Quantifying the responses of songbirds and woodpeckers to changes in habitat at the stand and landscape scales - does intensive monitoring result in different response curves?

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Executive Summary

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Background and Research Objectives:

How do species respond to changes in habitat, and can response curves be used to set reliable targets? How does the intensity of sampling affect the reliability of response curves? We propose to quantify changes in the abundance and reproduction of forest songbirds and woodpeckers to changes in habitat at stand and landscape scales using an intensive survey method. Results will be compared with a related study that will estimate response curves using a standard, less intensive survey method.

The proposed project addresses a key question in current approaches to sustain biodiversity in managed landscapes. How do species respond to changes in habitat attributes, and can response curves be used to set reliable retention or other targets?

Recently, a framework for species conservation in managed landscapes has been proposed based on the concepts of 'thresholds' and 'targets' (Huggett 2005). The theory of ecological thresholds proposes that species respond non-linearly to changes in resources through time such that there is a threshold beyond which large-scale, rapid, and potentially irreversible changes occur. Estimates of habitat thresholds may be useful in determining target amounts of forest necessary to support healthy populations (Huggett 2005). The theory of response thresholds is supported by recent modeling work showing a minimum habitat amount, a so-called 'extinction threshold', below which further habitat loss causes rapid population decline (Fahrig 2001).

A suite of variables can be measured to gauge the response of species to forestry-induced changes in habitat, including population-level responses such as presence/absence, density, productivity, and the more immediate behavioural responses of individuals. However, most empirical tests for thresholds have been limited to the relationship between the probability of occurrence generated from the presence/absence of forest songbirds and changes in percent forest cover (e.g. Guénette and Villard 2005). The use of presence/absence data to predict probability of occurrence is problematic because the required statistical transformations almost always produce a threshold-like relationship (back-transformation to the probability scale of logit-transformed binomial data).

To extend our empirical knowledge of responses to habitat change, more relevant response measures need to be quantified. Further, because forest songbirds use some areas with little cover, forest cover is an inadequate measure of habitat (Lindenmayer and Luck 2005). The measurement of abundance and reproduction, in response to habitat attributes more closely tied to known habitat requirements, will make significant contributions to the empirical assessment of the 'threshold' approach to management. Reliable estimates of the response of abundance and reproduction to habitat change are highly valuable whether or not these relationships contain thresholds. These relationships can still inform target-setting, provide useful information on the effectiveness of current forest practices, and allow prediction of the likely effects of changes in management practices. Thus, we propose to 1) quantify the responses of forest songbirds and woodpeckers to changes in habitat attributes at the stand and landscape scales, and 2) test for thresholds in responses to habitat change. Estimates of responses to habitat change, and thus response curves, may differ depending on the intensity of monitoring. Thus, we also propose to 3) compare the response curves generated by intensive survey methods used in the proposed study with those generated by a related study in the same area using a standard, less intensive survey method (Breeding Bird Survey).

Regional Applicability: Results of this study will be directly relevant to the development of a monitoring framework for Indicator 1-3 of CanFor's Sustainable Forest Management Framework. The project will result in the development of a protocol to identify focal species for adaptive management and monitoring throughout CanFor's tenure in northeastern BC. The protocol will be applied to forest birds, but can later be adapted by CanFor for application to other taxonomic groups. Results of the project will also be used to determine response curves of focal songbirds and woodpeckers to changes in habitat attributes at stand and landscape scales. Response curves will be used to assess coarse filter approaches, and inform operational guidelines for bird species requiring further management. The project will result in a cost-effectiveness comparison between high-intensity monitoring and CanFor's current low-intensity monitoring program. Thus, results of the project will be used to determine whether CanFor's monitoring program for forest birds is sufficient, and if not, to develop a cost-effective longterm monitoring program for forest birds in northeastern BC.

More generally, there is a significant provincial context for understanding habitat thresholds in the implementation of Ecosystem-Based Management in the North and Central Coasts of BC (Coast Information Team 2004) and a broad international research community interested in the application of habitat threshold to conservation in managed landscapes.

Methods overview: We propose to develop and apply a protocol to identify focal species for northeastern BC. We will use distance-sampling and call-playback at off-road stations to quantify the relative abundance and density of focal songbirds and woodpeckers respectively, in TFL 48 and the Fort St. John Timber Supply Area. Using a video camera mounted on an extendable pole ('cavity peeper', Sandpiper Technologies Inc.), we will quantify reproductive success (e.g. proportion of clutch fledged) for the four most abundant woodpeckers in the study area, two of which are expected to be 'keystone' species. Provided there are sufficient sample sizes, we will also quantify reproductive success for other focal species. Variation in stand-level habitat attributes will be quantified within 11.3 m (0.04 ha) radius circular plots. Plots will be centred on nest sites, 30 m from nest sites in two random cardinal directions, and at point-count stations along transects. Using GIS, variation in landscape-level habitat attributes will be quantified at 300 m and 500 radii from sampling points. For species for which we measure more than one habitat attributes at either scale, we will use Principal Components Analysis to derive univariate measures of 'habitat'. Habitat models may be developed for a small number of species. Relative abundance and reproductive measures will be related to variation in habitat at the stand and landscape scales using Akaike Information Criterion (AIC) selection of regression models.

To identify thresholds in responses, we will follow Lindenmayer and Luck (2005) and use statistical methods similar to those used in previous empirical studies of ecological thresholds to ensure results are broadly comparable (e.g. Guénette and Villard 2005). We will apply locally weighted non-parametric regression to first determine non-linearity in the relationship between habitat and relative abundance, density, and reproductive success. We will then use piece-wise ('broken-stick') regression models in which two or more linear relationships are joined at a 'breakpoint', representing the threshold (Toms and Lesperance 2003). Models will be parameterized for sharp and smooth breakpoints. Broken-stick models will be fitted at varying discontinuities and the suitability of each model will be compared using AIC. Following Huggett (2005), we will define 'targets' as the quantity of a habitat just above the habitat quantity associated with the response threshold. As a measure of a target's reliability, we will compare target amounts with literature accounts of species' requirements (e.g. 5 snags/ha).

Results to date: In the 2007 field season, songbirds and woodpeckers were surveyed in stands covering a gradient in forest cover type (varying in proportion of deciduous versus coniferous) and stand age (0-20, 20-89, 90-120, >120 years), but similar in elevation and slope. Bird abundance was estimated using distance sampling along line transects and at point count stations. Vegetation was sampled at the stand-scale in 11.3-m (0.04 ha) radius circular plots centred on nest trees and point-count stations, and at a point 30-m in a random direction away from nest trees and point-count stations. Using a video camera mounted on an extendable pole ('cavity peeper', Sandpiper Technologies Inc.), we monitored Yellow-bellied Sapsucker nests to determine the number of fledglings per nest. To quantify nest site selection of Yellow-bellied Sapsuckers, we compared the following variables of nest and nearby random trees: diameter at breast height, tree species, decay class, decay state, cavity height and aspect, tree height, height to live crown, number of fungal conks, and number of other cavities.

Preliminary data analysis: The 2007 field season was the first of three, and sample sizes are too small for multivariate analyses and the derivation of response curves. Thus, on-going data analysis is primarily focused on quantifying YBSA nest site selection, and we have summarized these analyses thus far. All 63 YBSA nests were in dying aspen trees with internal heart rot, as evidenced by the presence of fungal conks on the trunk. Cavity height for YBSA ranged between 4.3 and 24.0 m (mean 12.3 ± 0.58, n=59). The DBH of nest and random trees did not differ (nest tree mean 38.6 ± 0.78, n=43, range 27.1-55.0 cm versus random tree mean = 38.3 ± 1.10, n=43, range 27.5-58.0, t = -0.02 P = 0.99). Random trees were on average about 4.5 m taller than nest trees (random tree height, mean 30.4 ± 1.11, n=43, range 22.6-45.1 versus nest tree height, mean 26.0 ± 0.74, n=43, range 11.1-43.3, t = -3.28, P = 0.002). The trunks of nest trees had more fungal conks (9.05 ± 1.14 versus 5.39 ± 1.00, Mann-Whitney U-test P < 0.001) which may be indicative of more internal heart rot than in random trees. At least one other cavity was present in 37% trees used for nesting by YBSA in 2007, but no cavities were observed in any random trees.

Forest stands which were deciduous-leading (aspen, poplar, or birch 70-89%) contained the highest density of YBSA nests (0.28 ± 0.09), while densities in deciduous (>90% deciduous) and mixed stands (deciduous or coniferous between 40-60%) were similar (0.20 ± 0.07 and 0.18 ± 0.08, Figure 1). Nest densities were lowest in coniferous (>90% spruce, lodgepole pine, or fir) and coniferous-leading stands (0.06 0.06 and 0.08 0.07). These results are similar to those found in a study of YBSA in extreme northern BC (Savignac and Machtans 2006), however, the nest densities in stands more than 50% deciduous were about twice as high in this study.

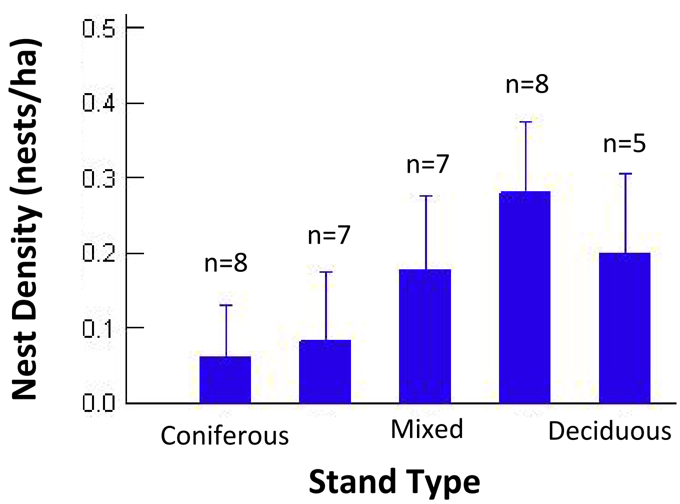

Figure 1. Mean densities of Yellow-bellied Sapsucker nests (n=52) in the mixed-wood boreal forests of northeastern British Columbia in 2007. Kruskal-Wallis testing showed no statistical differences in the means at the 0.05 significance level (H =6.31, df = 4, P = 0.18, n = 34). Bars are from left to right: Coniferous, Coniferous-leading, Mixed, Deciduous-leading, Deciduous.

Literature Cited

Fahrig, L. 2001. How much habitat is enough? Biological Conservation 100:65-74.

Guénette, J-B., M-A. Villard. 2005. Thresholds in forest bird response to habitat alteration as quantitative targets for conservation. Conservation Biology 19:1168-1180.

Huggett, A.J. 2005. The concept and utility of 'ecological thresholds' in biodiversity conservation. Biological Conservation 124:301-310.

Lindenmayer, D.B., and G. Luck. 2005. Synthesis: thresholds in conservation and management. Biological Conservation 124:351-354.

Savignac, C., and C.S. Machtans. 2006. Habitat requirements of the Yellow-bellied Sapsucker, *Sphyrapicus varius*, in boreal mixedwood forests of northwestern Canada. Canadian Journal of Zoology 84:1230-1239.

Toms, J.D., and M.L. Lesperance. 2003. Piecewise regression: a tool for identifying ecological thresholds. Ecology 84:2034-2041.