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Working with experts to quantify changes in the abundance of furbearers following rapid and large-scale forest harvesting

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ABSTRACT

Across western Canada, furbearers are being subjected to the cumulative impacts of industrial development. This region has witnessed unprecedented levels of anthropogenic change, primarily in the form of increased forest harvesting. We used trapping records to investigate the relationship between habitat and the abundance of Canada lynx (*Lynx canadensis*) and American marten (*Martes americana*). We applied expert-based habitat models to ten reference landscapes (i.e., traplines) in two distinct study areas to serve as measures of habitat change from 1990 to 2013. We elicited fur harvest records from trapper experts and then used negative binomial count models to relate capture success to habitat availability and quality. We controlled for factors that were hypothesized to influence capture success, including effort and weather conditions, allowing us to model the effects of habitat availability and quality on population abundance. Expert-based habitat models revealed that the area and quality of habitat declined significantly as a result of increased forest harvesting. The top-ranked count models identified combinations of habitat availability and quality, trapping effort, and trapline area as factors positively influencing the capture success of lynx and marten. Results suggested that the reduction in high-quality habitat negatively affected the abundance of marten in the study area. Methods and findings also illustrated the utility of harvest records for investigating population abundance of furbearer species. A precise measure of trapping effort, however, is necessary to relate environmental covariates, including habitat, to harvest at the scale of individual traplines.

1. Introduction

Furbearer species have significant cultural and economic importance across North America (Hamilton et al., 1998; Webb and Boyce, 2009). Between 2000 and 2012, the fur trapping industry in British Columbia (BC), Canada, grossed nearly $17 million in revenue (BC Fur Returns unpub. data). Recent increases in forest harvesting, however, have led to concerns about the distribution and abundance of furbearer populations. In particular, a recent epidemic of mountain pine beetle (*Dendroctonus ponderosae*) has resulted in the mortality of lodgepole pine (*Pinus contorta*) across approximately 16 million ha of the province. This has resulted in rapid and broad-scale salvage harvesting with implications for wildlife that are dependent on old-forest conditions (BC Ministry of Forests, Lands, and Mines, 2010).

A number of furbearer species are dependent on forest structure associated with old stands (Forsey and Baggs 2001). Thus, rapid and cumulative landscape change that leads to a reduction in forest age may have substantial and long-term negative impacts on the habitats and ultimately the distribution and abundance of some furbearer populations (Lofroth et al., 2010; Thompson, et al. 2012). Canada lynx (*Lynx canadensis*) and American marten (*Martes americana*) use a range of habitats that may be affected differently by forest harvesting. Lynx have large home ranges and are adaptable to a variety of seral stages of forest. Lynx populations may benefit from some forest disturbance that promotes habitat for prey, provided other life-history requirements remain available (Poole, 2003). In contrast, marten have small home ranges and often are old-forest specialists dependent on structure such as coarse woody debris, cavities in live trees, snags and overhead cover (Thompson et al., 2012). The loss of contiguous habitat to timber harvesting can have negative impacts on marten populations, a concern which has been voiced by trappers in BC (Bridger, 2015).

There are approximately 2600 registered traplines in BC. Trappers are required to document their capture totals when selling furs to market, which are entered into a provincial database. Additionally,

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many trappers consider themselves stewards of populations on their traplines, keeping personal records of trapping activity and harvest. Trapping records have been used to monitor abundance and population trends of furbearers (McDonald and Harris, 1999; Ruette et al., 2003; Webb and Boyce, 2009) and they can be particularly useful when the behavior of furbearer species makes typical monitoring difficult (Ruette et al., 2003). Also, trapping records represent a significant amount of data that can be collected for large geographic areas at a relatively low cost (Ruette et al., 2003). However, such data require careful interpretation (Poole and Mowat, 2001). Researchers have cautioned against the use of databases that only report harvest totals with no consideration of trapping effort (McDonald and Harris, 1999).

We developed an expert-based approach to quantify variation in the harvest and ultimately the population abundance of two species of furbearers following rapid change in the availability and quality of habitat. Where previous studies have used harvest datasets collected from large geographical areas, we used the personal records of trappers specific to their registered traplines. This allowed us to account for both effort and success. We related trap data for lynx and marten to the availability and quality of habitat, as modeled using expert knowledge. We hypothesized that the capture success of lynx and marten would be related to trapping effort and habitat. Furthermore, we predicted that trapping success for marten would decline across traplines with the greatest cumulative level of forest harvesting and habitat loss. The cumulative impact of habitat loss would be less for lynx, as that species is less dependent on old-forest structure.

2. Methods

2.1. Study area

Reference landscapes (i.e., traplines) were located within two distinct study areas that were centered on the city of Prince George, but ranged across the central interior of BC (Fig. 1). Differences in ecosystem type and forest distribution resulted in two broad zones or areas of mountain pine beetle occurrence and resulting salvage logging. In the West Study Area, up to 75% of individual traplines were harvested in the past 40 years. In contrast, traplines in the East Study Area were subjected to a maximum of 11% total area harvested. Six trappers were responsible for the traplines in the West Study Area (244,923 ha) and the seven distinct trapline areas in the East Study Area (357,767 ha) were registered to four trappers. Contiguous trapline areas ranged in size from 9012 to 159,800 ha.

In the West Study Area, traplines occurred primarily within the Sub-Boreal Spruce (SBS) biogeoclimatic zone (Meidinger and Pojar, 1991). The zone is at relatively low elevations, between 1100 and 1300 m, and is dominated by upland coniferous forests consisting of hybrid spruce (*Picea engelmannii x glauca*), subalpine fir (*Abies lasiocarpa*), lodgepole pine, or Douglas-fir (*Pseudotsuga menziesii*) on dry, warm sites. Trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are common deciduous species. The extensive timber harvesting in this area has resulted in a seral distribution that is skewed towards younger age classes. The climate of the SBS zone is characterized by deep snow with mean monthly winter temperatures below 0 °C. Summers are warm with monthly temperatures above 10 °C. Annual precipitation ranges from 440 to 900 mm. The SBS zone contains ideal habitat for a variety of furbearers, including marten, fisher (*Pekania pennanti*), lynx, wolverine (*Gulo gulo*), and beaver (*Castor canadensis*), resulting in some of the province's highest fur-harvest levels.

The East Study Area includes portions of the SBS and the Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zone (Meidinger and Pojar, 1991). The ESSF zone occurs at mid-elevations ranging from 900 to 1700 m. Low temperatures are common with mean monthly winter temperatures below 0 °C. Annual precipitation ranges from 500 to 2200 mm, with snow accounting for 50–70% of the total. Engelmann spruce (*Picea engelmannii*) and subalpine fir are the dominant climax species, but lodgepole pine is also present. Small areas of the Interior Cedar Hemlock biogeoclimatic zone are also found within the East Study Area. These are low- to mid-elevation ecosystems with productive, wet sites dominated by large spruce (*Picea glauca*), hemlock (*Tsuga heterophylla*) and cedar (*Thuja plicata*) trees. Mean annual precipitation in the ICH ranges from 500 to 1200 mm with 25–50% falling as snow (Meidinger and Pojar, 1991).

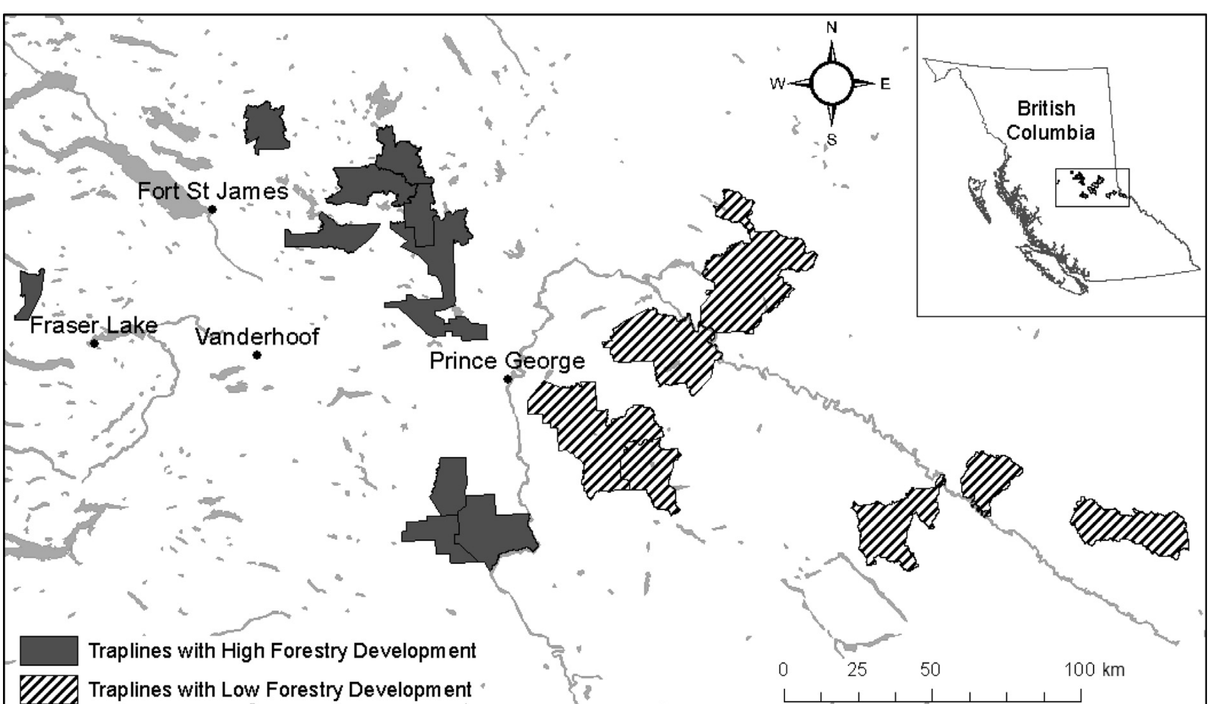

Fig. 1. Location of registered traplines for the population analysis of lynx and marten across central British Columbia, Canada. Cumulative forest harvesting was extensive on the dark-shaded traplines (West Study Area) during the study period, whereas the hash-marked traplines (East Study Area) had much less harvesting.