VALIDATION AND MODIFICATION OF A MARTEN HABITAT SUITABILITY INDEX MODEL FOR MANITOBA

Prepared For

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March, 1994

Manitoba Forestry Wildlife Management Project

WILDLIFE HABITAT CANADA

Manitoba Natural Resources

Canada-Manitoba Partnership Agreement in Forestry

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VALIDATION AND MODIFICATION OF A MARTEN HABITAT SUITABILITY INDEX MODEL FOR MANITOBA

1.0 INTRODUCTION

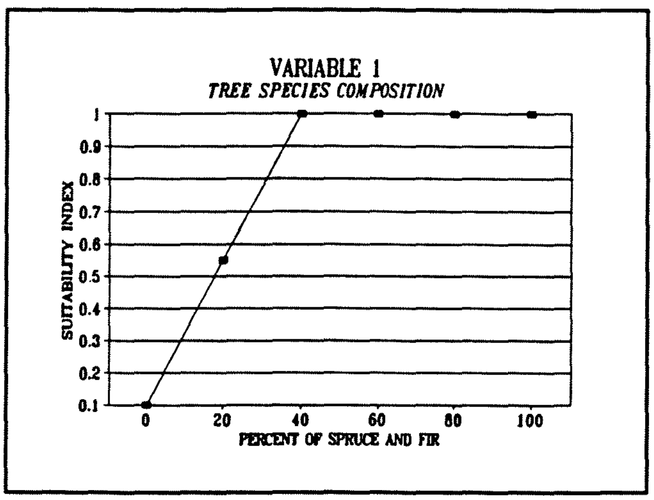
Habitat suitability index (HSI) models were initially developed by the U.S. Fish and Wildlife Service (USFWS) in an attempt to numerically describe habitat quality and quantity for a variety of wildlife species. The HSI is a numerical index ranging from 0.0, representing unsuitable habitat, to 1.0 which represents optimum habitat. This value is derived from an evaluation of the ability of key habitat components to supply the life requisites of selected species of wildlife. The index is assumed to have a positive linear relationship with the potential carrying capacity of the habitat (U.S. Fish and Wildlife Service, 1981). As a consequence, HSI models are often applied in planning, impact assessment and resource management.

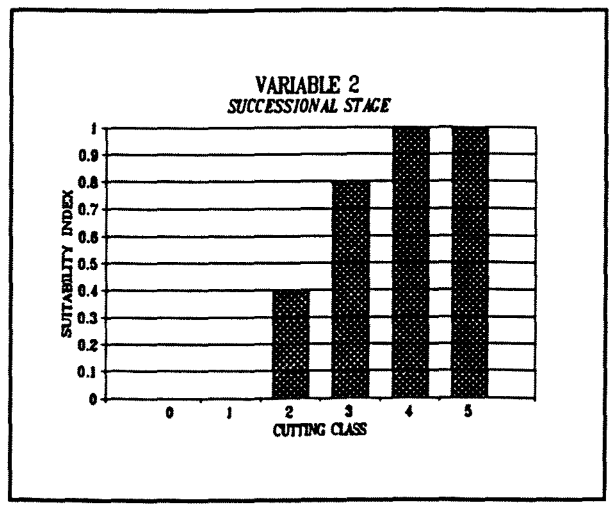
Models can be developed using information on habitat requirements from the literature, field and laboratory studies, a committee of experts on the species, or a combination of approaches. Ideally, model construction is an reiterative process of development, testing, modifying and retesting until the model objectives are met. Most HSI models have been constructed at a fairly rapid pace and for relatively large geographic regions and are often initially applied without adequate testing in order to facilitate implementation.

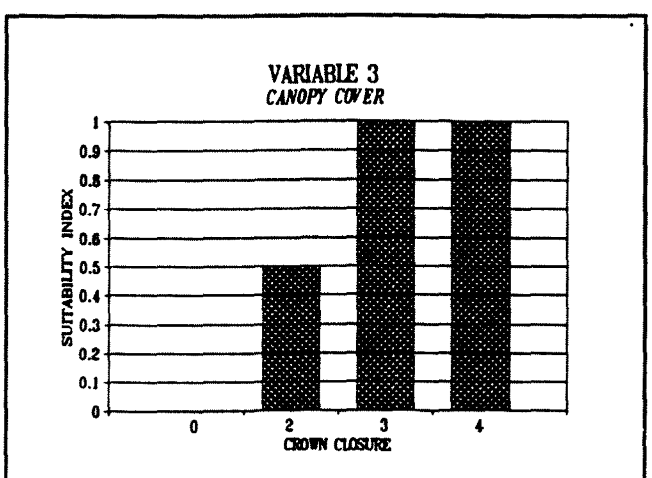
Development of high quality HSI models requires a long-term approach to model validation and refinement. In the long-term and for all management applications, users desire a model which will give precise and understandable results. However, in the short-term, a first cut model that is reasonably accurate may have to do. The long-term approach usually involves thorough testing of a model under various conditions and locations over a period of time. For the short-term, a species authority or expert may have to serve as a surrogate for multiple years of population data and habitat variable sampling.

The marten HSI model was developed for application in the boreal forest of Manitoba and is a modification of the USFWS marten model (Allen 1982). It provides a quantitative method to predict habitat suitability based on descriptions of forested habitats from the provincial Forest Resource Inventory (FRI). A copy of the Forest Resource Inventory codes used in Manitoba is included for reference in appendix I. Since the winter cover requirements for this species are more restrictive than for other seasons of the year, the model evaluates the potential quality of winter habitat for marten. The model assumes that food availability will not be a limiting factor for marten if adequate cover is present and that suitable winter cover is a function of the successional stage of the forest stand, the percent of the stand comprised of spruce or fir, and the percent canopy closure of the stand (Figure 1).

Fig. 1. Variables and Suitability Index curves for the draft marten HSI model.







2.0 METHODS

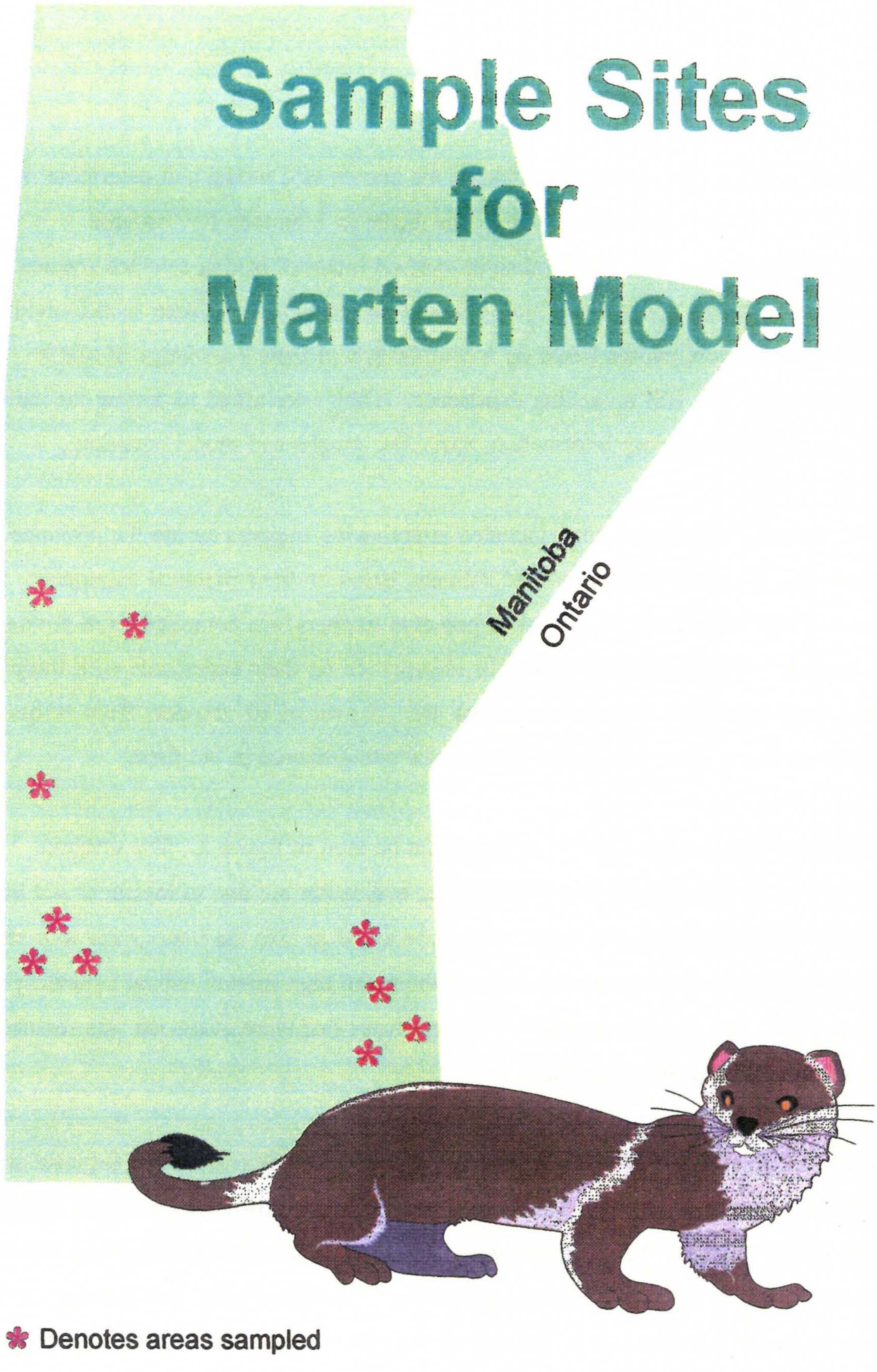
The objective of this study is to validate the marten HSI model and determine if modifications are required in order to utilize this model in Manitoba for resource management applications. The first evaluation method included having selected species experts review the model and provide their opinions and comments. Three such individuals from across Canada were chosen based on a combination of their knowledge of marten habitat requirements and HSI modelling experience. They were asked to review the entire model including the life history information, variables, graphs and model equation.

The second evaluation method included interviewing trappers across the province and having them rate the suitability of forested habitats, based on their practical experience, for comparison to HSI model ratings. A list of potential trappers was compiled from provincial trapping records. They were interviewed for information on their experience with trapping marten and their familiarity with winter habitat use. A total of 10 trappers from across the boreal forest region of Manitoba, were selected for rating habitat in the field.

The general locations of the study areas can be seen in figure 2. The original methods were to include preselection of stands for evaluation but due to logistical and budget constraints it was decided that the trapper would be asked to take the interviewer to a series of sites that the trapper felt represented low, medium and high marten habitat suitability along his trapline. As such the number of habitat types that were evaluated was restricted to those forest types visited by the trapper.

Trappers were asked to rate potential habitat quality of each site from 0 (unsuitable) to 1.0 (optimal) based on their practical field experience and knowledge of marten utilization of forested winter habitats. Each trapper was also asked to provide additional comments and explanations as to why the rating values were given. This information may provide clues for improving the model's performance. A copy of the HSI model validation form used in the interview process is provided in appendix II.

Fig. 2. General location of sampling sites from across Manitoba.



In addition to obtaining the trappers' HSI scores and comments at each site, model variables including tree species composition, crown closure, and cutting class were measured in the field. Two additional HSI values were then calculated. The first was based on the measured field variables and the second on the information from the FRI for that site. These indices can then be compared to obtain some results on accuracy and potential problems with using the FRI in evaluating habitat suitability. At the end of this study a one day field trip occurred with participation from some of the technical advisory committee members of the Manitoba Forestry Wildlife Management Project. This was done in order to summarize the study findings in a field setting. Photographs were taken of the various sites and will be referenced in the results and discussion sections of this report.

All information has been stored in an electronic database for data analysis and graphical representation of the results. The HSI values were then grouped for similar forest habitats and compared in order to evaluate overall model performance. Recommendations for model modification will be made based on these results, the comments from the expert review of the model, and information gained from the one day field trip.

3.0 RESULTS

3.1 Expert Review

The following results are a compilation of the comments from the expert reviewers. The implications of these comments on model modifications will be discussed in conjunction with the results from the field validation project later in this report. Two of the reviewers suggested modifications to the first variable (ie. percent of spruce or fir in the stand) based on their opinion that site productivity is an important habitat component. Both felt that it is those sites which are mesic and richer that are the most productive for small prey. Forest stands which are greater than 70% conifer are often less productive for prey because of less structure, reduced vegetative diversity and poorer site qualities compared to a mixedwood forest type. For these reasons it was recommended that site class should be included or inferred to in the model and that suitability index ratings for variable 1 be modified to reflect site class.

Two reviewers recommended changes to variable 2 (ie. successional stage of the stand). Both recommended scaling down the suitability ratings for all successional stages except cutting class 5 which represents over-mature age class forest types. To support this recommendation one of the reviewers provided data from his study which showed a much higher utilization of cutting class 5 by both male and female marten. His study results also indicated that males tend to utilize cutting class 3 (ie. intermediate aged forests) to a much greater degree than females. Since male home ranges are larger than females it is hypothesized that males may include greater proportions of intermediate seral stage habitat in their home range in order to take advantage of cyclic events in prey populations. However since these cutting classes have limited value for female marten and this model reflects suitability for both sexes it was recommended that suitability index for cutting class three and four be scaled down slightly.

For variable three, two reviewers cited studies where marten demonstrated avoidance of sites with less than 20% conifer crown closure, preferred sites with 20% to 60% crown closure and showed little preference for sites with 60% to 80% crown closure. Both reviewers hypothesized that although stands with high coniferous canopy closure may have good value for security, they tend to have low productivity in the understory and preclude maximum prey biomass. Recommended modifications to suitability indices for this variable were not exactly the same between reviewers however they were consistent in the overall rating trend.

3.2 Trapper Interviews

Table 1 presents a list of the trappers who participated in the validation study and the number of evaluation sites by township and range. The general evaluation areas include eastern Manitoba (Bird Lake and Cat Lake), western Manitoba (Duck and Porcupine Mountains) and northern Manitoba (Cranberry Portage and Snow Lake). One of the problems identified with this method of validation relates to the fact that some prompting of the trappers was necessary in order to obtain comments on why marten were or were not occurring in the evaluation sites. Without this prompting it is suggested that in some instances there would have been few comments received from the trappers. Further, it is acknowledged that the degree of prompting could have varied between the interviewers and may have influenced the results. However, for the purpose of this study trappers were not expected to be a species authority but instead were viewed as experienced and knowledgable on where marten were likely to occur and not occur in forested habitat during the winter. The trappers provided overall HSI values for each forest stand evaluated.

Table 1. Evaluation sites listed by Trapper and Township-Range

Trapper	General Location	Twp-Rge	# Sites
Ed Johnson	Bernic Lake	17-15e, 17-16e	11
Dennis Fontaine	Bird River	17-14e&15e, 18-15e	7
Danny Larocque	Cat Lake	18-16e, 19-15e&16e	11
Stuart Jansson	Long Lake	22-15e, 22-16e	17
Ted Pachkowski	Duck Mnts, SE corner	28-23w, 29-23w	12
Paul Yakimishyn	Duck Mnts, W side	30-27w	11
Daryl Enockson	Duck Mnts, NW side	31-28w, 32-28w&29w	11
John Bilow	Porcupine Mnts, NW	43-28w,44-28&29w	13
Len Abromovich	Herb Lake	63&64-15w&16w	13
Roger Carriere	Cranberry Portage	67-26w, 68-28w	14
Total No. = 10		Total No. Sites = 120	

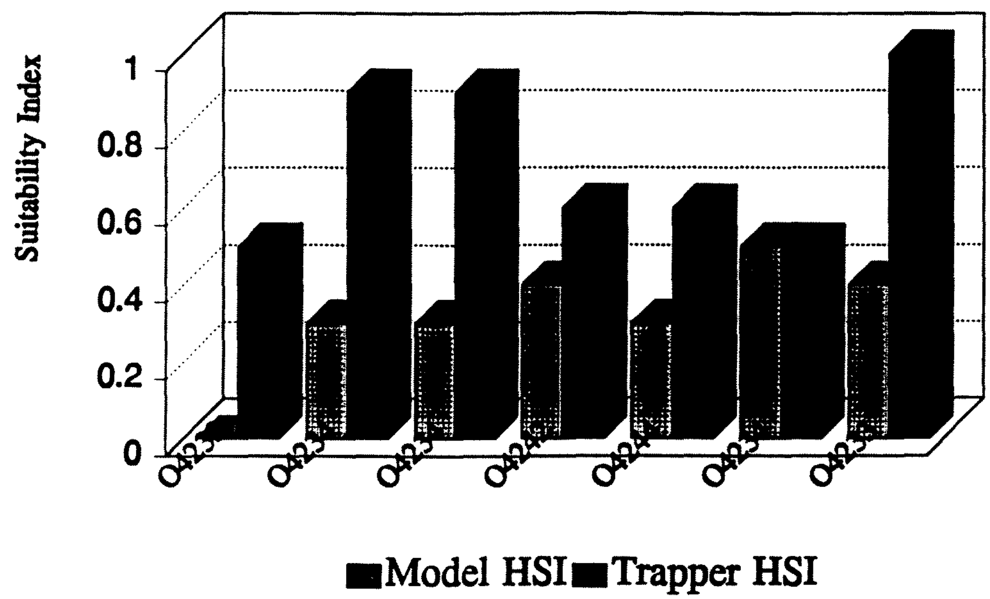
The results of the trapper ratings are presented in the following sections by the main forested habitat associations found in the FRI.

3.2.1 Jack Pine Habitats

The results from the trappers ratings indicates that intermediate to mature jack pine (*Pinus banksiana*) stands associated with up to 30% black spruce (*Picea mariana*) on a poorer site class were often rated high for winter habitat suitability. Figure 3 shows that this is contrary to the model ratings which were much lower.

Fig. 3. Comparison of Suitability Indices

for Jack Pine Stands/ Site Class 2



(71% to 100 % Jack Pine)

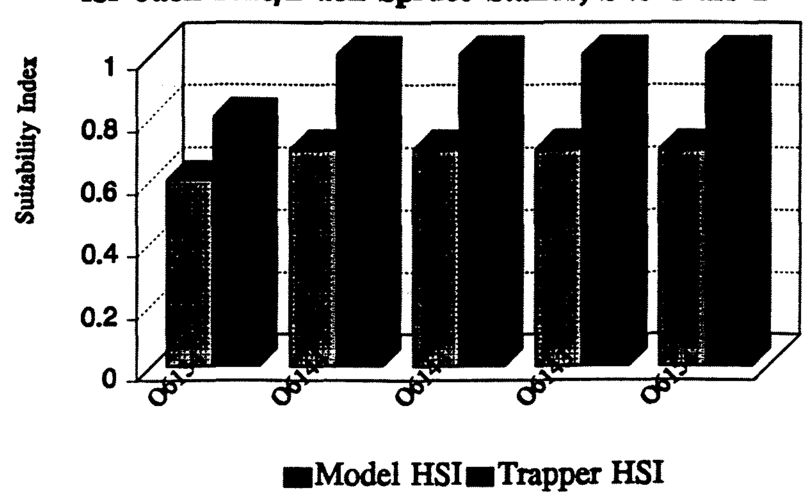
These stand types usually have a large component of mature to overmature jack pine along with a relatively open herbaceous layer, rolling topography and shallow soils. Other typical characteristics include fine grained patches or gaps in the overstory and numerous rock outcrops. This structural heterogeneity often results in natural pruning variability of many of the spruce trees in the stand leading to low conifer branching heights. It is hypothesized that foraging success in these stand types would increase by allowing for foraging and security cover. Thompson and Colgan (1987) suggested that marten populations are proximally food-regulated and should therefore forage where they can obtain the most prey, not necessarily where the most prey occur. Field observations in these stand types revealed that they should be highly selected for because of good line of sight distances near the forest floor, low conifer branching and structural heterogeneity. These stand types are described in the FRI as subtype 04, site class 2, cutting class 4 and 5 with crown closures between 50% to 70%.

Mature to overmature jack pine stands with less than 10% black spruce on a more productive site class (ie. site class 1) were rated low for winter habitat suitability by the trappers interviewed which is consistent with the model ratings. These sites can be considered relatively homogeneous in both structure and floristics, are associated with high canopy closures, good natural pruning and have consistent tree diameters and heights. Typical soils are pure sands to sandy loams with moderate depths. These stands are described in the FRI as subtype 04, site class 1, cutting classes 4 and 5 with crown closures between 70% and 100%.

Intermediate to overmature forest stands with 40% to 70% jack pine and 30% to 60% black spruce on site class 1 sites were rated relatively high by trappers for winter habitat suitability. This is marginally higher than the HSI model values as seen in figure 4.

Fig. 4. Comparison of Suitability Indices

for Jack Pine/Black Spruce Stands, Site Class 1



(40% to 70% Jack Pine & 30% to 60% Black Spruce)

These stand types are described as subtype 06, site class 1, cutting classes 4 and 5 with crown closures of 50% to 100%.

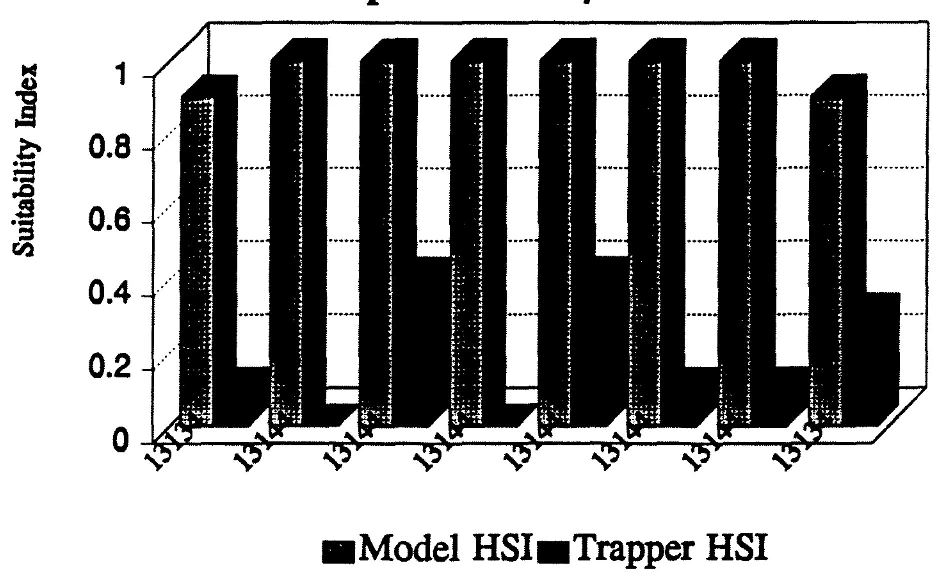
Mature and overmature forest stands with 40% to 70% jack pine and 30% to 60% black spruce on site class 2 sites were rated relatively high by trappers for winter habitat suitability. This is relatively consistent with the HSI model values. These stand types are described as subtype 06, site class 2, cutting classes 4 and 5 with crown closures of 50% to 100%.

3.2.2 Black Spruce Habitats

Results for intermediate and mature stands composed of 71% to 100% black spruce on site class 1 indicate that the trappers' HSI values are consistently much lower than the HSI model values. The model rates these forest types as optimum for winter habitat suitability however trappers rated these forest types as marginal winter habitats at best. These results can be seen in figure 5 and indicate that model modifications are definitely required. These stand types are described by FRI as subtype 13, site class 1, cutting classes 3 and 4 with crown closure greater than 70%.

Fig. 5. Comparison of Suitability Indices

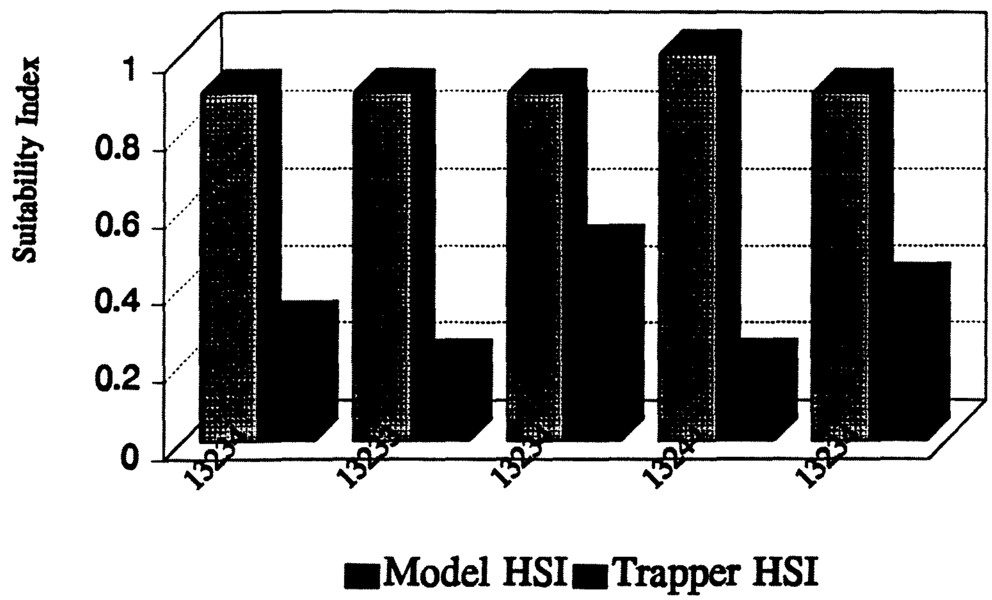
for Black Spruce Stands/ Site Class 1



(71% to 100 % Black Spruce)

Similar results were obtained for pure black spruce stands on site class 2 and can be seen in figure 6. The main difference between black spruce site class 1 and site class 2 is that the former is associated with moist to wet moisture regimes while the latter is associated with saturated moisture regimes. Field observations indicated that these sites are relatively homogeneous and contain a variety of ericaceous shrub species. These sites are likely to be less productive for prey because of less structure, reduced plant diversity, and poor site quality when compared to a richer mixed forest types.

Fig. 6. Comparison of Suitability Indices for Black Spruce Stands / Site Class 2



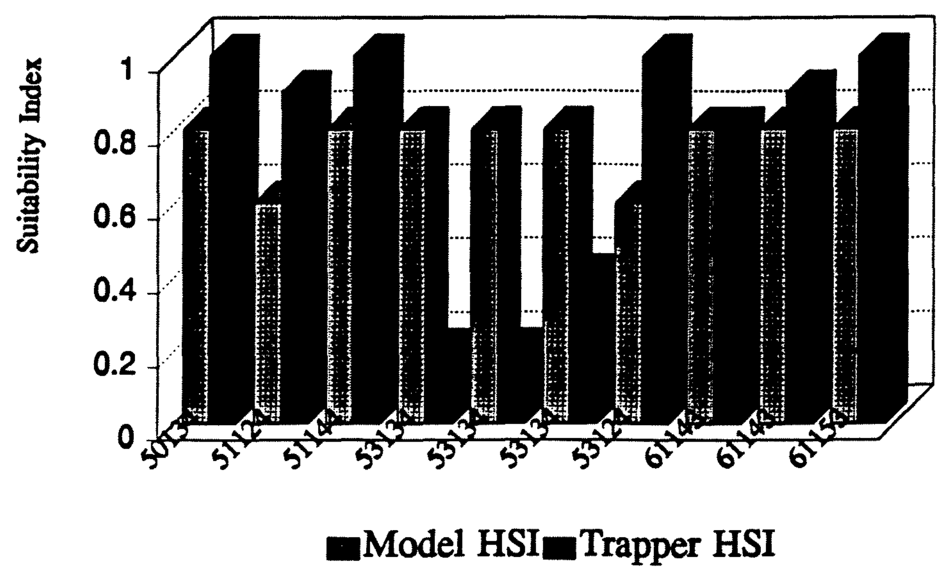
(71% to 100 % Black Spruce)

Other black spruce - conifer associations which were evaluated include black spruce-jack pine (subtype 14), black spruce - white spruce (*Picea glauca*) (subtype 15), and black spruce - tamarack (*Larix laricina*) (subtype 16). The HSI ratings between the model and trappers results were relatively consistent for the black spruce - jack pine associations in the eastern and northern evaluation sites . However, this did not hold for the Porcupine Mountain area where the trappers rated these forest types as having a low HSI value compared to the higher HSI model ratings. HSI ratings between the trapper and the model also appeared to be consistent for the black spruce - white spruce associations where HSI ratings ranged from 0.9 to 1.0. HSI rating consistency for the black spruce - tamarack associations appeared to be good for the Duck Mountain and Snow Lake areas but were completely opposite for the Cat Lake area in eastern Manitoba.

3.2.3 Mixedwood Conifer Habitats

These forested habitats contain between 51% to 75% coniferous species and corresponding percentages of mainly trembling aspen. No specific trends by individual mixedwood types could be identified due to the small sample size but the general trend indicates that white spruce and balsam fir (*Abies balsamea*) mixedwoods appear to be rated higher by the trapper than black spruce mixedwoods (figure 7).

Fig. 7. Comparison of Suitability Indices for Mixedwood Conifer Stands

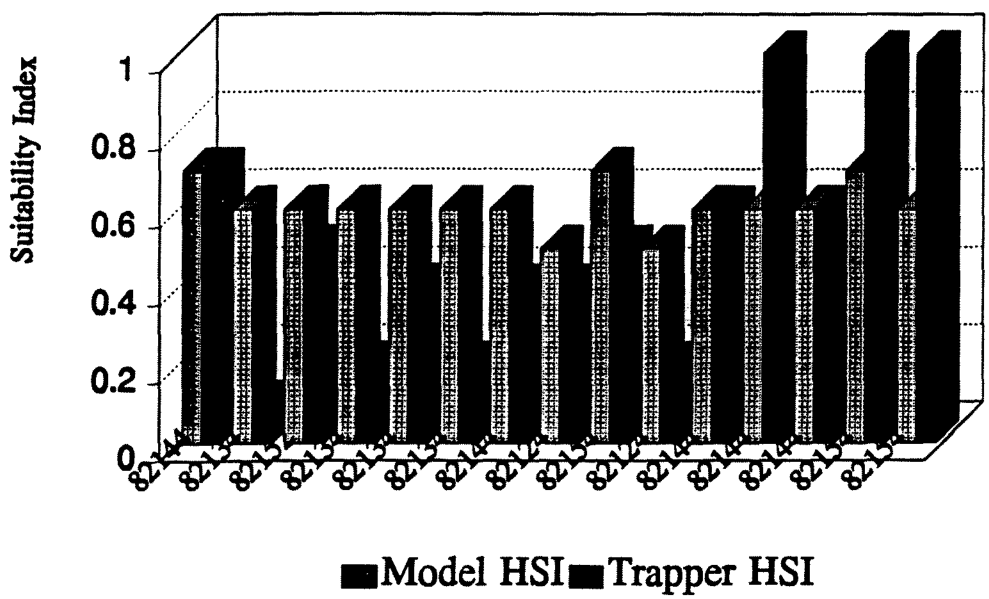


(51% to 75 % Conifer, '50' & '51' - WS, '53'-BS, '61'-BF)

3.2.4 Mixedwood Deciduous Habitats

These forested habitats contain between 50% and 74% hardwood species, mainly trembling aspen in this case, and corresponding percentages of white spruce and/or black spruce and/or balsam fir. The majority of these evaluation sites were in the Duck Mountains where a large amount of this habitat is present. The results in figure 8 indicate that in most cases the model HSI values are much greater than those assigned by the trappers.

Fig. 8. Comparison of Suitability Indices for Mixedwood Deciduous Stands



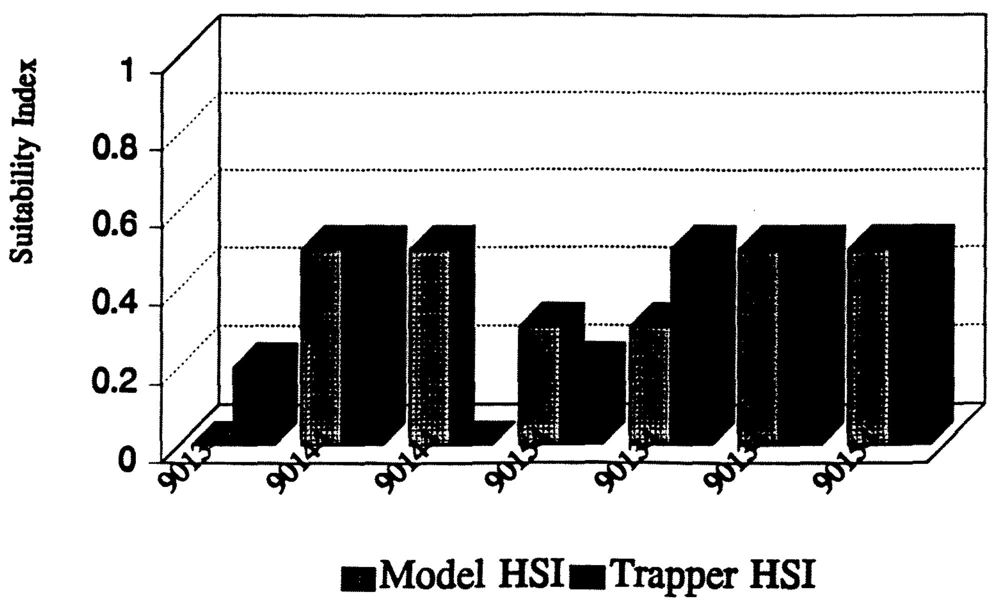
(26% to 51% Conifer, '82' = TA + WS,BS,BF)

This appears especially obvious where black spruce is the major conifer association with trembling aspen. The only time that the trappers' HSI ratings were higher than the model ratings was in those mixewood deciduous stands where white spruce was a large component and the successional stage was overmature or cutting class 5.

3.2.5 Deciduous Habitat

These forested habitats contain between 75% and 100% hardwood species, mainly trembling aspen, and corresponding percentages of white spruce and/or black spruce and/or balsam fir. The results presented in figure 9 are only from stands evaluated in the Duck Mountain area and indicate that in most cases the model and the trappers' HSI ratings are relatively consistent. Hardwood stands associated with white spruce were rated higher by trappers than those hardwood stands associated with black spruce.

Fig. 9. Comparison of Suitability Indices for Deciduous Stands



(76% to 100 % Deciduous, '90' - TA)

4.0 Discussion and Recommendations

4.1 Variable 1- Tree Species Composition

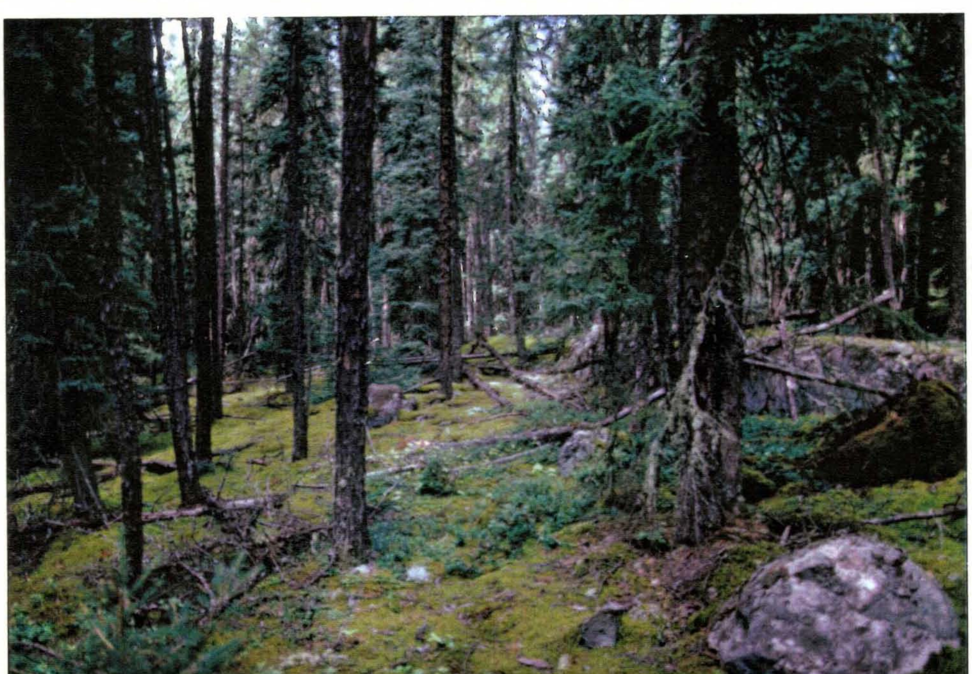
Some consistent trends between the expert review results and the trappers' ratings for HSI were noted. The expert reviewers suggested modifications to the first variable (ie. percent of spruce or fir in the stand) based on their opinion that site productivity is an important habitat component that can be related to an estimate of food or prey production. They felt that those sites which are mesic and richer are the most productive for small prey. They indicated that forest stands with greater than 70% conifer are often less productive for prey because of less structure, reduced vegetative diversity, and poorer site qualities compared to mixedwood stand types. Therefore they recommended that without including site productivity in the model, or relating it to the tree species composition of the stand, the influence of site productivity may be under-represented in the model. These comments are also corroborated by the trappers' comments which indicated that the suitability of a forest stand is linked primarily to food production and foraging success. Currently the model assumes that food is not a limiting factor if sufficient cover is available.

Results from the trapper interviews indicate that the trappers assigned medium to high HSI values when the black spruce composition in the stand was between 30% to 60% but would consistently assign low to medium HSI values from 0.1 to 0.4 when the black spruce composition was greater than 60% (ie. subtype 13). This suggests that pure black spruce stands are to be less productive for prey because of their structural and floristic homogeneity as seen in figure 10. This is inconsistent with the draft model which assigns optimum HSI values of 1.0 for tree species composition to any stand which has greater than 40% spruce composition. In addition trappers gave consistently higher HSI ratings to stands having at least 30% white spruce or balsam fir when compared to the model HSI values. These results indicate that white spruce offers more suitable habitat than black spruce in any stand.

Fig. 10. Typical mature black spruce stand (marten HSI = 0.1 to 0.4)

The trappers generally agreed that stands containing 80% to 100% jack pine on site class 1 sites should be given a low HSI value, which is consistent with the model ratings. However the trapper results indicate that the model is not assigning high enough values to jack pine - black spruce stands on site class 2 which were rated from 0.6 to 1.0 (figure 11).

Fig. 11. Jack pine/black spruce association on site class 2 (marten HSI= 0.6 to 1.0)



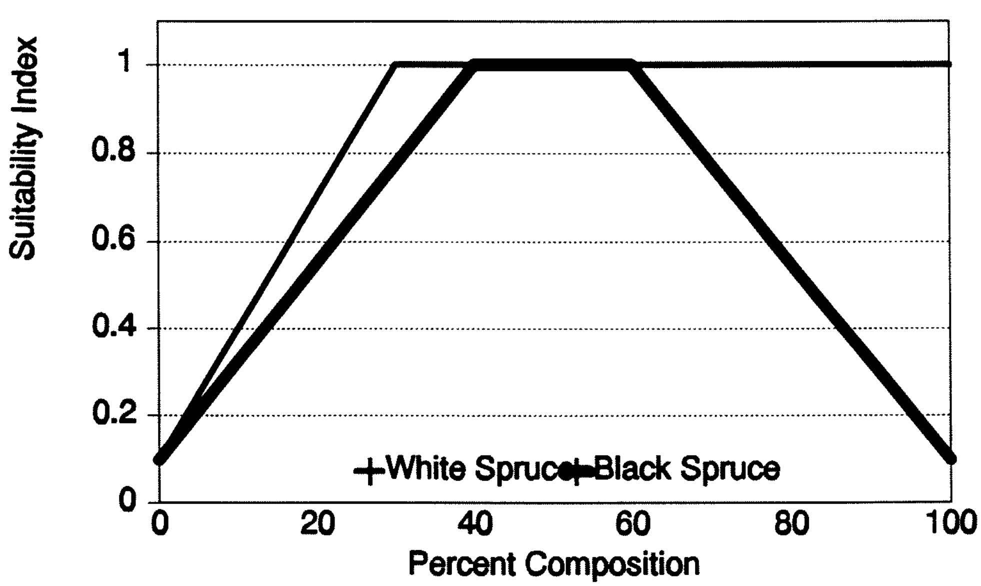
These stands often contain irregular topography and fine grained patches, or gaps, in the overstory where rock outcrops occur. Concentrations of black spruce are found in the draws and at the edges of rock ridges which are often associated with low branching heights offering foraging cover. It appears that although the suitability of winter habitat is generally linked to the amount of spruce/fir in the stand, for these stand types the spatial clumping characteristics of black spruce are equally important.

Mixedwood coniferous dominated stand results showed that in most instances the trappers rated those stands associated with white spruce higher than those associated with black spruce (figure 12). In addition where black spruce is the major conifer associated with trembling aspen, the model HSI values are slightly greater than those assigned by the trappers. For mixedwood deciduous dominated stands the only time that the trappers' HSI ratings were higher than the model HSI ratings was where white spruce was a large component and the successional stage was overmature or cutting class 5. For hardwood stands the model and the trappers' HSI ratings were relatively consistent. Once again hardwood stands associated with white spruce were rated higher by the trapper than those hardwood stands associated with black spruce.

Fig. 12. Mixedwood white spruce dominated stand (marten HSI = 0.8 to 1.0)

Currently the draft model does not differentiate between black spruce and white spruce. Based on field observations, site productivity as it relates to maximum prey biomass appears to be much better for stands containing mixtures of white spruce, black spruce and jack pine-black spruce in comparison to more pure black spruce and jack pine stands. For these reasons black spruce should be evaluated separately from white spruce in the model. Based on the expert review recommendation to include or infer site productivity differences in the model and the results from the trapper interviews it is recommended that HSI ratings for variable 1 be modified. Figure 13 offers a potential modification to the original variable based on recommendations provided by the expert reviewers and information gained through the trapper interviews.

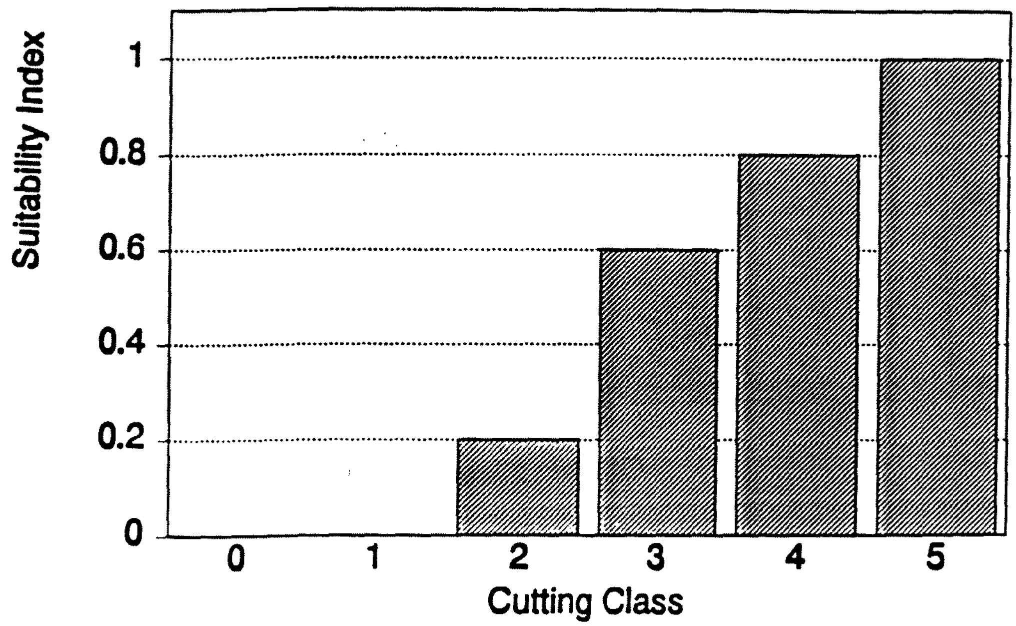
Fig. 13. Marten HSI for Tree Species Composition Variable 1



4.2 Variable 2 - Successional Stage

Recommendations from the expert review for variable 2 in the model were unanimous. Two of the reviewers recommended that suitability ratings for cutting classes 2 to 4 be reduced slightly from their original ratings. Results from the trapper interviews also supported this with cutting class 5 often rated optimum if spruce was present in the stand. Figure 14 offers a potential modification to the original variable based on recommendations provided by the expert reviewers and information gained through the trapper interviews.

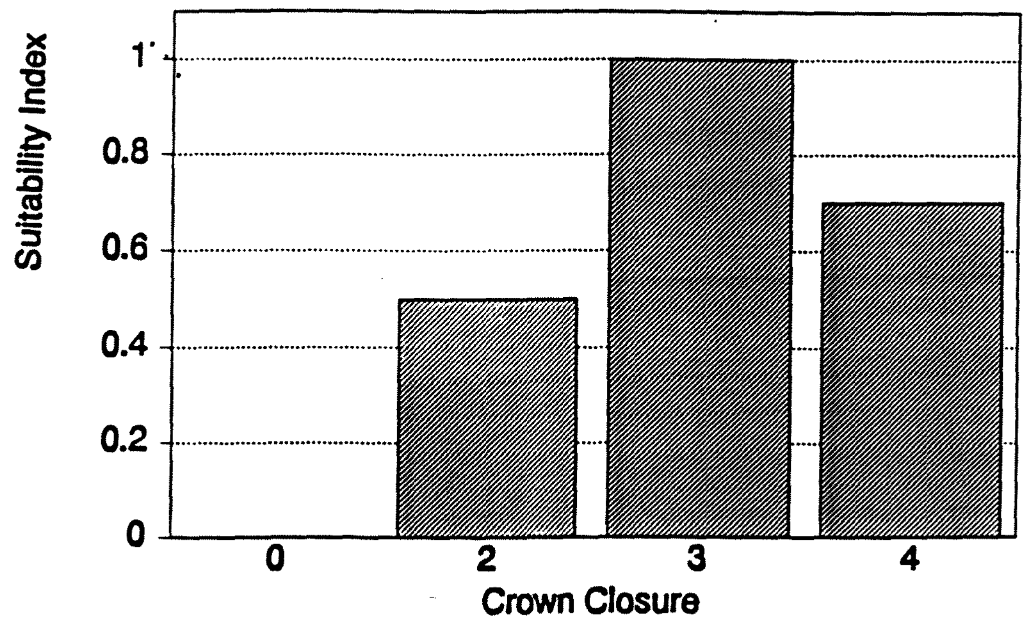
Fig. 14. Marten HSI for Successional Stage Variable 2



4.3 Varaible 3 - Conifer Crown Closure

Comments from the expert reviewers followed the same trend when evaluating the crown closure HSI ratings but differed slightly for 21% to 50% crown closure (ie. code 2). Only general trends could be observed in the trapper interviews however results indicated that crown closure codes 0 and 2 rate lower than crown closure codes 3 and 4. The expert reviewers hypothesized that although stands with high coniferous crown closure may have great value for security, they tend to have low productivity in the understory and lower small mammal populations. Figure 15 offers a potential modification to the original variable based on recommendations provided by the expert reviewers and information gained through the trapper interviews.

Fig. 15. Marten HSI for
Conifer Crown Closure
Variable 3



4.4 Model Equations

The conifer crown closure HSI values assigned to each stand in the draft model, based on the FRI crown closure code, were multiplied by the percent of spruce and fir in the stand in order to more accurately reflect crown closure values in the winter. This was done since the FRI bases the crown closure of forest stands on the photo-interpretation of all tree species which could include hardwoods. This calculation was then applied to all forest stand types. It is recommended that this calculation should only apply to forest stands with less than 51% conifer and that for stands with greater than 50% conifer the crown closure HSI be taken directly from the graph depicted in figure 15. This is because jack pine stands were generally rated higher by the trappers than by the draft model. Therefore the recommended equation for use in stands containing more than 50% conifer is:

$$\textbf{WINTER COVER HSI} = (V1 \times V2 \times V3)^{1/3}$$

The recommended equation for use in stands containing less than 51% conifer should remain the same as in the draft model which is:

$$\textbf{WINTER COVER HSI} = (V1 \times V2 \times V4)^{1/3}$$

$$\text{Where: } V4 = \left(V3 \times \frac{(\%\ \text{Spruce/Fir in Stand})}{100}\right)$$

5.0 Conclusions

Simplified models, such as the one tested in this document, are most useful when a rapid habitat evaluation is desired. They can provide guidance in planning timber and forest wildlife management activities, and can serve as the basis for habitat inventories or monitoring programs. This model is useful in landscape applications where the amount of sampling required by more data intensive field models would be prohibitive. The draft marten HSI model was written to be applicable over the entire range of marten in Manitoba and in theory should be tested in all parts of this range prior to management applications. The approach used to partially validate this model is not equivalent to a test of a model's accuracy in predicting the quality of habitat for a species. Although the objective of improving a literature-based HSI model was accomplished, it is recognized that the model requires more thorough testing under various conditions and locations over a period of time utilizing population data sets or other standards of comparison in order to be more fully validated.

Since models are a simplification of reality (Hall and Day, 1977), some measurement of reality is necessary to compare with the model output and to determine the amount of agreement between the model and its subject. Selection of an appropriate standard of comparison has caused the most difficulty and argument in model testing. The standard of comparison chosen to test this model was expert review and rating because of a lack of good census data and limited budgets and time frames for this project. This project has increased the understanding of the limits of the model and its applicability and has resulted in some recommended modifications based on expert review and opinion scores. The next stage which will determine the model's performance and adequacy, is to utilize it for planning purposes. To expand the model's utility, additional testing of it and habitat relationships of marten should occur in local areas of application.

6.0 Acknowledgements

Funding for this project was made possible through the Canada-Manitoba Partnership Agreement in Forestry. The Manitoba Forestry Wildlife Management Project extends appreciation to the Department of Natural Resources Operations Division - Western Region, Repap Manitoba for provision of staff time and maps, and Abitbi-Price Inc. for the provision of FRI data and maps. The assistance of trappers Ed Johnson, Dennis Fontaine, Danny Larocque, Stuart Jansson, Ted Pachkowski, Paul Yakimishyn, Daryl Enockson, John Bilow, Len Abromovich and Roger Carriere who provided their trapping expertise the field is gratefully acknowledged. Thanks are also extended to Eric Lofroth, Daniel Beaudette and Ian Thompson for serving as expert reviewers and Roger Toews and Ron Kowalewich for conducting the trapper interviews.

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APPENDIX I MANITOBA FOREST RESOURCE INVENTORY CODES

To assist the reader with interpreting the FRI codes referred to in this report the following is a brief description. The Manitoba FRI has a 5 digit type aggregate code associated with each forested stand. This code includes information on:

Covertype - are broad descriptions of the main treed cover categorized by softwood, softwood-hardwood, hardwood-softwood, and hardwood.

Subtype - the tree species composition rounded off to the nearest 10 percent.

Site Classification - as it relates to the potential for tree growth

Cutting Class - based on size vigour, state of development and maturity of a stand for harvesting purposes.

Crown Closure - an indirect measure of stand density based on estimations from photo-interpretation

For example if the stand aggregate code is **04134**:

0 - Covertype is softwood

4 - Subtype is Jack Pine 71% to 100%

1 - Site Class 1

3 - Cutting Class which is intermediate in maturity

4 - Crown Closure which is 71% and greater

NATURAL RESOURCES

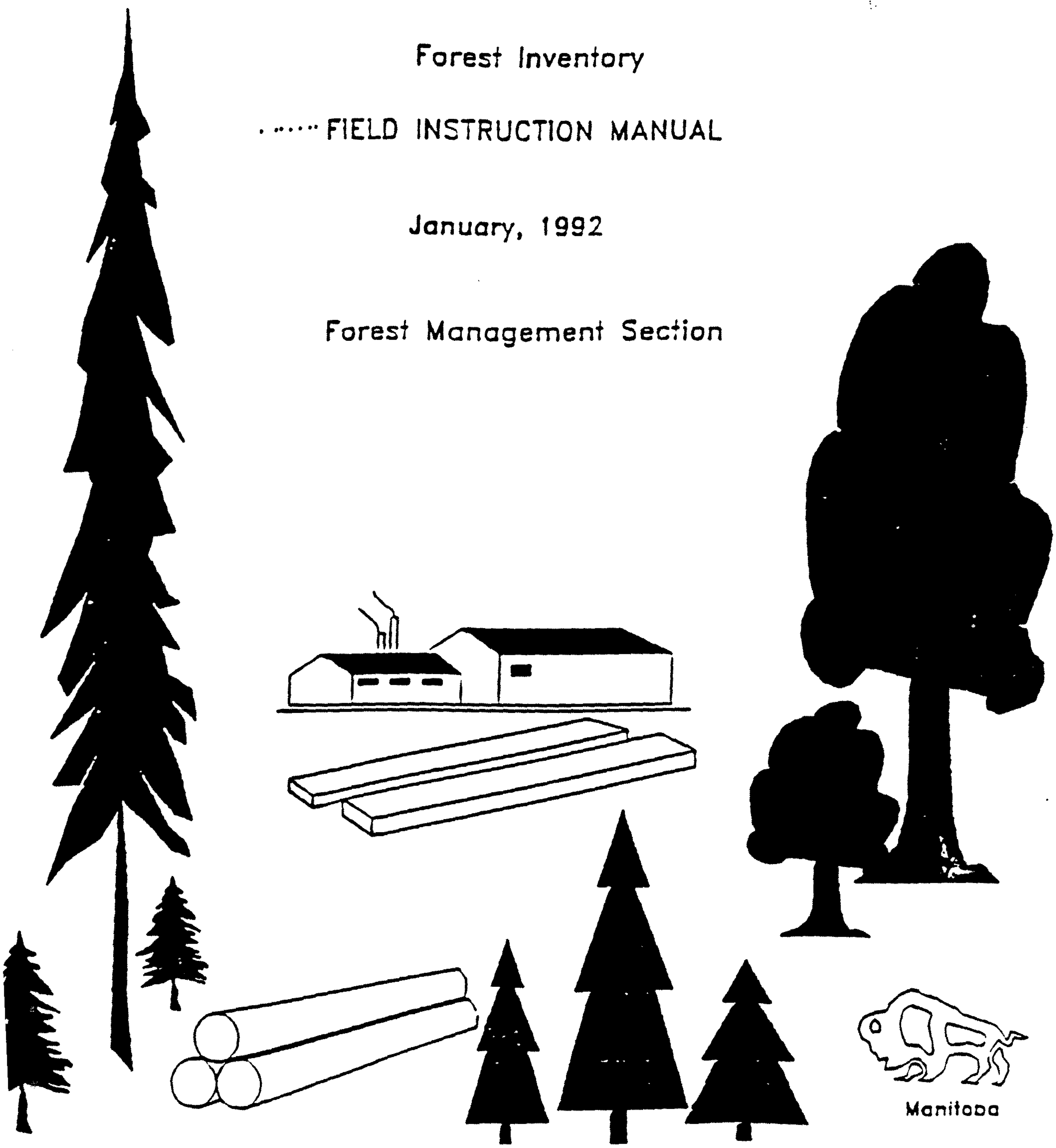
MANITOBA

Forest Inventory

FIELD INSTRUCTION MANUAL

January, 1992

Forest Management Section



Manitoba

III SUBDIVISION OF FORESTED PRODUCTIVE LAND

1. Type Aggregate

This term is used in reference to all productive stands or potentially productive areas in a Forest Management Unit or Forest Section which have common characteristics as to cover type, subtype, site, cutting class and crown closure.

Cover Type

Four broad cover types are recognized - Softwood 'S', Softwood-Hardwood 'M', Hardwood-Softwood 'N', Hardwood 'H'. The first number of the sub-type code indicated the type aggregate.

CODE	
0-3	Softwood 'S' includes all stands where at least 76 percent of the total basal area consists of coniferous species.
4-7	Softwood-Hardwood Mixedwood 'M' includes all stands where the basal area of all the coniferous species is between 51 percent and 75 percent of the total basal area.
8	Hardwood-Softwood Mixedwood 'N' includes all stands where the basal area of all coniferous species is between 26 and 50 percent of the total basal area.
9	Hardwood 'H' includes all stands where the basal area of all coniferous species is less than 25 percent of total basal area.

The above cover types are therefore to be determined by the percent of the basal area of softwood tally in proportion to the total basal area found on all plots taken within a stand.

2. Subtype

This term indicates the species composition in broad groups within the cover type. Subtype is determined by the proportion of basal area of two or three main species in the stand as found on sample plots to the total basal area of all species. To determine the subtype, the basal area of individual species must be computed and rounded off to the nearest ten percent.

The percentage range marked after the species symbol indicates the proportion of the basal area of this particular species in comparison to the total basal area of all species in the type. The second number of the code of type aggregate identifies the subtype.

On the following page is a list of the recognized subtypes:

Working Group Classification

Working Group	Subtype Code	Cover Type	Species Content
Red Pine	01	Softwood (S)	Red Pine 71-100%
	02	Softwood (S)	Red Pine 40-70%: 2nd major species Jack Pine
	41	Softwood-Hardwood (M)	Red Pine 51%+: 2nd major species Hardwood
	42	Softwood-Hardwood (M)	Red Pine 50% or less: 2nd major species Jack Pine; 3rd major species Hardwood
White Pine	43	Softwood-Hardwood (M)	White Pine 51%+: 2nd major species Hardwood
Jack Pine	04	Softwood (S)	Jack Pine 71-100%
	05	Softwood (S)	Jack Pine 40-70%; 2nd major species Red Pine
	06	Softwood (S)	Jack Pine 40-70%: 2nd major species Spruce
	44	Softwood-Hardwood(M)	Jack Pine 51%; 2nd major species Hardwood
	45	Softwood-Hardwood(M)	Jack Pine 50% or less: 2nd major species Red Pine: 3rd major species Hardwood
	46	Softwood-Hardwood (M)	Jack Pine 50% or less: 2nd major species Spruce; 3rd major species Hardwood
Scots Pine	08	Softwood (S)	Scots Pine 71-100%
	09	Softwood (S)	Scots Pine 40-70%: 2nd major species Jack Pine
	48	Softwood-Hardwood (H)	Scots Pine 51%+: 2nd major species Hardwood
	49	Softwood-Hardwood (H)	Scots Pine 50% or less: 2nd major species Jack Pine; 3rd major species Hardwood
White Spruce	10	Softwood (S)	White Spruce 71-100%
	11	Softwood (S)	White Spruce 40-70%: 2nd major species Jack Pine, Balsam Fir or Black Spruce
	50	Softwood-Hardwood (M)	White Spruce 51%+: 2nd major species Hardwood
	51	Softwood-Hardwood (M)	White Spruce 50% or less: 2nd major species Balsam Fir, Jack Pine or Black Spruce
Black Spruce	13	Softwood (S)	Black Spruce 71-100%
	14	Softwood (S)	Black Spruce 40-70%: 2nd major species Jack Pine
	15	Softwood (S)	Black Spruce 40-70%: 2nd major species Balsam Fir, White Spruce
	16	Softwood (S)	Black Spruce 40-70%: 2nd major

3. Site Classification

The following site classification has been described for the INTERLAKE SECTION of Manitoba ONLY. The land types and associated indicator plants are described for each moisture regime in the following table. The moisture regime in return denotes the site class for each tree species. Since height growth and stand density are reflections of site, these factors should be considered when evaluating the growth of timber types. A site class will be assigned to each subtype on the basis of its major species.

Although these plants generally reflect the moisture regime of the area, they become important site indicators only when they occur in abundance throughout the entire type. Localized elevations and depressions in the timber stand can reflect entirely different plant indicators then those throughout most of the type. Mineral and nutrients strongly influence tree growth but may not affect the presence of minor vegetation. Most of the soil in the Interlake area of Manitoba consists of strongly calcareous till. Although this high calcareous content does not affect the growth of indicators of Class 1 Jack Pine site, it seriously inhibits the growth of Jack Pine. On the other hand, Sphagnum spp. do not tolerate high lime conditions. For this reason, feather moss rather than sphagnum are found on much of the deep organic terrain in the Interlake Section.

Since most indicator plants grow over a range of moisture regimes, they generally become important only when they occur in abundance and when a variety of plants present. In isolated cases, however, the mere presence of a certain indicator plant throughout the type can denote site class. A good example of this is when bunchberry or twinflower occurs in association with jack pine. These plants do not occur on dry moisture regimes and therefore denote site class 1.

All factors of landform, indicator plants and tree growth should be considered when assigning site class. The following indicator plants should be used as a guide when evaluating site..

INDICATOR PLANTS

1. Cladonia mites (most common species of reindeer lichens)
   Typical for d type; indicates that soil is very surface dry
2. Cladonia rangiferna (Reindeer moss - a lichen)
   Often together with C.mites, not quite as common, but indication same conditions.
3. Juniperus horizontalis (Creeping savin)
   On vd type on limestone rock outcrops and on d type, on beach ridges.
4. Arctostaphylos uva-ursi (Bearberry)
   On surface dry soils, most abundant on d and f types; on d together with Clandonia, on f with Linnaea.
5. Oryzopsis pungens (Mountain [slender] rice)
   Specifically on d type on beach ridges.
6. Juniperus communis (Common Juniper)
   On beach deposits and outwash soils with good surface drainage from d to m(g) types usually in association with jp.
7. Shepherdia canadensis (Buffalo Berry)
   On beach and outwash; on habitats with good surface drainage ranging from d to m(g) types.
8. Linnaea borealis (Twin Flower)
   Typical of f types together with Acrtostaphylos, grows from here onto moister conditions, not on d type.
9. Oryzopsis asperifolia (Rough grained or rough mountain rice)
   Dominantly on f type, but ranges from d to m(g) type, note difference to O.pungens (slender mountain rice).
10. Cornus canadensis (Bunchberry)
    Scattered on f type, shows some soil moisture present (for separation from d type); more abundant on m(g) type, present on all moist types.
11. Cornus stolonifera (Red-ozier dogwood)
    On all moist habitats m(g), m, vm, and w; even in half bogs.
12. Ribes hirtellum (Low wild gooseberry)
    Typical for m type.
13. Ribes glandulosum (Skunk current)
    Typical for m type.
14. Mitella nuda (Naked miterwort)
    Very characteristic for m and vm habitat types.
15. Gaultheria hispidula (Creeping snowberry)
    Found on m(g) type of low margin of beach (mostly on rotten wood).
16. Alnus rugosa (Speckled alder)
    Characteristic of moist soil conditions, m, vm, wet, mineral soil types and half bogs.
17. Tomenthypnum nitens (and Oxycoccus quadripetalus) (Bog cranberry)
    On mineral soil only on vm and w types (not on m), abundant on low moors.
18. Calth palustris (Marsh marigold)
    Characteristic on w mineral soil type and useful for distinguishing this from m type. Also on deep organic deposits.
19. Sphagnum spp.
    Restricted to deep organic deposits and [illegible]

Indicator Plants

MOISTURE REGIME	LANDFORM	INDICATOR PLANTS		SUBTYPE AND SITE CLASS					
		ABUNDANT	SCATTERED	JP	WS	BF	BS	TL	TA
ARID	rock outcrop, higher gravel beach ridges	reindeer moss, creeping savin	bearberry	2	3	—	—	—	3
DRY	higher beach, outwash and moraine ridges	bearberry, creeping savin, reindeer moss, slender mountain rice	common juniper, soapberry	2	3	3	3	—	2
MOIST (ground water and vadose water types)	low positions and flaring-out margins on beach and outwash <u>OR</u> till plains, lacustrine flats and higher flood plains	red-ozier dogwood, bunchberry, Ribes sp. naked mitervort, creeping snowberry	buffalo berry, common juniper, rough grained mountain rice, alder	1	1	1	1	—	1
VERY MOIST	depressional positions on beach and outwash and lacustrine deposits	red-ozier dogwood, naked mitervort, bunchberry, Ribes sp., alder	bog cranberry	1	1	1	1	1	1
WET	depressional positions on till and lacustrine material	alder, marsh marigold, bog cranberry		—	—	—	1	1	1
SATURATED	deep organic terrain	sphagnum sp., labrador tea, marsh marigold		—	—	—	2	2	—

NOTE: - Arid sites are generally devoid of tree cover.

4. <u>Cutting Class</u>

Cutting class is based on size, vigour, state of development and maturity of a stand for harvesting purposes.

a) Class 0 - Forest land not restocked following fire, cutting, windfall or other major disturbances (hence, potentially productive land). Some reproduction or scattered residual trees (with net merchantable volume less than 20 m^3 per hectare) may be present.

b) Class 1 - Stands which have been restocked either naturally or artificially. There may be scattered residual trees present as in Cutting Class 0. To be in Cutting Class 1 the average height of the stand must be less than 3 metres.

c) Class 2 - Advanced young growth of post size, with some merchantable volume. The average height of the stand must be over 3 metres in order to be in this cutting class.

d) Class 3 - Immature stands with merchantable volume growing at or near their maximum rate, which definitely should not be cut. The average height of the stand should be over 10 metres and the average diameter should be over 9.0 centimetre (9.0 cm) at Dbh (1.3 m).

e) Class 4 - Mature stands which may be cut as the have reached rotation age (+\-) 10 years on Site 1 or (+\-) 20 years on Site 2.

f) Class 5 - Overmature stands, which should be given priority in cutting.

5. Crown Closure Class

Crown closure will be estimated from the photographs by the photo-interpreter. Four classes will be recognized and entered onto the stand description sheet for each township as part of the photointerpreter type aggregate. Changes of this estimate can be made only under exceptional circumstances.

Code

0 - 0 % - 20% crown closure
2 - 21% - 50% crown closure
3 - 51% - 70% crown closure
4 - 71% and over

Example of type aggregate written in full
04-1-3-4

Where:

0 - Cover Type: Softwood
4 - Subtype: Jack Pine 71% - 100%
1 - Site 1
3 - Cutting Class 3
4 - Crown closure 71% and over

Explanation of terms used:

a) <u>Productive Forested Land</u>
Includes all forest land capable of producing merchantable wood regardless of its existing stage of productivity.

1) Softwood: 'S' - (Cover Type 0-3) - includes all stands where 76 Percent and over of the total basal area consists of coniferous species.
2) Mixedwood: 'M' - (Cover Type 4-7) - includes all stands where the basal area of all the coniferous species is between 51 percent and 75 percent of the total basal area.
3) Mixedwood: 'N' - (Cover Type 8) - includes all stands where the basal area of all coniferous species is between 26 percent and 50 percent of the total basal area.
4) Hardwood: 'H' - (Cover Type 9) - includes all stands where the basal area of all coniferous species is less than 25 percent of the total basal area.

b) <u>Non-Productive Forested Land</u>
Includes all forest land not capable of producing merchantable timber due to very low productivity.

i) Treed Muskeg (700)- Similar to open muskeg, except that the area is supporting semi-stagnated or stagnated trees. Some of the trees may produce "Christmas" trees or fence posts, but will not produce pulpwood size trees within a rotation age of 140 years (9.0+cm d.b.h., height over 10.0m and 20m^3 of net merchantable volume per hectare). At least 10 percent of the area will be tree covered.

701 - Black Spruce Treed Muskeg	51 Percent of Species Composition
702 - Tamarack Larch Treed Muskeg	51 Percent of Species Composition
703 - Eastern Cedar Treed Muskeg	51 Percent of Species Composition
704 - Taiga (Northern Transition Forest)	

ii) Treed Rock (710) - Rock with a very shallow soil, supporting semi-stagnated or stagnated trees. At least 26 percent of the area will be tree covered. These sites do not produce merchantable stands.

711 - Jack Pine Treed Rock	51 Percent of Species Composition
712 - Black Spruce Treed Rock	51 Percent of Species Composition
713 - Hardwood Treed Rock	51 Percent of Species Composition

iii) Willow/Alder (720) - Low lying areas with a saturated water table presently supporting willow or alder growth. Without improvements these sites are not capable of producing merchantable timber stands. At least 51 percent of the area must be shrub covered.

721 - Willow	51 Percent of ground cover
722 - Alder	51 Percent of ground cover
723 - Dwarf Birch	51 Percent of ground cover
724 - Shrub	76 Percent of ground cover
725 - Shrub/Prairie	Shrub 51 Percent of ground cover

iv) Protection Forest (730) - Presently developed or reserved recreational areas and small islands (less than 2 hectares)

731 - Recreational sites
732 - Small Islands (less than 2 ha.)
733 - Precipitous slopes/Fragile sites
734 - Shelter Belts

c) Non-Forested Land

Includes areas withdrawn from timber production for a long period of time, such as cultivated fields, hay meadows, pastures, settlements,rights-of-way, gravel pits, beaches, wide ditches, summer resorts, bare rock, barren, mines, marsh and muskeg.

i) Barren-Bare Rock (800) - Tundra and rock with less than 25 percent tree cover.

801 - Barrens - Tundra
802 - Bare Rock - Igneous
803 - Bare Rock - Sedimentary
804 - Open Sand Dunes

ii) Fields (Agriculture) (810) - Areas of private and leased land cleared of tree cover and presently under an agricultural use. Less than 10 percent of the area will be tree covered.

811 - Hayland - cultivated
812 - Cropland - cultivated
813 - Pastureland - domestic animals
815 - Land clearing in progress
816 - Abandoned cultivated land

iii) Meadow (820) - Moist to wet grassland suitable for hay production (natural hay land), at least 51 percent of the area is covered by grass.

821 - Dry Upland Ridge Prairie
822 - Moist Prairie
823 - Wet Meadow
824 - Sand Prairie

iv) Marsh - Muskeg (830)

831 - Muskeg - Wetland which has a vegetative cover consisting mainly of sphagnum moss and heath plants with very scattered brush. Black Spruce, Tamarack or Cedar cover does no exceed 10 percent
832 - String Bogs
835 - Marsh - Wetland completely or partially covered with tall grass, rushes, or sedges, unsuitable for hay but can be used as a habitat for furbearing animals.
838 - Mud/Salt Flats
839 - Sand Beaches

......

v) Unclassified (840-859) - right-of-way, roads, gravel pits, beaches, summer resorts, mines, oil fields, etc.

841 - Townsites/Residential Sites
842 - Airstrips
843 - Roads/Railroads
844 - Transmission lines/Pipelines
845 - Gravel Pits/Mine sites
846 - Fence lines (Community Pastures), fire guards
847 - Drainage Ditches
848 - Beaver Flood
849 - Dugouts/Water holes
851 - Oil Fields - oil wells, all structures pertaining to.

d) <u>Water (900)</u>

Includes lakes and rivers, measured at the high water mark, able to be delineated with a double line on the aerial photographs. Narrow river and creeks marked by a single blue line are not to be considered as separate types, nor as type boundaries.

901 - Rivers, arrows showing direction of flow
991 - Lake Winnipeg
992 - Lake Manitoba
993 - Lake Winnipegosis
994 - Red River
995 - Assiniboine River

6. Species Composition

The species composition of the stand is based on the comparison of the tree count (basal area) for each species to the total tree count (basal area) of the stand expressed as a percentage. Species composition will be calculated to the nearest 1/10 percent for species group determination purposes and then rounded to the nearest 10 percent before entering the species composition as an introductory portion of the type aggregate.

EXAMPLE:

Species	Tree Count	Percentage
bs	68	$\frac{68}{118} \times 100 = 57.6\% = 6$
jp	$\frac{50}{118}$	$\frac{50}{118} \times 100 = 42.4\% = 4$

Hence: a) This is softwood - Black Spruce, therefore Cover Type - 1
b) The main species Black Spruce 40% - 70%, subtype Code - 4
c) Species composition - bs6jp4 - this symbol will be entered on the stand index card in front of the type aggregate code.

APPENDIX II MARTEN HSI MODEL VALIDATION FORM

MARTEN HSI MODEL

VALIDATION FORM

PART 1: TRAPLINE INFORMATION

General Location: ____________________

R.T.L. DISTRICT: ____________________ Line No: __________

Tiepoint Location: ____________________ UTM Coordinates: __________

Trapper: ____________________ No. of Yrs. Trapping __________

No. of Years Trapping Marten: ____________________ No. of Yrs. on RTL __________

Average No. of Marten Harvested per Year: ____________________

Length of R.T.L. (KM): ____________________

General Description of Trail (Habitat types traversed): ____________________

____

____

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____

____

Methods used to manage marten on the line? ____________________

____

____

____

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____

MARTEN HSI MODEL

VALIDATION FORM

PART 2: SITE ASSESSMENT
LOCATION

Site No. _______ TWP: _______ RGE: _______ STAND: _______ GPS CODE: _________

STAND CHARACTERISTICS

STAND AGGREGATE: ____________________ FRI SPECIES COMP : ____________________

FIELD SPECIES COMP: ______________________________ FIELD CUTTING CLASS: __________

% SPRUCE/FIR CANOPY CLOSURE IN STAND: ____________

SITE EVALUATION (TO BE FILLED IN BY TRAPPER)

1) WOULD MARTEN OCCUPY THIS SITE IN THE WINTER?: (YES) (NO) WHY? ____________

____

____

2) GENERAL WINTER USE RATING: L M H QUANTITATIVE RATING (0 - 10): ________

REASONS FOR RATING: ____

____

____

____

3) WHAT WOULD MAKE THIS HABITAT MORE FAVORABLE FOR WINTER USE? ____________

____

____

____

) WHAT WOULD MAKE THIS SITE LESS FAVORABLE FOR WINTER USE? ______________

____

____

____

PLEASE GIVE EACH HABITAT VARIABLE A VALUE BASED ON THE RELATIVE IMPORTANCE TO PROVIDE FOR GOOD WINTER MARTEN HABITAT:

HABITAT VARIABLE	DEGREE OF IMPORTANCE				
	NO IMP.	MARGINAL IMP.	IMP.	VERY IMP.	ABSOLUTELY ESSENTIAL
PERCENT OF SPRUCE/FIR IS THE STAND	____	____	____	____	____
TREE DIAMETER	____	____	____	____	____
TREE HEIGHT	____	____	____	____	____
CANOPY CLOSURE OF THE OVERSTORY	____	____	____	____	____
STAND AGE OR MATURITY	____	____	____	____	____
COARSE WOODY DEBRIS	____	____	____	____	____
LOW SNOW DEPTHS	____	____	____	____	____
SNAGS	____	____	____	____	____

WHAT OTHER HABITAT CHARACTERISTICS DO YOU FEEL ARE IMPORTANT FOR MARTEN WINTER HABITAT THAT MAY HAVE BEEN MISSED IN THIS EVALUATION PROCESS? ____________________

____

____

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