BEAKED HAZELNUT - A KEY BROWSE SPECIES FOR MOOSE IN THE BOREAL FOREST REGION OF WESTERN CANADA?

Garry C. Trottier
Canadian Wildlife Service, Western and Northern Region,
Rm. 1000, 9942 - 108 Street, Edmonton, Alberta, Canada T5K 2J5

Abstract: Beaked hazelnut (Corylus cornuta) is described as a key winter browse species for moose in the Boreal Forest region of western Canada. A review of the literature illustrates the importance of this shrub in moose diets at several North American locations and its contribution as a quality food item. The ability of hazelnut to withstand heavy browsing and to out-compete tree species following opening of the forest canopy are characteristics that should be exploited when planning moose habitat improvement programs in areas where this shrub is found.

A key forage species is one that can serve as an indicator of the degree of use of associated plant species, and which must, because of its importance, be considered in the management program (Society for Range Management 1974). Telfer (1978:464) states that key species are common and palatable, but not rare or highly sought after by the herbivore. Death of stems or severe reduction in yield of key species due to browsing indicates overuse of the range (Cole 1959).

The key species concept is relevant to moose (Alces alces) management because harvest strategies are partially based on carrying capacity and range condition. Range information is correlated with physical condition and productivity of the herd, to identify management requirements (Bergerud et al. 1968, Crichton 1977, 1979). In addition, manipulation of key browse species is implicit in habitat management programs.

The purpose of this paper is to suggest that beaked hazelnut (Corylus cornuta), hereafter referred to as hazelnut, should be recognized as a potential key species wherever it is abundant on moose winter range in western Canada. Hazelnut may be more important as moose food on western ranges than heretofore reported. Woody species most often cited as important for moose in the North American range are willows (Salix spp.) for western areas while paper birch (Betula papyrifera), aspen (Populus tremuloides) and balsam fir (Abies balsamea) assume importance on the eastern ranges (Peek 1974, Telfer 1978).

Recent studies of moose diets in western Canada by myself and my colleagues found hazelnut to be the most important winter food. Consequently, I felt there was a need to discuss the management implications of those results. Hazelnut has not been regarded as key browse for moose, although the area (the southern Boreal Forest) is one where moose management is active and hazelnut is a common understory shrub.

In this paper, I briefly review available information on habitat requirements, range and abundance, use by moose as food, nutritional value and response to browsing of hazelnut to substantiate its rating as a key browse species. A discussion of some apparent management implications and research needs is included.

ECOLOGY OF HAZELNUT

Habitat Requirements

Hazelnut is a shade intolerant shrub found mostly on well-drained upland sites with neutral or slightly acid soils (Gill 1957, Rosendahl 1955, Rowe 1956). It grows best in clearings and borders of mixed or deciduous woods but will also be found as the dominant understory of mature deciduous forest. A general rule is that hazelnut abundance is positively correlated with stand age due in part to optimum light penetration of the discontinuous tree canopy in mature and over-mature stands. Low light intensity in coniferous stands is chiefly responsible for high mortality while high intensity as in the open, favors vegetative multiplication but retards the height and shortens the life of hazelnut stems considerably (Hsiung 1951). This shrub is an indicator species for mesophytic (fresh) forest sites and will not tolerate very dry or very moist conditions (Hsiung 1951, Rowe 1956). Best soils for growth are light sandy-loam and loamy sand with a pH range of 5.6-6.1; heavier or lighter soils are not favorable to this species (Hsiung 1951). Temperature stress appears to be an important limiting factor. In north-central Ontario hazelnut is particularly abundant on fresh sites of ridge tops and south and west-facing slopes (MacLean 1960); similarly, in the more northerly areas of the Mixedwood Section (Rowe 1972) of Alberta, it is found only on protected south-facing exposures of river valleys where there are sufficient degree-days for successful reproduction (G. LaRoi, University of Alberta, pers. comm.). Both sexual and asexual reproduction are important; the former in range extension and invasion of new habitats since the seeds are relished by birds and mammals, and the latter (suckering) being the chief means of quickly repopulating within stands following disturbance (Hsiung 1951).

Range

Hazelnut is found over a large range in north-central North America from Newfoundland to British Columbia, south to Georgia, Tennessee, Kansas and Colorado (Fernald 1950). Northern extent of this range has not been defined; however, it appears little is found in the northern portion of the Mixedwood Boreal Forest (Scoggan 1957, G. LaRoi pers. comm.).

Important hazelnut range in western Canada is the belt of Aspen Grove and Aspen-Oak and southern portions of the Mixedwood forests (Rowe 1972) which extend from southwestern Manitoba westward through south-central Saskatchewan and into Alberta (Figure 1) (Waldron 1959). In the Mixedwood Section of Saskatchewan, hazelnut forms the dominant understory of the Poplar-Rose/Rye Grass, Poplar-Hazelnut, and Spruce-Poplar/Hazelnut forest types (Kabzems et al. 1976). Similarly, hazelnut dominates the Mixedwoods in southwestern Manitoba at Duck Mountain Provincial Park (Schewe in prep.), Riding Mountain National Park (Bailey 1968) and southeastern Manitoba (Mueller-Dombois 1964), and also the Aspen Grove Sections of Manitoba, Saskatchewan (Bird 1961) and Alberta (Moss 1955).

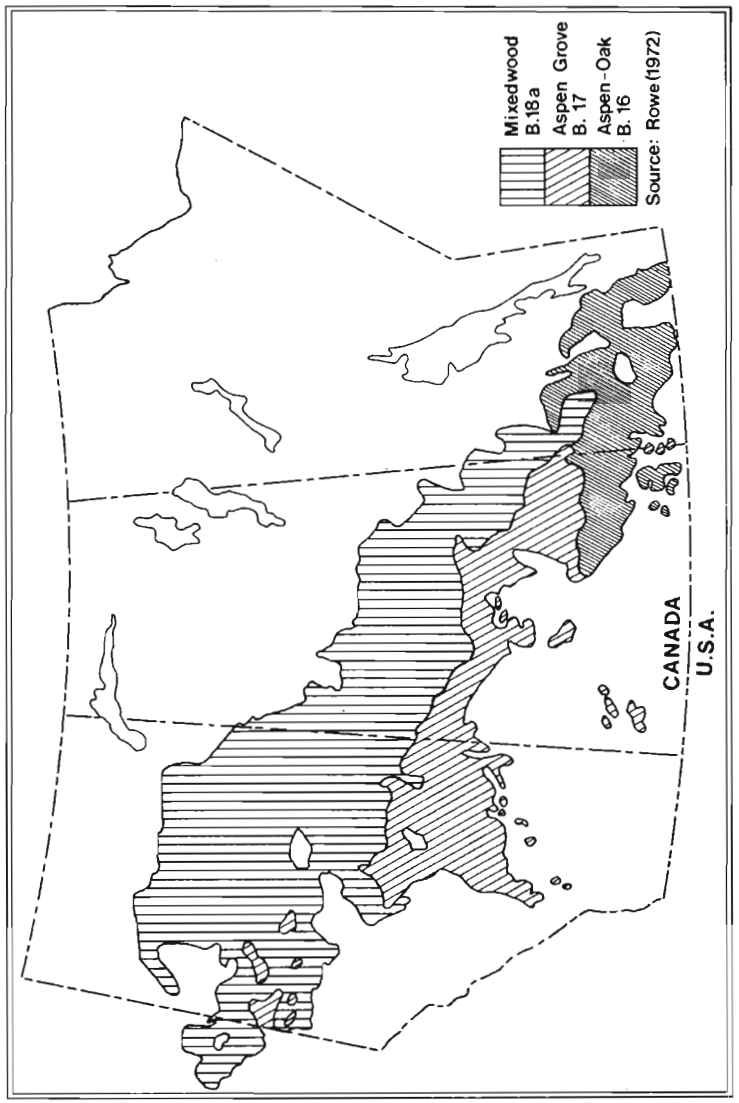

Figure 1. The Mixedwood, Aspen Grove and Aspen-Oak sections of the Boreal Forest in western Canada.

Hazelnut as a Food Item for Moose

Hazelnut has received little recognition as an important moose food (Peek 1974, Telfer 1978) despite its occurrence in moose diets from several North American locations. Based on information from Ontario, Minnesota and southern New Brunswick, Peterson (1955:133) described hazelnut as a preferred food eaten in all seasons and important wherever available in sufficient quantities. In northeastern Minnesota, hazelnut was heavily used during late winter when the availability of other browse was limited by snow thickness (Peek et al. 1976). In Isle Royale National Park moose feed on thick stands of hazelnut along open ridges (Krefting 1974, Allen 1979). On eastern Canadian range, moose eat hazelnut in Ontario (Cumming 1974, McNichol and Gilbert 1980), Quebec (Bedard et al. 1978, Crête and Jordan 1981), Newfoundland (Pimlott 1963) and Nova Scotia (Telfer 1967). Telfer (1967) rated moose preference for hazelnut over balsam fir and mountain maple (Acer spicatum) in a winter yard, but not as preferred as yellow birch (Betula alleghaniensis), sugar maple (Acer saccharum), red maple (Acer rubrum) and mountain maple over the entire winter range in Nova Scotia.

There is not much information on moose food habits for western Canada which is the possible reason why Peek (1974) did not list hazelnut as an important moose food on western ranges. The only reference to hazelnut for this region appeared in Peek (1974, citing J.E. Bryant pers. comm.) where he describes the importance of mountain maple, aspen and hazelnut in more southerly portions of Manitoba.

Crichton (1977) reports use of hazelnut by moose at Hecla Island, Manitoba, but red osier dogwood (Cornus stolonifera) was used as the key browse species.

Recent studies by Cairns (1976), Trottier and Hutchison (1980), and Trottier (in prep.) found hazelnut the most important moose food in restricted areas of central Alberta and southwestern Manitoba, respectively. At Elk Island National Park, Alberta 30% of the winter diet of moose was hazelnut followed by 23% willow (Cairns 1976), whereas hazelnut only ranked sixth in terms of total browse yield (Telfer 1977). At Riding Mountain National Park, Manitoba, hazelnut is the dominant tall shrub and was the most important moose food year-round, although greatest use was recorded during winter when up to 90% of the identifiable plant fragments in the feces collected during diet studies were hazelnut (Trottier and Hutchison ibid., Trottier in prep.). Schewe (Beak Consultants Ltd. in prep.) observed moderate use of hazelnut, the dominant shrub on upland sites, in Duck Mountain Provincial Park, Manitoba.

It must also be recognized that moose share hazelnut with other ungulates on sympatric range. Hazelnut was important in elk (Cervus elaphus), white-tailed deer (Odocoileus virginianus) and snowshoe hare (Lepus americanus) diets during winter in Riding Mountain National Park (Trottier in prep.) and has been recorded in white-tailed deer and elk diets at Elk Island National Park (Cairns 1976). Telfer (1972) and Skinner and Telfer (1974) noted that white-tailed deer and snowshoe hares browsed hazelnut in Nova Scotia.

Digestibility and Nutritional Value

Digestibility and nutritional contribution are important measures of forage quality. Conversely, preference indices determined by comparing plant utilization and availability are of questionable validity or utility because supply of some species is limited (Stoddard et al. 1975).

Proximate analyses for twigs of some moose foods from several North American locations are listed in Table 1. Comparisons are limited, however, by differences in sampling techniques and analysis, site conditions, climate and collection period. Furthermore the digestibility trials were specific for white-tailed deer. Given these limitations, the comparison nonetheless identifies those values which are consistently lower or higher and thus of nutritional significance.

Hazelnut exhibits nutritional parity with willow, aspen, and saskatoon (Amelanchier alnifolia), but appears to exceed red osier dogwood. Crude protein, so important to efficient rumen function, is not deficient in hazelnut. Conversely, hazelnut contains more crude fibre than aspen or red osier dogwood and would be less digestible. Pease et al. (1979) found less fat in hazelnut than in willow or aspen. Mautz et al. (1976) did consumption and digestibility trials with white-tailed deer and found that intake for hazelnut alone, and for diets containing hazelnut, was considerably greater than for diets tested which did not contain hazelnut. Similarly, protein digestibility was greater for hazelnut than for six other foods (Mautz et al. 1976) thus protein intake was optimized when hazelnut was available.

Table 1. Proximate analyses and apparent digestibility of some important moose foods (winter twigs).

Factor	Hazelnut					Willow			
Energy (cal/dry g)		45.3[1]							
Protein (% dry wt)	6.1[8]	7.0	7.7[2]	6.7[3]	11.8[4]	8.2[2]	7.0[5]	7.9[3]	6.4[8]
Nitrogen (% dry wt)			1.0			1.1			
Ash (% dry wt)		45.1							
Phosphorous (% dry wt)		0.1	0.2			0.3			
Potassium (% dry wt)	0.6		1.4			1.1			0.4
Calcium (% dry wt)	1.2		2.1			1.4			1.4
Crude fibre (% dry wt)				36.0	29.3			35.0	
Gross energy (K cal/g)					4.6				
Fat (% dry wt)	2.7								4.9
Apparent digestibility (%)									
Dry matter					32.2				
Crude protein					43.5				
Crude fibre					11.9				
Ether extract					54.3				
Metabolizable energy					28.7				
Net energy					35.1				

Table 1. Continued

Factor	Aspen						Saskatoon			Dogwood	
Energy (cal/dry g)							47.8[1]				
Protein (% dry wt)	8.7[2]	7.9[3]	8.1[5]	4.5[6]	6.5[7]	6.7[8]	7.1	6.0[5]	7.0[7]	6.2[5]	5.1[3]
Nitrogen (% dry wt)	1.4										
Ash (% dry wt)					3.5		2.9		3.6		
Phosphorous (% dry wt)	0.3			0.4	0.2		0.1		0.2		
Potassium (% dry wt)	0.7			1.8		0.5					
Calcium (% dry wt)	1.4			2.1	1.3	1.5			1.6		
Crude fibre (% dry wt)		28.4								30.0	
Gross energy (K cal/g)											
Fat (% dry wt)						9.8					
Apparent digestibility (%)											
Dry matter											
Crude protein											
Crude fibre											
Ether extract											
Metabolizable energy											
Net energy											

[1]Grigal and Moody 1980.
[2]Peek et al. 1976. (willow = pussy willow).
[3]Hellmers 1940. (dogwood = panicled).
[4]Mautz et al. 1976 (Digestibility for white-tailed deer).
[5]Stewart et al. 1977 (dogwood = red osier).
[6]McNamara 1979.
[7]Dietz 1972.
[8]Pease et al. 1979.

Peek et al. (1976) found that hazelnut contained considerably more calcium and slightly more potassium than willow or aspen. Mautz et al. (1976) reported that digestion of hazelnut provides high percentages of metabolizable energy. Superficially, there is no evidence that hazelnut is an inferior food for moose, although *in vivo* trials are needed to substantiate its true role.

Response to Browsing

Hazelnut is resistant to browsing pressure. Colonization and subsequent irruption of moose in Isle Royale National Park severely damaged the vegetation, but hazelnut was one of the few important shrubs that withstood heavy browsing and increased in abundance over a 25 year period (Krefting 1974). An irruption of elk in Riding Mountain National Park during the mid 1940's severely damaged willows, saskatoon, aspen, choke cherry (*Prunus virginiana*) and red osier dogwood. Hazelnut, the dominant shrub at that time, was browsed down to snowline but was still alive and healthy and appeared to be able to withstand heavy browsing (Banfield 1949). Presently, hazelnut is the dominant tall shrub in the Park, aspen and willow are in good condition, but, red osier dogwood has not recovered to former densities (Trottier in prep.).

Aldous (1952) observed considerable suckering in hazelnut plants subjected to heavy clipping while Bedard et al. (1978) recorded three to six-fold increases in stem density on seral winter range in Quebec, moderately browsed by moose. Banfield (1949) found that the amount of annual growth after heavy browsing was of the same order as the total annual growth on unbrowsed hazelnut. In all cases twig removal stimulated vigor and reproduction, whilst available browse increased as a result of vigorous adventitious growth of twigs and buds the following season.

Hazelnut appeared to be more resistant to heavy browsing than mountain maple and aspen and equal to willows, swamp birch (*Betula pumila*) and white birch based on clipping studies (Gill 1957). It should receive moderate to heavy browsing to maintain productivity and stimulate suckering (Gill 1957).

DISCUSSION

Moose management in the accessible and productive southern Boreal forests of western Canada is becoming more demanding and complex. Timber harvest, petroleum exploration and agriculture continue to alter or destroy moose habitat and create access to formerly undisturbed populations. Coincidentally, there is increased public demand for recreation and subsistence moose hunting. These limiting factors might some day be mitigated through habitat improvement if governments can be convinced to authorize sufficient funds, and since hazelnut is an important component of the vegetation throughout much of this region, it is important to identify management implications of the moose-hazelnut relationship.

Habitat Improvement

More attention must be given to manipulation of key shrub species if moose habitat improvement programs are to be successful. In Alberta (Usher 1978) and in Manitoba (Schewe in prep.), mixedwood stands have been manipulated to determine the practicability of providing trade-offs for moose habitat lost to industrial development. The objective of these experimental programs was to create small openings in the forest canopy in an attempt to stimulate browse production for use by wintering moose. Vegetation was cleared in winter by bulldozer with size of sites restricted to ensure accessible, adequate cover. In the Alberta tests, browse density peaked three years after treatment, following massive suckering by aspen and modest increases in density of white birch, willow, saskatoon, red osier dogwood and hazelnut (Usher 1978). Because aspen quickly grew beyond the reach of moose, Usher (1978) predicted available browse production would peak by year 15 then decline to pre-treatment levels as aspen grows to tree size. Recent work, however, has shown that this prediction may have to be adjusted downward (Usher pers. comm.). In any case, further treatment will be required.

The bulldozing treatment may have allowed aspen competitive advantage over shrubs, especially the key browse species. Aspen has evolved to successfully re-establish forest cover following disturbance (Farmer 1962, Eliasson 1971) and does not provide a stable food supply for browsing mammals (Banfield 1949, Gill 1957, Krefting 1974, Olmstead 1979). Adaptations which mediate this propensity to regenerate forest cover are dependence on efficient asexual reproduction (root and stem suckering) and accelerated leader and sucker growth (up to 150 cm in one growing season). Clearing dominant aspen cover from a site releases the entire lateral root system of those trees from apical dominance (Farmer 1962, Eliasson 1971). At the same time, the sparse understory shrubs are also cleared, but because the sucker producing root system is less dense, shrubs are at a numerical disadvantage. Aspen suckers grow more quickly and out-compete shrubs for light, moisture and nutrients while ungulate browsing pressure does not increase rapidly enough to check sucker growth.

Logging, both clear cutting and partial cutting, may have greater potential than clearing of brush and trees for long-term improvement of moose range. There is minimal disturbance of the shrub layer during logging as long as site preparation is avoided; therefore, tree suckers would have to compete with established shrubs in addition to withstanding increased browsing pressure from moose attracted to the site. Furthermore, allowance for residual aspen near shrub stands would suppress aspen suckering in the immediate area, yet provide cover.

Key shrubs such as hazelnut can be expected to out-compete tree seedlings and suckers by attaining greater density and production in response to removal of competing overstory and subsequent browsing pressure. Dense shrub cover shades the ground surface effectively suppressing soil temperature, thus limiting the ability of aspen to sucker (Bella and DeFranceschi 1972). Hazelnut successfully outcompetes softwood and hardwood tree regeneration for many years

following logging in areas of the Boreal Forest (Hslung 1951, Rowe 1955, Waldron 1959, MacLean 1960, Peek et al. 1976, Kabzems et al. 1976, Vallée et al. 1976, Bedard et al. 1978, Welsh et al. 1980). Trottier (in prep.) found that only 4% of the stems of dense hazelnut shrubland within Mixedwoods at Riding Mountain National Park were aspen. None of the aspen plants exceeded the mean height of other shrubs in these moderately browsed stands. Therefore, in contrast to the bulldozer treatment, browse production following logging treatment could be expected to increase and stabilize as long as browsing pressure is maintained, in which case further treatments would not likely be needed.

While it is important to increase browse production in order to improve moose habitat, maximizing production of key shrubs should be the priority objective. Areas supporting key browse species must be identified before sites are selected for improvement. Accordingly, site conditions must be carefully assessed, because as Usher (1978) pointed out, site was the major reason key shrubs were absent in some Alberta test areas. Removal of competing overstory must be conducted with minimal disturbance to the shrub layer.

Managing for increased density of hazelnut might be an important consideration for game ranching developments in the southern Boreal region because areas dominated by this shrub are capable of sustaining dense ungulate populations. For example, Riding Mountain National Park supports about 30 ungulates per 1,000 ha (13-14 moose per 1,000 ha) year round. The key winter range (80-150,000 shrub stems/ha) is dominated by hazelnut with lesser amounts of snowberry (Symphoricarpos albus), wild rose (Rosa acicularis), wild red raspberry (Rubus

strigosus), choke cherry, saskatoon, beaked willow (Salix bebbiana) and poplar (Populus spp.). The moose herd is increasing, the range is in excellent condition (Trottier in prep.) and 500-600 ungulates are taken annually near the Park boundary by hunters (D. Davies, Manitoba Dep. of Renewable Resources and Transportation Services, pers. comm.).

Although there has been little habitat disturbance in the Park since the mid 1960's, the entire area was selectively logged over the last 100 years and an irruption of elk severely damaged all browse species except hazelnut (Banfield 1949). These perturbations likely account for the dominance of hazelnut in contrast to nearby areas in southern Manitoba where hazelnut is common yet not the most important shrub. With these facts in mind then, I conclude that the Riding Mountain anomaly could be viewed as a model for habitat manipulation to increase game production in other similar areas.

In contrast to Riding Mountain, poplar, willow and white birch are more abundant than hazelnut on shrubland and forest edge sites in Elk Island National Park (Telfer 1977). Both parks appear to have similar parent materials, topography, glacial history, fire history and ungulate populations. The reasons for hazelnut dominating open sites in one area of its range and not in another of similar character should be investigated as the knowledge could provide insight on hazelnut management for range improvement.

Range Condition Evaluation

Moose managers must answer two questions before range conditions can be accurately rated. First, what is the diet of the moose herd and second, what are the more abundant shrub species on the range? Failure to address these questions leads to incorrect choice of key species and thus, incorrect assessment of range condition.

Should hazelnut be considered a key species when it is abundant on moose range but few stems are being browsed? The answer would appear to be yes because moose will switch to hazelnut as a staple food if severe winter conditions limit availability of other foods (Peek et al. 1976), or if other more palatable but rare shrubs are depleted by browsing (Krefting 1974). Furthermore hazelnut range maintains vigor under moderate to heavy browsing and is capable of supporting dense moose populations (Peek et al. 1976, Bedard et al. 1978, Trottier in prep.). In the situation given above, if hazelnut is not considered a key species, then it is possible the manager would wrongly attribute declining moose productivity to poor range condition because a few rare, highly palatable shrubs are severely hedged. However, winter severity, calf predation, disease, parasites or human disturbance should be investigated as possible limiting factors.

If in the future multi-species browsing systems are to be managed where hazelnut is one of the key species, allowance should be made for competitive coactions because hazelnut is useful winter food for elk, white-tailed deer and snowshoe hares. An increasing moose herd could damage key shrubs used by sympatric species, or competition from contemporaries may affect moose productivity.

Research Needs

Research is needed on the autecology and food-herbivore relationships of hazelnut. More definitive diet studies are needed in areas where hazelnut is available on moose range. The suitability of hazelnut as a moose food should be examined in more detail. What factors (edaphic, environmental, biological) contribute to optimal growth and range expansion of hazelnut? What constitutes a competitive advantage for hazelnut with respect to popular methods of vegetation manipulation (logging, bulldoze clearing, scarification, crushing, controlled burning) that serve to improve wildlife habitat?

CONCLUSIONS

1. Hazelnut is an important food for moose at many North American locations and should be considered a key browse species wherever it is abundant on moose range.
2. Ranges dominated by hazelnut will continuously support dense moose herds because this shrub is a nutritious food, it withstands heavy browsing pressure and when well established in thick, open stands, it out-competes invading tree species.
3. Hazelnut is a common understory shrub throughout much of the southern Mixedwood, the Aspen Grove and the Aspen-Oak sections of the Boreal Forest in western Canada. Many areas in this important moose range will have to be improved in the future to mitigate

habitat disturbance caused by industrial and agricultural development. Manipulation of key shrub species such as hazelnut must be part of future management plans.

4. Research on the autecology, biology and herbivore relationships of hazelnut is needed so that the species can be effectively managed to improve moose range where such action is warranted.

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