SECOND INTERIM PROGRESS REPORT

OCTOBER 1, 1993

AN ENERGETICS-BASED HABITAT MODEL FOR MARTEN IN WESTERN NEWFOUNDLAND

A RESEARCH COMPONENT OF THE MODEL FORESTRY PROGRAM IN WESTERN NEWFOUNDLAND

PREPARED FOR

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INTRODUCTION

The Western Newfoundland Model Forest Program represents a new approach to forest management, and is based on a cornerstone of integration and cooperation. Effectively managing forest ecosystems first requires integrating resource objectives as diverse as biodiversity conservation and economic sustainability. In turn, achieving integrated management requires cooperation from a diverse array of human objectives.

The Newfoundland marten (*Martes americana atrata*) is one measure upon which the success of the Model Forest as an integrated management venture may be judged. Previous research within the area encompassed by the Model Forest has shown that Newfoundland marten prefer large tracts of old forest with a contiguous tree canopy. As a consequence, marten and pulpwood timber appear to be incompatible management objectives. However, the Model Forest is charged with integrating both of these objectives on one landscape. Our chief contribution to the Model Forest will be a distinctive habitat model that provides a means for integrating marten and timber needs.

Our marten habitat model starts with the most basic of all life requirements- food. Each marten must glean sufficient energy (in the form of food) to survive the energetic demands (such as cold stress) exacted by its environment. Food is especially critical in Newfoundland, since the small mammals that marten eat are relatively sparse and may vary greatly from year to year. Therefore food serves as the primary link between the landscape and marten. First we need to determine just how much food each marten needs to survive, and how that energetic requirement is affected by environmental variation. Then we need to determine how much food, in the form of shrews, voles, hares, and other marten prey, could potentially be provided by the landscape. Energetic relationships are then used to convert food abundance into marten potential, with modifying constraints such as territory size and habitat fragmentation. Finally, the model will consider the suppressing effects of red foxes and ermine.

OBJECTIVES AND ACCOMPLISHMENTS

We had three principal objectives for the project up to October 1, 1993. First we developed a conceptual framework outlining the inner workings of the model, and how the model would be used in forest practice. Second, we commenced the metabolic experiments that form the scientific foundation for the model. Third, Bill Adair canvassed marten and forest modeling specialists at the International Union of Game Biologists Congress in Halifax, and then examined western Newfoundland in person the week following the conference.

Model Framework

The best way to explain how our marten model would contribute to forest planning is to actually apply the model to a sample landscape, using "dummy" data. Figure 1 illustrates the sort of landscape to which the model might be applied. A geographic information system (GIS) would provide the background landscape, with the mapping units defined by a system like the western Newfoundland forest ecosystem classification (FEC) developed by Meades and Moores (1989).

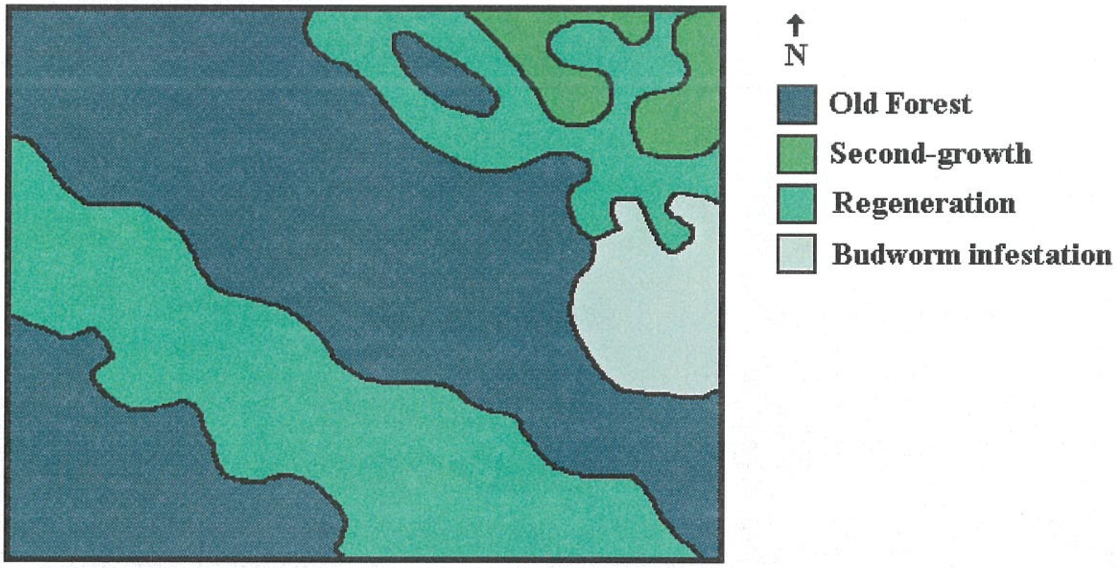

Figure 1. A simplified landscape typical of those to which our marten habitat model might be applied. Forest categories relevant to the model (such as old forest, second-growth, etc.) would be derived from an existing mapping system such as the FEC.

An abundant, accessible prey base is the first determinant of marten habitat suitability. Therefore, the first step in the model evaluates the landscape in terms of prey potential. Figure 2 illustrates how the model might distribute prey items across the sample landscape, based on the habitat affinities of each prey species. A combination of field survey and literature review will be needed to develop this portion of the model. All of the potential prey types will be combined to produce one landscape illustrating total prey potential (Figure 3).

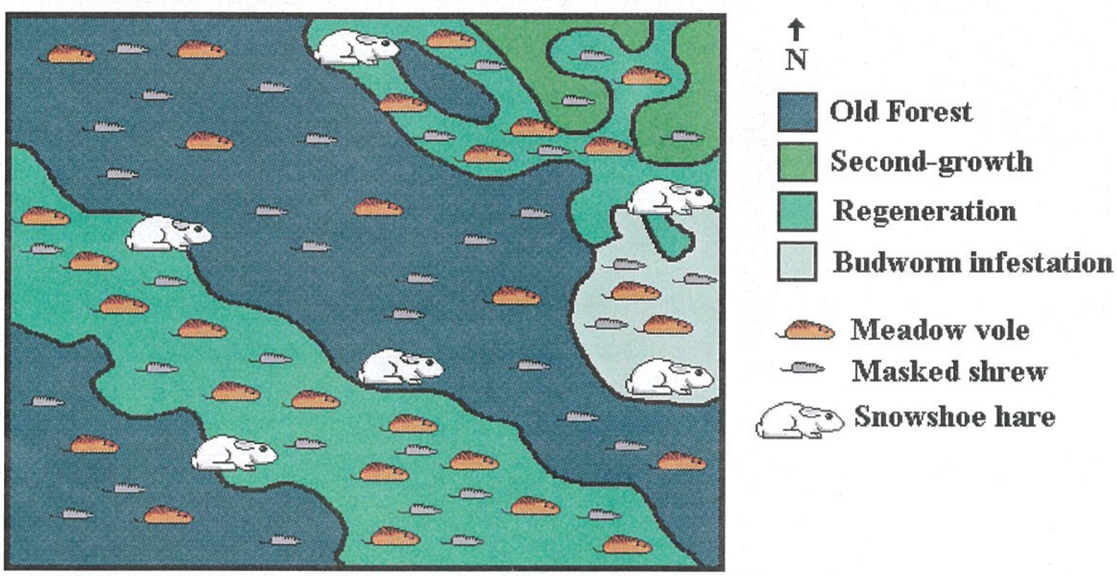

Figure 2. A pictoral representation of prey distribution across the sample landscape. Meadow voles (*Microtus pensylvanicus*) and masked shrews (*Sorex cinereus*) are more common in regeneration and defoliated stands, but occur at variable levels throughout all forest types. Snowshoe hare (*Lepus americanus*) primarily occupy forest-opening ecotones.

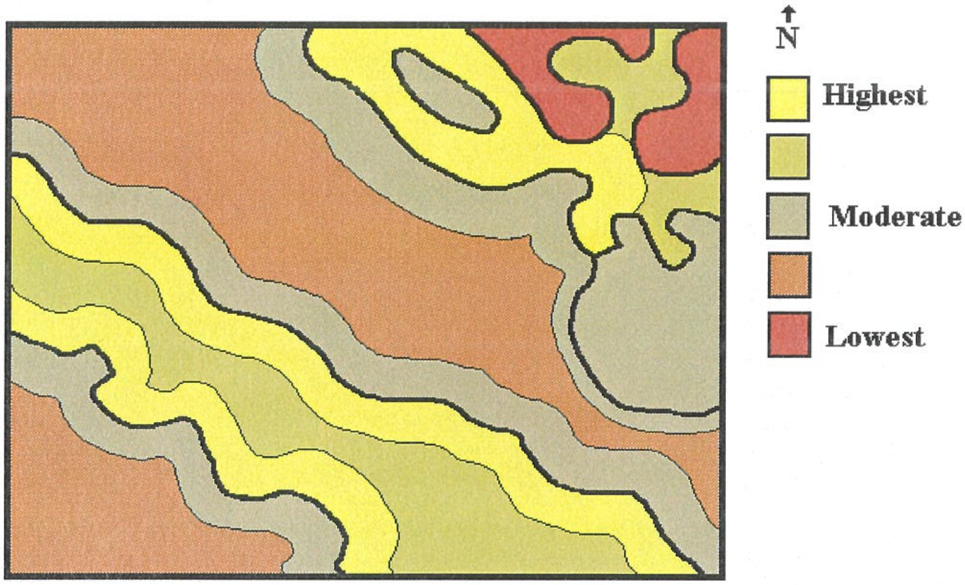

Figure 3. A map of the energy (Kcal/ha) provided by all potential prey species across the sample landscape. The individual contributions of each prey species have been combined to create one cohesive picture of energy availability.

At this point our model begins to differ from typical HSI or habitat supply models, and in effect becomes an "intelligent marten." This "marten" evaluates the landscape based upon energetic tradeoffs (Figure 4). The "marten" evaluates the landscape one point at a time, and includes the proximity of each resource in the form of a movement cost.

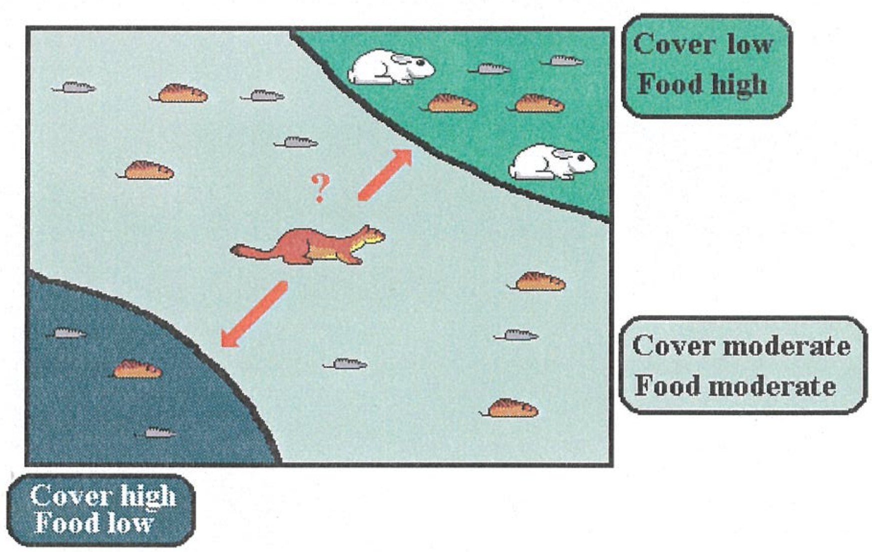

Figure 4. The "intelligent marten." First, a grid of points is arrayed across the landscape. At each point in this grid, the model assumes the role of an "intelligent marten," which balances the tradeoffs between energetic gains, in the form of food, vs. energetic costs, chiefly cover and movement. Movement costs also add a spatial aspect, and reflect the proximity of the resources.

The result of the roving "intelligent marten" is a landscape of varying suitabilities for marten, with the effects of cover, food, and the proximity of each incorporated into one picture (Figure 5). Marten "hot spots" will reflect optimal resource conditions (Figure 6).

Figure 5. A map of marten habitat suitability, based on the combined effects of energetic input (food) and costs (movement, cover), for the sample landscape. In some areas, such as the dark blue second-growth, cover may be adequate, but food is typically limiting. In others, such as regeneration, food is plentiful, but security cover is absent. The reserve old forest within the upper regeneration area suffers because of its isolated location-its use requires extra movement costs.

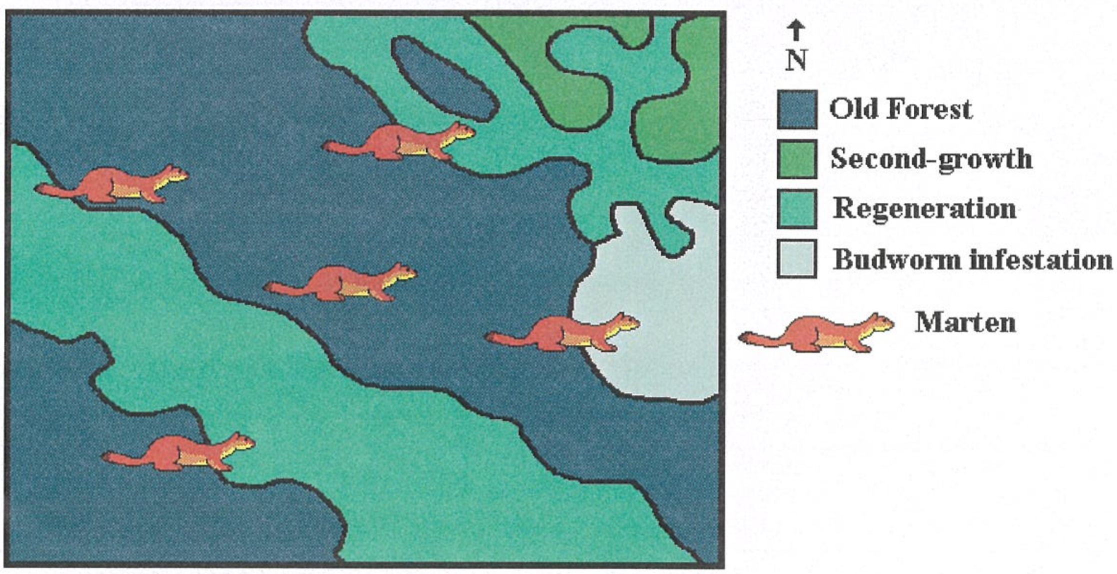

Figure 6. A pictoral representation of marten "hot spots," showing the areas of optimal marten habitat suitability, based on the combined effects of energetic input (food) and costs (movement, cover).

Finally, the model will incorporate the effects of non-energetic factors such as predation and competition. We suspect that landscape fragmentation, which benefits large prey such as snowshoe hare, also benefits red fox (*Vulpes vulpes*), an important marten competitor. As a consequence, where foxes are favored, marten are excluded. Figures 6 and 7 illustrate how the degree of local fragmentation might serve to limit marten habitat suitability. Here our habitat model could be linked to Rick Schneider's population persistence model.

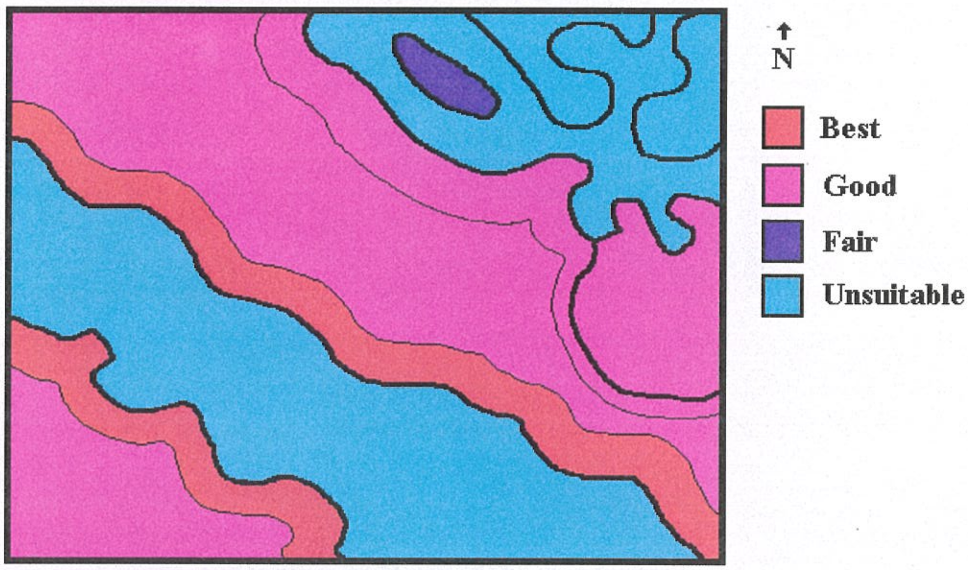

Figure 7. A map of marten habitat suitability, based on the combined effects of energetics and competitive suppression, for the sample landscape. Marten habitat suitability within the highly fragmented northeast corner becomes suppressed due to the increased potential for red foxes. In this example, "best" areas become "good," good categories "fair," and fair categories become "unsuitable."

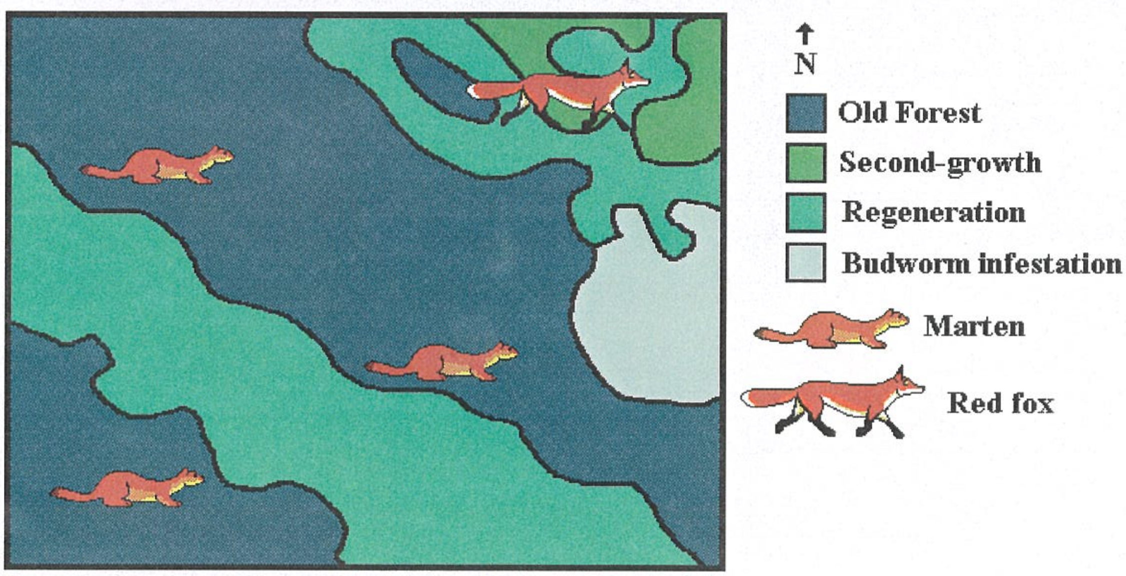

Figure 8. A pictorial representation of remaining marten "hot spots," after including the effects of competitive suppression. The high prey density supported by the fragmented northeast corner has the potential to support red foxes, and therefore marten habitat within that region could be suppressed.

Marten Energetics

Two purposes guided our marten energetics experiments. First, we wished to determine the basal metabolic rate (BMR) for marten in a resting condition, which serves as the basis of the habitat model. Second, we wished to examine how this BMR is affected by ambient temperature and seasonal condition. We commenced our marten summer metabolism experiments in the third week of July 1993. Special cages were built to transport the five marten (3 males and 2 females) from their housing within the Green Canyon Research Facility to the environmental physiology lab, and a special environmental control chamber was constructed to receive the marten.

The rate of oxygen consumption (VO_2), which reflects the rate of respiration (and therefore metabolism), was measured using open-circuit respirometry. Fractional excurrent oxygen levels were measured using an Ametek S-3A oxygen analyzer. Standard Metabolic Rate (SMR) and Metabolic Response to Temperature (MRT) were measured from 0800 to 2100 hours, to reflect the active period of marten in summer. For summer SMR, chamber temperature was maintained at 25° C, which is within the thermal neutral zone for most mammals.

For MRT, marten were exposed to 25° C, 20° C, 15° C, 10° C, 5° C, 0° C, and -5° C temperatures. Individual animals were exposed to three of these temperatures for one hour each, allowing 15 minutes equilibration once a stable temperature had been reached. Metabolic rates were determined as the mean VO_2 over the entire hour. The DataCan computer program was used to monitor output.

Our results from this summer's battery of tests were most encouraging. Our marten proved to be ideal test animals: all achieved a resting condition after 5 minutes in the chamber, and all equilibrated within a few minutes of each temperature change. While the data has not been fully analyzed (the software company failed to include all of the necessary materials with the analysis program), several key results are evident. Our Lower Critical Temperature (LCT) falls between 10° C and 15° C, which is similar to mink but much less than that observed for marten in previous tests. The most commonly quoted LCT for marten, published by Worthen and Kilgore (1981), is 29° C, which is exceedingly high for a boreal mammal, and may in fact be beyond the Upper Critical Temperature (UCT) for our marten. Due primarily to concerns for our animal's health, we did not attempt to find UCT.

We expect to begin a fall battery of tests, with 8 marten, in the second week of October, following renovation of the environmental chambers. Winter tests will commence immediately following the new year.

The IUGB and western Newfoundland

Bill Adair traveled to Halifax, Nova Scotia, for the International Union of Game Biologists (IUGB) conference, for the week of August 15-21, 1993. Bill presented a paper addressing the relationship between marten subnivean access point use and prey density, and attended two forest carnivore sessions, as well as the second meeting of the *Martes* working group. Bill arranged to use the "marten-proof" snowshoe hare snares developed by Gilbert

Proulx as part of this project, on an experimental basis. Contacts were made with marten researchers to ensure no duplication of effort.

Bill Adair traveled to western Newfoundland for the week of August 21-28, 1993, primarily to gain familiarity with the people and the ecosystem associated with the Model Forest. Bill gained a better appreciation for the importance of spatial configuration (given previous harvesting practices) and the terrain, which mandates digital elevation modeling (DEM), and the need for good rain gear and rubber boots.

The Near Future

A formal project proposal, in which our entire study plan will be laid out, should be completed by December 1993. This proposal will serve to guide field study, which should commence immediately following the January battery of energetics trials. Bill Adair expects to remain in Newfoundland gathering small mammal and carnivore habitat use data, and developing the spatial energetics model, for the period from January 1994 through September 1995.

Literature Cited

Meades, W.J., and L. Moores. 1989. Forest site classification manual: a field guide to the Damman forest types of Newfoundland. Joint publication of Forestry Canada and Newfoundland Department of Forestry and Agriculture. FRDA Rep. 003

Worthen, G.L., and D.L. Kilgore, Jr. 1981. Metabolic rate of pine marten in relation to air temperature. J. Mammal. 62(3): 624-628.