Environment and Natural Resources Trust Fund

Research Addendum for Peer Review

Project Manager Name: Gerald Niemi

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Project Title: Tree Retention Following Harvest: Benefit or Unnecessary Cost?

Project number: 0410-2-247

1. Abstract.

Forest management is increasingly focused on maintenance of biodiversity as a primary goal compared to a historic emphasis on timber production alone. The Minnesota Forest Resources Council (MFRC) established voluntary guidelines recommending that 6-12 scattered trees per acre or 5 percent of the harvest area in clumped aggregates >0.25 acre be left uncut to promote long-term sustainable management of Minnesota's forests. These leave trees are thought to be important in sustaining many wildlife species, but there has been no experimental test of the benefits of leave trees to wildlife. Monitoring data shows that leave tree guidelines are followed on only 60% of harvests in Minnesota, but is unclear if negative impacts to wildlife species are occurring given the uncertainty regarding leave tree effectiveness. We will test the hypothesis that bird, mammal, and herptile biodiversity measures are higher in sites where MFRC leave tree guidelines were followed than in sites where they were not. We will use an experimental design contrasting measurements or species counts between paired sites with contrasting leave tree implementation that span a wide range of site conditions and a post-harvest time period of 3-15 years. We will survey birds using Digital Audio Recorders (DARs), small mammals using Sherman, snap, or pitfall traps, large mammals using remote cameras, and herptiles using pitfall traps, cover boards, and DARs. Differences in species richness and relative density among treatments will be tested with ANOVA, regression, and possibly hierarchical modeling techniques using the factors of leave tree implementation, time since harvest, landscape context, and a coarse woody debris index. Project results will be summarized and presented to the MFRC for evaluation, and a summary report made available on NRRI's website and on the MFRC website. The MFRC will use the information to either validate the existing leave tree guidelines, or propose alternative guidelines that mitigate impacts on forest bird and small mammal species. Ultimately, the information will be transferred to loggers and resource managers during guideline training sessions.

2. **Background**

Forest management is increasingly focused on maintenance of biodiversity as a primary goal compared to a historic emphasis on timber production alone. Guidelines or recommendations to address this focus have been developed by forest certification organizations, international groups, and national and local governments. A central theme of these approaches is that silvicultural systems which mimic natural disturbance are more likely to maintain biodiversity than silvicultural systems that do not mimic natural disturbance (e.g., Niemi and Probst 1990, Brawn et al. 2001, Hobson and Schieck 1999). One silvicultural approach that has received much attention is variable retention harvesting (also known as green tree or leave tree retention) which leaves a portion of the stand uncut following forest harvest to provide more complex forest structure characteristic of older forests (Franklin et al. 1997).

The Minnesota Forest Resources Council (MFRC) is a state council established by the Sustainable Forest Resources Act (SFRA) of 1995 to promote long-term sustainable management of Minnesota's forests. Voluntary guidelines developed by the MFRC recommend that 6-12 scattered trees per acre or 5 percent of the harvest area in clumped aggregates >0.25 acre be left uncut. The rationale for these MFRC leave tree guidelines was that leave trees are key to sustaining some wildlife species of greatest conservation concern including many mammals, birds, and herptiles (amphibians, snakes, and lizards) (MFRC, 2005).

The MFRC leave tree guidelines were developed based on the best science available at the time, and on professional judgment (MFRC 2005). Inferences had to be drawn from studies with potentially confounding effects of time since harvest, taxa studied, and density of leave trees. Nuanced effects can be dependent on leave tree characteristics, abundance, and spatial arrangement (Rosenvald and Lohmus 2008, Atwell et al. 2008, Sullivan et al. 2001). For example, some studies have shown general positive effects of leave trees at maintaining some aspects of biodiversity, with bird species typical of edges and open areas increasing while forest interior bird species decreased (Niemi and Hanowski 1984, Tittler et al. 2001). In coniferous forests of western North America the relative abundance of genera of small mammals (*Microtus*, *Peromyscus*, *Clethrionomys*) will switch after forest harvest (Sullivan and Sullivan 2001).

Positive effects of tree retention on forest birds in Minnesota have been shown with higher levels of tree retention than called for in the MFRC guidelines (Niemi and Hanowski 1984, Atwell et al. 2008, Merrill et al. 1998). The 50% retention used in the Atwell et al. (2008) study is much higher then MFRC leave tree guidelines. Niemi and Hanowski (1984) studied logged areas in northern Minnesota and found increasing breeding bird density with habitat complexity, but it was difficult to separate the effects of dead and live trees from the density of shrubs. Scattered leave tree retention is the most widely used method in practice (Dahlman 2008, Dahlman and Rosman 2010), but the Merrill et al. (1998) study only assessed large (~1.3 ac.) leave tree clumps and it is unclear if their results are applicable to typical harvest conditions.

The effectiveness of MFRC leave tree guidelines has not been measured with a controlled experimental design in Minnesota. We will determine if leave trees retained following harvesting provide important habitat for different wildlife taxa across the range of site conditions found in northern Minnesota forests. Results will be used to validate use of the existing guidelines, or be used by the MFRC to revise and modify the current leave tree guidelines. The overall desired outcome of this project is to ensure that recommended tree retention guidelines are effective and efficient at mitigating harvest-related impacts on wildlife in the state.

3. Hypothesis

The overall hypothesis is that bird, mammal, and herptile biodiversity measures are higher in sites where MFRC leave tree guidelines were followed than in sites where leave tree guidelines were not followed. We will use an experimental design contrasting measurements or species counts from paired sites where guidelines were implemented at one site but not the other. After establishing 30 paired sites that are matched to the extent possible, we can then directly test for the effect of leave tree implementation on the number of bird, mammal, or herptile species between sites.

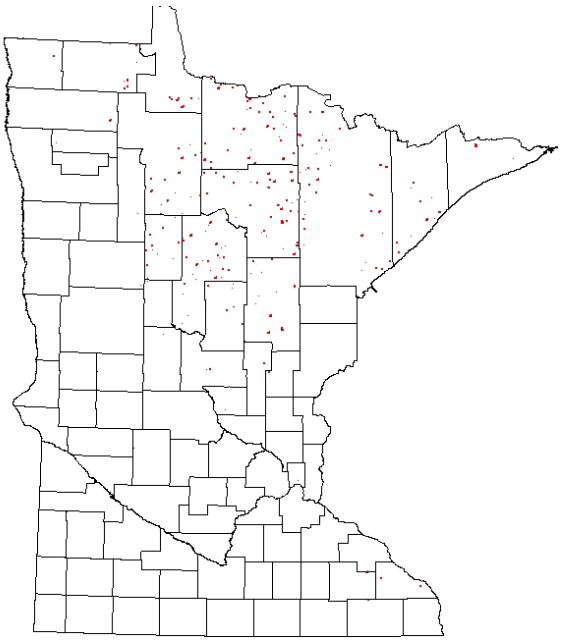
Other factors that could affect taxa biodiversity are time since harvest and abundance of coarse woody debris (CWD) on sites. We will match paired sites based on time since harvest, which ranges from 3 to 15 years (Dahlman 2008, Dahlman and Rosman 2010). We hypothesize that the biodiversity response will be dependent on time since harvest, with an initial short-term decrease followed by an increase in taxa biodiversity as the succeeding stand develops. We also hypothesize that animal taxa biodiversity will be positively related to the amount of CWD left at each site.

4. Methodology

Site Selection. We will use monitoring data on leave tree retention collected by MN DNR over the last decade to identify sites for this project (Fig. 1). The study design is retrospective, covering a range of site conditions across the state and a post-harvest period of 3-15 years. This approach addresses common limitations of existing leave tree studies associated with insufficient sample size and duration of response (e.g., Atwell et al. 2008, Rosenvald and Lohmus 2008).

We will compile implementation monitoring data for over 700 harvest sites collected by MNDNR Forestry over the period 2000-2009 (Dahlman 2008, Dahlman and Rossman 2010). The DNR randomly selected these sites from all forest harvests, providing a representative sample of conditions within the state. Sites will be evaluated and separated into two implementation categories: 1) implemented leave tree guideline as recommended, or 2) did not implement leave tree guideline. A random sample of at least 30 pairs of sites will be selected. Time since harvest of the 30 pairs of sites will cover the range of stand ages in the complete data set. The approach will allow for robust comparisons of the effect of leave tree implementation across a wide range of site conditions.

Figure 1. 2009 DNR monitoring site locations from which study sites would be selected (Dahlman 2008, Dahlman and Rossman 2010). Sites were randomly selected and cover the range of conditions found within the state. With reduced funding requested by LCCMR spatial extent of sampling will be reduced but still include most of harvest area in Minnesota.



Private lands are also included in the data set (Dahlman 2008, Dahlman and Rossman 2010). Landowners will be identified from previously collected information or county tax records, and then contacted to obtain permission to enter the site. We will use area-restricted sampling with sites focused in Cook, Lake, St. Louis, Koochiching, Itasca, Aitkin, Hubbard, Cass, and Beltrami Counties.

We will select site pairs consisting of one site where leave-trees were retained according to MFRC guidelines and one site where leave trees were not retained. Because nearly all sites with leave trees guidelines implemented have scattered individual trees rather than clumped blocks > 0.25 acres, we will use scattered leave tree sites for sampling. Characteristics of these paired sites (e.g., proximity, original forest type) will be standardized as much as possible using GIS analysis (ArcView, ArcMap). We will stratify site selection with respect to time since harvest, with the expectation of having 10 pairs of sites harvested 3-7 years ago, 10 pairs of sites harvested 8 to 12 years ago, and 10 pairs of sites harvested 13 to 15 years ago. Comparison of bird and small mammal responses between sites either with or without leave tree retention will identify the effect of scattered leave trees on those variables.

Because many species of wildlife are also affected by the landscapes surrounding a site (Pearson and Niemi 2000, Crozier and Niemi 2003, Niemi et al. 2004, Price et al. 2004), to the extent possible we will also consider the landscape context in the pairing of sites. There are many variables that could be incorporated into the landscape analysis. We will primarily focus on the degree of isolation of the logged area relative to the proportion of forest surrounding the logged area (e.g., within a 500 or 1000 m buffer). We will focus on insuring that the paired sites are not influenced by human development such as urban, exurban, or agricultural lands. During census of wildlife, we will also gather information on the percent cover of any invasive trees or shrubs found on the sites.

Bird Surveys. We will survey birds using Digital Audio Recorders (DARs). Historically, bird surveys have been done with point counts along line transects. Trained observers record birds heard or seen within a 10-minute sampling period on days with little wind and rain shortly after sunrise (Hanowski et al. 1990, Hanowski et al. 2005, 2006, Etterson et al. 2009).

In contrast, DARs are left on site and automatically record bird calls (Rempel et al. 2005). Advantages of the DAR are that they record sounds continuously over a 24-hour period, they create a permanent archival record, both bird and frog sounds are recorded, and sound recording can be post-processed by computer in the office. Although the DAR technique was criticized when searching for the ivory-billed woodpecker (Swiston et al. 2009) others have recognized the benefits of DARs (Penman et al. 2005, Charif and Pitzrick 2008, Tremain et al. 2008). Furthermore, DARs are likely the methodology that will be used on bird surveys in the future (Brandes 2008).

We will use 4 DARs that will be rotated among sample site pairs in the spring (May-July) when breeding bird surveys are typically conducted and randomly through the summer and fall months. Thus, there will be a broad range of temporal conditions in which sampling will occur. DARs will be deployed for at least 48 hours at each site. Sounds will be identified to species in the office. In initial analysis of the DAR technique, trained observers were able to identify the 34 most common bird species in boreal forests consistently (Rempel et al. 2005).

We will use a combination of analysis techniques, with automated identification followed by confirmation with human observers. Niemi will be developing protocols for DARs on other bird projects which have already been funded in Spring 2011, before the start of this leave tree project. These protocols will be directly transferable to this project and will include on-the-ground checking

with point counts at representative paired sites to validate that the DARs are comparable to human observers in detecting bird and anuran calls. **Mammal Surveys**. Several studies from broad geographic areas have shown that small mammal density and species composition is affected by forest harvest (Aarhus and Moen 2005). Small mammal density is also correlated with CWD density which could be an important source of site-level variance in small mammal trapping that is addressed in the Independent Variable section (see below).
We will trap small mammals in each site pair on the same days. We will use Sherman live traps, snap traps and pitfall traps to capture small mammals. We plan to use 2 lines of 10 live traps at each site with leave trees. One line would be near the leave trees, and the second line would be at least 2 home range diameters way from small mammal species that will be trapped. A similar spatial design will be used for the sites without leave trees. For the pitfall traps, we will have 4 to 6 pits per site, again in a paired design adjacent to and some distance from leave trees. Preliminary data from other projects by Moen indicate catch success of about 1 small mammal per 5-10 trap nights is possible.

Live traps will be baited with a mixture of oatmeal and potatoes while snap traps will be baited with peanut butter. Live traps will be set 4 days per site in spring or fall, and monitored every 24 hours (Table 1). Some shrews may be caught in live traps, but we expect most shrews to be captured in pitfall traps, which also will be used to capture amphibians (see Amphibian Surveys section). Pitfall traps will be at least 50 cm deep and 15 cm in diameter. Pitfall traps will be checked daily during mammal surveys. When mammals are not being surveyed a rope or stick will be placed in the trap to allow escape (Karraker 2001) or we will cover traps to exclude insectivores. Drift fences will be used to increase capture rate, with an expectation of catching up to 20 individuals per site.

For larger mammals (and other taxa) we will use trail cameras in selected locations, again making sure that cameras are deployed on both sites of each pair simultaneously. From other projects in northern Minnesota Moen has obtained over 200,000 photographs of animals with remote cameras (Moen and Lindquist 2006, Burdett et al. 2006). These cameras detect animals and birds as small as a deer mouse (*Peromyscus* spp.). Camera results can be analyzed the same as trap results, with a comparison of captures per trap night at treatment and control sites.

Amphibian Surveys. Pitfall traps, cover boards (Heyer et al. 1994), and the DARs will be used to survey amphibians. Pitfall traps are at least 15 cm wide and 50 cm deep to prevent escape. Drift fences (3 – 5 m) are usually installed to direct movement towards the pitfall. Pitfall traps will be checked at least twice weekly (except daily when mammals are being live-trapped). Cover boards of a standard size and material will be placed near each pitfall trap as a complementary method to survey amphibians. The boards will be checked at least monthly for presence of amphibians or other taxa (Table 1).

Anuran calls will also be recorded and processed using the DARs we are using to monitor birds (See Bird Surveys section above).

Independent Variables and Statistical Techniques. We will have at least 30 paired sites (Implemented leave tree guidelines or did not implement leave tree guidelines) for each of the dependent variables. Dependent variables will be the number of species and relative indices of density from the bird, mammal, and herptile sampling. This analysis will provide at least 20 or more tests of dependent wildlife variables consisting of community characteristics, guild analyses, and individual taxa.

The overarching independent variable will be whether MFRC leave tree guidelines were implemented at a harvest site or not. A second site-level independent variable is the time since

harvest, which we will stratify into three age classes (3-7 years, 8 – 11 years, 12 – 15 years since harvest). A third independent variable for small mammal, amphibian, and bird surveys is the abundance of CWD. At current funding levels it is not possible to measure CWD using a line transect technique (Harmon and Sexton 1996). Instead, we will classify CWD abundance into qualitative categories that will be estimated visually at each site. Finally, we will use leave tree density at time of sampling as a covariate.

Analysis of variance will be the primary technique used to determine the effect of leave trees, time since harvest, and CWD on various measures of biodiversity. With this experimental design we can also use a regression approach with covariates (e.g., leave tree density) which would be useful to detect trends across the range of measurements for each independent variable. The sample size is also adequate to explore models of different combinations of independent variables (e.g., number of leave trees, types of leave trees, and landscape context) with several dependent wildlife variables using hierarchical modeling techniques (e.g., Bayesian analysis).

Table 1. Sampling stations will sample multiple taxonomic groups. Information on sampling protocols is given above.

Target	Technique	When	Duration per site	Expectation
Leave Tree	Count, Species ID, Condition	May		
CWD	Classify	May		
Mammals	Snap traps or Live traps	Jun, Sep	3 days	5 to 20 captures / site
Mammals	Pit traps	Jun, Sep	2 weeks	Up to 20 captures / site, Soricomorpha
Mammals	Cameras	May – Sep	120 days	100 captures / site
Birds	Digital Audio Recorders	May - Jun	2 days	5-20 species per plot
Amphibians	Pit traps	Jun – Sep	60 days	10 captures / site
Amphibians	Cover boards	Jun – Sep	60 days	10 captures / site

5. Results and Deliverables

Activity 1: Identify research sites and obtain access to private lands.

The expected outcome of Activity 1 will be identification of at least 30 pairs of sites where we will sample bird, mammal, and herptiles, classify CWD, estimate leave trees present, and estimate percent cover of invasive trees or shrubs (see Activity 2). Each pair of sites will be as similar as possible except for the implementation of the MFRC leave tree guidelines.

Activity 2: Quantify leave tree effect on birds, mammals, and herptiles

The expected outcome of Activity 2 will be measurements of presence and relative density of birds, mammals, and herptiles using several different techniques (Table 1). We will measure bird and frog activity at each site using digital audio recorders. We will determine small mammal presence by trapping, and search for salamanders, frogs, and snakes using coverboards. We will also use remote cameras and digital audio recorders to document mammal and bird presence over longer time intervals.

Identical protocols at paired sites with and without leave trees present will enable a powerful test of leave trees on wildlife species following forest harvest. The outcome will be the first experimentally based test of whether MFRC guidelines for leave trees lead to an increase in biodiversity in different taxa across a range of site ages.

The deliverable from this activity will be a collection and analysis of data to create a summary report on the effects of leave tree guideline implementation on biodiversity. These recommendations will be separate for each taxa (birds, mammals, and reptiles) because it is possible that responses will vary, and that there will be species-specific responses within each taxa.

6. Timetable

Outcome for Activity 1	**Completion Date**
1. At least 60 sample sites selected from all monitored sites	October, 2011
2. Landowner permission to access sites obtained	January, 2012

Outcome for Activity 2	**Completion Date**
1. Bird, mammal and herptile data collection completed	October 2013
2. Provide guidance on bird and mammal use of leave trees	June, 2014
3. Present recommendations to the Minnesota Forest Resources Council	June, 2014

4. 7. Budget

2011-2012 Detailed Project Budget		
IV. TOTAL TRUST FUND REQUEST BUDGET 3 years		
BUDGET ITEM	**AMOUNT**	
Personnel:		
R. Moen, Res Assoc: analyze data, report. 36 mo, 11.25% sal, FB 33%	$ 31,210	
Tech/Temp: (Std-sample, doc. wildlife. 36 mo, 40% sal, FB 9%)	$ 40,335	
Ungrad: sample, input data 36 mo, sal 2% AY-FB 0, sal 45% sum-FB 7.3%	$ 10,080	
Contracts: None	-	
Other: GIS services @ $4.10/hr for approx. 100 hrs.	$ 410	
Equipment/Tools/Supplies:		
Binoculars, traps, automated bird call recording	$ 5,465	
Travel: To field sites, $0.50/mile, 25k mi	$12,500	
Additional Budget Items: None	-	
TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND $ REQUEST	$100,000	
V. OTHER FUNDS		
SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ Being Applied to Project During Project Period:		
G. Niemi, Sr Res Assoc: design,supervise,analyze data. 3yr, 5% sal, FB 33%	$20,655	Secured
Other State $ Being Applied to Project During Project Period:		

R. Slesak, Adj Prof: supervise student. 3 yr, 5% sal, FB 33%	$12,900	Secured

We are attempting to make up the reduction in the originally proposed budget with funding from other sources. We have no firm funding commitments yet but are encouraged by some responses. Additional funds that we acquire would be used to restore the initially proposed sample size (100 vs. 60), collect data on leave tree characteristics, and possibly expand the spatial extent of sampling.

8. **Credentials**: Key personnel are Dr. Gerald J. Niemi, Dr. Ron Moen, and Dr. Robert Slesak.

Dr. Gerald J. Niemi, professor of biology and senior research associate at the Natural Resources Research Institute at the University of Minnesota Duluth, will lead the efforts for birds and herps. He has over 35 years of experience designing and implementing field projects on birds throughout Minnesota. He also served as one of the lead scientists for the original Generic Environmental Impact Assessment on forest harvesting and management in Minnesota and served on the roundtable that originally developed the forest management guidelines.

Education
Florida State University, biology, Ph.D., 1983
University of Helsinki, Fulbright Scholar, Pre-doctoral, 1981
UMD, biology, zoology, B.S., 1974; M.S. 1977

Appointments
Professor: Biology, UMD, 1993 to present. *Senior Research Associate:* NRRI, UMD, 2008-present. *Director:* Center for Water and the Environment (CWE), NRRI, UMD, 1989-2008. *Department Chairman:* Biology, UMD, 1997-1998. *Graduate Faculty Appointments:* Integrated Biological Sciences/Biology UMD, 1987-present; Chemical Toxicology, UM-TC, 1992 to present; Conservation Biology Program, UM-TC, 1996 to present.

Publications *> 100 peer reviewed*

Etterson MA, Niemi GJ, Danz NP. 2009. Estimating the effects of detection heterogeneity and overdispersion on trends estimated from avian point counts. Ecological Applications 19(8):2049-2066.

Mattsson BJ, Niemi GJ. 2008. Causes and consequences of distribution patterns in a migratory songbird across its geographic range. Canadian Journal of Zoology 86:314-328.

Danz NP, Bracie A, Niemi GJ. 2008. Breeding bird monitoring in western Great Lakes national forests 1991-2007. NRRI/TR-2008/1.1

Miller C, Niemi GJ, Hanowski JM, Regal RR. 2007. Breeding bird communities across an upland disturbance gradient in the western Lake Superior region. Journal of Great Lakes Research 33(3):305-318.

Hanowski JM, Danz NP, Howe RW, Niemi GJ, Regal RR. 2007. Consideration of geography and wetland geomorphic type in the development of Great Lakes coastal wetland bird indicators. Ecohealth 4:194-205.

Niemi, G.J. and M. McDonald. 2004. Application of ecological indicators. Annual Review of Ecology and Systematics 35: 89-111.

Research Projects *- 48 managed, >$20 million*

2007-2008 Co-PI and Team Lead for Wildlife portion, Co-Lead for Land and Aquatic Habitat Conservation, Minnesota Statewide Conservation and Preservation Plan. LCCMR. $450,000 to U of Minnesota-Institute on the Environment;

2001-2006 Lead PI with 27 Co-PIs. Development of environmental indicators of condition, integrity, and sustainability in the Great Lakes basin. U.S. EPA-NASA STAR Grant Program, $6,979,667.

1991-2003 Lead PI. Effects of changes in the forest ecosystem on the biodiversity of Minnesota's northern forest birds. Minnesota LCCMR. $2,112,473 in cooperation with MN Department of Natural Resources.

Dr. Ron Moen is a research associate at the Natural Resources Research Institute, non-tenure-track assistant professor in biology at the University of Minnesota Duluth, and holds appointments in the graduate programs of Integrated Biological Science (University of Minnesota Duluth) and Conservation Biology (Twin Cities).

Education

University of Minnesota, Wildlife Conservation, Ph.D. 1995
University of Minnesota, Wildlife, M.S. 1988
Cornell University, Biological Sciences, B.S. 1984

Selected Grants

2010. Environmental Protection Agency Great Lakes Restoration Initiative. Restoring Habitats for Moose in Northeastern Minnesota. 198,000.

2010. Legislative-Citizen Commission on Minnesota Resources. Identifying Critical Habitats for Moose in Northeastern Minnesota. 507,000.

2009. U.S. Fish and Wildlife Service. Seth Moore, Andrew Edwards, and R.A. Moen. Mooz (Moose) Habitat Use in a Changing Climate. $199,999.

2009. U.S. Geological Survey. Steve Windels, Michael E. Nelson, and R.A. Moen. Investigate Effects of Climate Change and Other Factors on Population Viability of Moose in Voyageurs National Park. $307,700.

2008. National Park Service. R.A. Moen and S. Moore (Grand Portage Natural Resources and Grand Portage Indian Reservation). Beaver Populations in Grand Portage National Monument and the Grand Portage Indian Reservation $18,985.

2008. MN Department of Natural Resources. R.A. Moen. Pine Marten and prey in NE Minnesota. $20,000.

2004-2008. Over $800,000 in grant funding from federal, state, and private sources for research project on Canada lynx in Minnesota. For full list of funders see www.nrri.umn.edu/lynx.

Selected Publications

Moen, RA, CL Burdett, GJ Niemi. 2008. Predicting suitable denning habitat for Canada lynx based on past reproduction. In press. Journal of Wildlife Management.

Moen, R, GJ Niemi, C Burdett. 2008. Canada lynx in the Great Lakes region. Final report to USDA Forest Service and US Geological Survey and Minnesota Department of Natural Resources. NRRI Technical Report No. NRRI/TR-2008-14.

McCann, NP, RA Moen, GJ Niemi. 2008. Using pellet counts to estimate snowshoe hare numbers in Minnesota. Journal of Wildlife Management 72:955-958.

Burdett, CL, RA Moen, GJ Niemi, LD. Mech. 2007. Defining Canada lynx space use and movements with GPS telemetry. Journal of Mammalogy 88:457-467.

Moen, RA, J Pastor, Y Cohen. 2001. Effect of animal movement on GPS telemetry locations. Alces 37:207-271.

Moen, RA, J Pastor, Y Cohen. 1997. Accuracy of GPS telemetry collar locations with differential correction. Journal of Wildlife Management 61:530-539.

Robert A. Slesak is a site-level program manager for the Minnesota Forest Resources Council in St Paul.

Education
Ph.D. Forest Soil Science, Oregon State University, Corvallis, OR, 2008
M.S. Forest Ecosystem Science, State University of New York College of Environmental Science and Forestry, Syracuse NY, 2004
B.S. Forest Resources Management, SUNY ESF, Syracuse, NY, 2002
A.A.S Forest Technology, SUNY ESF, Ranger School, Wanakena, NY, 2000

Professional Experience
Current, Site-level Program Manager, Minnesota Forest Resources Council
2008, Post-Doctoral Associate, Dept. of Forest Engineering, Oregon State University
2005-08, Graduate Research Assistant, Oregon State University
2004, Watershed Program Assistant, Skaneateles Lake Watershed Agriculture Program
2003-04, Graduate Research Assistant, SUNY
2002, Forester, USDA Forest Service, Hubbard Brook Experimental Station, NH

Publications

Slesak RA, Schoenholtz SH. TB Harrington. 2010. Soil respiration and carbon responses to variable logging-debris retention and competing vegetation control in the Pacific Northwest. Soil Science Society America Journal 74:936-946.

Slesak RA, Harrington TB, Schoenholtz SH. 2010. Soil and Douglas-fir (*Pseudotsuga menziesii*) foliar nitrogen responses to logging-debris retention and competing vegetation control in the Pacific Northwest. Canadian Journal Forest Research 40:254-264.

Slesak RA, Briggs, RD. 2010. Foliar mass and nutrition of *Abies concolor* Christmas trees following application of organic and inorganic fertilizer. Northern Journal Applied Forestry 27(1):28-33.

Slesak RA, Scheonholtz SH, Harrington TB, Strahm BD. 2009. Dissolved carbon and nitrogen leaching following variable logging-debris retention and competing vegetation control in Douglas-fir plantations of western Oregon and Washington. Canadian Journal Forest Research 39:1484-1497.

Slesak RA, Briggs RD. 2007. Christmas tree response to N fertilization and the development of critical foliar N levels in New York. Northern Journal Applied Forestry 24(3):209-217.

Slesak RA, Schoenholtz SH, Harrington TB, Meehan NA. In press. Initial response of soil carbon and nitrogen to harvest intensity and competing vegetation control in Douglas-fir (*Pseudotsuga menziesii*) plantations of the Pacific Northwest. Forest Science.

Awards and Activities
Arnold and Vera Meier Fellowship, Oregon State University, 2006
Alfred W. Moltke Scholarship, Oregon State University, 2006
Forestry Graduate Fellowship**,** College of Forestry, Oregon State University, 2005
College Scholar, SUNY ESF, 2002
Salutatorian, SUNY ESF, Class 2002
New York State Scholarship of Academic Achievement, 2001
Salutatorian, SUNY ESF, Ranger School, Class 2000
Wesson Award, SUNY ESF- Ranger School, 1999
In-coming co-chair, Soils Working Group, Society of American Foresters

Reviewer for Forest Science, Forest Ecology and Management, Journal of Environmental Quality, Northern Journal of Applied Forestry

9. Dissemination and Use

Project results will be summarized and presented to the MFRC for evaluation, and a summary report made available on NRRI's website and on the MFRC website. In his role as Site-level Program Manager at the MFRC, R. Slesak will use the information to either validate the existing leave tree guidelines, or propose alternative guidelines that mitigate impacts on forest bird and small mammal species.

Ultimately, the information will be transferred to loggers and resource managers during guideline training sessions, as these groups are the primary users of Minnesota's Forest Management Guidelines. In addition to the above, manuscripts detailing project results will be written and submitted for publication in peer-reviewed journals.

10. References

Aarhus AJ, Moen R. 2005. The effect of removal of fine woody debris on small terrestrial vertebrates: A literature review. In: Berguson B, Moen R, Grigal D, Jacobson K. Analysis of forest harvest residue availability and environmental impacts of residue removal. Unpublished report to Laurentian Energy Authority.

Atwell RC, Schulte LA, Palik BJ. 2008 Songbird response to experimental retention harvesting in red pine (*Pinus resinosa*) forests. Forest Ecology and Management 255:3621-3631.

Brandes, ST. 2008. Automated sound recording and analysis techniques for bird surveys and conservation. Bird Conservation International 18:S163-S173.

Brawn JD, Robinson SK, Thompson III FR. 2001. The Role of Disturbance in the Ecology and Conservation of Birds. Annual Review of Ecology and Systematics 32:251-276.

Burdett CL, Lindquist EL, Moen R. 2006. National interagency Canada lynx detection survey in Minnesota, Wisconsin, and Michigan. Rep. NRRI/TR-2006-32, Natural Resources Research Institute, Duluth MN.

Charif, RA and M. Pitzrick. 2008. Automated detection of Cerulean Warbler songs using XBAT data template detector software. Preliminary Report. Bioacoustics Research Program Cornell Laboratory of Ornithology Technical Report 08-02

Crozier, G.E. and G.J. Niemi. 2003. Using patch and landscape variables to model bird abundance in a naturally heterogeneous landscape. Canadian Journal of Zoology 81:441-452.

Dahlman R. 2008. Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Monitoring for Implementation; 2004, 2005, 2005 Results Compared to Baseline Monitoring Report. Minnesota Department of Natural Resources, St. Paul, MN. See at www.frc.state.mn.us/documents/council/MFRC_Site-level_Monitoring_Compared_to_Baseline_2008-04-01_Report.pdf. Accessed 22 September 2010.

Dahlman R, Rossman D. 2010. Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: 2009 Monitoring Implementation Results. Minnesota Department of Natural Resources, St. Paul, MN. See at www.frc.state.mn.us/documents/council/site-level/MNDNR_FMG_monitoring_2009_report.pdf. Accessed 22 September 2010.

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