Impacts of Browsing on Key Wildlife Shrubs in British Columbia and Recommendations for their Use

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Wildlife Working Report No. WR-114
March 2005

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Wikeem, B., and S. Wikeem. 2005. Impacts of Browsing on Key Wildlife Shrubs in British Columbia and Recommendations for their Use. B.C. Ministry of Environment, Lands and Parks, Victoria, BC. Wildlife Working Report No. WR 114.

DISCLAIMER

NOTE: The content of this report was completed in March of 2003 and reviewed in 2004/2005, and reflects the state of our knowledge at that time. It has not been updated prior to publication 2011.

Information on current status of native species in British Columbia can be found through B.C. Species and Ecosystems Explorer http://www.env.gov.bc.ca/atrisk/toolintro.html

EXECUTIVE SUMMARY

Shrubs are a common landscape feature in British Columbia, providing forage, feeding sites, security cover, and breeding complexes for vertebrate and invertebrate species. Shrubs also bind soils with their roots, protect soils against wind and water erosion, and provide specialized habitat for plants and animals.

Grazing can be one of the most influential factors regulating shrub growth. Therefore, appropriate levels of browse use are essential to ensure the long-term productivity and sustainability of this resource for livestock and wildlife. The objective of this report is to review literature on the use as browse of important shrubs in British Columbia to help develop browse-use guidelines. The review is based on a combination of local literature from British Columbia and American literature and databases describing the autecology and management of important shrub species in the province.

The review found that browsing affects both the physiological processes and the physical structure of shrubs. Excessive browsing can be detrimental to individual plants, plant communities, soils, and animals. At low to moderate levels, however, browsing can enhance shrub production and improve forage quality and availability.

Although shrubs can be important food sources for Moose, Mule Deer, and White-tailed Deer on some ranges, they generally account for a low to moderate part of cattle diets in B.C. Most shrubs are relatively tolerant to browsing because of their deep root system, multiple stems, and height and their ability to resprout from root crowns.

Most shrubs are able to sustain annual defoliation of 25 to 65%. Proper use of key species is essential to sustaining browse resources, and browsing guidelines should reflect conservative levels of safe use on important associated shrubs as well.

In the past, browse-use guidelines have focused on trees and shrubs as primarily a source of forage for livestock and wild ungulates. More recently, other attributes, such as food and cover for non-ungulate wildlife, plant community values, biodiversity, soil protection, water quality, and maintenance of riparian features, have been incorporated into assessing shrub use on a landscape level.

The following recommendations are provided to help in establishing shrub-use guidelines for British Columbia:

1. Shrub-use guidelines should be applied on a site-specific basis described within Range Use Plans.
2. Management objectives for livestock and wild ungulates should be based on clearly defined objectives.
3. Shrub-use guidelines should consider other landscape features, such as herbaceous forage use, soil disturbance and erosion, and stream bank characteristics, as complementary criteria for determining proper use.
4. All standards for assessment should be based on scientifically acceptable knowledge.
5. Browse standards should be associated with key browse species that are dominants on the site, of high forage value to one or more ungulates, and/or valuable as indicators for management.

6. Moderate levels of forage use of 25 to 65% appear to be adequate to sustain populations of most key upland shrub species in B.C.
7. Some shrub species can sustain more than 50% defoliation. Higher levels of use can be justified for these species on some sites, providing it will not adversely affect other resource values.
8. Shrub-use standards should be based on the combined use of all ungulates during the active growing period.
9. Guidelines should be flexible and have provisions for change at the discretion of the statutory decision maker.
10. Any strategy adopted must be monitored to ensure its effectiveness and allow management practices to be adjusted as required.

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1 INTRODUCTION

Shrubs are a common landscape feature in British Columbia (B.C.) and a floristic component of all biogeoclimatic zones (Meidinger and Pojar 1991). Some shrubs, such as big sagebrush (*Artemisia tridentata*) and bitter-brush (*Purshia tridentata*), are dominant species in drier parts of the province in the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones. Similarly, willows (*Salix* spp.) are often principal shrubs in riparian habitats and in burned-over areas, particularly in northern B.C. (Meidinger and Pojar 1991). Other species such as alder (*Alnus* spp.) can dominate mesic forest sites after logging, fire, and other disturbances.

Shrubs are used by many animal species for food and cover. Their relative importance to animals, however, varies depending on the habitat requirements of animals, and the structure and palatability of shrubs. Grazing is one of the principal factors affecting rangeland ecosystems (DeVos 1969), and when shrubs are palatable, browsing may be an important influence regulating their populations. Therefore, appropriate levels of browse use are essential to ensure the long-term productivity and sustainability of this resource for livestock, wildlife, and other resource values.

2 OBJECTIVES

In 2002, the government of B.C. initiated a review of the regulations to the *Forest Practices Code of British Columbia Act* including standards for shrub use. The principal objective of this report is to review literature on browse use of important shrubs in B.C. to assist in developing browse-use guidelines.

3 MORPHOLOGICAL CHARACTERISTICS OF SHRUBS

Orshan (1989) defined shrubs as plants with lignified stems that do not develop on a distinct main trunk. Welch (1989) suggested “two morphological characteristics set shrubs apart from grasses and forbs: a deep and extensive root system, and a rigid and tall stature.” Although these are important features of shrubs, other attributes such as the location of meristematic tissue, position of buds and photosynthetic tissue, life span and longevity, and reproductive adaptations contribute to their ability to compete with other life forms and tolerate disturbance (Daubenmire 1968; Stoddart et al. 1975).

Most shrubs are deeply rooted and capable of acquiring water and nutrients from deeper in the soil profile than most grasses and broadleaf herbs. Consequently, re-growth is possible during the growing season even if drought conditions prevail for shallow-rooted species (Stoddart et al. 1975; Welch 1989). Moreover, deeply rooted plants are generally long-lived with a lower requirement for seed and vegetative reproduction as mechanisms for recruitment of new individuals into the population.

Shrubs range from less than 1 m to more than 8 m tall, depending on the species, climate, and soils. For many shrubs, their height provides a competitive advantage over lower shrubs and herbaceous plants because the most active leaves for photosynthesis are above other species (Daubenmire 1968).

Additionally, many of these leaves may be above the reach of large browsing animals although they remain available to small herbivores such as insects.

Unlike on shrubs, apical buds on grasses arise near, or below, the soil surface and once they have been removed, there is little opportunity for re-growth (Jameson 1963). In contrast, most forbs and shrubs produce meristematic tissue on the tips of the current annual growth (Stoddart et al. 1975). Virtually all buds on grasses and forbs are exposed to grazing, but meristematic tissue on shrubs is often unavailable to herbivores. On many shrubs, new buds and growing points may be completely protected from browsing damage by the height and growth form of the plant (Rutherford 1979). This protection may be enhanced by thorns and spines that limit use by some herbivores.

Generally, growth stops when meristematic tissue is removed from grasses and forbs, but most shrubs can produce new shoots from buds on previous year's wood, even when the current annual growth has been heavily cropped (Stoddart et al. 1975). Browsing on terminal buds often removes apical dominance and stimulates lateral branching if pruning occurs early in the growing season (Kozlowski 1964). Several important browse species in B.C., such as bitter-brush (Hormay 1943; Tueller and Towers 1979), Scouler's willow (*Salix scouleriana*; Argus 1957; Viereck and Dyrness 1979), saskatoon (*Amelanchier alnifolia*; Campbell et al. 1974), red-osier dogwood (*Cornus stolonifera*; Roath and Krueger 1982), and Douglas maple (*Acer glabrum*; Haeussler et al. 1990), are capable of resprouting after early-season browsing.

Shrubs are generally a more dependable food source for herbivores than grasses and forbs, providing leaves, buds, and twigs as food during active growing periods. After dormancy, they offer cured stems as fall, winter, and spring forage. Additionally, woody stems remain available when deep snow makes other plants inaccessible (Welch 1989).

4 IMPORTANCE OF SHRUBS AS FORAGE AND HABITAT

Both cattle and wild ungulates use shrubs for food and cover, but they may be more important for wildlife than cattle on important ungulate winter ranges. Indeed, Julander (1937) stated that "browse holds a more critical place than any other class of forage on ungulate winter ranges"; likely because of its nutritive value, cover potential, and relative availability under deep snowfall conditions. Appendix 1 provides detailed summaries of the values of important browse species in B.C.

4.1 Forage Value of Shrubs

Like grasses and forbs, the nutritional quality of shrubs varies throughout the growing season and among shrub species. Woody plants, however, generally maintain higher levels of protein, phosphorus, carotene, lignin, and fibre in winter (Wilson 1969; Welch 1989). In addition, the nutritive content of shrubs declines less from summer to winter than in grasses and forbs. Research on the chemical contents of shrubs in B.C. confirm this generalization for saskatoon, baldhip rose (*Rosa gymnocarpa*), Barclay's willow (*Salix barclayi*), soopolallie (*Shepherdia canadensis*), birch-leaved spiraea (*Spiraea betulifolia*), black huckleberry (*Vaccinium membranaceum*), and common snowberry (*Symphoricarpos albus*), Wyeth's buckwheat (*Eriogonum heracleoides*), snow buckwheat (*E. niveum*), prairie sagewort (pasture sage, *Artemisia frigida*), and big sagebrush in the Thompson and Okanagan valleys (McLean and Tisdale 1960; Wikeem 1984).

4.2 Habitat Value of Shrubs

Woody plants provide forage, feeding sites, security cover, and breeding complexes for a wide range of vertebrate and invertebrate species (Rutherford 1979; Urness 1989; Keigley et al. 2002). Additionally, they supply thermal cover, protecting animals from cold in winter and heat in summer. For birds, they afford perching sites, nesting habitat, and foraging opportunities for plant parts and insects (Welch 1989). They also bind soils with their roots, protect soils against wind and water erosion, and furnish refugia for plant and animal species that require specialized habitats (Longland and Bateman 2002).

4.3 Value of Shrubs for Biodiversity and Hydrological Functions

Kauffman and Krueger (1984) suggested that riparian/stream ecosystems are the most productive wildlife habitat in Oregon, providing water, food, and cover. Among other things, they also serve as biological filters that "provide sustained clean water for plant growth, fish, and wildlife habitat" Hennan (1998).

Riparian habitats generally have a high diversity of plants and animals relative to upland communities. Shrubs are often, but not always, a dominant feature of these communities, providing structural diversity in habitats for wildlife (Kauffman and Krueger 1984; Finch 1987). Indeed, more than 114 species of birds depend on wetlands in B.C. for nesting, escape cover, food, and resting habitat during migration (Spalding et al. 1998). Overhanging shrubs shade streams and lake edges, provide escape cover for fish, and produce organic matter important for fish habitat (Youngblood et al. 1985; Hansen et al. 1989).

Little is known about the relationship between browsing on shrubs in riparian habitats and the hydrology of these systems. Zeigenfuss et al. (2002) speculated that Elk browsing on willows contributed to hydrologic changes in Colorado wetlands. They reported that the stream surface decreased by up to 70% over 50 years as willow cover was reduced by 20% in response to increased Elk browsing. Although they described this apparent correlation, they also pointed out that Beaver activity, and their ponds, had declined by 94% over about the same period, which could account for the declining willow population as the water table receded. Singer et al. (1994) reported similar losses in willow production in Yellowstone National Park, which they attributed to reduced water tables because of a decline in the Beaver population.

Loss of riparian habitat can result in significant declines in wildlife populations. For example, Kauffman and Krueger (1984) reported that 72% fewer avian species, and 93% fewer birds of all species, were found on riprapped areas adjacent to undisturbed riparian habitats in California. Similarly, Taylor (1986) reported that passerine bird species richness decreased with increased grazing pressure. Conversely, bird abundance increased when shrub volume and height increased.

5 IMPLICATIONS OF BROWSING

Browsing affects both physiological processes and the physical structure of shrubs. Excessive browsing can be detrimental to individual plants, plant communities, soils, and the animals that depend on shrubs. At low to moderate levels of use, browsing can enhance above-ground

production of many shrub species and improve forage quality and availability for other herbivores (Young and Payne 1948; Perala 1979; Roath and Krueger 1982).

5.1 Effects of Defoliation

The most immediate effect of browsing during the growing season is the removal of twigs, buds, and leaves, which can reduce photosynthesis and alter the plant's capacity to manufacture and store carbohydrates (Jameson 1963; DeVos 1969; Anderson 1977). All plants tolerate defoliation to a critical point, but beyond this threshold, physiological processes are impaired. Although the amount of foliage removed is a significant factor, the timing and frequency of use are also important factors that determine browsing impacts (Heady 1975).

Trlica et al. (1977) found that intensive defoliation (90%) of bitter-brush and pasture sage during fruit development, seed shatter, and near dormancy significantly reduced herbage yields, plant vigour, and basal stem carbohydrate levels. Herbage yields were reduced by 50% or more on pasture sage plants that had only a single, heavy defoliation, and multiple defoliations reduced plant height by 75% (Buwai and Trlica 1977). Similarly, Singer et al. (1994) found that willow yields decreased by 75% on shrubs that were repeatedly and heavily browsed by Elk in Yellowstone National Park.

The season of defoliation can have significant effects on carbohydrate deposition for some shrubs. Donart and Cook (1970) found that little rabbitbrush (*Chrysothamnus viscidiflorus*) and snowberry (*Symphoricarpos vaccinoides*) clipped early in spring recovered from defoliation, and carbohydrate root reserves were higher than controls later in the growing season. In contrast, root reserves were lower than controls in plants that were intensively clipped when carbohydrates were high, and they remained low throughout the growing season. Wright (1970) reported similar results for big sagebrush in Utah.

Repeated high-intensity defoliation during the active growing period can reduce plant vigour; modify the timing of flowering, fruit set, and seed production; and reduce recruitment of new plants into the population. Moreover, mature plants will eventually die, ultimately resulting in floristic changes in plant community (Jameson 1963; DeVos 1969; Anderson 1977).

Relatively few studies have documented carbohydrate cycles and the implications of browsing on carbohydrate metabolism, accumulation, and depletion resulting from grazing for most shrub species. Willard and McKell (1973) reported that carbohydrate reserves were reduced when little rabbitbrush and snowberry were clipped at 30, 60, and 90% of foliage removal, even though twig lengths on most clipped plants exceeded those on unclipped plants.

Clipping studies suggest that complete rest in late phenological stages during some years may be required to maintain the health of pasture sage (Buwai and Trlica 1977; Trlica et al. 1977). Even after 26 months of rest, some plants had not fully recovered their vigour, and herbage yields remained lower than unclipped plants.

5.2 Physical Impacts of Browsing

Browsing animals can physically damage shrubs by rubbing bark and breaking stems, uprooting seedlings and small plants, and by compacting soils. Additionally, they can change plant size and growth form, which can reduce foliage cover that protect soils and provides habitat for other animal species (Dasmann 1951; DeVos 1969; Anderson 1977).

Under unbrowsed or lightly browsed conditions, shrubs assume their natural form in response to habitat conditions. Heavy browsing over a long period, however, can change the form of the shrub. Many of these shrubs become tightly hedged or high-lined, often with dead stems standing within the plant (Julander 1937; Dasmann 1951). Several important browse species in B.C., such as saskatoon, choke cherry (*Prunus virginianus*), willow, Douglas maple, and redstem ceanothus (*Ceanothus sanguineus*), are susceptible to these changes.

Living terminal buds are often absent on heavily cropped plants, and lateral budding may not be possible. Consequently, some plants grow above ungulate reach and are unavailable for browsing unless snow, or the animals, can force down tall stems (McCulloch 1955). Not only does excessive browsing alter forage availability, but it also reduces the carrying capacity of the range.

The relationship between shrub size and animal height also affects the susceptibility of plants to browsing damage. Leaves and reproductive organs are generally beyond ungulate reach on tall shrubs (>1.5 m), and most of the active photosynthetic surface is relatively unaffected by browsing (Jameson 1963). As a result, overall damage may be minimal, even when shrubs are heavily browsed within the zone of available forage.

Medium and small shrubs (<1.5 m) can be predisposed to both browsing and trampling damage with overuse. Leaves, stems, and new shoots arising from roots are all available for herbivores, and excessive use around these plants can compact soil, inhibit water percolation into the soil, and reduce root growth (DeVos 1969). Small shrubs, which are entirely within reach of browsing animals, are susceptible to complete defoliation of leaves and stems, and are readily trampled. Moreover, plants may be pulled from the soil during browsing because their shallow root systems are shallower than tall and medium shrubs (Anderson 1977).

5.3 Beneficial Impact of Browsing

Although heavy browsing can adversely alter plant communities for some plant and animal species, other species often benefit from environmental changes. Urness (1989), for example, reported that White-tailed Deer were rare in Texas grasslands before settlement. Heavy livestock grazing greatly reduced fire frequency and shifted successional patterns to favour woody plants, which provided ideal habitat for shrub-adapted wildlife species. Similar circumstances have occurred in B.C. for Moose (Ritcey 1965), Mule Deer, White-tailed Deer, and Elk where fire, logging, and cattle grazing have promoted shrub communities (Wikeem and Ross 2002b).

Some shrubs require defoliation and pruning to maintain their vigour. Tueller and Towers (1979) reported that above-ground production was 70% lower on bitter-brush plants that were protected from grazing for 9 years than on grazed plants, and some plants became stagnant after only 2 years of full protection from browsing.

Many shrub species are highly tolerant of defoliation and react favourably to browsing within limits. Aldous (1952) found that some willows responded to annual use of 50% of the twig length by increasing production up to 250% over unbrowsed plants. Other species, such as Douglas maple (Haeussler et al. 1990), red-osier dogwood (Perala 1979), redstem ceanothus (Miller 1976), and bitter-brush (Hormay 1943; Tueller and Towers 1979) react similarly to clipping. Garrison (1953), however, cautioned that “spectacular as terminal twig

removal may be in stimulating shrubs to greater twig production…twig harvesting can become a devitalizing process if carried on at too great an intensity for too long a time."

Disturbance by grazing animals may enhance conditions for shrubs and animals in other ways as well. For example, grazing results in some plants, such as willow, saskatoon, and redstem ceanothus, resprouting from their roots, which makes forage more available to smaller browsers (Campbell et al. 1974). Similarly, trampling enhances germination for some plant species by setting seeds in the soil and removing competitive vegetation (DeVos 1969).

6 FACTORS TO CONSIDER IN SETTING BROWSING STANDARDS

Key browse species are those that are most important to livestock and wild ungulates for food (Kothmann 1974). Usually, these species are also of managerial importance because they have indicator value. Although most ungulates can subsist on non-preferred forages, the loss of key plant species from a range is generally synonymous with decline in carrying capacity (Dasmann 1951). Julander (1937) stated that "management cannot be based upon all species or upon general types. Under such practices the highly palatable plants are likely to disappear gradually and the carrying capacity of the range will be undermined before it is detected."

Proper use of key species is essential to sustaining browse resources, and browsing guidelines for them should reflect conservative levels of safe use on important associated shrubs. Three fundamental points should be determined:

- What are the key species for wild ungulates and livestock?
- What constitutes proper use of plants?
- How can the degree of use be measured and used as a guide to proper stocking?

6.1 Animal Preferences

Forage preference is an important factor determining the degree of use on specific shrub species. Generally, preferred plants are more likely to be eaten than non-palatable species, and consequently they are more susceptible to browsing (Welch 1989). In addition, shrubs that are palatable to several herbivores using the same range are more vulnerable to overuse than those preferred by a single browser.

Many studies have measured the proportion of browse in ungulate diets compared to other forage classes and there is considerable variation among ungulate species, among populations in different habitats, and among individuals within populations. Browse composition in diets also varies by season, habitat type, and the floristic composition of herbage available to animals (Heady 1964; Wilson 1969).

Most ungulates feed selectively and choose forage classes (grass, forbs, or shrub), individual species, and specific plants within a species among the variety of alternatives available to them. In addition, animals preferentially choose buds, leaves, and certain palatable stems on individual shrubs. Consequently, some stems are browsed more heavily than others, and other branches on the same plant may not be browsed at all (Heady 1964; Klein 1969; Telfer 1972).

Stoddart et al. (1975) presented seasonal forage preferences of Mule Deer, White-tailed Deer, Elk, and Moose. In general, shrubs are most important to Moose as a food source, providing more than 70% of their summer, fall, and winter diets and up to 99% of their winter

forage. Mule Deer (74%) and White-tailed Deer (59%) also use browse significantly in fall and winter, whereas Bighorn Sheep (25%) and Elk (25%) tend to browse less (Stoddart et al. 1975). Food habit studies have been conducted for most ungulates in B.C. (Singleton 1976; Willms et al. 1978; Wikeem and Pitt 1992; Ross 1997), and browse-use patterns follow similar trends to those in the U.S.

Although shrubs can be an important food source for cattle (Schulz and Leininger 1990), they generally account for a low to moderate part of their diet, but considerable variation exists among seasons, sites, and shrub species (Wilson 1969; Kauffman et al. 1983). Kingery et al. (1996) studied dietary overlap among cattle, Elk, and White-tailed Deer in Northern Idaho. They concluded that competition between Elk and cattle was possible in some habitat types, but there was virtually no dietary overlap for shrubs. Indeed, cattle did not use key browse species such as saskatoon, baldhip rose, falsebox (*Pachistima myrsinites*), birch-leaved spirea, common snowberry, or willows. Although White-tailed Deer ate more browse species than Elk, there was no dietary overlap for shrubs with cattle either. Low levels of shrub use by cattle was attributed to the availability of Kentucky bluegrass (*Poa pratensis*) and sedges (*Carex* spp.), which cattle preferred to shrubs.

Ross (1997) reported similar results from four wildlife winter ranges in the East Kootenay. Except for bitter-brush, all other shrubs averaged less than 4% of spring, summer, and fall cattle diets between 1992 and 1994, even though all shrubs present were eaten at one time or another. Bitter-brush made up almost 23% cattle diets in July 1992 at Skookumchuck Prairie and 7% of their diet in August 1993 at Premier Ridge. This species, however, occupied less than 2% of their diets at all other sites, seasons, and years between 1992 and 1994. Individually, other species such as soopolallie, saskatoon, snowbrush, rose, and willow provided less than 3% of cattle diets over the three-year study (Ross 1997).

Quinton (1984) found that shrubs averaged 9% of cattle diets over three years on clearcuts in the Engelmann Spruce-Subalpine Fir zone north of Kamloops, B.C., but only 19 of the 28 shrub species available were eaten by cattle. Cattle used browse most in September when willow alone comprised 26% of their diet. Other browse species, such as birch-leaved spirea (*Spiraea lucida*; syn. *S. betulifolia*) and trembling aspen (*Populus tremuloides*), were negligible in their diet (Quinton (1984).

Willms et al. (1978) reported that cattle used a wide range of shrubs on Interior Douglas-fir forest range near Kamloops. Browse use of saskatoon, aspen, and willow increased linearly as grazing pressure increased from low to high. Browsing eventually declined as the most available stems were eaten. Bearberry (*Arctostaphylos uva-ursi*), soopolallie, and birch-leaved spirea were eaten sparingly (Willms et al. 1978).

No research has been conducted comparing cattle and Moose diets on B.C. rangelands. Dorn (1970), however, found no significant competition between Moose and cattle for browse in southwest Montana. Important shrubs on B.C. wildlife winter ranges, such as scrub birch (*Betula pumila*, synonym low birch) plane-leaved willow (*Salix planifolia*), Bebb's willow (*S. bebbiana*), and red-osier dogwood (*Cornus stolonifera*), were not used in common by cattle and Moose. Moose did not eat wolf willow (*S. wolfii*), which accounted for more than 50% of the browse used by cattle. Moreover, most of the browse used by cattle was less than 1.5 m tall and unavailable for Moose in winter because it was covered by snow.

Potential competition for forage is often an important consideration in setting forage-use guidelines. More than 33% of the shrubs surveyed in this review were rated as good to excellent for Moose but only 19% for cattle (Appendix 1). Plane-leaved willow, serviceberry willow, saskatoon, and snowberry were the only species ranked as good or excellent for both cattle and Moose, suggesting that competition is possible for these species on some ranges.

Similar dietary overlaps have been shown for deer and cattle, and Elk and cattle in B.C. (Willms et al. 1978; Ross 1997; Wikeem and Ross 2002b). For example, Wikeem and Ross (2002b) reported that browse accounted for 24 to 98% of Mule Deer and White-tailed Deer winter diets at Skookumchuck Prairie, with bitter-brush and snowbush (*Ceanothus velutinus*) dominating their diets. In contrast, soopolallie, low Oregon-grape, and Douglas-fir (*Pseudotsuga menziesii*) made up 35% of Elk diets in winter, whereas all shrubs combined were used only sparingly by cattle in summer and fall. Wikeem and Ross (2002b) concluded that although dietary overlap implies competition, it is only one factor in determining whether competition exists or not. Indeed, spatial and temporal overlaps of herbivores, the degree of forage use, and the relative choices available to herbivores are also critical criteria.

6.2 Shrub Tolerance to Browsing

Most shrubs are relatively tolerant to browsing because of their deep root system, multiple stems, and height, and their ability to resprout from root crowns (Bedunah et al. 1995). Several factors influence the amount of use shrubs can tolerate including climate, site conditions (soils, slope, aspect, and elevation), current vigour of the plant, timing and method of browsing (including annual variations in the degree of use), and the adaptability of shrub species to browsing (Julander 1937).

Many clipping trials have been conducted in the U.S. to evaluate the effects of different intensities, frequencies, and seasons of browse use on shrubs (Julander 1937; Young and Payne 1948; Aldous 1952; Garrison 1953; Lay 1965; Buwai and Trlica 1977). These studies have included many important browse species from B.C. (Table 1; Appendix 1), which can help establish browsing guidelines in this province. Nonetheless, information gained from American studies must be extrapolated cautiously and adapted to B.C. conditions on the basis of local knowledge and professional experience.

Clipping trials indicate that many shrub species can sustain annual twig use of 25 to 65%. In Oregon, Garrison (1953) investigated clipping impacts on bitter-brush, rabbitbrush, and snowbrush. He found that bitter-brush production was highest when it was clipped to 75% of annual growth, and recommended 60 to 65% use for this shrub on favourable sites, and 50% use on poorer sites. Similarly, he found that common rabbit-brush remained productive at 75% use, but suggested that 50% use would allow this species to maintain good vigour.

Although snowbrush was equally productive when clipped at 25 or 50% of annual twig production, Garrison (1953) recommended 35 to 40% as a safe level of use. Young and Payne (1948) suggested that 60 to 65% use was sustainable for saskatoon, Utah honeysuckle, and rose.

Table 1. Suggested levels of tolerance to browsing of selected shrub species in B.C. based on literature surveyed.

Scientific name	Common name	Tolerance to browsing
Tall Shrubs (>1.5 m)		
Acer glabrum var. douglasii	Douglas maple	25–70% [a]
Alnus incana	mountain alder	— [b]
Amelanchier alnifolia	saskatoon	25–70% [a]
Betula occidentalis	water birch	—
Betula pumila	scrub birch (synonym low birch)	—
Cornus stolonifera	red-osier dogwood	25–50%
Populus tremuloides	trembling aspen	60–65%
Prunus virginiana	choke cherry	25–70% [a]
Salix bebbiana	Bebb's willow	25–70% [a]
Salix planifolia	plane-leaved willow	25–70% [a]
Salix pseudomonticola	serviceberry willow	25–70% [a]
Salix scouleriana	Scouler's willow	25–70% [a]
Sambucus cerulea	blue elderberry	25–70% [a]
Sambucus racemosa	red elderberry	25–50%
Medium Shrubs (0.5 – 1.5 m)		
Artemisia tridentata	big sagebrush	25–50%
Ceanothus sanguineus	redstem ceanothus	35–40%
Ceanothus velutinus	snowbrush	35–40%
Ericameria nauseosus syn. *Chrysothamnus nauseosus*	common rabbit-brush	50%
Lonicera involucrata	black twinberry	—
Lonicera utahensis	Utah honeysuckle	60–65%
Purshia tridentata	bitter-brush	60–65% good sites 50% poor sites
Ribes lacustre	black gooseberry	—
Rosa acicularis	prickly rose	—
Rosa gymnocarpa	baldhip rose	High tolerance
Rosa woodsii	Wood's rose	Fairly high
Rubus idaeus	red raspberry	—
Rubus parviflorus	thimbleberry	—
Shepherdia canadensis	soopolallie	—
Symphoricarpos albus	common snowberry	Resistant to heavy grazing
Vaccinium membranaceum	black huckleberry	—
Vaccinium ovalifolium	oval-leaved blueberry	—
Vaccinium parvifolium	red huckleberry	50–70%
Vibernum edule	high-bush cranberry	—

Scientific name	Common name	Tolerance to browsing
Small Shrubs (<0.05 m)		
Arctostaphylos uva-ursi	bearberry	—
Artemisia frigida	pasture sage	50%
Mahonia aquifolium	tall Oregon-grape	—
Pachistima myrsinites	falsebox	—
Spiraea betulifolia	birch-leaved spiraea	—
Vaccinium scoparium	grouseberry	—

[a] Suggested tolerances to browsing by vigorous plants during mild (25%), "average" (50%), and severe (70%) winters (Cole 1959).

[b] No information available.

Lay (1965) studied the effects of clipping six shrub species at 25, 50, 75, and 100% removal of current annual growth at monthly intervals over 10 years in Texas. He observed that among species, resilience to use was highly variable, and that some species maintained production with 50% (or more) clipping better than others with 25% defoliation. For example, greenbrier (*Smilaxes tundifolia*), American cyrilla (*Cyrilla racemiflora*), and large gallberry (*Ibex coriacea*) sustained monthly clippings of up to 100% defoliation (Lay 1965). Regardless of these high levels of tolerance, Lay (1965) concluded that 25% use was an optimum for most species studied. Although none of these species occur in B.C., his conclusion supports previous research suggesting that shrub tolerance to browsing usually falls between 25 and 65% use. In Montana, Cole (1959) suggested that saskatoon, Douglas maple, willow, bitter-brush, choke cherry, big sagebrush, and common rabbit-brush (*Chrysothamnus nauseosus*) could sustain about 70% leader use on vigorous shrubs during severe winters, 50% during "average" winters, and 25% during mild winters.

6.3 Other Factors to Consider

Despite the importance of tolerance thresholds to browsing, other factors are also important to consider is establishing browsing standards.

Defoliation by all browsers

Research on shrub tolerance to browsing documents absolute amounts of defoliation and subsequent impacts on shrubs irrespective of the browsing animal (Aldous 1945; Young and Payne 1948; Garrison 1953). Where two or more ungulates share a common range, shrubs will respond to the total defoliation resulting from all browsing animals. Occasionally this may be difficult to quantify, however, because defoliation may occur over several seasons. In addition, the effects of browsing may vary as particular animal species express forage preferences for individual plants and plant parts. Moreover, the relative impacts of seasonal defoliations vary considerably depending on whether plants are actively growing or dormant.

Forage availability on common-use range

Many low-elevation ranges in B.C. are used by cattle and one or more wild ungulates (Willms et al. 1978; Ross 1997). Forage-use standards should consider seasonal forage demands of all ungulates using the range, particularly on critical wildlife winter ranges. Proper use factors should be based on shrub tolerances, but they must ensure that adequate browse remains on the winter range to meet ungulate winter forage requirements.

Requirements for non-ungulates and soil protection

Consideration for other values such as food and cover for birds, small mammals, and soil protection are likely not incremental beyond conservative standards for browsing. For example, if a key shrub species, such as saskatoon, can tolerate up to 65% defoliation (Young and Payne 1948) without threatening the physiological well being of the shrub, then establishing a standard of 35 to 50% use should accommodate these other factors. Lower levels of shrub use may be necessary where additional cover is required for sensitive species, to mitigate soil erosion, or to ensure carryover of berry crops on certain shrub species such as

saskatoon, common snowberry, red and blue elderberry, and choke cherry for winter use by birds and small mammals.

Herbaceous forage use

Browse often becomes a larger component of cattle diets as the availability of palatable understorey forage declines (Willms et al. 1978; Roath and Krueger 1982; Kauffman et al. 1983; Quinton 1984). For example, Kauffman et al. (1983) observed that cattle did not begin browsing on shrubs until stubble heights of herbaceous forages were reduced below 5 cm. Hall and Bryant (1995) also reported that cattle began browsing willow when herbaceous forages were grazed below a 10 to 15 cm stubble height, and shrub use quickly became excessive where herbaceous species were grazed below this threshold. From a management perspective, adhering to proper use guidelines for herbaceous forages in mixed shrub/herbaceous stands may mitigate overuse of shrubs on some sites.

Present condition of plant community

Information about shrub tolerances to browsing usually apply to plants in high vigour, and lower standards may be required when there has been a long history of browsing on existing shrub communities. In some cases, shrubs may require full protection from browsing, whereas on other sites, lower levels of use might be adequate to restore plant vigour.

Site-specific factors

Shrub tolerances to browsing can vary among sites. Mature plants, receiving direct sunlight, will usually tolerate moderate hedging and remain productive. Site factors can also modify the relative availability of forages. For example, willows may be heavily cropped at accessible points along the margins of meadows. Cattle, however, may not use the remaining shrubs in the meadow because water depths and wet soils prevent browsing. Consequently, there will be little impact from cattle grazing on the availability of browse for other ungulates such as Moose.

Management objectives

Specific management objectives may over-ride shrub-use guidelines that are based on providing and protecting shrub populations with forage values as the highest priority. Grazing guidelines should be tailored to specific objectives and may vary even for a single shrub species.

7 SHRUB-USE GUIDELINES IN THE PACIFIC NORTHWEST

Most shrub-use guidelines in the past have focused on trees and shrubs as primarily a source of forage for livestock and wild ungulates. More recently, other attributes such as food and cover for non-ungulate wildlife, plant community values, soil protection, water quality, and maintenance of riparian features have been incorporated into assessing shrub use at a landscape level (Mosley et al. 1999).

Several American states have been revising shrub-use standards over the last 5 years. Although they vary considerably from one state to another, riparian values play a considerably more prominent role as criteria for setting proper use standards than in the past.

In Montana, Bengeyfield and Svoboda (1998) recommended 10% allowable shrub use in riparian areas in the Beaverhead/Deerlodge National Forest. They list the following four steps for developing use levels for specific riparian areas:

1. Establish the "desired future conditions." This is a negotiated condition recommended by an interdisciplinary team and it usually falls between the minimum "potential future condition" and the "potential natural condition."
2. Choose a sensitivity level. This is defined as a measure of the value and/or existing conditions of a stream relative to its potential and is arrived at by consensus of the interdisciplinary team.
3. Determine the inherent stability. This criterion evaluates stream bank stability by measuring the amount of altered stream bank relative to the expected amount of stable stream bank on the reach .
4. Define the important and limiting factors to riparian function. Stubble height, forage use, riparian shrub use, and stream bank alteration were chosen as "critical parameters" for assessment. Suggested thresholds are recommended for each parameter, and livestock should be moved when the threshold is exceeded for any individual indicator. No ecological rationale are provided for recommending 10% shrub use or for any of the thresholds proposed for the other critical parameters.

In contrast to Bengeyfield and Svoboda (1998), Lee et al. (2002) suggested that shrub us should not exceed 50 to 60% during the growing season to sustain soils, plant, and animal resources in Montana. Although they recommended a single shrub use range for proper use, they recognized that "every grazing land situation is unique, so every grazing management plan should be site-specific."

A revision of the Caribou National Forest Land and Resource Management Plan covering part of Bannock County in southeastern Idaho provides comprehensive guidelines for herbaceous forage and browse use in riparian habitats. Shrub-use standards are presented for riparian areas based on an assessment of "proper functioning condition." The management plan recommends 30 to 50% shrub use on sites that are at proper functioning condition and for those "functioning at risk." Standards are lower for riparian areas that are "not functioning" and range from 0% (no use), 30%, to 40–50% use, based on site-specific assessments. Other factors such as stubble height, use of herbaceous plants, soil disturbance, and stream bank conditions are also evaluated in the overall assessment of each site.

Also in Idaho, Mosley et al. (1999) recommended that forage use of key browse species in riparian areas should not exceed 50% of the total annual growth of twigs and leaves within reach of animals during the grazing season. The authors qualified this recommendation by suggesting that use standards should be based on specific objectives that in turn are based on site condition and potential, and that other environmental features should be considered in evaluating proper use, such as stubble heights of herbaceous species, stream bank damage, and the condition of upland vegetation and soils.

8 RECOMMENDATIONS FOR BRITISH COLUMBIA

Although guidelines used in other jurisdictions are helpful in formulating local management guidelines, they must be critically reviewed to ensure that they are suitable for B.C.

conditions. The following recommendations are provided to facilitate establishing shrub-use guidelines in B.C.

1. Under ideal conditions, browse use guidelines should be applied on a site-specific basis, although this may not always be practical.
2. Management objectives for livestock and wild ungulates must be clearly defined.
3. Shrub-use guidelines should consider other landscape attributes, such as herbaceous forage use, soil disturbance and erosion, stream bank characteristics, and biodiversity targets, as important complementary criteria for determining proper use. The relative importance of each of these criteria, however, will vary among sites, particularly if shrub populations are growing in upland or riparian habitats.
4. All standards for assessment should be science-based where possible, to be credible and to ensure environmental protection.
5. Browse standards should be associated with key browse species that are dominants on the site, of high forage value to one or more ungulates, and valuable as indicator species for management.
6. Moderate levels of forage use, of 25 to 65%, appear to be adequate for most key upland species in B.C. Overuse in a particular year may have little long-term impact on shrubs, especially if they are given rest to recover. Conservative use, below physiological thresholds, offers the best opportunity to sustain shrub populations and range sites over the long term. Variations in above-ground production of shrubs, and impacts of environmental conditions (e.g., changing wildlife populations, insect populations, drought cycles and wet periods, harsh winters, and disease) can be better accommodated in a flexible framework.
7. Shrub-use standards should be based on the combined use of cattle and wild ungulates during the active growing period. Additional use beyond shrub tolerance thresholds may be possible on dormant stems, but this use also changes shrub morphology and the environment around the plant.
8. Willows, red-stem ceanothus, bitter-brush, and red huckleberry can sustain more than 50% use, especially on mesic sites. On some sites, higher levels of use can be justified for these species based on their individual tolerances to defoliation, providing it will not adversely affect other resource values.
9. Guidelines should be flexible and allow change at the discretion of the statutory decision maker and based on site potential, annual variations in weather, and changes in management objectives.
10. Any strategy adopted must be monitored to ensure its effectiveness and to allow management practices to be adjusted as required.

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APPENDIX 1. ANNOTATED REVIEW OF KEY WILDLIFE SHRUBS

This section contains annotated profiles for important wildlife shrub species in B.C. Profiles for each species were developed using information from the Fire Effects Information System (FEIS 2002) as the primary source. Further information was acquired from research publications, theses, and reports that included local information about shrub biology and details of food habits of cattle and wild ungulates in the province.

Singleton (1976) synthesized existing dietary information for wild ungulates in B.C. from published reports up to 1975. Species were classified into five categories ranging from high to low, presumably based on the amount of each species found in diets. Blower (1982) compiled a list of 60 grasses, forbs and shrubs and ranked their importance for wintering ungulates as high, moderate, and low. Additional dietary studies have been completed on Mule Deer (Willms and McLean 1978; Willms et al. 1978), California Bighorn Sheep (Wikeem 1984; Wikeem and Pitt 1992), cattle (Willms et al. 1978; Quinton 1984); and deer, elk and cattle (Ross 1997).

Common and scientific names that identify each species follow Douglas et al. (1998-2000), but common and scientific names within the descriptions of each species have not been changed from their original sources. Abbreviations of biogeoclimatic zones contained in the habitat description for each species are as follows: Alpine Tundra (AT), Bunchgrass (BG), Engelmann Spruce Sub-alpine Fir (ESSF), Interior Douglas-fir (IDF), Interior Cedar Hemlock (ICH), Montane Spruce (MS), Ponderosa Pine (PP), Sub-Boreal Spruce (SBS), and Sub-Boreal Pine-Spruce (SBPS).

Shrubs are organized alphabetically by scientific name in three categories: tall shrubs, medium shrubs, and small shrubs. Tall shrubs are plants generally taller than 1.5 m, where part of the plant is exposed to ungulate browsing but a large proportion of the shrub can grow beyond their reach. Medium shrubs range from 0.5 to 1.5 m tall and are completely in reach of browsing animals, but they still have deep root systems. Small shrubs are less than 0.5 m tall and may not reach above the herbaceous layer. These plants are more shallow rooted than other shrubs and are vulnerable to defoliation and trampling. They can be pulled from the ground by grazing animals.

TALL SHRUBS

Acer glabrum var. *douglasii* (Douglas maple)

Habitat: Douglas maple is also called Rocky Mountain maple (Douglas et al. 1998a), especially in the United States. This species is common throughout B.C., occupying mesic to dry open forests, rocky slopes, forest openings and clearings, seepage sites, and moist gullies in the lowland and montane zones. It is present in the PP, IDF, ICH, MS, and SBPS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998a).

Forage Value For Wildlife: Douglas maple is an important browse species throughout its range. Deer and Elk eat leaves and buds in spring and early summer; and twigs in fall and winter (USDA 1937), but shrubs often grow out of ungulate reach.

Douglas maple is valuable for Mule Deer (Mitchell 1950), Moose (Peek 1974), and Elk (Leege and Hickey 1966; Kufeld 1973) in the northern Rocky Mountains and Pacific Northwest. Although they browse it in summer, Mule Deer and White-tailed Deer use it mostly in late fall and winter (McCulloch 1955; Kufeld et al. 1973). In B.C., Douglas maple is rated as moderate to high for Elk and Mule Deer; and moderate for White-tailed Deer, Bighorn Sheep and Moose (Cowan et al. 1950; Singleton 1976; Blower 1982; Wikeem 1984). Ruffed Grouse in Idaho eat the leaves and buds, and seeds are also important forage for grosbeaks and small mammals (Peterson 1961; Smith 1968).

Forage Value For Livestock: Douglas maple has poor to fair palatability for domestic livestock in the U.S. (Young and Robinette 1939; Dittberner and Olson 1983).

Cover Value: In early- to mid-stages of growth, Douglas maple provides hiding cover for big game animals, small mammals, and birds (Wasser 1982). It also provides nesting sites for sharp-shinned hawks in Utah (Platt 1976). Cover value of Douglas maple has been rated as poor to fair for Elk, White-tailed Deer, small mammals, upland birds, and passerines. It is regarded as poor cover for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Excessive browsing can prevent full development of Douglas maple (Arno et al. 1985), but light to moderate browsing can stimulate vigorous resprouting (Haeussler et al. 1990). Cole (1959) suggested that vigorous plants could tolerate 70, 50, and 25% twig use during severe, average, and mild winters, respectively.

Alnus incana (mountain alder)

Habitat: Mountain alder is common east of the Coast-Cascade Mountains in the PP, IDF, ICH, MS, SBPS, SBS, and ESSF zones. This species is found in moist forests, stream banks, lakeshores, and wetlands in the montane zone to subalpine zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: Elk, Mule Deer, and Moose moderately use mountain alder twigs and leaves in summer, fall, and winter throughout the western U.S. (Knowlton 1960; Kufeld 1973; Kufeld et al. 1973; Kauffman et al. 1985). Muskrats, Beavers, Cottontails, and Snowshoe Hares eat twigs and leaves, and Beavers eat the bark and use branches to construct dams and lodges (USDA 1937). Seeds, buds, and catkins are considered important winter foods for Redpolls, Siskins, Chickadees, and Goldfinches (Haeussler and Coates 1986). Mountain alder is ranked as poor to fair for Elk, Mule Deer, small mammals, passerines, upland game birds, and waterfowl. It is regarded as a poor browse species for White-tailed Deer in several western states (Dayton 1931; Beetle 1962; Dittberner and Olson 1983).

Forage Value For Livestock: Mountain alder is ranked as poor to fair for cattle (Dittberner and Olson 1983), but it can be an important secondary forage on some ranges (USDA 1937). Willms et al. (1980) showed that cattle used alder in the Douglas-fir zone near Kamloops only sparingly (2%) when other forages were abundant, but use increase to more than 35% as other forages became depleted. In Oregon, cattle used mountain alder moderately (Roath and Krueger 1982), but use depends on stand accessibility, stand density, and the palatability of associated browse species. Dense stands restrict cattle access and reduce use (Hansen et al. 1988). Cattle usually avoid alder thickets located on saturated soils (Kovalchik 1987).

Cover Value: Mountain alder communities provide hiding and thermal cover for white-tailed and Mule Deer (Hansen et al. 1988) and often serve as travel corridors for ungulates (Hansen et al. 1989). Numerous bird species use mountain alder for nesting habitat (Kauffman et al. 1985) and it provides excellent cover for fish along stream banks (Kovalchik 1987). In the western U.S., mountain alder provides fair to good thermal and hiding cover for Elk, Mule Deer, and White-tailed Deer, depending on the stand density. It also provides fair to good cover for small mammals, passerines, and upland game birds; but is poor to fair cover for waterfowl (Dittberner and Olson 1983; Hansen et al. 1988).

Browsing Tolerance and Management Considerations: Mountain alder can stabilize soils and protect stream banks from erosion during severe spring runoff. Overbrowsing and excessive trampling by livestock and wildlife reduces its ability to maintain stream bank stability during flooding (Kovalchik 1987).

Amelanchier alnifolia (saskatoon)

Habitat: Saskatoon is a common and widespread shrub throughout B.C. occupying dry to moist forests, gullies and draws on grasslands, rocky slopes, and bluffs in the lowland to subalpine zone. This species is present in the PP, IDF, ICH, MS, SBPS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Saskatoon is valuable winter forage for Elk, Mule Deer, White-tailed Deer, Moose, and Bighorn Sheep. Wild ungulates browse twigs in winter; and twigs, buds and leaves in spring and summer (Kufeld 1973; Kufeld et al. 1973; Hemmer 1975; Wikeem and Pitt 1992). Ross (1997) found saskatoon in elk and deer diets on four winter ranges in the East Kootenay, but the amount eaten varied among sites and seasons. Deer used this species most at Skookumchuck Prairie in winter and spring, with diet composition ranging from less than 1% in winter to slightly more than 5% in spring (Ross 1997). Beaver and hares consume twigs, foliage, fruits, and bark; upland game birds eat berries and buds, and rodents and songbirds eat the berries (Brinkman 1974a). In B.C., saskatoon is ranked as high for Mule Deer, White-tailed Deer, Elk, and Moose; and moderate for Bighorn Sheep (Singleton 1976; Blower 1982).

Forage Value For Livestock: Palatability for cattle has been rated as fair to good in the western U.S. (Williams 1976; Dittberner and Olson 1983). In B.C., it has medium to high forage value for cattle, mostly in fall (McLean et al. 1964), but intake can be variable and appears related to availability of other forages. For example, spring, summer, and fall use of saskatoon by cattle was negligible (<1%) on four winter ranges in the East Kootenay between 1992 and 1994. At Skookumchuck Prairie, saskatoon averaged 2% of cattle summer diet in 1992 (Ross 1997). In contrast, cattle use increased from 23 to 73% as other forages became unavailable on forest range near Kamloops (Willms et al. 1980).

Cover Value: Saskatoon provides poor to fair cover for Elk, but fair to good cover for Mule Deer and White-tailed Deer. It also provides fair to good cover for small mammals, passerines, upland game birds; but poor cover for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Saskatoon is one of the most persistent browse species on the Canadian prairies, but excessive use can reduce plant vigour (Campbell et al. 1974). McLean (1979) ranked this species as fairly tolerant to browsing. Shrubs often resprout from their roots, and from buds within the inner stems of the shrub, even after heavy browsing by livestock and wildlife (Campbell et al. 1974; Wikeem 1984). This species can decline with heavy browsing (Zimmerman and Neuenschwander 1984) even though some shrubs can tolerate 90% removal of annual buds. Young and Payne (1948) suggested that 60 to 65% use was sustainable, but vigorous shrubs may tolerate 70, 50, and 25% leader use in severe, average, and mild winters, respectively (Cole 1959). Saskatoon twigs and leaves contain cyanogenic glycosides that are most concentrated in young twigs, but less toxic in older leaves (Majak et al. 1980; Quinton 1985). Under experimental conditions, Mule Deer died within a week when they were fed a diet of fresh saskatoon twigs (Quinton 1985). Quinton (1985) speculated that a winter diet consisting of more than 35% saskatoon could be fatal to Mule Deer.

Betula occidentalis (water birch)

Habitat: Water birch occurs in moist forests, openings, seepage areas, stream banks, and wetlands from the lowland to montane zone. It is frequent east of the Coast-Cascade Mountains in the PP, IDF, ICH, MS, and SBS (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Browsing of water birch by big game animals such as Mule Deer and Elk is light; use increases when other more palatable woody species become scarce (Hansen et al. 1989; Kufeld 1973; Kufeld et al. 1973). Birch (*Betula* spp.) catkins, buds, and seeds are eaten by numerous bird species including Sharp-tailed Grouse, Spruce Grouse, Ruffed Grouse, Redpolls, Pine Siskin, Chickadees, and Kinglets (Brinkman 1974b). Dittberner and Olson (1983) ranked water birch as poor to good for Mule Deer; and fair for Elk and White-tailed Deer in the western U.S. They also rated it as poor to good for small mammals, passerines, and upland game birds but poor for waterfowl. In B.C., water birch is ranked as low for White-tailed Deer and Bighorn Sheep, moderate for Mule Deer and Elk, and high for Moose (Singleton 1976; Blower 1982).

Forage Value For Livestock: Water birch is generally considered to have a poor to fair palatability, and is only lightly browsed by most classes of livestock. Sheep and goats browse it more readily than cattle in the U.S. (Van Dersal 1938). Occasionally water birch forms dense stands that restrict livestock access (Hansen et al. 1988). Dittberner and Olson (1983) ranked water birch as poor to fair for cattle in the western U.S. No information is available for B.C.

Cover Value: Dense thickets of water birch provide excellent thermal and hiding cover for wildlife (Hansen et al. 1989) and contribute to structural diversity that is important for many bird species (Youngblood et al. 1985). Grouse use water birch for cover and food, and often winter in these riparian habitats (Marks and Marks 1988). Cavity-nesting birds use mature trees for food and nesting (Youngblood et al. 1985). Overhanging plants provide shade along stream banks and deposit organic matter into streams that is important for fish habitat (Youngblood et al. 1985). Water birch provides fair to good cover for Elk, Mule Deer, and small mammals. It is rated as poor to good cover for upland birds, and poor for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: The dense root systems of water birch stabilize stream banks (Youngblood et al. 1985). Mature plants are likely able to sustain moderate to heavy use within the zone available to ungulate browsing.

Betula pumila var. glandulifera (scrub birch, synonym low birch)

Habitat: Scrub birch is frequent in wet to moist bogs, fens, marshes, meadows, and seepage areas in all vegetation zones. This species is most commonly found east of the Coast-Cascade Mountains in the PP, IDF, ICH, MS, ESSF, SBPS, and SBS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Scrub birch serves as summer and winter browse for Moose, Elk, and Mule Deer in the western U.S. (Dorn 1970; Kufeld 1973; Kufeld et al. 1973; Roath and Krueger 1982). Scrub birch is one of the most preferred browse species for Snowshoe Hares in Alaska and the Yukon (Wolff 1978b). Catkins, buds, and seeds are eaten by Ptarmigan, Sharp-tailed Grouse, Spruce Grouse, Ruffed Grouse, and by Redpolls, Pine Siskins, Chickadees, and Kinglets (Martin et al. 1951; Viereck and Little 1972; Brinkman 1974b). In the western U.S., it is ranked as poor to fair forage for Mule Deer and White-tailed Deer; poor to good for Elk; and good for Moose. It is also ranked as poor for waterfowl; fair for small mammals and upland game birds, and good for passerines (Dittberner and Olson 1983). In B.C., scrub birch is ranked as low for Mule Deer, White-tailed Deer, Elk and Bighorn Sheep; and high for Moose (Singleton 1976; Blower 1982).

Forage Value For Livestock: Scrub birch is only lightly to moderately browsed by livestock. Cattle tend to avoid the wet soils associated with this species, which limits their access until soils dry in late summer or fall (Dayton 1931; Hansen et al. 1988).

Cover Value: Scrub birch provides poor cover for ungulates because of its small stature but it is good hiding cover for small birds and mammals (Dittberner and Olson 1983).

Tolerance to Browsing and Management Considerations: No information is available regarding browsing tolerance. Ungulate browsing on wet soils may restrict plant growth and influence surface and stream bank erosion (Hansen et al. 1988).

Cornus stolonifera (red-osier dogwood)

Habitat: Red-osier dogwood is common throughout B.C., and found in moist to wet forests, stream banks and lakeshores, swamps and clearings in the lowland and montane zone. This species is found in the PP, IDF, ICH, MS, and SBPS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: Red-osier dogwood is used as forage by White-tailed Deer, Mule Deer, Elk, and Moose (McCulloch 1955; Kufeld 1973; Kufeld et al. 1973; Peek 1974). It is particularly important to Moose in the winter, although it also supplies browse in summer and fall (Knowlton 1960). In the western U.S., red-osier dogwood is valuable winter forage for Elk (Gaffney 1941; McCulloch 1955; Kufeld 1973); and Mule Deer eat this species in summer, fall and winter (Dusek 1975).

Red-osier dogwood berries are low in sugar and are less attractive to most wildlife than fruit from other shrub species. Consequently, the berries remain on the plant throughout the winter and are available to grouse, quail, partridge, passerines, ducks, crows, mice, and other mammals later in the year (Stiles 1980; Eyde 1988). In the northern Rocky Mountains, the berries are an important food for Grizzly and Black Bears (Rogers and Applegate 1983). Deer Mice and Meadow Voles feed on the young stems and bark and Beavers use branches for food and dam construction (Patric and Webb 1953). In B.C., red-osier dogwood is ranked as highly important for Moose; moderate for Mule Deer, White-tailed Deer, and Elk; and low for Bighorn Sheep (Singleton 1976; Blower 1982).

Forage Value For Livestock: Red-osier dogwood is rated as poor for cattle in the western U.S. (Dittberner and Olson 1983) and low to medium for cattle during late summer and fall in B.C. (McLean 1979). Cattle prefer young shoots for browse and find the leaves relatively unpalatable (Sampson and Jespersen 1963; Mozingo 1987).

Cover Value: In the Pacific Northwest, red-osier dogwood provides good security cover for Mule Deer fawning, and year-round security and thermal cover. It provides fair cover for Elk, and waterfowl; and fair to good cover for White-tailed Deer (Dittberner and Olson 1983). Red-osier dogwood furnishes valuable cover for birds and other small animals, especially where it grows in thickets (Smith 1953). It also supplies nesting habitat for flycatchers, warblers, hummingbirds, and sparrows in Arizona (Brown et al. 1977), and shade and cover along streams for trout (Smith 1953).

Browsing Tolerance and Management Considerations: Aldous (1945) reported that red-osier dogwood did not sustain heavy use, but did well with light clipping (Aldous 1952). He found that red-osier dogwood could not withstand 90% annual use, but 25% annual use over several years was not detrimental. Other studies confirm these findings and indicate that this shrub may increase with some browsing (Perala 1979). After cattle in Oregon browsed 61% of leaders, red-osier dogwood responded with exceptional growth the next year when it had light use (Roath and Krueger 1982). Under heavy use by cattle or wildlife, however, forage production and plant vigour can decline (Stevens 1970) and plants can be killed (White 1965).

Populus tremuloides (trembling aspen)

Habitat: Trembling aspen is common and widespread throughout B.C., occupying moist forests, edge of dry grasslands, ravines, ridges and depressions in the lowland and montane zone. Aspen occurs in the PP, IDF, ICH, MS, SBPS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Trembling aspen forests provide important breeding, foraging, and resting habitat for a variety of mammals, birds, and insects (Peterson and Peterson 1995). Wildlife use of aspen communities varies depending on understorey species composition and the age of the stand. Young stands generally yield the most browse for ungulates because the stems usually grow beyond ungulate reach in 6 to 8 years depending on the site (Patton and Jones 1977). Aspen provides year-round browse for many animal species. It is especially valuable during fall and winter when protein levels are higher than in other browse species (McLean et al. 1964).

Elk browse trembling aspen year-round in most of the western U.S., feeding on bark, leaves, and new twigs (Maini 1968; Peterson and Peterson 1995), but in some areas it is mainly used in winter (Patton and Jones 1977). White-tailed Deer, Mule Deer and Moose also eat leaves, buds, twigs, bark, and resprouting shoots from the root year-round in the Pacific Northwest (Maini 1968; Brinkman and Roe 1975; Ritchie 1978).

Trembling aspen supplies food for Porcupine and Beaver in winter and spring (Brinkman and Roe 1975; Peterson and Peterson 1995). In winter, Porcupines eat the smooth outer bark of the upper trunk and branches and in spring, they eat buds and twigs, and Beaver use stems for building dams and lodges (Peterson and Peterson 1995). Rabbits, squirrels, pocket gophers, voles, mice, and hares feed on buds, twigs, and bark in both summer and winter (Peterson and Peterson 1995). Mice and voles can girdle suckers and small trees by eating bark below the snowline during winter (Brinkman and Roe 1975; Peterson and Peterson 1995).

Trembling aspen communities furnish food and nesting habitat for Sandhill Cranes, Western Wood Pewees, ducks, Blue Grouse, Ruffed Grouse, Sharp-tailed Grouse, Mourning Doves, Red-breasted Nuthatches, and Pine Siskins. Ruffed Grouse depend on trembling aspen stands for foraging, courting, breeding, and nesting (Brinkman and Roe 1975). Trembling aspen has been rated fair to good for Elk, Mule Deer White-tailed Deer, small mammals, and upland game birds. It is ranked as fair and poor for passerines and waterfowl, respectively (Dittberner and Olson 1983). In B.C., trembling aspen has been ranked as low for Bighorn Sheep and Elk; and moderate for Mule Deer, White-tailed Deer, and Moose (Singleton 1976; Blower 1982).

Forage Value For Livestock: Trembling aspen is relatively palatable to cattle in the U.S. and has been rated as a fair to good forage (USDA 1937; Dittberner and Olson 1983; Irwin 1985). Cattle browse the leaves and twigs on mature trees, juvenile trees, and suckers in B.C. (Peterson and Peterson 1995; Wikeem et al. 1998). Usually, aspen suckers are totally available to cattle and are browsed mostly in fall (McLean 1979).

Cattle use on trembling aspen increased from nearly 21 to 42% as more palatable forages became unavailable in the Douglas-fir zone near Kamloops (Willms et al. 1980). Similarly, Quinton (1984) found that aspen was a minor part of cattle diets in July and August on seeded clearcuts in the central interior of B.C. over three years, and it only accounted for about 5% of cattle diets in September. Ross (1997) found that trembling aspen was negligible in summer and fall cattle diets at Skookumchuck Prairie in the East Kootenay over three years and comprised less than 1% of summer diets in 1992. This species was not found in summer diets in 1993 and 1994 and winter diets.

Cover Value: Moose, elk, deer, and cattle use mature trembling aspen stands for shade in summer. Seral communities provide excellent hiding cover when the trees are in leaf, and deer use aspen stands for fawning (Kovalchik 1987). Ungulates generally do not use aspen as thermal cover in winter as it provides less protection from wind than conifer stands. Trembling aspen provides good hiding and thermal cover in summer for small mammals such as Snowshoe Hares, and Beaver use branches for dams and lodges.

Northern Flickers, House Wrens, Robins, vireos, warblers, Juncos, the Western Wood Pewee, and Lazuli Buntings all use trembling aspen for hiding, nesting, and roosting cover. Ruffed Grouse often use aspen stands for burrowing cover in winter because snow accumulates there deeper and faster than in adjacent confer stands (Peterson and Peterson 1995).

Trembling aspen has been rated as fair to good cover for Elk, Mule Deer, and White-tailed Deer. It is ranked as good for small mammals, passerines, and upland game birds, but poor for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: On heavily grazed range, over-use of aspen may prevent reproduction (USDA 1937). Dense stands of young aspen shoots on cattle range usually indicate moderately grazed range (McLean 1979). Cattle generally cannot reach beyond a 1.8 m height, and browsing on mature trees causes little damage. Julander (1937) suggested that aspen could sustain itself at 70 to 75% use and that aspen recovery was fair at 65 to 70% use. Wikeem et al. (1998) proposed 60 to 65% use of new-growth aspen as an upper level of sustainable use.

Prunus virginiana (choke cherry)

Habitat: This species is found most commonly where it occupies moist to mesic open forests, openings and clearings, grassland streams, gullies and draws and rocky outcrops from the lowland to montane zones. Choke cherry is found in southern B.C. throughout the PP, IDF, ICH, MS, and SBPS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: Choke cherry provides forage and habitat for a diversity of wildlife species (Stanton 1974; Stubbendieck et al. 1997). Moose (Stevens 1970; Peek 1974; Pierce 1984), Bighorn Sheep (Wikeem 1984), Elk (Gaffney 1941; Kufeld 1973; Canon et al. 1987), and deer browse choke cherry (Brown and Doucet 1991), and it also supplies food for bears (Rogers and Applegate 1983), coyotes (Dibello et al. 1990), and small mammals (Hendricks and Allard 1988; Dibello et al. 1990). The fruit is an important food source for many species of birds (Marks and Marks 1988). It is ranked as good for small mammals, upland birds, and passerines, but poor for waterfowl (Dittberner and Olson 1983).

Choke cherry is ranked as highly important for Elk; and moderate for Mule Deer, White-tailed Deer, and Moose in B.C. (Singleton 1976; Blower 1982). It was considered of low importance to California Bighorn Sheep in the south Okanagan (Wikeem and Pitt 1992).

Forage Value For Livestock: Choke cherry is moderately palatable to livestock, although it is more heavily browsed by domestic sheep than by cattle (Dayton 1931). In the western U.S., choke cherry is regarded as fair for cattle (Dittberner and Olson 1983).

Cover Value: Choke cherry provides important cover and habitat for many bird species (Plummer et al. 1968; Pierce 1984), small mammals (Adams 1959; Gillis and Nams 1998), large mammals, and livestock (Dusek 1975; Unsworth et al. 1989; Bell et al. 1992). It furnishes fair to good cover for Elk; and good cover for Mule Deer, White-tailed Deer, small mammals, upland game birds and passerines. It is of little value for waterfowl cover (Dittberner and Olson 1983). It also affords excellent cover for fish and erosion control along stream banks.

Browsing Tolerance and Management Considerations: Choke cherry is moderately tolerant of browsing (Hansen et al. 1995), but heavy grazing by livestock and wild ungulates has adversely affected shrub populations in some parts of the U.S. (Zimmerman and Neuenschwander 1984; Lesica 1989). Choke cherry foliage and stems contains the toxic compound prunasin, which can be poisonous to cattle (Majak et al. 1980). Generally, cattle do not eat fatal quantities of chokecherry when other forage is available. Cole (1959) suggested that vigorous plants can sustain 70, 50, and 25% leader use during severe, average, and mild winters, respectively.

Salix bebbiana (Bebb's willow)

Habitat: Bebb's willow is a common shrub throughout B.C. east of the Coast-Cascade Mountains. It generally occurs in mesic to moist forests, openings, wetlands, and seepage areas from low-elevation to the montane. It is found in the PP, IDF, ICH, MS, and SBPS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Bebb's willow is an important browse species for Moose, Elk, and deer throughout the U.S. (Cowan and Guiget 1973; Hansen et al. 1988; Kovalchik et al. 1988). In Montana, Bebb's willow alone made up more than 15% of Moose diets during late winter. Its height made it easily accessible when low-growing shrubs such as bog birch (*Betula glandulosa*) and wolf willow (*Salix wolfii*) were covered with snow (Dorn 1970). Heavy snow can increase the availability of tall stems by bending branches within reach of Moose and smaller herbivores such as hares (Viereck and Little 1972).

No specific information on ungulate preference for this species is available for B.C. Singleton (1976) and Blower (1982), however, collectively ranked willows as highly important for Moose; moderate for Mule Deer, White-tailed Deer, and Elk; and low for Bighorn Sheep. Shoots, buds, and catkins are eaten by small mammals, birds, and Beaver (Haeussler and Coates 1986).

Forage Value For Livestock: Bebb's willow is rated as fair forage for livestock in several western U.S. states (Dittberner and Olson 1983). In southwestern Montana, this species accounted for nearly 11% of the total forage consumed by cattle in the summer (Dorn 1970). No comparable rating exists for B.C. Willms et al. (1980) found that cattle use on willows nearly doubled from 30.6 to 60.8% as preferred forages became unavailable on forest range near Kamloops. Similarly, Quinton (1984) found that willows averaged less than 5% of summer cattle diets over three years on seeded clearcuts in the central interior of B.C., but increased to 10% of diet in September after other forages were depleted.

Cover Value: Bebb's willow is ranked as fair to good cover for Elk, Mule Deer, and White-tailed Deer, small mammals, and upland birds, but only poor to fair for waterfowl (Dittberner and Olson 1983). It also provides shade for fish in streams and ponds (Dittberner and Olson 1983; Hansen et al. 1988).

Browsing Tolerance and Management Considerations: Vigorous plants can tolerate 70, 50, and 25% leader use during severe, average, and mild winters, respectively (Cole 1959). McLean (1979), citing use ratings from the B.C. Game Branch, reported that willows can withstand close browsing and that more than 80% = severe, 60 to 80% = heavy, 40 to 60% = moderate, and less than 40% = light use. (Boggs et al. 1990) suggested that livestock can compact soils on some Bebb's willow sites and recommended that grazing should be deferred until these sites dry out.

Salix planifolia (plane-leaved willow)

Habitat: Plane-leaved willow is common in the IDF, ICH, MS, SBPS, SBS, and ESSF zones, mainly east of the Coast-Cascade Mountains. It occurs in forest openings, moist to wet thickets, wetlands, lake edges, and stream banks in the montane and lower subalpine zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Most willows are palatable to livestock and big game (USDA 1937; Argus 1957). Plane-leaved willow is a valuable summer-forage for Moose in southwestern Montana (Dorn 1970) and Yellowstone National Park (Stevens 1970), but it is less important in winter in both locations. Palatability of this species is generally low for Elk and Mule Deer (Van Dersal 1938). Low-statured plants are often covered with snow and unavailable for ungulate use (Hansen et al. 1989). Ducks, grouse, and small mammals eat willow shoots, catkins, buds, and leaves (Argus 1957).

In B.C., Singleton (1976) and Blower (1982) ranked willows as highly important for Moose; and moderate for Mule Deer, White-tailed Deer, and Elk. They are usually unimportant for Bighorn Sheep.

Forage Value For Livestock: Plane-leaved willow is valuable as cattle forage in the U.S., especially in riparian areas (USDA 1937). Palatability often increases as the growing season advances (USDA 1937). Dorn (1970) reported that this species made up nearly 5% of cattle diets in southwestern Montana on Moose/cattle range, but no information is available for B.C.

Cover Value: Plane-leaved willow provides excellent nesting and foraging habitat for ducks, shorebirds, warblers, vireos, and sparrows (Finch 1987) and Sandhill Cranes have used low-statured plane-leaved willow as nesting cover in Idaho. Overhanging branches protect stream banks and provide cover and shade for fish (Hansen et al. 1989).

Browsing Tolerance and Management Considerations: Hansen et al. (1989) suggested this species is easily trampled by livestock and plants can become decadent or stunted when they are over browsed by cattle, wild ungulates, and Beavers. Decadent plants recover relatively rapidly when browsing pressure is reduced or removed (Schulz and Leininger 1990). Cole (1959) suggested vigorous shrubs could be browsed to 70, 50, and 25% leader use during severe, average, and mild winters, respectively.

Salix pseudomonticola (serviceberry willow)

Habitat: Serviceberry willow is infrequent east of the Coast-Cascade Mountains in the IDF, ICH, MS, SBPS, SBS, and ESSF zones. This species is most commonly found along forest edges and openings, thickets, fens, and floodplains from the montane to lower subalpine zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Serviceberry willow is an important food source for Moose, deer small mammals, Beaver, Snowshoe Hares, passerines, and game birds (Van Dersal 1938; Machida 1979). In south-central Colorado, this shrub was ranked high for Elk (Hobbs et al. 1981). In B.C., willows are rated as highly important for Moose; moderate for Mule Deer, White-tailed Deer, and Elk; and low for Bighorn Sheep (Singleton 1976; Blower 1982).

Forage Value For Livestock: Most willows are palatable to livestock (Argus 1957; Dorn 1970) and palatability generally increases as the growing season advances (Machida 1979). In Colorado, serviceberry willow suitability is considered high for cattle (Hobbs et al. 1981) and it is an important source of browse in riparian areas (Schulz and Leininger 1990). No information is available for B.C.

Cover Value: Serviceberry willow develops dense thickets along streams and rivers that provides thermal and hiding cover for Elk, deer, and Moose. Beavers use the branches for construction of dams and lodges. Willows also provide shade and cover for fish, and protect soils from erosion along stream banks (Kauffman and Krueger 1984).

Browsing Tolerance and Management Considerations: Serviceberry willow appears susceptible to heavy livestock use in riparian areas, and improper management can result in degradation of some shrub communities (Schulz and Leininger 1990). In Colorado, this species was unable to attain its maximum height on grazed stream banks even though grazing pressure had been reduced by nearly 65% over 50 years. Moreover, willow cover was more than 8.5 times higher in exclosures that had limited grazing for 7 to 30 years than in adjacent grazed areas (Schulz and Leininger 1990). They suggested that overused plants become decadent with overuse, but they can recover when grazing pressure is reduced. Cole (1959) suggested that vigorous plants could tolerate 70, 50, and 25% leader use during severe, average, and mild winters, respectively.

Salix scouleriana (Scouler's willow)

Habitat: Scouler's willow is common throughout B.C. and occurs in dry to moist forests, seepage areas, clearings, wetlands, lake edges and along stream banks. This species is present from the lowland to montane in the IDF, ICH, MS, and SBPS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 2000).

Forage Value For Wildlife: Scouler's willow affords valuable forage for Elk in summer, fall and winter; and it is an important winter browse for White-tailed Deer and Mule Deer (Gaffney 1941; Irwin and Peek 1983; Edge et al. 1988). Cowan et al. (1950) rated it as high palatable for Moose in B.C., and it often dominates winter and spring Moose diets in some locations in the U.S. (Peek 1974). Moose eat leaves, twigs, and bark, but they appear to prefer young plants to mature shrubs. Scouler's willow is most heavily browsed by deer and Elk on upland sites, and by Moose in riparian areas (Stevens 1970; Peek 1974). Upland game birds, ducks, and passerines forage on willow buds, leaves, twigs, and seeds (Argus 1957).

Scouler's willow is rated as good for Moose, Mule Deer, and White-tailed Deer; and fair to good for Elk and small mammals. It is ranked as fair to good for passerines, upland game birds and waterfowl (Dittberner and Olson 1983). In B.C., willows in general have been ranked as highly important for Moose; moderate for Mule Deer, White-tailed Deer, and Elk; and low for Bighorn Sheep (Singleton 1976; Blower 1982).

Forage Value For Livestock: Scouler's willow is considered a fair browse species for cattle in the western U.S. (Sampson and Jespersen 1963; Dittberner and Olson 1983) on both riparian areas and adjacent uplands (Bedunah et al. 1995).

Cover Value: In riparian areas, Scouler's willow shades streams and provides escape cover for fish. It furnishes good cover for Mule Deer, White-tailed Deer, small mammals, passerines, and upland game birds. It is ranked as fair to good cover for Elk; and is fair cover for waterfowl (Argus 1957; Dittberner and Olson 1983; Irwin and Peek 1983).

Browsing Tolerance and Management Considerations: Willows often produce dense growth through lateral branching when they are heavily browsed or burned (Argus 1957; Wolff 1978a). Although browsing stimulates twig production, long-term overuse can deplete root reserves (Wolff 1978b). Flowering and seed production can also be adversely affected by heavy browsing, which impedes recruitment of new plants into the population (Bedunah et al. 1995). The deep root system, multiple stems, and its ability to resprout from a below-ground root crowns enhances Scouler's willow ability to tolerate defoliation (Bedunah et al. 1995).

Scouler's willow can sustain browsing ranging from 50 to 100% use of annual growth (Zimmerman and Neuenshwander 1984), but Cole (1959) suggested that vigorous plants can tolerate 70, 50, and 25% leader use during severe, average, and mild winters, respectively.

Sambucus cerulea (blue elderberry)

Habitat: Blue elderberry is found in moist to mesic open forests, meadows, grasslands, and along watercourses from the lowland to montane zones. This species is common throughout southern B.C. in the PP, IDF, ICH, MS, and SBPS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: Blue elderberry is highly palatable for Elk in summer and fall (Young and Robinette 1939; Kufeld 1973). Depending on the community type, it can be seasonally important to Mule Deer in parts of the U.S. (Smith 1950, 1952; Kufeld et al. 1973). Leaves, stems and fruit all serve as forage for ungulates, small mammals, and birds. It is rated as fair to good for small mammals, passerines, and upland birds; but poor for waterfowl in the western U.S. (Dittberner and Olson 1983). In B.C., elderberries are ranked as low for Mule Deer, White-tailed Deer, and Bighorn Sheep; moderate for Elk; and high for Moose (Singleton 1976; Blower 1982).

Forage Value For Livestock: In the U.S., blue elderberry is less palatable in the spring than later in the growing season, and is regarded as an unimportant browse for domestic livestock (Dayton 1931; Sampson and Jespersen 1963). Overall, it is ranked as fair to good for cattle (Dittberner and Olson 1983), but in the southern interior of B.C., cattle can browse it heavily during summer.

Cover Value: Blue elderberry is ranked fair to good cover for Mule Deer, White-tailed Deer, and Elk; poor to good for small mammals; and poor for waterfowl (Dittberner and Olson 1983). Numerous birds eat the fruit, and it provides valuable cover, perching, and nesting sites for Bluebirds, Magpies, Warbling Vireo, Western Tanager, House Finch, Green-tailed Towhee, woodpeckers, Grosbeaks, Townsend's Solitaire, grouse, quail, pheasants, and hummingbirds (Van Dersal 1938; Stanton 1974). This species also provides cover and food for rabbits, squirrels, foxes, woodchucks, chipmunks, ground squirrels, woodrats, and mice (Martin et al. 1951).

Browsing Tolerance and Management Considerations: Blue elderberry is persistent and recovers well from heavy grazing (Plummer et al. 1968). In Oregon, it has declined with grazing pressure, but in New Mexico blue elderberry cover increased under light grazing pressure on some sites (Van Dyne and Payne 1964). Cole (1959) suggested 70, 50, and 25% leader use on vigorous plants during severe, average, and mild winters, respectively.

Sambucus racemosa (red elderberry)

Habitat: Red elderberry is common throughout B.C. and is found in shaded forests, moist to wet thickets, clearings, and along stream banks. This species occupies habitat from the lowland to the montane in the PP, IDF, ICH, MS, SBPS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: Red elderberry is widely used by wildlife for food (Martin et al. 1951; Ritter and McKee 1964). It is often considered an "ice cream" plant rather than a "key" species because it is not sufficiently abundant on most ranges to contribute significantly to the carrying capacity (Young and Robinette 1939; Gaffney 1941).

Subspecies and varieties of red elderberry vary in palatability throughout the western U.S. (Sampson and Jespersen 1963). In Idaho, Elk preferred var. *melanocarpa* in summer and fall, mostly foraging on leaves (Young and Robinette 1939). Deer and Moose heavily browsed var. *leucocarpa* in the eastern U.S. (Aldous 1952), whereas captive Mule Deer ate var. *microbotrys* in late spring and summer in feeding trials in Utah (Sampson and Jespersen 1963).

In Montana, Grizzly Bears eat red elderberry fruit in summer, but it is not regarded as an important food for bears (Zager 1980). Rabbits, squirrels, foxes, woodchucks, chipmunks, ground squirrels, woodrats, and mice also eat berries (Martin et al. 1951), and Porcupines and mice forage on buds and bark during the winter (Conrad and McDonough 1972).

In the western U.S., red elderberry is ranked fair to good for Elk, Mule Deer and White-tailed Deer; good for small mammals, passerine, and upland game birds; and poor for waterfowl (Sampson and Jespersen 1963). In B.C., Singleton (1976) and Blower (1982) ranked red elderberry as low for Mule Deer, White-tailed Deer, and Bighorn Sheep; moderate for Elk; and high for Moose.

Forage Value For Livestock: Red elderberry has been ranked as fair to good for cattle in the U.S. (Sampson and Jespersen 1963), depending on the location, subspecies, variety, and time of year. Red elderberry palatability improves after frost in some locations, and has been rated as fairly good to good for cattle (Dayton 1931). Populations of the plant appear scattered in southern B.C., but plants are often heavily browsed where they occur (B. Wikeem, pers. obs.)

Cover Value: In Utah and Wyoming, red elderberry was ranked as poor to fair cover for Elk, fair to good for Mule Deer and White-tailed Deer, and good for small mammals, passerines, and upland game birds. It has poor cover values for waterfowl (Dittberner and Olson 1983). Elderberries provide valuable nesting and perching habitat, and their fruit provides food for Bluebirds, Magpies, woodpeckers, Grosbeaks, Vireos, Tanagers, finches, solitaires, Crows, grouse, quail, pheasants, and hummingbirds (Van Dersal 1938; Martin et al. 1951; Denslow 1987).

Browsing Tolerance and Management Considerations: Aldous (1952) reported that red elderberry responds erratically to heavy clipping, but can withstand moderate use. In Utah, severe fall clipping on var. *microbotrys* did not significantly changes the number or length of rhizome stems, or the weight of stems and leaves (Conrad and McDonough 1972).

MEDIUM SHUBS

Artemisia tridentata (big sagebrush)

Habitat: Big sagebrush is most commonly found on arid grasslands in south central B.C. It is also found on dry open slopes to the subalpine in the BG, PP, IDF, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998a).

Forage Value For Wildlife: Big sagebrush is generally regarded as a good source of browse for wild ungulates (Stubbendieck et al. 1997), but palatability varies considerably depending on subspecies and habitat (Welch et al. 1991). In southwestern Montana, big sagebrush is browsed by Elk and Mule Deer from autumn to early spring (Wambolt et al. 1994), but elsewhere it is not preferred (Owens and Norton 1990; Wambolt 1996). It is described as "intermediate" in palatability in Oregon (Sheehy and Winward 1981). Big sagebrush palatability can vary even among certain populations and individual plants. For example, both Mule Deer (Smith 1950) and White-tailed Deer (Welch 1986) have shown aversions to individual big sagebrush plants.

Big sagebrush is an important food for small mammals and upland game birds (Welch et al. 1991). Pygmy Rabbits forage extensively on big sagebrush but prefer some accessions to others (Weiss and Verts 1984; Welch et al. 1991). Urness (1989) reported that big sagebrush leaves can make up to 100% of winter and spring Sage Grouse diets in Oregon and that grouse also exhibit preferences for individual plants.

Big sagebrush is rated in the U.S. as poor to fair for Elk and Mule Deer; fair for small mammals, small non-game birds, and upland game birds; and poor for waterfowl (Dittberner and Olson 1983). In B.C., Willms and McLean (1978) found that pasture sage and big sagebrush were the predominant shrubs eaten by Mule Deer during winter and spring on grassland range near Kamloops. Singleton (1976) and Blower (1982) ranked big sagebrush as low for Moose and White-tailed Deer; and moderate for Mule Deer, Bighorn Sheep and Elk in B.C.

Forage Value For Livestock: Big sagebrush is highly digestible and nutritious (Wambolt 1996), but some subspecies contain high levels of terpenoids that can reduce palatability (Striby et al. 1987). It is regarded as having poor palatability for cattle in the U.S. and in B.C., likely because of the high terpenoid content (McLean 1979).

Cover Value: Big sagebrush provides important cover for upland game birds and especially Sage Grouse (Collins and Harper 1982; Welch et al. 1991). It also provides cover for small mammals such as the Pygmy Rabbit (Weiss and Verts 1984). Big sagebrush affords some shade for domestic livestock and is considered fair to good cover for Elk, Mule Deer, White-tailed Deer, and small mammals. It is also ranked as good cover for passerines and upland game birds; but poor for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: An abundance and high density of big sagebrush usually indicates overuse of the range (McLean 1979). Fire can be effective in reducing big sagebrush populations, providing sufficient fine fuels exist in the understorey to carry a fire. Management to reduce big sagebrush on rangeland should consider its usefulness for providing cover for wildlife and livestock, and its value to protect soils from erosion where understorey vegetation is sparse (Hodgkinson 1989).

Clipping studies suggest that big sagebrush can sustain 25 to 50% use, but more than 50% use can result in plant mortality (Cook and Stoddart 1960, 1963). Wright (1970) found that 80% use of big sagebrush in July reduced yields most in July, moderately in spring, and least late in summer. Cole (1959) recommended 25, 50, and 70% use could sustain vigorous plants in mild, average, and severe winters, respectively.

Ceanothus sanguineus (redstem ceanothus)

Habitat: Redstem ceanothus generally occupies dry to moist open forests, clearings, and burns in southern B.C. This species occurs from the lowland to the montane in the IDF, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Redstem ceanothus is an important browse for Mule Deer, White-tailed Deer, and Elk (Kufeld 1973; Leege and Hickey 1975). Although it is browsed throughout the year, it is most important to Elk during the winter when it may account for up to 30% of their diet on some winter ranges (Leege and Hickey 1975). Redstem ceanothus is less important as summer browse, when Elk occupy higher elevation sites outside the range of the shrub (Young and Robinette 1939; Kufeld 1973). White-tailed Deer and Mule Deer heavily use this species year-round (Thilenius 1960; Conard et al. 1985). Young, tender leaves and twigs are particularly palatable to large ungulates especially after fire (Gaffney 1941; McCulloch 1955; Thilenius 1960).

Snowshoe Hares feed on redstem ceanothus leaves in some areas and rodents forage on seedlings during winter (Conard et al. 1985). Birds, ants, and other insects eat seeds, and can consume up to 99% of the annual seed crop (Conard et al. 1985). In B.C., redstem ceanothus is ranked as low for Bighorn Sheep; moderate for White-tailed Deer, Moose and Elk; and high for Mule Deer (Singleton 1976; Blower 1982).

Forage Value For Livestock: All classes of livestock eat redstem ceanothus but it is especially palatable to domestic sheep (USDA 1937) and moderately palatable to cattle in the U.S. (Thilenius 1960; Mitchell and Rodgers 1985).

Cover Value: Redstem ceanothus was ranked as fair cover for Elk, Mule Deer, White-tailed Deer, and small mammals in Montana. In Oregon, it supplies thermal cover for Mule Deer during cold, windy periods (Bodurtha et al. 1989). It is considered good cover for passerine birds; and fair cover for upland game birds (Hall 1974b; Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Redstem ceanothus can be overused by wildlife and livestock, which results in higher shrub densities on ungrazed areas than on grazed sites (Gaffney 1941; Zimmerman and Neuenschwander 1984). Hedrick (1969) reported that cattle suppressed shrub growth during the first years after timber harvest.

In clipping trials, Leege (1979) found redstem ceanothus plants clipped during full bloom produced only one-third as much annual growth as plants clipped during the bud stage. Plant mortality was highest when stems were pruned to ground level during the flowering stage. Young and Payne (1948) reported that twig production was enhanced when shrubs were clipped up to 50% during the spring. Miller (1976), but indicated that increases in twig height and weight resulting from pruning are related to stored carbohydrate reserves. Garrison (1972) concluded that 50% removal of twigs and foliage during the fall was an appropriate level of use to sustain forage production and maintain plant carbohydrate reserves.

Ceanothus velutinus (snowbrush)

Habitat: Snowbrush is common in southern B.C. on mesic to dry rocky slopes, openings, dry to moist forests, and burns. This species occupies habitats from the lowland to the montane in the IDF, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Snowbrush is browsed year-round by deer and Elk in the western U.S. (Kufeld et al. 1973; Leege 1984). It is considered a moderately to highly important winter browse for Mule Deer, White-tailed Deer, mountain sheep, Elk, and Moose (Klebenow 1965; Kufeld 1973; Peek 1974; Irwin and Peek 1983). Although it is evergreen and totally available to ungulates for browsing, deer and Elk mostly eat snowbrush when preferred forages are unavailable (Klebenow 1965; Mozingo 1987). Small mammals and birds eat snowbrush seeds (USDA 1976; Steele and Geier-Hayes 1989) and snowbush has even been found in mountain lion stomach samples (Toweill and Maser 1985).

In B.C., snowbrush was important forage for White-tailed Deer and Mule Deer on three winter ranges in the East Kootenay in spring, fall, and winter, 1992 to 1994 (Ross 1997). This species alone accounted for more than 14% of deer winter diets Skookumchuck Prairie in 1992.

In contrast, snowbrush was a minor component of Elk diets on the same winter ranges between 1992 and 1994 (Ross 1997). Snowbrush is ranked as low for Bighorn Sheep; moderate for White-tailed Deer, Moose and Elk; and high for Mule Deer in B.C. (Singleton 1976; Blower 1982).

Forage Value For Livestock: Snowbrush provides poor forage for domestic cattle, sheep, and horses (Mozingo 1987). The palatability of snowbrush has been rated as poor to fair for cattle in Utah, Wyoming, and Montana. Snowbrush was a minor component of cattle diets at Skookumchuck Prairie in the East Kootenay over 3 years, accounting for less than 1% of their summer diet in 1994 (Ross 1997). This species was not found in winter diets.

Cover Value: Snowbrush is rated as poor to fair cover for Elk, Mule Deer, and White-tailed Deer in Utah, Colorado, Wyoming, and Montana. It was also rated as fair to good for passerines, small, upland game birds, and small mammals; and poor for waterfowl (Dittberner and Olson 1983), but it does provide nesting sites for small birds (Steele and Geier-Hayes 1989).

Browsing Tolerance and Management Considerations: Garrison (1953) reported that snowbrush withstands 25 to 50% defoliation of annual twig growth without adversely affecting shrub production. Heavy and complete pruning of annual twigs impaired growth of new shoots. He recommended 35 to 40% defoliation as a safe level of use.

Ericameria nauseosus (common rabbit-brush)

(Syn. Chrysothamnus nauseosus)

Habitat: Common rabbit-brush is found on grasslands and dry open forests from low-elevation to the lower-montane in south central and southeastern B.C. This species is common in the BG, PP, IDF, and MS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998a).

Forage Value For Wildlife: Common rabbit-brush is highly valuable for wildlife in the western U.S., but is less important in B.C. Generally, wildlife forage only lightly on this species during summer, but winter browsing can be heavy in some locations (McArthur et al. 1978). In Montana, common rabbit-brush is considered to be an important fall and early winter food source for Mule Deer (Mackie 1970). Light Elk use has been reported in Montana (Mackie 1970). Black-tailed Jackrabbits graze common rabbit-brush in Utah (Currie and Goodwin 1966) and southern Idaho (Fagerstone et al. 1980). It is regarded a poor browse for White-tailed Deer and Moose; fair to good for Elk, White-tailed Deer, and Bighorn Sheep in the U.S. It is also ranked as fair to good browse for small mammals and passerines; but fair to poor for upland game birds and waterfowl (Rosentreter and Jorgensen 1986).

In B.C., common rabbit-brush was a minor component of Mule Deer winter and spring diets on grassland range near Kamloops (Willms and McLean 1978). Likewise, it contributed only a small part to California Bighorn Sheep diets in the south Okanagan (Wikeem and Pitt 1992). This species was ranked as low for White-tailed Deer and Moose; and moderate for Mule Deer, Bighorn Sheep, and Elk (Singleton 1976; Blower 1982).

Forage Value For Livestock: Common rabbit-brush palatability varies considerably from one geographic location to another depending on the subspecies. The subspecies present in B.C. is *Chrysothamnus nauseosus* var. *albicaulis*, which is equivalent to *C. nauseosus* ssp. *albicaulis* in the U.S. (Douglas et al. 1998a). In the U.S., this subspecies has medium to high palatability overall, but is rated as only poor to fair browse for cattle (Dittberner and Olson 1983). McLean (1979) ranked it as very low for cattle in B.C.

Cover Value: Common rabbit-brush is of little importance to large mammals for cover. In general, common rabbit-brush provides poor cover for Elk, Mule Deer, and White-tailed Deer (Dittberner and Olson 1983). It furnishes good cover for nesting birds including waterfowl and Sage Grouse in some locations (Gray 1967).

Browsing Tolerance and Management Considerations: Common rabbit-brush is considered an important browse species on some depleted rangelands in the U.S. (McArthur et al. 1977). Its abundance in the plant community usually indicates overuse of understorey species (McLean 1979). Clipping studies suggest that twig yields are higher on heavily clipped plants (75% removal) than on plants that are moderately clipped (Garrison 1953; Rosentreter and Jorgenson 1986). Garrison (1953) recommended 50% use of common rabbit-brush to maintain good shrub vigour.

Lonicera utahensis (Utah honeysuckle)

Habitat: Utah honeysuckle occupies moist forests, meadows, clearings, and grasslands from the lowland to the montane in south central and southeastern B.C. This species occurs in the IDF, ICH, and MS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: Utah honeysuckle is a valuable summer and fall browse for Elk, but less important for White-tailed Deer (Hansen et al. 1988; Thilenius 1960; Young and Robinette 1939). Moose lightly browse this species in summer, fall, and winter in Wyoming and Idaho (Harry 1957; Pierce 1984). Black Bears and Grizzly Bears eat Utah honeysuckle berries in summer and fall (Willard and Herman 1977; Steele and Geier-Hayes 1992), and Ruffed Grouse eat the fruit in summer in northern Idaho. It is not ranked as a browse species for ungulates in central and southern interior B.C. (Singleton 1976; Blower (1982).

Forage Value For Livestock: Utah honeysuckle palatability is rated as poor to fair for sheep; and poor for cattle in Utah and Montana (Dittberner and Olson 1983).

Cover Value: Utah honeysuckle provides poor cover for Elk and waterfowl; poor to fair cover for Mule Deer and White-tailed Deer; and fair to good cover for small mammals, passerines, and upland game birds (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Young and Payne (1948) suggested that 60 to 65% use of Utah honeysuckle was sustainable. Garrison (1972) concluded it can tolerate 60% fall defoliation of annual twig growth, but intense clipping levels caused decreased shrub vigour over time.

Purshia tridentata (bitter-brush)

Habitat: Bitter-brush, or antelope brush, is restricted to the extreme southern part of B.C. east of Coast-Cascade Mountains. This species inhabits dry open slopes, sagebrush grasslands, and open forests in the BG and PP zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Elk, Bighorn Sheep, Mule Deer, White-tailed Deer, and Moose use bitter-brush extensively in the western U.S. (Hobbs et al. 1981; Murray 1983). Bitter-brush seeds are eaten by rodents (Wagstaff 1980), especially Deer Mice and Kangaroo Rats (Evans et al. 1983).

Bitter-brush is ranked as low for Bighorn Sheep; moderate for Mule Deer, White-tailed Deer, and Moose; and high for Elk in B.C. (Singleton 1976; Blower 1982). Ross (1997), however, considered bitter-brush an increaser on Elk, Mule Deer, and White-tailed Deer winter range in the East Kootenay, and generally not important to Elk and Mule Deer except in extreme winters.

Forage Value For Livestock: In the western U.S., bitter-brush is rated as good forage for cattle but McLean (1979) considered the ecotypes in B.C. as only fair forage. Bitter-brush was the dominant shrub found in summer cattle diets at Skookumchuck Prairie in the East Kootenay between 1992 and 1994, accounting for up to 11.5% of the total diet. This species, however, only contributed 2.0% of their fall diet in 1993 (Wikeem and Ross 2002b).

Cover Value: Ungulates, rodents, and birds such as Sage Grouse use bitter-brush for cover throughout the year (Eastman 1960; Klebenow 1969; Griffith and Peek 1989).

Browsing Tolerance and Management Considerations: Bitter-brush is moderately tolerant to defoliation in the U.S. (Garrison 1953; Buwai and Trlica 1977; McConnell and Smith 1977). Spring browsing often produces lateral branching, and heavily browsed plants are usually more productive than those that are moderately used (Tueller and Towers 1979; Ross and Wikeem, unpubl. data). Tueller and Towers (1979) reported that unused bitterbrush was 70% less productive than browsed plants. In Montana, bitter-brush decreases with browsing pressure (Zacek et al. 1977), but in B.C. it often increases with cattle grazing (McLean 1979; Wikeem and Ross 2002b).

Domestic livestock and Mule Deer can compete for bitter-brush in late summer, fall, and/or winter in parts of the U.S. (Clements and Young 1997), but competition between deer and cattle appears only likely in severe winters in the East Kootenay region of B.C. (Wikeem and Ross 2002b). Clipping studies in the U.S. indicate that bitter-brush can sustain 60 to 65% use of stems and up to 90% of the buds without affecting future productivity. Garrison (1953) reported that it tolerates 60 to 65% use on good winter range sites in Oregon, and 50% use on poorer sites. Vigorous plants may tolerate up to 70% leader use during severe winters (Cole 1959). Hormay (1943), however, suggested that not more than 60% of the current twig growth should be browsed annually to sustain plant vigour and abundant seed production.

Ribes lacustre (black gooseberry)

Habitat: Black gooseberry is widespread throughout B.C. on stream banks and seepage areas, moist and wet forests and forest margins, and rock outcrops from the montane to alpine. This species is present in IDF, ICH, MS, SBS, SBPS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: Black gooseberry is moderately palatable to Elk and deer (Dittberner and Olson 1983). Elk, Mule Deer, and White-tailed Deer eat leaves and twigs (Edge et al. 1988), and rodents and birds eat berries (Kovalchik et al.1988). Grizzly Bears in southwestern Alberta also feed on berries in late summer and early autumn (Hamer et al. 1991). Singleton (1976) and Blower (1982) ranked *Ribes* spp. collectively as low for all ungulates in the central and southern interior of B.C.

Forage Value For Livestock: Black gooseberry is moderately palatable to livestock in the western U.S. (Dittberner and Olson 1983). In B.C., Willms et al. (1980) reported more than 30% use by cattle in the Interior Douglas-fir zone near Kamloops when other preferred forages became unavailable.

Cover Value: Black gooseberry is considered poor cover for Elk; fair cover for Mule Deer and White-tailed Deer; and good cover for upland game birds, passerines, and small mammals (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: In Utah, black gooseberry cover was significantly lower on cutblocks that were burned and grazed than on adjacent ungrazed and unburned blocks (Edgerton 1987), suggesting that black gooseberry is susceptible to ungulate browsing, fire, or a combination of both. No information is available for B.C.

Rosa acicularis (prickly rose)

Habitat: Prickly rose is found east of the Coast-Cascade Mountains occupying rocky or grassy slopes, dry to moist open forests and clearings, and stream banks and flood plains. This species is common from low-elevation to subalpine in the BG, PP, IDF, ICH, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Prickly rose is an important browse species for Mule Deer, White-tailed Deer, Elk, Moose, and mountain sheep (Martin et al. 1951; Wilkins 1957; Peek 1974). In Colorado, Mule Deer eat twigs and leaves in summer and fall (Wilkins 1957), and they browse twigs during fall and winter in Montana (Kufeld et al. 1973). Grizzly Bears and Black Bears eat rose hips in fall (Hatler 1972; Mace and Bissel 1986). They are also eaten by Snowshoe Hares, rabbits, Beaver, rodents, passerines, and grouse in fall and winter (Martin et al. 1951; Densmore and Zasada 1977; Wolff 1978b). Roses (*Rosa* spp.) are collectively ranked as low for Bighorn Sheep and Moose; and moderate for Mule Deer, White-tailed Deer, and Elk in B.C. (Singleton 1976; Blower 1982).

Forage Value For Livestock: Prickly rose is an excellent summer browse for livestock in some parts of the U.S., but the nutritional quality declines once the leaves are shed (Ferguson 1983).

Cover Value: Thickets of wild rose provide excellent nesting sites and cover for birds and small mammals (Martin et al. 1951). In Montana, prickly rose provides good thermal and feeding cover for Mule Deer and White-tailed Deer; and fair cover for Elk, upland game birds, passerines, and small mammals (Hansen et al. 1989).

Browsing Tolerance and Management Considerations: Prickly rose will sprout from the rhizomes if cut and after logging (Watson et al. 1980), suggesting it has the ability to recover from defoliation. Young and Payne (1948) suggested that *Rosa jonesii*, a synonym for Nootka Rose (*Rosa nutkana*), could sustain 60 to 65% use.

Rosa gymnocarpa (baldhip rose)

Habitat: Baldhip rose is common in B.C. south of 53ºN. This species occupies dry to moist open forest, forest edges, thickets, and openings from low-elevation to the montane in the PP, IDF, ICH, and MS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Baldhip rose serves as a year-round forage for mammals, birds, and insects. Apparently, the thorns do not restrict browsing by native ungulates or livestock, and overuse commonly occurs on some heavily used ranges (USDA 1937). White-tailed Deer and Mule Deer use baldhip rose in the Pacific Northwest, particularly in burned areas. The fruits (hips) persist throughout the winter, and are eaten by small mammals, birds, and insects (Gill et al. 1974).

Willms and McLean (1978) found that *Rosa* spp. were a relatively minor component (<10%) of Mule Deer diets in winter and spring on lower grassland range near Kamloops. Similarly, deer and Elk ate rose mostly in winter and spring on four wildlife winter ranges in the East Kootenay, but it never exceeded 5% and 2% of their annual diets, respectively (Ross 1997). Roses have been collectively ranked as low for Bighorn Sheep and Moose; and moderate for Mule Deer, White-tailed Deer and Elk in B.C. (Singleton 1976; Blower 1982).

Forage Value For Livestock: In general, *Rosa* spp. are palatable to livestock, but palatability varies considerably among species, habitats, and grazing animals (Campbell et al. 1974). Baldhip rose is considered one of the most palatable rose species, but sheep generally find roses more palatable than cattle (USDA 1937). In the U.S., cattle eat baldhip rose in late summer and fall. In the East Kootenay *Rosa* spp. contributed less than 1% of cattle diets in spring, summer, and fall on four wildlife winter ranges between 1992 and 1994 (Ross 1997). In general, they are considered of medium forage value for cattle (McLean 1979).

Cover Value: No information is available for baldhip rose. Wood's rose (*R. woodsii*), which is of similar size and growth form, is used for nesting and escape cover by birds and small mammals. It is rated as poor to fair cover for Mule Deer and Elk; and good for small mammals, passerines, and upland game birds (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Zimmerman and Neuenschwander (1984) reported that baldhip rose is highly tolerant to browsing by wildlife, but livestock browsing, and possibly trampling, can impede its spread. Cattle and sheep can overgraze sparse, or open stands, because this species is entirely available to browsing animals (Dayton 1931; Campbell et al. 1974). Young and Payne (1948) suggested that *Rosa jonesii*, a synonym for Nootka Rose (*Rosa nutkana*), could sustain 60 to 65% use.

Rosa woodsii (Wood's rose)

Habitat: Wood's rose, or prairie rose, inhabits dry rocky slopes, open forests and clearings, moist gullies, draws and stream banks in grasslands and savanna from low-elevation to the montane in B.C. This species is found throughout the province east of the Coast-Cascade Mountains in the BG, PP, IDF, and MS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Prairie rose is used as spring, summer, and fall browse by Mule Deer, White-tailed Deer, and Elk in the western U.S. and Alberta (Plummer et al. 1968; Welch and Andrus 1977; Hardy BBT Limited 1989). In Utah, Mule Deer browse leaves in spring and rose hips in winter (Plummer et al. 1968; Welch and Andrus 1977). Porcupines and Beavers also browse the leaves (Haeussler et al. 1990). Rose hips persist through much of the winter and are used by birds and mammals when other food sources are covered with snow (Plummer et al. 1968; USDA 1976). Squirrels, coyotes, and bears occasionally eat the hips (Haeussler et al. 1990).

Prairie rose is ranked as poor to good for Elk; fair to poor for Mule Deer and White-tailed Deer; and good for small mammals, non-game birds, and upland game birds in the U.S. It is considered poor for waterfowl (Dittberner and Olson 1983). In B.C., *Rosa* spp. are ranked as low for Bighorn Sheep and Moose; and moderate for Mule Deer, White-tailed Deer, and Elk (Singleton 1976; Blower 1982).

Forage Value For Livestock: Prairie rose is browsed by livestock from spring to fall in parts of the U.S. (USDA 1976). This species is most preferred by livestock in spring when the shrub first produces leaves, but it is generally ranked as fair to good forage for cattle (Plummer et al. 1968; Hansen et al. 1988; Stubbendieck et al. 1997).

Cover Value: Prairie rose often forms dense thickets that are used for nesting and escape cover by birds and small mammals (Hardy BBT Limited 1989; Haeussler et al. 1990). This species provides poor to fair cover for Elk, Mule Deer, and White-tailed Deer; and fair to good cover for small mammals, passerines, upland game birds, and waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Prairie rose has been rated as having fairly high tolerance to browsing (Hardy BBT Limited 1989; Haeussler et al. 1990), but no specific guidelines are available for B.C. or elsewhere.

Rubus idaeus (red raspberry)

Habitat: Red raspberry inhabits thickets, rocky slopes, clearings, dry to moist open forests, burns, and other disturbed areas in B.C. This species is common throughout the province from the lowland to the montane in the PP, IDF, ICH, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Red raspberry supplies food and cover for a wide range of wildlife species, but generally it is regarded as poor forage for most herbivores (Brinkman 1974c; Peek 1974; Whitney 1986). In some places, deer, rabbits, Mountain Beaver, and Elk eat leaves, whereas Porcupine and Beaver occasionally forage on buds, twigs, or bark (Van Dersal 1938).

Fruits of many *Rubus* spp. are eaten by Ruffed Grouse, Blue Grouse, Sharp-tailed Grouse, California Quail, Northern Bobwhite, Gray Catbird, Robin, Thrush, Towhee, Brown Thrasher, Summer Tanager, Pine Grosbeak, among other bird species (Van Dersal 1938). Coyotes, Raccoons, Black Bears, squirrels, chipmunks, skunks, foxes, Deer Mice, and Grizzly Bears also eat red raspberry fruit (Krefting and Roe 1949; Zager 1980).

Red raspberry is ranked as poor to fair for Elk and White-tailed Deer; and fair to good for Mule Deer. It is considered fair to good for small mammals, passerines, and upland game birds; but poor for waterfowl (Dittberner and Olson 1983).

Forage Value For Livestock: Raspberries have little forage value for domestic livestock (Van Dersal 1938) and it is ranked as poor for cattle in the western U.S. (Dittberner and Olson 1983).

Cover Value: Dense red raspberry thickets serve as favourable nesting habitat for small birds. Small mammals such as rabbits and squirrels also find shelter in raspberry thickets (Van Dersal 1938). It is generally regarded as poor cover for Mule Deer and White-tailed Deer, and fair to good for small mammals, passerines, and upland game birds. It is considered poor cover for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information is available regarding browsing tolerance.

Rubus parviflorus (thimbleberry)

Habitat: Thimbleberry occupies mesic to moist open forests, thickets, clearings, stream banks and roadsides from the lowland to subalpine. This species is common throughout B.C. south of 56ºN in the IDF, ICH MS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Thimbleberry has little value for most ungulates. In parts of the western U.S., it is regarded as a palatable forage for Mule Deer (Van Dersal 1938; Young and Robinette 1939) and an important summer browse for Moose (Peek 1974). Bighorn Sheep feed on *Rubus* spp. leaves where the plant is available (Van Dersal 1938). In Idaho, thimbleberry is apparently more palatable to Elk in late summer than earlier in the season (Young and Robinette 1939). On moist sites, thimbleberry can grow beyond the reach of deer and other large ungulates (Hines 1973).

Thimbleberry fruit is highly palatable to many birds and mammals but palatability varies among locations. Rabbits, Porcupine, And Beavers eat fruit, leaves, buds, twigs and bark (Dayton 1931; Van Dersal 1938). Black Bears, Grizzly Bears, Coyotes, foxes, chipmunks, Pikas, Red Squirrels, ground squirrels, and Skunks forage on berries (Van Dersal 1938; Zager 1980; Steele and Geier-Hayes 1992). Similarly, Ruffed Grouse, Blue Grouse, Sharp-tailed Grouse, California Quail, Robins, Thrushes, Thrashers, Towhees, Bobwhites, Gray Catbird, and Pine Grosbeak among others eat the fruit (Van Dersal 1938).

In the western U.S., thimbleberry is ranked as poor to fair for Elk and Mule Deer; and poor to fair for White-tailed Deer. It is ranked as good for small mammals and passerines; fair to good for upland game birds; and poor for waterfowl (Dittberner and Olson 1983). This species is not ranked as a browse species for ungulates in the central and southern interior of B.C. (Singleton 1976; Blower 1982).

Forage Value For Livestock: In B.C., Willms et al. (1980) found that cattle use of thimbleberry increased from zero to more than 45% use as preferred forages became depleted on Interior Douglas-fir forest range near Kamloops. In the western U.S., thimbleberry has little value as livestock forage and ranked as poor to fair for cattle (Van Dersal 1938).

Cover Value: Dense stands of thimbleberry provide nesting habitat for small birds, and cover for deer to bed down during the heat of the day (Hines 1973). It also affords cover for rabbits, Red Squirrel, Pika, Black Bear, and Beaver in some locations (Van Dersal 1938). It is ranked as poor cover for Elk, White-tailed Deer, and waterfowl; and fair to good cover for small mammals, passerines, and upland game birds (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Mueggler (1988) reported that thimbleberry decreased in response to heavy domestic sheep grazing suggesting that a threshold for use exists. It also appears susceptible to trampling damage but generally resprouts rapidly after mechanical removal (Cole 1988).

Shepherdia canadensis (soopolallie)

Habitat: Soopolallie is found throughout the interior of B.C. in dry to moist open forests, openings, and in clearings. This species is common from the lowland to subalpine in the IDF, MS, SBPS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: In Alberta, Rocky Mountain Bighorn Sheep moderately to heavily use new growth in early spring (Stelfox 1976). Snowshoe Hares browse soopolallie stems (Pease et al. 1979; Smith et al. 1988), and Black Bears, Grizzly Bears, and grouse eat berries from mid-summer to fall (Cowan et al. 1950; Freedman 1983; MacHutchon 1989; Unsworth et al. 1989). In the western U.S., soopolallie ranks poor for Elk, Mule Deer, Bighorn Sheep, and Moose; and poor to good for White-tailed Deer. It is rated as fair to good for small mammals and upland game birds; and fair for passerines (Dittberner and Olson 1983; Noble 1985).

The palatability of soopolallie is considered poor and it is usually eaten only when other forages are unavailable. It is listed as unpalatable to Moose in B.C. and Wyoming (Cowan et al. 1950). Ross (1997) found that Elk, Mule Deer, White-tailed Deer all used soopolallie for winter, spring, summer, and fall forage. Soopolallie contributed nearly 30% to combined Mule Deer and White-tailed Deer diet in winter 1994, but in other seasons and years it accounted for less than 5% of their diet. Singleton (1976) listed soopolallie as low for Mule Deer in winter and spring; and Blower (1982) does not rank soopolallie as an ungulate browse species in B.C.

Forage Value For Livestock: Soopolallie provides only fair forage for sheep and poor forage for cattle in the U.S. (Mozingo 1987). Cattle eat it only sparingly in B.C. (McLean 1979). Soopolallie was not an important browse species for cattle in the East Kootenay, accounting for about 2% of their summer diet, and was not eaten by cattle in fall (Ross 1997).

Cover Value: Soopolallie provides good cover for waterfowl in Colorado, Montana, and North Dakota, but is ranked as poor in Utah and Wyoming. It affords poor to fair cover for Elk; and fair to good cover for Mule Deer and White-tailed Deer. It also provides fair to good cover for upland game birds, passerines, and small mammals; but poor cover for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information is available on browsing tolerances.

Symphoricarpos albus (common snowberry)

Habitat: Common snowberry inhabits grasslands, open forests, thickets and dry rocky slopes through most of central and southern B.C. This species is found from the lowland to montane in the BG, PP, IDF, and MS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: White-tailed Deer browse snowberry during summer and fall in Idaho (Thilenius 1972). In Montana, Edge et al. (1988) reported frequent and heavy Elk browsing on snowberry during early summer, whereas Hansen et al. (1995) found that Elk rarely used this species, even when it was available. Similarly, Stevens (1970) reported extensive winter use of snowberry in Montana, but they lightly browsed this species only during winter in Idaho (Pierce 1984).

In the East Kootenay region of B.C., Rocky Mountain Bighorn Sheep browse snowberry in fall, winter, and early spring (Thompson 1990). California Bighorn Sheep lightly browse this species during spring and summer in the south Okanagan (Wikeem and Pitt 1992). Thompson (1990) reported that White-tailed Deer browsed common snowberry in fall, winter, and early spring in the East Kootenay. In contrast, Ross (1997) found that common snowberry was generally a minor part of deer and Elk diets on four winter ranges in the East Kootenay, although it accounted for more than 12% of deer diet in fall 1993 at Skookumchuck Prairie. *Symphoricarpos* spp. are ranked as low for White-tailed Deer, Bighorn Sheep, and Moose; and moderate for Mule Deer and Elk in B.C. (Singleton 1976; Blower 1982).

Forage Value For Livestock: Common snowberry is important forage for cattle in Oregon (Holecheck et al. 1987), Idaho (Thilenius 1972), and South Dakota (Uresk 1987), but palatability varies considerably among sites (Uresk 1987; Hansen et al.1995). McLean (1979) ranked common snowberry as a medium fall forage for cattle in B.C. Willms et al. (1980) found that cattle did not use common snowberry at all when preferred forages were available, but use exceeded 75% when palatable forages became unavailable on Interior Douglas-fir range near Kamloops. Similarly, Ross (1997) found that common snowberry was ungrazed by cattle at Pickering Hills, Peckhams Lake, Premier Ridge, and represented less than 1% of cattle fall diets at Skookumchuck Prairie in 1992.

Cover Value: In the western U.S., Ruffed Grouse, Blue Grouse, Sharp-tailed Grouse, and small mammals use common snowberry extensively as thermal cover (Schmidt 1936; Rickard 1960; Crawford et al. 1986). Bonar (1995) found that pocket gophers dig extensive burrows under common snowberry thickets in northeast Oregon. Common snowberry is rated as poor to fair cover or Elk, Mule Deer, and White-tailed Deer; and good cover for small mammals, upland game birds, passerines, and waterfowl (Hansen et al. 1995).

Browsing Tolerance and Management Considerations: McLean (1979) and Coates and Haeussler (1986) reported that common snowberry is resistant to heavy browsing, but specific tolerance levels were not described. Johnson and Simon (1987), however, stated that snowberry was eliminated from a site in Oregon by overbrowsing.

Vaccinium membranaceum (black huckleberry)

Habitat: Black huckleberry occupies dry to moist forests and openings throughout B.C. This species is commonly found in the montane and subalpine zones in the IDF, ICH, MS, SBPS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Black huckleberry is important fall forage for White-tailed Deer (Kingery et al. 1996) and Moose in Idaho (Pierce 1984). Although Elk feed on black huckleberry leaves early in the season (Young and Robinette 1939), it is a minor component of Elk summer diets in Montana (Edge et al. 1988). Grizzly Bears and Black Bears feed on the berries, leaves, stems, and roots (Noble 1985; Almack 1986).

Black huckleberry provides fall forage for Blue Grouse in Oregon (Crawford et al. 1986) and it is an important food source for Ruffed Grouse. Black huckleberry has been rated fair to good for Elk and Mule Deer; and good for White-tailed Deer, small mammals, passerines, and upland game birds. It is ranked as good for Grizzly Bear and Black Bear, but poor for waterfowl (Young and Robinette 1939; Klebenow 1965; Dittberner and Olson 1983). In B.C., *Vaccinium* spp. collectively are rated as low for Mule Deer, White-tailed Deer, and Bighorn Sheep; and moderate for Elk and Moose (Singleton 1976; Blower 1982).

Forage Value For Livestock: Black huckleberry is regarded as poor forage for cattle in the U.S. (Dittberner and Olson 1983).

Cover Value: Dense thickets of black huckleberry provide good cover for small birds and mammals. Its cover value is ranked as fair for Elk, Mule Deer, and White-tailed Deer; and good for small mammals, passerines, and upland game birds. It is considered poor cover for waterfowl (Klebenow 1965; Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information is available about tolerance to browsing. This species may be intolerant to heavy trampling by humans (Cole and Trull 1992) but no information exists on trampling effects by livestock or wildlife.

Vaccinium ovalifolium (oval-leaved blueberry)

Habitat: Oval-leaved blueberry occurs in mesic to wet forests, forest openings, and bogs throughout the central and southern interior. This species is found from the lowland to subalpine in the ICH, MS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: In western Washington, oval-leaved blueberry is a preferred browse of Black-tailed Deer, especially in spring and fall. Leaves and berries are important fall foods for Spruce Grouse in Alaska (Ellison 1966). Other birds such as the Scarlet Tanager, Thrushes, Thrashers, Towhees, Ptarmigans, Ring-necked Pheasant, Ruffed, Blue, And Sharp-tailed Grouse eat the fruit (Van Dersal 1938; Martin et al. 1951). Chipmunks, Red Fox, Skunks, squirrels, Gray Fox, and Raccoon, Black Bears, and Grizzly Bears also forage on berries (Van Dersal 1938; Martin et al. 1951; Banner et al. 1986; Halverson 1986).

Although the palatability of oval-leaved blueberry varies among sites, Hall (1974a) describes it as moderately palatability to big game. Oval-leaved blueberry is most important as a browse for Roosevelt Elk and Black-tailed Deer west of the Coast Mountains in B.C. (Haeussler and Coates 1986). Blower (1982) ranked *Vaccinium* spp. collectively as low for Mule Deer, White-tailed Deer, and Bighorn Sheep; and moderate for Elk and Moose.

Forage Value For Livestock: Oval-leaved blueberry appears to be relatively unpalatable to livestock in the U.S., although sheep and goats browse on species in some locations (Dayton 1931; Van Dersal 1938).

Cover Value: Oval-leaved blueberry likely provides similar cover opportunities for small mammals and birds, like black huckleberry, but no specific information is available for B.C.

Browsing Tolerance and Management Considerations: No information on tolerances to browsing by wildlife or livestock.

Vaccinium parvifolium (red huckleberry)

Habitat: Red huckleberry is found in dry to moist forests, and along forest edges and openings. This species is common on the coast and locally common in the wet Columbia Mountains and the Kootenay Valley in the ICH zone (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: Red huckleberry is an important deer and Elk browse in parts of the Pacific Northwest during fall and winter (USDA 1937; Van Dersal 1938;Viereck and Little 1972). In western Washington, red huckleberry is an important Elk browse and use can be heavy in some areas (Schwartz and Mitchell 1945; Hemstrom and Logan 1986). Deer consume the fruit, leaves, twigs, leafy shoots, and newly developing sprouts. Red huckleberry can grow beyond the reach of deer on some sites.

Black Bear, Deer Mice, White-footed Mouse, Raccoon, Pika, ground squirrels, chipmunks, Red Fox, squirrels, and Skunks, also eat the berries (Van Dersal 1938; Martin et al. 1951). Similarly,
Thrushes, Catbird, Bluebirds, Ptarmigans, Towhees, Spruce Grouse, Ruffed Grouse, Blue Grouse, and Sharp-tailed Grouse forage on the fruit (Van Dersal 1938; Martin et al. 1951; King and Bendell 1982).

Palatability of red huckleberry in the U.S. is described as moderate (Dayton 1931). In B.C., it is mostly used by Black-tailed Deer and Roosevelt Elk west of the Coast-Cascade mountains (Singleton 1976). Blower (1982) ranked the genus *Vaccinium* collectively as low for Mule Deer, White-tailed Deer, and Bighorn Sheep; and moderate for Elk and Moose.

Forage Value For Livestock: Cattle use red huckleberry sparingly in the U.S. (Dayton 1931). No information is available for B.C., but little cattle grazing occurs in most areas where this species grows.

Cover Value: Presumably huckleberry provides cover for wildlife similar to black huckleberry, which often forms dense thickets that serve as hiding nesting sites for small birds and mammals.

Browsing Tolerance and Management Consideration: Heavy ungulate browsing of red huckleberry has been observed on winter ranges in some parts of Washington. Schwartz and Mitchell (1945) recommended maximum use of 50 to 70% to maintain plant vigour.

Vibernum edule (high-bush cranberry)

Habitat: High-bush cranberry inhabits moist to wet stream banks, swamps, seepage areas, and forests throughout B.C. This species is found from the lowland to montane in IDF, ICH and MS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: High-bush cranberry is ranked as a low to moderate browse species for Elk, Bighorn Sheep, Mule Deer, and White-tailed Deer in southern interior B.C. (Singleton 1976; Blower 1982). Singleton (1976) reported that it was medium summer and fall forage for Moose. Berries are an important food for Grizzly Bears (Banner et al. 1986; Hamilton and Archibald 1986) and Black Bears in late fall (Hatler 1972). Beavers, rabbits, and Snowshoe Hares eat leaves and stems (Wolff 1978b; Pease et al. 1979; Haeussler and Coates 1986), and small mammals, passerines, Spruce Grouse, and Ruffed Grouse eat the fruit (Ellison 1966; Viereck and Little 1972; Haeussler and Coates 1986). Blower (1982) ranked high-bush cranberry as low for all ungulates in the central and southern interior except Moose, which Blower (1982) ranked as moderate.

Forage Value For Livestock: Van Dersal (1938) ranked palatability of high-bush cranberry as low for livestock in the western U.S.

Cover Value: *Vibernum* spp. are important components of forest-edge and hedgerow habitats that provide cover for small mammals and birds in the eastern U.S. (Gill and Healy 1974).

Browsing Tolerance and Management Considerations: No information on tolerances to browsing by wildlife or livestock.

SMALL SHRUBS

Arctostaphylos uva-ursi (bearberry)

Habitat: Bearberry is common in dry forests, openings, and dry rocky slopes throughout B.C. This species occurs from low-elevation to the lower alpine zones in the IDF, MS, ESSF, SBPS, and SBS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: Mule Deer, Elk and Rocky Mountain bighorn browse forage lightly, especially on winter range (Kufeld et al. 1973; Currie et al. 1977; Watson et al. 1980). Moose browse bearberry in early spring in Montana (Stevens 1970), and passerines, upland game birds, deer, Elk, and small mammals eat the fruit (Martin et al. 1951; Keown 1977; Watson et al. 1980). The berries are persistent and are important forage for Black Bear and Grizzly Bear in the autumn, winter, and early spring (Hatler 1972; MacHutchon 1989). Singleton (1976) and Blower (1982) ranked bearberry as low for Elk and Moose; moderate for White-tailed Deer and Bighorn Sheep; and high for Mule Deer.

Forage Value For Livestock: Although Willms et al. (1980) found that cattle grazed bearberry sparingly in the Interior Douglas-fir zone near Kamloops, it is generally regarded as unpalatable to domestic livestock and considered worthless (USDA 1937; McLean et al. 1964; Stubbendieck et al. 1997).

Cover Value: Bearberry has no cover value for ungulates, but it provides fair cover for some upland game birds; and fair to good cover for small mammals and passerines (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information is available about its tolerance to defoliation. McLean et al. (1964) concluded that bearberry grows too low to be grazed by cattle. Limited information suggests that bearberry responds variably to trampling. (Cole 1988) reported that cover declined on grazed areas in northern Idaho. In contrast, bearberry increased in response to heavy livestock grazing and trampling in Wyoming (Reed 1971).

Artemisia frigida (prairie sagewort)

Habitat: Prairie sagewort, or pasture sage, is most common and widespread on arid grasslands. This species is also found on dry open slopes to sub-alpine zones in south central B.C. in the BG, PP, IDF, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998a).

Forage Value For Wildlife: The value of prairie sagewort to wildlife varies seasonally and geographically (Cooperrider and Bailey 1986). It is preferred forage for many wildlife species during spring, fall, and winter, but is of little value during summer. Deep snow may limit its use on winter ranges in some areas (Cooperrider and Bailey 1986). Elk, Mule Deer, White-tailed Deer, California Bighorn Sheep, and Rocky Mountain Bighorn Sheep forage on prairie sagewort (Kufeld et al. 1973; Wikeem 1984; Cooperrider and Bailey 1986). Pasture sage is an important food for Sage Grouse in central Montana from March through November (Wallestad et al. 1975). In the U.S., it is ranked as good for Bighorn Sheep and Elk; fair to good for Mule Deer; poor to fair for White-tailed Deer; and fair to good for small mammals and upland birds. It is ranked as poor for waterfowl (Dittberner and Olson 1983).

Willms and McLean (1978) found prairie sagewort an important winter and spring forage for Mule Deer on grassland range near Kamloops. Singleton (1976) and Blower (1982) ranked prairie sagewort as low for Moose, moderate for White-tailed Deer and Elk, and high for Bighorn Sheep and Mule Deer.

Forage Value For Livestock: Cattle lightly graze prairie sagewort in some parts of the U.S., but its palatability varies from poor to fair in different areas (Cooperrider and Bailey 1986). In B.C., it is used by cattle in late fall and winter when other forages are unavailable (McLean 1979).

Cover Value: Prairie sagewort has no cover value for ungulates, but provides limited cover for small birds and mammals (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Clipping studies indicate that prairie sagewort can be injured when plants are defoliated during rapid growth and near maturity, or with repeated defoliation (Buwai and Trlica 1977). Damage is most severe when plants are heavily clipped and when carbohydrate reserve levels are low. Prairie sagewort appears sustainable with moderate defoliations (<50%), especially when plants are given adequate rest to recover (Buwai and Trlica 1977). Prairie sagewort generally increases in response to cattle grazing (Campbell et al. 1974; Mueggler and Stewart 1981) and its abundance often indicates overgrazed conditions (McLean 1979).

Mahonia aquifolium (tall Oregon-grape)

Habitat: Tall Oregon-grape occurs in dry to mesic forests, openings, and dry rocky slopes from the lowland to montane zones. This species is common throughout B.C. in the PP, IDF, ICH, MS, and SBS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: Tall Oregon-grape is an important fall and winter browse species for Mule Deer in Montana and Nevada (Kufeld et al. 1973), but is not used extensively by Mule Deer during summer in Utah (Smith 1953). In Idaho, it offers spring browse for White-tailed Deer and Elk (Keay and Peek 1980; Leege 1984). It is generally regarded as poor browse for Moose and Bighorn Sheep in all seasons (Ritchie 1978).

Tall Oregon-grape was a valuable winter browse species for deer and Elk at Skookumchuck Prairie in the East Kootenay, but it was of low value in spring, summer, and fall (Ross 1997). This species is ranked as low for Moose; and moderate for all other ungulates in the central and southern Interior (Singleton 1976; Blower 1982).

Forage Value For Livestock: Although summer and fall cattle diets contained 5 to 15% tall Oregon-grape at Pickering Hills in 1993 and 1994, this species was not used by cattle on other wildlife winter ranges in the East Kootenay between 1992 and 1994 (Ross 1997). It is rated poor for cattle in the western U.S. (Dittberner and Olson 1983), and as low to medium for cattle in B.C. (McLean et al. 1964).

Cover Value: Because of its small stature, tall Oregon-grape is rated as poor cover for Elk, Mule Deer, White-tailed Deer; and poor to fair for passerines, upland game birds, and waterfowl in the western U.S. (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information is available about grazing tolerance. Tall Oregon-grape is considered moderately resistant to trampling and recovers well (Cole 1988).

Pachistima myrsinites (falsebox)

Habitat: Falsebox inhabits dry to mesic forests in sun and shade, openings, and dry slopes in the lowland to montane zones. This species is common in B.C. south of 56ºN in the IDF, ICH, MS, and SBS zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1998b).

Forage Value For Wildlife: In the western U.S., falsebox is considered important forage for deer, Elk, and Moose (Peek 1974; Halverson 1986). It has been rated as fair to poor forage for Elk, Mule Deer, White-tailed Deer; and poor for small mammals and birds (Dittberner and Olson 1983). In B.C., falsebox is ranked as low for Bighorn Sheep; moderate for White-tailed Deer and Elk; and high for Mule Deer and Moose (Singleton 1976; Blower 1982).

Forage Value For Livestock: Livestock occasionally eat falsebox, but it is not considered an important forage species (Young and Payne 1948). The palatability of this species is generally low, but cattle graze it occasionally on overgrazed range (McLean et al. 1964).

Cover Value: Falsebox provides no cover for Elk, Mule Deer, White-tailed Deer; and poor to fair for small mammals, passerines, and upland game birds (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information is available about tolerances to browsing by wildlife or livestock.

Spiraea betulifolia (birch-leaved spirea)

(syn. Spiraea betulifolia var*. lucida)*

Habitat: Birch-leaved spirea occupies dry to moist open forests, openings and dry rocky slopes throughout B.C. east of the Coast-Cascade Mountains. This species is common from the lowland to montane in the PP, IDF, ICH, MS, SBPS, SBS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999b).

Forage Value For Wildlife: Birch-leaved spirea leaves persist on the plant longer than those of other deciduous shrub species, but it is not important forage for wildlife (USDA 1937; Dittberner and Olson 1983). Birch-leaved spirea is relatively unpalatable to Mule Deer and Elk (Steele and Geier-Hayes 1989). In the western U.S. it is rated as poor for Elk; fair for mule and White-tailed Deer and poor for all small mammals and birds (Dittberner and Olson 1983). Ross (1997) reported birch-leaved spirea as a minor component in Elk and deer diets on four winter ranges in the East Kootenay, but this species never accounted for more than 1% of diet on any site. Singleton (1976) and Blower (1982) did not rank birch-leaved spirea as an ungulate browse species in B.C.

Forage Value For Livestock: Quinton (1984) found this species as a minor part of cattle diets over three years on seeded clearcuts in central Interior B.C. Willms et al. (1980) reported that cattle use increased from about 10% to nearly 70% on birch-leaved spirea as preferred forages became unavailable on Interior Douglas-fir forest range near Kamloops. Ross (1997) found this species as a trace in cattle diets at Peckhams Lake in the East Kootenay, but absent from their diets on all other sites sampled. McLean (1979) rated birch-leaved spirea as low for cattle although they may graze the leaves and tops occasionally.

Cover Value: Birch-leaved spirea often grows in colonies, but its cover value for ungulates is low to virtually non-existent (Hansen et al. 1989). It offers poor to fair cover for small mammals and birds (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: No information on browsing tolerance is available. Abundance of this species may be an indicator of poor range condition on sites where cattle graze.

Vaccinium scoparium (grouseberry)

Habitat: Grouseberry occurs in dry to moist forests and openings in the montane and subalpine zones. This species is common in southeastern and south central B.C. in the IDF, MS, and ESSF zones (Meidinger and Pojar 1991; Parish et al. 1996; Douglas et al. 1999a).

Forage Value For Wildlife: Grouseberry provides food and cover for many wildlife species in the western U.S. (Van Dersal 1938; Halverson 1986), although its palatability is often considered low (Young and Robinette 1939; Hall 1974a). Depending on the location, it can be an important forage for Mule Deer (Deschamp et al. 1979), Moose (Peek 1974), and Elk (Beetle 1962). Bears eat berries and foliage (Mattson 1997). Grouseberry fruit is an important source of food for chipmunks, red squirrels, foxes, and skunks (Martin et al. 1951). They are also valuable forage for Spruce Grouse, Ptarmigans, Ruffed Grouse, Blue Grouse, Bluebirds, thrushes, and other birds (Van Dersal 1938; Smith and Fischer 1997).

It has been ranked as a fair to good forage for small mammal, passerines, and upland birds, and poor for waterfowl (Dayton 1931; Dittberner and Olson 1983). Singleton (1976) and Blower (1982) ranked *Vaccinium* spp. collectively as low for Mule Deer, White-tailed Deer, and Bighorn Sheep; and moderate for Elk and Moose.

Forage Value For Livestock: Palatability for domestic livestock has been classified as fair to poor in the U.S. and this species provides only minimal browse for livestock because of its small stature (Kelly 1970).

Cover Value: Because of its decumbent growth-form, grouseberry provides no cover value for large mammals. The cover value of grouseberry has been rated as fair to good for small mammals and upland birds; and poor for waterfowl (Dittberner and Olson 1983).

Browsing Tolerance and Management Considerations: Grouseberry is moderately resistant to trampling (Cole 1988). Johnson (1962) reported significant trampling damage to this species by domestic sheep in high-elevation fir-spruce forests. No information is available about browsing tolerances.