HABITAT USE OF POST-FLEDGING FOREST-NESTING SONGBIRDS IN NORTHERN HARDWOOD-CONIFEROUS FORESTS IN NORTHERN MINNESOTA[1]: 2009 SUMMARY REPORT

31 December 2009

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Abstract: In 2009 we continued (from 2006 – 2008) sampling bird use of early successional (regenerating clearcuts) cover types associated with mature upland forest during the post-fledging period in the Chippewa National Forest in north-central Minnesota. We continued (from 2008) sampling vegetation structure and food availability associated with these habitats. In 2009 we extended sampling of bird use of these habitats to include the nesting period, 22 May – 3 July, and to include additional cover types. We continued sampling habitat use on the 3 established study locations, each containing substantial continuous mature mixed deciduous and conifer forest and regenerating clearcut stands of 2 age ranges (1 – 6 and 7 – 12 years since harvest). In addition, in 2009, at 2 of the 3 study locations, we sampled a clearcut stand 13 – 20 years since harvest, and a forested wetland. We sampled all stands at these 2 locations twice weekly from 22 May through 24 August, and the 2 stands at the third location from 6 July through 26 August. On 72 occasions and a total of 3,456 mist-net hours, we had 2,102 captures of 1,875 birds representing 63 species, including 6 species not captured in the previous 4 years. Including recaptures, we captured a mean of 3.65 birds per hour of netting (6 nets in 1 stand). Species associated with nesting in mature forest habitats accounted for 41% (AHY = 537, HY = 302) of captures. Throughout the season, we collected blood, feather, and claw samples from 73 golden-winged warblers (*Vermivora chrysoptera*) for the Golden-winged Warbler Atlas Project. In addition we collected 1,572 larval and nymph ticks from 379 birds for a study of bird-mediated Lyme disease transmission at Yale University.

Compared to use of nesting habitat, habitat use by forest-nesting songbirds following fledging is relatively poorly understood. Recent studies based on point counts and mist-netting (e.g., Pagen et al. 2000, Marshall et al. 2003, Vitz and Rodewald 2007), and monitoring movement of fledglings via radio-telemetry (e.g., Anders et al. 1998,

Vega Rivera et al. 1998, Lang et al. 2002, Fink 2003, Cohen and Lindell 2004) suggest that for at least some species of forest-nesting songbirds, habitat use during the post-fledging period can be quite different from breeding habitat use. For example, Pagen et al. (2000) employed point counts and mist-netting in 4 Missouri Ozark habitats and observed both adult and hatch-year birds of several forest-nesting species in early successional habitats during the post-breeding and breeding seasons. Similarly, Marshall et al. (2003) captured adults, juveniles, and family groups of forest-nesting songbirds in early successional habitats with mist-nets in West Virginia and Virginia. In Missouri, Anders et al. (1998) and Fink (2003) observed that radio-marked wood thrushes (*Hylocichla mustelina*) used mid- to early-successional habitats, or habitats near edges and agriculture, after dispersing from natal territories. In Virginia, Vega Rivera et al. (1998) observed that fledgling wood thrushes frequented second-growth scrub/deciduous sapling sites along forest borders and abandoned farms, gypsy moth (*Lymantira dispar*)-damaged deciduous forests, and pine forests with heavy deciduous understory. Vega Rivera et al. (2003) monitored movements of scarlet tanagers (*Piranga olivacea*) in Virginia during the breeding and post-breeding periods, and observed a slight increase in use of early successional habitats in the post-breeding period. Conversely, in central Georgia, Lang et al. (2002) concluded that juvenile wood thrushes dispersed to habitat similar to what they had used before dispersal.

In the northern hardwood-coniferous forests of northern Minnesota, Wisconsin, Michigan, and south-central Canada, no published information exists regarding habitat use by forest-nesting birds during the post-fledging period. Considerable information exists regarding other aspects of forest bird ecology in the region, including distribution

of breeding birds across northern forested landscapes (e.g., Hawrot et al. 1998), nesting ecology (e.g., Perry and Andersen 2003), effects of forest configuration on nesting (e.g., Manolis et al. 2000), effects of forest-management practices on nesting success (e.g., Manolis et al. 2002), and identification of nest predators of forest-nesting songbirds (e.g., Fenske-Crawford and Niemi 1997). Currently, considerable debate is ongoing regarding the desired future condition of northern forests, especially relative to the composition and juxtaposition of different habitats and age structure. Considerations for forest wildlife, including forest-nesting birds, are an important part of this debate (e.g., Jaakko Pöyry Consulting, Inc. 1992). However, the absence of information about habitat use by forest-nesting birds throughout the breeding season, and the importance of habitats other than nesting habitat, limits the ability to incorporate considerations for forest-nesting birds into forest management planning.

In 2005 we initiated a study of habitat use of forest-nesting birds during the post-fledging period in north-central Minnesota. We focused efforts on mist-netting in regenerating clearcuts in the Chippewa National Forest during the post-fledging period of most forest-nesting birds. We found that these habitats were used sufficiently by some forest-nesting species to warrant further study. In 2006 - 2008 we expanded our study of post-fledging habitat use of forest-nesting birds using nest searching, radio telemetry, and continued mist-netting. The objectives of this research are to (1) determine what species of forest-nesting birds (both adults and fledglings) use a range of early successional habitats during the post-fledging period, and (2) document post-fledging movements, habitat use, and survival of selected forest-nesting species in northern hardwood-coniferous forests in north-central Minnesota. Using radio telemetry in 2006 – 2008, we

observed fledglings of mature forest nesting species using mid-successional habitats (clearcuts 13 – 20 years after harvest) and forested wetlands. Therefore, in 2009 we extended the sampling of regenerating clearcuts to include the entire breeding season, 22 May – 26 August, and to include additional cover types: clearcuts 13-20 years since harvest and forested wetlands.

STUDY AREA

In May 2006 we selected 3 study locations across the Chippewa National Forest (CNF) in north-central Minnesota. The CNF encompasses approximately 600,000 ha of Cass and Itasca Counties in the transition zone from hardwood to boreal forest, and includes northern hardwood and northern boreal forest stands interspersed with wooded wetlands, marshes, lakes, and other wet areas. Northern hardwood stands are comprised of sugar maple (*Acer saccharum*), American basswood (*Tilia americana*), paper birch (*Betula papyrifera*), ash (*Fraxinus* spp.), yellow birch (*B. alleghaniensis*), quaking aspen (*Populus tremuloides*), red maple (*A. rubrum*), red oak (*Quercus rubra*), big-tooth aspen (*P. grandidentata*), and bur oak (*Q. macrocarpa*). Northern coniferous stands are primarily comprised of white pine (*Pinus strobus*), red pine (*P. resinosa*), jack pine (*P. banksiana*), spruce *(Picea* spp.), balsam fir (*Abies balsamea*), and northern white-cedar (*Thuja occidentalis*).

We selected study locations based on extent of mature mixed-deciduous and conifer forest types, distribution and extent of early successional habitats, spatial distribution across the CNF, and accessibility. We used U.S. Forest Service forest inventory maps to identify areas that included forest stands >50 years old and >200 ha in extent for nest searching, and regenerating aspen (*Populus* spp.) clearcuts of 2 age ranges

(1 – 6 and 7 – 12 years since harvest) for mist-netting. We also considered distributions and densities of target species in the selection process by incorporating point-count data supplied by the Chippewa National Forest. Based on these selection criteria we chose 3 locations: Pike Bay (47° 21'N, 94° 30'W), Cutfoot Sioux (47° 29'N, 93° 59'W), and Suomi Hills (47° 26'N, 93° 40'W).

METHODS

Mist-netting

At each study location in 2009, we sampled bird use of early successional regenerating clearcuts of 2 ages (1 – 6 and 7 – 12 years since harvest) using mist-nests (Table 1). In addition, at each of the Suomi Hills and Cutfoot Sioux locations, we sampled a mid-successional regenerating clearcut 13 – 20 years since harvest, and a forested wetland (mixed conifer and deciduous shrub-sphagnum bog). Between 15 and 19 May, we cleared vegetation to prepare net lanes approximately 1.5 m wide and set 2, 12 x 2.8 m, 4-shelf mist-nets (36 mm mesh) at 3 locations within each stand: (1) within 25 m of mature forest edge, (2) 26 – 50 m from mature forest edge, and (3) > 50 m from mature forest edge. We sampled the 4 stands at the Suomi Hills and Cutfoot Sioux locations from 20 May through 26 August, and the 2 stands at the Pike Bay location from 4 July through 27 August. We opened nets at 0530 in May through July and 0600 in August, and closed nets between 0830 and 0930 or when conditions such as rain, high winds, or high temperatures potentially placed undue stress on birds entangled in mist nets.

We checked all nets at intervals ≤ 30 minutes and removed entangled birds. We carried birds in soft cloth bags to a bird-banding station set up each morning central to the

sampled locations. We identified the species, sex, and age of each bird (weighing and measuring when necessary) according to Pyle (1997) and banded them using standard aluminum U.S. Geological Survey legbands (Table 2). We released adult birds from the banding station immediately following banding and carried hatch-year birds back for release near the point of capture. We sampled 2 – 4 stands at 1 location each day, and we sampled each stand twice weekly for a total of 72 netting occasions.

In 2009, we collected vegetation structure data once, and sampled food availability weekly at each netting location in each stand during the post-fledging period. For each pair of nets, we sampled vegetation structure on 16, 1-m radius circular plots, with 8 plots 1 m from the net lane and 8 plots 5 m from the net lane. For each plot, we estimated canopy height, percent ground cover of herbaceous vegetation and woody debris, measured leaf-litter depth, recorded dominant tree species, and counted number of tree species present. We estimated vegetation density using a profile board, with the board held at the net and the observer standing 5 m from the net. We used a 2 x 0.25 m profile board divided into 8 0.25 x 0.25 m squares, and visually estimated the percent of each square obstructed by vegetation.

We estimated food availability weekly by counting fruit, setting pitfall traps, and hanging fly tape in each net lane. Between 0930 h and 1200 h on the first of 2 consecutive days of netting in each stand, we walked 2 24 x 1.5 m transects adjacent to each side of each pair of nets. Along each transect, we counted all ripe fruit ≤1.5m from the net. In addition, we set 2 pitfall traps (12 oz plastic cups with 2 oz of 50% ethanol) in each net lane and recovered those 24 hours later. We stored the contents (ethanol and invertebrates) in sealed plastic bags for later processing. In the lab, we are in the process

of taxonomically categorizing and drying the pitfall invertebrate samples and measuring dry biomass to within 0.0001 g. We will use vegetation and food availability variables as predictors in a model of habitat use by forest-nesting birds.

Golden-winged Warblers

We captured golden-winged warblers (GWWA; *Vermivora chrysoptera*) during netting described above or by targeting individual birds using call playback. From each captured GWWA we collected blood, claw, and feather samples. We collected a blood sample equal to 1 small drop from the brachial vein using a sterile needle and a heparinized capillary tube (a tiny glass tube that uses capillary action to draw in the drop of blood). We applied gentle pressure with a cotton ball to the puncture site for about 1 minute following blood drawing to prevent further bleeding. We immediately transferred the blood sample from the capillary tube to a tube containing lysis buffer for storage. We disposed of all needles and capillary tubes properly in a sharps waste container. A portion of each blood sample will be shipped to Rachel Vallender for genetic analysis for the Golden-winged Warbler Atlas Project (GOWAP). In addition, a portion of each blood sample will be sent to R. Jory Brinkerhoff at Yale University to be included in a study of bird-mediated Lyme disease transmission.

From each golden-winged warbler, we also collected a small clipping of the claw of one hallux. In addition, from each individual we collected feather samples, including Primary-1, Rectrix-1, and 3 small body feathers following instructions provided by Rachel Vallender of GOWAP. Feather and claw samples will be shipped to Rachel Vallender and will be used as backup DNA samples, and for stable isotope analysis to identify migratory origins of the birds.

Tick Collection

Continued from 2008, in 2009 we inspected each bird handled for larval and nymph ticks. We removed all ticks with ultra-fine-tip forceps and stored them in ethanol. Ticks were sent to R. Jory Brinkerhoff at Yale University for screening for Lyme disease by amplifying Lyme pathogen rDNA using nested polymerase chain reaction.

RESULTS

Mist-netting

We recorded 2,102 captures of 1,875 birds representing 63 species, and banded 1,561 individuals in non-mature-forest stands contiguous with mature upland hardwood and mixed conifer forests (Table 2). Including recaptures, we captured a mean of 3.65 birds per hour of netting (i.e., 6 nets in 1 stand). We recaptured 4.9% (n = 48) of individuals banded in 2008, 2.4% (n = 21) of individuals banded in 2007, and 2.0% (n = 15) of birds banded in 2006, and 0 of 107 birds banded in 2005.

Mature forest-nesting species accounted for 41% (AHY = 537, HY = 302) of all captures, 31% (AHY = 170, HY = 9) of captures during the nesting period, and 44% (AHY = 167, HY = 293) of captures during the post-fledging period. As in 2007 and 2008, we captured more ovenbirds (n = 287; *Seiurus aurocapillus*) than any other species. The second most captured species was the early successional-nesting Nashville warbler (n = 276; *Vermivora ruficapilla*). As in 2008, capture rates of HY ovenbirds increased throughout the post-fledging period, while capture rates of AHY ovenbirds decreased (Fig. 1).

We captured 73 golden-winged warblers: 66 (AHY males = 21, AHY females = 19, HY males = 14, HY females = 9, and HY unknown sex = 3) while sampling non-

mature forest stands, and 7 AHY males during target-netting with call playback along roadsides within the CNF. We collected blood, claw, and feather samples from 60, 65, and 73 of those birds, respectively. We collected 1,572 ticks during the processing of 442 captures of 379 birds representing 27 species.

DISCUSSION

In 2009 we completed data collection for this project. During this year we expanded the number of cover types sampled and the duration of the sampling period. In 5 years of sampling bird use of non-mature forest stands associated with upland mature forest in the CNF, we captured nearly 5,000 birds, ~40% of which were of species associated with nesting in mature forest. These data, and the associated vegetation and food availability data, constitute a dataset larger than any of its kind, with which we will improve knowledge of songbird post-fledging habitat use and selection and plan multiple peer-reviewed publications.

PRODUCTS

In 2009, we published a peer-reviewed journal article describing the effects of bird blow flies on ovenbird productivity (Streby et al. 2009), and submitted a manuscript for review describing the effects of brood parasitism by brown-headed cowbirds (*Moluthrus ater*) on ovenbird nest productivity and fledgling survival (Peterson et al. in review). We gave an oral presentation about ovenbird reproductive success at the 2009 Midwest Fish and Wildlife Conference in Springfield, Illinois. We published a popular article about the unique capture of a white-crowned sparrow (*Zonotrichia leucophrys*) during the 2008 field season, and our research was featured in a short educational documentary film produced by Time Stopper Films. Henry was awarded a Doctoral

Dissertation Fellowship by the University of Minnesota, and is currently writing his dissertation with plans to produce 6 additional manuscripts to be submitted for publication in peer-reviewed journals.

PLANS FOR 2010

We will finish analyzing data and preparing manuscripts for publication during January through May 2010. In May 2010, Henry plans to defend his dissertation, which will comprise the final report for this project.

ACKNOWLEDGMENTS

In 2009, Sean Peterson and Jeanine Refsnider assisted in gathering field data, and Greg Alle arranged for use of facilities in Marcell, Minnesota. Additional funding to support 2009 field work was provided by the U.S. Fish and Wildlife Service, Region 3, Migratory Birds.

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Table 1. Dates we sampled bird use of non-mature-forest cover types associated with mature upland hardwood and mixed conifer forest at 3 locations in the Chippewa National Forest, Minnesota, in 2009.

Stand (years since harvest)	Suomi Hills	Cutfoot Sioux	Pike Bay
Clearcut (1 - 6 years)	22 May - 23 Aug	24 May - 24 Aug	6 Jul - 26 Aug
Clearcut (7 - 12 years)	22 May - 23 Aug	24 May - 24 Aug	6 Jul - 26 Aug
Clearcut (13 - 20 years)	22 May - 23 Aug	24 May - 24 Aug	N/A
Forested Wetland (N/A)	22 May - 23 Aug	24 May - 24 Aug	N/A

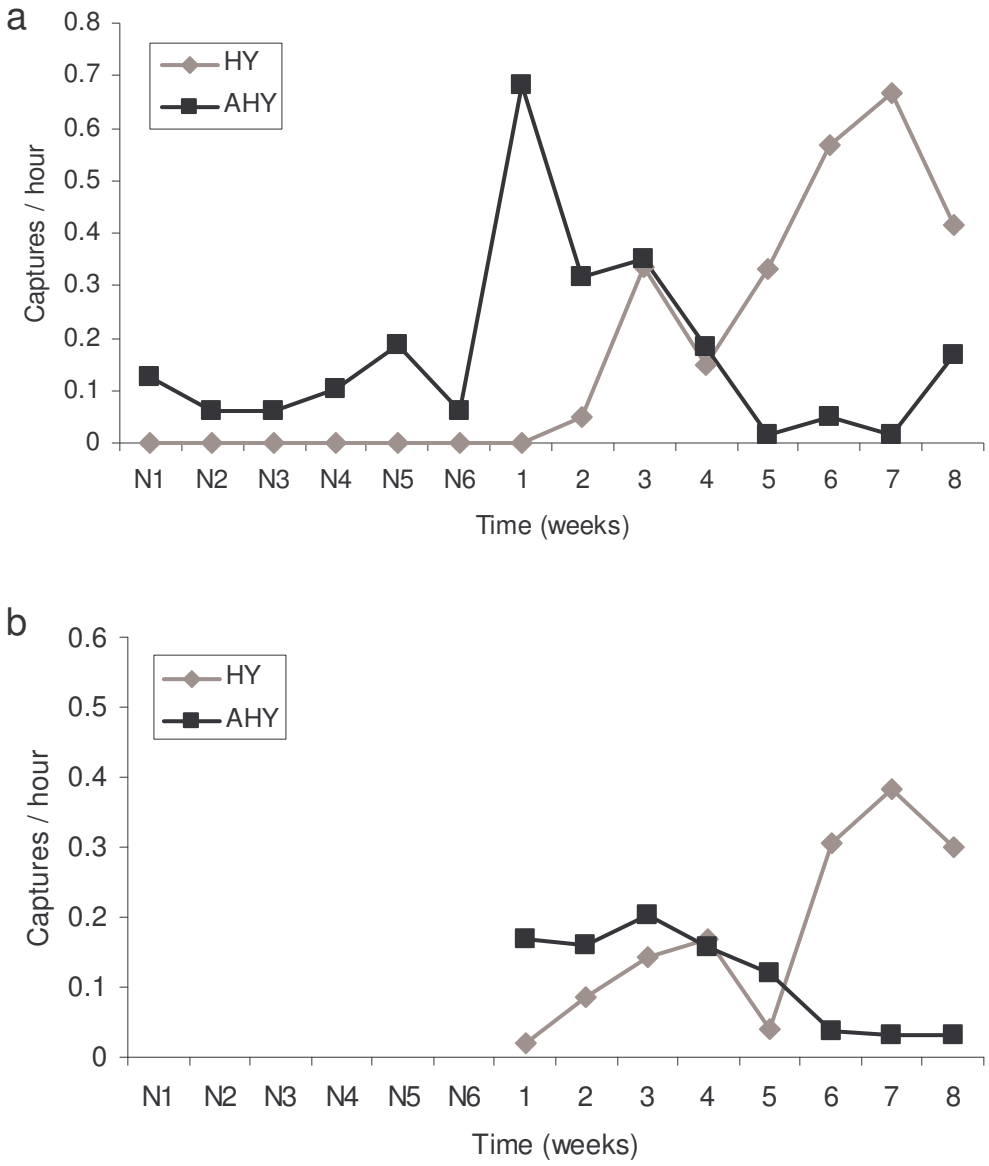
Table 2. Number of captures of hatch year (HY) and adult (AHY) birds in mist-nets in early-to-mid successional regenerating clearcuts and forested wetlands associated with mature upland hardwood and mixed conifer forest in the Chippewa National Forest, Minnesota, in 2009.

	Age			
Species	HY/JUV	AHY	Undetermined	Total
American Goldfinch [a]		2		**2**
American Redstart	48	59	4	**111**
American Robin	1	3		**4**
American Woodcock[b]		1		**1**
Baltimore Oriole		1		**1**
Black-and-white Warbler	18	42	1	**61**
Black-billed Cuckoo		1		**1**
Blackburnian Warbler	1	1		**2**
Black-capped Chickadee	17	28	15	**60**
Black-throated Green Warbler	8	7		**15**
Blue-headed Vireo		1		**1**
Blue Jay	3	10		**13**
Broad-winged Hawk		3		**3**
Brown Creeper	1	1		**2**
Canada Warbler	3	17		**20**
Cedar Waxwing	4	18		**22**
Chestnut-sided Warbler	34	207	5	**246**
Chipping Sparrow		1		**1**
Clay-colored Sparrow[b]	1			**1**
Common Yellowthroat	2	11	1	**14**
Connecticut Warbler			1	**1**
Downy Woodpecker	2			**2**
Eastern Wood-Pewee	1	3		**4**
Golden-winged Warbler	26	56		**82**
Gray Catbird	5	9		**14**
Hairy Woodpecker	1	1		**2**
Hermit Thrush	16	20		**36**
Indigo Bunting		6		**6**
Least Flycatcher	42	29	1	**72**
Magnolia Warbler	1	4		**5**
Mourning Warbler	11	56	1	**68**
Myrtle Warbler		1		**1**
Nashville Warbler	134	98	44	**276**
Northern Flicker		5		**5**
Northern Parula		1		**1**
Northern Waterthrush	1	1		**2**
Olive-sided Flycatcher		1		**1**
Orange-crowned Warbler[b]		3		**3**
Ovenbird	151	136		**287**
Philadelphia Vireo		1		**1**
Pine Warbler		2		**2**
Purple Finch		2		**2**
Red-breasted Nuthatch		1		**1**

Red-eyed Vireo	11	116	1	**128**
Rose-breasted Grosbeak	4	81		**85**
Ruby-crowned Kinglet		1		**1**
Ruby-throated Hummingbird	17	32	7	**56**
Ruffed Grouse[b]	1			**1**
Scarlet Tanager	3	6		**9**
Sharp-shinned Hawk[b]		1		**1**
Song Sparrow	12	13		**25**
Swainson's Thrush		14		**14**
Swamp Sparrow	4	1		**5**
Tennessee Warbler	7	15		**22**
Trail's Flycatcher	3	37		**40**
Veery	108	40	1	**149**
White-throated Sparrow	22	36	2	**60**
Wilson's Warbler		2		**2**
Winter Wren[b]		3		**3**
Wood Thrush	1	19		**20**
Yellow-bellied Flycatcher	7	5		**12**
Yellow-bellied Sapsucker	3	14		**17**
Yellow-throated Vireo			1	**1**
Total	**674**	**1342**	**86**	**2102**

[a] Scientific names of birds listed are presented in Appendix 2
[b] Species first captured in 2009

Figure 1. Capture rates of hatch-year (HY) and adult (AHY) ovenbirds in non-nesting cover types during (a) 22 May – 26 August 2009, and (b) 4 July – 27 August 2008 in the Chippewa National Forest, Minnesota. "N" denotes the nesting period.



Appendix 1. Peer-reviewed study plan for ongoing project on post-fledging habitat use by forest-nesting birds in north-central Minnesota.

Habitat Use of Post-fledging Forest-nesting Songbirds in Northern Hardwood-Coniferous Forests in North-central Minnesota

Proposed Study Plan

10 April 2005

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Introduction

Compared to use of nesting habitat, habitat use by forest-nesting songbirds following fledging is relatively poorly understood. Recent studies based on point counts and mist-netting (e.g., Pagen et al. 2000, Marshall et al. 2003), and monitoring movement of fledglings via radio-telemetry (e.g., Anders et al. 1998, Vega Rivera et al. 1998, Lang et al. 2002, Fink 2003, Cohen and Lindell 2004) suggest that for at least some species of forest-nesting songbirds, habitat use during the post-fledging period can be quite different from breeding-habitat use. For example, Pagen et al. (2000) employed point counts and mist nesting in 4 Missouri Ozark habitats—they observed both adult and hatching-year birds of several forest-nesting species in early successional habitats during the post-breeding and breeding seasons. Similarly, Marshall et al. (2003) captured adults, juveniles, and family groups of forest-nesting songbirds in early successional habitats with mist nets in West Virginia and Virginia.

In Missouri, Anders et al. (1998) and Fink (2003) observed that radio-marked wood thrushes (*Hylocichla mustelina*) used mid- to early-successional habitats, or habitats near edges and agriculture, after dispersing from natal territories. In Virginia, Vega Rivera et al. (1998) observed that fledgling wood thrushes frequented second-growth scrub/deciduous sapling sites along forest borders and abandoned farms, gypsy moth (*Lymantira dispar*)-damaged deciduous forests, and pine forests with heavy deciduous understory. Vega Rivera et al. (2003) monitored movements of scarlet tanagers (*Piranga olivacea*) in Virginia during the breeding and post-breeding periods, and observed a slight increase in use of early successional habitats in the post-breeding period. Conversely, in central Georgia, Lang et al. (2002) concluded that juvenile wood thrushes dispersed to habitat similar to what they had used before dispersal.

In the northern hardwood-coniferous forests of northern Minnesota, Wisconsin, and Michigan, and south-central Canada, no published information exists regarding habitat use by forest-nesting birds during the post-fledging period. Considerable information exists regarding other aspects of forest bird ecology in the region, including distribution of breeding birds across northern forested landscapes (e.g., Hawrot et al. 1998), nesting ecology (e.g., Perry and Andersen 2003), effects of forest configuration on nesting (e.g., Manolis et al. 2000), effects of forest-management practices on nesting success (e.g., Manolis et al. 2002), and identification of nest predators of forest-nesting songbirds (e.g., Fenske-Crawford and Niemi 1997). Currently, considerable debate is ongoing regarding the desired future condition of northern forests, especially relative to the composition and juxtaposition of different habitats and age structure. Considerations for forest wildlife, including forest-nesting birds, are an important part of this debate (e.g., Jaakko Pöyry Consulting, Inc. 1992). However, the absence of information about habitat use by forest-nesting birds throughout the breeding season, and the importance of habitats other than nesting habitat, limits the ability to incorporate considerations for forest-nesting birds into forest management planning.

To address these information needs, we propose to investigate habitat use of forest-nesting birds during the post-fledging period in north-central Minnesota. The objectives of this research are to (1) determine what species of forest-nesting birds (both adults and fledglings) use a range of habitats from early successional to mature forest during the post-fledging period, and (2) document post-fledging movements and habitat use of selected forest-nesting species in northern hardwood-coniferous forests in north-central Minnesota.

Study Area

The specific study area for this project has not yet been determined, but will be within the northern hardwood-coniferous forest region of northern Minnesota. Considerable information exists regarding distribution, relative abundance, nesting success, and nest predators for forest-nesting birds in north-central Minnesota (e.g., Fenske-Crawford and Niemi 1997; Hawrot et al. 1998; Manolis et al. 2000, 2002; Perry and Andersen 2003). Historical information on breeding forest-nesting songbirds and existing study plots (e.g., Perry 1998, Manolis 1999) on the Chippewa National Forest, coupled with habitat data in electronic format make this a potential site for additional research. The Chippewa National Forest has offered in-kind support (e.g., housing) for the initial field season of this project, and is seeking internal funds to contribute to the project.

Methods

The first project objective will be addressed through mist-netting (perhaps in conjunction with point counts). We will identify a range of habitats and sample these habitats across a forested landscape, following the procedures described by Pagen et al. (2000) and Marshall et al. (2003). Mist-netting will take place during the post-fledging period (mid-June through July, based on previous field studies conducted on the

Chippewa National Forest [e.g., Perry 1998, Manolis 1999]). Captured birds will be banded with U.S. Fish and Wildlife Service standard legbands to identify individuals if they are subsequently recaptured.

Mist-netting data will primarily be used to assess use of early successional habitats by forest-nesting birds following fledging. Because of potential variation among habitats in capture probability related to habitat structure and difficulties in setting mist nets in the canopy and sub-canopy, capture data will not be directly comparable among habitats. Thus, mist netting data will primarily be used to document use of early successional habitats by post-fledging birds, and relative use of habitats will be assessed based on results of radio telemetry. However, because radio telemetry will be employed with only a few species (see below), mist netting will also be used to assess relative abundance within habitats, and to document habitat use by species in addition to radio-marked species.

The second project objective will be addressed through radio telemetry, following the procedures described by Anders et al. (1998), Vega Rivera et al. (1998, 2003), Lang et al. (2002), Fink (2003), and Cohen and Lindell (2004). Nest will be located on plots established in interior forest habitats following the procedures described by Martin and Geupel (1993) and Martin et al. (1997), and used on previous studies of forest-nesting birds in north-central Minnesota (Perry 1998, Manolis 1999). Relatively abundant species for which nests were found in previous studies include ovenbirds (*Seiurus aurocappillus*), least flycatchers (*Empidonax minimus*), red-eyed vireo (*Vireo olivaceus*), and hermit thrush (*Catharus guttattus*). Currently, the smallest radio transmitter for attachment to songbirds (approximately 0.55 g, Advanced Telemetry Systems, Inc.; C. Kochanny personal communication; use of trade names does not imply endorsement by either the U.S. Geological Survey or the University of Minnesota) could be attached to ovenbirds, red-eyed vireos, and hermit thrushes.

Radio-telemetry transmitters will be attached on the backs of nestling birds prior to anticipated fledgling—only 1 nestling per nest will be equipped with a transmitter to maximize effective sample size (members of the same brood may not move independently of one another). Transmitters will be attached with adhesive to the backs of nestlings (Fink 2003, C. Kochanny personal communication). Following transmitter attachment, radio-marked birds will be monitored daily via ground-based telemetry using standard methodology, and we will determine locations via triangulation and visual observations. Estimated locations will be derived using handheld GPS units. Visual assessment of habitat will be recorded at the time that locations are obtained, and habitat characteristics at a subsample of these locations will subsequently be assessed following standard protocols for habitat measurement in northern forests (e.g., Perry 1998). In the event that birds become difficult to monitor from the ground, we will locate birds from the air. Finally, we have access to 2 remote telemetry data loggers, and we will use these devices to monitor activity and duration of habitat patch occupancy of radio-marked birds.

Telemetry data will be used to assess post-fledging habitat use and home range characteristics. Standard home range models (minimum convex polygon and fixed kernel) will be used to assess home range size and relative use within home ranges. Distance between nest sites and use areas, distance between subsequent daily locations, and habitat at use sites will be used to describe movements and habitat use during the post-fledging period. At larger spatial scales, we will compare habitats used by radio-marked birds with the abundance and distribution of those habitats across the landscape.

Preliminary Timeline

Timeline:
January 2005 – select student, select field site, plan for field season
May – August 2005 – Mist netting and point counts (objective 1)
May – August 2006 – Mist netting, nest searching, and radio telemetry
May – August 2007 – Nest searching and radio telemetry

Expected Products

Products will include annual project reports, a final project report, a graduate student thesis, and primary literature publications presenting project results.

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Appendix 2. Common and scientific names of birds handled in 2009.

Common name	Scientific name
American Goldfinch	*Archilochus colubris*
American Redstart	*Setophaga ruticilla*
American Robin	*Turdus migratorius*
American Woodcock	*Scholopax minor*
Baltimore Oriole	*Icterus galbula*
Black-and-white Warbler	*Miniotilta varia*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Blackburnian Warbler	*Dendroica fusca*
Black-capped Chickadee	*Parus atricapillus*
Black-throated Green Warbler	*Dendroica virens*
Blue-headed Vireo	*Vireo solitarius*
Blue Jay	*Cyanocitta cristata*
Broad-winged Hawk	*Buteo platypterus*
Brown Creeper	*Certhia americana*
Canada Warbler	*Wilsonia canadensis*
Cedar Waxwing	*Bombycilla cedrorum*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Chipping Sparrow	*Spizella passerine*
Clay-colored Sparrow	*Spizella pallida*
Common Yellowthroat	*Geothlypis trichas*
Connecticut Warbler	*Oporornis agilis*
Downy Woodpecker	*Picoides pubescens*
Eastern Wood-Pewee	*Contopus virens*
Golden-winged Warbler	*Vermivora chrysoptera*
Gray Catbird	*Dumetella carolinensis*
Hairy Woodpecker	*Picoides vellosus*
Hermit Thrush	*Catharus guttatus*
Indigo Bunting	*Passerina cyanea*
Least Flycatcher	*Empidonax minimus*
Magnolia Warbler	*Dendroica magnolia*
Mourning Warbler	*Oporonis philadelphia*
Myrtle Warbler	*Dendroica coronata*
Nashville Warbler	*Vermivora ruficapilla*
Northern Flicker	*Colaptes auratus*
Northern Parula	*Parula americana*
Northern Waterthrush	*Seiurus noveboracensis*
Olive-sided Flycatcher	*Contopus cooperi*
Orange-crowned Warbler	*Vermivora celata*
Ovenbird	*Seiurus aurocapillus*
Philadelphia Vireo	*Vireo philadelphicus*
Pine Warbler	*Dendroica pinus*
Purple Finch	*Carpodacus purpureus*
Red-breasted Nuthatch	*Sitta canadensis*
Red-eyed Vireo	*Vireo olivaceus*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*

Ruby-crowned Kinglet	*Regulus calendula*
Ruby-throated Hummingbird	*Archilocus colubris*
Ruffed Grouse	*Bonasa umbellus*
Scarlet Tanager	*Piranga olivacea*
Sharp-shinned Hawk	*Accipiter striatus*
Song Sparrow	*Melospiza melodia*
Swainson's Thrush	*Catharus ustulatus*
Swamp Sparrow	*Melospiza georgiana*
Tennessee Warbler	*Vermivora peregrina*
Trail's Flycatcher	*Empidonax* sp.
Veery	*Catharus fuscescens*
White-throated Sparrow	*Zonotrichia albicollis*
Wilson's Warbler	*Wilsonia pusilla*
Winter Wren	*Troglodytes troglodytes*
Wood Thrush	*Hylocichla mustelina*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-throated Vireo	*Vireo flavifrons*