Evaluating statewide marten (*Martes spp.*) distribution and habitat use in Montana

Federal Aid in Wildlife Restoration Grant W-190-R

Annual report, September 2024

Project Personnel
Nolan Helmstetter, PhD Student, Department of Ecology
Andrea Litt, Professor, Department of Ecology; Director, Fish & Wildlife Ecology and Management Program

Nick DeCesare, Research Biologist
Jessy Coltrane, Furbearer and Nongame Biologist – Kalispell

State: Montana
Agency: Fish, Wildlife, & Parks
Grant: Marten monitoring study
Grant number: W-190-R
Time period: FY24 (1 July 2023 – 30 June 2024)

Note: All results should be considered preliminary and subject to change; please contact the authors before citing or referencing these data.

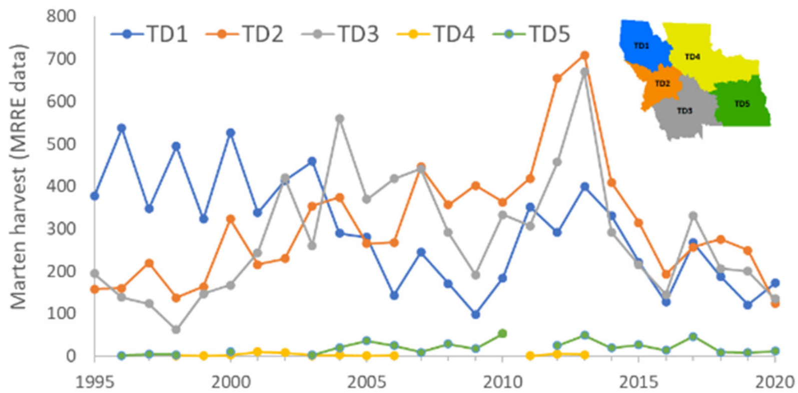
Background and Summary

The American and Pacific marten (*Martes americana* and *M. caurina*; hereafter marten) are charismatic forest carnivores and their presence often is considered an indication of forest health (Macfarlane 1994). Marten are associated with late seral stage forests, increased canopy cover, complex understories, and persistent, deep snowpack (Cheveau et al. 2013, Wiebe et al. 2014, Martin et al. 2021). These habitat characteristics offer an abundance of prey, nesting and denning sites, cover from predators, and subnivean space for thermoregulation and hunting during winter. However, reliance on these features make marten particularly sensitive to forest disturbance (e.g., timber harvest; Cheveau et al. 2013, Woollard et al. 2024).

In Montana, marten are an important harvestable furbearer. Marten trapping provides an entry point to learn the art of trapping and many seasoned trappers consider marten an important target species. Despite marten having both ecological and monetary value on the landscape, there are gaps in our knowledge about their status and distribution in Montana. Declines in harvest (Fig. 1) have prompted the need to develop effective monitoring techniques to improve the ability for Montana Fish Wildlife & Parks (MFWP) to manage marten populations. Further, marten in North America were recently reclassified as two distinct species (*Martes americana* and *M. caurina*) with a suspected hybrid zone centered along the Clark Fork Valley where the Clark Fork River, I-90 highway, and unforested valleys may limit dispersal and contact between the two species (Colella et al. 2019, Lucid et al. 2020). Lastly, MFWP wildlife managers have begun efforts to restore marten populations to previously occupied portions of their range, which places particular emphasis on both understanding the distribution of each marten species and developing effective methods to monitor restored populations.

This project is designed to address these information gaps regarding marten distribution, species taxonomy and hybridization, and field methods for monitoring population status. MFWP currently collects harvest location information for marten from all trappers. We will leverage these data as well as occurrence data obtained from the Montana Natural Heritage Program (MNHP) to develop a statewide distribution model for marten that will help guide upcoming efforts to monitor occupancy. Additionally, we have begun collecting samples of marten muscle tissue from participating trappers in cooperation with MFWP regional furbearer biologists. We are collaborating with the National Genomics Center for Wildlife and Fish Conservation at the USDA-USFS Rocky Mountain Research Station (RMRS) to extract DNA from those samples and use a genomic approach to quantify the breadth of the hybrid zone, the distribution of both marten species, and the extent of introgression occurring between the species. Additionally, we aim to evaluate habitat relationships, functional responses in habitat selection, and how forest disturbance impacts marten occupancy. This project will provide MFWP with tools to design long term monitoring and implement management actions for marten, including translocation efforts and harvest.

Figure 1. Marten harvest by trapping district in Montana, 1985-2020.



Location

Field studies will be located in Regions 1, 2, and 3 of Montana and genetic samples will be collected throughout these regions as well. Marten distribution models utilize occurrence data throughout western Montana.

Study Objectives

This project has 3 primary objectives: 1) development of a statewide habitat model to guide future monitoring and reintroduction efforts, 2) development of a methodology and framework for occupancy monitoring with statewide implications, and 3) a statewide assessment of the genetic differentiation and distribution of both marten species, the breadth of the hybrid zone, and the extent of introgression in Montana.

Objective #1: ***Species distribution modeling***

Species distribution models are a popular tool for wildlife conservation and management. Species distribution models use presence-only, presence-absence, or detection-non-detection data to make inferences about species-habitat relationships and predict habitat both spatially (e.g., throughout a species range) and (or) temporally (e.g., under future climate scenarios). Species distribution models can be used to guide translocation and survey efforts (Eyre et al. 2022), identify habitat for rare species of conservation concern (Helmstetter et al. 2021), and predict range shifts under future climatic conditions (Johnston et al. 2012).

During our first year of this study , we developed a preliminary statewide distribution model for marten using harvest data obtained from MFWP and occurrence records obtained from the MNHP. These results are preliminary and subject to change upon further review and analysis. MFWP requires all trappers to report the public land survey system (PLSS) township range and section number where marten were harvested. The MNHP is a repository for additional species occurrence records and includes opportunistic sightings or sign of species as well as occurrence data from camera trap and hair snare surveys.

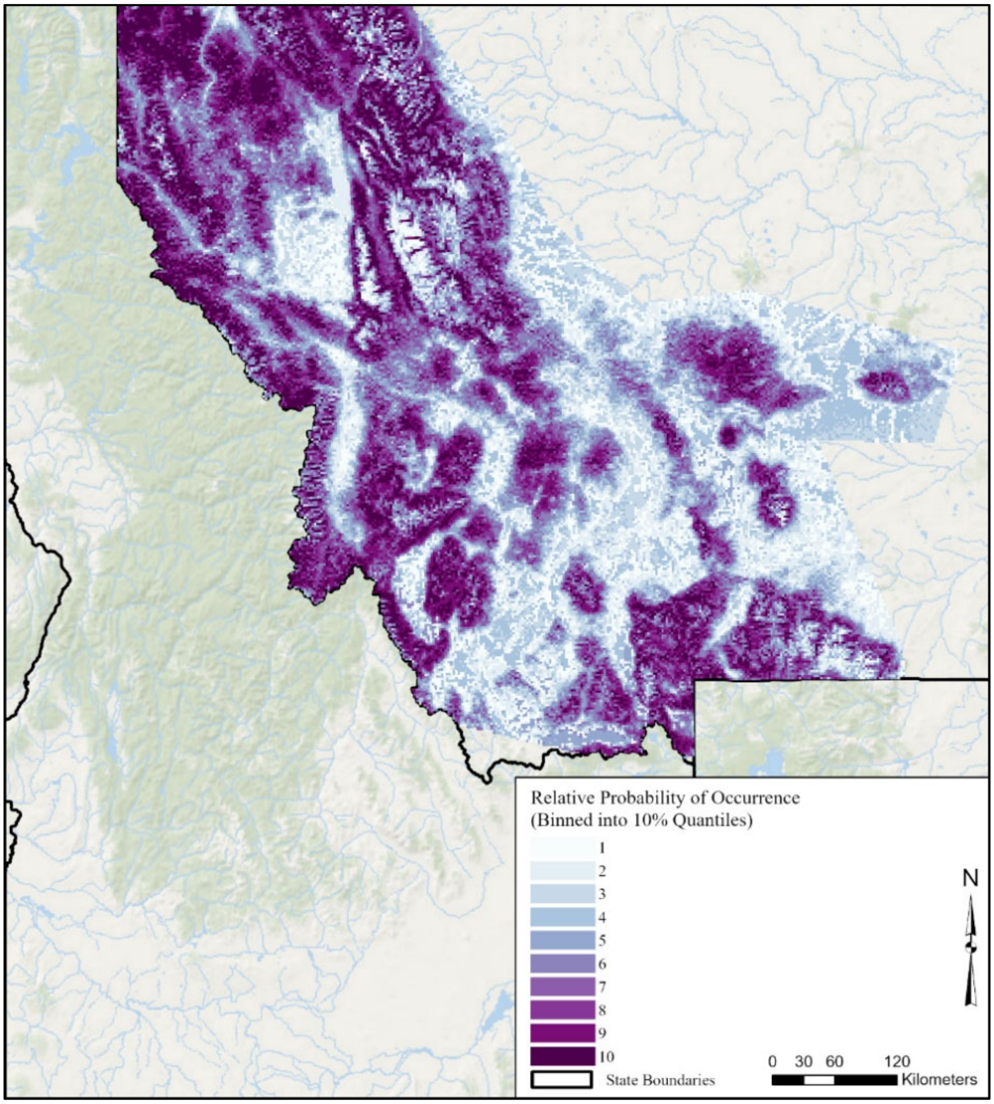
Both the MFWP harvest data and the MNHP data suffer from sampling biases likely associated with access. That is, areas that are closer to human population centers or easier to access (e.g., areas with roads, drainages, and gentle topography) are over-sampled. Therefore, following the techniques outlined in Elith et al. (2010), we down-weighted occurrence records located in regions with high sampling intensity. We created a minimum convex polygon around occurrence records and randomly selected 10,000 points within that polygon to use as background, or available, points. Prior to selecting background points, we expanded the minimum convex polygon to include mountain ranges in Montana where translocation efforts are on-going (e.g., Little Belts).

We used 7 environmental variables in the model believed *a priori* to be predictors of marten habitat at broad spatial extents. These variables included annual canopy cover, the coefficient of variation for annual canopy cover, snow depth, annual forest disturbance, average minimum temperature, topographic positioning index, and topographic ruggedness index (Wiebe et al. 2014, Chmura et al. 2024, Martin et al. 2021, Viau et al. 2024, Woollard et al. 2024). All environmental variables were measured as raster data and we matched the resolution of the harvest data by taking the average of each environmental variable within a 2.56km^2 buffer (i.e., the area of a PLSS section) around occurrence records and background points. Canopy cover can change over time; thus, we matched the year the occurrence record was recorded to the canopy cover raster data for the same year. Similarly, forest disturbance varies annually, however, marten likely respond post-disturbance. Therefore, we used the raster data for forest disturbance from the year before the occurrence record was recorded. We assigned a random year to background points that mimicked the distribution of years from the occurrence records and repeated the process for the canopy cover and forest disturbance covariates. All other variables were either static (e.g., topographic position index) or were averaged across all available years (e.g., snow depth and minimum temperature). We used weighted logistic regression to compare habitat use (i.e., occurrence records) to availability (i.e., background locations) and make spatial predictions of marten habitat throughout western Montana (Fig. 2).

We used spatially explicit k-fold cross validation to evaluate the model's out-of-sample predictive ability using the area under the receiver operating curve (AUC). Briefly, we partitioned the occurrence records and background points latitudinally into five spatially explicit folds. Regional differences in habitat characteristics likely occur with respect to latitude, ecoregion, or species identity throughout the marten's range in Montana (Chmura et al. 2024, Colella et al. 2024, Shirk et al. 2014). Therefore, having latitudinally segregated folds forces the model to predict into regions that differ from the data used to "train" the model. We trained the model on four of the five folds and used the remaining fold to test the predictive ability of the model. We iterated the process for all folds and averaged the AUC values.

Our preliminary analyses resulted in a species distribution model with good predictive ability (average AUC=0.77; Pearce and Ferrier 2000). Canopy cover and topographic position index appear to influence relative probability of occurrence more than other covariates used in the model. Our results suggest marten select for increased canopy cover and regions with relatively more drainages and topographic depressions. Our results also suggest that marten select for areas with uniform canopy cover and lower proportions of forest loss. Lastly, our results suggest intermediate levels of snow depth and minimum temperatures have higher relative probability of occurrence (i.e., a curvilinear relationship). We aim to refine this model and explore additional covariates (e.g., forest type). We will use the refined model to guide study design for the upcoming efforts to quantify occupancy (see Objective #2) and explore functional responses in habitat selection at broad spatial extents. Our refined model also can inform ongoing efforts to translocate marten and camera surveys to monitor translocated marten populations.

Figure 2. Predictions of the relative probability of marten occurrence across the state of Montana, based on a preliminary species distribution model. The predicted values were divided into quantiles, with each quantile representing 10% of the predicted probabilities. For example, a value of 1 corresponds to the lowest 10% of the predicted probabilities, while a value of 10 represents the highest 10%.

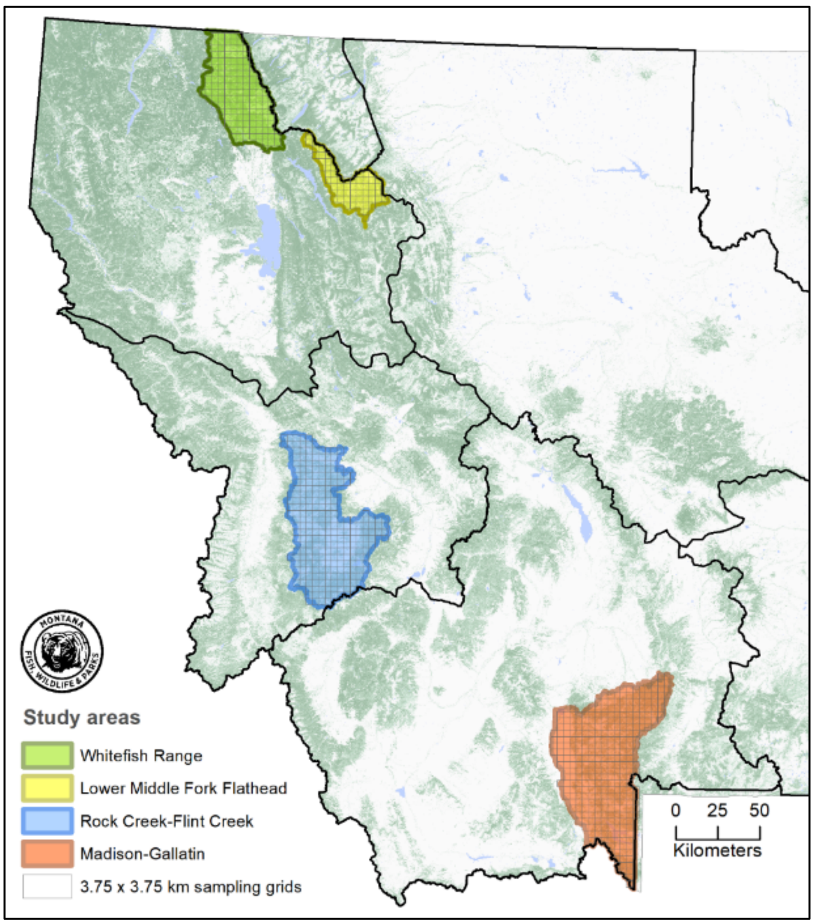


Objective #2: ***Marten monitoring and occupancy modeling***

Quantifying how habitat heterogeneity influences wildlife abundance and demographic parameters is critical for developing effective management strategies (Tyre et al. 2001, Morrison et al. 2012). Methods for quantifying such relationships, however, are often more adept at smaller spatial extents than are of interest for wildlife managers (Pollock et al. 2002). For example, capture-recapture studies that estimate changes in abundance or vital rates across ecological gradients are logistically challenging to implement over broad spatiotemporal extents (Saracco et al. 2010). Consequently, wildlife managers often rely on estimates of occupancy (i.e., the proportion of sites occupied) to elucidate habitat relationships and population trends (Mackenzie et al. 2017).

We will use occupancy modeling to evaluate habitat relationships for marten throughout their range in Montana, as well as explore how disturbance (e.g., timber harvest) influences occupancy. Additionally, having a fine resolution picture of the breadth of the hybrid zone and the distribution of both marten species (Objective #3) will allow us to discern whether habitat relationships differ or whether functional responses are influencing patterns in habitat selection. We will deploy camera traps co-located with scent dispersers and hair snares across four proposed study sites (Fig. 3) during the winters of 2025-26 and 2026-27 (data will be collected in 2 study sites each winter). The proposed study sites were selected to capture a representative amount of variation in habitat characteristics that marten occupy throughout Montana. Lastly, we will utilize the distribution model developed for Objective #1 in a spatially explicit power analysis to determine the optimal survey effort (i.e., number of camera traps and trap nights) and to help guide camera placement.

Figure 3. Study areas proposed for upcoming marten occupancy monitoring in Montana.

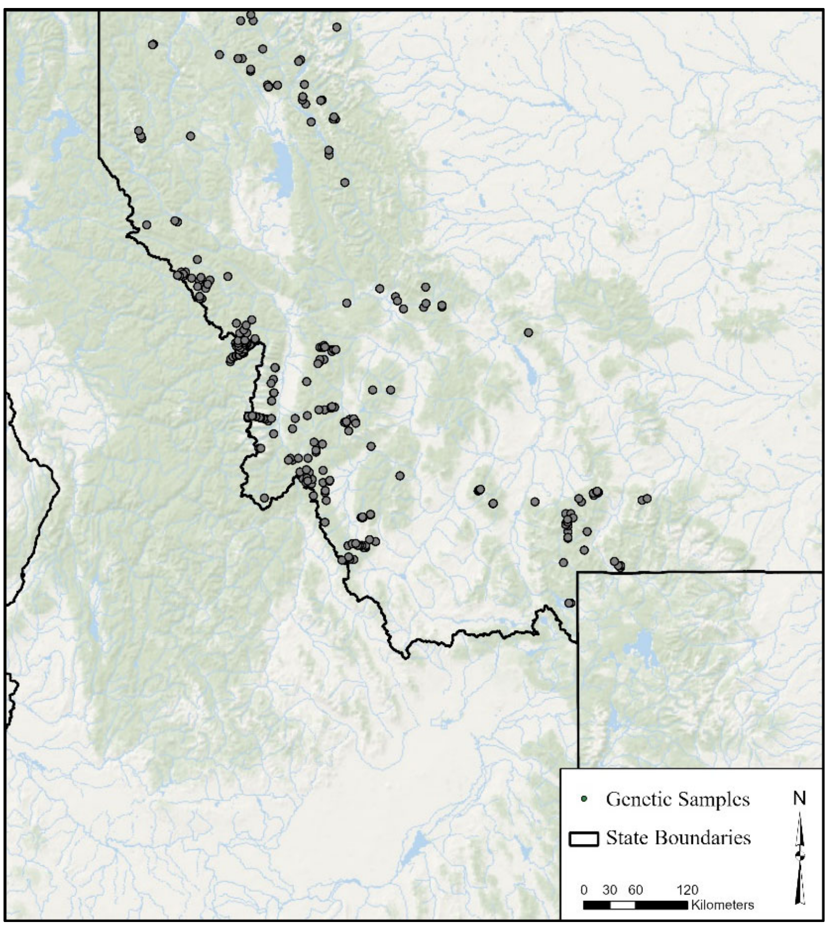


Objective #3: ***Marten genetics***

Marten have recently been delineated as two species (*Martes americana* and *M. caurina*) and several studies have identified a hybrid zone centered around the Clark Fork Valley (Colella et al. 2019, Lucid et al. 2020). These studies have primarily relied on microsatellites (i.e., nuclear DNA) in conjunction with mitochondrial DNA to identify each species and hybrids. While these techniques provide a probabilistic way of identifying species and hybrids, they fail to capture historical hybridization events and introgression between species. That is, they are primarily useful in identifying only first generation hybrids. Further, genetic studies investigating marten distributions and hybridization in Montana have identified several instances of mito-nuclear discordance (Chmura et al. 2024). This discordance suggests that past introgression and backcrossing may have occurred and highlights the need for a more refined genomic approach to better evaluate marten distributions and hybridization.

MFWP has been collecting marten muscle tissue from participating trappers throughout Regions 1, 2, and 3 for the past two years. To date, 409 samples of marten muscle tissue have been collected from 61 trappers (Fig. 4). For the upcoming trapping season (2024/2025), we will work with trappers to target areas that represent spatial gaps in our samples and areas around the suspected hybrid zone. We are collaborating with RMRS and will use a genomics approach to evaluate the distribution of both marten species and putative hybrids and quantify the breadth of the hybrid zone and extent of introgression occurring between marten species. Results supporting this objective will assist on-going translocation efforts by helping to avoid live trapping in regions that overlap the hybrid zone. Additionally, a finer resolution picture of the distribution of each species and the breadth of the hybrid zone will assist in quantifying habitat selection for both species (Objective #2).

Figure 4. Locations where marten muscle tissue samples were collected by participating trappers and will be analyzed by partners at the National Genomics Center for Wildlife and Fish Conservation at the USFS Rocky Mountain Research Station, trapping seasons 2021/2022 – 2023/2024.



Acknowledgements

We are thankful to MNHP and the many trappers in Montana for providing marten occurrence records, as well as the 61 trappers who have voluntarily provided marten tissue samples. This project includes collaboration between MFWP, Montana State University, and RMRS. Special thanks to Claire Gower and Tyler Parks for previous efforts in collecting genetic samples from trappers and, along with Jay Kolbe, Ethan Lula, and Leah Breidinger, for their help in earlier proposals to get this work started. Thanks to RMRS staff including Helen Chmura, Kristy Pilgrim, Cate Quinn, and Mike Schwartz for their expertise and collaboration as we explore genomics approaches for studying species differentiation and distributions. Thanks to Braden Burkholder from MNHP for providing insight based on previous efforts to model marten distribution. In addition to those listed at the front of this report, other collaborating MFWP personnel include but are not limited to Max Evans, Justin Gude, and Nathan Kluge. We appreciate the support of the Montana Cooperative Fisheries Research Unit at Montana State University for project administration.

Literature Cited

Cheveau, M., L. Imbeau, P. Drapeau, and L. Belanger. 2013. Marten space use and habitat selection in managed coniferous boreal forests of eastern Canada. The Journal of Wildlife Management 77:749–760.

Chmura, H. E., L. E. Olson, R. Murdoch, A. K. Fraik, S. Jackson, K. S. McKelvey, R. Koenig, K. L. Pilgrim, N. DeCesare, M. K. Schwartz. 2024. Climate change differentially alters distribution of two marten species in a hybrid zone. Ecology and Evolution 14:e70181.

Colella, J. P., N. A. Freymueller, D. M. Land, B. J. Wiens, K. D. Stone, and J. A. Cook. 2024 Ecological displacement in a Rocky Mountain hybrid zone informs management of North American martens. Landscape Ecology 39:125

Colella, J. P., R. E. Wilson, S. L. Talbot, and J. A. Cook. 2019. Implications of introgression for wildlife translocations: the case of North American martens. Conservation Genetics 20:153–166.

Eyre, A. C., N. J. Briscoe, D. K. P. Harley, L. F. Lumsden, L. B. McComb, and P. E. Lentini. 2022. Using species distribution models and decision tools to direct surveys and identify potential translocation sites for a critically endangered species. B. Leroy, editor. Diversity and Distributions 28:700–711.

Helmstetter, N. A., C. J. Conway, B. S. Stevens, and A. R. Goldberg. 2021. Balancing transferability and complexity of species distribution models for rare species conservation. Y. Fourcade, editor. Diversity and Distributions 27:95–108.

Johnston, K. M., K. A. Freund, and O. J. Schmitz. 2012. Projected range shifting by montane mammals under climate change: implications for Cascadia's National Parks. Ecosphere 3:1–51.

Lucid, M., S. Cushman, L. Robinson, A. Kortello, D. Hausleitner, G. Mowat, S. Ehlers, S. Gillespie, L. K. Svancara, and J. Sullivan. 2020. Carnivore contact: A species fracture zone delineated amongst genetically structured North American marten populations (Martes americana and Martes caurina). Frontiers in Genetics 11:735.

Macfarlane, D. 1994. Appendix C: national forest system status information. In: Ruggiero, Leonard F.; Aubry, Keith B.; Buskirk, Steven W.; Lyon, L. Jack; Zielinski, William J., tech. eds. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Gen. Tech. Rep. RM-254. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 176-184 254.

Martin, M. E., K. M. Moriarty, and J. N. Pauli. 2021. Landscape seasonality influences the resource selection of a snow-adapted forest carnivore, the Pacific marten. Landscape Ecology 36:1055–1069.

Morrison, M. L., B. Marcot, and W. Mannan. 2012. Wildlife-habitat relationships: concepts and applications. 3rd Ed. Island Press, Washington D.C., USA.
Pearce, J., S. Ferrier. 2000. Evaluating the predictive performance of habitat models developed using logistic regression. Ecological Modeling 133:225–245.

Pollock, K. H., J. D. Nichols, T. R. Simons, G. L. Farnsworth, L. L. Bailey, and J. R. Sauer. 2002. Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13:105–119.
Saracco, J. F., J. A. Royle, D. F. DeSante, and B. Gardner. 2010. Modeling spatial variation in avian survival and residency probabilities. Ecology 91:1885–1891.
Shirk, A. J., M. G. Raphael, S. A. Cushman. 2014. Spatiotemporal variation in resource selection: insights from the American marten (*Martes americana*). Ecological Applications 24:1434 1444.
Tyre, A. J., H. P. Possingham, and D. B. Lindenmayer. 2001. Inferring Process from Pattern: Can Territory Occupancy Provide Information about Life History Parameters? Ecological Applications 11:1722–1737.
Viau J. P., D. Sigouin, M. H. S. Laurent. 2024. Seasonal shifts in the habitat selection patterns of male American Marten (*Martes americana*) at a fine spatial scale. Journal of Mammalogy 105:740–751.
Wiebe, P. A., I. D. Thompson, C. I. McKague, J. M. Fryxell, and J. A. Baker. 2014. Fine-scale winter resource selection by American martens in boreal forests and the effect of snow depth on access to coarse woody debris. Écoscience 21:123–132.
Woollard, T. F., D. J. Harrison, E. M. Simons-Legaard, and K. E. Fagan. 2024. Functional responses in American marten habitat selection indicate cumulative effects of progressive habitat change. Ecosphere 15:e4715.