FP Project Description

Return to Full Proposal #: Y092251

Title: Effects of habitat composition on the fitness of a mature forest indicator; do thresholds exist?

Project Description: Industrial forest development can profoundly change the composition and spatial pattern of habitats across landscapes relative to historic ranges of natural disturbances. In central British Columbia landscape pattern is departing from the historic range of variability (Steventon 2003). In the longer term, seral stage composition is also predicted to depart significantly from historic means (Eadie 2003).

Empirical data quantifying minimum or optimal conditions for species at the landscape level are generally lacking and are recognized as a key knowledge gap (Boutin and Hebert 2002; DeStefano 2002). In an attempt to maintain biodiversity and wildlife habitat, without knowing the exact requirements for most species in a community, forest managers often utilize a variety of management practices that attempt to mimic natural process and conditions within a 'coarse-filter' management approach. Minimum thresholds or desired ranges for landscape composition (e.g. seral stages) and landscape pattern (e.g. patch size distribution) are often key components of coarse-filter strategies within sustainable forest management (SFM) plans. The rationale for landscape targets in SFM plans are generally based on principles of landscape ecology, however, there is little empirical evidence to support much of this theory (MacGarigal and Cushman 2002).

Most aspects of landscape ecology theory are based on two fundamental attributes, habitat amount and habitat configuration. Early papers emphasized habitat amount, but through the mid 1980s and 1990s much of the emphasis shifted to examining the effects of spatial configuration under the broad term of fragmentation (Fahrig 2002). More recently, research and literature reviews have re-emphasized the overriding importance of habitat amount relative to habitat configuration (Boutin and Hebert 2002; Fahrig 2003).

Relationships between habitat amount and the fitness or abundance of species often do not follow a linear relationship and the idea of threshold responses is pervasive in the literature (review by Dykstra 2004). Threshold responses are often described by a logistic curve that involves a dramatic change in the rate of ecological response to habitat change. Initially there may be little or no response to decreasing habitat, but once habitat loss reaches a critical region (i.e. the threshold) an ecological property (e.g. breeding rates or population size) can be drastically affected (May 1977). Habitat thresholds are widely applied in ecological modeling. A prominent example is the "extinction threshold" (Lande 1987) that is often a key component of minimum viable population analysis (e.g. Thompson and Harestad 1984).

Despite the development of fundamental principles of landscape ecology at least two decades ago (e.g. Harris 1984), and the recognition of the importance of empirical studies at that time, there have been few large scale, long-term, experimental studies to assess these principles (MacGarigal and Cushman 2002; Fahrig 2003). The number and success of field studies in this area have been limited by the logistical difficulty of conducting good landscape ecology experiments and differentiating between habitat loss and fragmentation effects (D'Eon 2002; MacGarigal and Cushman 2002; Schmiegelow and Monkkonen 2002).

The goal of this research is to provide empirical data to evaluate responses to habitat loss, with emphasis on potential threshold responses, that can be used to assess landscape ecology theory and refine SFM strategies. To do this I will quantify functional habitat relationships of a wide-ranging, mature forest-dependent species, the Northern Goshawk (Accipiter gentilis). This research is uniquely positioned to overcome some of the primary limitations of previous landscape studies by 1) examining a system undergoing profound landscape habitat changes resulting from epidemic mountain pine beetle attack and salvage logging (in the context of a natural landscape experiment), 2) studying a species that is a habitat specialist but that is relatively insensitive to habitat configuration, and 3) quantifying habitat use and prey availability to explain relationships observed between habitat composition and fitness.

This research will build on an existing research program being undertaken by the federal Sustainable Forest Management Network, the University of Alberta and the Morice and Lakes IFPA. FSP funding in 2007/08 allowed us to extend field research by an additional year to obtain optimal sample sizes. In 2008/09 we will analyze our results and work with government and industry to develop effective policy and best management practices that integrates those results. We will also conduct several extension activities to disseminate our research results and SFM strategies to the forest industry, government, and academia.

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FP Project Objectives

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Title: Effects of habitat composition on the fitness of a mature forest indicator; do thresholds exist?

Project Objective: The goal of this project is to quantify functional habitat-fitness relationships for a mature forest indicator, the northern goshawk, along a response curve and use that information to verify and refine SFM targets, such as seral stage distribution, within regional SFM plans (e.g. Morice and Lakes SFM Plans). We predict that goshawks will exhibit a threshold response as the amount of mature forest within territories decreases and either not breed or some individuals will expand their territories and squeeze out neighbours; either response will result in decreased breeding densities and reproductive output. To meet this goal we have 3 specific objectives:

1. Quantify the relationship between habitat composition (at multiple scales within territories) and breeding success for 80 known goshawk territories in west-central BC with long-term breeding histories.
2. Quantify habitat selection and home range size for a subsample of territories with a gradient of mature forest within them.
3. Quantify relative prey abundance among broad habitat types.

Information from objective 1 will allow us to describe the relationship between the amount of mature forest and reproductive success and information from objectives 2 and 3 will help us determine the functional mechanism driving the relationship.

The objectives of work in 2008/09 are to enter and analyze our long-term data sets, publish key research findings, develop management guidelines collaboratively with regional partners, and conduct comprehensive extension activities to disseminate our findings.

FP Experimental Design and Methods

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Experimental Design and Methods: **There have been no significant changes to our original experimental design and methods, as outlined below.

Key Research Questions and Predictions

Does goshawk fitness decrease when the amount of preferred habitat (mature forest) is reduced at key territory scales?

We are examining 2 types of fitness variables: 1) annual breeding and fledging rates and 2) home range size, which is inversely related to population density. We predict that goshawks will exhibit a threshold response as the amount of mature forest within territories decreases and either 1) not breed or 2) some individuals will expand their territories and squeeze out neighbours; either response will result in decreased breeding densities and overall reproductive output. The goal of this research is to quantify these habitat-fitness response curves and to determine what is driving the relationship. To meet this goal we are conducting 4 main research activities:
1. Monitoring breeding rates and fledging success at 40 known goshawk nest areas.
2. Quantifying home range size for a subsample of territories containing a broad range in the amount of mature forest within each one.
3. Assessing habitat selection for the subsample of territories where we can estimate home range
4. Quantifying relative prey abundance among broad habitat types.

Information from activities 1 and 2 will allow us to describe the relationship between the amount of mature forest and fitness and information from activities 3 and 4 will help us determine the functional mechanism driving the relationship.

Scale

We are conducting our analysis at multiple scales. This aspect of our research focuses on the breeding territory (~2400ha) and year-round home range scales (~6500ha), but results from this work will also contribute to ongoing adaptive management harvesting trials at the nest area (~24ha) and post-fledging area (~240ha) scales (Mahon and Doyle 2005).

Quantifying Annual Breeding Rates and Fledging Success

We will quantify annual breeding rates and fledging success at 40 known goshawk nest areas in the SBS portion of the study via ground-based nest monitoring during the incubation and post-fledging periods of the breeding season (see Mahon and Doyle 2005 for detailed monitoring protocol). Historical breeding and fledging rates are also available for an additional 40 goshawk nest areas in the ICH portion of our study area. This data will be incorporated into our analysis but monitoring will not be continued in 2007/08 due to logistical and funding limitations.

Home Range and Breeding Territory Estimation

We will estimate winter home range size and location for a subsample of territories in the SBS using standard radio telemetry methods (Resource Inventory Standards Committee 1998). Our goal is to determine home range parameters for 4-6 additional birds in 2007/08. This will increase our total project sample by 33%. Sample areas will be selected to provide a broad gradient in the amount of mature forest in the landscapes surrounding active nest areas. Territory estimates will be calculated using the Animal Movements extension (Hooge and Eichenlaub 1997) for ArcView GIS. Due to logistical limitations we cannot monitor radio-tagged birds during the breeding season, and therefore cannot use traditional home range estimation techniques to estimate breeding territory size. Instead, we will estimate breeding season territory size based on observed spacing distances between adjacent nest areas (Reich et al. 2004).

Habitat Selection
Habitat Classification

We plan to assess habitat selection using two habitat classification approaches – a univariate categorical approach and a multivariate resource selection function approach. For our categorical assessments we have stratified habitat based on Structural Stage classes (BC MELP and BC MoF 1998). For our resource selection function we will consider relevant variables available from the Forest Cover database (e.g. percent tree species composition, stand age, stand height, canopy closure, site index) and patch and landscape metrics (e.g. patch size, core area, edge, contagion).

Habitat Selection Analysis

We will conduct habitat selection analysis based on the same radio-telemetry locations obtain for home range analysis. Our scale of analysis corresponds to Johnson's (1980) third order – selection of habitat types within a territory, and Manly et al.'s. (2002) Design III – where both habitat use and habitat availability are measured for each radio-tagged animal. We will assess habitat selection using both selection ratios (for our categorical classification scheme; Neu et al. 1974, Byers et al. 1984) and logistic regression-based resource selection functions (using multiple variables; Manly et al. 2002). Each approach has specific merits and conducting both will maximize the interpretations we are able to make. For both the selection ratio and logistic regression approaches we will estimate available habitats using the 95% fixed kernel territory contour and used habitats from the point locations of goshawks observed in the field.

Relative Prey Abundance

We are assessing the relative abundance of prey (red squirrels, snowshoe hares and grouse) within Broad Habitat types using snow-tracking surveys following methods described by Thompson et al. (1989). Eight 3km triangular transects have been established to provide representative coverage of Broad Habitat types within the SBS study area. Each transect will be surveyed twice in 2007/08. Track densities for each species are determined for each broad habitat type within transects by tallying the number tracks and dividing by the length of transect through each habitat type. All track densities are standardized to tracks/km/24h since last snowfall.

**For more detailed information about project design, methods and rationale please refer to T. Mahon's attached PhD proposal.