What about the Berries?

Managing for Understorey Species

The Centre for Livelihoods and Ecology
Royal Roads University
Victoria, BC

December 2010

Royal Roads University

Michael Keefer[1], Wendy Cocksedge[2], Robin Munro[3], Jason Meuleman[4], Nancy MacPherson[5]

Acknowledgements

We are grateful for the extensive knowledge shared by the participants at the "What About the Berries" workshop held in Chase in March 2008. Chief Fred Sampson, of the Siska Band, played a valuable role in inspiring this guide. Many other Siska community leaders and members provided key inputs based on their knowledge and values. This small First Nation is forging the way in the ethical and economic use of non-timber forest products (NTFPs). We are also very grateful to the many elders in other bands who have been so generous with their time and knowledge, with a particular thank you to Cecelia deRose and Jean William. Evelyn Hamilton, a wildlife biologist who believes in compatible use of natural resources, supported the interest in managing this NTFP resource. Many thanks to Ted Lea, retired vegetation ecologist with the BC Ministry of Environment, who compiled BEC information for the species, and to Kim Everett, Ministry of Environment, who worked with Ted to develop cover maps. Thank you to the invaluable Ministry of Forests Research Branch employees who collaborated in developing information and reviewing our compilations. Thank you also to the Royal BC Museum for permission to use the species drawings.

December 2010

In partnership with Keefer Ecological Services Ltd and the British Columbia Ministry of Forests and Range Research Branch

Funding assistance from the British Columbia Forest Science Program and the Cascade Forest District

Available on the web at http://cle.royalroads.ca/

1 Ethnobotanist and Principal, Keefer Ecological Services Ltd. E-mail: Mike@KeeferEco.com

2 Coordinator of Ecology and Management. Centre for Livelihoods and Ecology, Royal Roads University. E-mail: wendy.cocksedge@royalroads.ca

3 Wildlife Information Specialist, British Columbia Ministry of Environment Fish and Wildlife Section. E-mail: Robin.Munro@gov.bc.ca

4 General Manager, Tipi Mountain Native Plants Ltd. E-mail: Jason@TipiMountain.com

5 Graduate Student, Faculty of Land and Food Systems, University of British Columbia. E-mail: nancymac@interchange.ubc.ca

Dedication

This report is dedicated to all elders of our society who help teach humanities' connection to the land. This report is particularly dedicated to the work and life of Peter Paul McCoy. Pete was born in Fernie, B.C. in 1953 and passed away in Cranbrook, B.C, on June 11, 2010. Pete was a proud member of the Ktunaxa Nation, a rare multi-talented man whose life included: teaching ethnobotany and the Ktunaxa language; researching traditional plant and other knowledge with his elders; and practicing artwork that highlighted local materials including deer hide and a wide variety of woods. Along with his botanical knowledge, he was particularly known as a trickster who excelled in the role of *skinkuc* (coyote), frequently employing humour in his teachings and other interactions with a talent and persistence that few possess. Pete will be well remembered by his family, friends, students, and many others.

Foreword

The British Columbia Inter-agency Non-timber Forest Resources (IANTFR) Committee was established in January 2006 to facilitate a co-ordinated approach to non-timber forest resource management in the province. The Ministry of Forests and Range and Ministry of Agriculture and Lands co-chair the IANTFR Committee. Other government partners include or have included what are now the Ministry of Small Business, Technology and Economic Development, the Ministry of Aboriginal Relations and Reconciliation, and the Ministry of Community and Rural Development (names of some Ministries have changed since 2006). Representatives from the First Nations Forestry Council and the First Nations Mountain Pine Beetle Initiative have participated in committee meetings. The Centre for Livelihoods and Ecology (formerly the Centre for Non-Timber Resources) at Royal Roads University provides expert advice and support services to the Committee. The Ministry of Forest and Range also contributes to the Committee by providing staff time and expertise, and resources to produce publications.

The goals of the Committee are (1) to improve communication and co-ordination across the provincial government, and (2) to advise government on issues related to non-timber forest resource management in British Columbia. The IANTFR Committee members have produced a communication strategy that includes the production of publications designed to improve awareness about non-timber forest resources so that they are managed appropriately.

A series on this theme are intended to be Land Management Handbooks and have been co-published by the Ministry of Forests and Range and the Centre for Livelihoods and Ecology at Royal Roads University. Documents as yet unpublished can be found at www.royalroads.ca/cle.

Understanding Non-timber Forest Products Activity on the Land Base by Gerrard Olivotto, 2009, LMH 62 http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh62.htm

Non-timber Forest Products, Tourism, and Small-scale Forestry: Income Opportunities and Constraints by Darcy Mitchell, 2009, LMH 63 http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh63.htm

Compatible Management of Timber and Pine Mushrooms by Shannon Berch and Marty Kranabetter, 2010, LMH 64 http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh64.htm

Non-timber Forest Product Development in British Columbia's Community Forests and Small Woodlands: Constraints and Potential Solutions by Emily Jane Davis, 2010, LMH 67 http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh67.htm

and

What about the Berries? Managing for Understorey Species by Michael Keefer, Wendy Cocksedge, Robin Munro, Jason Meuleman, and Nancy MacPherson, 2010 www.royalroads.ca/cle

Managed Access to Non-timber Forest Products on Private Land and Eligible Tenures by Wendy Cocksedge, Emily Keller, Art Mercer, and Grace Wang, 2011 www.royalroads.ca/cle

Creating a Regional Profile for Non-timber Forest Products by Wendy Cocksedge, Tom Hobby, Kathi Zimmerman, Dan Adamson, Russell Collier, and Emily Keller www.royalroads.ca/cle

Contents

1 INTRODUCTION

Compatible management is the practice of managing forests for both timber and non-timber values, including non-timber forest products (NTFPs) (Titus et al. 2004). This series of guidebooks developed out of a survey conducted in 2006, in which a wide range of participants in the forestry sector provided their views of the opportunities for, and barriers to, compatible management (Cocksedge et al. 2010). Incorporating NTFPs within forest management can provide social, ecological, and financial benefits for the land managers and for the surrounding communities and ecosystems. The purpose of the guidebook series is to provide a concise overview of the key issues and concerns for each topic, and to suggest resources that can help forest managers to overcome some of the barriers to the compatible management that they have identified.

There is rapidly growing attention to understorey forest plants, particularly fruit species. This results from many factors, including: Aboriginal rights and title assertions; the need for economic diversification within rural communities; a rise in trends such as food security, local foods ('hundred mile diet'), and wild and organic foods; wildlife habitat requirements, and; certification requirements. Concurrently, there is anecdotal evidence to suggest that it is becoming increasingly difficult to find reliable, accessible NTFPs in the wild. There are many pressures on fruit production and habitat, including land privatization (Keefer et al. 2008) and urban expansion, some forestry and range practices, and climate change. It is still unknown how many of these species will react to mass disturbance events such as fires and insect epidemics.

This guide provides management information for five edible wild species. The information comes from a variety of domains, and was compiled through through literature reviews[1], interviews on land and plant management[2], and interim results from a number of on-going berry projects[3].Input and review was also provided through a 2-day workshop in 2008 titled, "What about the Berries?" The seventy-six participants included Aboriginal Peoples, consultants, and representatives from government, post-secondary institutes, and Community Forest tenures (see Appendix 1). For the included species and others, there still remains a lack of specific ecological information, such as responses to stand changes, which emphasizes the need for more research.

---

[1] Y102160. Quantifying the effects of silvicultural techniques, wildfire and forest stand attributes on black huckleberry abundance and productivity.

[2] Y093329. Measuring success in managing for Saskatoon berries and other traditionally important plants.

[3] FIA-FSP 3318. Understanding the spatial and quality attributes of culturally important non-timber forest product species in mountain pine beetle affected areas of the Cariboo-Chilcotin;
FIA-FSP 1158. Impact of accelerated timber harvesting on NTFPs in Burns Lake Community Forest; Forest and Range Evaluation Program, Monitoring Cultural-Use Plants;
FIA-FSP S08-4006. Synthesis of knowledge and development of huckleberry management recommendations in BC.

1.1Who should read this guide?

- **Landowners**

  Private lands, including settled treaty claims, are an ideal place to consider investing in and managing for NTFPs, as the Nisga'a Nation is demonstrating. There may be many opportunities for resource management on reserve lands, particularly for Nations participating in the Regional Lands Administration Program (RLAP) and 53/60[4].

- **Forest managers**

  On Crown land in British Columbia, no rights are currently assigned to manage access to NTFPs. However, even in the absence of a policy framework, innovative NTFP management projects are underway in some areas (see Appendix 2, "Additional Resources"). Further, there may be some opportunities for management to consider, including:

  - In the absence of policy, but in recognition of Aboriginal interests[5], many Aboriginal Peoples are working to include cultural-use species (also called non-timber forest products) within the land and resource management plans. Some Nations, such as the Nlaka'pamux Siska First Nation, in cooperation with the Siska Traditions Society, are actively managing the land for berry production. Forest managers may have an opportunity to work with local Aboriginal Peoples to ensure reliable and accessible berry habitat.
  - Community Forest Tenures may be in a position to lobby for the right to manage for NTFPs within their tenure.
  - Again, in the absence of policy, some companies are initiating informal policies within their management areas to assist harvesters and to achieve sustainable use of resources. For example, a Tree Farm Licence (TFL) tenure manager has initiated a NTFP permitting system, regardless of the lack of regulation, and has a very high compliance rate from the harvesting community. In another TFL, the tenure manager has initiated a NTFP permitting system based on commercial use of the road, which also achieves the goals of controlled access.

- **Researchers, harvesters, and other members of the community**

  This information may be useful for harvesters and members of communities who wish to help the managers of the local forests to engage in NTFP activities. Researchers may find the information useful to build upon, either to increase the ecological information on the species included within this guide, or to follow the approach with further species.

---

[4] For more information visit the Indian and Northern Affairs Canada website page on Land Management: http://www.ainc-inac.gc.ca/enr/lds/lanm-eng.asp

[5] The term 'Aboriginal interests' is used as per the Ministry of Forests and Range Policy 15.1 (http://www.for.gov.bc.ca/tasb/manuals/policy/resmngmt/rm15-1.htm), which refers to Aboriginal Rights and Title as recognized by the Canadian Constitution Act 1982, Section 35 (http://laws.justice.gc.ca/en/const/annex_e.html). The term 'interests' is used here as recognition that legal proof of rights should not impede the recognition of Aboriginal use when conducting forest management.

1.2 Using this guide

This guide illustrates only a small sample of important understory plants, but provides a starting point for further management guides on other food, medicinal, and technological (e.g. baskets, building material) plants. It provides an overview of each of the five species, distribution information based on Biogeoclimatic Ecosystem Classification (BEC) data, habitat information, and responses to disturbance. The information presented is at a broad level, as many gaps remain in knowledge of the specific ecological requirements for high presence, abundance, and quality for these and many NTFP species. For specific inclusion of these species within management plans, it will be necessary to seek further input from local ecologists and NTFP harvesters for specific site and stand characteristics. Refer also to Appendix 2, "Additional Resources."

1.3 Contents of this guide

- An overview of why to manage for NTFPs, particularly fruit species
- An outline of key factors to consider when initiating management for NTFPs
- Management guidelines for 5 culturally important species:
    - Saskatoon (*Amelanchier alnifolia*)
    - beaked hazelnut (*Corylus cornuta*)
    - blackcap (*Rubus leucodermis*)
    - soapberry (*Shepherdia canadensis*)
    - black huckleberry (*Vaccinium membranaceum*)
- Contacts and additional information resources.

2 WHY INCORPORATE NTFPS INTO A MANAGEMENT SYSTEM?

Members of rural communities, both Aboriginal and non-Aboriginal, rely heavily on NTFPs, especially wild berries. It is not unusual in small communities for most households to conduct some level of harvest, from recreational through to subsistence or commercial (Murray et al. 2005). Given the prices of imported fruit in remote rural areas, it is not uncommon for many families to rely heavily on fresh or preserved wild harvested fruit throughout the year (Cocksedge 2009; CNTR 2006).

Understory species, such as huckleberries, are important ecosystem components of forest communities. Forest understory species contribute to biological diversity and long-term ecosystem productivity (Alaback and Herman 1988; Halpern and Spies 1995), are well correlated with mammalian and avian abundance (Carey 1995; Carey and Johnson 1995; Morrison 1982), and are important for wildlife, contributing browse, berries, and cover (Willams et al. 1980; Bunnell and Hamilton 1983; Campbell and Johnson 1983; Kasworm et al. 1984; Noyce and Coy 1990; Tirmenstein 1990 a & b; McLellan and Hovey 1995; Riddell 2005). These plant species can also contribute to fuel reduction treatments and in ecosystem restoration (Monsen et al. 2004).

Given the many pressures on rural communities, it is becoming increasingly important to manage for a variety of perspectives and values, including managing, where appropriate, specifically for food and non-market values as well as timber. Compatible management strategies should enhance both the timber and non-timber values.

The value of these resources within forest management has been recognized by organizations such as the UN Convention on Biological Diversity (Article 8(j)[6]), and the Canadian Council of Forest Ministers (CCFM). Within the CCFM Criteria and Indicators, non-timber forest products are specifically referred to in Criteria 5.1.4, 5.1.5 (values) and 5.3.1 (sustainability). They are indirectly referred to under Criteria 6 (Aboriginal rights, forest community resilience), and of note is Criteria 6.5, which addresses informed decision making based on reliable inventory, research, and updated management and guidelines based on new knowledge)[7].

2.1 Cultural importance

Subsistence and cultural use of plants continues to be extremely important to the majority of Aboriginal Peoples, with as much as 100% of winter fruit consumption being preserved wild berries (Cocksedge

[6] Article 8(j) states: Subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices. http://www.cbd.int/programmes/socio-eco/traditional/akwe.aspx

[7] http://www.ccfm.org/ci/rprt2005/English/toc.htm

2009; Schroeder 2002). There is traditionally a strong cultural and spiritual connection to the land and resources which plays a large role in resource management. Although compromised over the past two hundred years, this recognition and practice is being revitalized in many communities; assurance of access to the resources will greatly assist the revitalization. For the Siska Band, the training of community members in the correct harvest of plants has led to cultural learning opportunities that are resulting in significant health benefits (Chief Fred Sampson, Siska First Nation, pers. comm., 2007).

Jurisdiction, rights, and title are key concerns for many Aboriginal Peoples in British Columbia (Appendix 1). With lack of provincial regulations on these species, there is great concern over the maintenance and protection of both the species and their habitat. Other jurisdictions have found ways to address this; for example, in Washington State, U.S.A., the "handshake agreement" has protected a portion of the Native Americans' huckleberry harvesting rights in the Sawtooth berry fields since 1932 (USDA 2007).

2.2 Access

There are anecdotal reports indicating that it is becoming increasingly difficult for many community members, both Aboriginal and non-Aboriginal, to easily access the plants they require. There are several contributing reasons for this, which often have a cumulative effect.

- **Development.** Privatization and development of lands close to communities often encroach on harvest grounds.
- **Changing land ownership.** Many long-term resident ranchers had understandings with pickers, for example neighbouring First Nations, that allowed for continued use of plants such as bitterroot (Keefer et al. 2008).
- **Logging and silviculture**. Manipulation of the overstory has an effect on the quantity and quality of the understory. Silvicultural practices can either help or hinder suitable berry habitat. For example, high density planting or mechanical scarification may decrease the abundance and quality of some species, particularly in the short-term (Haeussler et al. 2002; Minore 1984). Such disturbances can also propagate invasive plants that may impede the re-establishment of valuable plants. Other silvicultural practices, such as broadcast burns (depending on timing and intensity), spacing, and pruning may enhance berry habitat for some species (Kerns et al. 2002; Johnson 1999; Halpern and Spies 1995; Minore 1975; Burton 1998).
- **Ranching.** There are many anecdotal reports of the effects of grazing, browsing, and soil compaction on a variety of NTFPs.
- **Mining.** Many communities are concerned about the possible contamination from mining as well as the large-scale loss of harvesting grounds from open pit mining.
- **Mass disturbance events** such as intense fires and insect epidemics. Understory response to fires is very dependent on the timing and intensity of the fire, and it is possible that intense fires may decrease rather than enhance understory habitat, particularly in the short-term (Trusler and Johnson 2008; Whittle et al. 1997; Peterson 1989). It is still unclear how many ecosystems and NTFP species will respond to insect epidemics such as the mountain pine beetle, and to the resulting salvage logging.

- **Climate change.** There is increasing concern of the effects of climate change on traditional gathering (Turner and Clifton 2009). There are anecdotal reports of berry production becoming more variable year to year in response to weather. For example, increasing extremes such as late frosts and drought can result in decreased berry production in habitats that would otherwise have provided abundant crops.
- **Investment costs.** Higher costs, such as increased gas prices, inevitably decrease the ability of community members to drive further to find resources; this emphasizes the importance of local wild plant management.
- **Landscape changes.** Many community members, particularly elders, rely on landmarks and roads to locate their harvest areas. A changing landscape, with decommissioned roads and new roads for further development or exploration, makes it difficult to navigate.

It is important, therefore, to maintain areas of suitable habitat for high quality NTFPs both over the landscape as a whole and also in areas with reasonable access for community members.

Although there are many benefits to agriculture and agroforestry, many participants in the NTFP sector do not want these systems to replace 'wild' access on Crown Land. There are many reasons for this, including: loss of connection to the land; potential genetic modification or loss of native stock; lack of access to suitable private land (i.e. wild harvest does not require land investment; costs would be prohibitive for many harvesters); and potentially decreased nutritional and medicinal value of cultivated versus wild stock, including concerns of chemical usage (Kalt et al. 1999; Health Canada 1995; Kuhnlein 1985).

In some areas, special management zones may be required to alleviate commercial harvest of berries within subsistence and traditional cultural areas, either within informal but recognized cultural areas or within the more established division of land into owned territories or patches (e.g. see Johnson-Gottesfeld 1994). Management zones can also exclude human harvest from wildlife forage areas.

2.3 Aboriginal traditional management

Many Aboriginal traditional management techniques, which were used to enhance NTFP crops, could be re-introduced. An example is low intensity fires (Turner 1991) which could also assist with issues of fuel loading. Highly analogous treatments have been occurring in the East Kootenay through the Ministry of Forests and Range Ecosystem Restoration Program. The program is using prescribed fire to enhance wild plants in their natural ecosystems. In 2009 a collaborative effort was made between this program and community elders in the Okanagan for a traditional burn that encompassed traditional knowledge and western science (W. Houde, Technician, Okanagan Nation Alliance, pers. comm., 2009). Other traditional management regimes include transplanting, clipping, pruning, and harvest techniques which enhance productivity. A modern adaptation of transplanting is the planting of native plant stock from locally collected seeds.

2.4 Compatible management

Managing for both timber and non-timber species can potentially increase values, including both market and non-market, for a wider array of human and non-human users. The challenge has been, and often continues to be, defining the objectives of the management. Often understory species were simply not included within these objectives. Competition with timber growth has led to practices of enhancing timber production at the expense of (i.e. the removal of) understory species. Although the goal was not to reduce berry production per se, inevitably that would happen when the vegetation management program was effective. Simply increasing the awareness of important NTFP species, and including these within management considerations, may decrease the negative effects due to timber management practices.

Low investment compatible management actives could include notifying NTFP harvesters of road building to allow for salvage of understory plants prior to contraction, or decreased chemical and mechanical herb and shrub reduction in areas of NTFP harvesting. More involved activities may include manipulation of the forest overstory to manage light levels to the understory; e.g. pre-commercial thinning of a very young forest (shrub stage, trees 2-10m) to maintain berry crops for a longer duration, or commercial thinning of a young forest (structural stage 5) to increase NTFP root or foliage production. The Forest Practices Board report on "Integrating Non-Timber Forest Products into Forest Planning and Practices in British Columbia" (2004) provides a number of examples of compatible management activities in British Columbia.

Silviculture regimes, such as clearcuts, partial cuts, shelterwoods, patch clearcut, single-tree selection, etc., can be carried out in conjunction with NTFP stand management regimes. The question to forest managers is the implication to growth and yield and to stand establishment. How the two growth and yield metrics (timber and NTFP) interact is still in the early stages of research, especially considering the substantial suite of variables, including the broad number of species identified as cultural or NTFP use and the lack of substantial autecological information on many of these species (Clason et al. 2008; Haeussler et al. 2002). The extent of the benefits to each of timber and non-timber values varies greatly depending on ecosystem, stand conditions, species of focus, methods, annual climatic conditions, and the overall objectives.

It is far beyond the scope of this document to provide cost-benefit analysis for compatible management actives. However, there are numerous public resources available that can provide some degree of prediction of the effects of compatible management on the value of timber. For example, if a woodlot manager wished to commercially thin a 50 year old coastal Douglas-fir stand down to 60% of the original basal area in order to realize the interim economic value from thinning, increase mean log diameter, and increase sunlight penetration to enhance salal foliage production for commercial harvest, then the manager could use available growth and yield models, such as TIPSY (Table Interpolation Program for

Stand Yields) and VDYP (Variable Density Yield Prediction system)[8] to estimate the effects on the value of the timber. Appendix 2 provides a small number of potential resources for estimating timber yields when initiating compatible management.

3 CONSIDERATIONS WHEN INITIATING LOCAL NTFP INVENTORY AND MANAGEMENT

3.1 Define goals for initiating inventory and management of non-timber species

There are many potential benefits of, and reasons for, incorporating understory species into forest management plans. Which species and how they are incorporated will vary, however, depending on the purpose of the inclusion. It is important to have clearly defined purposes and goals in order to ensure that the approach, species selection, and collaboration are appropriate. For example, if the approach is to enable better Aboriginal access, different species may be identified than if the purpose is to initiate economic diversification. Regardless of the purpose, it is important to have a diversity of participants involved in the planning and development.

Goals may be synergistic, such as managing for biodiversity and wildlife habitat, or they could be potentially exclusive, such as managing for Aboriginal cultural access and commercial development. It is possible to manage for a multitude of benefits; if each goal is clearly defined, it will be easier to avoid misunderstandings of intent and to ensure effective management techniques are in place to maintain each value. For example, it is possible to manage for each of wildlife, personal, and commercial use by developing separate use areas, and ensuring that commercial access does not interfere with traditional harvest areas or areas set aside for wildlife.

It is necessary to be transparent and open about the defined goals. Multiple values should be considered when determining goals and priorities.

3.2 Develop Memorandums of Understanding

Developing management practices for NTFP species must include the local community, particularly Aboriginal Peoples given their long-standing and continuing traditional use of forest species. Meaningful involvement is essential to incorporate NTFP species into management in a way that will work for the community as well as the ecosystem. Identification of key areas for protection and enhancement, as well as techniques for enhancement, must be done in consultation with local harvesters and experts.

Relationships are essential in order to have true collaboration, multi-way sharing of knowledge, meaningful input, and an ability to combine traditional and local ecological knowledge with scientific

[8] http://www.for.gov.bc.ca/hre/gymodels/tipsy/assets/intro.htm

knowledge. There is no quick answer or technique for developing relationships; they take a long time to develop and depend upon actions far more than words. In the short-term, it is extremely important to develop agreements which include purpose, ownership of knowledge, and end use of shared knowledge.

There are existing examples of memorandums and protocols, many of which reside within communities. The Nuu-chah-nulth, for example, have a "standards for research" protocol as well as a Research Council Ethics Committee with a contact person at their Tribal Council. Many of the currently available templates are specific to research but may be appropriate or amenable for initiating discussion for species management (see the section on "Examples of protocols, Memorandums of Understanding and suggested resources", Appendix 2).

Recognize that lack of willingness to share information is to be expected. Currently, with no legislation on NTFPs, many harvesters may see the only way to protect their information and resources is through secrecy. Transparency, time, and relationship development may help to increase trust and sharing of information for all parties. Clarify what information is required and how it will be used.

- **Information on species use.** Use of the species, including recipes and traditional knowledge, is NOT required in order to manage for the species.
- **Management goals.** Be very clear as to how the information will be used, who will have access to it, and if any members or sectors of the community will benefit more than others.
- **Levels of access of information.** Working collaboratively with the community, develop various levels of access of information. For example, some information may be required for management but need not be made widely available to the public.

3.3 Develop a list of species for initial focus

It is not realistic, and often impossible, to incorporate all species of interest right away. It is recommended that a short list of species be selected with which to start, and with which to develop and test methodology, and initiate collaboration and communication.

It must be clearly understood, and communicated, that the initial list of focus species is not representative of a finite, definitive, or static identification of important understory species. Inevitably, the selected species represent a snapshot in time and will depend on a multitude of influences, such as the participants involved in the selection process, the stated purpose of management (e.g. cultural access, commercial development, wildlife habitat), current status (e.g. species at risk), or knowledge of the local ecosystems.

The list of species identified for management must be adaptable, developing, and flexible. The species chosen for focus will likely change over time, and new species will need to be incorporated. There is no single list of priority species. Reasons for this may include: a list of commercial priority species will be different than a list of culturally important species; the commercial NTFP sector is very flexible, and markets and demand can sometimes change overnight; new culturally important species may be added as trust is gained; forest development or disturbances could suddenly change access and species presence; and additional species are added to the species at risk classifications.

The species chosen for management should reflect at least one of the following values. Best choices are species which support a multitude of values.

- **Ecological importance**. Considerations should include: plant or fungal species which are sensitive to disturbance and development, such as those reliant on old-growth ecosystems or restricted to specific habitat conditions; indicator species; keystone species.
- **Wildlife importance.** Considerations should include plant or fungal species that provide crucial habitat or forage for wildlife, such as huckleberry (*Vaccinium* spp.) use by bears.
- **Cultural importance.** Regardless of the goal for management, there must be consideration and inclusion of the cultural use of the species, which takes precedence over commercial development. Each Nation regards some species as particularly important for spiritual, health, and cultural use.
- **Local values and use.** Even though a species may be very important for use in one area, it may not necessarily reflect the priorities of the community in another area. For example, even though a species may have market value, if there is no local expertise or interest in harvesting it, it does not make sense to include the species as a top focus, at least initially.
- **Economic diversification.** There are established markets for many NTFP species, such as wild mushrooms, fiddleheads, stinging nettle, etc. Including these species in compatible management is important for two reasons. Firstly, it may be easier for local entrepreneurs to establish themselves in the sector using common commercial species, and secondly, these species will have greater potential harvesting pressure by both local and outsider harvesters, and maintaining sustainable harvest levels will be important.

4 ECOLOGICAL OVERVIEW OF FIVE FRUIT SPECIES

The five species covered within this document were chosen largely due to their inclusion in on-going projects, particularly within the Forest Sciences Program Y093329 which focused on Siska Band berry management, Forest Sciences Program Y093318, which focused on the Xat'sull and T'exelc Nations culturally important plants, and Forest Sciences Program Y091160 which is focusing on huckleberry abundance in the East Kootenay with cultural information provided by the Ktunaxa nation. These species should be viewed as examples, and we hope that more species will be added in the future.

The following overviews are meant to assist in compatibly managing for a suite of values, including both timber and non-timber. The information can aid in management decisions when seeking to enhance fruit presence, abundance, and quality.

4.1 Saskatoon (Amelanchier alnifolia)

4.1.1 Species Name

Latin*:* *Amelanchier alnifolia* Nutt.
Family*:* Rosaceae (the Rose family)
Common*:* Saskatoon, service berry, Juneberry
Aboriginal*:* Each language group or dialect has its own name for this plant, or multiple names based on plant parts or usages. Some languages are included here for informational purposes but the languages are by no means inclusive of all groups. For the most comprehensive coverage including pronunciation, see First Voices at: www.firstvoices.com.

Language	Name for Saskatoon
Ktunaxa	sq’umu, sq’umu7-wu7k (bush)
Okanagan – Colville	síya7, slhaq, siyíya, sk’ek’sálha7q, lexwús, lheq’alhpákst, wusxenílheml’x, skw’lkw’lkin, sqw’ets’qw’ets’wi7hálha7q, t’et’íkwt’ekwt, kt’et’íkws
Halkomelem	təshnéts, ts’esláts, ts’eslátselhp (bush), sk’ak’áxwe (dried berries)
Nlaka’pamux	stsáqwm ~stséqwm, stseqwm-úy, y’h-úse7, sqwistm, spəqpáq, si7h-úse7, y’h-ús(e7), qwu7qwu7-úse7, snk’y’ep-úpse7, təxtəx-óxse7, tl’əxwixw-úse7, nəq’naq’-óqw’se7
Secwepemctsin	peqpqéllp (bush); speqpqéllp (bush); speqpeq7ú i (berry)
Stl’atl’imx	(s-)tsáqwəm, stsaqwəm-7úl, (s)pə´qpəq, (s)wəlhkwa7ú7sa7, (s)tl’əxl'ús, təxl’ús, nəq’-nəq’úq’sa7
Tsilhqut’in	dîg, dîgichen (bush)
Wet’suwet’en	lhighah

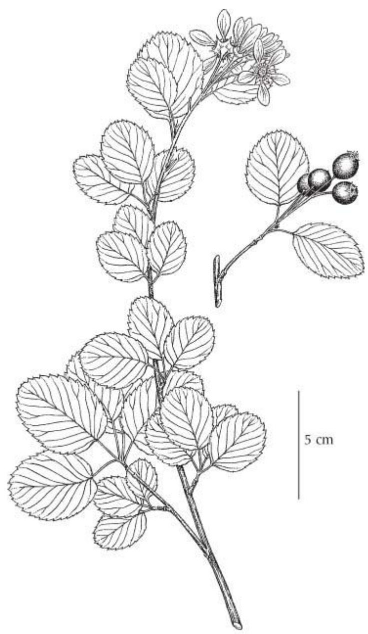


Figure 1. *Amelanchier alnifolia*. Drawing used with permission from the Royal BC Museum, photo by Wendy Cocksedge.

4.1.2 Taxonomy

Within British Columbia there are four varieties of *Amelanchier alnifolia* currently recognised by science (Douglas et al. 1999b):
A. alnifolia var. *humptulipensis* (G.N. Jones; C.L. Hitchc.)
A. alnifolia var. *alnifolia*
A. alnifolia var. *semiintegrifolia* (Hook.)
A. alnifolia var. *cusickii* (Fern.; C.L. Hitchc.)
First Nations' taxonomy of this species is varied, but in general it recognizes more taxa than the scientific system (Turner 1997). The Nlaka'pamux recognise eight different varieties of Saskatoon based on plant morphology, habitat, colour, fruit qualities, and other factors (Turner et al. 1990).

There are a number of horticultural varieties of the species including Smokey, Pembina, Northline, Honeywood, Regent, and Thieson. These and other varieties are all commercially grown for fruit production (Kris et al. 1990).

4.1.3 Description

General: Saskatoon is a deciduous shrub or occasionally a small tree (up to 12 m) that grows in a wide variety of ecosystems. The form of the plant is typically upright with ascending branches. The bark is smooth and ranges in colour from reddish-brown to greyish-brown. Leaves are alternate, thin and round to oval in shape with toothed edges primarily on the upper half. The leaf underside is smooth to variously hairy (Douglas et al. 1999b).

Saskatoon is most visible in May and early June when it is in full bloom with its characteristic masses of white flowers that can be seen from a distance. The flowers have 5 white petals and many stamens. The plant forms its berry-like pomes (like miniature apples) that are crowned with the calyx from June to August, depending on site conditions. The fruits are borne in elongated clusters that may cover much of the plant. The ripe fruit range in colour from shades of red to purplish black. Depending on variety and/or location, the fruit may either be juicy and flavourful or else dry and mealy. Historically, the fruit was a dietary staple for many First Nations and continues to be of high importance to them (Turner 1975, 1997; Turner et al. 1990; Kuhnlein and Turner 1991).

BC CDC and SARA status: Not listed.

Growth and Development, Reproduction and Regeneration: Saskatoon is best known to regenerate through sprouting of its root crown (Howard 1997). In some sites, the plant spreads by rhizomes and forms dense colonies. In the wild, one seldom finds a Saskatoon seedling, but this is likely due to poor conditions for spring germination, such as low temperatures, inadequate soil moisture, and disease. It produces berries most prolifically when growing in open and semi-open sites with moderate levels of moisture.

Successional Status: Saskatoon is a characteristic plant of younger seral stages in many ecosystems and light levels (Klinka et al. 1989).

4.1.4 Distribution

General: The species may be found throughout much of Western North America from south to Baja California, Mexico and north to the Bering Sea and Mackenzie Delta, and as far east as the St. Lawrence River (Major and Rejmanek 1992). The typical variety of Saskatoon (*A. alnifolia* var. *alnifolia*) occurs from southern Alaska south to southern Oregon, mostly east of the Cascade Range, and east to the Dakotas, Nebraska, and Colorado. Saskatoon is found throughout British Columbia (Douglas et al. 1999b).

In cooler and moister ecosystems the species is found primarily on the warmer and drier aspects. From the perspective of a berry picker, Saskatoon is generally most productive in warmer and drier ecosystems, in particular warmer variants of the Interior Douglas-fir (IDF), Ponderosa Pine (PP) and Interior Cedar-Hemlock (ICH) zones.

Biogeoclimatic zones in British Columbia where Saskatoon occur: Bunchgrass (BG), Boreal White and Black Spruce (BWBS), Coastal Douglas-fir (CDF), Coastal Western Hemlock (CWH), Engelmann Spruce-Subalpine Fir (ESSF), Interior Cedar-Hemlock (ICH), Interior Douglas-fir (IDF), Mountain Hemlock (MH) Montane Spruce (MS), Ponderosa Pine (PP), Sub-Boreal Pine-Spruce (SBPS), Sub-Boreal Spruce (SBS), Spruce-Willow-Birch (SWB).

The modal BEC zone (most common zone the species occurs in the BEC database) is the Interior Douglas-fir (IDF) (Klinkenberg 2007).

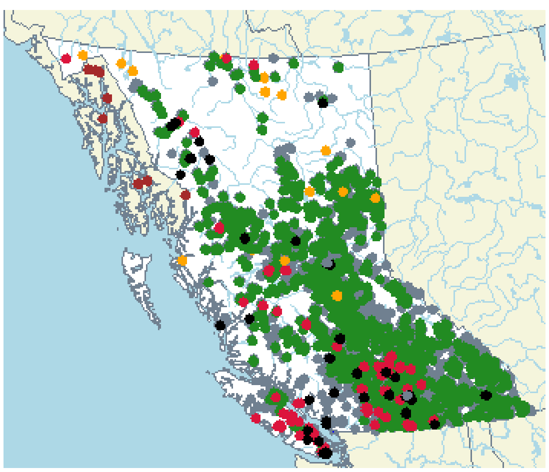


Figure 2. Distribution of *Amelanchier alnifolia* in British Columbia, used with permission from the Royal BC Museum.

For more information and to check for species occurrence in your area, refer to the Eflora distribution map at:
http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Amelanchier%20alnifolia&redblue=Both&lifeform=4 or the biogeoclimatic maps and field guides at:
http://www.for.gov.bc.ca/hre/becweb/resources/maps/wall_map_download.html
http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/regional/index.html

4.1.5 Habitat

Elevation Range: Largely, but not exclusively limited to warm aspects in British Columbia, Saskatoon plants may be found from sea level to subalpine (0-2400 m) with an average elevation of 871 m (Parish et al. 1996; Klinkenberg 2007).

Climatic relations: The prominence of Saskatoon in British Columbia increases in continental ecosystems and decreases with cooler and moister conditions (Klinka et al. 1989). In Montana for example, Saskatoon does not occur in sites with less than 355 mm of precipitation (Howard 1997).

Site and soil conditions: Saskatoon grows on a variety of sites, from mountain slopes and hillsides to prairies and riparian zones where the soils are well drained (Howard 1997). It is "characteristic of young seral forests on disturbed sites", and is "common to scattered in clearings and open-canopy Douglas-fir and lodgepole pine stands on water-shedding sites" (Klinka et al. 1989).

Plant Associations: Little plant association research has been done for this species, but Klinka et al. (1989) noted that Saskatoon is often associated with *Acer glabrum* (maple), *Aster conspicuus* (showy aster), *Calamagrostis rubescens* (pinegrass), *Mahonia aquifolium* (Oregon-grape), *Rhytidiadelphus triquetrus* (rough goose neck moss), *Shepherdia canadensis* (soopolallie), and *Spiraea betulifolia* (birch-leaved spirea) (Klinka et al. 1989).

Nutrient Relations: The modal nutrient regime class across BEC plots for Saskatoon is medium (Klinkenberg 2007; Douglas et al. 1999b).

Water Relations: Saskatoon occurs across a moisture gradient ranging from very xeric to subhygric, but is most prevalent on moderately dry to fresh (sub-mesic to mesic) sites (Klinkenberg 2007; Klinka et al. 1989; Douglas et al. 1999b).

Light Relations: Saskatoon is shade tolerant (Klinka et al. 1989), however, it rarely produces fruit under the forest canopy.

4.1.6 Response to disturbance

Response to Grazing/Browsing: Browsing or grazing forage animals tend to prune the tips of branches, stimulating lateral branch formation the following year. Removal of up to 90% of the leaf buds by browsers in spring stimulates production of new growth and the browsing of outer twigs creates bushy, dense growth of inner foliage (Wandera et al. 1992). Continuous use of Saskatoon for browse will ultimately cause the stand to decline (Riggs and Urness 1989).

Response to Disturbances: This species responds positively to fire and other disturbances.

Canopy Removal: Saskatoon primarily fruits in open canopy sites so canopy removal is expected to be beneficial.

Wildfire: Studies indicate a variety of responses from wildfire. The species is known to be a 'fire follower' that produces most prolifically in burns from 20-40 years of age (Boyd 1999). The most productive sites near Lytton, B.C. are burns that are roughly 20 years old (Keefer, unpublished notes, 2005).

***Prescribed Burning*:** Given the current lack of research, it is unclear what type of fire intensity is most ideal for enhancing Saskatoon in ecosystem restoration fires.

***Cutting*:** The species is expected to respond well to cutting. However, in the East Kootenay region of B.C. plants cut along the roadside are also frequently heavily browsed making re-establishment to fruit production slow (Keefer, unpublished notes, 2008).

***Herbicide*:** Susceptible to both glyphosate and tricopyr (Howard 1997).

***Soil Disturbance*:** Disturbance to root crowns and rhizomes should be minimized.

Predation, Pests & Fungal Disease: Saskatoon is subject to a wide range of insect pests and diseases. Common fungal pathogens and insect pests are listed and described in Appendix 3. In many cases, the damage from disease and pests can by mitigated by increasing plant vigour and health through proper drainage, soil fertility, aeration, shelter, and pruning (St. Pierre 1999).

For further information on control practices and chemical recommendations consult the *Guide to Fruit Crop Protection* (http://www.gov.mb.ca/agriculture/crops/cropproduction/gaa01d15.html). Also consult *A Manual for Orchardists* (St. Pierre 1999).

4.1.7 Human uses

Nutritional

These berries are a moderate source of vitamin C, manganese, magnesium, iron, calcium, potassium, copper, and carotene (Mazza 1982; Kuhnlein 1989). However, much of the health benefits from Saskatoons are linked to flavonoids, specifically anthocyanins, which give Saskatoons their deep red, blue, and purple colours (Mazza 1986; Ozga et al. 2006). The anthocyanins identified in Saskatoons show a high level of anti-oxidant activity and are easily digestible in humans (Hou 2003; Adhikari et al. 2005; Hu et al. 2005; Zatylny et al. 2005). Laboratory and animal experiments demonstrate the role Saskatoon anthocyanins play as free radical scavengers and potentially as anti-cancer agents through mechanisms of anti-initiation, anti-mutagen effects, anti-oxidative, and anti-inflammatory effects (Hou 2003). Anti-oxidants also have been shown to reduce the risk of diabetes onset, improve glucose metabolism, and decrease related complications (McCune and Johns 2007).

Since Saskatoon cultivation began in the late seventies and early eighties much research examining the nutritional and health benefits has been done. Kuhnlein's (1989) nutritional analysis of fresh, wild Saskatoon berries, from the Bella Coola region of British Columbia demonstrates that a 100g serving fulfilled the following recommended daily allowances: 10% vitamin C, 30% manganese, 6% magnesium, 6% iron, 7% calcium, and 50% copper (Health Canada: Required Daily Intake for 25 year old man). A similar nutrient content was found by Mazza (1982). However Mazza measured nutrients by dry weight resulting in higher mineral concentration because water makes up 80% of fresh Saskatoon berry weight (Mazza 1982; Kuhnlein 1989).

The predominant almond-cherry flavour is produced by benzaldehyde (Mazza and Hodgins 1985). The anthocyanin content reported in Saskatoon berries of the same cultivar vary from 86-309 mg/100g

(Mazza 1986; Yakimishen et al. 2002). A similar variation is also found in other cultivated and wild fruit (Ozga et al. 2006). Saskatoon demonstrates similar levels of anthocyanins to blackberries (*Rubus spp.* 83-326 mg/100g*),* blueberries (*Vaccinium spp.* 25-495 mg/100g), and bilberries *(Vaccinium myrtillus* L. 300-320 mg/100g) (Ozga et al. 2006).

Anthocyanin levels change throughout the harvest: greater maturity is associated with higher anthocyanins (Yakimishen, et al. 2002). It is interesting to note that McCune and Johns (2007) found elevated anti-oxidant activities in a variety of wild plant species collected from drier and less fertile areas. There is very little research into anthocyanin levels and anti-oxidant activity of wild Saskatoon populations (St. Pierre 1997; Zatylny et al. 2005), although wild varieties are expected to demonstrate similar health properties to cultivars.

The type and quantity of anthocyanins present in mature Saskatoon berries exhibit high antioxidant activity in both *in vivo* and *in vitro* experiments (Hou 2003). The anti-oxidant composition of Saskatoon's was confirmed by Mazza (1986) showing cyanidin-3-O-glucoside and cyanidin-3-O-galactoside were the most abundant anthocyanins. The proportions of these two anthocyanins were similar across cultivars and are the main phytochemicals responsible for Saskatoon's antioxidant activity (Adhikari et al. 2005; Hu et al. 2005; Zatylny et al. 2005).

Testing of tolerability and safety of anthocyanins demonstrated no toxic symptoms in rats. Clinical safety was confirmed in a post-marketing surveillance study where most persons took 160 mg twice daily for 1-2 months (Hou 2003). However, more experiments need to be done *in vivo* to confirm these effects. Anthocyanins present in Saskatoon are bioavailable (directly absorbed and distributed to the blood) in humans making this phytochemical attractive to protect against disease (Hou 2003).

Variation in vitamin, mineral and phytochemical make-up can be attributed to variety or cultivar, environmental differences in soil composition, habitat and the time of harvest (Mazza 1982; Kuhnlein 1989; Yakimishen et al. 2002; McCune and Johns 2007).

Effects of storage*:* The stability of flavour and anthocyanin is of significance to the marketability of berries and processed products (Mazza 1986). Saskatoon flavours and anthocyanins are temperature sensitive (Mazza and Hodgins 1985; Stephanson et al. 2002; Yakimishen et al. 2002; Kwok et al. 2004).

Stephanson et al. (2002) found significant levels of anthocyanin are lost in the freezing process discernable even a few days after freezing. Tests done following 5 days of freezing demonstrated an anthocyanin content loss of 23 to 30% respectively; benzaldehyde (aroma and flavour of Saskatoon) loss of approximately 23% to 80% respectively; sugar levels decreased from 14.8% to 11.5%; however there did not appear to be any change in acidity measured by malic acid. Regular chest freezers and blast freezers preserved equal quantities of flavour and anthocyanins (Yakimishen et al. 2002).

While there is significant anthocyanin loss in freezing, this method is more effective in preserving anthocyanin than freeze drying, vacuum microwave drying, and air-drying (Kwok et al. 2004). Compared to the fresh frozen berries, the freeze-drying method retained 65% of the anthocyanins, while the air-drying method (using a convection dryer at 75° C for 3 days) was least effective retaining only 12-16% of the anthocyanins (Durance et al. 2003; Kwok et al. 2004). The degree of thermal damage during dehydration is directly related to the temperature and the duration of the dehydration process (Lin et al. 1998).

From a review of the current research, it can be concluded that conventional chest freezers are the most effective method for preserving fresh Saskatoon berries. However, there is a need for research into the effects on flavour and anthocyanin content resulting from other popular storage methods such as canning, jamming, and sun-drying

Cultural

Due to its high productivity and broad geographic range, Saskatoon berries are believed to have been the most important fruit to the subsistence of First Nations in southern British Columbia (Turner 1997). In addition, Saskatoon berries and bark continue to be an important food and medicine resource to Aboriginal Peoples from the Pacific to the Plains. The bark was commonly used in a decoction as a tonic for stomach troubles and as an aid in childbirth (University of Michigan-Dearborn 2008). In combination with other plants Nlaka'pamux women used the bark as a contraceptive (Turner et al. 1990). Currently, Saskatoon berries are one of the most important traditional foods harvested and are an important sweetener to many Aboriginal peoples (Turner et al 1990; University of Michigan-Dearborn 2008).

Historically, the wood from Saskatoon bushes was used by the Nlaka'pamux for making combs, digging sticks, firedrills, arrows, salmon spreaders, arrows, reinforcing dipnets, tool handles, and other uses (Turner et al. 1990). This wood was also preferred by the Ktunaxa for making arrows and pipestems (Keefer and McCoy 1999).

The Southern Interior First Nations ate the berries fresh and dried them for later use. Different berry varieties, as recognized by the aboriginal people, were treated differently prior to drying due to the varying qualities (Turner et al. 1990). The Ktunaxa of Southern Interior British Columbia processed the berries by squashing them into patty-like cakes and drying them in this form (Keefer and McCoy 1999). The Nlaka'pamux dried them in cakes and also as individual berries, again depending on the variety (Turner et al. 1990). Currently, the berries are preserved by canning and are made into jams and jellies.

Agricultural

Saskatoon may be used in naturalized plantings or as hedges and shelterbelts (Flessner et al. 1992) and is an attractive plant for use in landscaping (Hitchcock and Cronquist 1976). Several cultivars of Saskatoon are available for ornamental plantings and commercial fruit production in North America. There are approximately 16 cultivars of *A. alnifolia* with many of these cultivars and ecotypes originating in western Canada and the northern region of the United States (Zatylny and St. Pierre 2003). The named varieties have been bred to provide larger, tastier fruits than their wild relatives. Commercial production and processing of Saskatoon berries is steadily increasing especially throughout the Prairie Provinces (Wilson 1993).

Restoration

Saskatoon is an excellent species to consider in restoration plantings given the multiple values that it provides. The low flammability of the species makes it a preferred plant to consider in the urban interface.

4.1.8 Wildlife and livestock uses

The Saskatoon plant provides valuable food and cover for a variety of wildlife species. Both the stems and fruit are utilized as an important food source for wild and domestic ungulates, including deer, elk, moose, mountain goats, and bighorn sheep, because of its palatability, wide distribution, and availability (Hemmer 1975; Leege and Hickey 1966; Martinka 1968). In North Dakota, Norland and Marlow (1984) found bison browsed Saskatoon and used the wooded gulleys in which it grows for cover. Saskatoon browse, together with *Salix* spp. (willow) and *Cornus stolonifera* (red-osier dogwood), made up 83% of moose diet in southeastern British Columbia (Poole and Stuart-Smith 2005). Saskatoon is one of the nine main food items of beavers in Manitoba, where they forage on the twigs, barks and leaves. Small mammals and rodents, such as rabbits, mice and voles, may also feed on bark, stems and roots, negatively affecting the growth of the plant (St. Pierre 1999). In Pennsylvania, berries of Saskatoon together with insects constituted the bulk of the summer diet of black bears (Bennett et al. 1943). Many song and game birds, including robins, finches and sparrows, eat and damage berries (St. Pierre 1999).

Saskatoon is an important component of the winter diet for many of these species especially during periods of deep snow (Hemmer 1975; Leege and Hickey 1966; Martinka 1968; Scotter 1980). Throughout their range, black bears rely heavily on both hard and soft mast in late summer and fall to increase fat reserves before hibernation. In these seasons, fleshy fruits have importance values of 38 - 91% in the diet (Grenfell and Brody 1983; Raine and Kansas 1990; Richardson 1991). The berries are also important fall and winter food for birds, chipmunks, and squirrels (Howard 1997).

Saskatoon also provides cover, nesting, and roosting for some bird species including song and upland game birds but poor cover for waterfowl (Howard 1997). It also provides poor to good cover for mule and white-tailed deer and good cover for small mammals (Howard 1997).

Nutritional Content. Nutritional content of the leaves and stems of Saskatoon changes throughout the year (Brooke et al. 1988; see Table 2). In the Black Hills of South Dakota, Saskatoon was found to provide adequate nutrition for white-tailed deer in all seasons but digestibility decreased from 54% in winter to 48% in spring (Dietz 1972).

Table 1. Nutritional content of the leaves and stems of Saskatoon in spring and fall (Brooke et al. 1988)

Nutritional Component	**Spring**		**Fall**	
	Leaves	Stems	Leaves	Stems
Crude Protein (%)	18.5	13.6	6.2	6.4
ADF (1)	18.7	32.0	29.8	44.4
ADL (2)	7.4	6.9	15.2	19.7
Cellulose (%)	13.2	24.8	13.3	25.6
Ash (%)	6.6	5.8	5.3	3.5
Ca (%)	1.1	1.3	1.5	1.6
P (%)	0.6	0.3	0.4	0.1
Energy (cal/g)	4,862	4,746	4,999	4,922

1. Acid Detergent Fibre, 2. Acid Detergent Lignin

Although Saskatoon is often a primary component of winter diets (Leege and Hickey 1966), ungulates normally consume a variety of other shrubs as well. Ingestion of large amounts of the shrub can be fatal because it contains the cyanogenic glycoside, prunasin (Majak 1992). The glycoside is converted to hydrogen cyanide by microbial enzymes in the animal's rumen (Majak 1992). Glycoside is lethal at a rate of 2 mg/kg body weight (Majak 1992). The most hazardous period for ruminants appears to be spring, when the browse contains high levels of prunasin in twigs and leaves (Brooke et al. 1988). Glycosides are least concentrated in the older leaves (Brooke et al. 1988). A diet of over 35% Saskatoon is fatal to mule deer and captive mule deer fed only fresh, winter-collected Saskatoon twigs died within a week (Quinton 1985).

The nutritional content of Saskatoon berries collected in northern Ontario is as follows: moisture 75.20%; dry matter 24.80%; fat 0.28%; protein 1.51%; soluble carbohydrate 11.36% (Usui et al. 1994).

4.1.8 Cultivation and propagation

It is recommended that if intensive cultivation is planned, information on the various cultivars should be reviewed to assess the suitability of cultivars. If Saskatoon plants are selected from the wild for non-intensive cultivation purposes, they can readily be propagated by seed or cuttings. Cleaned seeds need to receive a four month cold, moist stratification in order to germinate. Take softwood cuttings prior to bud set in the spring and use a rooting hormone for soft or hardwood cuttings (3000ppm IBA) (Sound Native Plants 2007). Well-drained medium should be used with intermittent misting to keep the cuttings from drying out. Propagation protocol for production of container Saskatoon plants as well as information regarding cultivation of Saskatoon berries is readily available through the following Provincial Ministry of Agriculture sites for Alberta, Manitoba, and Ontario: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/econ7053/$file/saskatoon.pdf?OpenElement; http://www.gov.mb.ca/agriculture/crops/fruit/bld01s01.html; http://www.omafra.gov.on.ca/english/crops/facts/info_saskatoon_production.htm.

Saskatoon grows on a variety of soil types but they do best on sandy to medium loam soils which are well drained. Preferable planting sites are those with non-alkaline, well-drained soils and which allow for good winter snow cover. In addition, because of Saskatoon-juniper rust and lygus bugs, it is advisable to plant far away from existing juniper and alfalfa plants. Planting density is determined mainly by harvesting methods; U-pick operations can achieve higher densities than machine harvested sites. Saskatoon is usually planted to achieve approximately 2400 plants per hectare for U-pick sites. This density is achieved by planting 1 m within the row and 4.5 m between rows. Machine harvesters need wider spacing between rows of approximately 5–6 m.

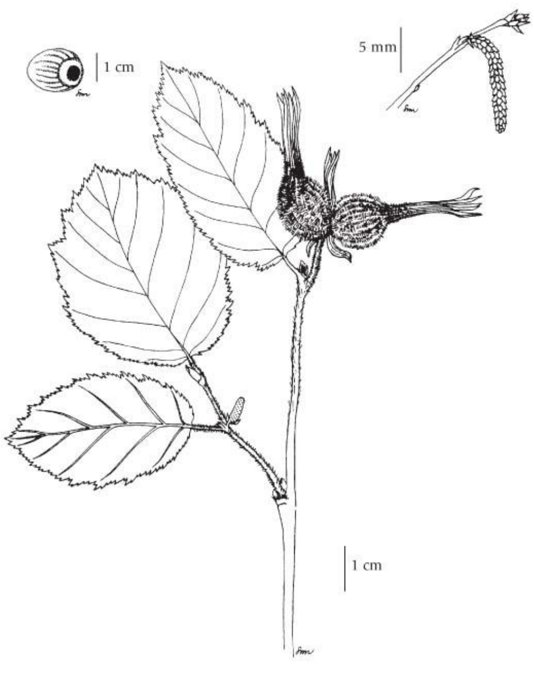
The site should ideally be protected from desiccating summer and winter wind. Because of this, shelterbeds should be established to protect the plants from exposure. Saskatoon bushes are quite drought tolerant in their native habitat but to produce good quality berry crops it is necessary to provide regular irrigation particularly during the first few years of crop development. Drip or tickle systems work well for this purpose because they reduce canopy humidity and disease spread, and require much less water than traditional overhead systems. Mulches, such as woodchips and manure, help retain soil moisture, aid in reducing weed competition, and provide nutrients to the plant over time as the mulch decomposes.

4.2 Beaked hazelnut (Corylus cornuta)

4.2.1 Species Name

Latin: *Corylus cornuta* Marsh
Common: beaked Hazelnut, California hazelnut
Family: Betulaceae (the Birch family)
Aboriginal: Each language group or dialect has its own name for this plant, or multiple names based on plant parts or usages. Some languages are included here for informational purposes but the languages are by no means inclusive of all groups. For the most comprehensive coverage including pronunciation, see First Voices at: www.firstvoices.com.

Language	Name for hazelnut
Ktunaxa	7impum
Okanagan – Colville	q’íp’xwa7, (s)q’ep’xwílhp (bush)
Halkomelem	sth’íitsem, sth’íitsemelhp
Nlaka’pamux	q’apúxw, q’apuxw-élhp (bush)
Secwepemctsin	qep’c^{w}
Stl’atl’imx	q’áp'xw, q'áp'xw-az' (bush)
Wet’suwet’en	n



Corylus cornuta var. cornuta

Figure 3. *Corylus cornuta.* Drawing used with permission from the Royal BC Museum, photo by Mike Keefer.

4.2.2 Taxonomy

Within British Columbia there are two varieties of native hazelnuts: *C. cornuta:* var. *cornuta* Marsh, which is commonly referred to as beaked hazelnut, and *C. cornuta* var. *californica* Marsh, which is commonly referred to as California hazelnut (Douglas et al. 1998).

Within British Columbia the two sub-species have overlapping ranges and for the purpose of this text we are describing beaked hazelnut. Much of the same information applies to California hazelnut which has a more limited range.

4.2.3 Description

General: Beaked hazelnut is a medium to tall deciduous shrub with multiple stems. It is rhizomatous and tends to form thickets on disturbed areas and clearings (Fryer 2007). The closely related California hazelnut is not rhizomatous (Fryer 2007). The leaves of hazelnut are 4-10 cm long, alternate, elliptic to oval with double saw-toothed edges. In the spring the male and female catkins are found on the same plant but on separate twigs; the male catkins appear before the female catkins. As the name implies, these shrubs produce edible, hard-shelled nuts commonly referred to as hazelnuts. These nuts are enclosed in bristly bractlets which are fused at the tip to form a 'beak'.

BC CDC and SARA status: Not listed.

Growth, Development Reproduction and Regenerative Processes: Beaked hazelnut most commonly reproduces asexually by suckering, but also from rhizomes, and sexually through its nuts (Fryer 2007). In early seral sites, stem densities can exceed 7,400 stems per hectare in mature understories and 148,000 stems per hectare in seral stands (Fryer 2007). Most plants are monoecious (meaning that they exhibit male and female reproductive structures on the same plant), but some plants are dioecious (Fryer 2007).

Successional Status: Hazelnut is a characteristic plant of young deciduous forests (Klinka, et al. 1989). It is most likely to produce nuts in open or semi-open settings. Hazelnut may be found in the understory of mature forests in the Sub-Boreal Spruce biogeoclimatic zone, however the numbers of bushes decline in increasing shade, are small in stature and unlikely to produce nuts (Keefer and Veenstra, field notes 2007). Top-killed plants are reported to produce male flowers in the following flowering season (Fryer 2007). Stems in Minnesota have been reported to stop producing nuts at 18 years of age (Fryer 2007). Birds, especially jays, are believed to be crucial in the distribution of the nut (Fryer 2007).

4.2.4 Distribution

General: Beaked hazelnut (var. *cornuta*) is widespread throughout North America; its range extends from Alabama and Georgia north to Newfoundland and continues west through Canada and the northern states to northeast British Columbia with isolated pockets east of the Coast-Cascade Mountains.

California hazelnut (var. *californica*) has a smaller range extending from northern California through Oregon and Washington into southern British Columbia.

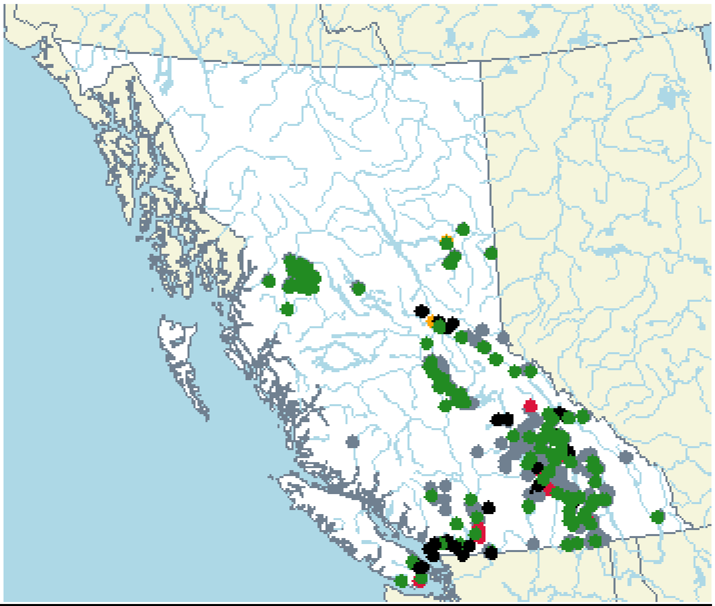


Figure 4. Distribution of *Corylus cornuta* in British Columbia, used with permission from the Royal BC Museum.

For more information and to check for species occurrence in your area, refer to the Eflora distribution maps at:
http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Corylus%20cornuta&redblue=Both&lifeform=4

4.2.5 Habitat

Elevation Range**:** Sea level to 1700 m (Klinkenberg 2007).

Climatic relations: Beaked hazelnut is found in both coastal and interior sites. The California hazelnut apparently favours milder areas (Haeussler and Coates 1986).

Site and soil conditions: Loamy sands produce optimal growth for the hazelnut (Fryer 2007). Hazelnut is an indicator for calcium and nitrogen rich sites and it typically grows on moder and mull humous forms (Klinka et al. 1989).

Plant Associations**:** These vary by ecosystem and are not described in the literature.

Nutrient Relations: Hazelnut prefers nitrogen rich sites (Haeussler and Coates 1986; Klinka et al. 1989).

Water Relations: Hazelnut favours moist but not wet sites throughout its range (Haeussler and Coates 1986).

Light Relations: High light intensity favours beaked hazelnut regeneration, and a dense basal area of overstory trees increases mortality (Fryer 2007).

4.2.6 Response to disturbance

Response to grazing/browsing: Research indicates that beaked hazelnut can tolerate moderate to high intensity browsing, however, its distribution has decreased in certain eastern areas where browsing is intense (Fryer 2007).

Canopy Removal: Increased light favours the growth of hazelnut (Fryer 2007), hence most disturbances that open the canopy—including fire, insects, disease, and logging—increase beaked hazelnut frequency (Fryer 2007). Since it readily suckers and spreads from rhizomes, it is difficult to kill.

Wildfire: Above ground portions of the stems are generally killed by fire (Fryer 2007). Fires that do not kill the rhizomes benefit the spread of this species (Turner et al. 1990; Fryer 2007). Many of the larger stands of hazelnut are thought to have originated from frequent fires (Haeussler and Coates 1986).

Prescribed Burning: Hazelnut is reported to be an early fire follower (Turner 1999). In Oregon, nut production is reported to resume approximately 5 years following fire (Boyd 1999). Between Spuzzum and Kanaka Bar, B.C. the Nlaka'pamux managed the beaked hazelnut through fire (Turner 1991). Boyd (1999) speculates that burning may have been in the autumn to regenerate plants and cleaned the husks off the nuts. Though not directly stated, it is very likely that the burning was rotational allowing for a range of hazelnut stand ages. LaLande and Pullen (in Boyd 1999) report that the Tututni burnt the bushes in five-year intervals. Scientific literature suggests that burn intervals of 10 or more years optimize the plants performance (Fryer 2007).

Cutting: Cutting is likely to stimulate the plant to produce suckers. In one multi-year study hazelnut was clipped for multiple years and only showed a decline in twig production after four years (Haeussler and Coates 1986). Saplings have few rhizomes, therefore, their ability to sprout is limited (Fryer 2007).

Herbicide: Hazelnut is intolerant of many commercially available herbicides.

Soil Disturbance*:* As long as rhizomes are not destroyed, hazelnut is resistant to such disturbance (Haeussler and Coates 1986).

Predation, Pests & Fungal Disease: There are many animals and birds that harvest hazelnuts including squirrels, chipmunks, and birds such as Jays and crows, and it can be difficult to find any nuts in late fall because of their harvesting.

The types of pests and diseases of beaked hazelnut varies depending on the region, however, the following is a list of commonly encountered problems in cultivated hazelnuts (Olsen 2007).

Eastern Filbert Blight (*Anisogramma anomala*)

As the name implies, this has mainly been a disease of hazelnut species in eastern North America. However, it has been spreading west through infected nursery stock.

This fungal disease is the most serious disease of cultivated hazelnuts and has the potential to decimate whole plantations. Native populations of beaked hazelnut are more resistant than cultivars (Rutter and Shepard 2002). In the year following inoculation, symptoms appear as raised black 'stromata' which are arranged in parallel longitudinal lines along the branch or trunk. The fungus kills the tissue which results in a canker.

Spores are released during rainy periods, which typically occur in spring and fall. Spores are spread through water droplets and wind (Pinkerton 2008).

Control is achieved by pruning out affected areas, including 0.6-0.9 m below the affected area, and burning the cuttings. Preventative spraying with chemicals can also provide effective protection. Some recently developed cultivars show resistance to this disease.

Bacterial blight (*Xanthomonas arboricola* pv. *corylina*)

Symptoms of this disease include spotting on husks and leaf lesions. Serious infections can cause dieback of buds and new shoots or, in the case of young trees and branches, the disease may girdle trees resulting in mortality.

Extended periods of wet weather favour spread of this disease.

Hazelnut weevil (*Curculio obtusus*)

Nuts attacked by these insects have a distinct hole usually through the basal end. Adult females deposit eggs in the developing nuts and the larvae feed on the nut resulting in empty shells.

This species is a relatively small weevil, approximately 0.6–0.8 cm long. Its color varies from ash grey to brown with darker markings along the top of the wing covers. It has one life cycle per year.

Filbert bud mite (*Phytocoptella avellanae*)

These very small mites feed on and within leaf, flower buds, and catkins. Infested buds swell and do not produce nuts.

Eyespotted bud moth (*Spilonota ocellana)*

These chocolate brown larvae with black heads feed on leaves and buds. Adult moths are small and grey in color.

Filbert leafroller *(Archips rosana)*

These greenish larvae feed on buds and developing leaves. Damage begins early in spring. There is one generation each season.

Oblique banded leafroller *(Choristoneura rosaceana)*

This insect species is bright green with a black head. It reproduces twice during a year.

Developing leaves are rolled together while the insect feeds on developing nuts.

Omnivorous leaftier (*Cnephasia longana)*

Larvae of this species are yellow in colour; they roll leaves and feed on leaves and buds.

Aphids, Spider Mites, Scale Insects

These insects suck plant juice and reduce plant vigour. If left untreated these insect populations can rapidly expand causing reduced yields and nut size and extensive foliar damage.

4.2.7 Human Uses

Nutritional

Beaked hazelnuts are an important food for many Indigenous Peoples from the Pacific to central North America (University of Michigan-Dearborn 2008). Indigenous Peoples from the Boreal Forest Region, including the Algonquin, Abenaki, and Cree, also use the bark and twigs of beaked hazelnut for treatment of diabetes and its complications (McCune and Johns 2007). Research is affirming this medicinal use, with hazelnut having antioxidant activity in bark and twigs (McCune and Johns 2007). In laboratory and animal experiments, antioxidants demonstrate a role in preventing cancer, reducing inflammation, reducing risk of diabetes onset, improving glucose metabolism and decreasing related complications (Hou 2003; McCune and Johns 2007; Shahidi et al. 2007).

According to Health Canada and the US Food and Drug Administration, the mono-saturated fats present in nuts reduce the risk of cardiovascular disease. Beaked hazelnuts contain 18% protein and 43% fat, which is almost entirely mono-saturated fat (Pershern et al. 1995; Mercanligil et al. 2007). Beaked hazelnuts are also an excellent source of Vitamin E; by eating 60 g of the nuts the daily recommended intake is fulfilled (Pershern et al. 1995). Natural Vitamin E has demonstrated protection against cardiovascular disease (Huang and Appel 2003; Vivekanathan et al. 2003; Lonn et al. 2005; Mercanligil et al. 2007).

In addition, beaked hazelnuts are an excellent mineral source having higher mineral content than cultivated hazelnut (Corylus avellana) (Pershern et al. 1995). Beaked hazelnuts contain the following recommended daily intakes per 100g serving: vitamin B6 38%, calcium 20%, iron 70%, copper 300%, zinc 38%, magnesium 41%, manganese 26%, potassium 18%, and selenium 200% (Pershern et al. 1995; Koksal et al. 2006; Simsek and Aykut 2007). In conclusion, while further human research confirming medicinal benefits is needed, beaked hazelnuts have been proven to be an excellent nutritional food source (Oliveira et al.2008).

Cultural

The beaked hazelnut was an important plant for both food and technology (Turner et al. 1990; Turner 1991, 1997, 1998; Anderson 2005). Unbroken nuts were an important food that could be easily stored (Turner 1977). The nuts were sometimes processed by mixing crushed shelled nuts with bear grease, meat, cooked camas bulbs or berries (Turner 1977).

Young flexible wood was used for a variety of purposes including basketry and arrows, and the bark from the stems was stripped for making cordage (Turner 1979, 1998). A blue dye was made from the roots. For the Fraser Canyon Nlaka'pamux, the nuts were an important trade item and in order to assure a regular supply of the nuts, hazelnut stands were managed through burning (Turner et al. 1990).

Commercial

Beaked hazelnuts tend to be smaller with thicker shells than cultivated varieties. However, the beaked hazelnuts are still appealing and native plants provide better resistance to pest and disease problems and are more cold-hardy than cultivated varieties. There are large numbers of this shrub in the wild and since it grows quite aggressively under the right conditions, the nuts are a good crop to harvest even though it can be difficult to obtain large quantities when competing with squirrels, chipmunks, and birds.

Agricultural

Hazelnut trees can make beautiful additions to the landscape by providing shade and edible nuts. They can be planted as a tall background shrub in woodland settings, in shelterbelts and in streamside plantings, as well as informal hedging when allowed to sucker freely (Link 1999). When choosing a location to plant this species, it should be noted that it can spread aggressively by suckering and rhizomes. Currently, there are no registered cultivars from C. cornuta; most available hazelnut varieties have been bred from C. avellana and C. maxima. Some of these cultivars include 'Barcelona,' 'Butler,' 'Ennis,' 'Lewis,' 'Clark,' 'Hall's Giant,' and several recently developed cultivars which display increased disease resistance. However, in the midwest in particular, recent breeding efforts have been focusing on developing 'hardier' and more pest resistant varieties which are based on crosses between C. avellana and native C. cornuta (Rutter and Shepard 2002).

Restoration

Beaked hazelnut seedlings are used in restoration plantings. In the West Kootenay region of B.C. this species has been planted under a newly constructed powerline (Keefer et al. 2006). Commercial use is limited due to the difficulties in collecting the nuts before the birds or squirrels get them.

Propagation of native beaked hazelnut can be achieved from seed, cuttings, and layering. Nuts should be collected in the fall before squirrels, chipmunks and birds have collected all of them. It is important not to let the nuts dry out because this can induce chemical dormancy (Fryer 2007). Place the nuts in a cool moist stratification for at least 2-3 months prior to planting. Germination is variable and uneven (Barbour and Brinkman date unknown).

4.2.8 Wildlife and livestock uses

There are no studies specifically on the use of beaked hazelnut by livestock. However, it is moderately palatable to most wild ungulates and is used as forage by several species including deer, moose, and elk (Stearns 1974).

Taking into account the relative abundance of the various shrubs, a study in Riding Mountain National Park found elk and moose browsed on beaked hazelnut less than other shrubs. However, because of the abundance of the beaked hazelnut shrubs, its total browse use was higher than all other shrubs with the exception of willow (*Salix* spp) (Rounds 1979). Because of its high availability, beaked hazelnut is considered to be important year-round forage for white-tailed deer in the Great Lakes area (Stearns 1974). However, two different studies in Minnesota and New Brunswick found white-tailed deer used beaked hazelnut slightly less than expected based on the availability of the shrub (DelGiudice et al. 1991; Telfer 1972).

It is primarily used as a winter food by ungulates, although some browsing in other seasons has been recorded. A study in Riding Mountain National Park found elk and moose browsed beaked hazelnut seasonally, as a winter food, and year-round depending on the particular locale (Haeussler et al. 1990; Stearns 1974). A study on the Little Sioux Burn near Ely, Minnesota, showed that in the second year after a fire, moose browsed beaked hazelnut sprouts "moderately" from October through December, "lightly" in spring, but did not use beaked hazelnut through the summer (Irwin 1985). A study on a northern Minnesota aspen burn found that white-tailed deer and moose prefer new beaked hazelnut sprouts to old stems, that both species tended to concentrate in areas with large amounts of beaked hazelnut and other hardwood sprouts, and the greatest use was in late fall, although spring browse was also used heavily (Irwin 1975).

Beaked hazelnut has been identified as a browse for beaver and snowshoe hare in some areas. In Ontario, it was one of the top six browse species selected by beavers (Donkor and Fryxell 1999), and was browsed more often than expected by beavers in Michigan (Belovsky 1984). It has been suggested that beavers may locally influence forest structure by reducing relative abundance of beaked hazelnut and other palatable browse species and increasing relative abundance of conifers (Donkor and Fryxell 1999). Snowshoe hares utilized beaked hazelnut browse moderately to heavily on Manitoulin Island, Ontario. However, a study in New Brunswick found that snowshoe hare used beaked hazelnut slightly less than expected based on availability of the shrub (Telfer 1972).

The nut is the part of the plant that is mainly used by wildlife. The seed of hazelnut is valued by many species including black bears, many small mammal species, and many bird species, including wild turkeys (Brenner 1986; Rogers 1976; Stearns 1974; Glover 1948). Chipmunks and squirrels can consume tremendous quantities of hazelnuts (Stearns 1974). Near Edmonton, researchers found red squirrel middens containing only beaked hazelnut seeds (Kemp and Keith 1970).

On the Clayoquot Forestry Center in British Columbia, beaked hazelnut buds and catkins generally ranked second only to quaking aspen catkins as food for the ruffed grouse in winter and early spring (Gullion and Svoboda 1972).

Beaked hazelnut thickets also provide cover for white-tailed deer, rabbits and other small mammals, and birds (Stearn 1974). For example, Hobson and Bayne (2000) found these plants provide understory habitat for a variety of bird species in quaking aspen forests of the North (Hobson and Bayne 2000);

Magnus (1949) found aspen/paper birch/beaked hazelnut communities were prime ruffed grouse habitat in all seasons; Gullion and Marshall (1968) found survival of male ruffed grouse during mating season was associated with drumming logs located next to dense beaked hazelnut cover.

4.2.9 Cultivation and propagation

For vegetative propagation, take cuttings prior to bud break on dormant wood or from actively growing semi-hardwood. Propagation using semi-hardwood cuttings taken during the summer showed 50% rooting success using 3000ppm indole-3-butyric acid (IBA) rooting hormone (Barbour and Brinkman date unknown). Many commercial growers of cultivated varieties use mound layering to reproduce their trees from suckers (Wilkinson 2005).

Details on the commercial production of native beaked hazelnut for its nuts could not be found. However, this plant does well in a mesic environment and grows well in sandy loam soils with moderate moisture and fertility. Hazelnut prefers slightly acidic to neutral soil (pH 6-7). Flowering occurs from lateral buds of one-year wood, hence selective thinning and pruning during winter provides vigorous shoot growth the following season. Proper pruning also provides adequate light, ventilation and increased nut size. Both male and female flowers (catkins) are borne on the same plant but the plants are self-infertile meaning another hazelnut must be planted as a pollinator to produce a nut crop. If planting cultivars, a different cultivar should be planted as a pollinator to ensure that pollen from male catkins shed pollen at the same time that female flowers are open.

Fertilization requirements are dependent on soil conditions and should be determined after a soil analysis has been completed. During the first two years of growth, little or no nitrogen is recommended. In subsequent years, incremental increase of nitrogen fertilizer is recommended, starting at approximately 0.1 kg/tree (available nitrogen) for a young tree and up to 0.5-0.9 kg/tree for a mature tree, which may be broken up into two or more applications (Vossen and Silver 2000; Olsen 2001). Since this is a multi-stemmed shrub, it is necessary to prune the suckers and thin out stems to achieve good plant structure for nut production and harvesting. For commercial cultivation of hazelnuts, cultivars use approximate densities of 300-500 trees per hectare depending on spacing.

Techniques to Encourage Species: Beaked hazelnut prefers sites with ample light such as recently disturbed areas or forested areas with an open canopy. Once the overstory begins to close the canopy, hazelnut populations decline (Fryer 2007).

Flammability: Low.

Effects on Crop Trees (competition and beneficial effects): In much of its range, hazelnut is thought to interfere with the growth of trees; however, due to its relatively narrow range of distribution in British Columbia it is not considered a problem species from this perspective (Haeussler and Coates 1986).

4.3 Blackcap (*Rubus leucodermis*)

4.3.1 Species name

Latin: *Rubus leucodermis* Dougl. ex Torrey &Gray ssp. *Leucodermis*

Common: blackcap, whitebark raspberry, occasionally called black raspberry (not to be confused with *R. occidentalis*)

***Family**:* Rosaceae (the Rose family)

Aboriginal: Each language group or dialect has its own name for this plant, or multiple names based on plant parts or usages. Some languages are included here for informational purposes but the languages are by no means inclusive of all groups. For the most comprehensive coverage including pronunciation, see First Voices at: www.firstvoices.com.

Language	Name for blackcap
Okanagan – Colville	mtsakw, metskwílhml’x (bush)
Halkomelem	t’thqw’am’ə7, tsəlqáma, tsəlqáama7, tselqó:me, tselqó:ma:lhp (plant)
Nlaka’pamux	mə´tsək^{w}, mətsəkw-xín (bush)
Stl’atl’imx	tsats7-úsa7, squólamuq, (s-)tsats7-ús7-az’ (bush)
Tsilhqut’in	nitŝan, nibaxalyish

Figure 5. *Rubus leucodermis*. Drawing used with permission from the Royal BC Museum, photo by Virginia Skilton.

4.3.2 Taxonomy

There are no varieties of blackcap recognised.

4.3.3 Description

***General**:* Blackcap is a medium-sized deciduous shrub with glaucous branches that have curved, flattened prickles and which sometimes arch back to the ground and root at the tip (Douglas et al. 1999b). The leaves are similar to most raspberry plants, arranged alternately and pinnately compound with 3-5 leaflets. They are green on the top surface, white woolly underneath and are armed underneath on the veins and stems. Flowers are white to whitish pink and are born singly or in small clusters. The fruits are drupelets that are raspberry-like and range in colour from shades of red to black when ripe.

BC CDC and SARA status: Not listed.

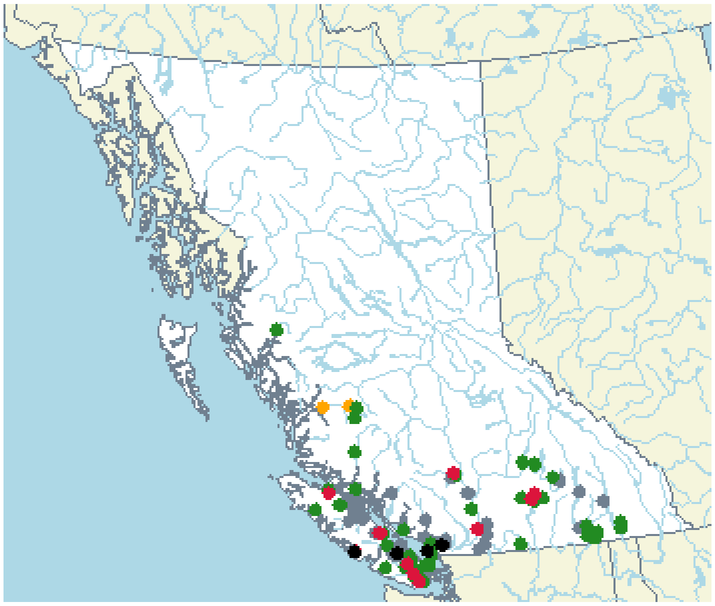
Growth, Development, Reproduction and Regenerative Processes: Blackcap is a plant of disturbed sites, germinating primarily from seed but also by layering (Brayshaw 1996). The stems regenerate annually from a perennial base, and fruiting is on second year wood (Morris 2004).

Successional Status: Blackcap is an early seral plant that is most frequently found following fire, logging and other types of disturbance (Klinka et al. 1989). It is intolerant of shade so disappears once trees and larger shrubs overtop it with growth.

4.3.4 Distribution

General: In North America blackcap is found from Alaska in the north to New Mexico and Arizona in the south (Explorer 2007). Blackcap is common in southwestern British Columbia, and infrequent in southcentral and southeastern portions of the province; it is reported on the coast as far north as the Kitimat area (Douglas et al. 1999b).

***Biogeoclimatic Ecosystem Classification (BEC*)**:** Blackcap is found in the Coastal Douglas-fir (CDF), Coastal Western Hemlock (CWH), Engelmann Spruce-Subalpine Fir (ESSF), Interior Cedar-Hemlock (ICH), Interior Douglas-fir (IDF), Mountain Hemlock (MH) and Ponderosa Pine (PP) BEC zones in British Columbia (Klinkenberg 2007). The modal BEC zone (average of all plots in BEC database) is the CWH (Klinkenberg 2007).



<u>Figure 6. Distribution of *Rubus leucodermis* in British Columbia, used with permsission from the Royal BC Museum.</u>

For more information and to check for species occurrence in your area, refer to the Biogeoclimatic maps and field guides at:
http://www.for.gov.bc.ca/hre/becweb/resources/maps/wall_map_download.html
http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/regional/index.html

Elevation Range*:* Blackcap is reported in BEC plots from approximately sea level to 1587 m, with an average of 418 m (Klinkenberg 2007).

4.3.5 Habitat

Climatic relations: This species is found across a wide range of different climatic types from low to upper-middle elevations. Blackcap occurs on "water-shedding and water-receiving sites in boreal, temperate, cool semiarid, and cool mesothermal climates; on moderately dry to fresh, nitrogen-rich soils" (Klinka et al. 1989).

Site and soil conditions: This shade intolerant plant favours open and often disturbed sites that are nitrogen-rich and well- to somewhat well-drained (Klinka et al. 1989). Blackcap is found in dry to moist thickets, on rocky slopes, in clearings and open forests in lowland to montane habitats (Douglas et al. 1999b).

Plant Associations: Little plant association research has been done for this species, but Klinka et al. (1989) noted that blackcap is often associated with fireweed (*Epilobium angustifolium*), brackenfern (*Pteridium aquilinum*), and thimbleberry (*R. parviflorus*).

Nutrient Relations: Blackcap is a nitrophytic species characteristic of nutrient-rich sites (Klinka et al. 1989; Douglas et al. 1999b).

Water Relations: Blackcap occurs across a moisture gradient ranging from very xeric to subhydric, but is most prevalent on moderately dry to fresh sites (Klinkenberg 2007; Klinka et al. 1989; Douglas et al. 1999b).

Light Relations: Blackcap is a plant of open sites and requires full sun.

Temperature Relations: Blackcap may be found on cool moist sites to very hot and dry sites.

4.3.6 Response to disturbance

Response to grazing/browsing: Due to the thorns, the plants of this species are likely not grazed extensively. The closely related red raspberry (*R. idaeus)* is thought to be of little use to browsing species (Tirmenstein 1990a). However, a large number of animals are known to use the fruit of the red raspberry (Tirmenstein 1990a).

Response to Disturbances: This species is seldom found on undisturbed sites.

Canopy Removal: Following the removal of the canopy, blackcap may be expected to invade into suitable sites (Dyrness 1973).

Wildfire: Blackcap is known by Nlaka'pamux Elders to grow after fire (Turner et al. 1990) and it has been reported by naturalists to inhabit burn areas for a considerable period (Anderson 1925). Blackcap can be expected to die out in young forests as they approach the stem exclusion phase, which occurs when the forest canopy matures, closing in and causing dieback.

Prescribed Burning: The Nuxalk and the Nlaka'pamux are known to have used fire to encourage blackcap (Turner 1991).

Cutting*:* Techniques, such as pruning, work well on the closely related black raspberry (*R. occidentalis*), thus it is assumed pruning of old growth from the plants will enhance this species. Canes regenerate from the root crown and from suckering.

Herbicide*:* No literature was found specific to this species. However, it is assumed this species is sensitive to the same herbicides as the closely related red raspberry (Tirmenstein 1990a) which is reported to be highly sensitive to hexazinone at rates of 2-5 kg per ha (Haeussler et al. 1990).

Soil Disturbance*:* Blackcap is frequently found growing on old landings and skid roads so it is assumed that soil disturbance is beneficial to the species.

Predation, Pests & Fungal Disease: The wild plant is susceptible to honey fungus (Morris 2004). Some common pests of cultivated raspberries and blackberries would likely be problematic if wild blackcap was to be cultivated. These include: spider mites, raspberry cane borers, leaf-rollers, and other minor pests such as thrips, whitefly, leaf-hoppers, and fruitworms. Common diseases of cultivated raspberries and blackberries include: anthracnose, cane blight, crown and cane gall, crumbly berry, cane botrytis, blossom blight and fruit rot, and phytopthera root rot. Sites previously used for fruit crops are poor choices for raspberry and blackberry cultivation because of potential problems with crown gall infection. Likewise, there is increased risk of infection from verticillium wilt on land recently planted with solanaceous crops (e.g., tomatoes, potatoes, peppers, eggplant, and tobacco).

Studies done on seeds of wild blackcap collected from many Pacific northwest regions found no incidence of tobacco streak, tomato ringspot, or raspberry bushy dwarf viruses, whereas these viruses were found in related trailing blackberry (*R. ursinus*) seed (Finn and Martin 1996). Because of this, native blackcap may be an excellent source of disease resistance in black and red raspberry breeding programs (Finn et al. 2003). In addition, wild populations tend to be hardier and more vigorous than cultivated varieties which often reduce pest and disease influence.

4.3.7 Human uses

Nutritional

Rubus species are among the most studied plants with medicinally attractive characteristics (Kaufman et al. 2006), but research is limited on blackcap. Both leaves and berries of *Rubus* species demonstrate a large variation of antioxidant activity, depending on the cultivar and species (genotype), with the highest level of antioxidant activity found in the eastern species, *R. occidentalis* (Reyes-Carmona et al. 2005; Chen et al. 2006; Kresty et al. 2006; Reen et al. 2007). While more human clinical trials are needed to better understand how blackcap berries and leaves bring about health benefits, existing research is very encouraging.

While little research exists for blackcaps, much has been done on its close relative, *R. occidentalis* (Chen et al. 2006; Kresty et al. 2006; Reen et al. 2007; Stoner et al. 2007). *R. occidentalis* is an abundant source of flavonoid compounds (e.g. ellagic acid, ferulic acid, coumaric acid, quercetin, and the anthocyanins), vitamins (e.g., vitamins A, C, and E and folic acid), minerals (e.g., calcium, potassium, selenium, and zinc), and phytosterols (e.g., h-sitosterol, campesterol, and stigmasterol) (Chen et al. 2006). It is thought that blackcaps are an abundant source of flavonoids, which, like its close relative *R. occidentalis*, contain the red, blue and purple colours of berries and are responsible for antioxidant properties. Antioxidants play an important role in neutralizing oxidative stress thereby contributing to the prevention of chronic diseases including cancer, cardiovascular disease, and inflammatory conditions and diabetes onset and related complications (Hou 2003; Hu et al. 2005; Kitts 2006; Stoner and Aziz 2007). Further analysis is required to determine the exact phytochemical properties of blackcap berries and leaves.

In animal experiments R. occidentalis significantly inhibited oral, esophageal and colon carcinogensis. Currently, clinical trials are underway to examine the effectiveness of R. occidentalis in preventing cancer in humans. Kresty et al. (2006) are currently conducting a human chemopreventative trial administering 32 and 45 g (female and male respectively) of freeze-dried R. occidentalis berries daily to patients at high risk of developing malignant esophageal cancer (30-40 fold increased risk). Preliminary results show that daily consumption of the R. occidentalis berry promotes reduction in urinary excretion of two markers of oxidative stress (Kresty et al. 2006). R. occidentalis was used for this study because a previous study had shown that ellagic acid inhibited carcinogen-induced esophageal and colon cancer in rats by 30-60% and 80% respectively (Stoner et al. 2007). The mechanism of the freeze-dried R. occidentalis berries works by influencing cancer metabolism, resulting in reduced levels of carcinogen-induced DNA damage in animal trials. Researchers testing a series of fruits for their ellagic acid content found that R. occidentalis contains the highest amount. However ellagic acid alone does not give the results; it is a combination of chemicals from these fruit that produces the anti-cancer affects (Chen et al. 2006; Reen et al. 2007).

R. occidentalis berries also reduce parameters of tissue inflammation. On a molecular level, berries modulate the expression of genes involved with proliferation, apoptosis, inflammation and angiogenesis (Stoner et al. 2007). It is not known if blackcap has similar activity.

Phenolics and anthocyanins are not only found in the fruit of *Rubus* species but also the leaves (Wang and Lin 2000). Analysis of leaves from twenty-eight species of *Rubus* in China show anti-oxidant values significant in nourishment and health protection (Sang Jian-Zhong 2003). Wang and Lin (2000) had similar findings, noting that fresh leaves of *R. idaeus* L., *R. occidentalis* L., and *Fragaria X ananassa* D. had higher anti-oxidant activity than the fruit. Younger leaves had higher anti-oxidant activity and total phenolics than older leaves.

Morimoto et al. (2005) showed wide variation between genotypes of different cultivars of *R. idaeus*, and not surprisingly a yellow cultivar had close to zero anthocyanin content. Reyes-Carmona et al. (2005) demonstrated that antioxidant and flavenoid levels in blackberry genotypes were more dependent on genotype than region and/or season, and that wild varieties have higher antioxidant levels than cultivars.

Nutritional analysis conducted by Kuhnlein (1989) in Bella Coola, B.C. found a 100 g serving of fresh blackcaps contained the following percent of daily recommended allowances: 30% fiber, 7% vitamin C, 5% folate, 8% iron, 5% zinc, 5% phosphorus, 6% magnesium, and 2% manganese (11.5 mcg/100 g fiber, 6.5 mg/100 g vitamin C, 20.9 mcg/100 g folate, 38 mg/100 g calcium, 40 mg/100 g phosphorus, 28 mg/100 g Mg). While this nutritional analysis may be unremarkable, phytochemical analysis of closely related *R. idaeus* cultivars indicates the health benefits of eating it (Benvenuti et al. 2004). This study tested European cultivars, and confirmed previous findings that *Rubus* species are a good source of natural anti-oxidants, specifically anthocyanins, and total phenols. The antioxidant levels found are considered to have potential health benefits (Benvenuti et al. 2004). Kuhnlein (1989) has done the only nutrient analysis of wild blackcaps (*R. leucodermis*) and there has not been a phytochemical analysis of this species' wild berries or leaves (Chen et al. 2006).

Cultural

Blackcap berries were important to tribes throughout their distribution (Kuhnlein and Turner 1991; Moerman 1998). Blackcap continues to be one of the most prized berries in Nlaka'pamux territory (Kaufman et al. 2006). Berries were eaten fresh in season and dried in various forms for later use, and young shoots were peeled and eaten in the spring (Kuhnlein and Turner 1991; Turner et al. 1990). A mild infusion of the roots was used by the Nlaka'pamux for influenza (Turner et al. 1990) and infusions were made of the leaves and used for stomach problems (Moerman 1998). The Shoshoni made a poultice of powdered stems that was applied to cuts and wounds (Moerman 1998).

Commercial

Though more difficult and slow to pick when compared to species such as Saskatoon, wild blackcap berries are picked commercially. The Siska Traditions Society makes jams and syrups from this berry for commercial sale (M. Michelle, pers. comm., 2006).

Agricultural

Horticultural Uses: The fruit of blackcap is relatively soft compared to other *Rubus* species and is probably not well suited for storage. The 'black raspberry' variety, EarlySweet, is a cross between the wild blackcap (*R. leucodermis*) and the closely related black raspberry (*R. occidentalis*) (Finn et al. 2003). This cultivar can be planted for its fruit or as a hedgerow barrier. As with other bramble berries, these fruits can be eaten fresh or made into jams, jellies, syrups, juices, and many other products (Barney et al. 1999).

Restoration
Within its range, blackcap is known to rapidly re-colonize sites following disturbances, most likely from its seedbank in the soil. It would be a good species to plant on disturbed sites, such as mine spoils, which are unlikely to have a seedbank.

4.3.8 Wildlife and livestock uses
Palatability to Wildlife and Livestock: Some herbivores browse raspberry species, but it is considered poor forage and is relatively unpalatable to most ungulates. In general, raspberries, including blackcaps, provide minimal browse for domestic livestock (Van Dersal 1938). Thorns generally prevent excessive wildlife use of raspberry browse (Watson et al. 1980); however, deer, rabbits, beaver, and elk have been known to eat the foliage of raspberries (Core 1974; Van Dersal 1938). Peek (1974) found that moose in Alaska browse red raspberry (R. idaeus) but it was considered a relatively unimportant food item. Porcupine and beaver occasionally consume buds, twigs, or cambium of species within the genus Rubus (Van Dersal 1938).

Fruits of many species within the genus Rubus are eaten by several bird species including grouse, greater prairie chicken, California quail, ring-necked pheasant, northern bobwhite, gray catbird, northern cardinal, yellow-breasted chat, American robin, thrushes, towhees, brown thrasher, orchard oriole, summer tanager, pine grosbeak, gray partridge, and band-tailed pigeon (Core 1974; Van Dersal 1938). Mammals such as the black bear, grizzly bear, coyote, raccoon, opossum, squirrels, chipmunks, skunks, foxes, and deer mice also utilize the fruits of raspberries when available (Core 1974; Krefting and Roe 1949; Van Dersal 1938; Zager 1980).

Importance to Wildlife and Livestock: Little is known about the importance of blackcap (R. leucodermis) to wildlife. Rubus spp., however, provide food and cover for a wide range of wildlife species (Brinkman 1974; Whitney 1986). Dense raspberry thickets serve as favourable nesting habitat for many small birds (Core 1974) and provide cover for small mammals such as rabbits and squirrels (Van Dersal 1938).

4.3.9 Cultivation and propagation
Propagation can be achieved using various techniques including tip layering, division, semi-hardwood stem cuttings, seed, and tissue culture. Tip layering involves burying actively growing shoots in shallow holes in the late summer. Lateral roots form on these stems and can be transplanted the following spring. Division involves separating the crown into smaller pieces each of which becomes a plant. Semi-hardwood stem cuttings can be taken during the summer and easily rooted under mist.

Literature on seed propagation of blackcap (*R. leucodermis*) could not be found. However, closely related black raspberry (*R. occidentalis*) requires at least a 30-day cold, moist treatment prior to sowing. Thimbleberry (*R. parvifolius*) requires a 4-5 month cold, moist stratification (Hudson and Carlson 1998). Some literature suggests that *Rubus* species need be immersed in sulphuric acid for 10-30 minutes prior to cold treatment (Heit 1967).

Tissue culture requires more skill and the use of a laboratory but is excellent for producing disease free plants of known genetic origin.

Cultivation of blackcap follows similar procedures to that of related *Rubus* species. The following information is for raspberries and blackberry cultivation (Barney et al. 1999). Usually they grow best in full sun on a mesic but well-drained site with a pH of 5.6-7.0. *Rubus* species tend to be shallow-rooted and are susceptible to water stress during hot, dry periods and root rot during extended wet periods. Mulching is a good way to conserve soil moisture, reduce weed competition, provide slow release of nutrients to the plant, and provide winter protection to the crown. Farmers tend to plant rows 2.4-3.7 m (8-12 feet) apart to accommodate machinery. However, rows can be spaced closer for hand harvesting situations. The use of a trellis system to support the canes keeps the rows tidy and keeps fruit-bearing branches from wind damage and from bending over too far. Hedgerow barriers require closer plant spacing of 0.6-0.9 m (2-3 feet) within the row depending on how aggressively the plant suckers.

Most *Rubus* species produce canes biennially, with fruiting on two-year wood; old canes (floricanes) should be pruned out. Additionally, weak, diseased or excess canes should also be removed. Fertility requirements vary with soil type and current nutrient status as determined by soil analysis. Blackberries are not heavy feeders and have low fertility requirements initially. The main macro-nutrient required is nitrogen and commercially available fertilizers can be band incorporated while manure may be top-dressed then incorporated. Although their fertility requirements are low, raspberries and blackberries benefit from regular fertilization. Applications of 34 kg/ha during establishment year and 67 kg/ha in subsequent years is recommended (Kuepper et al. 2003). Yellowing of leaves may be a symptom of iron chlorosis which can be caused by planting on alkaline or heavy soils and soils with excessive phosphorous.

Berry yields of approximately 1.1–1.4 kg per hill can be expected with 2.4 x 0.9 m spacing.

Techniques to Encourage Species: Blackcap can be encouraged by fire, logging and other types of disturbances that remove the forest canopy. Pruning also encourages new growth; Nlaka'pamux Elders note that when you are harvesting these berries you should "pick like a bear" (i.e. break the branches) (M. Michelle, pers. comm., 2008).

Flammability: Not reported in literature but expected to be low in living stems.

Effects on Crop Trees (competition and beneficial effects): The species may impede the growth of shade-intolerant conifers and slow natural regeneration of these trees (Klinka et al. 1989).

4.4 Soopolallie (*Shepherdia canadensis*)

4.4.1 Species name

Latin: *Shepherdia canadensis* Nutt.
Family: Eleagnaceae (the Oleaster Family)
Common: soopolallie, Canada buffalo-berry, russet buffalo-berry, soapberry
Aboriginal: Each language group or dialect has its own name for this plant, or multiple names based on plant parts or usages. Some languages are included here for informational purposes but the languages are by no means inclusive of all groups. For the most comprehensive coverage including pronunciation, see First Voices at: www.firstvoices.com.

Language	Name for soapberry
Ktunaxa	kupa7tilh, kupa7tilh-wu7k (bush)
Okanagan – Colville	sxwusm, sxwesmílhp (bush)
Halkomelem	sxwásəm, sxwesm, sxwō´sem
Nlaka'pamux	sxwúshm sxwúsm, sxwusm-élhp (bush)
Secwepemctsin	, sx^{w} (bush)
Stl'atl'imx	(s-)xwúsum, xwúsum-az' (bush)
Tsilhqut'in	nuŵîsh
Wet'suwet'en	niwis

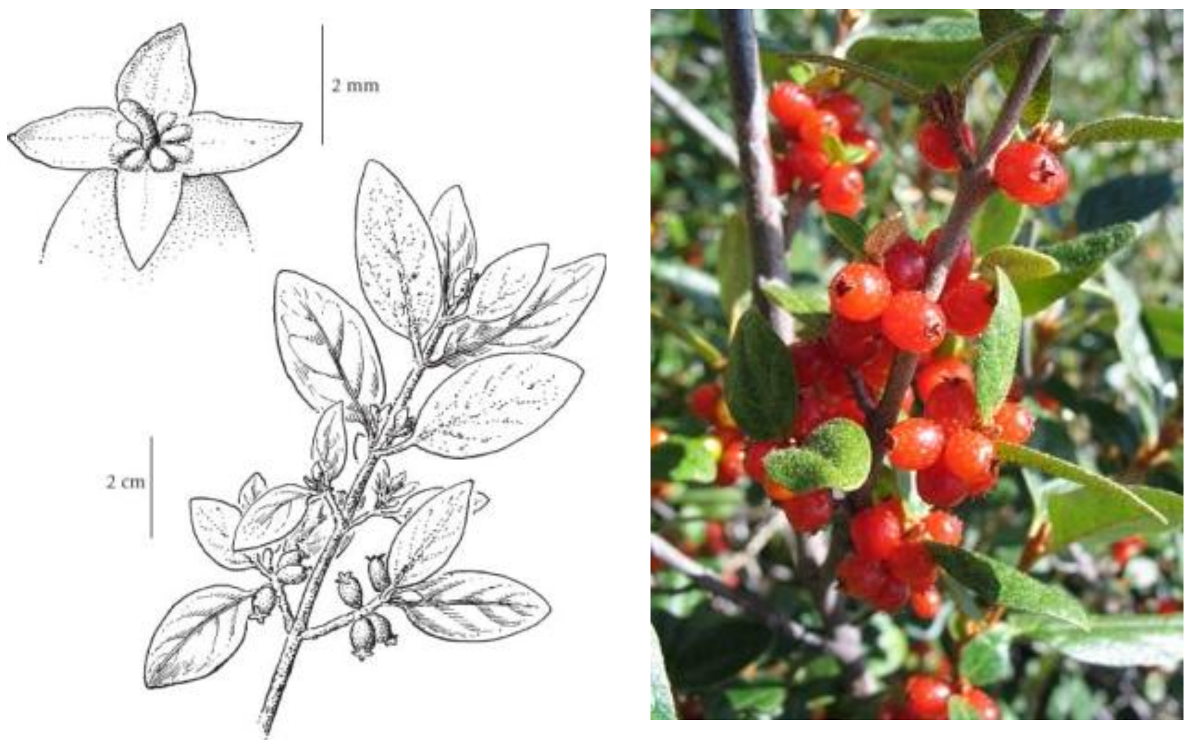


Figure 7. *Shepherdia canadensis*. Drawing used with permission from the Royal BC Museum, photo by Wendy Cocksedge.

4.4.2 Taxonomy

There are currently no varieties or ecotypes of soopolallie recognised (Douglas et al. 1999b; Monsen et al. 2004).

4.4.3 Description

General: Soopolallie is a medium-sized deciduous shrub, typically with multiple stems. It commonly grows up to 1.5 m tall but sometimes reaches 3 m. Nitrogen-fixing bacteria (*Frankia* spp.) attach to its roots (Lewis 1990; Benson and Dawson 2007). The leaves, young branches, and fruit are covered in distinctive brown-coloured hairs giving the plant a somewhat rusty appearance. The egg-shaped leaves are arranged opposite on the stem. An easy method to identify soopolallie in the winter is by the dormant pre-formed leaves. The flowers are small, green, and inconspicuous. The ripe berries range in colour from bright red to orange, and the juice has a soapy feel due to the saponin it contains, hence its common name soopolallie (literally soap berry in Chinook). The berries are an important food for wildlife, especially during years when the huckleberry plants fail to fruit. They are also of high importance to First Nations and are probably best known as being the key ingredient in 'Indian Ice Cream.'

BC CDC and SARA status: Not listed.

Growth, Development, Reproduction and Regeneration: Soopolallie is a dioeceous species, meaning that there are male and female plants. Some sites are dominated by either male or female plants leading to poor fruit production on these sites. Sex ratios are typically highly variable (Lewis 1990) making local knowledge valuable in determining which areas may be productive when berries or flowers are not present. The species is believed to reproduce entirely from seeds which are known to be disbursed by birds, small mammals, and bears (Lewis 1990). As with the leaves, the flowers are preformed on the branches from the previous year and plants with more than one stem should be expected to produce flowers (Lewis 1990).The plant flowers before its leaves begin growth in the spring. Both the male and female flowers produce nectar that attracts pollinators; however, it is also likely that the plants are pollinated by airborne pollen (Lewis 1990). Plants that are 56 years of age have been recorded (Lewis 1990). In Alberta, Lewis (1990) found that juvenile plants are more likely located near adult plants in relatively undisturbed sites.

Successional Status: Although soopolallie can reproduce in undisturbed sites, the successional status of this species is unclear as it is found in a wide variety of ecosystems. Evidence from Alberta suggests the species relies extensively on disturbance for regeneration (Lewis 1990). It may be a fire successional species because in some regions it dominates fire-adapted forest ecosystems (Hamer 1996); in Alberta this species dominates the understory of fire maintained lodgepole pine forests on drier sites (La Roi and Hnatiuk 1980; Munro et al. 2006).

4.4.4 Distribution

General: Soopolallie occurs across North America, ranging north from within the Arctic Circle (about 69^{o} N) to New Mexico in the southwest perimeter and east to Pennsylvania. In British Columbia the species is sporadic on the coast and increases with increasing continentality (Klinka et al. 1989). It is absent from the Queen Charlotte Islands.

Biogeoclimatic Ecosystem Classification (BEC): Soopolallie occurs across a wide range of BEC zones in British Columbia: Alpine Tundra (AT), Bunchgrass (BG), Boreal White-Black Spruce (BWBS), Coastal Western Hemlock (CWH), Engelmann Spruce-Subalpine Fir (ESSF), Interior Cedar-Hemlock (ICH), Interior

Douglas-fir (IDF), Montane Spruce (MS), Ponderosa Pine (PP), Sub-Boreal Pine-Spruce (SBPS), Sub-Boreal Spruce (SBS), Spruce-Willow-Birch (SWB) (Klinkenberg 2007) (see http://www.for.gov.bc.ca/hre/becweb/).
The modal BEC zone across the BEC plot data is the Interior Douglas-fir (IDF) (Klinkenberg 2007).

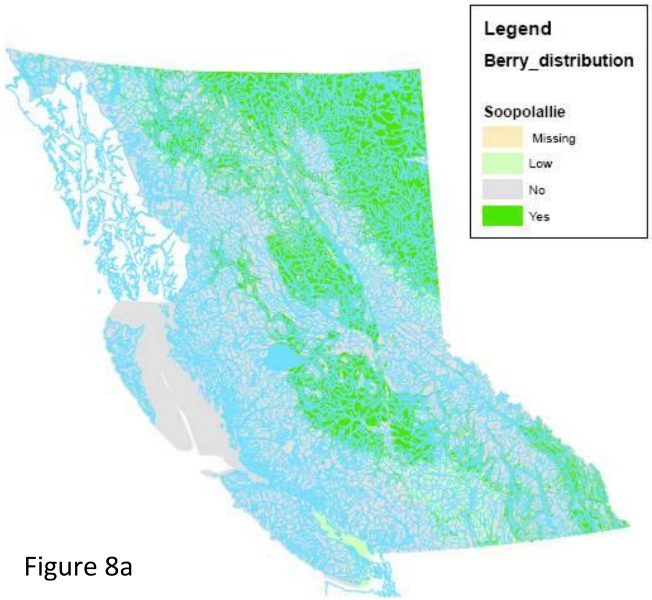


Figure 8a

Figure 8b

<u>Figure 8. Distribution of *Shepherdia canadensis* in British Columbia. Figure 8a is based on presence within biogeoclimatic ecosystems, developed by Ted Lea and Kim Everett. Figure 8b is an occurence map used with permission by the Royal BC Museum.</u>

For more information and to check for species occurance in your area, refer to the Eflora distribution map at: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Shepherdia%20canadensis or the biogeoclimatic maps and field guides at:
http://www.for.gov.bc.ca/hre/becweb/resources/maps/wall_map_download.html
http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/regional/index.html

4.4.5 Habitat

Plant occurrence does not always correspond to berry occurrence because it is likely that additional environmental variables are important for berry production. The requirements for berry production are poorly known. The following information relates largely to plant occurrence unless otherwise stated.
Elevation Range**:** Reported in BEC plots from 0-2460 m, averaging 1045 m (Klinkenberg 2007).
Climatic relations: Soopolallie is associated with a montane boreal and cool temperate climate (Douglas et al. 1999a) and is characteristic of continental forests (Klinka et al. 1989).
Site and soil conditions: The species is known to occur on a wide range of sites and is commonly found growing in sandy, rocky and/or calcareous sites (Lewis 1990). In the East Kootenayregion of B.C., soopolallie is most abundant on sites with high levels of carbonates (M. Keefer, unpublished field notes,

2007). On the coast soopolallie is almost exclusively found growing on top of limestone bedrock or shell middens (N.J. Turner, pers. comm., 2008).

The plant is associated with nitrogen-fixing bacteria, allowing it to thrive in nutrient poor and disturbed sites (Klinka et al. 1989; Lewis 1990). It has been found that there are numerous strains of *Frankia* that infect plants found in different ecological variants (Batzli et al. 2004; Benson and Dawson 2007). Infecting nursery stock with the respective strain for the intended planting site may increase the success of plantings in poor sites.

Plant Associations: Little plant association research has been done for this species, but Klinka et al. (1989) noted that soopolallie is often associated with plants such as pinegrass (*Calamagrostis rubescens*), twinflower (*Linnaea borealis*), and falsebox (*Pachistima myrsinites*).

Nutrient Relations: The modal nutrient regime class across BEC plots for soopolallie is medium (Klinkenberg 2007; Douglas et al. 1999), though the species is able to thrive on nutrient-poor sites due to its nitrogen-fixing ability.

Water Relations: The species occurs across a wide range of soil moisture regimes, from very xeric to hydric sites, but is most commonly found on mesic to dry sites (Klinka et al. 1989; Klinkenberg 2007). For example, the soil moisture regime for best growth in the ICHmc ecosystem appears to be 1-3 (Burton et al. 1998).

Light Relations: Soopolallie has been reported to be both shade tolerant and shade intolerant (Klinka et al. 1989). Hamer (1996) found fruit production decreased precipitously with more than a 50% canopy cover.

4.4.6 Response to Disturbance

Response to grazing/browsing: Given that the species is typically only lightly browsed there is little data available on its response to browsing.

Response to Disturbances: Both soil compaction (Haeussler and Kabzems 2005) and removal of organic debris by machine (Benson and Dawson 2007) has been found to reduce the cover of soopolallie.

Forest Canopy Removal: The various studies referenced in this section do not all agree, confirming the need for further research on this species. Productivity of soopolallie in northern British Columbia has been shown to increase with light availability up to 75% global irradiance[9] (Burton et al. 1998). This corresponds with Mead's (1995) finding that soopolallie abundance in interior Alaska is maximised under a forest canopy closure of 25% to 59% (Mead 1995, cited in Burton et al. 1998). However, two studies found no detectable differences in fruit production between clearcuts and forests (Knight 1999; Nielsen et al. 2004).

Furthermore, when Nielsen et al (2004) examined the influence of forest canopy cover on soopolallie in cutblocks, he found maximum fruit occurrence at low to negligible overstorey canopy levels, while the maximum predicted occurrence for the species in clearcuts was at more intermediate forest canopy levels. Hamer (1996) found similar patterns between forest canopy cover and fruit production of soopolallie.

However, Burton (1998) found that berry size decreased by up to 40% from forest understory to fully open conditions; thus although numbers increased, berries were much smaller in open conditions. It should be noted that many elders have indicated a preference for larger berries when harvesting (W. Cocksedge, pers. comm., 2009).

Wildfire: In burned habitats Hamer (1996) found that fruit production began 5 years after recent burns. Furthermore, fruit production was most likely a function of canopy closure rather than age of burn.

[9] Global irradiance is close to percent canopy cover in our latitudes.

Older burns (>50 yrs old) that remained forest-free still produced abundant fruit while 25 yr old burns, where regenerating lodgepole pine canopy cover measured 72%, already had low berry production (Hamer 1996). Noble (1985) measured soopolallie fruit production in southeast British Columbia and found the highest berry production was recorded in 2 sites within a 1928 burn. Noble (1985) noted, however, that conclusions were limited due to small sample sizes.

Prescribed Burning: Though no specific studies were found, it is assumed that soopolallie will respond positively to prescribed fire given its response to wildfire.

Cutting: Soopolallie is likely to respond positively to cutting if the plant is in full sun. If the plant is under a dense canopy it can be expected that the result of cutting will be negative.

Herbicide: Hexazinone is known to kill soopolallie (Boateng 2002). The effects of other herbicides are currently unknown.

Pollutants: Soopolallie can accumulate mercury when it is grown in polluted soils (Schofield 1990).

Soil Disturbance: Knight (1999) and Nielsen et al. (2004) examined the effect of logging on soopolallie in southeastern British Columbia and westcentral Alberta, respectively. Both studies have found that mechanical scarification had a negative impact on this plant species (Knight 1999; Nielsen et al. 2004) Knight (1999) found that non-scarified cutblocks tended to have greater soopolallie shrub density than forested sites, suggesting that timber harvesting can enhance the recruitment of soopolallie provided there is no intensive post-harvesting mechanical scarification.

4.4.7 Human uses

Nutritional

Nutritionally, soopolallie berries contain high levels of vitamin C with up to 166 mg/100 g (approximately 1/3 of a cup contains almost double the required daily intake) (Kuhnlein 1989). However, the berries are normally consumed in smaller portions. Soopolallie berries are also an excellent source of carotenoids, including beta-carotenoids (precursor of vitamin A), responsible for its orange yellow colouring (Kraft et al. 2008). Known for their antioxidant activity, leucoanthocyanins, catechols, flavonols, and chlorogenic acid are also found in soopolallie (Boberko et al. 1978; Bekker and Glushenkova 2001; Kraft et al. 2008). *In vitro* research demonstrates the capacity of soopolallie berries to reduce inflammation, reduce diabetic complications related to circulation, and improve glucose uptake and metabolism (Kraft et al. 2008). Soopolallie berries show anti-cancer activity and the leaf extract, rich in tannins, shows an inhibitory activity against human immunodeficiency virus (HIV)-1 (Ritch-Krc et al. 1996a; Yoshida et al. 1996). Compounds similar to those in soopolallie are used in treating dysentery confirming traditional use for diarrhea by the Siksika (Blood) First Nations (Ayer and Browne 1970).

A number of alkaloids such as harmala, seratonin and tryptamines present in soopolallie affirm the sedative characteristic described by various First Nations (Ayer and Browne 1970; Turner et al. 1990; University of Michigan-Dearborn 2008). While scientific research has affirmed many of the benefits to human health, most studies are based on laboratory tests (*in vitro*) and animal testing and there remains a need for further human clinical trials (Seeram 2008).

Cultural

Soopolallie is an important food and medicine for Interior First Peoples of the Northwest and it is traded with the Coastal First Peoples. Neighbouring Plains Nations use the close relative *Shepherdia argentea* which is often also referred to as buffaloberry (Kraft et al. 2008). Most commonly soopolallie is prepared by mixing it with water as a whipped frothy dessert or used as a concentrate and mixed with water to make a thirst quenching juice (Kuhnlein 1989; Turner et al. 1990; Ritch-Krc et al. 1996b). These two products are also known to have medicinal effects (Turner et al. 1990, 1997).

Its medicinal properties are highly valued. Nlaka'pamux Elder, the late Mabel Joe, explained that the juice can be used for heart attack, indigestion, acne, boils, digestive problems, and gallstones. Tea from the twigs and sticks are used as a laxative, while tea of leaves and fruit treats ulcers and acts as a sedative. For more serious illness, like stomach cancer and high blood pressure, decoctions of branches and leaves are used, and it is said that eating the berries is also good for these ailments. The roots are used as a physic or purgative (Turner et al. 1990). Much of the current soopolallie scientific research relies upon this advanced Indigenous knowledge to formulate research inquiries (Ayer and Browne 1970; Ritch-Krc et al. 1996a).

The bitter-tasting fruit of soopolallie continues to be highly prized by many First Nations people (Turner 1975, 1997; Turner et al. 1990; Keefer and McCoy 1999) and it remains an important trade and gift item in the informal First Nations society.

Subsistence

As noted in Section II above, soopolallie continues to be an important subsistence food for many First Nations. Many rurally-based families rely heavily on wild-harvested berries; in some cases up to 100% of annual fruit consumption is harvested from the wild (W. Cocksedge, pers. comm., 2009). Easily preserved through canning, soopolallie is important for a winter supply of fruit.

Recreational

Soopolallie appears to be an acquired taste, and as such remains in low demand as a recreational harvest species.

Agricultural

Horticultural Uses: Though soopolallie is not commonly found in plant nurseries, it has high potential for use in horticulture, and is propagated by several native plant nurseries in British Columbia (British Columbia Nursery and Landscape Association 2009). A particularly good use for soopolallie plantings is in school landscaping where the species can serve as part of a living edible laboratory for teaching students about the value of native plant species. Though the berries don't last long on the plant, in season they make a very attractive display. For berry production, both male and female plants are required.

Restoration

The ability of this plant to fix nitrogen allows it to be competitive on damaged sites making it ideal for use in reclamation of disturbed sites including mine spoils and urban landscapes. Within the coal mines of the Elk Valley where there is major pressure from browsing/grazing ungulates on palatable shrubs (W. Franklin, pers. comm., 2008), planting of less palatable species such as soopolallie may make it possible to establish a plant cover that could act to protect other species.

With the goal to increase the prominence of First Nations plants and bear foods this is an ideal species to plant on suitable sites. If there is existing soopolallie on the site then it may be beneficial to reduce forest canopy cover to enhance plant growth and berry production; however, this should be done as a research trial to establish this relationship more firmly.

4.4.8 Wildlife and livestock uses

Palatability to Wildlife and Livestock: Soopolallie plants are known to have low palatability to wildlife (Lewis 1990) in spite of the fact that the stems have high protein values, and there is high sugar content in the browse. The explanation for the low palatability may be in the phosphorus (P):calcium (Ca) ratio of the stem. A P:Ca ratio less than 1:5 results in poor digestibility due to calcium's inhibition of phosphorus uptake; soopollalie stems have a 1:10 ratio. The fruit, however, has a 1:1 ratio, making it the most palatable portion of the plant. Furthermore, measures used to determine digestibility of the berries found that soopolallie has one of the highest dry matter digestibility at 70.3% (Welch et al. 1997) which further explains why wildlife use berries more frequently than browse.

Importance to Wildlife and Livestock: Despite the wide distribution of soopolallie, animals often utilize it as a browse only in the absence of alternatives (Cowan et al. 1950; Gastler et al. 1951). Mozingo (1987) reported that soopolallie provided fair to poor forage for sheep, cattle and horses. Salter and Hudson's (1979) study on feral horses in western Alberta further supported these findings. The occurrence of soopolallie in the diet of feral horses was inconsistent and never exceeded 1% during any one month (Salter and Hudson 1979).

The use of soopolallie browse for mule deer, white-tailed deer, elk, mountain goat, and bighorn sheep has been ranked from poor to good (Campbell and Johnson 1983; Mozingo 1987; Nobel 1985; Stelfox 1976; Wallmo and Bruce 1973; Wallmo et al. 1972). Soopolallie was absent from white-tail deer diet in the Black Hills of South Dakota, but was found to be an important food source for white-tailed deer in Montana (Freedman 1983). In Washington State, soopolallie comprised 9% and 28% of the summer diet of mule deer and mountain goats, respectively (Campbell and Johnson 1983). Bighorn sheep used it as a low-preference shrub, with moderate to heavy use of new growth in the spring (Stelfox 1976) and Riggs (1977) reported that sheep selected dormant plants. Among small mammals, snowshoe hares in Kluane, Yukon utilized soopolallie as winter browse but it was not considered a preferred food (Pease et al. 1979; Smith et al. 1988).

Soopolallie berries are used by a variety of wildlife including small mammals, small non-game birds, upland game birds, and waterfowl (Howard 1997). The berries have also been identified as an important summer food for both grizzlies (Hamer and Herrero 1987; Mattson et al. 1991; McLellan and Hovey 1995; Munro et al. 2006) and black bears (Irwin and Hammond 1985; MacHutchon 1989; Raine and Kansas 1990; Holcroft and Herrero 1991). In the drier slopes of the Rockies, soopolallie fruit is the usual summer food for grizzly bears (Hamer and Herrero 1987; McLellan and Hovey 1995; Hamer 1996; Munro et al. 2006). Comparable results were obtained in a study of black bears in Banff (Raine and Kansas 1990), and southern Alberta (Holcroft and Herrero 1991). Soopolallie berries provide the major food from midsummer until first frost for black bears in the Yukon Territory (MacHutchon 1989).

Berries play an important role in the accumulation of fat and the overall nutritional status of grizzly bears and black bears (Stirling and Derocher 1990). Matteson et al. (1991) concluded that the Yellowstone grizzly bear population is limited primarily by the lack of fleshy fruits in its ecosystem. Captive bears fed berries during autumn showed impressive daily intake rate of about 35% of their own body mass (Welch et al. 1997). Grizzly bears in the Flathead drainage, in southern B.C., are known to gain over a kg/day eating berries prior to hibernating (B.N. McLellan, pers. comm., 2006).

Bears consuming berries to build up energy reserves are constrained by intake rate (Welch et al. 1997). Because densely fruited bushes and plants are important for optimal foraging efficiency of grizzly bears (Welch et al. 1997), most grizzly bear populations seek out important early seral, shrub-dominated berry-producing habitats in late summer and fall (Mowat and Ramcharita 1999).

In Banff, Hamer and Herrero (1987) recorded grizzly bears feeding on soopolallie berries in fire-successional shrubland and regenerating forest originating from wildfires but did not record bears feeding on soopolallie in climax stands.

As young fire-regenerated stands mature and effective fire suppression continues one might expect timber harvesting to provide a consistent mechanism of disturbance required for early seral, shrub-dominated sites. Although berry-producing shrubs occur in cut-blocks, in many areas studied cut-blocks generally received less use by grizzly bears than other habitat types (Servheen 1983; Zager et al. 1983; Simpson et al. 1985; McLellan 1989). Few studies, to date, have examined the effects of timber harvesting on soopolallie.

4.4.9 Cultivation and Propagation

Propagation of Soopolallie is accomplished mainly through seed propagation although cuttings can also be used (Luna and Wick 2008; Luna et al. 2008; Walker 2008). Berries of soopolallie ripen relatively early and are picked from late June into July. Berries are gathered by spreading a tarp underneath the bushes and shaking or beating the branches to cause the berries to fall onto the tarp where they can be collected. Seed is easily separated from the berry through mechanical separation. Several rinses are necessary to remove the 'soapy' bubbles which are produced during cleaning and agitation. Cleaned soopolallie seeds should be soaked in hydrogen peroxide (5-10%) for approximately 15 minutes to reduce fungal contamination during cold stratification (Hudson and Carlson 1998).

Dormancy is a combination of physical and physiological factors (Luna et al. 2008; Walker 2008). Physical dormancy is a result of the hard seed coat and can be removed through acid scarification as described below. It should be noted that this species displays high variability in seed quality from year to year which affects resulting germination and crop quality (Walker 2008). Prior to harvesting berries, the seeds should be examined to ensure adequate viable embryos within the seeds. Seed should be soaked in water for 24 hours and placed in a moist stratification for 3-5 months at approximately 2-5^{o}C. Check and clean the seed during this period to keep the seed from rotting (Hudson and Carlson 1998). Other literature suggests acid scarification using sulfuric acid followed by a 14 week cold, moist treatment (Rosner and Harrington 2003). Protocols for acid scarification of this species vary but 95-98% concentrated sulfuric acid for 5-15 minutes has been used successfully (Rosner and Harrington 2003).

This technique requires caution and should not be attempted without proper laboratory equipment and handling procedures. The goal of acid scarification is to dissolve enough of the seed coat to allow the radicle to emerge without damaging the embryo. This takes care and attention, and duration of exposure to acid will vary depending on acid strength and thickness of seed coat.

Moderate success has been achieved using semi-softwood tip cuttings taken prior to budbreak. Rooting hormone containing 800 ppm indole-3-butyric acid (IBA) works best for this species (Luna et al. 2008). Soopolallie is quite slow to establish and does best in a well-drained growing medium. Personal experience indicates that it grows best when daytime temperatures are kept between 20-25^{o}C and night temperatures not below 15^{o}C. Daytime temperatures above this maximum appear to be detrimental to this species' germination and early establishment. Supplemental lighting may be used to achieve long-day conditions (>12 hours light) which favour germination and establishment during early spring sowing.

4.5 Black huckleberry (*Vaccinium membranaceum*)

4.5.1 Species Name

Latin*: Vaccinium membranaceum* Douglas ex Hooker
Family: Ericaceae (the Heath family)
Common*:* black huckleberry, black blueberry, big huckleberry, blue huckleberry, black whortleberry, thin-leaved huckleberry
Aboriginal: Each language group or dialect has its own name for this plant, or multiple names based on plant parts or usages. Some languages are included here for informational purposses but the languages are by no means inclusive of all groups. For the most comprehensive coverage including pronunciation, see First Voices at: www.firstvoices.com.

Language	Name for black huckleberry
Ktunaxa	lhəwiyalh
Okanagan – Colville	st’xalhk, st’exlhkílhmel’x (bush)
Halkomelem	kwxwó:mets, kwxwó:mólselhp
Nlaka’pamux	ts’əlts’ále, ts’əlts’ales-élhp (bush)
Secwepemctsin	w p (bush)
Stl’atl’imx	məxáz’, məxáz’-az’ (bush), 7úsa7, 7ús7-az’ (bush)
Tsilhqut’in	nelghes
Wet’suwet’en	

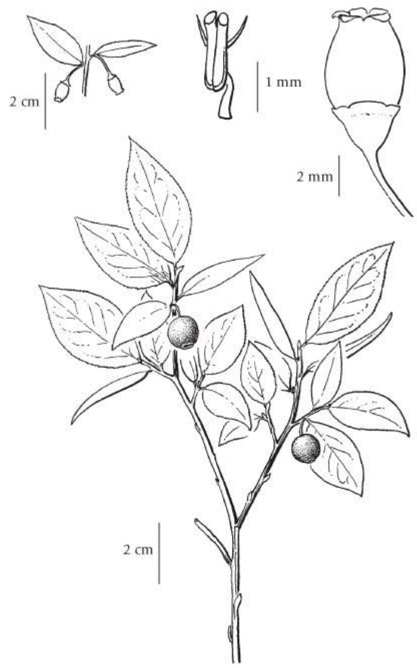


Figure 9. *Vaccinium membranaceum*. Drawing used with permission from the Royal BC Museum, photo by Wendy Cocksedge.

4.5.2 Taxonomy

In the extreme southeast of British Columbia and extending into Idaho, Montana and Washington there is a closely related species (*Vaccinium globulare*) that is classified as a distinct species in some texts (Douglas et al. 1999a; Stark and Baker 1992) while other authors suggest that it should be classified as a variety of *V. membranaceum* (Brayshaw 1996; Vander Kloet 1988; Vander Kloet and Dickinson 1999).

Black huckleberry is a tetraploid species (meaning that it has four complete sets of chromosomes in each cell), giving it high genetic diversity and plasticity. Within the genus *Vaccinium*, *V. membranaceum* is within the section *myrtillus*. Within this section a number of hybrids are possible but apparently are uncommon in nature. Individual transplanted clones have been found to be plastic with the new plants showing different characteristics when planted on different sites (Vander Kloet and Dickinson 1999).

4.5.3 Description

***General**:* Black huckleberry is a medium-sized deciduous shrub, ranging in height from approximately 20 cm in poor sites to over 1 m in better sites (Douglas et al. 1999a) but rarely up to 3 m (Vander Kloet and Dickinson 1999). Black huckleberry is undoubtedly one of British Columbia's most important wild berry species for First Nations and wildlife and is highly popular amongst recreational harvesters (Gayton 2000; Keefer and McCoy 1999; Trusler 2002; Turner 1975, 1977; Turner et al. 1990).

The berries and flowers are both globe shaped. Ripe berries may range in colour from shades of dark red to purple and are up to 1 cm in diameter. These berries are borne singly on the branches. BC FSP Y091160 found that, in the East Kootenay, huckleberry production averaged 121,000 fruit/hectare in 2008 and 42,250 fruit/ hectare in 2009. The young branches are typically light green in colour and strongly angled at the leaf joints. Old branches have greyish, shedding bark. As with all the other huckleberry and blueberry species, the leaves are arranged alternately, meaning that the leaves are staggered on the branches. The leaves are finely toothed, smooth in texture and up to 4 cm long. Early in the season the leaves are a vibrant green, later in the season they generally turn a bright red colour.

BC CDC and SARA status: Not listed.

Growth, Development, Reproduction and Regeneration*:* Black huckleberry is best known to spread through its extensive rhizomes (Miller 1977; Stark and Baker 1992). These rhizomes allow for reproduction and nutrient storage in a wide diversity of ecosystems (Trusler 2002) and are typically found 8-30 cm below the soil surface (Minore 1975). Occasionally deep taproots have been found that extend to 100 cm below the soil surface (Minore 1975). Following disturbances such as fire, the plant actively resprouts from its rhizomes (Miller 1977; Minore 1975). In Lamb Creek black huckleberry was found to be resprouting only weeks after a wildfire (M. Keefer, unpublished data, 2003).

Black huckleberry rarely reproduces from seed in its natural habitat (Miller 1977; Stark and Baker 1992). However, in higher mountains it is not often warm enough, or warm enough for long enough periods, for huckleberries to propagate naturally from seed with any frequency. Typically, close examination of a huckleberry seedling reveals that the plant is growing from a rhizome (D. Barney, pers. comm., 2007). Despite the rarity of huckleberry seedlings growing from seed in the wild, they are easy to propagate by seed in the nursery setting (J. Meuleman, unpublished data, 2007). Planted seedlings develop rhizomes within the first three years of growth.

Successional Status: As with many forest plants, the successional status of black huckleberry is not clear, as highly productive fruiting stands may be found in the shade of open old growth forests and in full sun, but generally not in dense second growth. An experiment in Oregon found huckleberry cover to be at its maximum 15 years following logging (Schoonmaker and McKee 1988).

4.5.4 Distribution

General: Within North America black huckleberry may be found in the southwestern portions of the Northwest Territories, and south to California; there are also disjunct populations in Arizona as well as Michigan and northern Ontario (Vander Kloet and Dickinson 1999).

As Biogeoclimatic Ecosystem Classification (BEC) data are largely focused on mature climatic climax ecosystems, other factors that influence black huckleberry distribution, and berry production in particular, may not be evident from an examination of BEC data alone. Good black huckleberry sites are often noted to be in transitional ecosystems. For example, many good sites in the West Kootenay occur between 1100–1500 m in the transition between interior cedar-hemlock (ICH) forests and Engelmann spruce-subalpine fir (ESSF) forests (P. Corbett, pers. comm., 2008). Other factors on huckleberry distribution include disturbance effects, particularly from canopy alteration and fire (Hauessler et al. 1990; Simonin 2000; Tmix^{w} Research and Nicola Tribal Association 2002). Forest management actions to improve berry production include partial cutting to increase the amount of light reaching the understory and burning to stimulate vegetative growth.

Black huckleberry is widely distributed in British Columbia (figure 1), although it is very scattered in the far north, on the north coast, and in the dry Chilcotin plateaus and Kamloops areas (Haeussler et al. 1990), and does not grow in Haida Gwaii (Queen Charlotte Islands) (Klinkenberg 2007). Within the Interior its distribution is concentrated south of 57^{o} N latitude (Klinkenberg 2007). It is noted to be particularly abundant in the montane slopes of the Kootenay and the Cascade mountains (Hitchcock and Cronquist 1976).

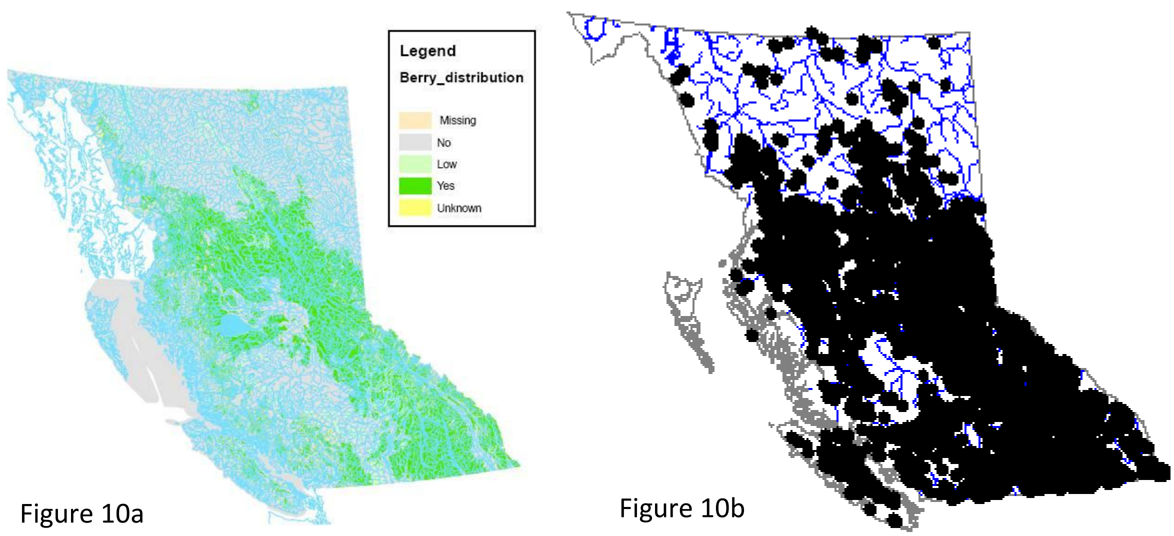


Figure 10. Distribution of *Vaccinium membranaceum* in British Columbia. Figure 10a is based on presence within biogeoclimatic ecosystems, developed by Ted Lea and Kim Everett. Figure 10b is an occurence map used with permission by the Royal BC Museum.

Biogeoclimatic zones: Black huckleberry occurs across a wide range of BEC zones in British Columbia: AT (Alpine Tundra), BWBS (Boreal White and Black Spruce), CWH (Coastal Western Hemlock), ESSF (Engelmann Spruce – Subalpine Fir), ICH (Interior Cedar – Hemlock), IDF (Interior Douglas fir), MH (Mountain Hemlock), MS (Montane Spruce), PP (Ponderosa Pine), SBPS (Sub-Boreal Pine – Spruce), SBS (Sub-Boreal Spruce), SWB (Spruce – Willow – Birch) (Klinkenberg 2007).

The modal BEC zone (average of all plots in BEC database) is the Engelmann Spruce Sub-alpine Fir (ESSF) (Klinkenberg 2007).

Black huckleberry is most abundant in the Interior Cedar Hemlock (ICH) and Engelmann Spruce Sub-alpine Fir (ESSF) zones; high abundance values also occur in the Mountain Hemlock (MH) zone and cool, wet subzones of the Sub-Boreal Spruce (SBS) zone (Haeussler and Coates 1986; Tmix^{w} Research and Nicola Tribal Association 2002).

For more information and to check for species occurance in your area, refer to the Eflora distribution map at: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Vaccinium%20membranaceum or the biogeoclimatic maps and field guides at:
http://www.for.gov.bc.ca/hre/becweb/resources/maps/wall_map_download.html
http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/regional/index.html.

4.5.5 Habitat

Black huckleberry is distributed north to southeastern Yukon Territory, east to Alberta and south to Idaho, Montana and northern California (Klinkenberg 2007). In general black huckleberry is an understory species that favours relatively moist, open coniferous forests on well-drained mountain slopes that usually coincide with high snow pack through the winter (Haeussler and Coates 1986). In British Columbia, black huckleberry is found in dry to moist forests and in unforested openings in the montane and subalpine zones.

Elevation Range: It has been reported in BEC plots from 0-2400 m, averaging 1236 m (Klinkenberg 2007). Many productive sites are located at 1200-1800 m (Barney 1999). Preliminary data from the BC FSP Y091160 research project suggests that elevation has a non-linear relationship with fruit production, and highest fruit production is predicted at 1500-1550 m (Keefer, unpublished data 2010).

Climatic relations: Provincially, black huckleberry abundance increases with elevation and continentality (Klinka et al. 1989). On a more local scale, huckleberry cover increases with increasing moisture allowing it to thrive at relatively low elevations (400 m) within the Interior Cedar Hemlock biogeoclimatic zone (M. Keefer, unpublished data, 2009) and in the Bulkley Valley of northwestern B.C. (Trusler 2002). In drier regions, such as the East Kootenay region of B.C., black huckleberry is commonly found from elevations of 1300 m and above.

Site and soil conditions: Huckleberry is known to tolerate a wide range in pH, favouring acidic forest soils with more humus (Haeussler et al. 1990). A pH of 5.5 is ideal for black huckleberry in terms of abundance indices (Minore and Dubrasich 1978; Nelson 1975). Analyses of mineral soil pH yielded an average of 5.3 from sites with a high abundance of the plant (Tm*i*x^{w} Research and Nicola Tribal Association 2002).

Soils are typically Humo-Ferric Podzols, Dystric Brunisols and Grey Luvisols on morainal, colluvial or fluvial parent materials (Haeussler et al. 1990). Sandy-loam soils have been found to be ideal for the growth of black huckleberry and many of the most productive sites have this soil type (Barney 1999). Greater berry production is associated with soil high in organic matter content (Stark and Baker 1992, cited in Simonin 2000).

Huckleberry has been found to perform poorly on soils with high clay content. It is believed that these soils make rhizome growth difficult (D. Barney, pers. comm., 2007). Old burns prove to be very important habitat for huckleberries; many of these sites have or are reverting to low value subalpine forests (Minore 1975). Huckleberries are known to be associated with ericoid mycorrhizae; this association assists the plants in absorbing nitrogen (Trusler 2002).

Plant Associations: Little plant association research has been done for this species, but Klinka et al. (1989) noted that black huckleberry has wide ecological amplitude and occurs in association with diverse plant communities. The following table of plant associates is derived from Simonin (2000), based on a review of the literature for the species:

Table 2: Black huckleberry plant associations (Simonin 2000).Trees	**Shrubs**	**Forbs**
Engelmann Spruce (*Picea engelmannii*)	Sticky Flowering Currant (*Ribes viscosissimum*)	Common beargrass (*Xerophyllum tenax*)
Western Larch (*Larix occidentalis*)	Mountain Snowberry (*Symphoricarpos oreophilus*)	Brewer's Aster (*Chrysopsis breweri*)
Limber Pine (*Pinus flexilus*)	Common Snowberry (*Symphoricarpos albus*)	Pinewoods Lousewort (*Pedicularis semibarbata*)
Ponderosa Pine (*Pinus ponderosa*)	Grouse Whortleberry (*Vaccinium scoparium*)	Fireweed (*Epilobium angustifolium*)
Western White Pine (*P. monticola*)	Cascade Bilberry (*V. deliciosum*)	Sitka Valerian (*Valeriana sitchensis*)
Western Hemlock (*Tsuga heterophylla*)	Red Huckleberry (V*accinium parvifolium*)	Queencup beadlily (*Clintonia uniflora*)
Mountain Hemlock (*T. mertensiana*)	Utah Honeysuckle (*Lonicera utahensis*)	Twinflower (*Linnaea borealis*)
Pacific Silver Fir (*Abies amabilis*)	Bearberry (*Arctostaphylos uva-ursi*)	Lupine (*Lupinus* spp.)
Subalpine Fir (*A. lasiocarpa*)	False Azalea (*Menziesia ferruginea*)	Pacific Trillium (*Trillium ovatum*)
Grand Fir (*A. grandis*)	White Spirea (*Spirea betulifolia*)	Threeleaf Foamflower (*Tiarella trifoliata*)
Douglas-fir (*Pseudotsuga menziesii*)	Whiteveined Wintergreen (*Pyrola picta*)	
Western Redcedar (*Thuja plicata*)	Pink Mountainheath (*Phyllodoce empetriformis*)	
Pacific Dogwood (*Cornus nuttallii*)	White-Flowered Rhododendron (*Rhododendron albiflorum*)	

Lodge Pole Pine (*Pinus contorta*)	Sitka Mountain-Ash (*Sorbus sitchensis*) Western Moss-Heather (*Cassiope mertensiana*) Five-Leaved Bramble (*Rubus pedatus*) Menzie's Pipsissewa (*Chimaphila menziesii*) Douglas Maple (*Acer glabrum*)

Nutrient Relations: Black huckleberry occurs on poor to rich soils (Haeussler et al. 1990); the average or modal nutrient regime recorded from BEC data is medium (Klinkenberg 2007; Tmix[w] Research and Nicola Tribal Association 2002). Huckleberries are indicators of nitrogen-poor sites. Research has found that the black huckleberry responds well to applications of ammonium nitrate fertilizers (D. Barney, pers. comm., 2007).

Water Relations: Across BEC plot data, soil moisture regime (SMR) ranges from 0 (very xeric) to 8 (hydric), with an average of 3.8 (mesic)(Klinkenberg 2007). Although it occurs across a wide range of moisture conditions, huckleberry is most frequently found on mesic sites (Klinka et al. 1989; Minore et al. 1979). Sites that do not experience summer drought conditions are more likely to be productive for berries as summer drought is believed to trigger the loss of the berry crop (Minore et al. 1979; Trusler 2002). Soil moisture availability will affect quality and quantity of berry production within a growing season (Stark and Baker 1992, cited in Simonin 2000). Huckleberries grow poorly on poorly drained soils (Barney 1999).

Light Relations: Burton et al. (1998) found that huckleberry fruit productivity declines sharply at light levels below 60% full sun, and that they are most productive from 75% to 90% full sun[10]. However, moisture can also be limiting to berry production in full sun conditions on some sites which would affect quantity and quality (Barney 1999; Burton et al. 1998). Martin (1980) reported tree canopy cover over 30% full sun tends to severely reduce berry productivity. Shade trials at the University of Idaho have found that 60-80% full sun is optimal (Barney 2007). Burton et al. (1998) also found that huckleberry stems grow profusely in full light but that these plants are not productive from the perspective of fruit production. Though linked to berry productivity, canopy cover has not been significantly linked to berry sweetness (Minore and Smart 1975).

Positive responses to increased light through partial cutting may be related to moisture availability. A partial canopy cover might provide the optimum conditions that balance protection from frost and drought with sun exposure necessary for fruit production. On dry south aspects, partial cutting might cause excessive desiccation of plants and berries as it increases exposure to wind, sun and frost (Simonin 2000). In Montana berry production has been reported to be highest on northwest aspects (Martin 1979, cited in Simonin 2000).

[10] These values are approximate to full solar input which was reported in some of the literature. For the purposes of facilitating easy understanding we have reported in percent of full sun.

While black huckleberry may be present as an understory species under dense forest canopies, it is most vigorous with highest berry production in partial shade conditions (Minore et al. 1979). Plants may flourish in openings, but berry production might be impeded by drought conditions experienced under full sun exposure. Cooler aspects have been found to produce more berries on a more consistent basis (Martin 1980).

Temperature Relations: The species is fairly tolerant of cold temperatures, as indicated by its growth at higher elevations and in areas experiencing deep snow packs. Early and late frosts can be damaging to plants (Haeussler et al. 1990) but overstory trees and snow may provide protection from damaging frosts (Minore 1972). Frost is also a major factor in berry production as late frosts have been found to destroy berry productivity (Minore and Smart 1978). Early cold snaps prior to snowfall have been implicated in poor crops the following year (Nelson 1975).

The response of seedlings and mature plants to frost is dependent on phenological differences (Minore and Smart 1978), suggesting that in some areas frost is not as important in reducing berry production. These interplant differences may be related to some plants initiating growth later in spring when frost danger is reduced.

In southern British Columbia productive huckleberry sites are most frequently found on the cooler aspects (Hamilton et al. 2006), whereas in the Bulkley Valley of northwestern B.C. south aspects are more productive (Trusler 2002).

4.5.6 Response to Disturbance

Black huckleberry has extensive rhizomes (Miller 1977). Disturbances that do not damage these rhizomes can be expected to stimulate regeneration of the species.

Response to grazing/browsing: The leaves and young shoots of black huckleberry make excellent browse for wild ungulates such as elk, deer, and moose (Edge et al. 1988; Simonin 2000). Larger mammals such as grizzly bears depend on huckleberries almost exclusively during certain times of the year ingesting up to 70,000 berries per day (Hamer et al. 1991; Servheen 1983; Welch et al. 1997). In one study, huckleberry fruit production was found to be undamaged from overgrazing by sheep (Minore et al. 1979), however smaller mammals, birds and insects may cause considerable berry loss and plant damage. Small mammals such as mice, voles and rabbits chew on the bark impeding the plant's ability to transport water and nutrients (Trehane 2004). Berry production loss from animals browsing on the plants is likely more significant than damage from insect pests and diseases. Birds, such as ruffed grouse, eat the berries while insects, such as leaf-cutter bees, damage leaves and berries (Simonin 2000; Stark and Baker 1992).

Canopy Removal: Disturbances of tree canopies are believed to result in an increase in huckleberry plants and fruit production. However, on south and west aspects in warm sites, canopy removal may decrease the density of black huckleberry due to subsequent moisture stress (Martin 1979, cited in Simonin 2000). In the Moyie River region of eastern B.C., forest strip cutting to maintain mountain caribou habitat has produced good huckleberry crops in drought years, likely from maintaining some level of shade and moisture levels (M. Keefer, unpublished data, 1997-2008). Management recommendations include minimising disturbance to the forest floor by logging on a winter snowpack and avoiding mechanical site preparation (Burton et al. 1998).

Although berry-producing shrubs occur in cut-blocks, in many areas studied these generally received less use by bears than other habitat types (Servheen 1983; Zager et al. 1983; Simpson et al. 1985; McLellan 1989). It would appear that cut-blocks do not support the habitat attributes for bears that other habitat types, such as burns and timbered sites, support (McLellan 1989; Nielsen et al. 2004). In Hinton, Alberta, *V. ceaspitosum*, *V. membranaceum*, and *V. vitis-idaea* were all more likely to occur in upland forests, suggesting that clearcut harvesting was negatively impacting their occurrence (Nielsen et al. 2004). Furthermore, total fruit production for *Vaccinium* species was estimated at 15.1 and 27.6 kg/ha for clearcut and upland forest stands, respectively (Nielsen et al. 2004). Previous work has shown negative affects from mechanical scarification of ericaceous shrubs, suggesting that the destruction of rhizomes was to blame (Zager et al. 1983; Haeussler et al. 1990; Roberts and Zhu 2002). Several authors have suggested that berry producing shrubs can be encouraged by using certain silvicultural practices (Mealey et al. 1977; Conteras and Evans 1985; LeFranc et al. 1987) but it is not clear what combination of extraction methods or silvicultural prescription promotes the growth of berry producing species at a particular site.

Wildfire: With wildfire events one can expect highly variable regeneration of huckleberry depending on fire intensity and duration, site moisture, and a host of other variables. In the pre-fire suppression era, it is assumed that many of the fires burnt cooler creating consistently better berry regeneration. Major fires such as those observed in Southern British Columbia through the summer of 2003 had intense fire behaviour (Filmon 2004). Such fires may be expected to produce a less vigorous regeneration response from the huckleberries due to rhizome death. The rhizomes of *Vaccinium* have been found in one study to die at soil temperatures of over 55^{o}C; another study in the sub-boreal spruce biogeoclimatic zone found these temperatures occurred only in the first few centimetres of the soil horizon (Trusler 2002). Cool fires that do not consume organic horizons are believed to stimulate the production of large and abundant berries (Gottesfeld and Johnson 1994). In 2003, the Lamb Creek fire in the East Kootenay region of B.C. burnt just under 11,000 ha. Fieldwork in 2008 revealed widespread regeneration of huckleberry plants in the Lamb fire area, but low berry production, confirming reports in the literature that berry production may take over a decade to reach productive levels (M. Keefer, unpublished data, 2008).

Natural-burn habitats were strongly selected by bears during the summer and fall seasons in McLellan's (1989) work, and Mealey et al. (1977) demonstrated that burns have high food values for wildlife. Burns in both these study areas were important huckleberry producing habitats. To date, however, site level characteristics that define high quality burns are poorly understood. McLellan (1989), however, reported that bears preferred burns with medium canopy closure over open burns. It has been suggested that burned habitats may become more useful as they age because this gives the newly regenerated huckleberry plants time to grow and mature into berry producing shrubs (Hauessler and Coates 1986). Martin (1979) has shown that berry production, however, declines dramatically at > 30% canopy closure. As such, late seral burns with dense canopy closure result in a decline in berry production and reduce habitat quality for bears (Mowat and Ramcharita 1999).

Fire suppression is believed to be causing a decline in the huckleberry resource (Minore and Dubrasich 1978).

Prescribed Burning: Perhaps the best-known and longest standing technique for enhancement of huckleberry productivity is fire (Richards and Alexander 2006; Trehane 2004; Turner 1991). The enhancement of huckleberry with fire by many First Nations has been documented (Deur and Turner 2005; Trehane 2004; Trusler 2002; Turner et al. 1990; Turner 1991). These burns were executed with considerable expertise in a manner that minimised the chances of wildfire or overly hot fires (Gottesfeld and Johnson 1994). These practices were quenched due to the fire suppression program but there is now strong interest in the rekindling of these practices (Gottesfeld and Johnson 1994).

Prescribed fire has been found to have varying results in enhancing huckleberry patches, and has been used for thousands of years (Gottesfeld and Johnson 1994; Miller 1977; Minore et al. 1979; Trusler 2002; Turner 1991). Evidently the Gitxsan and Wet'suwe'en were highly effective in managing for productive berry resources; an exerpt from the Delgamuukw court case found in Trussler (2002) concerning the frequency of when to burn reads:

"Q: How often would you burn one part of the valley up the river? How much of a period of time before you would go and burn the other side?
A; They go by the crop of the berry patch. If you don't see your footprints amongst the berries. " (page 55).

When planning fires, the ideal goal is a fire which only kills above ground portions of the plants (Miller 1977). Therefore, fire treatments to increase the density of black huckleberry should be done during relatively moist conditions to avoid excessive heat transfer to the soil (Minore et al. 1979; Tirmenstein 1990b). Burns are likely best conducted in the spring when lower duff and soil are still moist. Fall burns are likely to be hotter with resulting damage to rhizomes and a reduction in plant density. However, sites with low fuel loading may respond very positively to fall burns as such fires will mostly prune top growth (Miller 1977). When planning a prescribed burn it is germane to measure both the fuels and the fuel moisture in order to estimate fire intensity and, with the high cost of prescribed burns, it is prudent to locate the most productive berry areas for treatment (Minore and Dubrasich 1978).

Logged sites that have been burnt have been found to be far more productive for huckleberries than unburnt sites (Martin 1980). Another important factor for the planning of huckleberry enhancement fires is the pre-burn plant density. Areas of high plant density are likely to become productive berry grounds first (Miller 1977).

A key benefit of burning huckleberry sites is that two of the key competing shrubs, false azalea (*Menzesia ferruginea*) and white mountain rhododendron (*Rhododendron albiflorum*) are more sensitive to fire, effectively giving huckleberry the advantage in these recovering communities (Hamilton and Peterson 2003).

Prescribed burning trials in Montana resulted in variable responses by the huckleberry in the short-term (less than 10 years) (Miller 1977). After spring burns, the number of huckleberry stems was always greater than pre-burn; fall burn results were far more variable. Analysis of fire behaviour of spring fires shows that these fires primarily consume fine fuels leaving the coarse woody debris. This research found that the depth of heat penetration was a key variable in plant responses with hotter fires causing patchy death of rhizomes. Fires that do not consume the larger wood may also be seen as more desirable because many characterised productive huckleberry sites have a high content of rotten wood in the soils (D. Barney, pers. comm., 2007). It is likely that huckleberry sites managed by aboriginals had low coarse woody debris levels due to the frequent re-burning of these sites (Trusler 2002).

In Montana, research has found that huckleberry rhizomes are highly effective in capturing the post fire nutrient flux that may otherwise be lost to the system (Stark 1977). The plant's association with ericoid mycorrhiza (Read 1996) may explain its ability to capture this surge of nutrition, especially nitrogen.

Given the uncertainty of the results of fire, especially in the short-term, it is recommended that in the planning stage, a mosaic of burns be created. Trusler (2002) indicates that the Gitxsan and

Wet'suwet'en likely practiced rotational burning which created a mosaic of huckleberry stand ages even within one berry patch. It is recommended that this type of mosaic be considered at different spatial scales with the goal of creating or enhancing a variety of huckleberry stand ages.

Cutting: One study found no difference in plant regeneration to seasonality suggesting that the plant growth stage at disturbance has little relation to shoot regeneration (Miller 1978). Given the results of the browsing study reported in Minore et al. (1979) it is likely resistant to cutting.

Herbicide: Herbicides are believed to have limited effects on black huckleberry (Beaudry et al. 2001; Haeussler and Coates 1986; Miller 1981; Tirmenstein 1990b). Other competing plants such as alder are more sensitive to herbicides possibly giving a competitive advantage to huckleberry following herbicide applications. Minore (1984) suggests that the most effective means for enhancing huckleberries in the Pacific silver fir zone in Oregon is by killing overstory trees by "hack and squirt" with 2,4D. Given the cultural sensitivity towards herbicide use this practice is not recommended.

Soil Disturbance: Soil disturbances that damage the rhizomes may result in poor regeneration of black huckleberry. In Montana, site scarification has been found to destroy rhizomes and thus lower production (Martin 1980). Hence, the practices of disc trenching, soil mounding and other silvicultural techniques should be discouraged in areas with black huckleberry and other closely related *Vaccinium* species.

Predation, Pests & Fungal Disease: It is reasonable to assume that many of the diseases which affect closely related cultivars could also affect wild huckleberry plants, particularly if grown under intense cultivation. Some of the more common pests and diseases are described below (Finn and Young 2002; Glawe 2006; Oregon State University 2007; Stark and Baker 1992; Trehane 2004).

Mummy Berry (*Monilinia corymbosae*)

Mummy Berry causes berries to harden and dry into a white, crinkled sphere; flowers, stems and foliage may also die. This fungus over-winters on diseased berries and foliage mainly on the soil surface. Spores are spread mainly by insect vectors. Insects are attracted to the sporulating structures which become ultraviolet reflective, fragrant, and secrete sugars all of which mimic real flowers. Spores can also be spread locally by water droplets and wind.

Control measures include burying mummified berries in the fall, cultivating soil in spring to disrupt fungal growth, weed control, cleaning up dropped leaves, berries, stems, or cull piles.

Huckleberry Witches' Broom Rust (*Pucciniastrum goepertianum, P. vaccinii*)

Huckleberry Witches' Broom Rust causes stems to become excessively thickened and turn reddish-brown. It may inhibit leaf development.

Incidence of this fungal disease is seen following cool, wet spring conditions.

Control measures include removing the alternate hosts of this disease which include true firs (*Abies* spp.) for *P. goepertianum*; and hemlock (*Tsuga* spp.) and false azalea (*Menziesia* spp.) for *P. vaccinii*.

Botrytis blight (*Botrytis cinerea*)

Blossoms, foliage, and wood may be covered with dense masses of grey powdery *Botrytis* spores. Blossoms turn brown and look 'watersoaked' in appearance.

Disease spreads under wet conditions and high humidity. It over-winters on infected plant tissue and is saprophytic on organic matter on soil surface.

Control by pruning out and destroying infected plant parts, avoiding late season fertilization, and reducing humidity. This is accomplished through effective pruning, reducing/monitoring watering frequency, and controlling weeds.

Powdery Mildew (*Microsphaera pencillata var. vacinii*)

Spreads under humid, wet conditions giving leaves a whitish, dusty appearance. Spore germination does not depend on water but on high humidity.
Cool, wet spring weather favours spread of this disease.
Leaf-roller (Family: Tortricidae)
These insects roll leaves for shelter against the environment while feeding on leaves, buds, and developing berries. They are generalist feeders with a wide number of host plants.
Blueberry aphid (*Illinoia pepperi*)
Yellowish green to dark green in colour, they secrete honeydew, deform leaves, and devitalize plants. Aphids can also be vectors for viral diseases.
Excess nitrogen fertilization can be a factor in causing aphid populations to rise.
Chemical and biological controls can be used. In natural systems predators should be expected to remain sufficiently high and will prevent aphid populations from reaching critical numbers.
In addition to these pests and diseases, cultivated huckleberries can be subject to the following insects: blueberry bud mites (*Aceria vaccinii*), blueberry maggot (*Rhagoletis mendax*), blueberry stem borers (*Oberia spp.*), cherry fruitworm (*Grapholita packardi*), cranberry fruitworm (*Mineola vaccinii),* weevils (Curculionoidea), scale insects, sharp-nosed leafhoppers (*Scaphytopius magdalensis*).
Fungal, bacterial, and viral diseases which also affect huckleberry are: Twig blight (*Phomopsis vaccinii*), Stem blight (*Botryosphaeria dothidea*), Phytophthera root rot (*Phytophthora cinnamomi*), fruit rots (i.e. Anthracnose {*Glomerella cingulata*}), red ringspot virus, blueberry shoestring disease, and Stunt disease.

4.5.7 Human Uses

Nutritional

Huckleberries are especially known for high levels of anthocyanins, a type of flavanoid, which are responsible for its red, blue, and purple colours. Anthocyanins are believed to be responsible for many health benefits associated with *Vaccinium* species including reducing risk of cancer, cardiovascular disease, diabetes and inflammation (Hou 2003; Reen et al. 2007; Seeram et al. 2006; Torri et al. 2007). In addition, the chemical resveratrol as well as anthocyanins present in huckleberries have showed promising results in anti-aging (Rimando et al. 2004).

Antioxidant activity can vary depending on plant part, species, variety, and environmental conditions (Lee et al. 2004; McCune and Johns 2007). *Vaccinium* leaves have higher antioxidant activity than the fruit (Harris et al. 2007). A range of antioxidant activity has been measured in wild huckleberry and wild blueberry species, and they contain higher activity than cultivated varieties (Kalt et al. 2008; Moyer et al. 2001; Wang and Jiao 2000).

Cultural

Black huckleberries are one of the most prized berries of many First Nations throughout its range and especially in the Northwest inland areas where it is more abundant (University of Michigan-Dearborn 2008). As well as an important food, the Flathead Confederacy use huckleberry stems and roots in an infusion for rheumatism, arthritis, and heart troubles (University of Michigan-Dearborn 2008). This superior knowledge of huckleberry is now beginning to be understood by western science and is affirming First Nations medicinal uses.

In the past, the fruits were processed by drying, rolled into fruit leather, in animal grease, and by canning; now the fruits are primarily processed by freezing and manufacturing into preserves. Archaeological evidence of huckleberry drying has been found in the Cascade Mountains of British Columbia and Washington (Franck 2000).

First Nations have been involved in both active and passive management of the huckleberry for generations (Burton and McCulloch 2000; Trusler 2002; Turner 1977, 1991; Williams et al. 2002). However, in more recent years a lack of active land management for huckleberry has been of significant concern. The records of the Lower Nicola Band contain an account of a 1943 band council meeting in which Nlaka'pamux elder, Shulee Kilroy described her concerns about the decline of huckleberries in the absence of Nlaka'pamux management (D. Moses, pers. comm., 2008).

Agricultural

For horticultural uses, commercial cultivars for black huckleberry are being tested in Idaho and British Columbia (Danny Barney, pers. comm., 2010). Wild huckleberries, like related domestic cultivars, provide excellent aesthetic appeal and food and wildlife values. Huckleberry species have particularly striking fall colour and their berries have excellent flavour. Flowers attract a variety of wildlife including bumblebees and a variety of birds including hummingbirds (Link 1999).

Restoration

The foliage of huckleberry has low flammability (Simonin 2000). Black huckleberry is only consumed by fire once it is heated and dried from the burning of surrounding fuels (Miller 1977). The fact that huckleberry does not promote or carry fires makes it a species of interest to enhance fire breaks within appropriate ecosystems.

Commercial

Black huckleberry has high value as a Non-timber Forest Product (NTFP) species as its fruit is widely considered to be among the best tasting of the native blueberries in western North America (Trehane 2004). Its use as an NTFP is documented back to the fur trade era (Trusler 2002). The delectable fruit has been commercially harvested since the time of European contact and undoubtedly it had a high value in the pre-contact economy as well (Richards and Alexander 2006). The industry is perhaps best developed in Montana where a wide range of huckleberry products are for sale in stores, ranging from fruit spreads, soap, dried berries, and beer with huckleberry essences (Richards and Alexander 2006). In areas where the plant has a taller growth form it is occasionally harvested as a floral green in its dormant season (B. Shore, pers. comm., 2007).

The commercial value of the fruit is often perceived as being in conflict with its value to First Nations, wildlife and recreational harvesters (Gayton 2000; Richards 1998). In the Coquihalla Pass area there are many reports of agricultural labourers from the Fraser Valley harvesting huckleberries. These workers are reported to harvest using rakes, which leave little fruit for First Nations harvesters or key forage for wildlife (Keefer, unpublished data, 2008). In Washington State there is NTFP legislation in development that will ban the harvest of huckleberries with rakes or other implements. In British Columbia there is currently no legislation concerning wild berry harvesting on Crown lands, except within protected areas.

4.5.8 Wildlife and livestock uses

Huckleberries are important food sources for birds and small and large mammals. Nearly all parts of the plant are utilized by wildlife.

Palatability to Wildlife and Livestock: Areas dominated by a huckleberry understory often serve as important summer range for ungulates including deer, elk, and moose (Edge et al. 1988; Kingery et al. 1996; Pierce 1984). Herbivores graze on the entire plant. Elk may feed on huckleberry browse during much of the summer, but use is often greatest early in the season (Edge et al. 1988). In some areas, elk also feed on huckleberry twigs during the winter months. Roosevelt elk on the Olympic Peninsula of Washington eat twigs from spring through fall, with use tending to be greatest in early spring (Jenkins and Starkey 1991). Black huckleberry is also known to provide browse for moose in northcentral Idaho (Pierce 1984) and British Columbia (Poole and Stuart-Smith 2005)

Huckleberry fruit, leaves, and blossoms are commonly fed upon by several species of grouse including blue, ruffed, and spruce grouse (Beer 1943; King 1969; Pendergast and Boag 1970).

Other bird species, which are known to feed on huckleberries, include: catbirds, orchard orioles, scarlet tanagers, towhees, gulls, cranes, pigeons, turkeys, and upland game birds (USDA 2008). Small mammals such as foxes, opossums, raccoons, squirrels, pikas, cottontail rabbits, and skunks also eat the huckleberry fruit, twigs, and foliage (USDA 2008).

Importance to Wildlife and Livestock: Though huckleberries are important to a wide variety of wildlife, they are by far the most important to bears. The short digestive tract of bears means they are unable to digest most plant material efficiently (Bunnell and Hamilton 1983; Pritchard and Robbins 1990) and are consequently constrained by both food quantity and quality. They are forced to seek out the most nutritious food resources, such as berries, as they become available over time (Bunnell and Hamilton 1983; Stirling and Derocher 1990). Fruit produced by most huckleberry species are an extremely valuable and high-energy food source for both grizzly bears and black bears from late July through September (Davis and Butterfield 1991; Welch et al. 1997). Black huckleberry is a critical food item for both species of bears in Montana (Noble 1985) and southeastern British Columbia (McLellan and Hovey 1995), and an important shrub species in Yellowstone National Park (Knight and Blanchard 1983).

Berries play an important role in the accumulation of fat and the overall nutritional status of grizzly bears and black bears (Stirling and Derocher 1990). Captive bears fed berries during autumn showed impressive daily intake rate of about 35% of their own body mass (Welch et al. 1997). Grizzly bears in the Flathead drainage in southeastern B.C. are known to gain over a kilogram per day eating berries prior to hibernating (B. McLellan, pers. comm., 2006). Black bears in Alberta gained weight when blueberry (*Vaccinium myrtilloides*) density averaged 423 berries/m^2, but lost body mass when the annual berry density averaged 66 berries/m^2 (Pelchat and Ruff 1986).

Bears will alter their geographic and elevation distribution annually to exploit huckleberry crops more effectively (Rogers 1976). Huckleberry crop failures have been known to increase the likelihood of bear-human encounters as hungry bears come into contact with recreationists or wildland residents (Schorger 1946; Hatler 1967). Depredations, such as damage to crops and beehives and livestock losses, typically increase during poor huckleberry years (Rogers 1976).

Bears that consume berries to build up their energy reserves are constrained by intake rates, therefore locating large patches of densely fruited huckleberry is important for optimizing their foraging efficiency (Welch et al. 1997). Shrub dominated sites are often excellent berry producing areas and tend to be important late summer and fall habitats for most grizzly bear populations (Mowat and Ramcharita 1999). As a result, managing berry producing habitats is an essential component of grizzly bear habitat management (Mowat and Ramcharita 1999).

LITERATURE CITED

Adhikari, D.P., J.A. Francis, R.E. Schutzki, A. Chandra, and M.G. Nair. 2005. Quantification and characterisation of cyclooxygenase and lipid peroxidation inhibitory anthocyanins in fruits of Amelanchier. Phytochem. Anal. 16(3):175-180.

Alaback, P. B. and F.R. Herman. 1988. Long-term response of understory vegetation to stand density in Picea-Tsuga forests. Can. J. For. Res. 18(12):1522-1530.

Anderson, J. R. 1925. Trees and shrubs: food, medicinal, and poisonous plants of British Columbia. Charles F. Banfield, Printer to the King's Most Excellent Majesty, Victoria, B.C.

Anderson, M. K. 2005. Tending the wild: Native American knowledge and the management of California's natural resources. UC Berkley. Berkley, CA.

Ayer, W. A. and L. M. Browne. 1970. Alkaloids of Shepherdia argentea and Shepherdia canadensis. Can. J. Chem. 48:1980-1984.

Barbour, J. and K.A. Brinkman. Date unknown. Betulaceae – birch family Corylus L. hazel. Woody Plant Seed Manual. pp 434-436. U.S. Dep. Agric. For. Serv. http://nsl.fs.fed.us/wpsm/Genera.htm#c (Accessed Mar. 29, 2009)

Barney, D. L. 1999. Growing western huckleberries: University of Idaho.

___________2007. Huckleberries and bilberries: management strategies for western foresters. Paper presented at the Big Huckleberry Summit, June 21, 2007. Eatonville, WA.

Barney, D. C., M. Robbins, and J.M. Wiese. 1999. Growing raspberries and blackberries in the Inland Northwest and Intermountain West. Univ. ID, Coop. Exten. Syst. Boise ID.

Batzli, J.M., J.F. Zimpfer, V. Huguet, C.A. Smyth, M. Fernandez, and J.O. Dawson. 2004. Distribution and abundance of infective, soilborne Frankia and host symbionts Shepherdia, Alnus, and Myrica in a sand dune ecosystem. Can. J. Bot. 82:700-709.

Beaudry, L., M. Martin, and J. Paczkowski. 2001. Using silviculture to maintain and enhance grizzly bear habitat in six variants of the Prince George Forest Region. For B.C. Min. Env. Lands and Parks. P. Beaudry and Associates Ltd., Prince George, B.C.

Beer, J. 1943. Food habits of the blue grouse. J. Wildlife Manag. 7(1):32-44.

Bekker, N. P. and A.I. Glushenkova. 2001. Components of certain species of the Elaeagnaceae family. Chem. Nat. Comp. 37:97-116.

Belovsky, G.E. 1984. Summer diet optimization by beaver. Am. Midl. Nat. 111(2):209-222.

Bennett, L. J., P.F. English, and R.L. Watts. 1943. The food habits of the black bear in Pennsylvania. J. Mammal. 24(1):25-31.

Benson, D. R. and J. O. Dawson. 2007. Recent advances in the biogeography and genecology of symbiotic Frankia and its host plants. Physiol. Plantarum 130: 318-330.

Benvenuti, S., F. Pellati, M. Melegari, and D. Bertelli. 2004. Polyphenols, anthocyanins, ascorbic acid, and radical scavenging activity of Rubus, Ribes, and Aronia. J. Food Sci. 69:FCT164-FCT169.

Boateng, J. O. 2002. Herbicide Field Handbook. Min. For., Victoria, B.C.

Boberko, E. Z. S., L. V. Anikhimovskaya, and T.I. Narizhnaya. 1978. Shepherdia argentea (Pursh.) Nutt. as a promising vitamin source and decorative plant. Vesti Akad. Navuk BSSR, Ser. Biyal. Navuk 4:89-91.

Boyd, R. (editor). 1999. Indians, fire and the land in the Pacific Northwest. Oreg. State Univ. Press, Corvalis, OR. 313 p.

Brayshaw, T. C. 1996. Trees and Shrubs of British Columbia. UBC Press. Vancouver, B.C.

Brenner, D.M. 1986. Variation in wild hazelnuts (Corylus cornuta Marsh.) of the northwest United States. Thesis. Univ. OR., Eugene, OR. 105 p.

Brinkman, K.A. 1974. Rubus L. blackberry, raspberry. In Seeds of woody plants in the United States. C.S. Schopmeyer (editor). U.S. Dep. Agri. For. Serv. Agric. Handbook No. 450. Wash., DC.738-743.

British Columbia Nursery and Landscape Association. 2009. Buyer's Guide and Directory; Complete listings of British Columbia's nursery and landscape products and services. http://www.bclna.com.

Brooke, B.M., R.E. McDiarmid, and W. Majak. 1988. The cyanide potential in two varieties of Amelanchier alnifolia. Can. J. Plant Sci. 68:543-547.

Bunnell, F. L. and N. Hamilton. 1983. Forage digestibility and fitness in grizzly bears. Int. Conf. Bear Res. and Manag. 5:179-185.

Burton, P. C. and L. McCulloch. 2000. Exploring options for the management of wild berries in the Kispiox Forest District: Phase one of a pilot project focusing on the Suskwa River Area. B.C. Min. For. Rep., Hazelton, B.C.

Burton, P. J., C. Burton, R. Collier, M. Goertzen, D. Goertzen, A.G. Mattes, G. Newman, T. Newman, S. Reed, D. Vech, and M. Woodcock. 1998. Inferring the response of berry-producing shrubs to different light environments in the ICHmc (No. SCBC Project Number FR-96/97-118. FRBC Project Number SB96030-RE). Symbios Res. Restor., Smithers, B.C.

Burton, P.J. 1998. Inferring the response of berry-producing shrubs to different light environments in the ICHmc. Final Report on FRBC Project SB96030-RE, prepared for the Sci. Coun. of B.C. Symbios Res. Restor., Smithers, B.C.

Campbell, E.G. and R.L. Johnson. 1983. Food habits of mountain goats, mule deer, and cattle on Chopaka Mountain, Washington, 1977-1980. J. Range Manag. 36(4): 488-491.

Carey, A. B. 1995. Sciurids in Pacific Northwest managed and old-growth forests. Ecol. Appl. 5(3):648-661.

Carey, A. B. and M. L. Johnson. 1995. Small mammals in managed, naturally young and old-growth forests. Ecol. Appl. 5(2):336-352.

Centre for Non-Timber Resources (CNTR). 2006. Critical information for policy development and management of non-timber forest products in British Columbia: baseline studies on economic value and compatible management. B.C. For.Sci. Prog. and Royal Roads Univ., Victoria, B.C.

Chen, T., H. Hwang, M.E. Rose, R.G. Nines, and G.D. Stoner. 2006. Chemopreventive properties of black raspberries in N-nitrosomethylbenzylamine-induced rat esophageal tumorigenesis: down-regulation of cyclooxygenase-2, inducible nitric oxide synthase, and c-jun. Cancer Res. 66(5):2853-2859.

Clason, A.J., P.M.F. Lindgren, and T.P. Sullivan. 2008. Comparison of potential non-timber forest products in intensively managed young stands and natural/old-growth forests in south-central British Columbia. For. Ecol. Manag. 156:1897-1909.

Cocksedge, W. 2009. Understanding the spatial and quality attributes of culturally important non-timber forest product species in mountain pine beetle affected areas of the Cariboo-Chilcotin. Final Report FSP 3318, Victoria, BC.

Cocksedge, W., B.D. Titus, and D. Mitchell. 2010. Benefits of and barriers to compatible management for timber and non-timber values in British Columbia: Results of a survey. BC Journal of Ecosystems and Management 11(1&2):9–26.

Conteras, G.P. and K. E. Evans. 1985. Proceedings-grizzly bear habitat symposium. Ogden, Ut.: Intermountain Res. Stn.

Core, E.L. 1974. Brambles. In Shrubs and vines for Northeastern wildlife. J.D. Gill and W.M. Healy (compilers). U.S. Dep. Agri. For. Serv., Broomall, Pa., Gen. Tech. Rep. NE-9: 16-19.

Cowan, I.M.T., W.S. Hoar, and J. Hatter. 1950. The effect of forest succession upon the quantity and upon the nutritive values of woody plants used by moose. Can. J. Res. 28(5):249-271.

Davis, D. and B. Butterfield. 1991. The Bitterroot grizzly bear evaluation area: A report to the Bitterroot Technical Review Team. Unpublished report on file with: U.S. Dep. Agri., For. Serv., Rocky Mountain Res. Stn, Fire Sci. Lab., Missoula, MT. 56 p.

DelGiudice, G.D., L.D. Mech, and U.S. Seal. 1991. Browse diversity and physiological status of white tailed deer during winter. In Wildlife and habitats in managed landscapes. J.E. Rodek and E.G. Bolen (editors). Island Press, Wash., DC.77-93.

Deur, D. and N. J. Turner (editors). 2005. Keeping it living: Traditions of plant use and cultivation on the Northwest Coast of North America. Seattle, Vancouver, Toronto. Univ. of Wash Press, UBC Press.

Dietz, D.R. 1972. Nutritive value of shrubs. In Wildland shrubs-their biology and utilization: An international symposium. C.M. McKell, J.P. Blaisdell, J.R. Goodin. (tech. eds.). Proceedings; 1971 July; Logan, UT. Gen. Tech. Rep. INT-1.: U.S. Dep. Agric., For. Serv., Intermountain For. Range Exp.Stn. Ogden, UT. 289-302.

Donkor, N.T. and J.M. Fryxell. 1999. Impact of beaver foraging on structure of lowland boreal forests of Algonquin Provincial Park, Ontario. Forest Ecol. Manag. 118(1/3):83-92.

Douglas, G. W., D. Meidinger, and J. Pojar (editors). 1999a. Illustrated flora of British Columbia. Volume 3: Dicotyledons (Diapensiaceae through Onagraceae). B.C. Min. Environ., Lands and Parks, and Min. For., Victoria, B.C.

___________ (editors). 1999b. Illustrated flora of British Columbia. Volume 4: Dicotyledons (Orobanchaceae through Rubiaceae). B.C. Min. Environ., Lands and Parks, and Min. For., Victoria, B.C.

Douglas, G.W., G.B. Straley, D.V. Meidinger, and J. Pojar (editors). 1998. Illustrated Flora of British Columbia. Volume 2: Dicotyledons (Balsaminaceae through Cuscutaceae). B.C. Min. Environ., Lands and Parks and B.C. Min. Forsts., Victoria, B.C.

Durance, T.D., Z. Vaghri, and C.H. Scaman. 2003. Process for dehydration of berries. US Patent 6312745.

Dyrness, C.T. 1973. Early stages of plant succession following logging and burning in the western cascades of Oregon. Ecology 54(1):57-69.

Edge, W. D., C. L. Marcum, and S. L. Olsen-Edge. 1988. Summer forage and feeding site selection by elk. J. Wildlife Manag. 52(4):5.

Explorer, N. 2007. NatureServe Explorer. In NatureServe. Updated Oct. 6, 2006. http://www.natureserve.org/explorer (Accessed Feb. 26, 2007).

Filmon, G. 2004. Firestorm 2003-provincial review. Province of B. C., Victoria, B.C.

Finn, C. and A. Young. 2002. Variability for reproductive and vegetative traits in Vaccinium membranaceum. Acta Horticulturae (ISHS) 574(27):181-187.

Finn, C., K. Wennstrom, J. Link, and J. Ridout. 2003. Evaluation of Rubus leucodermis populations from the Pacific Northwest. Hortscience 38(6):1169-1172.

Finn, C.E. and R.R. Martin. 1996. Distribution of tobacco streak, tomato ringspot, and raspberry bushy dwarf viruses in Rubus ursinus and R. leucodermis collected from the Pacific Northwest. Plant Dis. 80(7):769-772.

Flessner, T. R., D.C. Darris, and S.M. Lambert. 1992. Seed source evaluation of four native riparian shrubs for stream bank rehabilitation in the Pacific Northwest. In: Proceedings, Symposium on Ecology and Management of Riparian Shrub communities. U.S. Dep. Agric. For. Serv. Gen. Tech.l Rep. INT-289. Franck, I. 2000. An archaeological investigation of the Galene Lakes area in the Skagit range of the North Cascade Mountains, Skagit Valley Park, British Columbia. Simon Fraser Univ, Vancouver, B.C.

Franck, I. 2000. An archaeological investigation of the Galene Lakes area in the Skagit range of the North Cascade Mountains, Skagit Valley Park, British Columbia. Simon Fraser Univ, Vancouver, B.C.

Freedman, J.D. 1983. The historical relationship between fire and plant succession within the Swan Valley white-tailed deer winter range, western Montana. Univ. Mont., Missoula, Mont., 139 p. Dissertation.

Fryer, J. L. 2007. Corylus cornuta. In Fire Effects Information System, U.S. Dep. Agric. For. Serv., Rocky Moun. Res. Stn., Fire Sci. Lab. http://www.fs.fed.us/database/feis/plants/shrub/corcor/all.html (Accessed Mar. 20, 2008).

Gastler, G.F., A.L. Moxon, and W.T. McKean. 1951. Composition of some plants eaten by deer in the Black Hills of South Dakota. J. Wildlife Manag. 15(4):352-357.

Gayton, D. V. 2000. Non-timber forest product workshop: report and recommendations. Creston, B.C.

Glawe, D. A. 2006. Pacific Northwest fungi database (Publication). Department of Plant Pathology, Wash. State Univ., Puyallup, Wash. http://cru23.cahe.wsu.edu/fungi/programs/aboutDatabase.asp (Accessed March 22, 2008)

Glover, F.A. 1948. Winter activities of wild turkey in West Virginia. J. Wildlife Manag. 12(4):416-427.

Gottesfeld, L. and M. Johnson. 1994. Aboriginal burning for vegetation management in Northwest British Columbia. Human Ecol. 22(2):171-188.

Grenfell, W.E. and A.J. Brody. 1983. Black bear habitat use in Tahoe National Forest, California. Int. Conf. Bear Res. and Manag. 6:65-72.

Gullion, G.W. and F.J. Svoboda. 1972. The basic habitat resource for ruffed grouse. U.S. Dep. Agric. For. Serv., North Central For. Exper. Stn, Gen. Tech. Rep. NC-1. Duluth, Minn. In Aspen: Symposium proceedings,St. Paul, MN. 113-119.

Gullion, G.W. and W.H. Marshall. 1968. Survival of ruffed grouse in a boreal forest. Living Bird 7:117-167.

Haeussler, S. and D. Coates. 1986. Autecological characteristics of selected species that compete with conifers in British Columbia: a literature review. FRDA, Econ. RDA, Victoria, B.C.

Haeussler, S. and R. Kabzems. 2005. Aspen plant community response to organic matter removal and soil compaction. Can. J. For. Res. 35:2030-2044.

Haeussler, S., D. Coates, and J. Mather. 1990. Autecology of common plants in British Columbia: A literature review. FRDA Report 158Canada-British Columbia Economic & Regional Development Agreement, For. Can. and B.C. Min. For., Victoria, B.C. 272 p.

Haeussler, S., L. Bedford, A. Leduc, Y. Bergeron, and J.M. Kranabetter. 2002. Silvicultural disturbance severity and plant communities of the southern Canadian boreal forest. Silva Fen. 36(1):307–327.

Halpern, C. B. and T.A. Spies. 1995. Plant species diversity in natural and managed forests of the Pacific Northwest. Ecol. Appl. 5(4):913-934.

Hamer, D. 1996. Buffaloberry [Shepherdia canadensis (L.) Nutt.] fruit production in fire-successional bear feeding sites. J. Range Manag. 49:520–529.

Hamer, D. and S. Herrero. 1987. Grizzly bear food and habitat in the front ranges of Banff National Park, Alberta. Int. Conf. Bear Res. Manag. 7:199–213.

Hamer, D., S. Herrero, and K. Brady. 1991. Food and habitat used by grizzly bears, Ursus arctos, along the continental divide in Waterton Lakes National Park, Alberta. Can. Field-Nat. Ottawa ON. 105(3):25-329.

Hamilton, A. C., P. Hamilton, World Wildlife Fund, UNESCO and Royal Botanic Gardens Kew. 2006. Plant conservation: an ecosystem approach. People and plants conservation series. Earthscan. London, UK; Sterling, VA. 324 p.

Hamilton, E. and L. Peterson. 2003. Response of vegetation to burning in a subalpine forest cutblock in Central British Columbia: Otter Creek Site. Unpublished manuscript.

Harris, C. S., A. J. Burt, A. Saleem, P. Mai Le, L. C. Martineau, P. S. Haddad, S. A. L. Bennett, and J. T. Arnason. 2007. A single HPLC-PAD-APCI/MS method for the quantitative comparison of phenolic compounds found in leaf, stem, root and fruit extracts of Vaccinium angustifolium. Phytochem. Anal. 18(2):161-169.

Hatler, D. F. 1967. Some aspects in the ecology of the black bear (Ursus americanus) in Interior Alaska. MSc Thesis, Univ. of Alaska, College, Fairbanks, AK.

Health Canada. 1995. Native foods and nutrition. Min. Supply and Services Can.. Cat. H34-59/1995E.

Heit, C. E. 1967. Propagation from seed: 11. Storage of deciduous tree and shrub seeds. American Nurseryman 126(10):12B13.

Hemmer, D.M. 1975. Serviceberry: ecology, distribution, and relationships to big game. Thesis. U. Mont. Missoula, MT. 76 p.

Hitchcock, C.L. and A. Cronquist. 1976. Flora of the Pacific Northwest, Univ. of Wash. Press. Seattle, Wash.

Hobson, K.A. and E. Bayne. 2000. Effects of forest fragmentation by agriculture on avian communities in the southern boreal mixed woods of western Canada. Wilson Bull. 112(3):373-387.

Holcroft, A.C. and S. Herrero. 1991. Black bear, Ursus americanus, food habits in southwestern Alberta. Can. Field Nat. 105:335-345.

Hou, D.-X.D.L. 2003. Potential mechanisms of cancer chemoprevention by anthocyanins. Curr. Mole. Med. 3(2):149.

Howard, J.L. 1997. Species: Amelanchier alnifolia F. S. U.S. Department of Agriculture, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Fire effects information system. http://www.fs.fed.us/database/feis/ (Accessed Mar. 12, 2008).

Hu, C., B.H.L. Kwok, and D.D. Kitts. 2005. Saskatoon berries (Amelanchier alnifolia Nutt) scavenge free radicals and inhibit intracellular oxidation. Food Res. Int. 38(8-9):1079-1085.

Huang, H.Y., and L.J. Appel. 2003. Supplementation of diets with alpha-tocopherol reduces serum concentrations of gamma- and delta-tocopherol in humans. J. Nutr. 133(10):3137-40.

Hudson, S. and M. Carlson. 1998. Propagation of Interior British Columbia native plants from seed. B.C. FRBC Research Award: HQ96363-RE. Min. For., Res. Br., Victoria, B.C.

Irwin, L.L. 1975. Deer-moose relationships on a burn in northeastern Minnesota. J. Wildlife Manag. 39(4):653-662.

___________1985. Foods of moose, Alces alces, and white-tailed deer, Odocoileus virginianus, on a burn in boreal forest. Can. Field Nat. 99(2):240-245.

Irwin, L.L. and F.M. Hammond. 1985. Managing black bear habitats for food items in Wyoming. Wildlife Soc. B. 13(4):477-483.

Jenkins, K. J. and E. E. Starkey. 1991. Food habits of Roosevelt elk. Rangelands 13(6):261-265.

Johnson-Gottesfeld, L.M. 1994. Conservation, territory, and traditional beliefs: an analysis of Gitksan and Wet'suwet'an subsistence, Northwest British Columbia, Canada. Human Ecol. 22(4):443-465.

Johnson, L.M. 1999. Aboriginal burning for vegetation management in Northwest British Columbia. In Indians, fire and the land in the Pacific Northwest. Boyd, R. (editor). Oreg. State Univ. Press, Corvallis, OR. 238-254.

Kalt, W., J.E. McDonald, R.D. Ricker, and X. Lu. 1999. Anthocyanin content and profile within and among blueberry species. Can. J. Plant Sci. 79(4):617-623.

Kalt, W., Shawna MacKinnon. J. McDonald, M. Vinqvist, C. Craft, and A. Howell. 2008. Phenolics of Vaccinium berries and other fruit crops. J. Sci. Food Agr. 88(1):66-76.

Kasworm, W.F., H.B. Ihsle, and L.R. Irby. 1984. Diets of ungulates using winter ranges in northcentral Montana. J. Range Manag. 37(1):67-71.

Kaufman P.B., A.K. M. McKenzie, P. Dayanandan, J.E. Hoyt, and C. Li. 2006. The uses of plant natural products by humans and risks associated with their use. In Natural products of plants. L.J. Cseke, A. Kirakosyan, P.B. Kaufman, S.L. Warber, J.A. Duke,H.L. Brielman (editors). CRC Press Online.

Keefer, M. and P. McCoy. 1999. Aqxamis Qapi Qapsin - All living things. Ktunaxa Kinbasket Tribal Council.

Keefer, M. E., T. Ehlers, and N. MacPherson. 2008. Profile of non-timber resources and their use in the Cascade Forest District. Royal Roads University. Victoria, B.C. http://cntr.royalroads.ca/publications (Accessed March 16, 2009).

Keefer, M., B. Wilson, M. McDonough, and P. Miller. 2006. Final report on the monitoring at revegetation sites on the Kootenay 230 kV system transmission line ROW from 2005-2007. Keefer Ecological Services, submitted to FortisBC Inc., Kelowna, ..

Kemp, G.A. and L.B. Keith. 1970. Dynamics and regulation of red squirrel (Tamiasciurus hudsonicus) populations. Ecology 51(5):763-779.

Kerns, B.K., S.J. Alexander, D. Pilz, and L.H. Liegel. 2002. Assessing commercial understory species: quantity, quality, supply and demand. In Congruent management of multiple resources: Proceedings from the Wood Compatibility Initiative Workshop. A.C. Johnson, R.W. Haynes, and R.A. Monserud (editors). 2002.Gen. Tech. Rep. PNW-GTR-563. Portland, Oreg: U.S. Dept. of Agric., For. Serv., Pac. N.W. Res. Stn. No. 20.

King, R.D. 1969. Spring and summer foods of ruffed grouse on Vancouver Island. J. Wildlife Manag. 33(2):440-442.

Kingery, J. L., J. C. Mosley, and K. C. Bordwell. 1996. Dietary overlap among cattle and cervids in Northern Idaho forests. J. Range Manag. 49(1):8-15.

Kitts, D. D. 2006. Antioxidant phytochemicals and potential synergistic activities at reducing risk of cardiovascular disease. In Food-Drug Synergy and Safety. L.U. Thompson and W.E. Ward (editors). CRC Press LLC. 27-62.

Klinka, K., V.J. Krajina, A. Ceska, and A.M. Scagel. 1989. Indicator plants of coastal British Columbia. UBC Press. Vancouver, B.C.

Klinkenberg, B. 2007. E-Flora BC: electronic atlas of the plants of British Columbia. http://www.eflora.bc.ca (Accessed Mar. 29, 2009).

Knight, R.E. 1999. Effects of clearcut logging on buffaloberry (S. canadensis) abundance and bear myrmecophagy in the Flathead River drainage, British Columbia. MSc thesis. U. of Alberta, Edmonton, Alta.

Knight, R. R. and B. M. Blanchard. 1983. Yellowstone grizzly bear investigations: annual report of the Interagency Study Team: 1982. Washington, DC: U.S. Dep. Int., Nat. Park Serv. 45p.

Koksal, A. I., N. Artik, A. Simsek, and N. Gunes. 2006. Nutrient composition of hazelnut (Corylus avellana L.) varieties cultivated in Turkey. Food Chem. 99(3):509-515.

Kraft, T.F.B., M. Dey, R.B. Rogers, D.M. Ribnicky, D.M. Gipp, W.T. Cefalu, I. Raskin, and M.A. Lila. 2008. Phytochemical composition and metabolic performance-enhancing activity of dietary berries traditionally used by native North Americans. J. Agr. Food Chem. 56(3):654-660.

Krefting, L.W. and E.I. Roe. 1949. The role of some birds and mammals in seed germination. Ecol. Monogr. 19(3):269-286.

Kresty, L.A., W.L. Frankel, C.D. Hammond, M.E. Baird, J.M. Mele, G.D. Stoner, and J.J. Fromkes. 2006. Transitioning from preclinical to clinical chemopreventive assessments of lyophilized black raspberries: Interim results show berries modulate markers of oxidative stress in Barrett's Esophagus patients. Nutr. and Cancer 54(1):148-156.

Kris, P., N. Jerzy and G. Grainger. 1990. Micropropagation of four cultivars of Saskatoon berry (Amelanchier alnifolia NUTT.). Plant Cell, Tissue and Organ Culture V21(2):103-109.

Kuepper, G., H. Born, and J. Bachmann. 2003. Horticulture production guide: organic culture of bramble fruits. ATTRA Publication #IP022.

Kuhnlein, H.V. 1985. Wild foods for modern diets. In Nutrition Update. Vol.2. J. Weininger and G. Briggs(eds). 1985. John Wylie and Sons Inc., Toronto, Ont. 153-169.

___________ 1989. Nutrient values in indigenous wild berries used by the Nuxalk people of Bella Coola, British Columbia. J. Food Compos. Anal. 2(1):28-36.

Kuhnlein, H.V. and N.J. Turner. 1991. Traditional plant foods of Canadian indigenous peoples: nutrition, botany, and use. Gordon and Breach, N.Y.

Kwok, B.H.L., C. Hu, T.D. Durance, and D.D. Kitts. 2004. Dehydration techniques affect phytochemical contents and free radical scavenging activities of Saskatoon berries (Amelanchier alnifolia Nutt.). J. Food Sci. 69(3):122-126.

La Roi, G.H. and R.J. Hnatiuk. 1980. The Pinus contorta forests of Banff and Jasper National Parks: a study in comparative synecology and syntaxonomy. Ecol. Monogr. 50:1-29.

Lee, J., C. E. Finn, and R. E. Wrolstad. 2004. Comparison of anthocyanin pigment and other phenolic compounds of Vaccinium membranaceum and Vaccinium ovatum native to the Pacific Northwest of North America. J. Agric. Food Chem. 52(23):7039-7044.

LeFranc, M. N., M. B. Moss, K. A. Patnode, and W. C. Sugg (editors). 1987. Grizzly bear compendium. Interagency Grizzly Bear Committee, Wash., D. C.

Leege, T.A. and W.O. Hickey. 1966. Lochsa elk study. Big game surveys and investigations: W 85-R-17, Job No. 8. July 1, 1965 to June 30, 1966. State of Idaho Fish and Game Dep. Boise, ID. 22 p.

Lewis, G. 1990. Sex ratios, sexual dimorphism and population dynamics in the dioecious shrub Shepherdia canadensis (L.) Nutt. PhD thesis. U. of Calgary. Calgary, AB.

Lin, T.M., T.D. Durance, and C.H. Scaman. 1998. Characterization of vacuum microwave, air and freeze dried carrot slices. Food Res. Int. 31(2):111-117.

Link, R. 1999. Landscaping for wildlife in the Pacific Northwest. UW Press and the WA (State). Dept. of Fish and Wildlife, Seattle.

Lonn, E., J. Bosch, S. Yusuf, P. Sheridan, J. Pogue, J.M. Arnold, C. Ross, A. Arnold, P. Sleight, J. Probstfield, and G.R. Dagenais. 2005. Effects of long-term vitamin E supplementation on cardiovascular events and cancer: a randomized controlled trial. J. Amer. Med. Assn 11:1338-47.

Luna, T. and D. Wick. 2008. Propagation protocol for production of container Shepherdia canadensis Nutt. plants (160 ml containers); USDI NPS - Glacier National Park, West Glacier, Montana. In: Native Plant Network. U. of Idaho, College of Natural Resources, For. Res. Nurs., Moscow, Idaho. http://www.nativeplantnetwork.org (Accessed Mar. 26, 2009)

Luna, T. and D. Wick. 2008. Propagation protocol for production of container Shepherdia canadensis Nutt. plants (160 ml containers); USDI NPS - Glacier National Park, West Glacier, Montana. In: Native Plant Network. U. of Idaho, College of Natural Resources, For. Res. Nurs., Moscow, Idaho. http://www.nativeplantnetwork.org (Accessed Mar. 26, 2009)

MacHutchon, A.G. 1989. Spring and summer food habits of black bears in the Pelly River Valley, Yukon. Northwest Sci. 63(3):116-118.

Magnus, L.T. 1949. Cover type use of the ruffed grouse in relation to forest management on the Cloquet Forest Experimental Station. Flicker 21(2):29-44.

Majak, W. 1992. Metabolism and absorption of toxic glycosides by ruminants. J. Range Manag. 45:67-75.

Major, J. and M. Rejmanek. 1992. Amelanchier alnifolia vegetation in Eastern Idaho, USA and its environmental relationships. Plant Ecol. 98(2):141-156.

Manitoba Agriculture. Food and Rural Initiative. 2006. Saskatoons. http://www.gov.mb.ca/agriculture/crops/fruit/bld01s00.html (Accessed Mar. 12, 2008).

Martin, P. 1979. Productivity and taxonomy of the Vaccinium globulare, V. membranaceum complex in western Montana. Thesis. Univ. Mont., Missoula, Mont. 136 p.

__________1980. Factors influencing globe huckleberry fruit production in Northwestern Montana. Int. Conf. Bear Res. and Manag 5:159-165.

Martinka, C.J. 1968. Habitat relationships of white-tailed and mule deer in Northern Montana. J. Wildlife Manag. 32(3):558-565.

Mattson, D.J., B.M. Blanchard, and R.R. Knight. 1991. Food habits of Yellowstone grizzly bears, 1977–1987. Can. J. Zool. 69:1619–1629.

Mazza, G. 1982. Chemical composition of Saskatoon berries Amelanchier alnifolia. J. Food Sci. 47(5):1730-1731.

__________1986. Anthocyanins and other phenolic compounds of Saskatoon berries Amelanchier alnifolia. J.Food Sci. 51(5):1260-1264.

Mazza, G. and M.W. Hodgins. 1985. Benzaldehyde, a major aroma component of Saskatoon berries. HortScience 204(4):742-744.

McCune, L. M. and T. Johns. 2007. Antioxidant activity relates to plant part, life form and growing condition in some diabetes remedies. J. Ethnopharmacol. 112(3):461-469.

McLellan, B.N. and F. W. Hovey. 1995. The diet of grizzly bears in the Flathead River Drainage of Southeastern British Columbia. Can. J. Zool. 73:704-712.

McLellan, B.N. 1989. Effects of resource extraction industries on behavior and population dynamics of grizzly bears on the Flathead drainage, British Columbia and Montana. PhD thesis. UBC. Vancouver, BC.

Mealey, S. P., C. J. Jonkel, and R. Demarchi. 1977. Habitat criteria for grizzly bear management. In XIIIth Congress of Game Biologists. T.J. Peterle (editor). Washington, DC. 276-289.

Mercanligil, S.M., P. Arslan, C. Alasalvar, E. Okut, E. Akgul, A. Pinar, P.O. Geyik, L. Tokgozoglu, and F. Shahidi. 2007. Effects of hazelnut-enriched diet on plasma cholesterol and lipoprotein profiles in hypercholesterolemic adult men. Eur. J. Clin. Nutr. 61(2):212-220.

Miller, M. 1977. Response of blue huckleberry to prescribed fires in a western Montana larch-fir forest. Missoula, MT, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range ExperimentStation. Res. Pap. INT-188.: 33.

Miller, M. (1978). Effect of growing season on sprouting of blue huckleberry. Ogden, Utah, USDA Forest Service: 1-8.

Miller, D. L. 1981. The effects of Roundup herbicide on Northern Idaho conifers and shrub species (No. TP-81-2). Potlatch Corporation Wood Products, Western Division. Lewiston, Idaho.

Minore, D. 1972. The wild huckleberries of Oregon and Washington – a dwindling resource. USDA For. Serv., Res. Paper No. 143., Portland, Or.

__________1975. Observations on the rhizomes and roots of Vaccinium membranaceum. U.S. Dep. Agric. For. Serv., Res. Note PNW-261. Portland, Oreg.

__________1984. Vaccinium membranaceum berry production seven years after treatment to reduce overstory tree canopies. N.W. Sci. 58:208-121.

Minore, D. and A. W. Smart. 1975. Sweetness of huckleberries near Mount Adams, Washington (No. PNW-248): U.S. Dep. Agric. For. Serv., Portland, Oreg.

__________1978. Frost tolerance in seedlings of Vaccinium membranaceum, Vaccinium globulare and Vaccinium deliciosum. Northwest Sci. 52(3):179-185.

Minore, D., A. W. Smart, and M. E. Dubrasich. 1979. Huckleberrry ecology and management research in the Pacific Northwest (No. Gen. Tech. Rep. PNW-93). Portland, Or.

Minore, D. and M. E. Dubrasich. 1978. Big huckleberry abundance as related to environment and associated vegetation near Mount Adams, Washington. Pac. N.W. For. Range Exp. Stn. Portland, Or.

Moerman, D.E. 1998. Native American Ethnobotany. Timber Press. Portland, OR.

Monsen, S.B., R. Stevens, and N.J. Shaw. 2004. Restoring western ranges and wildlands. Vol. 3. U.S. Dep. Agric. For. Serv., Rocky Mountain Research Station. Gen. Tech. Rep. RMRS-GTR-136-vol-3. Fort Collins, Colo.

Morimoto, C., Y. Satoh, M. Hara, S. Inoue, T. Tsujita, and H. Okuda. 2005. Anti-obese action of raspberry ketone. Life Sci. 77:194-204.

Morris, R. 2004 as cited in Torr. & A. Gray. Rubus leucodermis - Plants For A Future: Edible, medicinal and useful plants for a healthier world www.pfaf.org/database/plants.php?Rubus+leucodermis (Accessed: March 22,2008)

Morrison, M. L. 1982. The structure of western warbler assemblages: ecomorphological analysis of the black-throated gray and hermit warbler. The Auk 99:503-513.

Mowat, G. and R. Ramcharita. 1999. A review of grizzly bear habitat use and habitat management options for the Kootenay region of British Columbia. Min. Environ., Lands and Parks,Victoria, B.C.

Moyer, R. A., K. E. Hummer, R. E. Wrolstad, and C. E. Finn. 2001. Anthocyanins, phenolics and oxygen radical absorbing capacity of berry germplasm. Hortscience 36(3).

Mozingo, H.N. 1987. Shrubs of the Great Basin: A natural history. University of Nevada Press, Reno, Nev. 342 p.

Munro, R.H.M, S.E. Nielsen, M.H. Price, G.B. Stenhouse, and M.S. Boyce. 2006. Seasonal and diel patterns of grizzly bear diet and activity in west-central Alberta. J. Mammal. 87(6):1112–1121.

Murray, G., P. Boxall, and R. Wein. 2005. Distribution, abundance, and utilization of wild berries by the Gwich'in people in the Mackenzie River delta region. Econ. Bot. 59(2):174-184.

Nelson, E. A. 1975. Greenhouse and field fertilization of thin-leaved huckleberry. U.S. Dep. Agric. For. Serv., Res. Note PNW-236.

Nielsen, S.E, R.H.M. Munro, E.L. Bainbridge, G.B. Stenhouse, and M.S. Boyce. 2004. Grizzly bears and forestry II. Distribution of grizzly bear foods in clearcuts of West-central Alberta, Canada. Forest Ecol. Manag. 199:67–82.

Noble, W. 1985. Shepherdia canadensis: its ecology, distribution, and utilization by the grizzly bear. Unpublished paper on file at: U.S. Dep. Agric. For. Serv., Intermountain Research Station, Fire Sciences Laboratory, Missoula, Mont. 28 p.

Norland, J.B. and C.B. Marlow. 1984. Use of wooded draws by free-roaming bison. In Wooded draws: characteristics and values for the northern Great Plains: symposium proceedings. Great Plains Agric. Counc. 11:40-43.

Noyce, K. V. and P. L. Coy. 1990. Abundance and productivity of bear food species in different forest types of Northcentral Minnesota. Int. Conf. Bear Res. and Manag. 8:169-181.

Oliveira, I., A. Sousa, J.S. Morais, I.C.F.R. Ferreira, A. Bento, L. Estevinho, and J.A. Pereira. 2008. Chemical composition, and antioxidant and antimicrobial activities of three hazelnut (Corylus avellana L.) cultivars. Food Chem. Toxicol. 46:1801-1807.

Olsen, J. 2001. Nutrient management guide-hazelnuts. Oreg. State Univ. Ext. Serv. Bull. EM8786. Corvallis, Oreg.

__________2007. 2007 Pacific Northwest Insect Management Handbook. http://pnwpest.org/pnw/insects/ (Accessed Mar. 20, 2008).

Oregon State University. 2007. An online guide to plant disease control. http://plant-disease.ippc.orst.edu/ (Accessed Mar. 22, 2008).

Ozga, J.A., A. Saeed, and D.M. Reinecke. 2006. Anthocyanins and nutrient components of Saskatoon fruits (Amelanchier alnifolia Nutt). Can. J. Plant Sci. 86(1):193-197.

Parish, R., R. Coupé, and D. Lloyd (editors). 1996. Plants of Southern Interior British Columbia. Lone Pine Publishing, Vancouver, B.C.

Pease, J.L., R.H. Vowles, and L.B. Keith. 1979. Interaction of snowshoe hares and woody vegetation. J. Wildlife Manag. 43(1):43-60.

Peek, J.M. 1974. A review of moose food habits studies in North America. Nat. Can. 101:195-215.

Pelchat, B.O. and R.L. Ruff. 1986. Habitat and spatial relationships of black bears in the boreal mixedwood forest of Alberta. International Conf. on Bear Res. Manage. 6:81-92.

Pendergast, B. A. and D. A. Boag. 1970. Seasonal changes in diet of spruce grouse in Central Alberta. J. Wildlife Manag. 34(3):605-611.

Pershern, A.S., W.M. Breene, and E.C. Lulai. 1995. Analysis of factors influencing lipid oxidation in hazelnuts (Corylus spp.). J. Food Process. Pres. 19(1):9-26.

Peterson, L. D. 1989. Vegetation response to slashburning: a 3-year progress report 1989. A cooperative project between Min. Environ. and Min. For., Government of British Columbia, Victoria B.C.

Pierce, J. D. 1984. Shiras moose forage selection in relation to browse availability in north-central Idaho. Can. J. Zool. 62(12):2404-2409.

Pinkerton, J. Eastern filbert blight help page. http://www.oregonstate.edu/dept/botany/epp/EFB/lifecycle/lifecycle6.htm (Accessed Mar. 20, 2008).

Poole, K.G. and K. Stuart-Smith. 2005. Fine winter habitat selection by moose in interior montane forests. Alces 41:1-8.

Pritchard, G.T. and C. T. Robbins. 1990. Digestive and metabolic efficiencies of grizzly and black bears. Can. J. Zool. 68:1645-1651.

Quinton, D.A. 1985. Nutrient distribution in major shrubs and grasses in Interior British Columbia. BC Min. of Agric.and Food, Victoria, B.C.

Raine, R.M. and J.L. Kansas. 1990. Black bear seasonal food habits and distribution by elevation in Banff National Park, Alberta. Bears: Their Biol. and Manag. 8:297-304.

Read, D. J. 1996. The structure and function of the ericoid mycorrhizal root. Ann. Bot-London 77: 365-374.

Reen, R.K., A.A. Dombkowski, L.A. Kresty, D. Cukovic, J.M. Mele, S. Salagrama, R. Nines, and G.D. Stoner. 2007. Effects of phenylethyl isothiocyanate on early molecular events in N-nitrosomethylbenzylamine-induced cytotoxicity in rat esophagus. Cancer Res. 67(13):6484-6492.

Reyes-Carmona, J., G.G. Yousef, R.A. Martinez-Peniche, and M.A. Lila. 2005. Antioxidant capacity of fruit extracts of blackberry (Rubus sp.) produced in different climatic regions. J. Food Sci. 70(7):S497-S503.

Richards, R. T. and S. J. Alexander. 2006. A social history of wild huckleberry harvesting in the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-657. U.S. Dept. Agric. For. Serv., Pac. N.W. Res. Stn., Portland, Oreg.

Richards, R. T. 1998. Special forest product harvesting: cultural patterns, community development, and natural resource management. Nat. Resource News 8(4):1-2.

Richardson, W.S. 1991. Habitat selection and feeding ecology of black bears in Southeastern Utah. MSc thesis. Brigham Young Univ., Provo, Utah.

Riddell, R. N. 2005. Critical grizzly bear habitat mapping MacKay Landscape Unit, British Columbia. Prepared for B.C. Min. of Water, Land and Air Protection, Williams Lake, B.C. 72 p.

Riggs, R.A. 1977. Winter habitat use patterns and populations of bighorn sheep in Glacier National Park. Thesis. University of Idaho, Moscow, Idaho 87 p.

Riggs, R.A. and P.J. Urness. 1989. Effects of goat browsing on Gambel oak communities in Northern Utah. J. Range Manag. 42(5):354-360.

Rimando, A. M., W. Kalt, J. B. Magee, J. Dewey, and J. R. Ballington. 2004. Resveratrol, pterostilbene, and piceatannol in Vaccinium berries. J. Agr. Food Chem. 52(15):4713-4719.

Ritch-Krc, E.M., N.J. Turner, and G.H.N. Towers. 1996a. Carrier herbal medicine: an evaluation of the antimicrobial and anticancer activity in some frequently used remedies. J. Ethnopharmacol. 52(3):151-156.

Ritch-Krc, E.M., S. Thomas, N.J. Turner, and G.H.N. Towers. 1996b. Carrier herbal medicine: traditional and contemporary plant use. J. Ethnopharmacol. 52(2):85-94.

Roberts, M. R. and L. X. Zhu. 2002. Early response of the herbaceous layer to harvesting in a mixed coniferous-deciduous forest in New Brunswick, Canada. Forest Ecol. Manag. 155:17–31.

Rogers, L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. NA Wildlife and Nat. Res. Conf. 41:431-438.

Rosner, L.S. and J.T. Harrington. 2003. Optimizing acid scarification and stratification combinations for Russet Buffaloberry seeds. Native Plants J. 4(2):81-86.

Rounds, R.C. 1979. Height and species as factors determining browsing of shrubs by wapiti. J. Appl. Ecol. 16(1):227-241.

Rutter, P.A. and M.L. Shepard. 2002. Hybrid hazelnut handbook. Experiment in Rural Cooperation, Minneapolis, Minn.

Salter, R. E. and R.J. Hudson. 1979. Feeding ecology of feral horses in western Alberta. J. Range Manag. 32(3):221-225.

Sang Jian-Zhong, G.Y. 2003. An analysis of nutrient constituents of leaves of 28 Rubus species. J. of Plant Resources and Environ. 4(4):33-37.

Schofield, J.J. 1990. Discovering wild plants, Alaska, Western Canada, and the Northwest. Alaska Northwest Books. Portland, Or.

Schoonmaker, P. and A. McKee. 1988. Species composition and diversity during secondary succession of coniferous forests in the Western Cascade Mountains of Oregon. Forest Sci. 34(4):960-979.

Schorger, A. W. 1946. Influx of bears into St. Louis County, Minnesota. J. Mammal. 27:177.

Schroeder, R. 2002. Contemporary subsistence use of nontimber forest products in Alaska. In Nontimber forest products in the United States. E.T. Jones, R.J. McLain, and J. Weigand (editors). University Press of Kansas. Lawrence, KS.

Scotter, G.W. 1980. Management of wild ungulate habitat in the western United States and Canada: A review. J. Range Manag. 33(1):16-27.

Seeram, N.P. 2008. Berry fruits: compositional elements, biochemical activities, and the impact of their intake on human health, performance, and disease. J. Agr. Food Chem. 56(3):627-629.

Seeram, N. P., L. S. Adams, Y. Zhang, R. Lee, D. Sand, H. S. Scheuller, and D. Heber. 2006. Blackberry, black raspberry, blueberry, cranberry, red raspberry, and strawberry extracts inhibit growth and stimulate apoptosis of human cancer cells in vitro. J. Agr. Food Chem. 54(25):9329-9339.

Servheen, C. 1983. Grizzly bear food habits, movements, and habitat selection in the Mission Mountains, Montana. J. Wildlife Manag. 47(4):1026-35.

Shahidi, F., C. Alasalvar, and C.M. Livana-Pathirana. 2007. Antioxidant phytochemicals in hazelnut kernel (Corylus avellana L.) and hazelnut byproducts. J. Agr. Food Chem. 55(4):1212-1220.

Simonin, K. A. 2000. Vaccinium membranaceum. In Fire Effects Information System [Electronic Version]. www.fs.fed.us/database/feis/plants/shrub/vacmem.all.html (Accessed Mar. 22, 2008).

Simpson, K., K.B. Hebert, G.P. Woods. 1985. Habitats and management of the grizzly bear in the Columbia mountains of British Columbia. Fish and Wildlife Bulletin, B. C. Min. Environ., Nelson, B.C.

Simsek, A. and O. Aykut. 2007. Evaluation of the microelement profile of Turkish hazelnut (Corylus avellana L.) varieties for human nutrition and health. Int. J. Food Sci. and Nutr. 58(8):677-688.

Smith, J.N.M., C.J. Krebs, A.R.E. Sinclair, and R. Boonstra. 1988. Population biology of snowshoe hares II. Interactions with winter food plants. J. Anim. Ecol. 57:269-286.

Sound Native Plants. 2007. Propagation protocol for production of container Amelanchier alnifolia plants; sound native plants, Olympia, Washington. In Native Plant Network, Univ. of Idaho, College of Nat. Res., For. Res. Nursery, Moscow Idaho. http://www.nativeplantnetwork.org (Accessed Mar. 14, 2008).

St-Pierre, R. G. 1997. Growing Saskatoons: A manual for orchardists. Depart. Plant Sci., Univ. of Sask., Saskatoon, Sask.

___________1999. Growing Saskatoons - A manual for orchardists. http://www.prairie-elements.ca/Saskatoons.html (Accessed Mar. 12, 2008).

Stark, N. M. 1977. Fire and nutrient cycling in a Douglas-fir/larch forest. Ecology 58(1):16-30.

Stark, N. and S. Baker. 1992. The ecology and culture of Montana huckleberries: A guide for growers and researchers. Mont. For. Conserv. Exp. Stn, Misc. Publ. 52:87. Missoula, Mont.

Stearns, F.W. 1974. Hazels. In Shrubs and vines for northeastern wildlife. J.D. Gill and W.M. Healy (editors). U.S. Dep. Agric. For. Serv., NE For. Exp. Stn. Gen. Tech. Rep. NE-9:65-70, Upper Darby, Pa.

Stelfox, J.G. 1976. Range ecology of Rocky Mountain bighorn sheep in Canadian national parks. Canadian Wildlife Service Report Series Number 39, Ottawa, Ont. 50 p.

Stephanson, N.G., S. Cenkowski, W.E. Muir, M. Izydorczyk, and S. Tessier. 2002. On-farm blast-freezing of Saskatoon berries. Can. Biosyst. Eng. 44:3.01-3.06.

Stirling, I. and A.E. Derocher. 1990. Factors affecting the evolution and behavioral ecology of the modern bears. Int. Conf. Bear. Res. and Manag. 8:189-204.

Stoner, G. D. and R. M. Aziz. 2007. Prevention and therapy of squamous cell carcinoma of the rodent esophagus using freeze-dried black raspberries. Acta. Pharmacol. Sinic. 28(9):1422-1428.

Stoner, G.D., L.-S. Wang, N. Zikri, T. Chen, S.S. Hecht, C. Huang, C. Sardo, and J.F. Lechner. 2007. Cancer prevention with freeze-dried berries and berry components. Semin. Cancer Biol. 17:403-410.

Telfer, E.S. 1972. Browse selection by deer and hares. J. Wildlife Manag. 36(4):1344-1349.

Tirmenstein, D. 1990a. Rubus idaeus. In The Fire Effects Information System (Data base). W.C. Fisher (compiler). U.S. Dep. Agric., For. Serv., Intermountain Res. Stn., Intermountain Fire Sc. Lab., Missoula, Mont. http://www.fs.fed.us/database/feis/plants/shrub/rubida/all.html (Accessed May 18, 2009).

___________1990b. Vaccinium membranaceum. In The Fire Effects Information System [Data base]. W. C. Fisher (compiler). U.S. Dept. Agric. For. Serv., Intermountain Res. Stn, Intermountain Fire Sci. Lab., Missoula, Mont. http://www.fs.fed.us/database/feis/plants/shrub/vacmem/all.html (Accessed Jun. 2, 2009).

Titus, B.D., B.K. Kerns, W. Cocksedge, R. Winder, E. Pilz, G. Kauffman, R. Smith, S. Cameron, J.R. Freed, and H.L. Ballard. 2004. Compatible (or co-) management of forests for timber and non-timber values. CD of Proc. Can. Instit. Forestry/Institut forestier du Canada and the Soc. Amer. For. Joint 2004 Annual Gen. Meet. Con."One Forest Under Two Flags – Une Forêt Sous Deux Drapeaux," Oct. 2-6, 2004, Edmonton, Alta. 27 p.

Tmixw Research and Nicola Tribal Association. 2002. Distribution characteristics of black huckleberry (Vaccinium membranaceum Dougl.) in the province of British Columbia: An analysis of biogeoclimatic ecosystem mapping (BEC) and terrestrial ecosystem mapping (TEM) datasets. Unpublished file report prepared for Evelyn Hamilton, B.C. Min. Forests. Tmixw Research, Nicola Tribal Association, Merritt, B.C. B.C. For. Serv., Res. Br., Victoria, B.C.

Torri, E., M. Lemos, V. Caliari, C. A. Kassuya, A. L. Candida, J. K. Bastos, and S. F. Andrade. 2007. Anti-inflammatory and antinociceptive properties of blueberry extract (Vaccinium corymbosum). J. Pharm. Pharmacol. 59(4):591-596.

Trehane, J. 2004. Blueberries, cranberries, and other Vacciniums. Timber Press, Inc., Portland, Oreg.

Trusler, S. and L. Main Johnson. 2008. "Berry Patch" as a kind of place – the ethnoecology of black huckleberry in Northwestern Canada. Human Ecol. 36:553-568.

Trusler, S. G. 2002. Footsteps amongst the berries: the ecology and fire history of traditional Gitxsan and Wet'suwet'en huckleberry sites. Unpublished MSc thesis. Univ. North. B.C., Prince George, B.C.

Turner, N.J. 1975. Food plants of British Columbia Indians. B.C. Prov. Museum, Victoria, B.C.

__________1977. Ethnobotany of the Okanagan Indians of British Columbia and Washington State. British Columbia Indian Language Project. Victoria, B.C.

__________1979. Plants in British Columbia Indian technology. B.C. Prov. Museum. Victoria, B.C.

__________1991. Burning mountainsides for better crops: Aboriginal landscape burning in British Columbia. Archaeology in Mont. 32(2):57-73.

__________1997. Food plants of Interior First Peoples. UBC Press, Vancouver, B.C.

__________ 1998. Plant technology of First Peoples in British Columbia. UBC Press,Vancouver, B.C.

__________1999. Time to burn: Traditional use of fire to enhance resource production by Aboriginal Peoples in British Columbia. In Indians, fire and the land in the Pacific Northwest. R. Boyd (editor). Oreg. State U. Press, Corvallis, Oreg. 313 p.

Turner, N. J. and H. Clifton. 2009. "It's so different today": Climate change and Indigenous lifeways in British Columbia, Canada. Global Environ. Chang. 19(2):180-190.

Turner, N. J., L. C. Thompson, M. T. Thompson, and A. Z. York. 1990. Thompson ethnobotany : Knowledge and useage of plants by the Thompson Indians of British Columbia. R.B.C. Museum. Victoria, B.C.

United States Department of Agriculture (USDA). 2007. Commercial huckleberry permits available August 15th. USDA For. Serv., Gifford Pinchot Nat. For. http://www.fs.fed.us/gpnf/news/2007/20070806a-commercial-huckleberry-permits.shtml. (Accessed March 16, 2009).

USDA Natural Resources Conservation Service National Plant Data Center, and Oregon Plant Materials Center.2008. Plant guide: black huckleberry: Vaccinium membranaceum Dougl. http://plants.usda.gov/plantguide/pdf/cs_vame.pdf (Accessed Mar. 17, 2008).

University of Michigan-Dearborn. 2008. Native American ethnobotany database. http://www.herb.umd.umich.edu/ (Accessed Mar.17, 2008).

Usui, M., Y. Kakuda, and P.G. Kevan. 1994. Composition and energy values of wild fruits from the boreal forest of northern Ontario. Can. J. Plant Sci. 74:581-587.

Van Dersal, W.R. 1938. Native woody plants of the United States, their erosion-control and wildlife values. U.S. Depart. Agric. Wash., D.C. 362 p.

Vander Kloet, S. P. 1988. The genus Vaccinium in North America. Res. Br. Agri. Can. Ottawa. Ont.

Vander Kloet, S. P. and T. A. Dickinson. 1999. The taxonomy of Vaccinium section Myrtillus. Brittonia 51(2):231-254.

Vivekanathan, D. P., M.S. Penn, S.K. Sapp, A. Hsu, and E.J. Topol. 2003. Use of antioxidant vitamins for the prevention of cardiovascular disease: Meta analysis of randomized trials. Lancet 361(9374):2017-23.

Vossen, P. M. and D. Silver. 2000. Growing temperate tree fruit and nut crops in the home garden. UCA Res. Inf. Center. The California Backyard Orchard. http://homeorchard.ucdavis.edu/ (Accessed March 31, 2009).

Walker, S. 2008. Shepherdia. In USDA Forest Service Agricultural Handbook 727. Washington, D.C.

Wallmo, O.C. and G.R. Bruce. 1973. Middle Park deer study: Physical characteristics and food habits. In Federal Aid Completion Report: Project W-38-R-27: WP-14: J4. Colo. Div. Wildlife, Denver, Colo. 83-103.

Wallmo, Olof C., W.L. Regelin, and D.W. Reichert. 1972. Forage use by mule deer relative to logging in Colorado. J. Wildlife Manag. 36:1025-1033.

Wandera, J.L, J.H. Richards, and R.J. Mueller. 1992. The relationships between relative growth rate, meristematic potential and compensatory growth of semiarid-land shrubs. Oecologia 90(3):391-398.

Wang, S. Y. and H. Jiao. 2000. Scavenging capacity of berry crops on superoxide radicals, hydrogen peroxide, hydroxyl radicals, and singlet oxygen. J. Agr. Food Chem. 48(11):5677-5684.

Wang, S.Y. and H.S. Lin. 2000. Antioxidant activity in fruits and leaves of blackberry, raspberry, and strawberry varies with cultivar and developmental stage. J. Agric. Food Chem. 48:140-146.

Watson, L.E., R.W. Parker, and D.F. Polster. 1980. Manual of plant species suitability for reclamation in Alberta. Vol. 2. Forbs, shrubs and trees. Land Conserv. Reclamation Coun., Edmonton, Alta. 537 p.

Welch, C.A., J. Keay, K.C. Kendall, and C.T. Robbins. 1997. Constraints on frugivory by bears. Ecology 78(4):1105-1119.

Welch, C.A., J. Keay, K.C. Kendall, and C.T. Robbins. 1997. Constraints on frugivory by bears. Ecology 78(4):1105-1119.

Whitney, G.G. 1986. A demographic analysis of Rubus idaeus and Rubus pubescens. Can. J. Bot. 64:2916-2921.

Whittle, C.A., L.C. Duchesne, and T. Needham. 1997. The impact of broadcast burning and fire severity on species composition and abundance of surface vegetation in a jack pine (Pinusus banksiana) clear-cut. For. Ecol. and Manag. 94:141-148.

Wilkinson, J. 2005. Propagation. Nut grower's guide: The complete handbook for producers and hobbyists. CSIRO Publishing, Collingwood, Victoria, Aust. 280 p.

Williams, R., J. L. Clarricoates, and Ktunaxa Kinbasket Treaty Council. 2002. Ktunaxa Kinbasket Treaty Council huckleberry use study. Cranbrook, BC.

Willms, W., A. McLean, R. Tucker, and R. Ritcey. 1980. Deer and cattle diets on summer range in British Columbia. J. Range Manag. 33(1):55-59.

Wilson, B. 1993. Saskatoon berries. In Summer Harvest Berry Farm. Bemidji, Minn. 5p.

Yakimishen, R., S. Cenkowski, and W.E. Muir. 2002. The effect of dry-ice freezing on Saskatoon berry quality. Can. Biosys. Eng. 44:3.17-3.25.

Yoshida, T., H. Ito, T. Hatano, M. Kurata, T. Nakanishi, A. Inada, H. Murata, Y. Inatomi, N. Matsuura, K. Ono, H. Nakane, M. Noda, F.A. Lang, and J. Murata. 1996. New hydrolyzable tannins, shephagenins A and B, from Shepherdia argentea as HIV-1 reverse transcriptase inhibitors. Chem. Pharm. Bull. 44(8):1436-1439.

Zager, P., C. Jonkel, and J. Habeck. 1983. Logging and wildlife influence on grizzly bear habitat in Northwestern Montana. Int. Conf. Bear Res Manag. 5:124–132.

Zager, P.E. 1980. The influence of logging and wildfire on grizzly bear habitat in Northwestern Montana. Univ. Mont., Missoula, Mont. 131 p.

Zatylny, A.M. and R. G. St. Pierre 2003. Revised international registry of cultivars and germplasm of the genus Amelanchier. Small Fruits Rev. 2:1.

Zatylny, A.M., W.D. Ziehl, R.G. St-Pierre. 2005. Physicochemical properties of fruit of 16 Saskatoon (Amelanchier alnifolia Nutt.) cultivars. Can. J. Plant Sci. 85(4):933-938.

APPENDIX 1. Concerns and recommendations from the 'What about the Berries' workshop

The following points were recorded at a two-day workshop titled, "What about the Berries?" held in Chase B.C., March 2008. The purpose of the workshop was to present an overview of the plant guide, "What about the Berries? Managing for Understorey Species," including ecological overviews for five fruit species, and to receive input from participants on the approach, contents, and concerns. The first day of the workshop was designed to be specific to First Nations, to allow their perspective to be heard, although other participants were invited to attend. The second day included more government participants. There were many participants from day 1 who also participated in day 2. Participant background is listed in Table 1.

Table 1. Participation at the "What about the Berries?" workshop. Total numbers are not summation, but reflect total number of actual participants per sector (duplication not included).

Sector background	**Day 1**	**Day 2**	**Total**
Aboriginal Peoples, **including harvesters, elders, resource managers, and community members**	31	34	39
Government, **including federal and provincial**	3	14	14
Post secondary institutes, **including faculty, researchers, and students**	15	2	15
Consultants	3	5	5
Community Forest tenure		1	1
Unidentified	1	1	2
TOTALS	**53**	**57**	**76**

The majority of input and discussion from participants during the two days focused on issues surrounding the NTFP sector, rather than on the guide itself. Many participants viewed the workshop as an opportunity to raise larger concerns which are included within the guide. particularly within the sections, "Considerations when initiating local NTFP inventory and management" and "Why incorporate NTFPs into a management system." The points below summarize the views raised by one or more individuals participating, but may not have reflected the views of the group.

Concerns and recommendations raised:

- It is important to stress the rights of Aboriginal Peoples, and the value and relationship between people and plants.
- Zoning should be considered to avoid conflicts over harvest areas
    - There is a lack of provincial legislation, which makes it all the more important for communities to initiate their own management plans for the area.
    - It is important for both Aboriginals and non-Aboriginals to have access for cultural use through to commercial use – many people depend on the berries.

    - Wildlife considerations.
- There must be meaningful involvement of local Aboriginals, in terms of discussions of areas (e.g. traditional ownership of patches, etc.), and how to manage (e.g. traditional burning), etc.
- Legislation – there is fear of being adversely affected or not included in the decision-making, as has been seen in the United States. There were very strong recommendations from the workshop participants that the issue of jurisdiction needs to be resolved. It was also very clear that there should be no permits required for traditional food gatherers.
- There must be careful use of information. Any information shared should be used ethically, keeping in mind that cultural and subsistence use supersedes commercial use, and any information shared (e.g. locations etc.) must be carefully protected.
- Management doesn't seem to be taking into consideration the cumulative effects of climate change and disturbances such as mountain pine beetle on the berries.
- More information is needed on the effects of nutrifor fertilizer (and other fertilizers) used for trees; how does this affect berries?
- More information is needed on the effect of cattle grazing on berry production. For example, does grazing increase the spread of disease or invasive plants? Does cow manure cause root rot for some plants? How does compaction affect growth and production?
- There was concern over the spread of disease and insect infestations by increased traffic in an area, both for timber and non-timber harvest activities. For example, one participant noted increased blackcap in an area, and suggested that it resulted in what appeared to be a greater infestation of non-beneficial insects in local gardens (increased blackcap would have resulted from a disturbance, such as clearcut or fire).
- Wild is important; forest farming and agriculture does not meet all the needs of people and wildlife, nor can some plants be easily cultivated. We need more focus on sustaining natural growth instead of cultivation.
- Multiple habitats are very important as species can produce different quality products under different conditions. For example, root material for baskets is stronger and straighter in some areas; soapberry colouring is different in different areas (may indicate varying levels of compounds such as carotene). People travel to get the diversity they need.
- Government (and resource managers) must listen better to Aboriginal Peoples' input, especially the vast array of on-the-ground experience accumulated over years.
- Fire management should be brought back; there needs to be a greater focus and inclusion of traditional methods for management of berries.
- Enforcement is very important (e.g. with zoning for various uses, if implemented)

APPENDIX 2. Additional resources

Examples of similar or supportive work

There is an increasing body of research that is being conducted on berries, including autecology, production, and modeling. Some of this work, though by no means definitive, is listed in the table below.

ACTIVITY	RESEARCHER	PUBLICATION	URL or CONTACT
NTFP inventory using PEM/TEM	Berch et al.	Non-timber forest product plant and fungal species in the Robson Valley Forest District	http://www.for.gov.bc.ca/hcp/enhanced/robson/efmpp/research/mushroom.html
NTFP inventory using conventional inventories and quality inclusion	Cocksedge et al.		Wendy.cocksedge@royalroads.ca
Response to climate modeling; proposed	DeLong et al.		Craig.delong@gov.bc.ca
Nicola Similkameen Innovative Forest Practices Society and Tmix^w^ Research	Tmix^w^ Research		http://www.nsifs.bc.ca/
Quantifying the effects of silviculture, wildfire and forest stand attributes on black huckleberry	Michael E. Keeefer		Mike@KeeferEco.com
Combining knowledge systems	Shirley Mah et al.		Shirley.mah@gov.bc.ca
At a community level, many communities are documenting traditional use species and areas. E.g.:			
Skeetchestn documenting culturally significant plants via photos and inventories to establish baseline data.			http://www.skeetchestn.ca/ or http://www.skeetchestn.ca/Natural%20Resources%20Website/index.html
Oral history interviews by Siska Traditions Society on the management of Saskatoon, hazelnut, blackcap	Michael Keefer, Maurice Michelle, Nancy		Mike@KeeferEco.com or Siskaaib@hughes.net

raspberry, soopolallie and black huckleberry.	MacPherson		
NTFP resource examples within MoFR :			
research	B.K. Chapman and B. Bravi	Managing for Pine Mushrooms through the Mountain Pine Beetle Epidemic in the West Chilcotin	http://www.for.gov.bc.ca/hfd/Pubs/RSI/FSP/EN/RSI_EN09.htm)
guidelines	Coast Forest Region	Managing Cedar for Cultural Purposes	http://www.for.gov.bc.ca/ftp/DSI/external/!publish/Stewardship/SIFD_Objectives_Matrix/7_Cultural_Heritage/Guidelines/Cedar_Guidelines_MOF_Consultation_Final_Jan_2005.pdf)
extension	Okanagan Shuswap Forest District	Information provided including a District map to help identify some of the public access issues / constraints / restrictions in the Okanagan Shuswap fire areas.	http://www.for.gov.bc.ca/dos/dist_docs/mushroom.htm
extension	BC MoFR Research Branch	Overview of NTFP activity, research, and contacts	http://www.for.gov.bc.ca/hre/ntfp/
monitoring	BC MoFR, Forest and Range Evaluation Program (FREP)	At the provincial level, FREP is working on developing monitoring systems for cultural heritage resources	http://www.for.gov.bc.ca/hfp/frep/
Resources for assessing timber values in compatible management regimes			
TIPSY; Woodlots for Windows	BC MoFR	Assist in determining growth and yield and AAC on discrete landbases	http://www.for.gov.bc.ca/HTH/woodlots/aac-program.htm
Silvcultural Systems Handbook for British	BC MoFR	Describes the stand	www.for.gov.bc.ca/hfp/publications/00085/silvsystemshdbk

Columbia		management regime, and details on implementation and site planning.	-web.pdf
How to Use a Stand Density Management Diagram - Getting the Stand and Site Data	BC MoFR	A step-by-step example of how to obtain the necessary input data for a Stand Density Mangement Diagram.	www.for.gov.bc.ca/hfp/publications/00168/sdmd_yld.pdf
How to Use a Stand Density Management Diagram - Yield Predictions for a Spacing Prescription	BC MoFR	A step-by-step example of how to obtain rough yield predictions at rotation for a spacing prescription through the use of a stand density management diagram (SDMD).	www.for.gov.bc.ca/hfp/publications/00168/sdmd_yld.pdf
Stand Density Management Diagram; Spacing to increase diversity within stands	BC MoFR	Illustrates growth and yield principles relevant to spacing prescriptions designed to enhance structural diversity	www.for.gov.bc.ca/HFP/publications/00167/Sp_Div.pdf
Pre-Commerical Thinning Operational Guidelines	BC MoFR	Provides operational guidelines for pre-commercial thinning activities	http://www.for.gov.bc.ca/HFP/publications/00064/
Guidelines for Developing Stand Density Management Regimes	BC MoFR	Provides a structured decision process for making site-specific density management prescriptions.	http://www.for.gov.bc.ca/hfp/publications/00083/
Useful MoFR silvicultural documents, including:			http://www.crownpub.bc.ca/

• SIL Background Report, Development of Juvenile Spacing Guidelines • SIL014 Background and Recommendations for Juvenile Spacing Standards in BC • SIL040 Correlated Guidelines for Management of Uneven-aged Drybelt Douglas-fir Stands in British Columbia: First Approximation • SIL233 Guidelines for Maintaining Biodiversity During Juvenile Spacing • SIL376 Stand Tending Impacts on Environmental Indicators • SIL462 Basic Wood Properties of Second-Growth Western Hemlock • SIL9 An Exploratory Study of the Density and Annual Ring Weight in Fast-Growth Coniferous Woods in British Columbia • SILV119 Managing Forest Habitats: An Integrated Approach - Compendium of Products 1989-1990. FRDA II, Issued by the Habitat Silviculture Protection Account- HSP" • SILV137 Managing Forest Habitat Integration - Compendium 1989 - 1990 • SILV219 Juvenvile Spacing in B.C. • SILV226 Lodgepole Pine Density/Wildlife Diversity • SILV233 Predator Habitat Enhancement - A Strategy for Management	
• Notes to the Field, Vol. 7 - The Retention System: Maintaining Biological Diversity (pdf, 210 k, posted April 22, 2002) • PartCuts 2001 Summary (pdf, 3,433 k, posted December 13, 2001) • Silvcultural Systems Handbook for British Columbia WEB VIEWING VERSION (pdf, 7,431 k, UPDATED March 25, 2003) | PRINTING VERSION (higher resolution images) (pdf, 16,493 k, UPDATED March 25, 2003) • Notes to the Field, Vol. 6 - Partial Cutting Solutions Workshops (pdf, 165 k, posted April 10, 2001) • Enhancing Biodiversity through Partial Cutting (pdf, 497 k, posted April 11, 2000) • Notes to the Field, Vol. 2 - "An evaluation of worker safety in partial cutting operations" (pdf, 451k, posted April 10, 2000) • Notes to the Field, Vol. 5 - Developing Management Objectives and Measures for Silviculture Prescriptions (pdf, 142 k, posted February 22, 2000) • FPCMR9 Silvicultural Systems Guidebook (Forest Practices Code) • Silvicultural Systems in British Columbia (pdf, 361 k, updated Feb. 11, 2000) • Silvics and Partial Cutting Field Cards (pdf,467 k, updated July 18, 2001) • Forest Harvesting: Following Nature's Lead	http://www.for.gov.bc.ca/hfp/meta/publications.htm

Examples of on-line sources of autecological or ethnobotanical information

WEBSITE	DESCRIPTION	URL
Fire Effects Information System	FEIS summarizes and synthesizes research about living organisms in the United States—their biology, ecology, and relationship to fire, including plant, animal and lichen species.	http://www.fs.fed.us/database/feis/
CNTR NTFP bibliography	On-line, searchable databases, covering many disciplines and topics.	http://cntr.royalroads.ca/ntfp-bibliography/

E-Flora	The E-Flora atlas pages provide detailed information on British Columbia's plant species.	http://www.eflora.bc.ca/
US Forest Service	Northern Research Station, Treesearch website. Access to: M.R. Emery and S.L. O' Halek 2001. Brief overview of historical non-timber forest product use in the U.S. Pacific Northwest and Upper Midwest. Haworth Press.	http://www.treesearch.fs.fed.us/pubs/19169
Secwempemc ethnobotany	On-line information regarding the ethnobotany gardens in Kamloops	http://www.secwepemc.org/SECethnogardens2/index.htm
Native Plant Network	Based out of Idaho, this website is an example of the extension services provided by U.S. institutions. This website provides propagation techniques for a number of native plant species.	http://nativeplants.for.uidaho.edu/network/
First Voices	This website provides a variety of resources on Aboriginal languages	http://www.firstvoices.com/

Examples of protocols, Memorandums of Understanding, and suggested resources

Examples of developed protocols are listed below. Although these protocols should not be seen as applicable to all peoples and situations, they do offer good examples of how to work across cultures with respect and consideration.

- **The Aboriginal Human Resource Council.** 2007. Building a memorandum of understanding. http://www.aboriginalhr.ca/en/resources/articles/MOU. Accessed Feb 28, 2009.
  Provides questions to consider when developing a memorandum of understanding, as well as a sample MOU.

- **First Peoples Heritage and Language Cultural Council.** 2009. Sample documents for language research projects. http://www.fphlcc.ca/language/language-toolkit/sample-documents-for-language-research-projects. Accessed Feb 28, 2009.
  Provides resources for initiating proposals, including developing memorandums of understanding.

- **Community University Connections.** 2002. Links and resources on community-university collaborations. http://web.uvic.ca/~scishops/resources.htm. University of Victoria. Accessed Feb 28, 2009.
  Provides resources and links for research-based projects working with Aboriginal Peoples, including examples of protocols, principles, and guidelines.

- **University of Victoria Faculty of Human and Social Development.** 2003. Protocols and principles for conducting research in an Indigenous context. http://www.hsd.uvic.ca/policies/documents/igovprotocol.pdf. Accessed Mar 20, 2008.
  Provides protocols and principles for researchers working with Aboriginal communities.

Further reading:

Bombay, H. 1996. Aboriginal forest-based ecological knowledge in Canada. National Aboriginal Forestry Association.

Ellen, R.F. and H.H. Harris. 1996. Concepts of indigenous environmental knowledge in scientific and development studies literature: A critical assessment. Draft paper East-West Environmental Linkages Network Workshop 3, Canterbury, U.K .

Ermine, W, R. Sinclair, and B. Jeffery. 2004. The ethics of research involving Indigenous Peoples; Report of the Indigenous Peoples' Health Res. Centre, Saskatoon, Sask.

Grenier, L. 1998. Working with Indigenous knowledge: A guide for researchers. IDRC. Ottawa, ON.

Honda-McNeil, J and D. Parsons. 2003. Best practices handbook for traditional use studies. Gov. Alta, Aboriginal Affairs and Northern Dev., Edmonton, Alta. www.assembly.ab.ca/lao/library/egovdocs/alaa/2003/138222.pdf (Accessed March 27, 2009).

Jones E, L. Liegel, T. Love, and D. Piltz. 1998. Integrating biological, socioeconomic and managerial methods and results in the MAB mushroom study. AMBIO 9:26-33.

Kaniki, A.M. and M.E.K. Mphahlele. 2002. Indigenous knowledge for the benefit of all: Can knowledge management principles be used effectively? S. Afr. J. of Lib. Inf. Sc. 68(1):1.

Miller, V. 2003. Filling in the gaps: Amalgamating and applying indigenous and western science. Natural resources information management forum: Putting knowledge to work FORREX series no.8, Kamloops, B.C.

Smith, P, G. Scott, and G. Merkel. 1995. Aboriginal forest land management guidelines: A community approach. Nat. Aboriginal For. Assoc., Ottawa, Ont.

Travers, O.R. 1993. Nemaiah First Nations natural resource management policy plan for the Brittany Triangle within the Nemaiah declaration area.

Turner, N.J. 2001. "Doing it right": Issues and practices of sustainable harvesting of non-timber forest products relating to First Peoples in British Columbia. B.C. J. Ecosyst. Manag. 1(1):1-11.

Vance, N.C. 2001. Section II: Research on non-timber forest products in the Pacific Northwest: Research in non-timber forest products contribution of the USDA Forest Service, Pacific Northwest research station. J. Sustain. For. 13(3/4):71-82.

APPENDIX 3 - Saskatoon Disease and Pest Table

Fungal Diseases[1]	Symptoms	Information	Cultural Control	Chemical Control
Entomosporium Leaf and Berry Spot (*Entomosporium mespili*)	reddish-brown spots followed by leaf yellowing	high humidity, 20ºC to 25ºC temperatures and rainy conditions facilitates spread	regular thinning and adequate weed control	Funginex 190EC, Kumulus DF, Topaz 250E, Mission 418EC, Propiconazol 250E
Saskatoon-Juniper Rust (*Gymnosporangium nelsonii*)	yellowish-orange spots, swellings and outgrowths on leaves and fruit; occurs in cool springs and when berries are delayed	Two host life cycle - saskatoon berries and junipers	pruning out rust galls from nearby junipers (spores can travel over 2km)	Funginex 190EC, Mission 418EC, Propiconazol 250E
Brown Fruit Rot (Mummyberry) (*Monilinia amelanchieris*)	flowers prematurely turn brown and subsequent berries appear discoloured - eventually berries shrivel and mummify	humidity during flowering facilitates spread - results from insect damage to flowers and berries and from excessive nitrogen fertilization	pruning infected areas and burning leaves	no effective registered pesticides, Funginex 190EC for Entomosporium control may provide some resistance
Cytospora Canker (*Cytospora leucostoma*)	sunken, 'watersoaked' and discoloured areas on young wood sometimes with wrinkled bark; sunken areas on older wood that is surrounded by cracked and folded back bark showing rusty coloured inner bark	predisposed by exposure to drought, cold, frost and wind; physical injury from machines and equipment or rodents, poor soil drainage, high salt levels, low available soil nutrients	prune and burn infected plant material; if the crown is infected remove the entire plant	no registered fungicides
Black Leaf (Witches Broom)	leaf edges curl down, grey, felt-like growth on underside of leaves,	only new wood is affected; exposure to wind and low snow	prune off affected growth 10-20cm below affected	no registered fungicides

[1] Information provided was obtained from online excerpts from St-Pierre's (1997) 'Growing Saskatoons- A Manual for Orchardists' and from the Manitoba Agriculture, Food and Rural Initiatives web site: http://www.gov.mb.ca/agriculture/crops/fruit/bld01s00.html

(*Apiosporina collinsii*)	eventually turns black; infected stems begin to produce many new shoots	cover seem to increase vulnerability	area; may need to remove entire plant (seedlings and young plants)	
Powdery Mildew (*Podosphaera clandestine*)	white, fine powdery growth on upper or lower leaf surface; can cause leaf discolouration and death of leaves and young shoots	increased incidence in wetter climates - 'Honeywood', 'Moonwood', and 'Thiessen' cultivars may be less susceptible	affected wood can be removed if areas are not too large	Nova 40W
Fireblight (*Erwinia amylovora*)	appear the month after flowering; wilting of young shoots in the shape of a crook, wilting blossoms, scorching leaves, and oozing from cracked bark; infected fruit may become brown or black	spores spread mainly by bees and somewhat by water droplets and pruners; prolonged wet spring weather increases disease incidence	prune affected branches 25-45 cm below affected area and destroy	no registered fungicides; streptomycin and copper based compounds are used for control in other closely related fruit trees and ornamentals
Insect Pests				
Saskatoon Bud Moth (*Epinotia bicordana*)	flower buds with tiny holes, may ooze droplets; yellowish flower buds fall off when touched	newly hatched larvae feed on interior of flower buds usually late April to early May		
Saskatoon Sawfly (*Hoplocampa montanicola*)	small holes on top or sides of immature berries; later affected berries may appear as black, empty shells	damage to berries occurs when larvae begin feeding on developing berries		
Apple Curculio (*Anthonomus quadrigibbus*)	adults feed on immature fruit and shoot tips leaving dark puncture wounds less than 1 mm diameter on immature berries ; berries may develop irregularly and become hard	larvae or pupae may be found feeding inside the ripe berries		Decis 5.0EC
Lygus Bugs (*Adelphocoris lineolatus* and *Lygus lineolaris*)	leave yellow, aborted flower buds, which may exude a brownish liquid; affected areas become deformed or drop off	these insects feed on weedy plants; do not grow alfalfa near Saskatoon berries	good weed management is essential	Decis 5.0EC

Midges and Mites (*Cecidomyiidae*) and (*Eriophyiidae*)	mostly cosmetic damage to leaves and flower buds; cause purplish abnormal swellings on either side of the leaf and at the base of developing flower buds		control is not necessary	
Tent Caterpillars (*Malacosoma spp.*)	feed on the leaves causing extensive defoliation	produce large masses of webbed nests (tents)	prune out affected areas and burn	
Wooly Elm/Apple Aphid (*Eriosoma americanum*)	colonies congregate on the roots, causing severe damage or death to young plants; above-ground symptoms are flagging of leaves, early defoliation, and a lack of vigour; roots are mostly destroyed with a proliferation of young white or yellowish roots appearing above the affected area	bluish-white waxy, woolly colonies may be found on the roots in late July to October		Admire 240 and Orthene
Cherry Shoot Borer (*Argyresthia oreasella*)	larvae tunnel into young shoot tips causing wilting and death	small, light green larvae may be found in young shoots	prune dying shoots when symptoms first appear	
McDaniel Spider Mite (*Tetranychus mcdanieli*)	feed on leaf and flower buds in spring and mature leaves in summer; stippled, yellowish leaves with fine webbing, may drop off the plant; may lack vigour, flower bud production may be decreased, berries may be small	hot dry conditions favour mites; can produce 8-15 generations per season		
Leaf-Rolling Caterpillars (*Archips argyrospilus* and *Argyrotaenia quadrifasciana*)	roll leaves to form shelter as they feed - sometimes rolling developing flower or fruit clusters within leaves; results in substantial loss of leaves, flowers and immature fruit			no registered insecticides