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Short Communication

Pacific Martens (*Martes caurina*) Use Structurally Complex Habitats in The Coastal Western Hemlock Ecosystems of Southern Vancouver Island, British Columbia, Canada

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Abstract

In Canada, little information exists on habitat use by Pacific martens (*Martes caurina*). In this study, we used remote video-cameras to study the distribution of the species in the Coastal Western Hemlock ecosystems of southern Vancouver Island. All video-cameras were set in May-June 2019 and February-March 2020. In 2019-2020, 32 video-cameras were functional. A total of 18 cameras (56%) in simple stands (6048 h of recording) and 14 (44%) in complex stands (4704 h of recording) recorded 26 and 38 independent Pacific marten visits, respectively. There was a significant difference (χ^2= 6.0; df: 1; P<0.02) between observed and expected frequencies of Pacific marten recordings per stand type. There were significantly (t=3.2, P<0.05) more Pacific marten recordings/camera site in complex stands ($\bar{x}$=2.7 ±1.45) than in simple ones ($\bar{x}$=1.4 ±1.6). Our hypothesis that Pacific marten recordings will be significantly more frequent in stands with structural complexity than in simple stands with little or no structure was supported.

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INTRODUCTION

In western Canada and United States, Pacific martens (*Martes caurina*) and American martens (*Martes americana*) appear to prefer coniferous forests containing high basal areas and large-diameter trees that provide complex vertical and horizontal structure, including snags and decaying trees, high volumes of fallen deadwood, and a well-developed understory (see review by Proulx and Aubry 2017). Structurally complex stands are necessary for martens for several reasons: effective foraging, resting and denning sites, escape cover from larger predators, and thermal cover (Moriarty 2003). Also, Proulx and Aubry (2017) suggested that forests with high structural complexity provide animals with a diversity of microhabitats that are resilient to variation in environmental conditions, and provide access to a diversified and abundant food base.

Because mature and old-growth forests usually are more structurally developed than young forests (Mowat 2006; Slauson *et al.* 2006; Proulx 2009), the loss of late-successional forests due to the development of urban, industrial, and agricultural areas on Vancouver Island, British Columbia, Canada, may possibly compromise the habitats of the Pacific marten. On the other hand, Baker (1992) found that the use of second growth forests by martens was greater than that of mature and old-growth forests; however, these young forests had retained structural characteristics of old-growth forests. In the United States, using GPS telemetry, Moriarty (2014) found that Pacific martens avoided simple (i.e., with little structural complexity) stands year-round.

In British Colombia, little information exists on habitat use by Pacific martens. Most past studies were conducted in landscapes inhabited by American martens, particularly in areas with large cut blocks interspersed with contiguous forest stands (Lofroth 1993; Proulx 2009). Although previous studies in the United States suggested that Pacific martens are associated with structurally complex forests (Moriarty 2014; Moriarty *et al.* 2015), it is important to verify if this species requires similar habitats in British Columbia; in the past, studies have shown that habitat use by species in the *Martes* Complex may vary considerably among regions (Proulx 2017; Moriarty *et al.* 2019; Triska *et al.* 2020). In order to learn more about habitat use by Pacific marten, we used remote video- cameras to study the distribution of the species in the Coastal Western Hemlock (CWH) ecosystems of southern Vancouver Island. We hypothesized that Pacific marten recordings will be significantly more frequent in stands with structural complexity than in simple stands with little or no structure.

STUDY AREA

The study was conducted in the Greater Victoria Water Supply Area (GVWSA), which is located northwest of the City of Victoria (Figure 1) and is comprised of 20,550 ha of forested land within the CWH biogeoclimatic zone (Pojar *et al.* 1991). Mature stands are usually well stocked with Douglas fir (*Pseudotsuga menziesii*) in the upper tree stratum, western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*). The shrub layer is very well developed with salal (*Gaultheria shallon*) dominant, and cascade barberry (dull Oregp-grape, *Mahonia nervosa*) and red huckleberry (*Vaccinium parvifolium*) scattered. Advanced regeneration of western hemlock and western redcedar is common in late-seral stands (Pojar *et al.* 1991).

Intensive logging from 1957 to 1993 created a mosaic of successional stages. The GVWSA is now protected from human activities such as trapping and hunting, and from logging except for fire management.

MATERIAL & METHODS

Stand selection

In spring 2019 and winter 2020, using Terrestrial Ecosystem Mapping (TEM; Howes and Kenk 1997) and Vegetation Resources Inventory (VRI; British Columbia Forestry 2019), we randomly selected 7 stands in each of the following age classes: 1) early-seral, 21–60 yrs old – based on the history of the GVWSA, most of the stands visited were approximately 45 years old; 2) mid- to late- seral, 81–120 yrs old; and 3) late-seral, ≥141 years old. All selected stands were at least 500-m-apart from each other, and different stands were used in spring 2019 and winter 2020 (Figure 1).

We walked through the stands and classified them relative to their structural complexity using field observations and photographs of canopy and ground vegetation, and the presence of large snags and coarse woody debris in advanced stage of decay. Stands were classified as follows (e.g., Moriarty 2014):

- *Simple stand type*: single-layered canopy with little or no >60-cm-dbh snags and structure at ground level. Young stands commonly had few branches to the ground, little

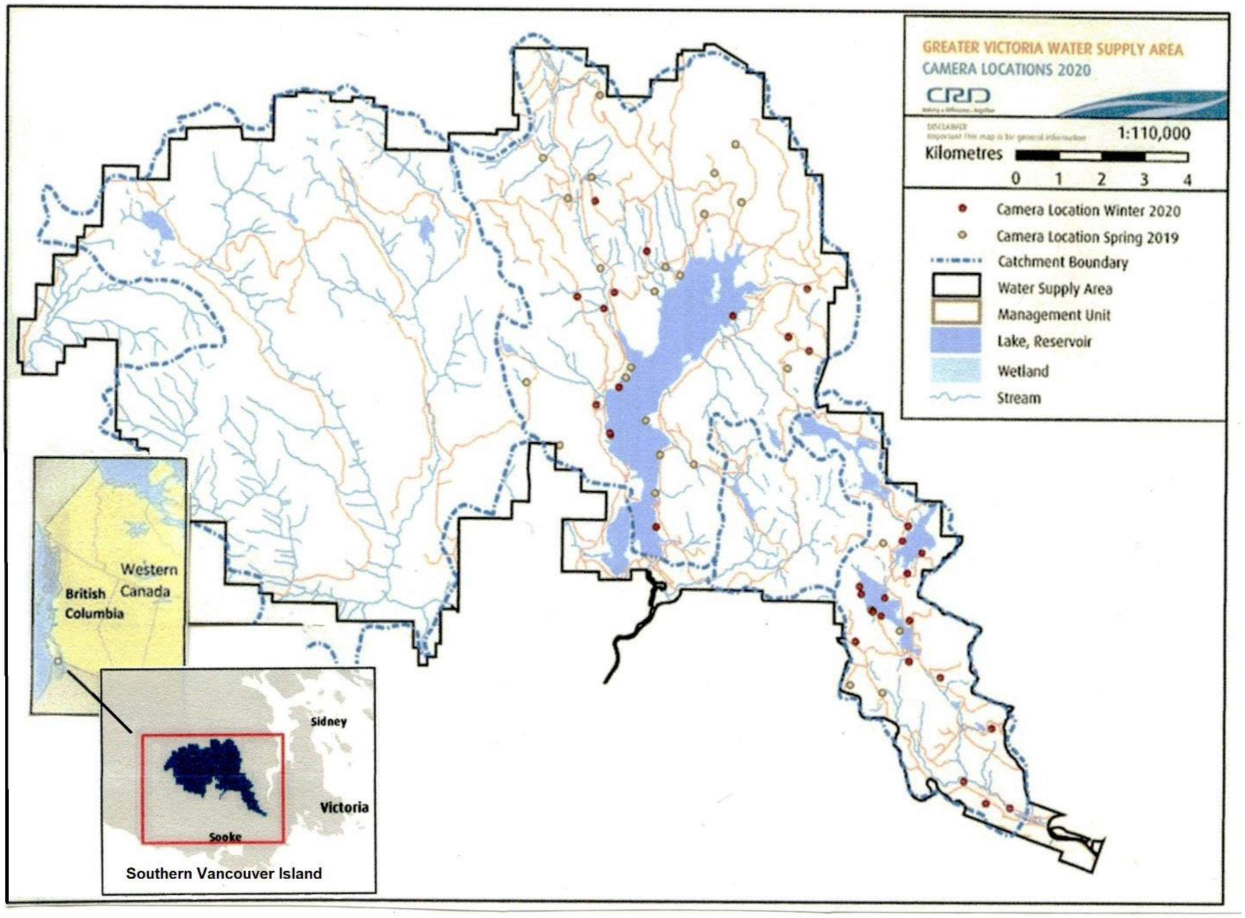

Figure 1. Location of the study area and camera sites in the Greater Victoria Water Supply Area, spring 2019 and winter 2020.

Figure 2. Examples of stands with simple structural complexity.

Figure 3. Examples of stands with complex structural complexity.

ground cover, and <30-cm-diameter hard, woody debris. (Figure 2).

- *Complex stand type*: multi-layered canopy with structure provided by a variety of trees of different ages, with >60-cm-dbh snags, and a complex and diversified horizontal structure at ground level, with ≥30-cm-diameter coarse woody debris in advanced stage of decay, or piles of debris (Figure 3).

Camera sites

All video-cameras were set in spring (May 2019) and winter (February 2020). Two remote video-camera models were used: Bushnell Trophy Cam XLT (model 119436, Bushnell Outdoor Products, Overland Park, Kansas, USA), and Moultrie Digital Game Camera (model M-990i, Moultrie Products, Alabaster, Alabama, USA). One video-camera was set ≥100 m from the edge of the stand, in a location representative of the overall structure and composition of the stand. Cameras were approximately 1.5–2 m from the ground, and approximately 2–3 m from an opposite tree or log with lure (a mixture of fat, oils and egg) and bait (chicken parts) placed ≤2 m from the surface of the ground. We programmed cameras for 30-sec-long videos with a 20-sec delay between motion-triggered recordings.

Analysis of video cards

Video-camera cards were retrieved in June 2019 and March 2020. Whereas cameras were functional for different periods of time, all of those that were properly set and undisturbed by black bears (*Ursus americanus*) or vegetation in the spring, and snow or vegetation in the winter, provided reliable information for the first 2 weeks of activation.

Because of the poor quality of some of the recordings or the remoteness of the animals from the cameras, we did not attempt to identify individuals on the basis of their coat colour, phenotypic marks and size. One or many individuals may have been recorded at a bait station. Most visits by Pacific martens at camera sites lasted <40 min at a time; only one visit lasted 70 min. Therefore, we considered that Pacific marten video recordings at a same camera site were independent from each other if they were ≥60 min apart.

The number of functional cameras varied among stand types and seasons. The total number of camera hours (*CH*) in each stand type was calculated for each season as follows:

CH: Σ functional cameras x 14 d x 24 h

The proportion of *CH* within each stand type was used to determine the expected frequency of Pacific marten recordings/stand type if Pacific martens were distributed randomly with respect to these habitat types (Proulx 2006). Chi-square statistics with Yates correction (Zar 1999) were used to compare observed to expected frequencies of Pacific marten recordings among stand types. A Student *t*-test was also used to compare the average number of independent Pacific marten recordings per camera site in each stand type. A probability value $P \leq 0.05$ was considered statistically significant.

RESULTS

In 2019-2020, 32 video-cameras were functional. A total of 18 cameras (56%) in simple stands (6048 h of recording) and 14 (44%) in complex stands (4704 h of recording) recorded 26 and 38 independent Pacific marten visits, respectively. The majority of simple stands (10 or 55%) were in 21-60-year-old stands; the majority of complex stands (13 or 71%) were in ≥81-year-old stands. There was a significant difference (χ^2 = 6.0; df: 1; $P<0.02$) between observed and expected frequencies of Pacific marten recordings per stand type (Figure 4). There were significantly (t=3.2, $P<0.05$) more Pacific marten recordings/camera site in complex stands ($\bar{x}$ =2.7 ±1.45) than in simple ones ($\bar{x}$ =1.4 ±1.6).

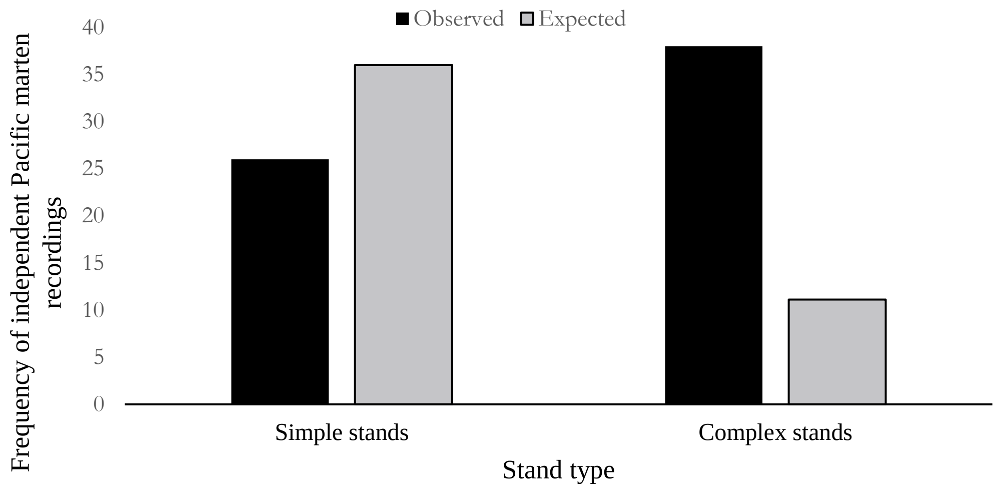

Figure 4. Observed and expected frequencies of independent Pacific marten recordings per stand type, 2019-2020.

DISCUSSION & MANAGEMENT CONSIDERATIONS

Our hypothesis that Pacific marten recordings will be significantly more frequent in stands with structural complexity (Figure 5) than in simple stands with little or no structure was supported. In 2019–2020, there were nearly twice as many recordings/camera site in complex stands than in simple ones. Our findings are in agreement with Moriarty (2014) and Moriarty *et al.* (2015) who followed GPS-collared animals, and found that Pacific martens avoided simple stands year-round, but were willing to travel through them when motivated by bait. Moriarty (2014) strongly suspected increased predation risk and fewer opportunities for Pacific martens to pursue and obtain prey in simple stands. In our study, the presence of baits at camera sites may explain why some martens were observed in simple stands. Nevertheless, our findings suggest that, ultimately, martens preferred complex stands over simple ones.

In our study, martens used complex stands independently of stand age. However, complex stands usually corresponded to late seral stages. Age plays an important role in the development of stand structure because the production of large, old, live trees and snags with cavities, and large decayed coarse woody debris, is a lengthy process (Raphael and Jones 1997; Slauson and Zielinski 2009). Late-seral stages should therefore be maintained to meet the habitat needs of Pacific martens.

In simple stands resulting from timber harvest that occurred approximately 45 years ago, partial logging may be considered to promote the growth of residual trees and reduce the amount of fine fuel loading. Partial logging may be an opportunity for managers to produce mosaics of forest stands with various structural characteristics interconnected by riparian and upland corridors (Proulx 2009; Weir and Almuedo 2010). The partial logging of these stands should be done in conjunction with the establishment of >100-m-wide connectivity corridors between diverse habitats (Huggard 1999; Proulx and Verbiski 2001). Also, trees from harvested stands may be used for debris piles in mesic and hygric habitats with low fire risk potential to provide small prey with cover, and small carnivores with refuges and food along these corridors (Proulx and Aubry 2020).

Because the GVWSA is protected from human activities such as trapping and hunting, and from logging except for fire management, it can play the role of a refuge for Pacific martens in southern Vancouver Island. No refuge has ever been established solely to conserve any of the species in the *Martes* Complex (Proulx and Aubry 2020). Studying Pacific marten populations and dispersal movements inside and outside the GVWSA would be an opportunity to investigate how this refuge may help protecting Pacific martens from surrounding human activities in southern Vancouver Island.

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Figure 5. A Pacific marten in a structurally complex stand, Greater Victoria Watershed Supply Area, spring 2019,

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