MOOSE
WINTER HABITAT

HABITAT SUITABILITY INDEX MODEL
VERSION 5

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1. INTRODUCTION

Habitat Suitability Index (HSI) models predict the suitability of habitat for a species based on an assessment of habitat attributes such as habitat structure, habitat type and spatial arrangements between habitat features. This HSI model for moose (Alces alces) applies to habitats of the Foothills Model Forest (FMF) in west-central Alberta. The intended use is to predict habitat suitability at landscape scales and over long-time periods. The model will be used to determine potential changes in moose habitat area and carrying capacity throughout an entire forest management cycle (200 years). The model was primarily developed using literature review. M.Sc. Candidate Jason Kerr is currently working on a moose habitat use study in the FMF.

2. SPECIES DESCRIPTION AND DISTRIBUTION

The moose is the largest member of the deer family (Banfield 1974). Moose have long legs, high shoulders, a large broad muzzle and a dewlap or bell hanging from the throat (Banfield 1974). Males possess wide, heavy palmate antlers and are generally larger than females with a length of 2.6 m, shoulder height of 1.8 m and a mass of 453 kg. Females average 2.3 m in length, 1.8 m in height and are 350 kg (Banfield 1974).

Moose are distributed across forested regions of Canada including northern and western Alberta (Banfield 1974). They are associated with shrublands and wetlands interspersed with forest cover (Banfield 1974). In Alberta, moose are not at risk and their habitat is secure (Wildlife Management Branch 1996).

3. FOOD

During the winter, moose browse on deciduous trees and shrubs (Soper 1964). Browse species include willow (*Salix* spp.), aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), saskatoon (*Amalanchier alnifolia*), red-osier dogwood (*Cornus stolonifera*), chokecherry (*Prunus pennsylvanica*), alpine fir (*Abies lasiocarpa*), hazelnut (*Corylus cornuta*), buffalo-berry (*Shepherdia canadensis*), bush cranberries (*Viburnum* spp.), rose (*Rosa acicularis*), and gooseberry (*Ribes* spp.; McNicol and Gilbert 1980, Irwin 1985, Westworth et al. 1989, Reneker and Hudson 1993). During spring and summer moose acquire sodium from aquatic plants (primarily in eastern Canada) or mineral licks. (OMNR 1984).

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In Alaska, moose used deciduous forests and alder/willow communities during the winter more than expected based on availability (Suring and Sterne 1998). These plant communities provided the best access to tall willow (Suring and Sterne 1998). Shrub cover was associated with moose in the winter in south-central Montana (Van Dyke et al. 1995a). During the winter in north-central British Columbia, moose were in habitats with the most available winter browse, which were in 10 year old clearcuts and aspen habitats (Westworth et al. 1989). An adjacent copper mine had less of an impact on habitat use than the habitat surrounding the mine, indicating moose responded more to available browse than to the presence of the mine (Westworth et al. 1989). In south-western Alberta, moose were associated with shrubland and aspen forests that provided the best forage (Telfer 1988). Use of grassland and forbs did increase during periods of deep snow as a result of snow blowing off these areas and providing accessible forage (Telfer 1988).

Browse has a greater influence on habitat selection than dense cover (Westworth et al. 1989). During the winter in northern Ontario, moose were in 15 year old cutovers with scattered residual trees and available winter forage compared with open cutovers and dense conifer forests (McNicol and Gilbert 1980). Moose appeared to choose their winter habitat based on the presence of suitable winter food rather than protective cover in south-western Quebec (Proulx and Joyal 1981).

4. COVER

Generally, moose respond more to food availability than cover when compared to other ungulates (Kearney and Gilbert 1976, Telfer 1978). During periods of deep snow, cows, calves, and sometimes bulls, will move from open areas to areas with low snow cover (Telfer 1970, Hauge and Keith 1981, Pierce and Peek 1984, Timmerman and McNichol 1988). On warm winter days, moose often move under conifers for shade (Collins and Helm 1997). Snow depths of 65 cm restrict movement of cow and calf moose and 90 cm is considered the "critical" depth for moose (Peek et al. 1982). Dense stands with > 60% coniferous species and > 10 m in height provide maximum thermal protection and lower snow depths (Allen et al. 1987). In south-central Montana, moose forage and resting sites had similar habitat attributes on a microhabitat scale (Van Dyke (1995). Both activities occurred on sites with high shrub cover, and low canopy closure, canopy height, slope, tree density and sapling diameter at breast height (dbh at 1.3 m; Van Dyke 1995).

In mixedwood forests in Alberta, moose were more abundant in young (20-30 yr) and old stands (120+ yr), compared with mature stands (50-65 yr) during the winter (Stelfox et al. 1995). Moose abundance increased with greater densities of small aspen, willow, shrub/saplings, snags, and less conifer. Cover was not important in this area during the winter when there was less than 40 cm of snow cover. In addition, distance to road or cutlines appeared to be unimportant to moose (Stelfox et al. 1995). In contrast, moose were found in all forest ages during the summer (Stelfox et. al 1995). During January in red spruce forests of New Brunswick, moose were found in open forests and tended to avoid dense coniferous and mixedwood types. However, moose were found more often in the dense conifer in March when snow depth ranged from 76 cm to 112 cm (Telfer 1970). Foraging occurred less than 100 m from cover in Ontario (Hamilton et al. 1980, OMNR 1984). However, in Alaska moose foraged on willow hundreds of metres away from cover to the same degree as they foraged on willow a few metres from cover (Collins and Helm 1997).

5. REPRODUCTION

Rutting season typically occurs in mid September to late November (Banfield 1974). A bull remains with a cow until her oestrous period occurs and then will search out other pre-oestrous cows (Banfield 1974). Gestation lasts between 240-246 day with calves born in late May or early June (Banfield 1974). Secluded areas are selected for calving (Mytton and Keith 1981) and include islands, isolated muskegs, riparian areas, or isolated patches of forest (Timmerman and McNichol 1988). The cow will guard her new-born calf for several weeks (Banfield 1974).

Twins are often born in areas with optimal habitat (Banfield 1974). Calves double their mass in three weeks and are weaned by September (Banfield 1974). Calves remain with their mother for the first year and are driven off just before the next calving season (Banfield 1974). Females usually reach sexual maturity at 2.5 years. Males also mature at this age but rarely have the opportunity to breed until they are 5 or 6 years old (Banfield 1974).

6. HABITAT AREA

In north-eastern Alberta, mean size of winter home ranges was 30 km^2 (range 3-111 km^2) and there was no difference in size between sexes (Hauge and Keith 1981). In north-central Alberta, mean winter home range size was 15 km^2 (range 2-54 km^2) with both bulls and cows having similar home ranges (Mytton and Keith 1981). In the Boreal Foothills Ecoregion, male and female home ranges were 51.6 km^2 and 46.8 km^2 respectively, in winter (Lynch 1986). Mean home range size for moose in south-central Montana during winter-spring and summer-autumn was 12 km^2 and 15 km^2 for males and 21 km^2 and 16 km^2 for females (Van Dyke et al. 1995b). In Maine, moose winter home range

when snow cover exceeded 70 cm was 1.5 km^2 (Thompson et al. 1995) and a core area of intensive use was observed in areas less than 2 ha.

In northern Ontario moose density was estimated to be 0.23 moose/km^2 in an actively logged area (Hamilton et al. 1980). The density estimate for north-eastern Alberta was 0.18 moose/km^2 (Hauge and Keith 1981). The density estimate of moose in north-central Alberta was 0.64 moose/km^2 (Mytton and Keith 1981). The density estimate used in the HSI model developed for the Lake Superior Region (Allen et al. 1987) and the density found in north-eastern Minnesota (Peek et al. 1976) was 0.02 moose/ha. This is also the density estimate used for the most suitable habitat in the FMF as no density estimates for this area were found.

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Moose (Alces alces).

Habitat Evaluated: Foraging habitat.

Geographic area: This model is applicable to the Foothills Model Forest in west-central Alberta.

Seasonal Applicability: This model produces HSI values for winter food habitat.

Cover types: This model applies to all forest and non-forest habitat areas of the Lower and Upper Foothills, Montane and Subalpine Natural Subregions (Beckingham et al. 1996) since suitability is determined from structural characteristics within stands rather than classified forest stands directly. The model should also be broadly applicable to other habitat areas dominated by vegetation similar to that in this region, including pure deciduous, mixedwood and pure coniferous forest types, as well as wetland and riparian forests, meadows, shrublands, and areas regenerating after forest harvesting.

Minimum Habitat Area: Minimum habitat area is defined as the minimum amount of contiguous habitat to which the model will be applied. In the case of the moose, no minimum habitat area is given, as moose are capable of using small patches of habitat interspersed throughout a managed landscape.

Model Output: The model will produce Habitat Units (HU) of food for each classified plant community based on HSI value and stand area. HU are calculated by multiplying the HSI value with the area in hectares. The performance measure for the model is potential carrying capacity (adult moose per ha). HU should be correlated to estimates of carrying capacity to verify model performance.

Carrying Capacity (Moose per ha where HSI = 1.0): Based on the literature, the current estimate of the maximum number of adult moose per optimal hectare is 0.02 (Peek et al. 1976, Allen et al. 1987).

Verification Level: The reliability of this model has not been evaluated against local data. The verification level is 3: model based on literature and reviewed by species experts.

Application: This HSI model is designed to assess habitat suitability for relatively large forest landscapes using generalized species-habitat relationships and stand-level vegetation inventory. Its purpose is to predict relative changes in moose habitat supply at the landscape level over long time periods (200 years), for integration with forest management planning. The model is not designed to provide accurate prediction of suitability or use at the stand level. Approximate population size can be calculated by assuming linear habitat-population relationships, but the model is not designed to provide accurate population density estimates. Any attempt to use the model in a different geographic area or for other than the intended purpose should be accompanied by model testing procedures, verification analysis, and other modifications to meet specific objectives.

7.2 MODEL DESCRIPTION

Versions 1-4 of this model had a cover component as well as a food component. Several simulations using habitat data from the FMF, indicated that cover, as defined in the model, was abundant but winter food could be limiting. It was therefore assumed that suitable cover would be present in proximity to food for all habitats within the FMF and was not necessary to include in the model.

7.2.1 Habitat Variables and HSI Components

One habitat variable is used to predict foraging habitat for moose. The model predicts food habitat suitability based on shrub cover (Table 1). In winter, moose browse primarily on deciduous trees and shrubs. The cover of shrubs > 1 m in height and deciduous sapling cover determines S_1.

Table 1. Relationship between habitat variables and life requisites for the moose HSI model.

HSI Component	Life Requisite	Habitat Variable	Habitat Variable Definition
S_1	Food	Tall Shrub and Deciduous Sapling Cover	Shrub cover of species ≥ 1 m in height and deciduous sapling cover

7.2.2 Graphical HSI Component Relationships

S_1 Deciduous tree and shrub cover is optimal at values > 25%. At 0% cover, the suitability is 0 and rises linearly to optimal suitability at 25% (Figure 1).

7.3 MODEL ASSUMPTIONS

1. Moose are able to migrate freely to their winter range from their summer range.
2. Habitat used throughout spring to fall which includes calving, summer activities and reproduction is not limiting.
3. Winter is the critical period which determines moose habitat supply.
4. All tall shrub species (> 1 m in height) have the same value as food and this does not diminish throughout winter.
5. Moose do not modify their feeding behaviour in the presence of human activity.
6. Water and minerals are not limiting winter resources.
7. Suitable cover is always present.

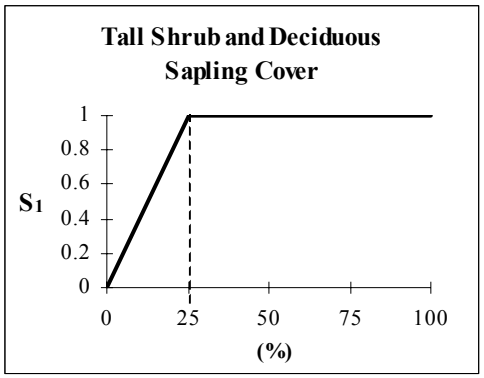

Figure 1. Graphical relationships between habitat variables and HSI components in the moose model.

7.4 EQUATIONS

The HSI-foraging equation consists of component S_1. It is assumed that adequate cover is available throughout the FMF.

HSI-foraging = S_1

8. SOURCES OF OTHER MODELS

The U.S. Fish and Wildlife Service developed an HSI model for the moose (Allen et al. 1987). Delta Environmental Management Group also published an HSI model for the moose (Delta Environmental Management group 1990). The Saskatchewan Forest Habitat Project also released a moose HSI model in their 1991 annual report.

Model History

All of the HSI models for the Weldwood Forest Management Area have undergone several revisions, and they will be revised again as new information becomes available. Contact Rick Bonar for information about the most current version.

- Version 1 (1989) was developed by the Weldwood of Canada Integrated Resource Management Steering Committee (IRMSC).
- Version 2 (1994) was revised by Barb Beck and Melissa Todd, using local information from a telemetry-based marten research study conducted within the Foothills Model Forest by Rob Stewart.
- Version 3 (1995) was written by Tony Romito for a special topics course in habitat modelling at the University of Alberta. Comments provided by Kirby Smith, Area Wildlife Biologist for Alberta Fish and Wildlife Services, Edson area, were incorporated into the model.
- Version 4 (1996) was edited and reformatted by Wayne Bessie and sent to species experts for critical comment.
- Version 5 (1999) was revised by Karen Graham, Rick Bonar, Barb Beck, and Jim Beck to incorporate reviewer comments and information from recent literature.

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