Habitat Suitability Index (HSI) Model for Woodland Caribou (*Rangifer tarandus caribou*)

Version 3.0

Developed For:

The Eastern Manitoba Woodland Caribou Advisory Committee

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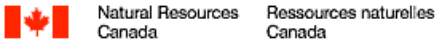

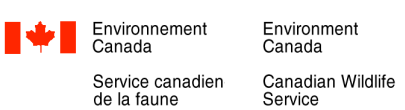

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EXECUTIVE SUMMARY

The following report is intended as a documentation summary as it relates to the development of a Version 3 Woodland Caribou Habitat Suitability Index (HSI) Model for the Manitoba Model Forest. The previous HSI model (Version 2.1) is outdated due to the a more current and ecologically based Forest Resource Inventory (FRI) for specific Forest Management Units (FMU's) on the East Side of Lake Winnipeg. A Delphi workshop was conducted on December 9 and 10 of 2003 to integrate the older HSI values into the new attributes contained in the updated FRI.

This workshop resulted in the development of a Version 3 HSI model for use on the current FRI in eastern Manitoba. The outputs of this model were then validated using a Geographic Information System (GIS), current caribou borne Global Positioning System (GPS) data, and habitat use availability analysis. The development and application of HSI models requires acceptance by both developers and potential users. This is typically accomplished through a scientifically valid Delphi process where expert opinion combined with biological data and scientific information provides a basis to establish habitat index value relationships for various FRI attributes.

This Version 3 HSI model provides a basis to assess habitat quality and quantity on a landscape basis, and is recommended for application on the East Side of Lake Winnipeg. The parameters of use and validation that apply to other HSI models in Manitoba should be adhered to when using this model. The minimum application area remains at one township or 36 square miles. The following report provides the written documentation of the Delphi process and illustrates the index values and overall HSI model algorithm developed for use on specific FMU's in the Manitoba Model Forest area. Also included in the Appendix are woodland caribou habitat use versus availability data.

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Delphi Workshop

Title: Applying the Woodland Caribou Habitat Suitability Index (HSI) Model To the Revised Manitoba Forest Resource Inventory in Eastern Manitoba.

Date: December 9 & 10 2003

Place: University of Winnipeg Centre for Forest Interdisciplinary Research (C-FIR)

Introduction

The objective of this workshop was to adapt and enhance the existing woodland caribou HSI model for application with the revised Forest Resource Inventory (FRI). The current HSI cannot be run on the new FRI due to the finer resolution of FRI interpretation (more polygons or stands) and enhance ecological attribute data. Given the new FRI and extensive GPS location data, there is an opportunity to re-tool and enhance the current HSI for application in Eastern Manitoba, and perhaps in other Eco-Regions of Manitoba.

Generally, the construction of HSI models requires the subjective allocation of habitat values to (FRI) data. A Delphi exercise is a discussion by knowledgeable participants in hope of reaching an agreeable position, and that the opinions of experts are justified inputs into the modeling process where absolute answers are unknown. The consensus of experts will provide a more accurate assessment of habitat values than that of a single authority. It also provides a level of acceptance among those involved in the management and conservation of the species.

Also by using available data to validate The Suitability Index (SI) curves and model assumptions developed in this process, it will have certain utility in the context of Integrated Woodland Caribou and Forestry Planning. It is hoped that the revised HSI will continue to be a necessary tool in the assessment and management of woodland caribou habitat objectives and integrated management in Eastern Manitoba.

Workshop Approach and Agenda

Due to interactive nature of the Delphi exercise and the need to reach consensus on SI values, the following agenda is outlined for the two-day exercise. The facilitator will guide and direct the exercise in an attempt to complete the development of the model within the time allocated. It is expected that due to the fact that this is a re-tooling of the existing model, agreement between the participants is likely to be achieved in a timely manner. The habitat use and availability data (Charts attached) will also facilitate agreement between participants.

AGENDA

Opening Remarks and Discussion on Agenda

Forestry Branch and HSI Models and Incorporation into the FRI Provincially

- Tim Swanson (Eastern Region Forestry).

Slide Presentation Habitat Evaluation Procedures and HSI (Schindler)

Review of Woodland Caribou Life Requisites (Schindler)

- Winter food, winter cover, foraging habitat, escape cover, reproductive etc.

Overview of Habitat Use vs Availability Analysis (Schindler)

- These data will be used throughout the workshop

Review Existing HSI Model (Schindler)

Setting the Model Objectives (Schindler)

- Defining the model outputs
- Define the geographic area of applicability
- Define the season.
- Model output

Define the Variables that will be Used (All)

- Define the life requisits (ie food, cover, escape, reproductive)
- Define the FRI attributes that link to the life requisites (age, covertype etc.)
- Examples include (V1 Food – Subtype, V2 Food – Age, etc.)

Assign Values to Major FRI Attributes and Develop Suitability Index for Each Variable. (All)

- Those variables that show strong preference in the habitat use vs availability analysis will be assessed.
- Literature and opinion will be incorporated

Develop the Relationship Between Variables (All)

- This will involve the aggregation of SI values to form an overall index for the specific life requisite. (winter food = V1, V2, V3 and V4)
- Assess the value of each variable and consider "weighting" or eliminating weak variables.

Construct the HSI Model (All)

- Finalize life requisites and weightings
- Develop HSI Algorithm

Test the HSI Model (Schindler, Lidgett)

- Manual application of the HSI on a number of FRI polygons to test
- Discussion on running the model and verification

Documentation (Schindler)

- Discussion on final outputs and reporting requirements.

Documentation of Caribou Delphi Workshop

The following section provides a summary of the discussion in the form of meeting notes. All details of discussions are not included, however there was an attempt to capture the main points of discussion. The following persons attended and participated in the HSI workshop.

Participants

- Trevor Barker – Eastern Regional Wildlife Technician
- Gerry Becker – Manitoba Forestry Branch
- Gene Collins – Central Region Wildlife Manager
- Vince Crichton – Manitoba Wildlife and Ecosystem Protection Branch
- Dale Cross- Northwest Region Wildlife Technician
- Brian Hagglund – Oak Hammock Marsh Manager
- Vince Keenan – Tembec Industries, Pine Falls
- Kelly Leavesley – Eastern Region Wildlife Manager
- Jennifer Lidgett – Tembec Industries, Pine Falls
- James Matthewson – Manitoba Forestry Branch
- Peter Miller – Time to Respect Earths Ecosystems
- Ron Rawluk – Manitoba Hydro
- Doug Schindler – C-FIR Wildlife Biologist and Facilitator
- Tim Swanson – Eastern Region Forester
- Kent Whaley – Northwest Region Wildlife Manager
- Wenli Xu – Manitoba Forestry Branch

Workshop Notes

- Doug Schindler introduced the workshop process and the area being evaluated for habitat suitability (southern range and northern range). Some data for the Northern range was missing because it went into the park and the study was not allowed in there.
- The goal was to ensure that 2/3 of the area was kept as good quality habitat.
- Discussion followed regarding new forest inventory in the East
    - New forest inventory does not have sub-type but strata
    - Question was should the data for caribou be changed from sub-type and related to strata
    - Decision was to proceed with the data as it was (using sub-type and not strata) – develop the curves and model – Tembec and Manitoba Forestry Branch to develop rules and tables that would link model with strata – this would be brought before a sub-committee[3].
- Forest inventories are different across the province however this model can be adapted to areas beyond the east side of Lake Winnipeg
- Doug Schindler gave a slide presentation on caribou
    - Winter food critical (terrestrial lichen, arboreal lichen, Labrador tea)
    - Foraging habitat (cover)- mature jack pine, open forest, muskeg, ericaceous shrubs, large areas
    - Nival conditions (stand structure)- not use homogenous stands, beaver flood use
    - Summer food- plants, deciduous leaves, herbaceous plants, mushrooms
    - Summer habitat- open stands, islands
    - Special habitats- rutting, loafing, mineral licks, migration, fidelity to range, calving, islands (lakes and bogs) (peninsula)
- Jennifer/Doug explained the data and graphs that were distributed.
    - Start with southern range- red = available, blue = winter use, green = summer use
    - Jack Pine spikes in summer, muskeg (base on GPS collar 2002)
    - Trends similar from radio collar to historic- keep trend inmind when examine graphs- 06 = jack pine, black spruce (caribou key in) 11 = 40-70% ws, bf, jp, spr

[3] Version 3 HSI for Woodland Caribou has been incorporated into Manitoba Conservation and Tembec Timber Supply Strata for long term assessment of caribou habitat using successional timber supply model. Developed by D.W. Schindler for Tembec and submitted to Manitoba Conservation (2005).

Discussion on Habitat Selection and Preference

The following section generally describes discussion relative to caribou habitat selection. The region was separated into two major ecological land units consisting of a southern area and a northern area. Due to higher use and prevalence of bogs in the north area and marked differences in habitat selection patters between areas supported the group's decision to conduct separate HSI evaluations for each area.

The Comments are general in nature and attempt to capture the main points of group discussion. Main participant illustrated points are discussed where appropriate.

Caribou habitat selection

- Southern
  - Lots of available aspen but not key in on in summer or winter
  - Black spruce showed lots of winter use (spruce and pine)
  - Strong relation 06
  - Non-productive, treed muskeg showed high use (701)
- Historic
  - Trend similar to current southern trends
  - Non-productive use similar to southern range
- Northern
  - Lot more habitat in north than south combine with selecting more non-productive sites
  - Interspersion of upland mixed in with muskeg (muskeg with small islands of upland
  - No water use – use muskeg areas for calving?

- Matthewson questioned why the comparison of historic with 2002
- Schindler/Lidgett respond that it is to compare and see if there has been any difference
- Kennan states that white spruce does not show up in the table, nor is it seen in historic values because use is so low. Use is more visible in 2002
- Schindler/Lidgett show that the Northern range has greater difference from the southern range

Caribou age class selected

- Southern
  - Younger forest not really selected for
  - Highest use in 60 year old forest

❖ Becker stated that age was quite variable. If examine age should be done in terms of species

- Historic
  - Evidence of disturbance (due to cutting or burn?)- greater use of younger areas can be seen

❖ Keenan stated that age of disturbance origin should be determined

- Northern
  - Select ages between 40 and 90
  - Younger areas were not used much

❖ Suspect data for summer levels were skewed because of a lack of data for the park

Caribou moisture class selected (productive site)

- Southern
  - Greatest use in arid areas
- Historic (southern)
  - Trend very similar

❖ Moisture class did not seem like a good variable because it did not match with sub-type used (muskeg)

- Northern
  - Similar to southern

Caribou landform class (productive site)

❖ Hagglund wanted to choose attributes for both productive and non-productive sites

❖ Schindler and Lidgett did not think it was necessary as it was not done the last time

- Southern
  - There was little use of dense productive jack pine (4- sandy area)
- Historic (southern)
  - Not big difference from the south
- Northern
  - High value number 2

❖ Keenan thought landform wise that 1 and 2 were the same

Caribou crown closure selected

- Southern
  - Focus on denser crowns (60-70% closure)
  - Avoid more open areas in winter (cutover and burn)
- Historic
  - Similar to south

❖ Miller wondered if the relationship had to be straight linear or if it could dip in the middle

❖ Lidgett and Schindler said it did not have to be a linear relationship

- Northern
  - Similar

Caribou height class selected (new)

- Southern
  - Greater the height the greater the amount of caribou
- Historic
  - Similar trend
- Northern
  - Similar trend

Caribou stand type selected

- Southern
  - Trends are greater in Jack Pine and treed muskeg
- Northern
  - Trends are greater in marsh (summer), and treed muskeg (summer/winter)

Choosing limiting factors and variables

❖ Food was chosen as the only limiting factor in the last model because the other life requisites were offered throughout

❖ Make up H.S.I for winter and summer

❖ Variables (values discussed are those from the last model)

- 1st variable = subtype (4 and 6 are high)
- 2nd variable = cut class (3, 4, 5 are high)
  - Younger should be higher because of cutover- over mature class is too high
- 3rd variable = site class

- 4th variable = crown closure (somewhere in the middle would be ideal)
- 5th variable = non-productive sites

(Note: Those that had a zero value should be given a minimal value in order to have them in the equation)

- Should discuss weighting variables
- Miller questioned whether the H.S.I considered specialty habitats
- It did not and Hagglund thought it should be looked at because focus has been on winter areas

Address some questions of attributes

Landforms- look at 3, 4 and 2

- It is a poor indicator because there is not much correlation
- Only use landform 2 and 8

Moisture- little bit of relation (look at graph)

Crown Class- see a relation

Height- possible correlation

Age- and Sub-type- both showed a correlation

- Swanson stated that height was a surrogate for age- it was not perfect but they were related (correlation falls apart in jack pine, disperses at age 40 in spruce)
- Hagglund stated that use of height created noise in the data set
- Rawluk suggested that minimum convex boundaries should have been used (they had been)
- Noted that the Owl Lake herd were not near Lake Winnipeg- suggested that Lake has some effect not taken into account by us
- Leavesley suggested road use

Assigning values to winter variables in terms of food

- Look at both north and south because only want one model
- Hagglund was not sure about doing one model that included the north and south. He wondered if the north should be left out because of the lack of data from the park
- Crichton cautions that should not accept something that is extremely weak for one area in comparison to the other
- Crichton also said to keep in mind that the old method was working and should not be altered drastically

Variable values
Excellent = 1.0 Good = 0.75 OK = 0.5 Poor = 0.25 No Value = 0.1

S.I. V1- Sub-type

Sub-type	Value
1	n/a
2	n/a
4	0.8
6	1
10	0
11	0
13	0.3
14	0.5
15	0.2
16	0.1
17	n/a
20	0.01
21	0.1
22	n/a
30	0.1
31	0.1
32	n/a

36	n/a
37	n/a
41, 42, 43	n/a
44	0.1
45	n/a
46	0.1
48, 49	n/a
50-56	0.01
57	n/a
58	0.01
60	0.01
61	0.01
62	n/a
70	0.01
71	0.01
72	n/a
76 and 77	n/a

80’s	0.01
90's	0.01
701	0.8
702	0.8
703 and 704	n/a
711	0.8
712	0.8
713	0.1
720’s	0.1
730's	0.01
801-820	n/a
831	0.8
832	0.5
835	0.01
Rest 800's	n/a
848	0.4
900's	n/a

- Schindler thought 04 and 06 were similar but 04 value should be slightly lower because the southern value was lower
- Leavesley did not want to give 13 a good rating because she did not think it would be an area used greatly however the data showed otherwise – question, if use shown was because of cover or an issue of adjacency
- 14 showed greater use than 13 (because of the pine) - value should be good

- For 15 most of the use is seen in the north because of the balsam combination
- For 16, there is more on the landscape but it is not used as much as 15
- 17 is n/a for this study however the caribou are tied to cedar in the far north - it has potential in the Interlake area
- 20 is in the landscape but they are not choosing it
- There is not a lot of 21 available and they are not keying in on it
- 22 is Balsam and cedar
- 30 is not widely used
- 44 is very similar to 31
- 46 has a lot of aspen. The caribou food is only found in the buffer areas. They are not making use of the sub-type from a food perspective
- 50 is not being used at all
- 51 is low because of hardwood component
- 54 shows some use but it may be due to overlap with buffer
- 57 is a cedar sub-type
- Surprised that 60 is not being used as much. It has a Balsam Fir component but it is also ½ hardwood
- 76 and 77 are cedar/hardwood sub-types
- There is a little bit of use for 90's sub-types but suspect it is owed to relationship
- 701 is a Black Spruce Treed Muskeg area and its use is very high, but, not as high as sub-type 06. Its value should be raised from the last model
- 702, the Tamarack/Larch. It seems to have more importance in the North than South. Possibly because there is not as much available in the south. They are using it twice as much as it is available in all areas
- 703 and 704 are Eastern Cedar Taiga
- 711 was only 0.4 in the last model. They are keying in on it less than the Black Spruce however it is a good area. It needs to be bumped up. As good as 701/702.
- There is not much in 712 but they key in on it when they find it. It does not appear to be a factor of buffer
- There is not a lot of 713 but there is rock and therefore lichen

There is some value

- Discussion on sedges
- Schindler suggest need look at summer food as well as some of the areas are better in summer than winter

- 831 in the last model was 0.5 but it is being used a great deal in the north. They were using it significantly in terms of what was available. The value should therefore be higher.
  - Schindler suggested that these sites should be examined come winter – are they using or are they stuck
- There was not a lot of 832 but they were using it (especially up north). In terms of availability they were not using it a lot (summer)
- Not see them in the tall grass (835). There is no indication they use them
- 848 are used as much as they are available in the south but the areas are used as travel corridors. The value should be as good as sub-type 13. Some believed a little higher because of arboreal lichen and possible mineral licks
- 900 sub-type is used just for travel

S.I. V2- Age Class

Age Class	Value
10	0.10
20	0.20
30	0.30
40	0.50
50	0.45
60	1.00
70	1.00
80	1.00
90	1.00
100	0.80
120	0.75

- Looking at the old model it was thought that class 4 and 5 should be lower than originally rate (over-mature)
- Highest values were thought to occur at 60 years old (appears to be threshold)
- It must be remembered that Owl Lake range is a burn area and they are using what is available. Also caution the burned areas because interpreters say it is bedrock when it is actually treed rock
- There are two different scales in terms of north and south (north peaks never get above 20%)

- 60-90 are a patchwork- they are not really choosing it, it is just there as such pick mid points then reach plateau
- 30 year old class has greater lichen availability but there may be other limiting factors as to why they are not taking advantage of those areas

Note:	**Age class is the most variable-least confidence** **There was disagreement about linear relation regarding winter food and age variable**

S.I. V3- Height class

Height Class	Value
1	0.10
2	0.10
3	0.10
4	0.10
5	0.20
6	0.20
7	0.20

8	0.20
9	0.30
10	0.50
11	0.60
12	1.00
13	1.00
14	1.00

15	1.00
16	1.00
17	1.00
18	0.75
19	0.75
20	0.75
21	0.50

- Breaking point is 13 (use is greater than availability)
- Has an almost normal distribution however the greatest use is in the taller range until it gets overly tall
- Preference begins at class 12 with the highest use and proportionately greatest is in class 14 and 15
- Data should reflect breaking point at 17. Value should drop after that
- The use however is still high up until height class 20.
- There was disagreement regarding shape of curves for age class and height class. Whaley thought they should both be “bell curves”
- Collins pointed out that the decisions should be based on what caribou (data) were saying not on what we thought
- Swanson stated we should defer to height
- It was decided that height and sub-type were important

Note: There is a non-linear relation with height class in early classes

S.I. V4- Moisture Classes

Moisture Class	Value
1	1
2	0.8 or 1.0
3	0.2
4	0.4

- Class 1 appears to have some correlation when look at arcview
- Pivot table appears to show 100% correlation between landform 2 and arid
- Using igneous presented a problem- appears moisture is a better indicator than landform
- Swanson wanted to give arid 1.0 and the others 0- would give us those sites
- Problem is that if arid given 1.0 arid would be driving factor of model
- Keenan stated that number 2 had to be given a fairly high value based on use
- Class 4 seemed to be used 60-70% whereas the others were 30-40% (escape /cover)
- Must consider that the wet areas are important for calving
- Species associated with moisture code 3 and 4 sub-type are ranked low and as such their moisture classes should be low
- Also class 4 is used more and has more food than site 3 and should therefore be rated higher

S.I. V5- Crown Closure

Crown Closure Class	Value
0	0.01
1	0.30
2	0.50
3	1.00
4	1.00
5	1.00
6	0.80
7	0.80
8	0.50
9	0.30

- Difference in use between south and north. Class 0, 1, and 2 are very low except in the south.
    - 0 is not used at all. There is some activity in class 1
    - Class 2 shows an increase in activity

- Leavesley believed it was difficult to sort out a relation in terms of crown closure. She saw the distribution as being fairly straight across and did not see a statistical basis for importance. She saw the data as weak.
- Swanson stated that open stands were better habitat and that 90% crown closure was avoided.
    - More open canopy has more food
- Swanson stated that a high value should be kept in class up to 80-90% crown closure.

Testing H.S.I. Values Against Old Inventory

Equations

Geometric Mean = $(V1 \times V2 \times V3 \times V4 \times V5)^{1/5}$

Arithmetic Mean = $\frac{(V1 \times V2 \times V3 \times V4 \times V5)}{5}$

Weighted Variables = V1(0.6) + V2(0.1) + V3(0.1) + V4(0.1) + V5(0.1)

Stand #758 (old inventory)		
Variables	Class	H.S.I value
V1 = 6	1.00	
V2 = 90	1.00	GM = 1
V3 = 15	1.00	AM = 1
V4 =1	1.00	
V5 = 3	1.00	

Stand #795 (old inventory)		
Variables	Class	H.S.I value
V1 = 14	0.50	
V2 = 80	1.00	GM = 0.87
V3 = 13	1.00	AM = 0.9
V4 = 1	1.00	WM = 0.7
V5 = 3	1.00	

Stand #19 Ta8-Jp2 (old inventory)		
Variables	Class	H.S.I value
V1 = 90	0.01	
V2 = 1	0.25	GM = 0.08
V3 = 0	0.10	AM = 0.27
V4 = 1	1.00	WM = 0.14
V5 = 0	0.01	

Stand #244 Bx7 Jp30 (old inventory)		
Variables	Class	H.S.I value
V1 = 14	0.50	
V2 = 60	1.00	GM = 0.63
V3 = 16	1.00	AM = 0.74
V4 = 3	0.20	WM = 0.82
V5 = 3	1.00	

Stand #910 Jp8 Bs1 TL1 (old inventory)		
Variables	Class	H.S.I value
V1 = 04	0.80	
V2 = 06	1.00	GM = 0.87 @ 0.8 V4 0.91 @ 1.0 V4
V3 = 14	1.00	AM = 0.88 @ 0.8 V4 0.92 @ 1.0 V4
V4 = 2	0.8 or	WM = 0.84 @ 0.8 V4 0.86 @ 1.0

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	1.0	V4
V5 = 70	0.80	

Discussion regarding which equation to use (geometric, arithmetic, weighted)

- Appeared to be a problem using arithmetic mean. Those with poor habitat seemed to indicate really good habitat
- Should compare the arithmetic mean to the others using regression to see how far off the points are. This would give a better understanding of how the model was working
- Geometric equation was determined to be the best choice because of
    - Documentation regarding geometric method in HEP procedures
    - Weighted and arithmetic equations do not identify the burn area like the geometric
    - The result of weighted and arithmetic means is high. The geometric mean brings this down so that not every stand will work out to good habitat
    - The geometric mean worked last time was it necessary to change it

Note: should look at use in relation to new H.S.I. values

- Examine using values 0.01 and 0.1 to see if that makes a difference
- Stand #19 variable 5 value was changed from 0.01 to 0.1
    - AM = 0.29
    - GM = 0.12
    - Difference not substantial
- Questions regarding behaviour of caribou and the reflection on the model
    - Is it possible that the lack of spread into available habitat is due to an insufficient population size
    - Issue of fidelity and social habit– they keep going back to the same area year after year and it is expected that they will stay together until they are pushed out

Note: recommended look at 831's on ground

    - Would make a good project approach for university- project for students
- Use of variable is an indirect way of assessing lichen productive areas
- Question about using vegetation type

- Vegetation type is just interpretation of the FRI

- Miller suggested it would be a good idea to map October and March to get between season data
    - Not possible because it is different for each animal due to time threshold
- There is value in going back to look at the 1980's unpublished reports for caribou data on the east side. Could help because of discussion about crown closure. The use cratering data, verify what values we achieved. Part of validation process.

Assigning values to summer variables in terms of food and cover

- Less focus on food because they are not as restricted as they are in winter but food important to get through the winter
- Difference between summer and winter range
    - Summer use higher country, lake area
    - Winter use lowland bogs
- Summer browse is lichen rock ridges, stripping leaves (birch, pincherry), sedges
- Nothing seems to stick out as key
- South shows better data because too much data missing from north range (because of park)
- Islands are not used because cannot get on them and they are site specific
- Data for water seemed off suggest buffering water- where intersect with more suitable habitat, bump it up
- Cover important in summer- according to literature they are keying in on cover
- Stick to data from south because lack of data for north
- When applying values stick to broader numbers

Variable values

Excellent = 1.0 Good = 0.75 Okay = 0.5 Poor = 0.1

S.I. V1- Sub-type

- Crichton suggested that 13 should be the same as 14
    - Leavesly questioned this because did not feel the data supported this
    - Schindler pointed out that the variable was also being rated based on cover not just food
- The southern range is keying in on number 11 but this was not seen in historic
- Tamarack stands are used more than available
    - Denser tamarack is of higher value
    - Bump tamarack

- 40's and 50's (hardwood and mixed-wood) offer more in terms of cover and food in summer than in winter therefore bump 54-56
- Beaver floods are used less
- Crichton questions why they would use 701
    - Escape from predator
- 701 should be treated differently than 702 but still high
- Swanson stated that treed rock should be 0.8
    - Lidgett and Schindler stated it should be lower (treed rock)
    - Cross noted there was some use but mostly in terms of cover
    - 711 and 712 should be 0.5
- 721 rated low (willows)
- Everything up to 848 should be low
    - Disagreement because 831 use is great in north (predator avoidance)
    - 832 used a lot in north – not as much use in south because not as much available
- 838-848 rated low

S.I. V2- Crown Class

- Class 5, 6, 7 high values- need to bump up values for 6, 7
- Class 3 and 4 should stay the same food value still high (especially in north)
- Class 9 is much lower in the north- food drops and use drops
- Animals in north out of range in summer, put more weight on data from south
    - Examining south- class 3 and 4 should be brought down, 5 stays the same, 6-9 raised

S.I. V3- Height

- Decided that Class 12 in winter should be less and Class 18 should be raised
- More of a drop off in higher areas for summer
- Start with 16 at 0.5, 18 at 0.5, 19 at 0.25, 21 at 0.25, 22 at 0.1 summer and winter

S.I. V4- Age

- Large difference between north and south use and availability
    - Confidence using south data for H.S.I.
    - No confidence for north- requires testing, caution, retooling

- Lidgett stated that need age for wood supply
- Swanson noted they are keying in on certain age groups
- Age is tough for summer habitat
- Age 50 use increases, drops at 30 and at 90
- Swanson suggested 110 should be no/low value

S.I. V5- Moisture Class

- Keensn stated that logically arid should be skinny soils- 2 should be slightly more productive
- Leavesly stated the data was no different than winter
- Lidgett agreed
- Cross suggested brining up number 2
- Leavesley disagreed
- Schindler noted that sub-type and age are critical, if the wet sites are kept low then black spruce habitat is lost
- Disagreement about the values for class 3 and 4
    - Should raise class 4 and drop class 3 because not really using it when look at sub-types
    - Class 3 and 4 should be bumped up so as not to lose important black spruce
- Keep class 3 and 4 the same

Note: concern about value of black spruce in terms of summer cover

SUITABILITY INDEX VARIABLES AND ASSOCIATED VALUES (0.0 – 1.0)

Subtype	SI_1_W	SI_1_S
1	0.01	0.01
2	0.01	0.01
4	0.8	0.8
5	0.01	0.01
6	1	1
8	0.01	0.01
9	0.01	0.01
10	0.01	0.01
11	0.01	0.1
13	0.3	0.75
14	0.5	0.75
15	0.2	0.2
16	0.1	0.1
17	0.01	0.01
20	0.01	0.01
21	0.1	0.1
22	0.01	0.01
30	0.1	0.5

Age10C	SI_2_W	SI_2_S
1	0.1	0.1
10	0.1	0.1
20	0.2	0.2
30	0.3	0.2
40	0.5	0.8
50	0.75	1
60	1	1
70	1	1
80	1	1
90	1	0.8
100	0.8	0.8
110	0.8	0.5
120	0.75	0.1
130	0.75	0.1
140	0.75	0.1

Height	SI_3_W	SI_3_S
0	0.1	0.1
1	0.1	0.1
2	0.1	0.1
3	0.1	0.1
4	0.1	0.1
5	0.2	0.2
6	0.2	0.2
7	0.2	0.2
8	0.2	0.2
9	0.3	0.3
10	0.5	0.5
11	0.6	0.6
12	0.75	1
13	1	1
14	1	1
15	1	1
16	1	0.5
17	1	0.5

Moist Class	SI_4_W	SI_4_S
1	1	0.9
2	1	1
3	0.2	0.2
4	0.4	0.4

Crown	SI_5_W	SI_5_S
0	0.01	0.01
1	0.3	0.3
2	0.5	0.5
3	1	1
4	1	1
5	1	1
6	0.8	1
7	0.8	1
8	0.5	0.5
9	0.3	0.3

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Final Version 3 Habitat Unit Calculations

Based on the above documentation the following HSI algorithm was developed.

Productive Stands

HSI Winter = ([Si_1_w] * [Si_2_w] * [Si_3_w] * [Si_4_w] * [Si_5_w]) ^ 0.20

HSI Summer = ([Si_1_s] * [Si_2_s] * [Si_3_s] * [Si_4_s] * [Si_5_s]) ^ 0.20

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Non Productive Stand

HSI Winter = [Si_1_w]

HSI Summer = [Si_1_s]

Habitat Unit Calculations

HU Winter = [HSI Winter] * [Hectares]

HU Summer = [HSI Summer] * [Hectares]

Validation Process

Following the Delphi workshop, the authors developed the HSI logarithm for the current FRI database in Esri ArcView. An interactive analysis was conducted by comparing model outputs and manually generated stand values. Validation of various FRI ploygons HSI values was conducted using the result of the habitat use versus availability analysis conducted by Schindler (2005). This was done using the model for both the Owl Lake Range (FMU 31) and the Atikaki/Berens Range (FMU 31 and 35). The assessment of habitat use based on the version 3 HSI model illustrateed that there is a high degree of selectivity of stands that have predicted high HSI values. In the Owl Lake area, caribou were found to use high HSI stands 62% of the time, compared to an availability rate of 30%. In the Atikaki/Berens Range, caribou used high value stands at a rate of 77% relative to a 44% availability rate.

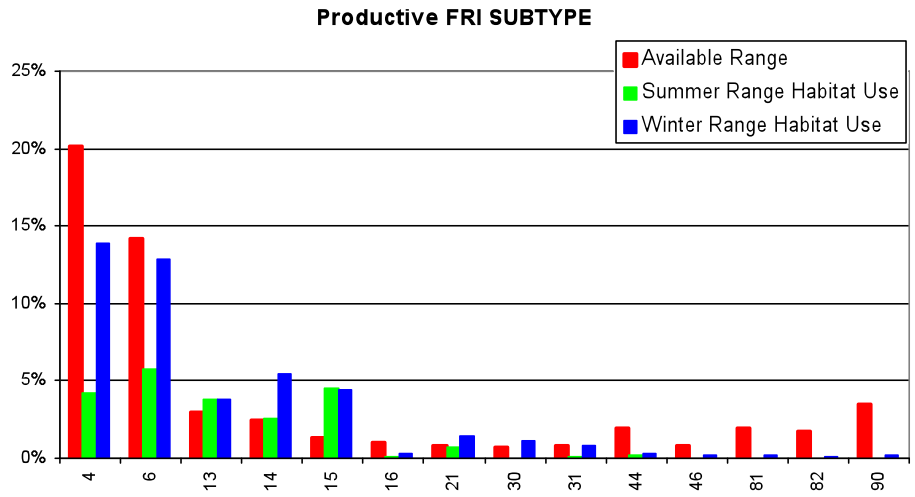
Further validation processes could include assessment of current and updated woodland caribou relocation data, and comparisons of habitat selection. These data may be available on an annual basis. Annual review of these data is recommended to assess the validity of model outputs and potential to adjust one or more of the model components.

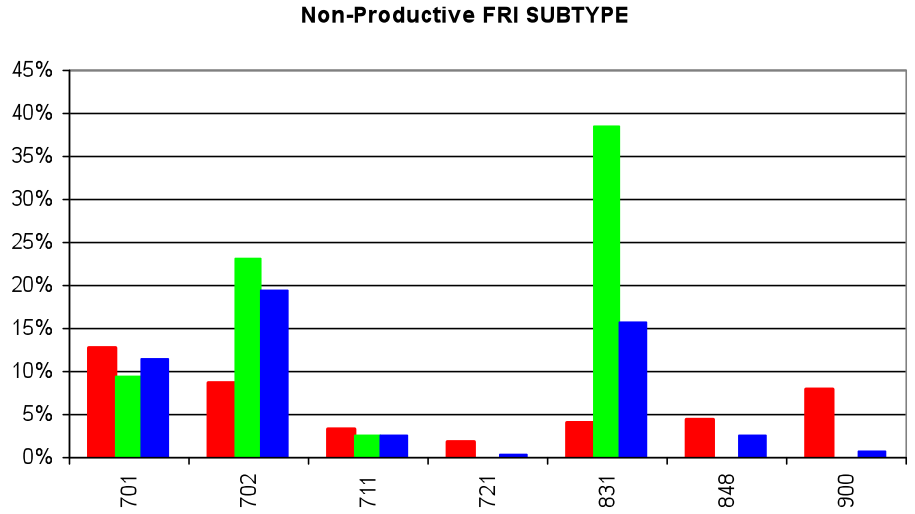
The Version 3 HSI model as documented is assumed to provide an estimate of habitat quantity and quality for woodland caribou. The minimum application area for evaluation of habitat is one township or 36 square miles.

APPENDIX 1 USE AVAILABILITY DATA

Subtype Breakdown

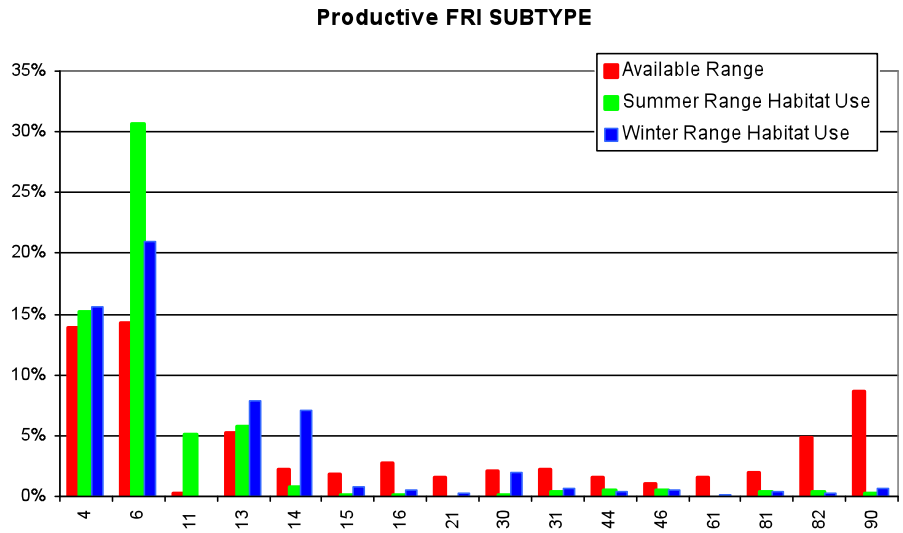
Northern Range

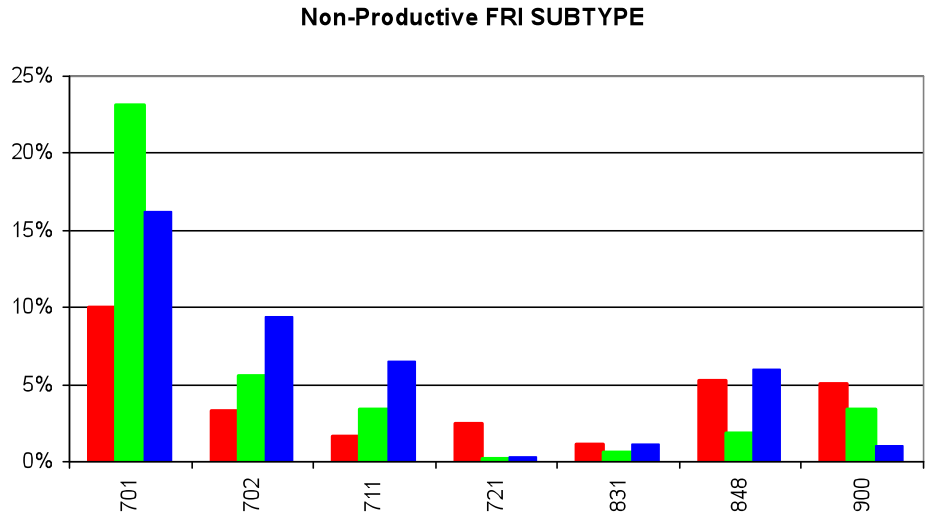




Subtype Breakdown

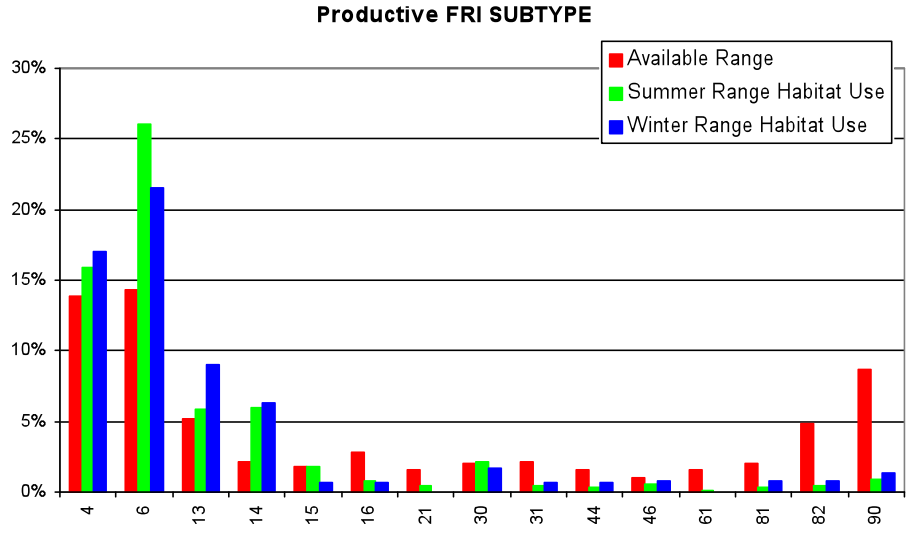
Southern Range

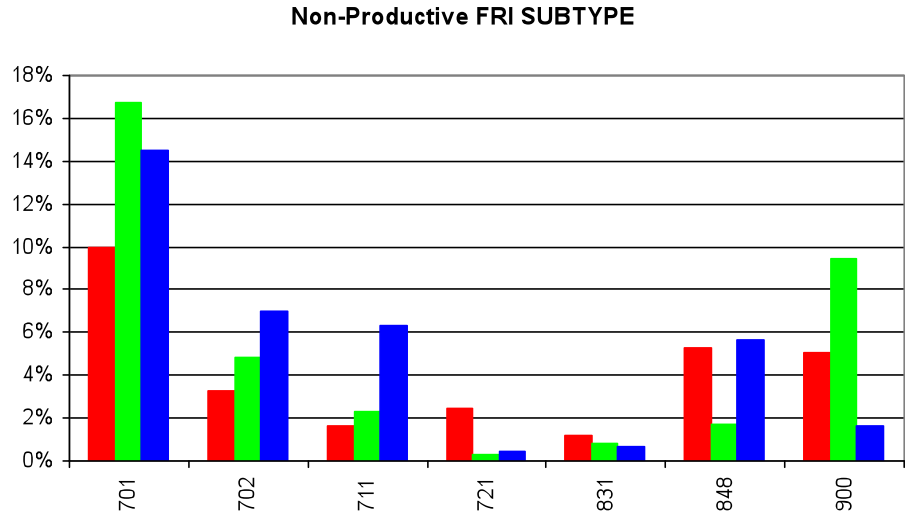




Subtype Breakdown

Southern Historic Range (based on historical range of Owl Lake caribou)





APPENDIX 2 – SUBTYPE DESCRIPTIONS

Productive Subtypes	Description
4	jp 71-100%
6	jp 40-70%-spr
13	bs 71-100%
14	bs 40-70%-jp
15	bs 40-70% - bf, ws
16	bs 40-70% - tl
21	bf 40-70% - spr
30	tl 71-100%
31	tl 40-70% - spr
44	jp >50% - mixedwood
46	jp <=50% - spr, mixedwood
61	bf <=50 % - spr, mixedwood
81	ta with jp
82	ta with spr, bf, tl
90	ta

Non-Productive Subtypes	Description
701	Tree muskeg- bs
702	Tree muskeg - tl
711	Tree rock – jp
721	Willow
831	Muskeg - wetland
848	Beaver Flood
900	Water