A REVIEW OF MOOSE HABITAT REQUIREMENTS

by

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for

ALBERTA OIL SANDS
ENVIRONMENTAL RESEARCH PROGRAM

Project TF 1.1

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The Hon. John W. (Jack) Cookson
Minister of the Environment
222 Legislative Building
Edmonton, Alberta

and

The Hon. L. Marchand
Minister of the Environment
Environment Canada
Ottawa, Ontario

Sirs:

Enclosed herein is the report on "A Review of Moose Habitat Requirements".

This interim report was prepared under the former Terrestrial Fauna Technical Research Committee (now part of the Land System) of the Alberta Oil Sands Environmental Research Program, under the Alberta-Canada Agreement of February 1975 (amended September 1977).

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

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A REVIEW OF MOOSE HABITAT REQUIREMENTS

DESCRIPTIVE SUMMARY

BACKGROUND AND PERSPECTIVE

This research was undertaken as part of project TF 1.1, Moose, Wolf, and Caribou Ecology which was designed to supply information on the baseline states of these large mammals in the oil sands area.

Research on moose (*Alces alces*) under Project TF 1.1 includes collecting information on population parameters (sex and age ratios, density, seasonal distribution, recruitment, mortality) moose-vegetation-landform interactions, and predator relationships.

The information on moose habitat selection contained in this report together with field data will be useful in explaining moose movements, seasonal distribution, and in identifying winter ranges and critical areas.

Additional reports on Project TF 1.1 are currently in preparation.

ASSESSMENT

The report "A Review of Moose Habitat Requirements" which was prepared by R. Rolley and L. Keith (Department of Wildlife Ecology, University of Wisconsin) has been reviewed and accepted by the Alberta Oil Sands Environmental Research Program. This report will receive limited distribution in selected Canadian libraries.

The report contains a good summary of the literature currently available on moose habitat requirements.

The content of this report does not necessarily reflect the views of Alberta Environment, Fisheries and Environment Canada, or the Alberta Oil Sands Environmental Research Program. The mention of trade names for commercial products does not constitute an endorsement or recommendation for use.

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ABSTRACT

This paper reviews moose habitat selection and discusses the environmental factors which affect selection. Moose use open areas and lowlands extensively in spring and early summer in apparent response to snow melt and early green-up in such areas, and possibly to the greater protein content of plants growing there. Increased use of taller more-mature stands in later summer and fall may be associated with a higher protein content of browse beneath a forest canopy. Disturbed sites (burns, logged areas, epidemic areas, windfalls, etc.) and stands of tall shrubs with an abundance of deciduous browse are heavily utilized during early winter and/or periods of low snow depth. Increasing snow depths restrict moose activity and intensify use of areas having dense vegetation and coniferous cover where snow is shallower. This constraint on movement may in part explain the increased consumption of coniferous browse during winter. Altitudinal migrations are frequently observed in mountainous regions. These are probably caused by selection of areas of greater forage quantity and quality, in addition to lesser snow depths during winter. Other factors that may affect moose habitat selection include the availability of escape cover and mineral licks.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

This report summarizes information currently available on moose (*Alces alces*) habitat selection as determined through a review of the literature. Such areas can usually be broadly characterized by vegetational and topographical features. In the first part of this report, the habitats that are selected by moose are identified while in the second section the environmental factors which interact with moose and affect habitat selection are discussed.

2. MOOSE HABITAT SELECTION

There is considerable variation in the habitats reportedly selected by moose (Tables 1, 2, and 3), but there are obvious seasonal patterns.

2.1 SPRING

Spring habitats are generally open areas supporting either low or tall shrubs. Berg and Phillips (1974) noted a sudden movement by Minnesota moose during mid-April into open areas of mixed willow (*Salix* spp.). Similar movements into open park-like areas were observed in New Brunswick (Kelsall and Prescott 1971) and Wyoming (Houston 1968).

Heavy spring use of lowlands and river bottoms are recorded for moose in Alaska (Le Resche et al 1974) and Alberta (Hauge and Keith in prep.; Keith and Frokjer in prep.).

2.2 SUMMER

Tall shrubs and low open vegetation continue to receive heavy use through the summer (Berg and Phillips 1974; Le Resche et al. 1974; Van Ballenberge and Peek 1971), but the importance of sites dominated by mature deciduous and coniferous trees increases. In Minnesota, the use of open areas dominated by white birch (*Betula papyrifera*), aspen (*Populus tremuloides*), and balsam fir (*Abies balsamea*) was disproportionately greater than the occurrence of such sites (Peek et al. 1976). Aspen and mixed aspen-conifer cover dominated at 32, 51, and 60 percent of the June, July, and August locations, respectively, of radio-tagged moose in northeastern Alberta (Hauge and Keith in prep.). In addition, both Peek et al. (1976) and Krefting (1974a) noted a shift to taller, more densely stocked mature stands as summer advanced.

Lowlands and aquatic areas remain important during summer, particularly east of the Rocky Mountains (Berg and Phillips 1974; Keith and Frokjer in prep.). However, in mountainous regions, moose move into high mountain meadows at the beginning of summer (Edwards and Ritcey 1956; Knowlton 1960).

Table 1. Reported dominant life-forms of preferred moose habitat.[a]

Region	Spring	Summer (Seasons[a])	Autumn	Winter	References
Alaska	LO, TS	LO, TS	LO, DT	TS, SC	Le Resche et al. 1974
Alaska				SC	Spencer and Hakala 1964
British Columbia				SC	Edwards and Ritcey 1956
Wyoming			TS, DT	TS	Altman 1959
Wyoming	LO, TS, DT	TS, DT	TS, DT	mild-TS, LO, DT severe-TS, CT	Houston 1968
Montana		TS, CT	TS, LO, CT	TS, CT	Knowlton 1960
Montana				DT, CT	Peek 1974b
Alberta	TS, CT	DT, CT	DT, CT	DT, CT	Hauge and Keith 1977
Minnesota	open TS	open TS	TS, DT	DT	Berg and Phillips 1974
Minnesota		DT, CT	DT	mild-open DT severe-dense DT, CT	Peek et al. 1976
Minnesota		DT, CT, TS			VanBallenberge and Peek 1971
Isle Royale, Mich.				SC	Allan 1974
Isle Royale, Mich.			SC		Krefting 1974b
Isle Royale, Mich.				CT, SC	Peterson and Allen 1974
Ontario				mild-DT, open CT severe-DT, dense CT	Chamberlin 1972

Continued ...

Table 1. Concluded.

Region	Spring	Summer	Autumn	Winter	References
Quebec				SC	Brassard et al. 1974
New Brunswick	LO				Kelsall and Prescott 1971
New Brunswick				mild-DT severe-dence CT	Telfer 1970
Siberia	SC, TS				Kistchinski 1974

[a]Key: LO = Low-open: herbaceous bogs, sagebush-grasslands, and open areas

TS = Tall Shrubs: willow, mixed willow, willow birch, riparian williow, riparian brush, and young deciduous vegetation

DT = Deciduous Trees: birch, aspen, mature hardwood, and mixed timber

CT = Coniferous Trees: spruce, fir, tamarack, and pine

SC = Seral Communities: burns, logged areas, and disturbed areas

[b]Actual dates of seasons vary between regions. Generally, spring refers to April-mid June; summer, mid June-August; autumn, September-November; winter, December-March.

Table 2. Summary of reported dominant life-forms of preferred moose habitat.

Life-Form Key[a]	Percent Use of Life Forms by Season: Spring	Summer	Fall	Winter	Percent of Total Reports
DT	9	29	40	31	29
TS	45	36	27	17	28
CT	9	29	13	28	22
SC	9	0	7	21	12
LO	27	7	13	3	10

[a]LO = Low-open: herbaceous bogs, sagebrush-grassland, and open areas

TS = Tall Shrubs: willow, mixed willow, willow-birch, riparian willow, riparian brush, and young deciduous vegetation

DT = Deciduous Trees: birch, aspen, mature hardwood, and mixed timber

CT = Coniferous Trees: spruce, fir, tamarack, and pine

SC = Seral Communities: burns, logged areas, and disturbed areas

Table 3. Reported seasonal changes in moose distribution in relation to topography and elevation.

Regions	Spring	Summer	Autumn	Winter	References
Mountainous					
Alaska	Lowlands, River bottoms	Lowlands, Uplands >2000m	Lowlands Uplands	River bottoms	LeResche et al. 1974
British Columbia		Mountain meadows 1500-2100m		Valley Floor 750-1200m	Edwards and Ritcey 1956
Montana		Mountain meadows >2400m	Mountain meadows >2200m	River valleys <2100m	Knowlton 1960
Montana				Flood plains	Peek 1974b
Montana				Lowlands	Stevens 1970
Scandinavia				Lowlands	Ahlen 1975
Non-Mountainous					
Alberta	Lowlands	Uplands	Uplands	Uplands	Hauge and Keith in prep.
Alberta	Lowlands	Lowlands	Lowlands and nearby uplands	Uplands	Keith and Frokjer in prep.
Minnesota		Aquatic areas			Berg and Phillips 1974
New Brunswick				High elevations >220m	Kelsal and Prescott 1971
Nova Scotia				Uplands >120m	Telfer 1967
Ontario		Aquatic areas			de Vos 1958

2.3 FALL

The gradual shift into "tall-mature" areas observed by Berg and Phillips (1974) occurred in autumn. Knowlton (1960) noted a slight downward movement of moose in Montana. A similar gradual downard movement was observed in British Columbia (Edwards and Ritcey 1956).

2.4 WINTERS

Seral communities, in previously burned, logged, or otherwise disturbed sites, in addition to areas permanently supporting tall shrubs are frequently mentioned as important moose winter habitats (Brassard et al. 1974; Edwards and Ritcey 1956; Le Resche et al. 1974; Spencer and Hakala 1964). Similarly, Peek et al. (1976) found a clear preference for lower, open stands of deciduous trees during early winter and mild periods. As snow depths and hardness increased, they observed an increase in use of dense stands of hardwoods and conifers. This greater use of conifer cover and dense stands during severe winter periods was also found in Wyoming (Houston 1968), Ontario (Chamberlin 1972), and New Brunswick (Telfer 1970).

Winter movements out of high elevation meadows into river bottoms, valleys, and lowlands are commonly observed in mountainous regions (Edwards and Ritcey 1956; Knowlton 1960; Le Resche et al. 1974; Stevens 1970). In non-mountainous regions, uplands remain important through winter. Eighty-six percent of winter observations of radio-collared moose, in central Alberta, were on upland sites (Keith and Frokjer in prep.). In northeastern Minnesota, 60 percent of observed tracks, during early winter, were in uplands (Peek et al. 1976).

3. ENVIRONMENTAL FACTORS AFFECTING HABITAT SELECTION

3.1 FOOD

The general distribution of moose is closely related to the quality and quantity of available forage. It is widely recognized that the highest densities of moose occur on the early successional stages that follow burns, logging, or other disturbances (Peterson 1953). Peek (1974a) observed an increase in density on the Little Sioux Burn, Minnesota from 0.16 moose/km^2 (0.41 moose/mi^2) preburn to 0.90 moose/km^2 (2.33 moose/mi^2) 2 years after the fire. Similar increases in moose populations occurred following the 1947 Kenai burn, in Alaska (Spencer and Chatelain 1953), and the 1936 Isle Royale burn (Hansen et al. 1973). Cowan et al. (1950) related the high density of moose in seral communities to a greater quantity and quality of palatable species in these areas. The percentage ground cover of palatable species decreased from 19.5 percent on a recently disturbed site to 6.4 percent on a mature site. There was also a decrease in the ascorbic acid, ether extract, total carbohydrate, and protein content of forage as the forest matured. Houston (1968) also noted a decrease in crude protein with age in willow twigs.

The seasonal distribution of moose is likewise affected by changes in forage quality and availability. The heavy use of areas dominated by tall shrubs in all seasons is apparently related to a preference for willow browse through the year (Tables 4 and 5). The spring movement into open areas and increased use of forbs is chronologically tied to the more rapid snow melt and green-up of these areas (Phillips et al. 1973; Houston 1968; Berg and Phillips 1974). Klein (1970) found that plants in the earliest physiological stages of growth were more nutritious; and this increased use of areas having more nutritious forage coincides with a period of rapidly increasing energy demands linked to late pregnancy and lactation (Gasaway and Coady 1974).

Table 4. Reported food species heavily utilized by moose.[a]

Region	Season: Spring	Summer	Autumn	Winter	References
Alaska	WL, AS, AQ, CB	WL, AQ, BR	WL, BR	WL. AS	Cushwa and Coady 1976
Alaska	LI, CB	BR, FB		BR, CB	Le Resche and Davis 1973
British Columbia				WL, FT	Eastman 1974
British Columbia		AQ			Ritcey and Verbeek 1969
Wyoming	WL, BT	WL, AS	WL, BT, SV, CE	WL, FR, DW, CW, BT	Houston 1968
Wyoming		WL, AQ			McMillan 1953
Montana		FB, WL	WL, FR	WL, FR, SV, AL	Knowlton 1960
Montana	WL, BB, HB, CR, SB, FB		HB, FR, WL, CC	MA, DW, CC, CR WL, FR	Stevens 1970
Minnesota		WL		WL	Berg and Phillips 1974
Minnesota		WL, AS, FC, BR, AH	WL, DW, BH, CR, AS	WL, BH, AS, FR DW	Peek et al. 1976
Isle Royale, Mich.		AH, MA, AQ			Belovsky et al. 1973
Isle Royale, Mich.		AH, BR, MA	AH, BR, MA, WL, DW		Krefting 1974b
Quebec				FR, AH, BR, BH WL	Brassard et al. 1974

Continued ...

Table 4. Concluded.

[a]Key:

WL = willow	AH = ash	FB = forbs, stick geranium	CR - currant	CW = cottonwood
BR = birch	AQ = aquatics	CC = choke-cherry	AL = thin-leaf alder	FR = alpine fir, subalphine fir, balsam fir
DW = dogwood	BT = bitterbrush	FC = fire-cherry	BB = bearberry	BH = beaked hazel
HB = huckleberry	LI = lichen	SB = snowberry	AS = aspen	CB = cranberry
MA = maple	CE = ceanothus	SV = serviceberry		

Table 5. Summary of reported food species heavily utilized by moose.

Food Species Key[a]	Percent use of Food Species by Season Spring	Summer	Autumn	Winter	Percent of Total Reports
WL	21	25	27	25	25
BR	0	16	14	6	10
FR	0	0	9	19	9
AS	7	8	5	6	7
AH	0	13	5	3	5
AQ	7	16	0	0	5
DW	0	0	9	9	5
Misc.[b]	64	20	31	31	34
Total Reports	14	24	22	32	

[a] WL = willow
BR = birch
AQ = aquatics
AS = aspen
AH = ash (*Sorbus* spp.)
DW = dogwood (*Cornus* spp.)
FR = alpine fir or (*Abies lasiocarpus*)
subalpine fir
balsam fir

[b] Misc. = species listed in Table 4 that occurred in less than 5 percent of total reports.

Increased utilization of lowlands and aquatic areas in spring and early summer may be related to a greater protein content of plants in these areas. Oldemeyer (1974) noted a positive correlation between soil moisture and plant protein content. Tew (1970) also found a close correlation between leaf moisture content and potassium levels. It seems logical to suggest that plants in these lowland sites would be highly nutritious.

The use of wet areas is also related to the availability of aquatic vegetation. Aquatic plants made up 25 percent of the summer diet of moose on Isle Royale (Belovsky et al. 1973). Dodds (1974) felt that aquatic vegetation was heavily utilized if available but was not essential. Jordan et al. (1973) tied the high use of aquatics to their high levels of sodium.

Increased use of taller more-mature stands in late summer and early fall may also be related to changes in nutrient quality of the forage. The protein content of forage generally decreases through the growing season (Dietz et al. 1962; Tew 1970). This may be partly compensated for by increasing use of species growing in denser stands, since Laycock and Price (1970, cited in Oldemeyer 1974) found a higher protein content in plants growing under a canopy than in plants growing in the open. In addition, the crude fat content of aspen is higher in the fall than in spring (Dietz et al. 1962).

Summer forage is essentially important to moose populations. Quality and quantity of forage affects summer weight gain. Gasaway and Coady (1974) estimated that winter rumen fermentation supplied less than half of the energy needed for maintenance of moose. The rest came from metabolism of fat and protein stores deposited during summer. In addition the quality of food on summer range appears to influence the ovulation rate of adult moose (Blood 1974; Markgren 1974).

Coady (1974) felt that the ultimate cause of winter moose movements was a minimization of metabolic demands and enhancement of energy intake by selecting areas of greater forage quality, quantity, and availability. The importance of seral communities and areas of tall shrubs during winter is clearly related to the abundance of browse in these areas. Le Resche et al. (1974) felt that the heavy winter use of the 1947 Kenai burn was due to the tremendous amount of edge created between rich deciduous browse and mature coniferous stands.

The reason for the increased use of coniferous browse during winter is not clearly understood. Dietz et al. (1962) showed that evergreen species on mule deer winter range retained protein during winter better than deciduous species. If this holds true on moose winter ranges, than the increased use of coniferous species may indicate a selection for more nutritious forage. Pimlott (1953), on the other hand, felt that balsam fir was used heavily only when the more palatable deciduous species had been severely over-browsed.

The Appendix gives the scientific and common names of species discussed in this paper.

3.2 SNOW DEPTH

As mentioned above, Coady (1974) suggested that moose selected winter habitats to minimize metabolic demands. The metabolic cost of movement is greatly increased by deep snows; and snow depths greater than 70 cm cause impairment of moose (Kelsall 1969). As snow depth increases, moose: (1) reduce their total activity; (2) increase browsing intensity on individual bushes; and (3) increase utilization of species least preferred in early winter (Heptner and Nasimovitch 1968, cited in Geist 1974). At depths greater than 90 cm, approximately chest height for standing moose, adquate food intake may become impossible (Coady 1974). It is, therefore, adaptive for moose to seek out areas of lesser snow depth.

An increase in use of dense vegetation and conifer cover during periods of heavy snow is frequently mentioned (Chamberlin 1972; Kelsall and Prescott 1971; Telfer 1970; Van Ballenberge and Peek 1971). The tendency for New Brunswick moose to travel in shallower snow under forest canopy increased with snow depth (Kelsall and Prescott 1971). Phillips et al. (1973) found a similar correlation between use of "tall-mature" habitat types and snow depth, in Minnesota, during the winter of 1969-70, but not in 1970-71.

Both Knowlton (1960) and Van Ballenberge and Peek (1971) suggest that moose readily move back to open cover during warmer periods after storms. Whether this is due to a more rapid increase in snow depth in open areas or reduced need for possible thermal shelter provided by the denser cover is not clear. Van Ballenberge and Peek (1971) also found a change in food habits from balsam fir, mountain maple (*Acer spicatum*?), and beaked hazel (*Corylus cornuta*), to willow, white birch, and aspen, during milder periods, suggesting that restricted movements caused by deep snow may force feeding on less palatable browse species.

In regions that commonly have more than 70 cm of soft snow, particularly the high western mountains and the Ungava plateau of Quebec, moose commonly concentrate in "yards". Yarding of moose in Quebec has been mentioned by Brassard et al. (1974) and Poliquire et al. (1977). Houston (1968) found concentrations of 50 moose/mi^2 (19.3 moose/km^2) in river valleys in Wyoming. In Scandinavia, moose will remain evenly distributed if snow depths are shallow but usually concentrate on lowlands near rivers, lakes, and valleys (Ahlen 1975). Similar movements to lowlands have been observed in British Columbia (Edwards and Ritcey 1956) and Montana (Knowlton 1960; Stevens 1970).

3.3 ESCAPE COVER

The exact role of cover in providing protection from predation is poorly understood. Le Resche et al. (1974) felt that small stands of mature timber were important escape cover for moose, and stressed the importance of extensive edge between prime feeding areas and escape cover. Knowlton (1960) concluded that coniferous timber on summer ranges served as escape cover. Observations by both P.C. Shelton (cited in Mech 1970) and Peterson (1955) suggest that dense cover is useful in preventing detection by predators, but once detected moose often move into deep water for protection.

Cover may be most important at and shortly after parturition. Peterson (1955) noted that cows sought out areas of seclusion or the protection of peninsulas and islands shortly after calving. Eight of the ten birth sites found by Stringham (1974) were located within at least moderately dense cover. The only consistent feature of birth sites located by Markgren (1969) was seclusion from the surrounding terrain.

Although cows are very protective of their calves, they frequently separate for short periods while the cow feeds. Young calves tend to remain in or near cover while their dam feeds in lakes or open meadows (Stringham 1974). As calves mature, dependence on cover decreases and the frequency of visits by calves to their dam, while the dam remains in the open, increases (Stringham 1974).

3.4 MINERAL LICKS

The importance of mineral licks in determining quality of moose habitat is not clear. Best et al. (1977) observed radio-tagged moose, in Swan Hills, Alberta, making special trips to licks during the spring while moving from winter to summer range. On Isle Royale, one lick was used during midwinter, but lick use was not frequent in summer (Jordan et al. 1973). McMillan (1953) recorded regular summer use of licks in Yellowstone National Park. Jordan et al. (1973) felt that moose were strongly motivated to use licks, based on their boldness when humans were present at licks.

The mineral content of licks is highly variable. Best et al. (1977) found sodium to be the only element at licks significantly different from surrounding soils. Sodium concentrations averaged 131 ppm. Mud lick soil on Isle Royale contained an average of 24 ppm sodium, and Jordan et al. (1973) felt that this was inadequate to meet the moose's sodium requirement. Four samples of Isle Royale lick water all contained calcium, iron, magnesium sulfates, and sodium chloride (Hosley 1949). Copper and manganese were the only elements consistently found in licks in western Canada (Cowan and Brink 1949). Of 14 licks in northern Ontario, analyses indicated that a majority contained high concentrations of nitrogen, sodium, potassium, calcium, magnesium, manganese, and iron (Chamberlin et al. 1977). Chamberlin et al. (1977) hypothesized that no single element serves to attract big game. To complicate matters further, minimum requirements and tolerances of minerals for pregnancy, growth, hair growth, and antler growth are still not established for moose.

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5. APPENDIX

Table 6. Scientific names of plant species mentioned in text and tables.

Common Names	Scientific Names
Alpine fir (Subalpine fir)	*Abies lasiocarpus*
Ash	*Sorbus* spp.
Aspen	*Populus tremuloides*
Balsam fir	*Abies balsamea*
Beaked hazel	*Corylus cornuta*
Bearberry	*Arctostaphylos uva-ursi*
Birch	*Betula* spp.
Bitterbrush	*Purshia tridentata*
Ceanothus	*Ceanothus velutinus*
Choke-cherry	*Prunus virginiana*
Cottonwood	*Populus* spp.
Cranberry	*Vaccinium vitis-idaea*
Current	*Ribes* spp.
Dogwood	*Cornus* spp.
Fire-cherry	*Prunus pensylvanica*
Huckleberry	*Vaccinium* spp.
Lichens	*Peltigera* spp.
Maple	*Acer* spp.
Mountain maple	*Acer spicatum*
Serviceberry	*Amelanchier alnifolia*
Snowberry	*Symphoricarpos albus*
Sticky geranium	*Geranium viscossissimum*
Thinleaf alder	*Alnus tenuifolia*
White birch	*Betula papyrifera*
Willow	*Salix* spp.

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