alluvial grassland. To sample the intensively managed portion of the landscape, or the timber harvest zone (THZ), I used 24 owl survey points established in 2000 at one-mile intervals throughout the road network (Lambert 2000). I added another 23 stations at the midpoints for a total of 47 THZ points. These points were located adjacent to a variety of forest cover types and seral stages, including mature forest fragments. Map 1 depicts survey point locations. A list of points and their coordinates appears in Appendix 1.

I surveyed each RNC and THZ station once between 1 and 20 June, 2001. Survey periods began within 15 minutes of sunrise and ended within four hours. During a 10-minute listening period at each point, I counted all individuals seen and heard in two distance classes: within and beyond 50 m. I also recorded new species for addition to the NBD bird list.

Data analysis

To describe bird communities associated with harvested and undisturbed portions of the landscape, I analyzed RNC and THZ results separately. First, I combined the two distance classes into an unlimited distance class and calculated frequency of occurrence and relative abundance for each species. I defined frequency of occurrence as the number of points at which a species occurred divided by the total number of points surveyed. Relative abundance was measured as the total number of individuals divided by the total number of points surveyed.

Direct comparison of RNC and THZ results required subsampling for two reasons: differences in the geographic spread of sampling locations in the northern portion of the refuge (Map 1) and uneven representation of habitat types in the two categories. To resolve these issues, I subsampled from a portion of the refuge located west of the Vermont Electric Company powerline and south of UTM 4,971,000 m N (North American Datum 1927). This 16,171-acre area (hereafter the basin proper) captures nearly the entire Nulhegan lowland and includes comparable spatial distributions of RNC and THZ sampling points. Eighty-five percent of the basin proper is designated as lowland conifer forest (58%) or mixed forest (27%). To subsample

Map 1. Point Count Stations in the Nulhegan Basin Division

- Road Station
- Off-road Station
- Nulhegan Basin Division

Land Cover

- Non-forested Upland
- Conifer Forest
- Deciduous Forest
- Mixed Forest
- Open Water
- Non-forested Wetland

1 0 1 Kilometers



Land cover data provided by UVM Spatial Analysis Lab based on Landsat and ancillary sources. Boundary data from the US Fish and Wildlife Service. Point data collected in the field with GPS by J.D. Lambert.



these habitats in direct proportion to their availability, I randomly selected 17 lowland conifer points and 8 mixed forest points from the RNC and THZ categories. To reduce error and enable interspecific comparisons, I restricted the analysis to individuals detected within 50 m of the survey point. Such comparisons using unlimited distance data are inappropriate due to interspecific differences in detectability (Pence 1996).

To avoid pseudoreplication, I summed counts for each species in both management categories. As a result, statistical options for the comparison of RNC and THZ counts were reduced to tests for goodness of fit. This approach proved capable of detecting differences only when effect sizes were great (> 0.8). Rather than wrongly apply inferential statistics, I opted for simple comparison of summed counts. I charted these counts for any species that showed a three-fold or greater difference in number between management categories, with a minimum requirement of four individuals counted in at least one category. This method, though elementary, pointed toward timber management effects that are consistent with findings of more robust analyses.

I further compared the harvested and undisturbed portions of the basin proper by measuring the proportionate representation of species appearing on state and/or PIF priority lists and by calculating Shannon's diversity index (H) for each management category. This index accounts for species richness, abundance and evenness. In the formula below, s represents richness and p_i is the proportionate representation of species i among the total number of individuals.

$$H = - \sum_{i=1}^s p_i \ln p_i$$

Survey results formed the basis of 2001 distribution maps for priority species. To these, I added observations made during transect layout and during occasional area searches. The resulting maps do not necessarily represent the true distribution of rare species, since sampling effort was uneven across the 26,000 acres. Nonetheless, they provide useful information to guide future decision-making and bird study.

RESULTS

Species Presence and Conservation Ranks

I detected 85 bird species during and between point counts in 2001, including 13 species not documented in the study area during 2000. After two years of breeding season surveys, the Nulhegan Basin Division's bird list stands at 103 species (Table 1). Of these, 43 are neotropical migrants, 24 appear on the Partners in Flight priority list for the Eastern Spruce-Hardwood Forest (Rosenberg and Hodgman 2000), and 18 are listed by the state as uncommon, rare, very rare, of special concern, threatened, or endangered. In all, 32 of the 103 observed species (31%) are considered conservation priorities by the state and/or Partners in Flight.

Table 1. Alphabetical species list and conservation ranks for the Nulhegan Basin Division, based on 2000 and 2001 data. Asterisks designate neotropical migrants. State ranks from VDFW (1996); PIF ranks from Rosenberg and Hodgman (2000).

Common name	Scientific name	VT status	PIFRank
Alder Flycatcher *	<i>Empidonax alnorum</i>	S	NR
American Black Duck	<i>Anas rubripes</i>	S	NR
American Crow	<i>Corvus brachyrhynchos</i>	S	NR
American Goldfinch	<i>Carduelis tristis</i>	S	NR
American Redstart *	<i>Setophaga ruticilla</i>	S	NR
American Robin	<i>Turdus migratorius</i>	S	NR
American Woodcock	<i>Scolopax minor</i>	S	1
Baltimore Oriole *	<i>Icterus galbula</i>	S	NR
Barred Owl	<i>Strix varia</i>	S	NR
Bay-breasted Warbler *	<i>Dendroica castanea</i>	VR	1
Belted Kingfisher	<i>Ceryle alcyon</i>	S	2
Black-and-White Warbler *	<i>Mniotilta varia</i>	S	NR
Black-backed Woodpecker	<i>Picoides arcticus</i>	SC	NR
Blackburnian Warbler *	<i>Dendroica fusca</i>	S	2
Black-capped Chickadee	<i>Parus atricapillus</i>	S	NR
Blackpoll Warbler *	<i>Dendroica striata</i>	S	2
Black-throated Blue Warbler *	<i>Dendroica caerulescens</i>	S	2
Black-throated Green Warbler *	<i>Dendroica virens</i>	S	2
Blue Jay	<i>Cyanocitta cristata</i>	S	NR
Blue-headed Vireo *	<i>Vireo solitarius</i>	S	NR
Boreal Chickadee	<i>Parus hudsonicus</i>	S, U	2
Broad-winged Hawk	<i>Buteo platypterus</i>	S	NR
Brown Creeper	<i>Certhia americana</i>	S	NR
Canada Goose	<i>Branta canadensis</i>	S	NR
Canada Warbler *	<i>Wilsonia canadensis</i>	S	1
Cape May Warbler *	<i>Dendroica tigrina</i>	U, R	1
Cedar Waxwing	<i>Bombycilla cedrorum</i>	S	NR
Chestnut-sided Warbler *	<i>Dendroica pennsylvanica</i>	S	NR
Chimney Swift *	<i>Chaetura pelagica</i>	S	NR
Chipping Sparrow *	<i>Spizella passerina</i>	S	NR
Common Grackle	<i>Quiscalus quiscula</i>	S	NR
Common Loon	<i>Gavia immer</i>	E	4
Common Raven	<i>Corvus corax</i>	S	NR
Common Snipe	<i>Gallinago gallinago</i>	S	NR
Common Yellowthroat *	<i>Geothlypis trichas</i>	S	NR
Cooper's Hawk	<i>Accipiter cooperii</i>	SC	NR
Dark-eyed Junco	<i>Junco hyemalis</i>	S	NR
Downy Woodpecker	<i>Picoides pubescens</i>	S	NR
Eastern Phoebe	<i>Sayornis phoebe</i>	S	NR
Eastern Wood Pewee *	<i>Contopus virens</i>	S	2
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	S	NR
Golden-crowned Kinglet	<i>Regulus satrapa</i>	S	NR
Golden-winged Warbler *	<i>Vermivora chrysoptera</i>	U, R	NR
Gray Catbird *	<i>Dumetella carolinensis</i>	S	NR
Gray Jay	<i>Perisoreus canadensis</i>	SC	NR
Great Blue Heron	<i>Ardea herodias</i>	U, R	NR

Great Crested Flycatcher *	<i>Myiarchus crinitus</i>	S	NR
Great Horned Owl	<i>Bubo virginianus</i>	S	NR
Hairy Woodpecker	<i>Picoides villosus</i>	S	NR
Hermit Thrush	<i>Catharus guttatus</i>	S	NR
Least Flycatcher *	<i>Empidonax minimus</i>	S	2
Lincoln's Sparrow *	<i>Melospiza lincolnii</i>	S	NR
Magnolia Warbler *	<i>Dendroica magnolia</i>	S	NR
Mallard	<i>Anas platyrhynchos</i>	S	NR
Mourning Dove	<i>Zenaida macroura</i>	S	NR
Mourning Warbler *	<i>Oporornis philadelphia</i>	S	NR
Nashville Warbler *	<i>Vermivora ruficapilla</i>	S	2
Northern Flicker	<i>Colaptes auratus</i>	S	NR
Northern Goshawk	<i>Accipiter gentilis</i>	S	NR
Northern Harrier	<i>Circus cyaneus</i>	SC	4
Northern Parula *	<i>Parula Americana</i>	S	2
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	S	NR
Northern Waterthrush *	<i>Seiurus noveboracensis</i>	S	NR
Olive-sided Flycatcher *	<i>Contopus borealis</i>	S	2
Osprey	<i>Pandion haliaetus</i>	E	4
Ovenbird *	<i>Seiurus aurocapillus</i>	S	NR
Palm Warbler *	<i>Dendroica palmarum</i>	VR	NR
Philadelphia Vireo *	<i>Vireo philadelphicus</i>	U, R	2
Pileated Woodpecker	<i>Dryocopus pileatus</i>	S	NR
Pine Siskin	<i>Carduelis pinus</i>	S	NR
Purple Finch	<i>Carpodacus purpureus</i>	S	2
Red-breasted Nuthatch	<i>Sitta Canadensis</i>	S	NR
Red-eyed Vireo *	<i>Vireo olivaceus</i>	S	NR
Red-tailed Hawk	<i>Buteo jamaicensis</i>	S	NR
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	S	NR
Rock Dove	<i>Columba livia</i>	S	NR
Rose-breasted Grosbeak *	<i>Pheucticus ludovicianus</i>	S	NR
Ruby-crowned Kinglet	<i>Regulus calendula</i>	S	NR
Ruby-throated Hummingbird *	<i>Archilochus colubris</i>	S	NR
Ruffed Grouse	<i>Bonasa umbellus</i>	S	2
Rusty Blackbird	<i>Euphagus carolinus</i>	SC	NR
Scarlet Tanager *	<i>Piranga olivacea</i>	S	NR
Sharp-shinned Hawk	<i>Accipiter striatus</i>	S	NR
Song Sparrow	<i>Melospiza melodia</i>	S	NR
Spotted Sandpiper	<i>Actitis macularia</i>	S	NR
Spruce Grouse	<i>Dendragapus canadensis</i>	E	2
Swainson's Thrush *	<i>Catharus ustulatus</i>	S	NR
Swamp Sparrow	<i>Melospiza georgiana</i>	S	NR
Tennessee Warbler *	<i>Vermivora peregrina</i>	U, R	NR
Tree Swallow	<i>Tachycineta bicolor</i>	S	NR
Veery *	<i>Catharus fuscescens</i>	S	2
Warbling Vireo *	<i>Vireo gilvus</i>	S	NR
White-breasted Nuthatch	<i>Sitta carolinensis</i>	S	NR
White-throated Sparrow	<i>Zonotrichia albicollis</i>	S	NR
White-winged Crossbill	<i>Loxia leucoptera</i>	S	NR
Wild Turkey	<i>Meleagris gallopavo</i>	S	NR

Willow Flycatcher *	<i>Empidonax trailii</i>	S	NR
Wilson's Warbler *	<i>Wilsonia pusilla</i>	VR	NR
Winter Wren	<i>Troglodytes troglodytes</i>	S	NR
Yellow Warbler *	<i>Dendroica petechia</i>	S	NR
Yellow-bellied Flycatcher *	<i>Empidonax flaviventris</i>	S	NR
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	S	2
Yellow-rumped Warbler	<i>Dendroica coronata</i>	S	NR
<u>VT status codes</u>	<u>PIF ranks</u>		
S = secure or apparently secure	NR = not ranked		
U = uncommon	1 = high global priority		
R = rare	2 = high regional priority		
VR = very rare	4 = state R,T, and E		
T = threatened			
E = endangered			

Representative Natural Community Results (2000 and 2001)

I counted 714 individuals during unlimited distance, 10-minute surveys at 55 RNC stations in 2001, just two more birds than were recorded in 2000. The count included 65 species, four fewer than the previous year. Of the 75 species observed over the two years, eight showed no change in number, 30 increased in abundance, and 37 decreased. The magnitude of change exceeded 20% for two out of three species. The 30 species with the highest measures of relative abundance were the same each year (Table 2), with two exceptions. Brown Creeper and Palm Warbler increased by 143% and 29%, respectively, replacing Blackburnian Warbler, which experienced no change in number, and Blue Jay, which declined by 46%. Two more species from the top-thirty list increased by over 40%. These were American Redstart (46%) and Winter Wren (87%). Besides Blue Jay, the only species from this group with a pronounced (> 40%) drop in abundance was Northern Parula. Its numbers were down by 41% in 2001. Resident species were uncommon compared to short- and long-distance migrants. Each year, only three of the 30 most abundant species were residents (Golden-crowned Kinglet, Blue Jay, and Black-capped Chickadee in 2000; Golden-crowned Kinglet, Black-capped Chickadee, and Brown Creeper in 2001).

Table 2. Frequency and abundance of bird species detected by unlimited distance point counts from 55 stations located in representative natural communities of the Nulhegan Basin Division in 2000 and 2001.

Species	Frequency		Relative abundance				
	of occurrence		2000		2001		change
	2000	2001	mean	se	mean	se	
White-throated Sparrow	0.58	0.73	0.75	0.10	0.98	0.11	+
Nashville Warbler	0.47	0.45	0.75	0.13	0.69	0.12	-
Red-eyed Vireo	0.42	0.31	0.71	0.15	0.62	0.14	-
Yellow-bellied Flycatcher	0.49	0.35	0.71	0.12	0.55	0.12	-
Magnolia Warbler	0.53	0.45	0.67	0.10	0.64	0.11	-
Hermit Thrush	0.49	0.51	0.62	0.10	0.71	0.11	+
Yellow-rumped Warbler	0.44	0.36	0.49	0.09	0.44	0.09	-
Blue-headed Vireo	0.36	0.22	0.44	0.09	0.27	0.08	-
Winter Wren	0.38	0.64	0.42	0.08	0.78	0.10	+

Black-throated Green Warbler	0.29	0.25	0.42	0.10	0.29	0.07	-
Golden-crowned Kinglet	0.38	0.36	0.40	0.07	0.44	0.09	+
Common Yellowthroat	0.31	0.22	0.36	0.08	0.29	0.08	-
Ovenbird	0.25	0.33	0.35	0.09	0.40	0.08	+
Black-throated Blue Warbler	0.29	0.20	0.35	0.08	0.24	0.07	-
Northern Parula	0.29	0.15	0.31	0.07	0.18	0.06	-
Chestnut-sided Warbler	0.20	0.18	0.27	0.08	0.27	0.08	none
Swainson's Thrush	0.24	0.18	0.27	0.07	0.22	0.07	-
Northern Waterthrush	0.24	0.16	0.25	0.06	0.20	0.07	-
American Redstart	0.18	0.24	0.24	0.08	0.35	0.10	+
Swamp Sparrow	0.15	0.16	0.24	0.09	0.31	0.10	+
Cedar Waxwing	0.07	0.09	0.24	0.14	0.29	0.20	+
Red-breasted Nuthatch	0.20	0.20	0.24	0.07	0.20	0.05	-
Blue Jay	0.22	0.11	0.24	0.06	0.13	0.05	-
Canada Warbler	0.18	0.15	0.22	0.07	0.18	0.06	-
Veery	0.16	0.16	0.20	0.07	0.25	0.09	+
Black-capped Chickadee	0.16	0.18	0.20	0.07	0.24	0.07	+
Alder Flycatcher	0.15	0.13	0.20	0.07	0.16	0.07	-
Ruby-crowned Kinglet	0.18	0.15	0.18	0.05	0.16	0.06	-
Yellow-bellied Sapsucker	0.16	0.18	0.16	0.05	0.20	0.06	+
Blackburnian Warbler	0.13	0.11	0.15	0.05	0.15	0.06	none
Brown Creeper	0.13	0.27	0.13	0.05	0.31	0.07	+
Palm Warbler	0.09	0.13	0.13	0.06	0.16	0.06	+
Evening Grosbeak	0.09	0.00	0.13	0.06	0.00	0.00	-
Gray Jay	0.07	0.07	0.11	0.06	0.09	0.05	-
Song Sparrow	0.05	0.05	0.11	0.07	0.07	0.04	-
Purple Finch	0.07	0.16	0.09	0.05	0.16	0.05	+
American Robin	0.09	0.02	0.09	0.04	0.02	0.02	-
Black-and-White Warbler	0.07	0.15	0.07	0.04	0.15	0.05	+
Dark-eyed Junco	0.07	0.05	0.07	0.04	0.05	0.03	-
Mourning Warbler	0.05	0.05	0.07	0.04	0.05	0.03	-
American Goldfinch	0.05	0.04	0.07	0.04	0.04	0.03	-
Tree Swallow	0.04	0.02	0.07	0.06	0.02	0.02	-
Blackpoll Warbler	0.04	0.09	0.05	0.04	0.09	0.04	+
Common Raven	0.05	0.05	0.05	0.03	0.05	0.03	none
American Crow	0.05	0.04	0.05	0.03	0.04	0.03	-
Black-backed Woodpecker	0.04	0.02	0.05	0.04	0.02	0.02	-
Bay-breasted Warbler	0.05	0.00	0.05	0.03	0.00	0.00	-
Northern Flicker	0.04	0.04	0.04	0.03	0.04	0.03	none
Pileated Woodpecker	0.04	0.04	0.04	0.03	0.04	0.03	none
Scarlet Tanager	0.04	0.04	0.04	0.03	0.04	0.03	none
Least Flycatcher	0.04	0.02	0.04	0.03	0.04	0.04	none
Red-winged Blackbird	0.04	0.02	0.04	0.03	0.02	0.02	-
Spruce Grouse	0.04	0.00	0.04	0.03	0.00	0.00	-
Olive-sided Flycatcher	0.02	0.07	0.02	0.02	0.07	0.04	+
Boreal Chickadee	0.02	0.05	0.02	0.02	0.07	0.04	+
Downy Woodpecker	0.02	0.04	0.02	0.02	0.07	0.06	+
Mourning Dove	0.02	0.05	0.02	0.02	0.05	0.03	+
Eastern Wood Pewee	0.02	0.04	0.02	0.02	0.04	0.03	+
Rose-breasted Grosbeak	0.02	0.04	0.02	0.02	0.04	0.03	+

Chipping Sparrow	0.02	0.02	0.02	0.02	0.02	0.02	none
Common Grackle	0.02	0.00	0.02	0.02	0.00	0.00	-
Eastern Phoebe	0.02	0.00	0.02	0.02	0.00	0.00	-
Gray Catbird	0.02	0.00	0.02	0.02	0.00	0.00	-
Great Blue Heron	0.02	0.00	0.02	0.02	0.00	0.00	-
Ruby-throated Hummingbird	0.02	0.00	0.02	0.02	0.00	0.00	-
Ruffed Grouse	0.02	0.00	0.02	0.02	0.00	0.00	-
Warbling Vireo	0.02	0.00	0.02	0.02	0.00	0.00	-
Willow Flycatcher	0.02	0.00	0.02	0.02	0.00	0.00	-
Yellow Warbler	0.02	0.00	0.02	0.02	0.00	0.00	-
Canada Goose	0.00	0.04	0.00	0.00	0.15	0.11	+
Hairy Woodpecker	0.00	0.04	0.00	0.00	0.04	0.03	+
White-winged Crossbill	0.00	0.02	0.00	0.00	0.04	0.04	+
Barred Owl	0.00	0.02	0.00	0.00	0.02	0.02	+
Common Snipe	0.00	0.02	0.00	0.00	0.02	0.02	+
Rusty Blackbird	0.00	0.02	0.00	0.00	0.02	0.02	+
Tennessee Warbler	0.00	0.02	0.00	0.00	0.02	0.02	+
Wilson's Warbler	0.00	0.02	0.00	0.00	0.02	0.02	+

Timber Harvest Zone Results (2001)

Sixty-nine species were observed during unlimited distance road-based surveys conducted in 2001. The 10 most abundant species, which occurred at levels exceeding 0.5 individuals per point, were also the most widespread in the THZ (Table 3). All occurred at more than 40% of the survey stations. The list includes a mix of short- and long-distance migrants: Hermit Thrush, White-throated Sparrow, Red-eyed Vireo, Winter Wren, Common Yellowthroat, Ovenbird, Black-throated Green Warbler, Chestnut-sided Warbler, Yellow-rumped Warbler, and Magnolia Warbler. As in representative natural communities, residents were a minor component of the THZ bird community. Of the 30 most abundant species in this category, only four occur in the area year-round (Golden-crowned Kinglet, Blue Jay, Black-capped Chickadee, and Brown Creeper).

Table 3. Frequency and abundance of bird species detected by point count in two distance categories from 47 road-based stations located in the Nulhegan Basin Division's timber harvest zone in 2001.

	All distances			Within 50 m		
	frequency of occurrence	relative abundance mean	relative abundance se	frequency of occurrence	relative abundance mean	relative abundance se
Hermit Thrush	0.74	1.00	0.11	0.11	0.11	0.05
Red-eyed Vireo	0.62	0.96	0.13	0.30	0.40	0.10
White-throated Sparrow	0.68	0.89	0.11	0.15	0.15	0.05
Winter Wren	0.55	0.72	0.12	0.17	0.19	0.07
Ovenbird	0.47	0.70	0.13	0.17	0.19	0.07
Magnolia Warbler	0.40	0.60	0.12	0.30	0.36	0.09
Common Yellowthroat	0.51	0.57	0.09	0.15	0.15	0.05
Black-throated Green Warbler	0.45	0.55	0.10	0.11	0.13	0.06
Chestnut-sided Warbler	0.45	0.53	0.10	0.23	0.28	0.08
Yellow-rumped Warbler	0.43	0.51	0.10	0.30	0.32	0.08
Black-capped Chickadee	0.30	0.43	0.11	0.11	0.15	0.07

Nashville Warbler	0.38	0.43	0.08	0.11	0.11	0.05
Black-throated Blue Warbler	0.34	0.38	0.08	0.15	0.15	0.05
Yellow-bellied Flycatcher	0.30	0.38	0.10	0.09	0.09	0.04
Yellow-bellied Sapsucker	0.34	0.36	0.08	0.02	0.02	0.02
American Robin	0.32	0.34	0.08	0.17	0.17	0.06
Veery	0.21	0.32	0.10	0.17	0.17	0.06
Black-and-White Warbler	0.30	0.30	0.07	0.17	0.17	0.06
Swainson's Thrush	0.23	0.28	0.08	0.02	0.02	0.02
Blue Jay	0.23	0.26	0.07	0.09	0.09	0.04
Canada Warbler	0.26	0.26	0.06	0.17	0.17	0.06
Northern Parula	0.23	0.26	0.08	0.15	0.15	0.05
Golden-crowned Kinglet	0.19	0.21	0.07	0.19	0.21	0.07
Least Flycatcher	0.11	0.21	0.10	0.11	0.15	0.07
Red-breasted Nuthatch	0.17	0.21	0.09	0.06	0.06	0.04
Alder Flycatcher	0.17	0.17	0.06	0.02	0.02	0.02
American Redstart	0.13	0.15	0.06	0.11	0.11	0.05
Purple Finch	0.13	0.15	0.06	0.09	0.09	0.04
Northern Waterthrush	0.11	0.13	0.06	0.04	0.04	0.03
Blackburnian Warbler	0.11	0.11	0.05	0.11	0.11	0.05
Canada Goose	0.04	0.11	0.08	0.00	0.00	0.00
Tree Swallow	0.04	0.11	0.08	0.02	0.04	0.04
Chimney Swift	0.04	0.09	0.07	0.02	0.06	0.06
Dark-eyed Junco	0.09	0.09	0.04	0.02	0.02	0.02
Blue-headed Vireo	0.06	0.06	0.04	0.02	0.02	0.02
White-winged Crossbill	0.02	0.06	0.06	0.02	0.06	0.06
American Goldfinch	0.02	0.04	0.04	0.02	0.04	0.04
Blackpoll Warbler	0.04	0.04	0.03	0.02	0.02	0.02
Broad-winged Hawk	0.02	0.04	0.04	0.00	0.00	0.00
Common Raven	0.04	0.04	0.03	0.00	0.00	0.00
Common Snipe	0.04	0.04	0.03	0.00	0.00	0.00
Gray Jay	0.04	0.04	0.03	0.00	0.00	0.00
Mourning Dove	0.04	0.04	0.03	0.00	0.00	0.00
Mourning Warbler	0.02	0.04	0.04	0.02	0.04	0.04
Northern Flicker	0.04	0.04	0.03	0.02	0.02	0.02
Olive-sided Flycatcher	0.04	0.04	0.03	0.00	0.00	0.00
Palm Warbler	0.04	0.04	0.03	0.02	0.02	0.02
Rose-breasted Grosbeak	0.04	0.04	0.03	0.02	0.02	0.02
Ruby-crowned Kinglet	0.04	0.04	0.03	0.00	0.00	0.00
White-breasted Nuthatch	0.02	0.04	0.04	0.02	0.04	0.04
American Crow	0.02	0.02	0.02	0.00	0.00	0.00
Baltimore Oriole	0.02	0.02	0.02	0.00	0.00	0.00
Brown Creeper	0.02	0.02	0.02	0.02	0.02	0.02
Cape May Warbler	0.02	0.02	0.02	0.00	0.00	0.00
Cedar Waxwing	0.02	0.02	0.02	0.02	0.02	0.02
Chipping Sparrow	0.02	0.02	0.02	0.00	0.00	0.00
Eastern Phoebe	0.02	0.02	0.02	0.02	0.02	0.02
Golden-winged Warbler	0.02	0.02	0.02	0.02	0.02	0.02
Gray Catbird	0.02	0.02	0.02	0.00	0.00	0.00
Great Horned Owl	0.02	0.02	0.02	0.00	0.00	0.00
Lincoln's Sparrow	0.02	0.02	0.02	0.02	0.02	0.02

Pileated Woodpecker	0.02	0.02	0.02	0.00	0.00	0.00
Pine Siskin	0.02	0.02	0.02	0.02	0.02	0.02
Ruby-throated Hummingbird	0.02	0.02	0.02	0.02	0.02	0.02
Ruffed Grouse	0.02	0.02	0.02	0.00	0.00	0.00
Scarlet Tanager	0.02	0.02	0.02	0.00	0.00	0.00
Song Sparrow	0.02	0.02	0.02	0.02	0.02	0.02
Swamp Sparrow	0.02	0.02	0.02	0.00	0.00	0.00

A Comparison of RNC and THZ Results (2001)

Table 4 compares RNC and THZ bird communities associated with mixed and lowland conifer forests, based on 25 off-road and 25 road-based counts in the basin proper. Golden-crowned Kinglet, Magnolia Warbler, Yellow-rumped Warbler, and Winter Wren were among the most common species in both categories (≥ 0.24 individuals per point). Overall bird abundance was nearly identical in the two management categories, with 136 individuals detected in undisturbed areas, compared to 137 along the logging roads. The proportion of RNC and THZ species represented on state or PIF priority lists was also similar (RNC = 0.33, THZ = 0.31). Differences emerged in species richness, overall diversity, and in the total number of individuals representing priority species. Species richness was higher at THZ stations (39) than at RNC stations (33). Shannon Diversity Indices for the two management categories reflect this difference. Shannon's H for the harvested portion of the landscape (3.36) was slightly higher than the diversity score for forests held in reserve (3.17). However, abundance of birds in the priority species class was 28% higher in undisturbed forests than in forests managed for timber production (39 vs. 28 individuals).

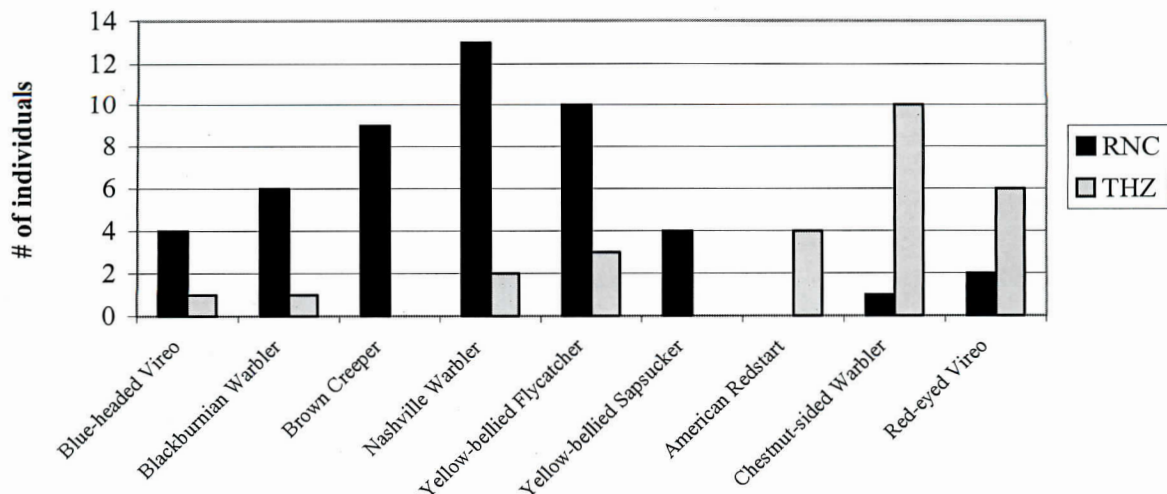
Table 4. Frequency and abundance of bird species detected by point count within 50 m of stations located in representative natural communities and the timber harvest zone of the Nulhegan Basin proper. Observations made in 2001 at 25 stations located in each of the management categories.

	RNC			THZ		
	Frequency of occurrence	Relative abundance mean	Relative abundance se	Frequency of occurrence	Relative abundance mean	Relative abundance se
Golden-crowned Kinglet	0.48	0.56	0.13	0.36	0.40	0.12
Nashville Warbler	0.40	0.52	0.14	0.08	0.08	0.06
Magnolia Warbler	0.32	0.40	0.13	0.40	0.52	0.14
Yellow-bellied Flycatcher	0.36	0.40	0.12	0.12	0.12	0.07
White-throated Sparrow	0.24	0.36	0.14	0.20	0.20	0.08
Brown Creeper	0.36	0.36	0.10	0.00	0.00	0.00
Blackburnian Warbler	0.20	0.24	0.10	0.04	0.04	0.04
Yellow-rumped Warbler	0.20	0.24	0.10	0.36	0.40	0.12
Winter Wren	0.24	0.24	0.09	0.24	0.28	0.11
Yellow-bellied Sapsucker	0.12	0.16	0.09	0.00	0.00	0.00
Black-capped Chickadee	0.12	0.16	0.09	0.16	0.24	0.12
Blue-headed Vireo	0.16	0.16	0.07	0.04	0.04	0.04
Common Yellowthroat	0.16	0.16	0.07	0.16	0.16	0.07
Canada Warbler	0.16	0.16	0.07	0.20	0.20	0.08
Gray Jay	0.08	0.12	0.09	0.00	0.00	0.00
Ovenbird	0.12	0.12	0.07	0.12	0.12	0.07

Black-and-White Warbler	0.12	0.12	0.07	0.20	0.20	0.08
Northern Parula	0.12	0.12	0.07	0.24	0.24	0.09
White-winged Crossbill	0.04	0.08	0.08	0.00	0.00	0.00
Mourning Warbler	0.08	0.08	0.06	0.00	0.00	0.00
Blackpoll Warbler	0.08	0.08	0.06	0.04	0.04	0.04
Dark-eyed Junco	0.08	0.08	0.06	0.04	0.04	0.04
Red-breasted Nuthatch	0.08	0.08	0.06	0.08	0.08	0.06
Red-eyed Vireo	0.08	0.08	0.06	0.20	0.24	0.10
Black-backed Woodpecker	0.04	0.04	0.04	0.00	0.00	0.00
Rose-breasted Grosbeak	0.04	0.04	0.04	0.00	0.00	0.00
Black-throated Blue Warbler	0.04	0.04	0.04	0.04	0.04	0.04
Palm Warbler	0.04	0.04	0.04	0.04	0.04	0.04
Scarlet Tanager	0.04	0.04	0.04	0.04	0.04	0.04
American Goldfinch	0.04	0.04	0.04	0.04	0.08	0.08
Black-throated Green Warbler	0.04	0.04	0.04	0.08	0.08	0.06
Hermit Thrush	0.04	0.04	0.04	0.12	0.12	0.07
Chestnut-sided Warbler	0.04	0.04	0.04	0.32	0.40	0.13
Alder Flycatcher	0.00	0.00	0.00	0.04	0.04	0.04
Eastern Phoebe	0.00	0.00	0.00	0.04	0.04	0.04
Golden-winged Warbler	0.00	0.00	0.00	0.04	0.04	0.04
Pine Siskin	0.00	0.00	0.00	0.04	0.04	0.04
Swainson's Thrush	0.00	0.00	0.00	0.04	0.04	0.04
Blue Jay	0.00	0.00	0.00	0.08	0.08	0.06
Least Flycatcher	0.00	0.00	0.00	0.04	0.08	0.08
Northern Waterthrush	0.00	0.00	0.00	0.08	0.08	0.06
Tree Swallow	0.00	0.00	0.00	0.04	0.08	0.08
American Robin	0.00	0.00	0.00	0.12	0.12	0.07
Purple Finch	0.00	0.00	0.00	0.12	0.12	0.07
Veery	0.00	0.00	0.00	0.12	0.12	0.07
American Redstart	0.00	0.00	0.00	0.16	0.16	0.07

In a simple comparison between RNC and THZ counts, nine species showed notable differences in number (Figure 1).

Figure 1. Comparison of RNC and THZ counts for species with a minimum of four in one category and a three-fold or greater difference in numbers between categories.



Priority Species Mapping

Appendix 2 contains maps depicting the locations of state- and/or PIF-listed species observed in the study area during 2001. Of the 28 mapped species, four occurred at more than 20 points: Black-throated Blue Warbler (24), Yellow-bellied Sapsucker (26), Black-throated Green Warbler (36), and Nashville Warbler (45). The first three of these were broadly distributed, however Nashville Warbler was restricted to the conifer and mixed forests of the basin proper. Eleven species were detected at two or fewer locations, including three rare woodland warblers with boreal distributions: Cape May, Tennessee, and Wilson's. For additional rare species locations, land stewards are referred to results from the Vermont Department of Fish and Wildlife's periodic Spruce Grouse survey and Weinhausen's thesis, "Nest-site selection by Black-backed Woodpeckers in northeastern Vermont" (1998).

Species Presence and Conservation Significance

The two-year species list compiled for the Nulhegan Basin Division resembles those reported for other northern New England forests with boreal characteristics and a history of timber management. All but one of the species observed on the property appear on at least one of the species lists prepared for the West Mountain Wildlife Management Area (Lambert 2000), the McConnell Pond Tract (Loso et al. 1996), the Center for Ecosystem Management (Benoit 1999), the Pondicherry Wildlife Refuge (Quinn 1997), and an industrial forest in Maine (Hagan et al. 1997). The lone exception, a Golden-winged Warbler, was observed on just one occasion in an isolated patch of Golden-wing habitat, a shrubby field bordered by forest (Confer 1992). Repeated efforts to relocate the bird failed, suggesting that it was transient.

The number of observed species (103) remains lower than: northern forest sites that contain extensive emergent wetlands and adjacent grasslands (e.g. Quinn 1997), sites that are surveyed year-round (e.g. Benoit 1999), and sites that have been surveyed for many years (e.g. Holmes and Likens 1999). Because the NBD is a predominantly forested tract, adding marsh specialists and grassland-dwellers to the list would require extensive manipulations of existing habitat. On the other hand, the addition of relatively widespread species (e.g. Indigo Bunting, Eastern Kingbird, and Sharp-shinned Hawk) is virtually assured by continued, breeding-season surveys. Incorporation of Christmas Bird Count data and checklists kept by experienced bird-watchers would enable further development of this preliminary species list. Species to be added include those that overwinter in Essex County (e.g. Common Redpolls, Pine Grosbeaks, Snow Buntings) and those that stop over on migrations to and from Canadian breeding grounds (e.g. Fox Sparrow).

Neotropical migrants and state- or PIF-listed species make up a substantial part of the Nulhegan Basin Division's avian community, confirming previous assessments of the area's value to regional bird conservation. Anderson et al. (1998) recommended the area as a conservation priority site for the Connecticut River watershed based on the relationship of birds to natural communities. Of the 72 neotropical migrants listed by Anderson et al., 43 (60%) have been observed in the Division over the last two years. Rosenberg and Hodgman (2000) describe this physiographic area as a breeding stronghold for forest-dwelling, long-distance migrants, many of which are considered high regional or global priorities by Partners in Flight.

Representative Natural Community Results (2000 and 2001)

The 75 species observed during 2000 and 2001 RNC bird counts were divided evenly between those that decreased in abundance (37) and those that increased or were unchanged in number (38). No pattern related to habitat, guild, or migratory strategy was evident in these groups. Although four fewer species were detected in 2001 than 2000, this finding holds little biological significance, given that the difference is exceeded by the number of new species represented by a single bird (5).

Changes in avian abundance are common (Franzreb and Ohmart 1978, Blake et al. 1994), and may result from variations in reproductive success (Holmes et al. 1992), food availability (Morse 1978), plant succession (Yahner 2000), climate cycles (Silllett et al. 2000), and winter mortality (Holmes et al. 1986). The variety of potential mechanisms for population change demands that results be interpreted with caution, particularly in the absence of patterns related to life history characteristics. Lack of spatial uniformity in population trends and inconsistency between short-term and long-term results reinforce the need for a deliberate approach (James et al. 1996).

The two-year data set contains no consistent responses among species groups that would suggest mechanisms for population change. A variety of foraging and nesting guilds, habitat associations, and migratory strategies were represented in both the increasing and decreasing populations. The long-term significance of short-term changes is likewise unclear. Nevertheless, species that experienced large changes in abundance warrant further discussion. Four out of five species that increased or decreased by over 40% showed the same direction of change in surveys conducted in the West Mountain Wildlife Management Area (WMWMA). Blue Jays declined by nearly the same amount in the WMWMA (50%) as in the NBD (46%). The magnitude of increase was muted in the WMWMA for Brown Creeper (20% vs. 146%), Winter Wren (56% vs. 87%), and American Redstart (29% vs. 46%). Northern Parula showed strong, opposing changes on the two properties, with a 41% drop in the NBD and 60% growth on the neighboring, state land.

With a typical clutch size of six eggs and the capacity to lay eight (Davis 1978), Brown Creepers have the potential for the type of rapid, numerical growth observed in this study. Winter Wrens share this capacity, with females laying up to seven eggs and raising one to two broods each year (Ehrlich et al. 1988). Resident and short-distance migration strategies, displayed by the Brown Creeper and Winter Wren, respectively, enable high fecundity in a given year. By avoiding demands of long-distance migration and getting an early start to the breeding season, residents and short-distance migrants have a greater opportunity to renest following nest failure. The costs of overwintering in temperate environments include exposure to inclement weather, winter food shortages, and susceptibility to disease during periods of high physiological stress. The spatially consistent drop in the Blue Jay population may have resulted from one or a combination of these factors. However, the relatively high availability of hard and soft mast during the winter of 2001 (pers. obs.) and the lack of similar declines among other resident species do not support this interpretation.

Future surveys will reveal whether short-term changes in Nulhegan Basin bird populations reflect long-term trends at local or regional scales. USFWS protocols require a minimum of five years of data before conducting trend analyses for breeding landbirds (Pence 1996). The

significance of even a five-year analysis is limited given that 30 or more years may be required to detect significant declines in breeding birds (Holmes and Sherry 2001, Sauer et al. 2001).

Timber Harvest Zone Results (2001)

The ten most abundant birds in the timber harvest zone are typical of bird communities found elsewhere in northern New England, where logging has created a complex mosaic of forest types and seral stages. Both Thompson and Capen (1988) and Hagan et al. (1997) list White-throated Sparrow, Common Yellowthroat, Chestnut-sided Warbler, and Magnolia Warbler among the six most abundant birds of recent and regenerating clearcuts. Hermit Thrushes are associated with coniferous or mixed woodlands with dense undergrowth (DeGraaf and Rudis 1986), a structure found in selection cuts or at the edge of clearcuts. Yellow-rumped Warblers were the most common bird in 20-60 year old softwoods in Maine, while Winter Wrens were the second most abundant in mature softwoods (Hagan et al. 1997). Studies in Vermont, New Hampshire, and Maine have all found Red-eyed Vireo, Ovenbird, and Black-throated Green Warbler to be the primary species of mature hardwoods and/or mixedwoods (Holmes et al. 1986, Thompson and Capen 1988, Lent and Capen 1995, Hagan et al. 1997). In the Nulhegan Basin Division, hardwoods have been logged less intensively than softwoods (B. Engstrom pers. comm.) and persist in medium-aged to mature patches along the basin's rim and to its north. Pole stands and selection cuts support populations of Red-eyed Vireos, Ovenbirds, and Black-throated Green Warblers, as well (DeGraaf and Rudis 1986).

Representative Natural Community and Timber Harvest Zone Results Compared (2001)

Several studies conducted in forested landscapes have found a positive effect of timber management on avian abundance, richness, and/or diversity (Welsh and Healy 1993, Hagan et al. 1997, Annand and Thompson 1997). Benefits of harvesting primarily accrue to species adapted to early successional or young forest habitats, especially ground and shrub foragers (Yahner 2000, Thompson et al. 1992). These benefits are frequently realized at the expense of birds that inhabit mature forest interiors. Documented effects of timber activity on forest birds include: reduced abundance from habitat loss (Welsh and Healy 1993, Lent and Capen 1995, Hagan et al. 1997), avoidance of logging roads (Ortega and Capen 1999), low pairing success (Hagan et al. 1996), reduced brood density (Buford and Capen 1999), and reduced dispersal between isolated forest fragments (Schmiegelow et al. 1997). Research conducted in northern New Hampshire indicates that clearcut harvesting can also result in elevated nest predation in adjacent forests (King et al. 1996).

As in previous investigations, harvested areas in this study exhibited higher species richness and diversity than areas kept in forest reserve. The difference can be attributed to the variety of forest age classes in the timber harvest zone, an area that retained at least small numbers of most mature forest associates. For their part, undisturbed forests contained few early successional species. The lack of difference between the two management categories in overall abundance appears to contradict results from similar studies, which have documented higher numbers in young forest settings. This finding may reflect natural variation or it may be an artifact of point placement. Point count circles located in representative natural communities were 100% vegetated. Point count circles in the timber harvest zone were centered on roads and contained approximately 10% less vegetative cover. Because road-based surveys detected the same number of birds in a smaller vegetated area, the density of birds was slightly higher in vegetated portions of the timber harvest zone than in representative natural communities. Verifying and

determining the significance of this finding will require placement of survey points in harvested stands as part of a well replicated design.

Effects of timber management on species richness, diversity, and abundance were slight compared to the magnitude of harvest effects on individual species. Six forest-dwelling species were notably fewer in harvested areas compared to representative natural communities. Half of these are considered high regional priorities by Partners in Flight (Blackburnian Warbler, Nashville Warbler, and Yellow-bellied Sapsucker). According to two measures, proportion of species and count of individuals, state- or PIF-listed species make up a more prominent component of undisturbed forests than forests managed for timber production.

Five of the six species with notably greater numbers in representative natural communities require structural features of mature forests for nesting. Yellow-bellied Sapsuckers excavate nest sites in dead trees or live trees with rotten heartwood, preferring aspen when available (Howell 1952). Trees with a d.b.h. of over 25 cm are best suited for sapsucker nesting (Thomas et al. 1979 as cited by DeGraaf and Rudis 1986). Yellow-bellied Flycatchers often nest among the roots of a fallen tree or at the base of a leaning tree trunk (Gross and Lowther 2001). Brown Creepers build a hammocklike nest under the shelter of flaking bark (Ehrlich et al. 1998). Such sites are most numerous in old forests. In the Northeast, Blackburnian Warblers nest in conifers at an average height of 10 m and as high as 23 m (Morse 1994), while Blue-headed Vireos nest in 2- to 5-m shrubs in the shade of extensive forests (James 1998). Nashville Warbler is the only ground-nesting member of this group and the only one that characteristically nests at edges, both natural and anthropogenic (Williams 1996). In this study, Nashville Warbler showed strong selection for undisturbed forests. This may reflect the structural heterogeneity of these mature forest sites and/or the reduced prominence of conifer in the harvest zone. Nashville Warblers, like Yellow-bellied Flycatchers, Brown Creepers, Blackburnian Warblers, and Blue-headed Vireos, are closely linked to softwood forests.

In the absence of strong management prescriptions, the composition of a regenerating forest may not resemble that of the originally harvested stand (Thompson et al. 1992). Management practices that favor fast-growing aspen and birch over slow-growing fir and spruce are likely to result in concomitant changes in the avian community: specifically, the replacement of softwood associates with species that breed in deciduous forests. This pattern is evident in the higher THZ numbers of three hardwood nesters: Chestnut-sided Warbler, American Redstart, and Red-eyed Vireo. The first two gain not only through conversion of softwoods to hardwoods, but also through the shift in age-class structure from mature to young forest. Chestnut-sided Warblers and American Redstarts are shrub nesters that achieve their highest densities in clearcuts and young forests, respectively (Hagan et al. 1997, Holmes and Sherry 2001).

None of the three species that showed a positive association with timber management are of conservation concern to the state or Partners in Flight. Moreover, the status of their breeding habitat appears to be secure in nearly 100,000 acres surrounding the Nulhegan Basin Division. These areas, managed by Essex Timber Company and the Vermont Agency of Natural Resources, contain a higher hardwood component than the NBD and will continue to produce shrubby openings and young forests through logging (VANR 2001).

The Nulhegan Basin Division's vast stands of lowland conifer distinguish it from surrounding properties. Of the bird species that are rare in Vermont and occur in the NBD, nearly all are linked to this complex of black spruce swamps, black spruce bogs, and lowland

spruce-fir forests. Restoring the extent, continuity, and maturity of the Division's conifer forests may not promote local richness or diversity. But when combined with small-scale manipulations for target species (e.g. Spruce Grouse), this management approach will produce the greatest benefit to bird conservation by promoting avian diversity at the regional scale. This broad view of bird conservation is consistent with the founding principles of the Conte Refuge, which was established as a watershed-wide, cooperative management effort (USFWS 1995).

Future Directions

The first report on NBD bird surveys identified three main goals for future investigations: improvement of species lists and distribution maps, measurement of bird population trends, and evaluation of management strategies (Lambert 2000). Although achieving these goals will require many years of effort, work completed in 2001 represents significant progress. Annual surveys using the existing approach will continue to improve our understanding of the Nulhegan avifauna by adding species, location records, and trend information. Considerably more effort will be necessary to improve on the preliminary, inferential assessment of management impacts. A better understanding of bird community responses to forest management can be gained by testing hypotheses with a mix of observational and manipulative experiments. Such experiments should incorporate randomly selected experimental units, adequate replication, high statistical power, treatments that represent the full range of management activities, and measures of reproductive success (Thompson et al. 2000).

The Nulhegan Basin Division's basic point count protocol enables Refuge managers and biologists to monitor the distribution, abundance, and general habitat associations of over 100 species. It also provides a reasonable basis for formulating hypotheses, designing experiments, and analyzing statistical power. I recommend that the USFWS seek opportunities to address bird conservation questions while developing and executing stewardship plans for the property. Experimental studies and an adaptive approach to management will enhance the Nulhegan Basin's role as one of the watershed's most significant areas for birds.

ACKNOWLEDGMENTS

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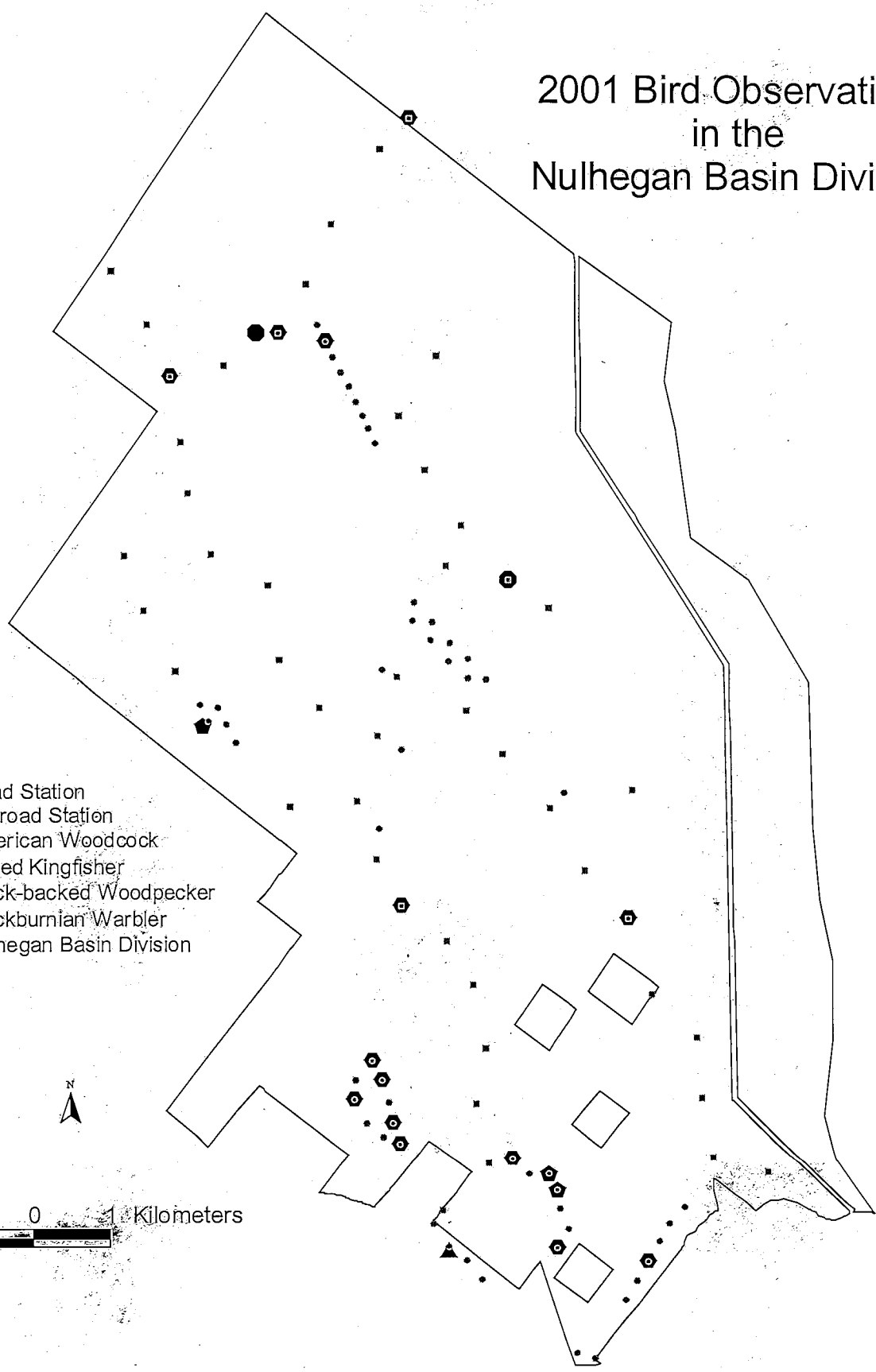
Appendix 1. Survey point locations in the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. UTM projection, Zone 19, North American Datum 1927.

Survey station	m east	m north	Survey station	m east	m north
NUL001	282687	4969721	NUL052	283978	4962471
NUL002	282676	4969479	NUL053	283152	4961302
NUL003	282923	4969465	NUL054	283384	4961105
NUL004	282915	4969225	NUL055	283579	4960862
NUL005	283164	4969203	NUL056	287303	4962294
NUL006	283154	4968957	NUL057	286598	4962497
NUL007	283399	4968990	NUL058	286460	4963268
NUL008	283395	4968732	NUL059	286385	4964077
NUL009	283644	4968728	NUL060	285806	4964626
NUL010	282503	4962669	NUL061	285492	4965610
NUL011	282425	4962945	NUL062	284933	4966233
NUL012	282363	4963217	NUL065	284467	4967042
NUL013	282283	4963502	NUL066	283863	4967754
NUL014	282153	4963768	NUL067	283374	4968330
NUL015	281925	4963515	NUL071	2830104	4970187
NUL016	281918	4963248	NUL072	283924	4970020
NUL017	282078	4962949	NUL073	284446	4969653
NUL018	282285	4962764	NUL074	283305	4970725
NUL019	282947	4961607	NUL075	282834	4971441
NUL020	285060	4959808	NUL076	282493	4972161
NUL021	284824	4959882	NUL077	282979	4972940
NUL022	285456	4960592	NUL080	283071	4961785
NUL023	285605	4960843	NUL081	283682	4962417
NUL024	285753	4961101	NUL082	283517	4963194
NUL025	285895	4961370	NUL083	283636	4963921
NUL026	286026	4961605	NUL084	283467	4964764
NUL027	286222	4961819	NUL085	283130	4965328
NUL028	284658	4967244	NUL086	282537	4965783
NUL029	282282	4968846	NUL087	282206	4966386
NUL030	282536	4967817	NUL088	281941	4967134
NUL031	282236	4966772	NUL089	282214	4967992
NUL032	280007	4968178	NUL090	282470	4968758
NUL033	279901	4968391	NUL091	281451	4968365
NUL034	280134	4968360	NUL092	280935	4968978
NUL035	280238	4968137	NUL093	280781	4969947
NUL036	280373	4967902	NUL094	280035	4970345
NUL037	282188	4971788	NUL095	279730	4971144
NUL038	282102	4971987	NUL096	279632	4971804
NUL039	282016	4972158	NUL097	279491	4972667
NUL040	281926	4972344	NUL098	280207	4972811
NUL041	281833	4972531	NUL099	280916	4973230
NUL042	281736	4972727	NUL100	281268	4973857
NUL043	281626	4972918	NUL101	281604	4974635
NUL044	281529	4973120	NUL102	282244	4975626
NUL045	281421	4973327	NUL103	282625	4976015
NUL046	284572	4961279	NUL106	279179	4973329
NUL047	284709	4961535	NUL107	278709	4974017
NUL048	284598	4961806	NUL108	281085	4967066
NUL049	284568	4962061	NUL111	279574	4968830
NUL050	284449	4962276	NUL112	279144	4969604
NUL051	284200	4962279	NUL113	278896	4970329

Appendix 2. 2001 distribution maps for 28 bird species identified by the state of Vermont and/or Partners in Flight as conservation priorities. In most cases, points represent the location from which one or more individuals were detected, not the actual position of the observed bird(s).

2001 Bird Observations in the Nulhegan Basin Division

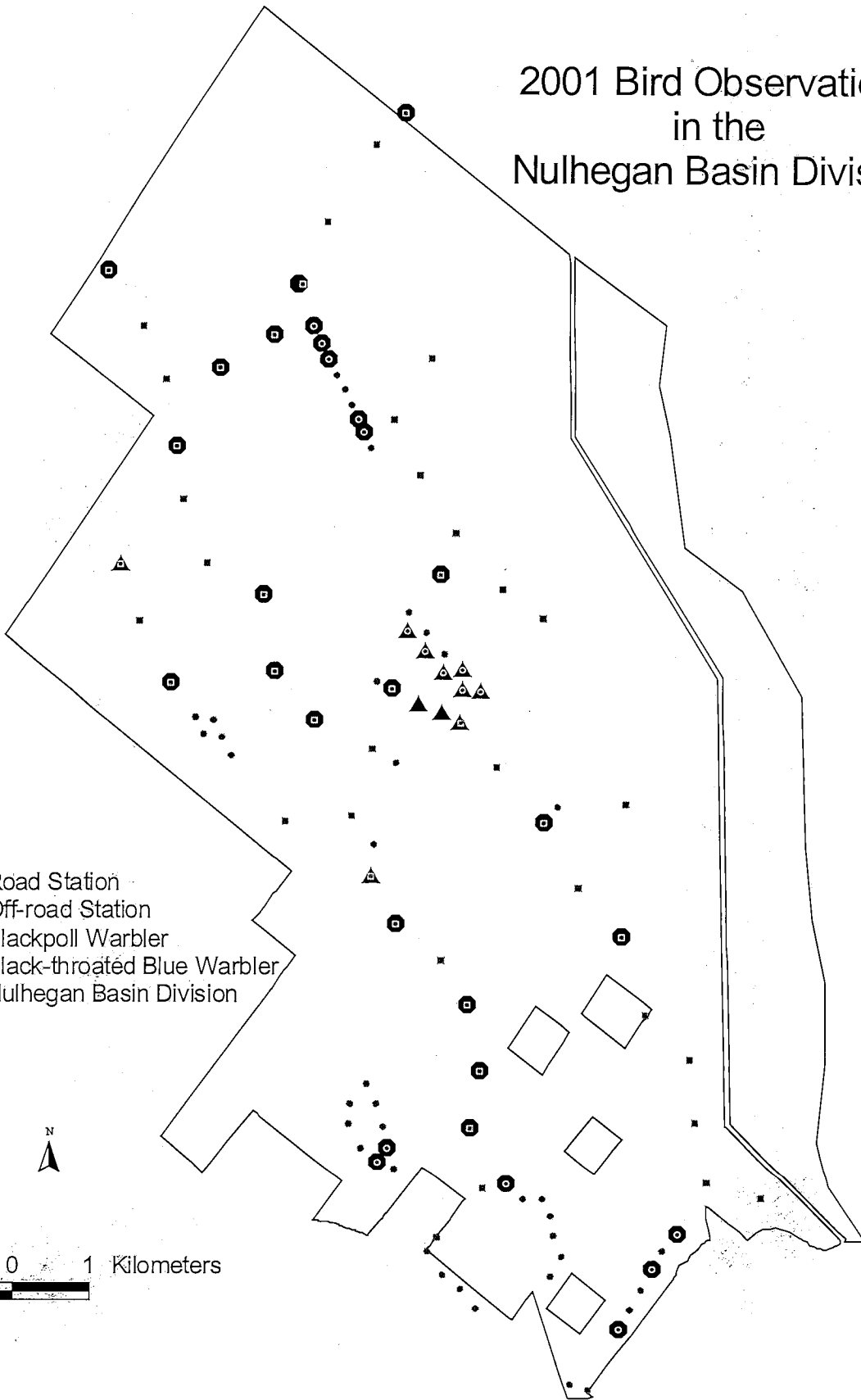
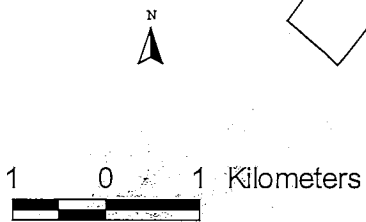
- Road Station
- Off-road Station
- ▲ American Woodcock
- Belted Kingfisher
- ◆ Black-backed Woodpecker
- ◈ Blackburnian Warbler
- Nulhegan Basin Division



1 0 1 Kilometers

2001 Bird Observations in the Nulhegan Basin Division

- Road Station
- Off-road Station
- ▲ Blackpoll Warbler
- Black-throated Blue Warbler
- Nulhegan Basin Division

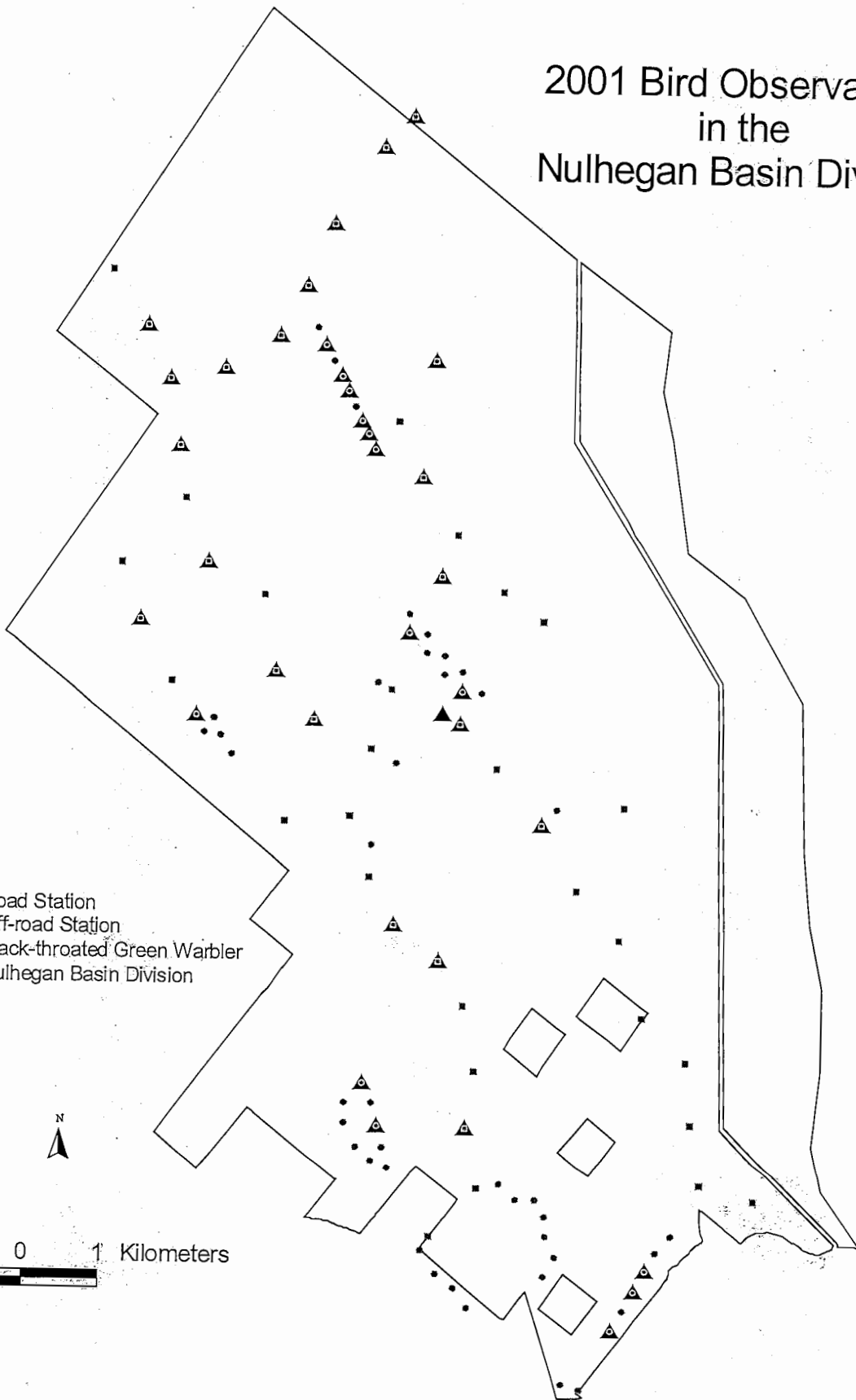


2001 Bird Observations in the Nulhegan Basin Division

- Road Station
- Off-road Station
- ▲ Black-throated Green Warbler
- Nulhegan Basin Division

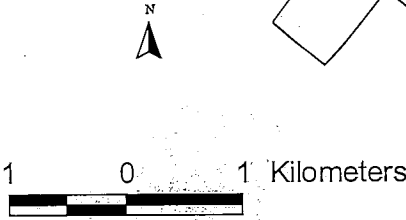


1 0 1 Kilometers



2001 Bird Observations in the Nulhegan Basin Division

- Road Station
- Off-road Station
- ▲ Boreal Chickadee
- Canada Warbler
- Nulhegan Basin Division

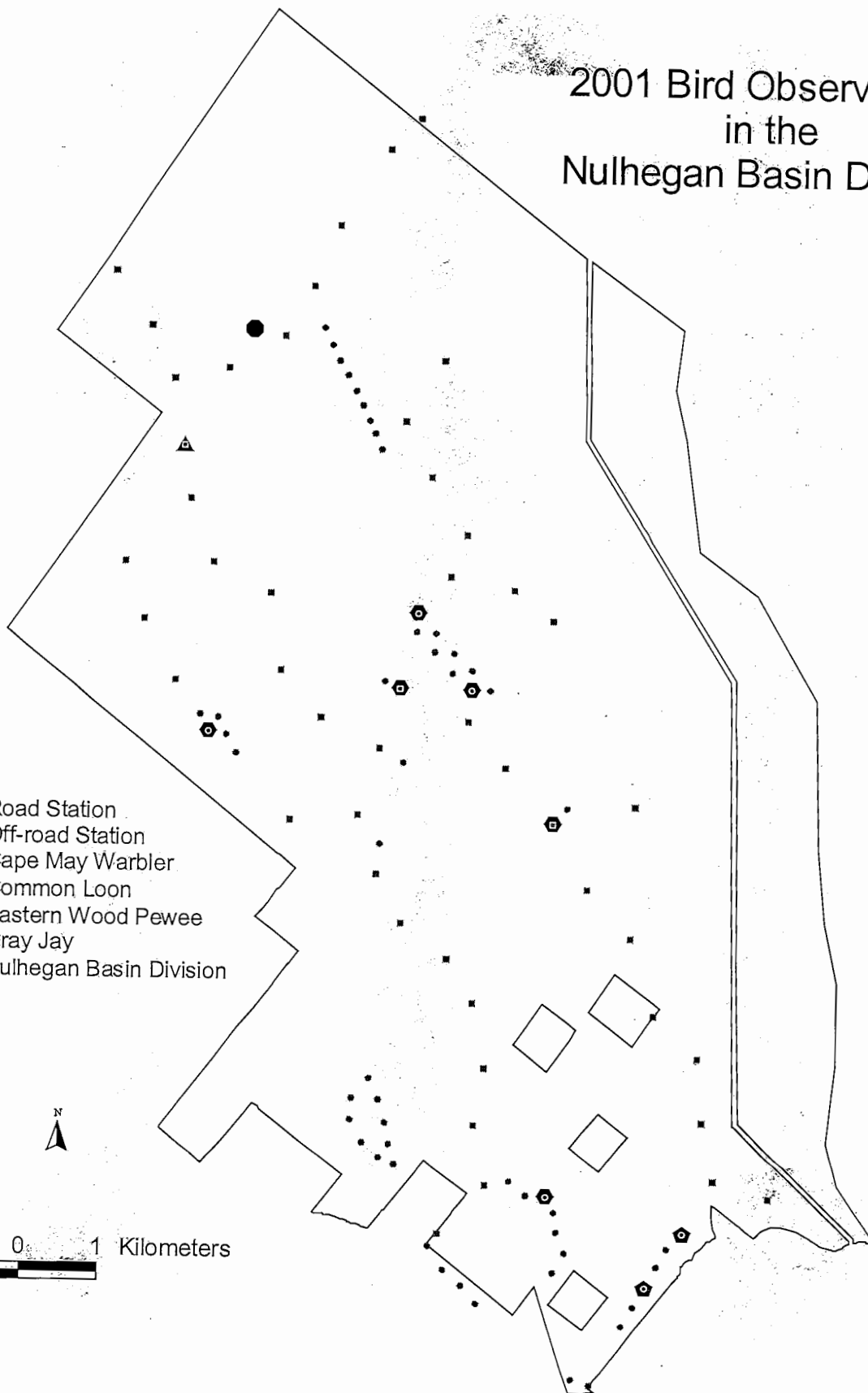


2001 Bird Observations in the Nulhegan Basin Division

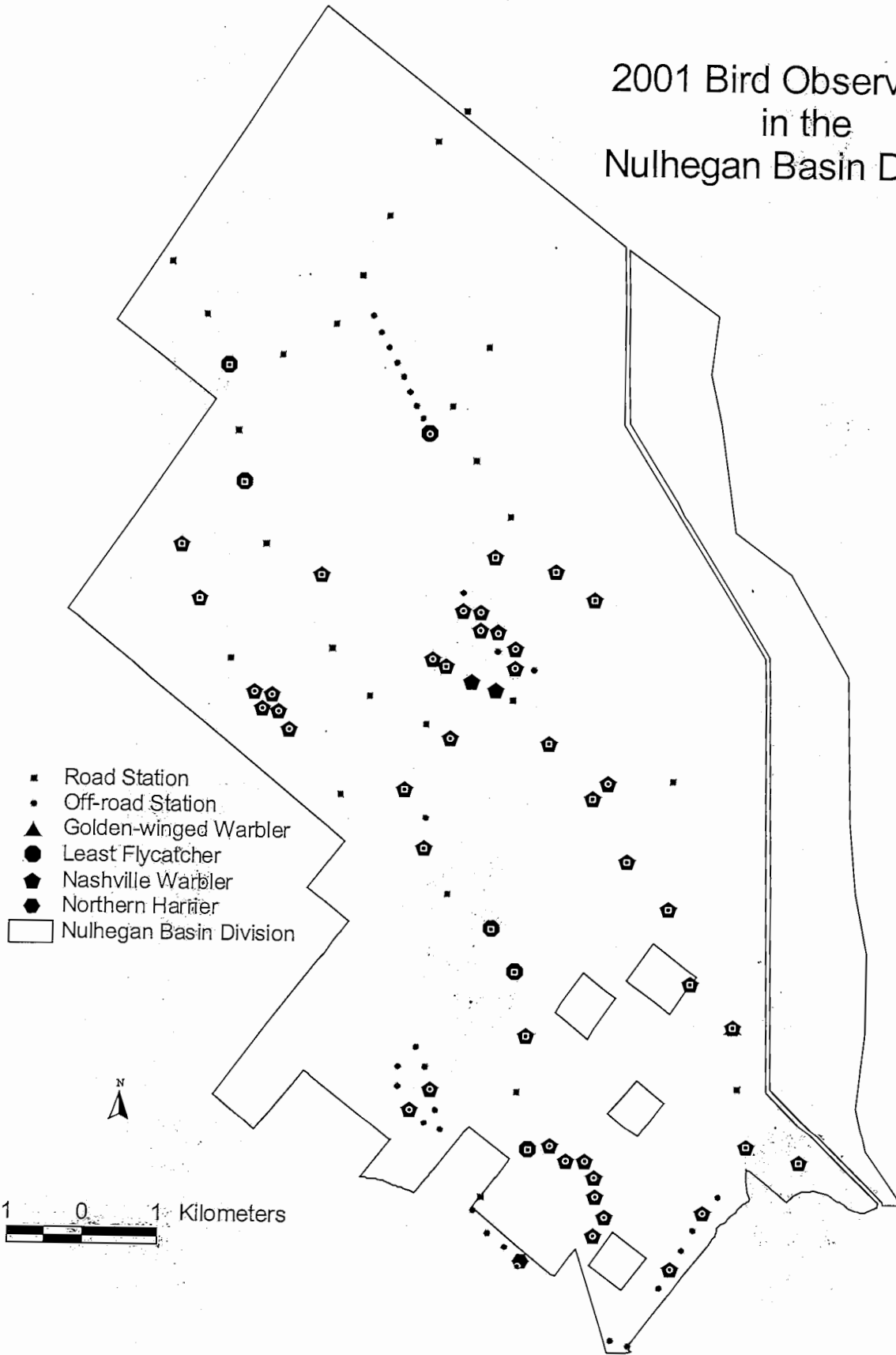
- Road Station
- Off-road Station
- ▲ Cape May Warbler
- Common Loon
- ◆ Eastern Wood Pewee
- ◆ Gray Jay
- Nulhegan Basin Division



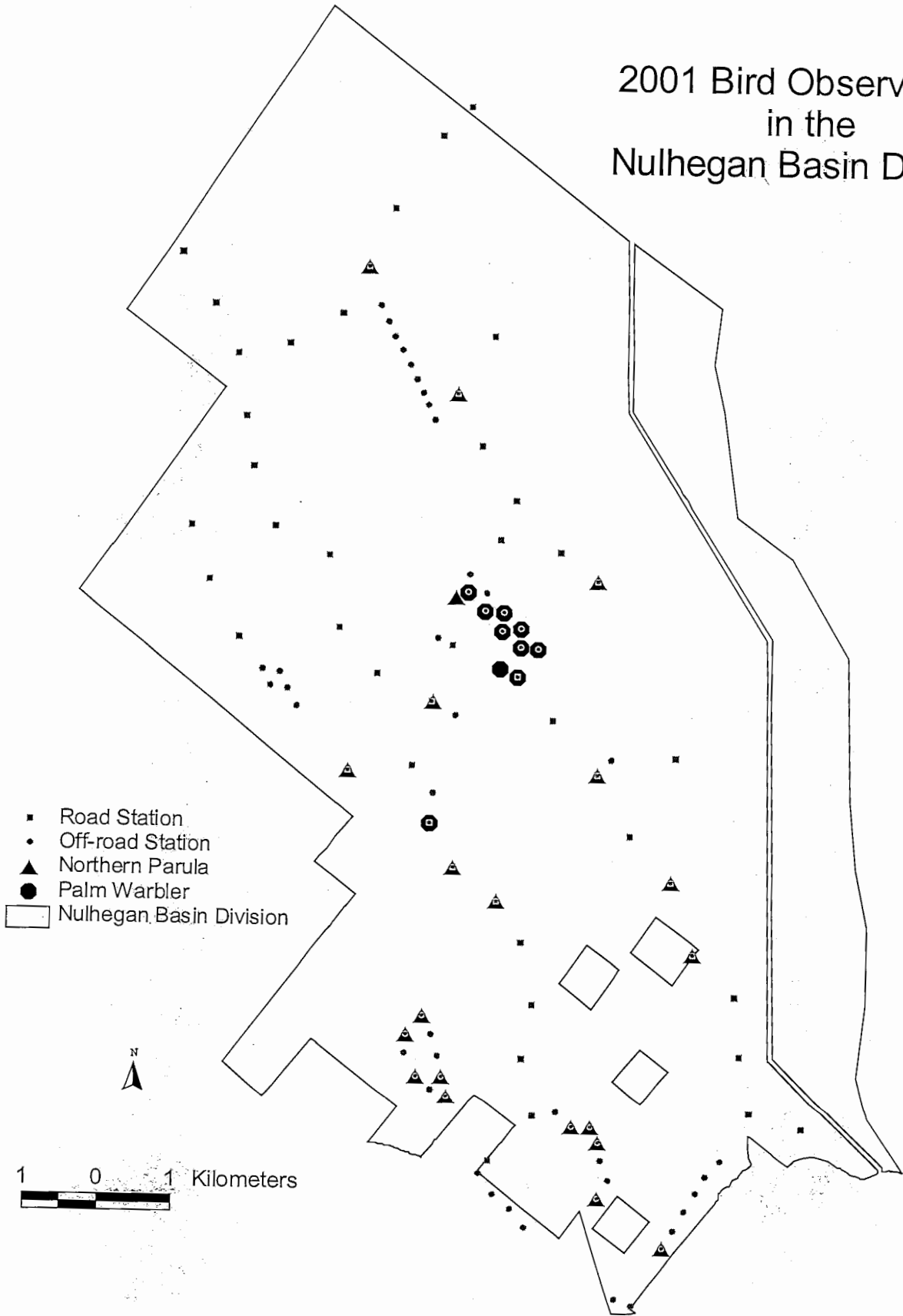
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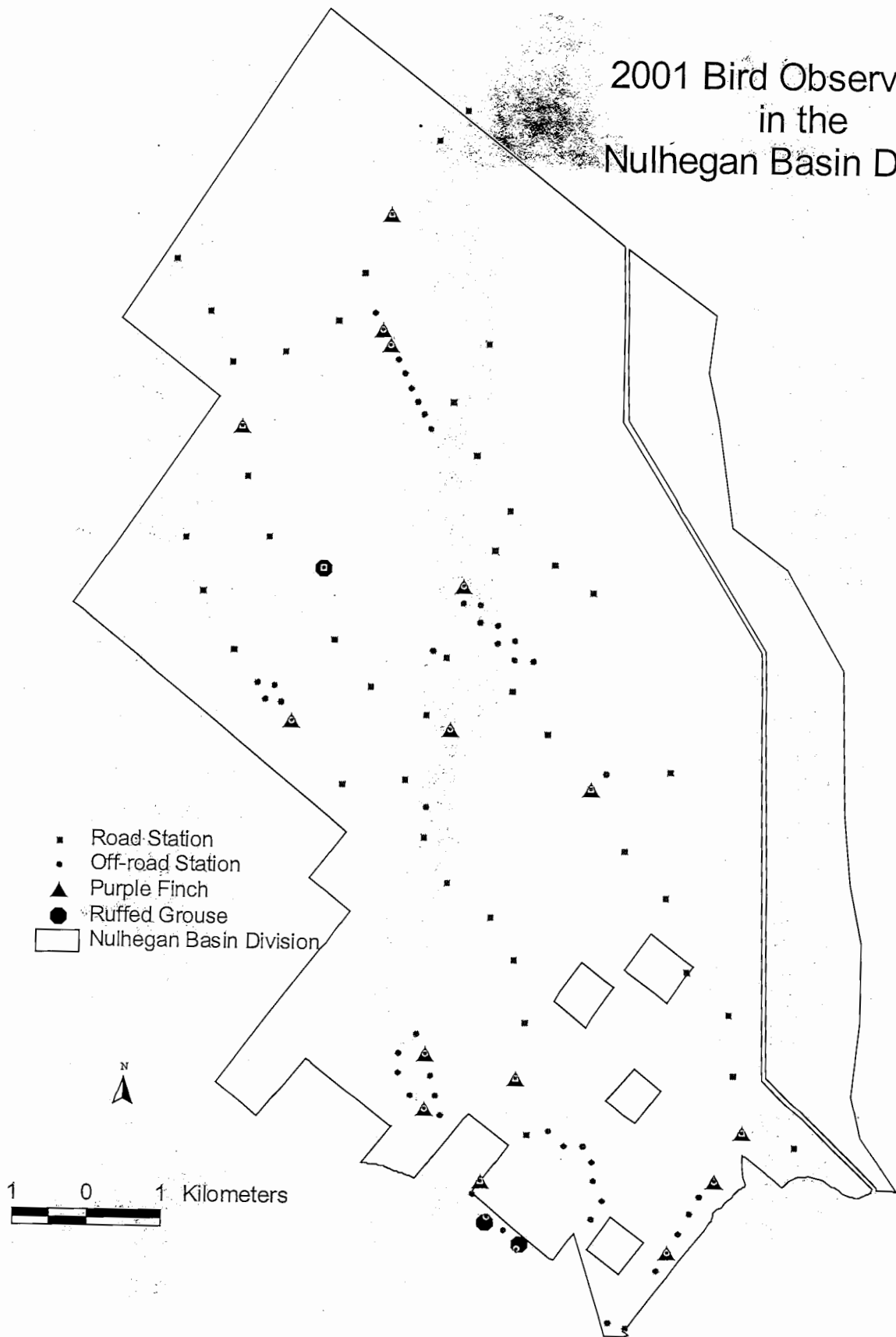
2001 Bird Observations in the Nulhegan Basin Division



2001 Bird Observations in the Nulhegan Basin Division



2001 Bird Observations in the Nulhegan Basin Division



2001 Bird Observations in the Nulhegan Basin Division

- Road Station
- Off-road Station
- ▲ Olive-sided Flycatcher
- Rusty Blackbird
- ◆ Spruce Grouse
- Tennessee Warbler
- Nulhegan Basin Division

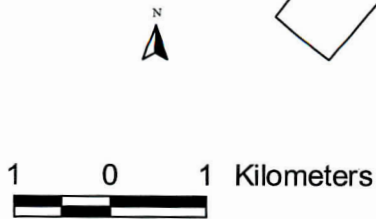


1 0 1 Kilometers



2001 Bird Observations in the Nulhegan Basin Division

- Road Station
- ◆ Off-road Station
- ▲ Veery
- Wilson's Warbler
- Nulhegan Basin Division



2001 Bird Observations in the Nulhegan Basin Division

- Road Station
- Off-road Station
- ▲ Yellow-bellied Sapsucker
- Nulhegan Basin Division



1 0 1 Kilometers

