
MULE DEER 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 the mule deer (*Odocoileus hemionus*) 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 mule deer habitat area and carrying capacity throughout an entire forest management cycle (200 years). The model was primarily developed using literature review.

2. SPECIES DESCRIPTION AND DISTRIBUTION

Mule deer are heavier built than white-tailed deer (*Odocoileus virginianus*), with larger ears, and a narrow black-tipped tail (Banfield 1974). The buck's antlers are upswept with forked tines, whereas white-tailed deer tines are not forked (Banfield 1974). Mule deer are reddish-brown or tawny-brown in colour (Banfield 1974). Bucks measure 142-188 cm in length and have a mass of 50-215 kg, while does are 132-152 cm in length and a mass of 32-72 kg (Banfield 1974).

Mule deer range from south-western Manitoba to British Columbia, including all of Alberta (Banfield 1974). They are common in montane, subalpine and foothill habitats as well as prairie land and along major river valleys throughout Alberta (Stelfox and Stelfox 1993). Mule deer are not considered at risk in Alberta and have stable populations with secure habitat (Wildlife Management Division 1996).

3. FOOD

During spring and summer, grass and forbs make up a substantial part of the diet of the mule deer (Martinka 1968, Kerr 1979, Collins and Urness 1983). In fall and throughout winter, mule deer primarily browse on shrubs (Martinka 1968, Wallmo et al. 1972, Kerr 1979, Austin and Urness 1985). Important shrubs during the winter include willow (*Salix* spp.), saskatoon (*Amelanchier alnifolia*), red-osier dogwood (*Cornus stolonifera*), rose (*Rosa* spp.), chokecherry (*Prunus pennsylvanica*), snowberry (*Symphoricarpos albus*), silverberry (*Eleagnus commutata*), and young aspen (*Populus tremuloides*) trees (Alberta Fish and Wildlife 1989). Arboreal lichen and Douglas-fir litter fall is also an important winter food component in the central interior of British Columbia (Waterhouse et al. 1991).

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4. COVER

Mule deer successfully inhabit prairie areas with no forest cover. In forested areas, mule deer are associated with hiding cover year-round and thermal cover (> 1.5 m tall, $> 70\%$ canopy closure) for protection and snow interception during winter (Cope 1975, Thomas 1979, Hall 1985, Nietfeld et al. 1985, Wambolt and McNeal 1987). In forested habitat, deer are usually found within 180 m of the cover/forage edge (Reynolds 1966, Thomas 1979). A cover/forage ratio of 60 /40 is considered optimum (Kerr 1979, Hall 1985).

5. REPRODUCTION

The rutting season occurs between late October and early December (Banfield 1974). Bucks are polygamous but remain with a doe until she reaches oestrous (Banfield 1974). Does are seasonally polyoestrous (Banfield). Gestation period is 210 days (Banfield). Fawns are typically born in early June but birthing can occur any time between March and November (Banfield). Twins are usually born (Banfield).

Optimal fawning habitat has dense shrub cover and is generally near forest cover and water, such as riparian areas (Thomas 1979, Hall 1985). The does cache their fawns for the first month (Banfield). Fawns are weaned after 4-5 months. Sexual maturity occurs after 18 months (Banfield 1974) and does normally produce young after 2 years of age (Alberta Fish and Wildlife 1989).

6. HABITAT AREA

A population of 4 animals/km² is estimated for the most suitable habitat in winter range (K. Smith, personal communication). Based on this value, a genetic effective population of 500 individuals would require 125 km² of suitable habitat.

A conversion of the Alberta Deer Management Areas to the Weldwood FMA identifies a winter population objective of 1,475 mule deer (Alberta Fish and Wildlife 1989). An estimated winter density of 4 animals/km² would require 370 km² of optimal mule deer winter range to meet the area component of the Alberta population objectives (Alberta Fish and Wildlife 1989).

6.1. INTERSPERSION

A 60:40 ratio of forage:cover is considered optimal for winter mule deer habitat (Kerr 1979, Thomas et al. 1979, Hall 1985).

6.2. HABITAT EFFECTIVENESS

Roads generally decrease the value of habitat for mule deer (Towry 1984). The estimated zone of influence extends for 100 m from the road into adjacent habitat.

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Mule deer (*Odocoileus hemionus*).

Habitat Evaluated: Food, Thermal Cover and Habitat Effectiveness.

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

Seasonal Applicability: This model assesses winter 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. This model will apply to all stands throughout the above cover types regardless of size, since mule deer are highly mobile.

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

Carrying Capacity (Mule Deer per ha where HSI = 1.0): Based on limited local information, the current estimate of the maximum number of adult mule deer per optimal hectare is 0.04 (K. Smith, personal communication).

Verification Level: The reliability of this model has not been evaluated against local data. The verification level is 2: local knowledge has been incorporated into the model but the model has not been tested.

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 mule deer 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

The HSI model for mule deer assumes the habitat requisites of thermal cover and food are limiting. Two equations; one for food habitat suitability and one for thermal cover habitat suitability are determined. Habitat effectiveness for both food and cover is calculated to address the potential effects of vehicle access on mule deer numbers. The two components are combined using an interspersion ratio to get the total number of habitat units of winter habitat for the area in question.

7.2.1 Habitat Variables and HSI Components

A. Cover

Thermal cover is determined from 3 elements of habitat structure: canopy closure, canopy height, and percent conifer composition (Table 1) and these elements define HSI components S_1 , S_2 and S_3 . Canopy closure provides thermal protection since it reduces wind speed and wind chill values. Tall trees reduce wind speed more than short trees because they deflect more air. Tall trees generally have large crown bases that provide more cover. Conifers are more effective at breaking wind flow because there are more branches and needles near the ground. Conifers also reduce ground snow accumulation, which eases travel and improves food availability during the winter.

The value of thermal cover is also reduced if the forested area is near a road or trail subject to vehicular traffic which increases the chances of mortality caused by collisions and hunting. This is defined in HSI component S_4 . Thermal cover is not useful unless it contains or is near food resources as defined by HSI component S_5 because of the energetic loss of travel between cover and foraging habitat.

B. Foraging

Winter food, in years with high snowfall, is primarily aspen and shrub stem tips that stick above the snow. Foraging cover is determined from the cover of shrubs and deciduous trees ≤ 2 m in height and is used to predict HSI component S_6 . The distance from food to adequate thermal cover (used to predict S_7) and the distance from food to access (which predicts S_8) are also important in defining the food HSI equation (Table 1).

Table 1. Relationship between habitat variables to life requisites for the mule deer HSI model.

HSI	Life Requisite	Habitat Variable	Habitat Variable Definition
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Component			
S ₁	Thermal Cover	Tree Canopy Closure (%)	Percent of ground covered by a vertical projection of tree crown areas onto the ground. Includes all trees ≥ 8 cm diameter at breast height (1.3 m).
S ₂	Thermal Cover	Tree Canopy Height (m)	Average top height of 100 trees/ha that have the largest dbh.
S ₃	Thermal Cover	Conifer in Tree Canopy (%)	Sum of the percent composition of pines, spruce and fir species in the tree canopy.
S ₄	Habitat Effectiveness	Distance of Food to Access (m)	Distance to the nearest point of human vehicle access (roads, trails, seismic lines, and gas pipeline corridors).
S ₅	Habitat Interspersion	Distance of Cover From Food (m)	Distance to the edge of a unit with adequate cover (based on the product of the non-spatial components of the HSI for mule deer cover).
S ₆	Food	Deciduous Sapling Cover ≤ 2 m in height + Shrub Cover (%)	Percent ground area covered by a vertical projection of the deciduous sapling and shrub crown areas onto the ground. Includes deciduous saplings ≤ 2 m in height and all shrub species.
S ₇	Habitat Interspersion	Distance from Cover (m)	Distance to the edge of a unit with adequate food (based on the product of the non-spatial components of the HSI for mule deer food).
S ₈	Habitat Effectiveness	Distance of Cover from Access (m)	Distance to the nearest point of human vehicle access (roads, trails, seismic lines, and gas pipeline corridors).

7.2.2 Graphical HSI Component Relationships

A. Cover

- S₁ From 0-30% tree canopy closure, $S_1 = 0$. This increases linearly until the optimum canopy closure is reached at values $\geq 70\%$.
- S₂ Tree heights ≤ 4 m do not provide adequate thermal cover and $S_2 = 0$. This increases over the range 4-10 m until $S_2 = 1$.
- S₃ This modifying component ranges only from 0.5 to 1. This reflects the idea that thermal cover is mainly determined by the first two variables, and is only partially influenced by the conifer composition. At 0% conifers, $S_3 = 0.5$. At $\geq 50\%$, $S_3 = 1$. Thus, pure deciduous stands are still able to provide up to 1/2 of the thermal protection of conifer stands.
- S₄ Food adjacent to human access is unsuitable habitat. The suitability then increases over the range 0-100 m and at values ≥ 100 m the optimal condition exists.
- S₅ To reflect the need for both food and cover to be in close proximity, $S_5 = 1$ when food is within 140 m of cover, but then drops to a value of 0 when mule deer have to travel > 220 m between the two habitats.

B. Foraging

- S₆ Habitat areas with no shrub cover or deciduous sapling cover ≤ 2 m in height do not provide winter food and are rated as unsuitable habitat ($S_6 = 0$). As the coverage rises the value of the area for food increases, until at 50% or higher optimal foraging habitat exists.
- S₇ If the foraging area is 0-140 m from thermal cover, $S_7 = 1$. This value drops down to 0 for areas ≥ 220 m from cover.

S₈ Suitable cover adjacent to human access is unsuitable habitat. The suitability then increases over the range 0-100 m and at values ≥ 100 m the optimal conditions exists.

7.3 MODEL ASSUMPTIONS

1. Winter is the critical period which determines mule deer habitat supply. Habitat for spring to fall which encompasses summer activities and reproduction is not limiting or is obtained in the same habitats used for winter food and cover.
2. Mule deer are able to migrate freely to their winter range from their summer range.
3. All shrub species have the same food value and this value does not diminish throughout winter.
4. All roads and other access points carry the same effect, no matter the size or frequency of use.
5. Food is useless if it is not within a certain distance of cover and vice versa.
6. Water and minerals are not a limiting winter resource.

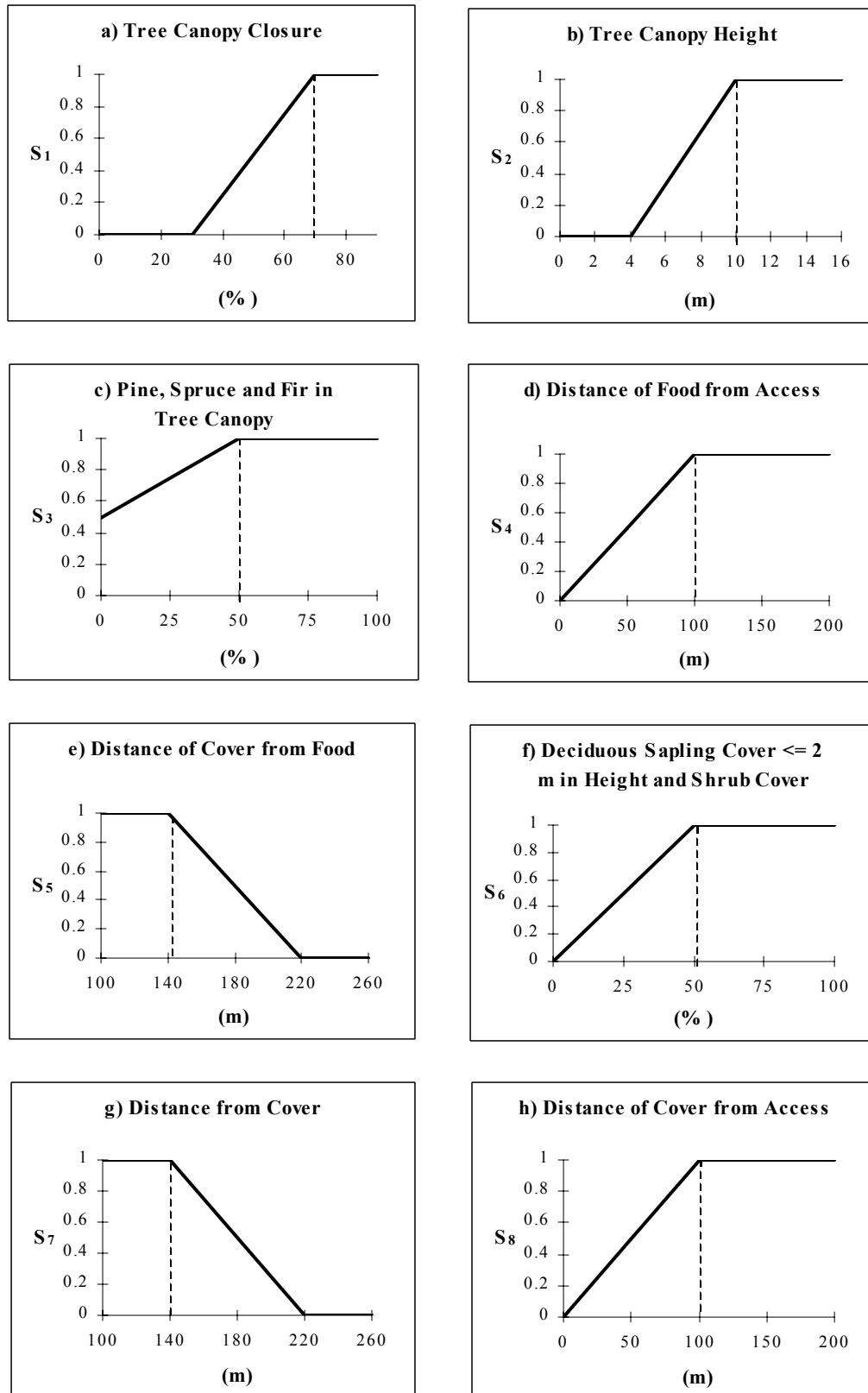


Figure 1. Graphical relationships between habitat variables and HSI components in the mule deer model.

7.4 EQUATIONS

A. Cover

The prediction of cover habitat has four components and considers them all equal and non-compensatory. However, component S_3 (conifer composition) is only a modifying variable since it never drives the equation to 0.

$$\text{HSI-cover} = S_1 \times S_2 \times S_3 \times S_5$$

B. Foraging

Foraging habitat is predicted from two components and are all considered equal and non-compensatory.

$$\text{HSI-foraging} = S_6 \times S_7$$

C. Habitat Effectiveness

An area may have suitable cover or foraging habitat, but if it is too close to a road or other access, the effectiveness of the habitat for mule deer becomes zero because of the increased chance of mortality due to hunters or car collisions. Habitat effectiveness is incorporated into the model by multiplying the HSI-cover value and HSI-foraging value by S_4 and S_8 respectively.

$$\text{Effective Cover Habitat} = \text{HSI-cover} \times S_4$$

$$\text{Effective Foraging Habitat} = \text{HSI-foraging} \times S_8$$

D. Winter Habitat

There must be a 60:40 ratio of forage:cover before an area is considered suitable for mule deer winter habitat (Kerr 1979, Thomas et al. 1979, Hall 1985).

8. SOURCES OF OTHER MODELS

No other HSI models for mule deer were found in the literature.

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.
- Version 3 (1995) was written by Lori Wood 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.
- Version 5 (1999) was revised by Karen Graham, Rick Bonar, Barb Beck, and Jim Beck to incorporate information from recent literature.

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