Application for Scientific Study in Baxter State Park

(This is a reapplication to continue research begun in 2013 and continued in 2014.)

Title: Effects of forest management practices in the Acadian Northern Hardwood/Conifer Forests of Maine on forest bird communities, with emphasis on species of regional conservation priority and concern

Name of Researchers:

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Researcher Credentials:

Dr. Cynthia S. Loftin has over 20 years of experience partnering with federal and state natural resource managers in research that uses Geographic Information Systems to model spatial relationships of biota and their habitats with an emphasis on system restoration applications.

Dr. Daniel Harrison has studied effects of forest harvest practices on forest mammals in Maine's forests for more than 20 years and has long-term collaborative relationships with landowners on whose land many of the study plots in the proposed study will be conducted.

Dr. Petra Bohall Wood is an avian ecologist with more than 20 years of experience studying effects of partial harvesting on forest bird communities in the central Appalachian Mountains.

Brian W. Rolek M.S. is a wildlife ecologist with more than 10 years of experience researching birds and habitat selection, and collaborating with nonprofits and government agencies.

Benefits to be derived from research:

The Eastern Spruce-Hardwood Forest is the largest physiographic area in the Northeast region (http://www.blm.gov/wildlife/pl_28sum.htm). This region, known as the "Northern Forest",

supports numerous US Fish and Wildlife Service avian species of high conservation concern including Bay-breasted Warbler, Cape May Warbler, Blackburnian Warbler, Canada Warbler, and Rusty Blackbird that occupy coniferous and mixed coniferous-deciduous forest. Despite significant decreases in spruce-fir acreage in the last century owing to high-grading and conversion to mixed-wood or hardwood forest type, the State of Maine has the greatest acreage of spruce-fir forest in the continental U.S —more than 40% of the total. As a result, Maine forests have supported a disproportionate share of U.S. populations of a suite of spruce-fir forest birds, e.g., 88% of the entire U.S. population of the Bay-breasted Warbler. Though many of these species have the bulk of their population in Canada, several species are of high conservation concern in the U.S. owing to declining populations. Our study examines relationships between forest bird community composition and forest harvest practices in coniferous forests of the Northern Forest region. The forest harvest approach in Maine shifted with passage of the Maine Forest Harvest Practices Act in 1991, followed by three citizens' initiatives to ban clear-cutting in the 1990s. The result has been a broad-scale shift from even-aged management and clear-cutting (with herbicide application to favor conifer regeneration), to increased reliance on partial harvesting, which now represents >96% of the total acreage harvested annually in Maine. Importantly, this shift has resulted in more than a doubling of the number of acres harvested annually (more than 500,000 acres) within the commercially managed forests of northern, western, and eastern Maine. The cumulative effect of this footprint over nearly 20 years has resulted in a large decrease in the extent of mature conifer forest remaining in the landscape, along with greatly reduced sizes of residual mature patches of forest, increased predominance of deciduous regeneration, and increased fragmentation.

Mature conifer forest stands deemed to have late successional value currently comprise <2% of Maine's commercial forest landscape. Harvest selection for the valuable large conifers can shift composition of residual forests towards a more deciduous composition, particularly in stands where heavy partial harvesting has been practiced across multiple stand entries. The shifts in forest composition, reduction in extent of mature stands, and the increased fragmentation of mature residual forest patches that have been documented in this region during the past 20 years (Simons 1999, Simons et al. 2010) represent conditions that could limit avian breeding habitat capacity and long-term persistence within this region for numerous high priority species and alter the composition of the forest bird communities historically found in these forests.

Our study is evaluating the broad array of forest harvest practices applied in conifer forests of the region and describing the bird communities (species composition and densities) they host. Target species for this project include species of high conservation concern for the USFWS such as Bay-breasted Warbler, Cape May Warbler, and Canada Warbler. We are targeting conifer-dominated forest stands that were harvested during the past 17-40 years with a variety of practices as well as stands that have not been harvested in at least 60 years. Some of our study

stands are part of a long-term, ongoing study on forest harvest effects on forest carnivores and their prey (Simons 2009, Scott 2009, Robinson 2006, Fuller and Harrison 2005, Homyack et al. 2004, 2005, 2007, Fuller et al. 2004, Payer and Harrison 2000, 2003, 2004). In this study, we are documenting the forest bird communities in a selection of these stands as well as several newly identified stands. This project will assess cumulative effects of multiple harvest intensities, the broad-scale shift to partial harvesting, and the resulting shifts in landscape composition occurring over the recent decades on breeding habitat availability for high priority avian species and the forest bird community as a whole. We are using the same methods to examine avian communities in conifer stands on refuges and adjacent lands in eastern Maine (Moosehorn and Aroostook NWRs), eastern New Hampshire (Umbagog NWR), and northern Vermont (Nulhegan NWR) to put our research conducted in northern Maine into a broader scope of regional context.

Detailed Description of Research:

Specific objectives of our study are to:

1) Relate avian diversity and abundance to stand quality (indicated by stand vegetation structure and composition) in forests that have been harvested with a range of intensities along a temporal gradient within multiple landscapes across the Northern Forest region. These relationships will inform efforts to assess regional habitat capacity for forest birds in the Northern Forest region and will inform descriptions of suitable forest conditions for sustaining priority species at desired population levels.

2) Identify forest attributes and management techniques that are beneficial to our focal species to inform silviculture practices, and quantify relationships between avian community composition and forest harvest pattern in the landscape. These relationships will inform efforts to assess regional habitat capacity for forest birds in the Northern Forest region based on landscape-scale habitat components and patterns.

3) Examine trends in regional and national surveys of USFWS priority bird species and relationships observed between avian species and forest conditions documented during this study to assess the degree to which forest conditions might be limiting habitat availability for these birds.

4) Assess the role that conservation lands in the Northern Forest region can play in providing habitat for priority forest birds and serve as demonstration areas for forest management practices that benefit these species.

Our previously established research sites outside the Park are part of an ongoing study on forest harvest effects on forest carnivores and are 15-20 ha in size. These study areas are 15-20

stands partitioned into harvest selection intensity and age categories ranging from no harvest, to selection harvest, to shelterwood harvest, and including regenerated clearcuts (17-40 years post-cut). This design allows data to be analyzed along a compositional and structural continuum to avoid arbitrary binning of data among harvest categories. These sites represent regenerating clearcuts 17-40 years post-harvest (n=17), selection harvests (n=8), and shelterwood overstory removals (n=2); vegetation in these areas were last measured in 2008 and 2009. Overstory removal within these stands was 0-98%, and the harvest history spans clearcuts that were harvested as early as 1973 to overstory removals as recent as 2003. Given that 11 of 13 stands representing mature mixed and conifer conditions have been harvested since our last vegetation surveys in 2008, we have added stands of mature forest that have not been harvested for >60 years as we find them.

We would like to continue during 2015 to work in study areas (n=5 to 10) in the Scientific Forest Management Area (SFMA) of Baxter State Park that are mature softwood and mixed stands >60 years post-harvest. Because few sites remain elsewhere on the landscape that meet this age criteria, sites on Baxter are critical to allow assessment of the mature forest end of the disturbance gradient that exists on the landscape. We would like to continue to include sites in the SFMA in our 2015 surveys. Site selection, ground truthing of selected stands, and bird surveys with auditory point counts will continue to occur during April-July 2015. We will collect vegetation structure and composition data (e.g., overstory basal area, canopy closure, species, understory composition and structure, coarse woody debris condition) during July and August (estimated time on ground for vegetation surveys is 1-2 days per stand), and we will not remove or cut vegetation during these surveys.

Sampling and Analysis Methods to be continued in 2015:

We are taking a hierarchical approach to extensively and intensively survey forest stands during mid-May to late-June, the breeding season for forest birds in this region. Vegetation data available from previously studied as well as newly selected stands will be related to avian metrics. The 5-10 stands in the SFMA contain 3-5 sampling points each, dependent upon stand size. These additional stands again will be sampled with point count surveys, and basic vegetation data will be collected such as tree stem density by size class and species. Our avian point count stations are located with >250 m between points. Each point will again be surveyed twice in each of the 2014 and 2015 breeding seasons with standard 10 min point count surveys (Ralph et al. 1993). All individuals seen or heard will be recorded by species. Points will be sampled between a half hour after sunrise and 1030 on days with appropriate weather conditions. Observations will be categorized into five detection types (calling, displaying, flyovers, singing, visuals), and sex will be determined if possible. We will record detections by distance categories and one-minute time intervals to calculate detection probabilities (Farnsworth et al. 2005). We will use N-mixture models in R and JAGS to estimate abundance (Royle 2004) for species with a large enough sample size.

Because we are sampling a wide range of habitat conditions resulting from a variety of harvest types and ages, we will use regression analyses to relate vegetation data to avian metrics. We also will explore a classification and regression trees (CART) approach for analyses. Historical (1970-2007) changes in landcover and forest structure in Maine have been assessed by Simons (2009) and by Legaard and Sader (*in prep*) based on a satellite time series, which will be used to infer broad-scale habitat implications of the stand-scale relationships that are observed during this proposed study. Context of the study areas will be described with spatial land cover data layers created in 2008 in Maine (LeGaard and Sader *in prep*) and publically available land cover layers for the other study areas. Updated land cover data will be identified as they become available, or the land cover data will be updated with ground truthing as appropriate. If data layers quantifying amount of mature forest in the landscape are deemed accurate, we will use program TITAN (Baker and King 2010) to calculate relative abundance thresholds for this metric for individual species and for the overall avian community. To evaluate response of the avian community to forest change in a broader context, we will seek out and assemble point count data sets for the Eastern Spruce-Hardwood Forest physiographic area collected over the last ~10 years. We will explore using available National Land Cover Data to examine change in mature forest to harvested forest to compare with these point count data. Survey data will be compared with archived data from the Park where available as well as with data from previous surveys conducted by Manomet Center for Conservation Sciences in mature and harvested forests in study areas in southwestern Maine. We also will examine our survey data in the context of regional breeding bird survey and population trend data to assess potential causes for regional trends based on stand- and landscape-scale habitat relationships identified during this study.

We would like to request permission to add sampling methods to address two additional research objectives:

Reproductive Success Surveys of Bay-breasted Warblers

We will survey point count locations where Bay-breasted Warblers were detected previously in 2013, 2014, or 2015 to conduct detailed reproductive success surveys. Because there may be too many sites to survey adequately over a single field season, we will sample along a succession gradient, which will be determined from tree height, basal area, and quadratic mean diameter calculated from vegetation plots measured in 2014. We will return to point count locations and observe focal birds for two, one-hour search periods. We will use GPS to record locations of birds and note any signs of breeding activity (see Table 1 for breeding index). During 0-60 minutes at the survey location, passive surveys will be conducted, and after 60 minutes the surveyor will switch to active surveys, using playback at 60 and 90 minutes. Playback surveys will be broadcast with a hand-held speaker, using Bay-breasted Warbler male territorial calls mixed with calls alternating four cardinal directions for duration of 5 minutes, after which surveyors will search for signs of breeding status. We will record number of responding males, indicating those defending territories in each stand type.

Arboreal Arthropod Sampling

To determine *why* habitat influences breeding index of Bay-breasted Warblers, we will investigate whether occupied and unoccupied habitats differ in their biomass and abundance of arthropods (i.e., potential food items) and whether these variables influence breeding success. We will use two techniques: 1) drumming branches with a pole during a timed interval to sample broadly for arthropods; and 2) pheromone traps focused toward spruce budworm.

All "drumming" samples will be collected from 0800 to 1400 hours which are the peak daily gleaning period for Bay-breasted Warblers (Crawford and Jennings 1989) and dates of sampling will range from 1 June through 7 July when Bay-breasted Warblers should be settling on territories and 4th, 5th, and 6th instar larvae of spruce budworm are most likely to be prevalent and captured. Sampling will be located at the center of each point count location and 30m from the center in a randomly selected compass direction coinciding with vegetation sampling locations. Each collection will consist of two, 1-minute vegetation beating samples while a 1 by 1m cotton sheet is placed beneath the area being sampled. We will use a retractable pole to sample branches up to 4m in height. Branches on the closest tree will be drummed lightly around the entire circumference of the tree at 0-4m height. Arthropods will be collected from the cotton sheet with a standard aspirator to prevent flying insects from escaping. We will freeze these samples and store for identification later. We will identify and categorize the samples in the lab as Lepidoptera, Coleoptera, Araneae, and all other taxa, similar to the categories described by McMartin et al. (2002). Additionally, Lepidoptera will be further categorized to distinguish between eastern spruce budworm and all other Lepidoptera. These samples will be dried in an oven and weighed to determine dry biomass.

Spruce budworm abundance is increasing across the state of Maine. We will document occurrence of budworm in the stands surveyed for reproductive success surveys of Bay-breasted Warblers with pheromone traps to sample for adult male eastern spruce budworm moths during the peak period of moth emergence. We will deploy covered funnel traps (one trap will be placed at each point count location. during 20 June to 15 August and will retrieve the traps approximately 21 days after deployment. Traps will be baited with Conrel, blend of 96:4 (E)- and (Z)-11-tetradecenal plus 2% antioxidant (Albany International, Massachusetts). A sticky pad will be placed within the traps to capture moths. The number of adult eastern spruce budworm moths on each sticky pad will be counted. After collection from the field sticky pads will be returned to the lab to count the number of moths captured.

Data collected during the study will reside at the USGS Maine Cooperative Fish and Wildlife Research Unit and the University of Maine. Data will be available for other purposes in consultation with the USGS Maine Cooperative Fish and Wildlife Research Unit and the University of Maine. Copies of all published reports will be provided to the Park. In addition, data and data summaries of information collected within the Park boundaries will be made available to the Park based upon a time table agreed upon by the Research team and Park staff.

Areas of the Park for the Research:

We would like to continue to survey ~10-15 mature (>60 years old) and selection harvested stands in the SFMA with bird and vegetation surveys, with the additions described above. Site

selection will continue to be in consultation with the Resource Manager, the Park Naturalist, and other appropriate Park staff.

Impact on the Park:
There will be no effects of the auditory bird survey protocol and only very short-term (5-10 minutes), minor effects of the playback bird surveys on the Park's avian community. The proposed insect sampling will remove minor portion of the available insect biomass, and our spruce budworm traps will provide important information about the status of the budworm outbreak in the Park. We will mark our survey points with wooden stakes and surveyors flagging to quickly relocate study plots; these stakes and flags will be removed at the end of the study. No flagging will be placed within view of existing roads and walking trails.

Budget:
Our project is funded by the U.S. Fish and Wildlife Service, the Cooperative Forest Research Unit, the U.S. Geological Survey Maine Cooperative Fish and Wildlife Research Unit, and the University of Maine. We are not requesting funds from Baxter State Park.

Timetable for Research and Completion of Application:
Field research will resume during 2015 in early May and continue until September. The final project report and student PhD dissertation will be completed by December 2016.

Date: 18 February 2015

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Tables

Table 1. Breeding indices for assessment of reproductive success of Bay-breasted Warbler from Ebird protocols.

	Breeding index	
Code	Description	Level
NY	NEST WITH YOUNG	CONFIRMED
NE	NEST WITH EGGS	CONFIRMED
ON	OCCUPIED NEST	CONFIRMED
FL	RECENTLY FLEDGED YOUNG	CONFIRMED
FY	FEEDING YOUNG	CONFIRMED
CS	CARRYING FECAL SAC	CONFIRMED
CF	CARRYING FOOD	CONFIRMED
DD	DISTRACTION DISPLAY	CONFIRMED
PE	BROOD PATCH AND PHYSIOLOGICAL EVIDENCE	CONFIRMED
NB	NEST BUILDING	CONFIRMED/PROBABLE
CN	CARRYING NESTING MATERIAL	CONFIRMED/PROBABLE
T	TERRITORY HELD FOR 7+ DAYS	PROBABLE
C	COURTSHIP, DISPLAY, OR COPULATION	PROBABLE
N	VISITING PROBABLE NEST SITE	PROBABLE
A	AGITATED BEHAVIOR	PROBABLE
P	PAIR IN SUITABLE HABITAT	PROBABLE
S	SINGING MALE	POSSIBLE
H	IN APPROPRIATE HABITAT	POSSIBLE
NR	NOT RECORDED	NO INFO