Nova Scotia Habitat Conservation Fund - 2009 - Year 3/3 Final Report
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Project Name: **An Individual Based Model of American Marten (*Martes americana*) in Cape Breton, N.S.**

Goals and Objectives

The ultimate goal of this research is to compliment the efforts of the Nova Scotia Marten Recovery Team (NSMRT) and the Nova Scotia Department of Natural Resources (NSDNR) towards achieving a viable self-sustaining marten population in Cape Breton Island (CBI). We aim to accomplish this by recommending augmentation and management strategies based on the results of simulated empirical testing within the framework of an individual based model (IBM) of the CBI marten population.

Background

The Cape Breton Island (CBI) marten population was once thought to be extirpated (Banfield 1974) but the persistence of a remnant local population has since been confirmed (Scott 2001). The few remaining individuals in CBI are at further risk of extirpation due to the fact that they are subdivided into two geographically isolated, non-interbreeding subpopulations (Scott 2001). Augmentation efforts are currently being undertaken by the Nova Scotia Department of Natural Resources (NSDNR; Wildlife Division and Regional Services in Victoria and Inverness Counties) and the Nova Scotia Marten Recovery Team (NSMRT). There is no certainty of the augmentation being a success, although the methods being employed are based on an extensive review of similar projects previously undertaken in other areas.

Individual based models (IBMs) are designed to answer a specific set of questions concerning a particular species in a given environment; here the CBI American marten (*Martes americana*) population. However, the insight gained into the system's mechanisms and the theory used in IBM development (e.g. model complexity, degree of stochasticity, feedback mechanisms among levels of biological organization, etc) will provide invaluable information to researchers dealing with similar species or ecosystems (Grimm and Railsback 2005). It will also have broader implications for the conservation of similar species in other geographical areas, as it will provide information concerning the impacts of various management practices and disturbance regimes on habitat. In this way, the research being proposed will directly compliment other provincial recovery efforts and broader research efforts related to marten and other mesocarnivores.

Outline of Work Completed

<u>Coarse Woody Debris Component</u> - Year 1/3

Data was collected from 126 plots in the Cape Breton Highlands and regression modeling was used to predict CWD volume from other forest attributes. CWD quantity was associated with forest type (natural, managed, dead/depleted), cover type (deciduous, mixed-wood, coniferous), and stand age. The density of CWD in the population (n= 71,483 stands) ranged from 0.02-1739.7m^3/ha with a mean of 54.4+/-39. m^3/ha across all forest types. CWD volumes were higher in dead/depleted stands (62.207+/-40.085m^3/ha) than managed (58.330+/-53.519m^3/ha)or natural (53.473+/-38.587 m^3/ha) forests. Hardwood stands had less CWD on average (32.272+/-24.865m^3/ha) than did softwood (57.146+/-50.175m^3/ha) or mixed stands (58.625+/-21.711m^3/ha). Managed hardwood forests had the highest average volume of all stand types (115.957+/-67.75 m^3/ha), followed by managed mixed-wood forests (114.521+/-72.162m^3/ha). Natural hardwood forests had the least CWD (29.666+/-19.728m^3/ha). When CWD volume was compared with stand age, the typical U-shaped distribution was evident with the least CWD in stands 30-49 years of age.

Geographic Information Systems (GIS) Based Habitat Component - Year 2/3

The estimated quantities of CWD in the population were used in the geographic information systems (GIS) based application of expert-based habitat suitability indices (HSIs) to the study area, used given the lack of presence data required for empirical habitat assessment modeling resulting from the small local population size. Two existing marten HSIs developed for use in the western United States and Canada were applied to the Cape Breton highlands region, and two new models parameterized from data contained in the literature were developed. Output of the four models was evaluated at 125 randomly selected forested locations across the study area using quantile-quantile plots for comparing distributions, and X-plots for a comparison between values. A total of 3300 forest stands comprising 1766 separate areas totalling 37,292 ha (mean 21.1 +/- 28.1 ha) were determined to provide contiguous high quality habitat by all models.

The Individual-based Model - Year 3/3

The previously developed geographic information systems (GIS) based model of habitat suitability was used as the habitat matrix in the IBM. It provides the virtual environment in which the individuals in the IBM live, reproduce, and disperse. The grid is a contiguous surface of cells, each with a corresponding habitat suitability score.

The IBM was developed using HexSim version 1.5; a software package designed by Nathan Schumaker of the United States Environmental Protection Agency for the development of stochastic spatially-explicit IBMs. Parameterization of demographic variables, life-history traits, and dispersal characteristics, as well as overall model structure is based on the results of a literature review. Parameters for which reliable data was not available in the literature were calibrated until

model output was consistent with that observed in real systems based on emergent properties (based on the results of 100 replicates), which are those that emerge as a result of the interactions and events between individuals and submodels within the IBM (here include namely sex structure, age structure, and population density). Model parameterization and sensitivity analysis were conducted using data concerning the sex and release locations of individuals translocated in 2007 and 2008 given that these data were not yet available for individuals translocated in 2009. Sensitivity analysis of each of the model's parameters was conducted using unrealistically high and low values to determine the influence of each parameter on overall model output. Data for all three years of releases were used in determining the likelihood of the augmentation being a success as defined by NSDNR and NSMRT (i.e. $\geq$ 350 marten by 2040). In all stages of IBM development, analysis, and implementation the model was run for 34 time steps, representing years 2006 - 2040.

Remaining Tasks

Each combination of sensitive parameters that have been identified for which reliable estimates cannot be located in the literature (e.g. certain movement rules concerning dispersal, quantification of resource requirements) will be run across a range of values calibrated to produce realistic output in the emergent properties. For each combination of these parameters both "best case" and "worst case" scenarios (including the number of marten in the remnant population which could range from 10 to 50 as per Scott 2001) will be run in order to identify a range of model outputs that seem reasonable (as per Bart 1995), thus producing a range of population sizes in 2040 that we can expect from the augmentation.

Additional Information

The proposal submitted for the final year of this research included an aerial telemetry component, where collared, released individuals would be tracked on a regular basis to obtain a measure of post-release survival, and to gain an understanding of species dispersal and movement patterns relating to habitat usage, and home range establishment. However, because of an unrelated issue only permanent NSDNR employees were permitted use of the helicopters this past year. As a result the aerial tracking was not possible during the internship period and subsequent home range analysis and habitat suitability index validation could not be conducted without the additional presence data that would have been provided through these efforts. In lieu of this component of the research, previously acquired presence locations were examined and the habitat quantified to gain insight into the type of habitat that translocated marten in the region were using. A report summarizing the findings was submitted to NSDNR. In addition, data concerning tree species composition, coarse woody debris, and understory were collected from large contiguous areas of high quality habitat identified by the previously developed habitat suitability index model for assessment as potential release sites for Fall 2009. A report outlining these findings has been

submitted to NSDNR; recommendations therein were used to determine release locations.

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