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

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Executive Summary

Wild berries are a non-timber forest resource with a long history of use and management. First Nations People in northwestern British Columbia have identified historic berry patches that were important elements of their subsistence economy. Those historic berry gathering areas were often named, controlled, managed and handed down from generation to generation by particular families or House Groups. Berry patches were traditionally managed by fire to reduce tree encroachment (and subsequent shading) and to periodically stimulate the growth of new shoots. Prescribed burns of this nature have been prohibited by B.C. Forest Service policy since the 1930's, resulting in the general deterioration of historic berry production levels. This trend has been somewhat offset by widespread logging activities, such that most berry pickers now forage in clear cuts. Subsistence and recreational berry picking continues today, along with the beginnings of commercial utilization of this resource. Berry pickers and the Gitxsan Treaty Office have expressed concerns that berry production is being compromised by some current forest management practices, and that the wild berry resource is not adequately considered in forest planning.

This pilot project focuses on the Suskwa River vicinity (defined as the Gitxsan territories of Luutkudziiwus, Gyet'm Galdoo and Djogaslee located east and northeast of the Bulkley River). Many wild berry species are located in this area, but those actively sought by people today include black huckleberry (*Vaccinium membranaceum*), oval-leaved blueberry (*Vaccinium ovalifolium*), highbush cranberry (*Viburnum edule*), and soapberry (*Shepherdia canadensis*). Other species picked opportunistically, but usually more abundant in valley bottoms near townsites and peoples' homes, include saskatoon (*Amelanchier alnifolia*), red raspberry (*Rubus idaeous*), and rose hips (*Rosa nutkana*). Low-bush blueberry (*Vaccinium caespitosum*) is also picked at both high and low elevations when encountered in sufficient densities. All of these species are early-successional and light-demanding in their ecology, though they persist in older forests to various degrees determined by canopy closure, slope and aspect. Previous studies have shown that 70 to 80% of full sunlight constitutes optimal irradiance for growth and berry production in black huckleberry and soapberry; other species are less well studied.

Recollections of local elders, contemporary written accounts, archaeological findings, and the testimony of Gitxsan chiefs in support of the Delgamuukw court case were used to identify the location of historical berry gathering areas in the Suskwa River vicinity. Eight broadly defined berry gathering areas, and four to six fairly well defined berry patches (with a combined area of 9,032 ha or 14.1% of the reference area) were documented as having been used in the study area at some time before 1950. These locations ranged in elevation from valley bottoms to the low alpine, but were usually found within a couple hours hike of level creekside camping areas where berry-processing camps were established. All historic berry patches in the study area were accessed by the Babine Trail or the Moricetown-Hazelton Trail. Historic berry gathering areas are characterized by signs of the repeated burning that was stopped early in the 20th century. Indicators of possible historic berry gathering areas include the presence of deciduous-leading forest cover (other than on floodplains) or dense, even-aged coniferous forest cover estimated to be 81 to 140 years old.

Current berry picking activities are conducted in open forest and in logged areas at both low and medium elevations. High quality huckleberry habitat is found between elevations of 930 m and 1050 m, with slopes of 16% to 28%, on south-facing slopes, with a predicted soil saturation index of 0.317 to 2.000, having site indices of 11.2 to 15.0 at 50 years, in the ICHmc1 biogeoclimatic variant, and with subalpine fir as the leading species. Oval-leaved blueberry habitat is similar, though this species is not found on extreme sites. High quality cranberry habitat is found from 520 m to 650 m elevation, with slopes of 10% to 32%, predicted soil saturation index of 0.442 to 2.203, with site indices between 12.8 and 16.4 m at 50 years, on flat sites or those with south-facing slopes, in the ICHmc2, dominated by subalpine fir or western hemlock. The best soapberry habitat was found between 450 m and 520 m elevation, on slopes of 7% to 19%, with predicted soil saturation index of 0.286 to 2.000, and site indices of 16 to 20 m at 50 years. The most extensive berry gathering areas are found in old, uncut forest, but current picking is concentrated in clearcuts 6 to 17 years of age. Current berry gathering areas cover approximately 4,187 ha, representing 6.6% of the total study area or and area equivalent to 12.1% of the timber harvesting land base (THLB). Black huckleberries are gathered from 2,916 ha, oval-leaved blueberries from 3711 ha, highbush cranberries from 736 ha, and soapberries from 128 ha in the study area. Historic and current berry patches are shown on an accompanying map, and the site affinities described above have been used to produce habitat suitability maps for black huckleberry, soapberry and highbush cranberry at a plotted scale of 1:60,000.

Wild berry production depends on stand and canopy attributes as much as more permanent site features. Being very much dependent on available sunlight, berry species tend to be moderately abundant in open-canopied mature and old forests, and in areas recently disturbed by wildfire or logging. Simulations with the SORTIE-BC stand model suggest that canopy closure would eliminate optimal growing conditions for most berry species within 10 to 15 years of logging, which agrees fairly well with field observations. Declining habitat quality for berries can be offset by maintaining low stocking levels, in the range of 420 to 700 stems per ha.

Draft management guidelines have been devised to protect, maintain or enhance wild berry resources. Different techniques and priorities for berry management should be implemented on the basis of site capability, survey results, the rarity of suitable sites and the current age structure of berry-producing stands within the management unit. We explore the implications of utilizing traditional Gitxsan house territories as the sustained yield unit for wild berry management. Tabulations of currently utilized berry patches by location and age indicate an uneven distribution of berry picking opportunities, requiring prioritization of berry species for management in each territory or active intervention to rectify unbalanced age class structures. It is suggested that damage to berry species (where they are already found on the site) in managed stands can be minimized through careful winter logging with understory protection, the use of partial cutting, light broadcast fire, and the use of selective brushing. Field surveys normally conducted in support of silvicultural prescriptions and free-growing assessments should include estimates of the abundance of designated berry species on high and moderate berry habitat capability sites. Management to maintain berry production in concert with timber production is tentatively suggested for stands having ≥10% berry bush cover pre-harvest, or ≥25% berry cover detected in free-growing surveys. "Berry maintenance" might consist of the use of light broadcast burns for site preparation, treating berry crop species as "ghosts" in free-growing surveys, and permitting reduced conifer stocking and extra-wide conifer spacing on good or medium berry-capacity sites. Opportunities for "enhanced" berry management should also be explored off the THLB, and may be financed by forest licensees as an alternative to compromising fiber production in THLB plantations. Activities which might be tested include the use of prescribed fire, manual cutting of trees or competing brush, browsing by sheep, pruning, planting cuttings and fertilization for the revitalization of existing or previously used berry patches.

At the landscape scale, it is recommended that berry habitat potential and known berry patch locations be considered in Forest Development Plans. Locations managed for enhanced berry production will also contribute to some wildlife habitat (e.g., for grizzly bear and moose) and seral stage distribution objectives, and hence should be considered in the design and implementation of Landscape Unit Plans. Berry emphasis areas might be designated in Landscape Unit Plans or Forest Development Plans. In the long run, estimates of berry yields and year-to-year variation in berry production by each identified species will be needed to plan for an assured berry supply over time. It is recommended that Phase II of this study should test mapped predictions of berry habitat potential, develop rapid berry yield survey techniques, investigate the fire history of traditionally managed berry gathering areas, and select sites for conducting berry maintenance and enhancement trials on and off the THLB.

It is noted that active management of selected areas for non-timber forest products such as wild berries would engender a considerable amount of good will in the local population of First Nations People and other non-industrial forest users. With appropriate planning, such actions need not conflict with timber management.

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1.0 GOALS, OBJECTIVES AND SCOPE

1.1 PURPOSE

A three-phase pilot project has been initiated by the B.C. Ministry of Forests (MoF) and the Gitxsan Treaty Office (GTO) in an effort to integrate Gitxsan interests in securing a sustainable supply of wild berries into forest management plans in the Kispiox Forest District. This project will explore the ability of MoF to address berry production interests at a strategic level while operating within the current MoF planning and policy framework, which includes no immediate impacts on the timber harvesting land base. MoF and GTO have jointly selected a small area in the SE corner of the Kispiox Forest District, which will serve as a case study for the cooperative development of a berry management regime. Phase One of this project (reported in this document) consists of a review of existing information and local knowledge, some preliminary mapping, and preparation for field work; Phase Two will consist of field sampling, more mapping and a workshop; and Phase Three will establish a planning team and will fully develop a spatially explicit berry management plan and implementation plan, to be followed by an evaluation of the pilot project and an assessment of the potential for its broader application.

1.2 BACKGROUND

The 1996 Kispiox Land and Resource Management Plan (LRMP) contains broad legal objectives for maintaining both cultural heritage resources and botanical forest products, including wild berries. The current approach of addressing these stand level management issues through consultation during forestry operational planning is often viewed as insufficient for addressing concerns that extend beyond a single cutblock or Forest Development Plan. Eventually, there will be a need to determine where and when wild berry resources warrant special attention for protection or enhancement. Unlike some other non-timber forest products (e.g., pine mushrooms) that are primarily associated with mature or old-growth forests, most wild berry species are found in early successional environments. As a result, berry production is potentially compatible with timber harvesting activities and the orderly development of forested landscapes.

This pilot project provides an opportunity to explore localized strategic planning options for meeting local (Gitxsan and non-Gitxsan) berry harvesting interests while operating within the current MoF policy environment. Past harvesting and management of berry patches by First Nations People is often viewed as an example of "traditional use and occupancy" of the land (Robinson et al. 1994), as exemplified by testimony submitted in the *Delgamuukw vs. The Queen* court case (Cassidy 1992, Gisday Wa and Delgam Uukw 1992). Consequently, the identification of historic berry gathering areas represents an uncovering of cultural geography, and is a component of many land claims negotiations. Restoration of these berry patches, particularly through traditional management techniques such as prescribed burning, is further viewed as a necessary element of First Nations cultural reclamation or even an act of political assertiveness. Political overtones aside, it is generally recognized that traditional use areas are a legitimate concern in resource development planning, and that berry picking continues as a significant sustenance activity for both Native and non-Native residents in the region. Commercial harvesting, processing and marketing of wild berries is also beginning in the Hazelton area (Burton 1999) and elsewhere in B.C (Anonymous 1995). It is prudent to implement management policies to safeguard sustainability of this resource before it becomes over-exploited.

1.3 OBJECTIVES

The objectives of this first phase of the berry management pilot project were the following:

1. To compile existing published information on preferred habitats of the wild berry species harvested in the Kispiox Forest District, and the techniques used for managing them and related species;
2. To compile existing information regarding the location and nature of wild berry patches in the southeast portion of the Kispiox Forest District;
3. To map the locations of known berry patches on a base map colour-themed to portray forest age classes;
4. To query a multi-layered Geographic Information System (GIS) database, silvicultural prescriptions and other sources to determine the degree of association of berry patches with forest stand attributes, biogeoclimatic classification, topographic features (elevation, aspect, slope position), etc.;
5. To utilize existing information and expert opinion to devise flow charts of predicted ecological succession for those ecosystems having high berry production;
6. To use all the above information in devising a prototype model for predicting the location of productive berry patches;
7. To identify a representative set of productive berry grounds and predicted berry patch locations to be field-checked in Phase Two, and to devise a preliminary field sampling procedure and berry crop ranking scheme for assessing those sites; and
8. To propose methods for determining sustainable berry yields and a sustainable area of productive berry sites for the study area.

In meeting those objectives, we are also exploring MoF's ability to address Gitxsan interests in securing a sustainable supply of berries at a strategic planning level, with a view to longer timeframes and larger spatial scales.

1.4 STUDY AREA AND SCOPE

For the purposes of this assessment, spatial analysis is limited to that portion of the Kispiox Timber Supply Area (Kispiox Forest District) encompassing the Gitxsan territories of Luutkudziiwus (known as *Madii Lii*), Gyet'm Galdoo (known as *Am Djam Lan*), and that portion of Djogaslee's territory (known as *Sagat*) located east and northeast of Highway 16 (see Map 1). This area is referred to as the "study area," "the project area," or "the area of interest" and is portrayed on maps spanning 55^{o} 05' N, 127^{o} 35'W (lower left) to 55^{o} 30'N, 126^{o}50'W (upper right). A summary of some forest cover features, the forest age class structure, and how these attributes are distributed among the house territories constituting the study area is provided in Table 1.

Table 1. Areas (ha) of the three house territories within the Suskwa study area, broken down by various forest cover attributes.

Attribute	House Territory			Total*
	Luutkudziiwus	*Gyet'm Galdoo*	*Djogaslee*	
Timber Harvesting Land Base (THLB)	12,553	3,692	4,610	20,940
Non-THLB Lands:				
Deciduous Leading	2,693	398	1,938	5,029
Alpine	7,651	4,254	3,152	15,116
Alpine Forest	1,877	330	461	2,672
Environmentally Senstive, ESA-1	2,647	868	589	4,131
Sensitive Terrain, Classes IV & V	817	809	1094	2,752
Total Study Area	35,075	14,135	14,414	63,892
Forest Age Classes	(THLB & non-THLB)			
1 (0-20 yrs old)	2,968	868	1,597	5,442
2 (21-40 yrs old)	705	77	553	1,334
3 (41-60 yrs old)	21	22	37	81
4 (61-80 yrs old)	1,016	37	734	1,801
5 (81-100 yrs old)	738	343	1,188	2,292
6 (101-120 yrs old)	695	393	502	1,597
7 (121-140 yrs old)	1,728	820	891	3,442
8 (141-250 yrs old)	12,492	3,760	3,681	20,0031
9 (>250 yrs old)	6,341	2,979	731	10,087
Total Coniferous Forest Cover	21,717	7,536	7,305	37,373

*values may differ slightly from the sum of territory areas because of slivers from unmatched boundaries.

Information on the biology and management of different berry species includes references from throughout the natural range of the respective species, with emphasis (especially in the case of traditional management techniques) on the traditional territories of the Gitxsan and Wet'suwet'en First Peoples. The habitat affinities and successional behaviour of identified species is based on information garnered from the forested biogeoclimatic subzones and variants found in the study area, namely the ICHmc1, ICHmc2, ESSFmc, and ESSFwv. Some tools and data layers used in predicting berry habitat suitability over space and time are based on predictive ecosystem mapping (PEM) and forest succession modelling tools under development by the B.C. Ministry of Forests. These tools are applied in this project for purposes of demonstration and experimentation, but are not approved for use in forest planning. Reference to relevant legislation, forest practices guidelines, and operating procedures refer to those in effect for the Kispiox Forest District at the time of writing (March, 2000).

2.0 BERRY SPECIES OF THE STUDY AREA AND THEIR BIOLOGY

2.1 EDIBLE FRUITS IN THE LOCAL FLORA

A total of 17 edible fruit or berry species are recorded as being found or utilized in the study area. Table 1 lists these species, and the sources of information we utilized in assessing their distribution in the area of interest. Compton et al. (1997) report H.I. Smith's catalogue of 25 species of wild plant fruits being known to Gitxsan peoples in the 1920's, including an additional 10 species not reported in Table 2. Despite this diversity of edible wild fruits, their sweetness, distribution, and the nutritional needs and preferences of people typically determine which species are actually utilized and sought after. For example, many people do not bother to eat thimbleberry, black currants, hazelnuts or rose hips these days. Likewise, raspberries, gooseberries, and lowbush blueberries are often picked opportunistically, but are rarely the subject of foraging trips. Saskatoons, raspberries, rose hips, and wild strawberries are usually quite abundant in the disturbed low-elevation forests characteristic of inhabited valley bottoms in the mid-Skeena and lower Bulkley drainages, so those species are rarely the object of foraging trips into the forested uplands, though they are found there too. In general, the target species for wild harvesting in the study area are soapberry, highbush cranberry, oval-leaved blueberry, and especially black huckleberry. Further discussion on the biology and management of wild berries in the Suskwa River area is primarily restricted to these four species.

Table 2. Major edible fruits found in the study area, and sources of information.

Species	Common Name	BEC Relevés	Silvicultur e Surveys	Oral Interviews
Amelanchier alnifolia	saskatoon	x		x
Corylus cornuta	hazelnut	x	x	x
Fragaria virginiana	strawberry	x	x	x
Prunus virginiana	chokecherry			x
Ribes lacustre	black currant	x	x	
Ribes oxycanthoides	gooseberry		x	x
Rosa acicularis	prickly rose	x	x	x
Rosa nutkana	Nootka rose	x		x
Rubus idaeous	red raspberry	x	x	x
Rubus parviflorus	thimbleberry	x	x	
Rubus spectabilis	salmonberry		x	x
Sambucus racemosa	elderberry		x	
Shepherdia canadensis	soapberry	x		x
Vaccinium caespitosum	lowbush blueberry	x	x	x
Vaccinium membranaceum	black huckleberry	x	x	x
Vaccinium ovalifolium	oval-leaved blueberry	x	x	x
Viburnum edule	highbush cranberry	x	x	x

2.2 BLACK HUCKLEBERRY (*Vaccinium membranaceum* Dougl.)

Black huckleberry is the most frequently harvested wild berry species in British Columbia. It grows at moderate to high elevations in British Columbia, usually in old burns and clearcuts (Minore 1975, Gottesfeld 1994c). Huckleberry shrubs are deciduous, densely branched, low to medium in size (0.1 to 2.0 m tall), with extensive underground rhizomes and round purplish-black shiny berries. They are most abundant in the mountainous regions of southeastern British Columbia in the Interior Cedar-Hemlock (ICH) and Engelmann Spruce-Subalpine Fir (ESSF) zones, and are abundant in the Mountain Hemlock (MH) zone and the cool moist subzones of the Sub-Boreal Spruce (SBS) (Haeussler et al. 1990). Typically considered a species of mountains and plateaus, this plant is usually found above 800 m on the coast, above 1200 m in the southern Interior but at lower elevations in northern B.C. Shrubs are found primarily in the understory of coniferous forests and in forest openings and clearcuts on well-drained mountain slopes. Berry density and yields, as well as the vigour of vegetative growth, vary according to light availability. Optimal growth appears to occur in 75% to 90% of full sunlight (P. Burton 1998). Black huckleberry grows on poor to rich sites on acidic forest soils with a mor humus. It appears to thrive on sites which receive moderate amounts of snow in winter and which do not experience a summer moisture deficit (Haeussler et al. 1990). Historically berry patches were maintained through routine burning by First Peoples but the fire suppression policy of the B.C. Forest Service curtailed most traditional burning by the 1930's (Parminter 1995). Since that time many berry producing areas have reverted from shrublands to closed forest. Minore (1975) reports that many former berry grounds in Washington and Oregon have succeeded to low-quality subalpine forest as a result of fire suppression. His research suggests that huckleberry sprouts vigorously after a light surface fire. Recovery from fire varies with fire intensity, fuel condition, soil moisture and burning season (Minore 1975). Slash burning as practiced in B.C. clearcuts for pre-planting site preparation is typically of sufficient intensity to inhibit black huckleberry recovery for many years (Coates et al. 1990, C. Burton 1998).

2.3 OVAL-LEAVED BLUEBERRY (*Vaccinium ovalifolium* Sm.)

Oval-leaved blueberry is a highly shade tolerant shrub which produces large quantities of viable seed, dominant in the understory of hemlock (*Tsuga heterophylla*) forests from the Olympic Mountains north to coastal Alaska (Tappeiner and Alaback 1989). It is a diffusely branched rhizomatous deciduous shrub, 1-2 m tall, with blue to bluish-black berries with a frosty bloom. The shrub grows along the entire length of the B.C. coast. In the northern interior it is most abundant in the ICH and moist southeastern subzones of the ESSF and in the wetter subzones of the SBS. In the north, it now grows primarily on mountain slopes and is no longer found on valley bottoms in settled areas due to excessive disturbance. It can grow on sites with very poor to very rich nutrient status on thick acidic mor humus and podzolic soils. Although it can tolerate xeric to hygric sites, it grows most successfully on mesic to drier sites when there is little competition from other shrub species (Haeussler et al. 1990). Research by Alaback and Tappeiner (1991) in northern southeast Alaska suggests that blueberry takes three to four years to respond after canopy opening. Oval-leaved blueberry does not appear to respond well to fire. A study by

Lafferty in southwestern B.C. (reported in 1972, as cited in Haeussler et al. 1990), suggests that three years after a moderate burn, oval-leaved blueberry had not yet regained its vigour.

2.3 HIGHBUSH CRANBERRY (*Viburnum edule* (Michx.) Raf.)

Highbush cranberry is a deciduous, multi-stemmed rhizomatous shrub that grows between 0.5 to 3.0 m tall and has red drupes with a large flattened stone. It is found throughout British Columbia in most biogeoclimatic zones but it is primarily a species of the true boreal region. In the north, it is rare in the MH zone, the Spruce Willow Birch (SWB) zone and the upper ranges of the ESSF zone. It is most dominant in the SBS and Boreal White and Black Spruce (BWBS) zones. Highbush cranberry can be found on moist well-drained soil types that are medium to very rich in nutrients. Best growth occurs on floodplains where it dominates under an overstory of black cottonwood (*Populus trichocarpa*) or balsam poplar (*Populus balsamifera*). It is commonly found in the understory in deciduous and coniferous forests and is described generally as a shade tolerant species. Highbush cranberry responds rapidly to shallow burns which promote both vegetative reproduction and regeneration by seed (Haeussler et al. 1990). Berry crops on the coast appear to improve following light disturbance or clearcutting (Haeussler 1987). In contrast, studies in the SBS zone north of Prince George, B.C., and in Alberta suggest that clearcutting does not promote rapid reestablishment of this species. But in boreal balsam poplar stands in Alaska, logging appears to increase establishment of highbush cranberry (Haeussler et al. 1990). These differences might be explained by differences in site richness or in differences in disturbance intensity.

2.4 SOAPBERRY (*Shepherdia canadensis* (L.) Nutt.)

Soapberry is largely an interior species found where the climate is dry. It is an upright deciduous, nitrogen-fixing dioecious shrub that attains 1 to 4 m of height on nutrient poor gravelly soils (Turner and Szczawinski 1988). It occurs most commonly at low elevations in interior valleys but its range can extend to the lower ESSF (or even the lower parkland phase of the ESSF), and the SWB zone. Although soapberry is very drought tolerant and is most abundant throughout the interior on drier sites, best growth occurs on moist fertile soils. However, in this type of habitat it does not respond well to competition from other species (Haeussler 1987). Perhaps more than any other species in the study area, soapberry might benefit from brushing and weeding to enhance growth. Because of its nitrogen fixing ability, soapberry is well adapted to regenerate after disturbance and it responds well to repeated burning. Soapberry grows well in stand openings, on forest edges, in the understory of lodgepole pine (*Pinus contorta*) or Douglas-fir (*Pseudotsuga menziesii*), and to a lesser degree on spruce (*Picea glauca* or *P. engelmannii* x *glauca*) or aspen sites. Berry production seems to be highest in full sunlight or partial shade (Haeussler 1987). This has been further confirmed by P. Burton (1998) who reports that berry production peaks at 75% of full sunlight but mean berry size decreases linearly with increasing light intensity. P. Burton (1998) also found that peak vegetative growth occurs somewhere between 41% to 75% of full sunlight.

3.0 TRADITIONAL FIRST NATIONS USE AND MANAGEMENT OF BERRIES

3.1 GENERAL

Historically, berries were a major food source for First Nations People in British Columbia (Lepofsky et al. 1984, Gottesfeld 1994a, Turner 1997). Coastal peoples were primarily dependent on fish and sea mammal for their protein (Turner 1995) and Interior peoples depended on large game and fish (Gottesfeld 1994b). Berries were an important food supplement for all First Peoples, along with roots, bulbs, and shoots gathered selectively and sustainably (Gottesfeld 1994a,Turner 1997). Roots, bulbs and shoots were eagerly sought in the early spring to relieve the monotony of the winter diet and at times to ward off starvation (Macnair 1997). Later in the summer, berries provided vitamins, minerals, natural sugars and calories (Turner and Szczawinski 1988). From interviews conducted with Wet'suwet'en elders, Gottesfeld (1994c) concluded that berries were quantitatively and nutritionally the most significant plant food in the pre-European diet.

Across North America, forests, parklands, and prairies were actively managed by First Peoples long before the arrival of European settlers (Lewis and Ferguson 1988). Evidence of such management can be traced through paeleoecological study (Spisak 1998), accounts of early explorers (Dawson 1881, Gauvreau 1891, Poudrier 1891, 1893) and through corroborative oral histories among First Nations elders (Leposfsky et al. 1984, Gottesfeld 1994a). Lands were managed by burning at regular intervals to facilitate the hunting of game, to improve grazing areas, to clear campsites, to facilitate travel, and to enhance the production of foods, especially berries (Parminter 1995). It has also been concluded that wild berries were actively managed by manually pruning the bushes and removing encroaching vegetation (Turner 1997, Spisek 1998).

3.2 NORTHWESTERN BRITISH COLUMBIA

In the traditional Gitx̱san territories of the mid-Skeena region, a variety of berry species were picked throughout the summer. Berry collection began in June as the first wild strawberries and soapberries ripened, or (in the case of soapberries) were harvested green. Saskatoon, currant, raspberry and thimbleberry were harvested in July, followed by blueberries and huckleberries in mid to late August. The berry season ended with highbush cranberry and rose hips being picked in the fall, or even in early winter. The berries were either eaten fresh, dried on racks and made into berry cakes, or preserved in rendered grease (Gottesfeld 1994c). Principal species used for berry cakes were black huckleberry, blueberries, soapberry, and saskatoons.

The ethnographic record of cultural geography compiled in support of the Delgamuukw court case (inspected at the Gitx̱san Treaty Office in Hazelton, with salient details summarized in Appendix I) reports that each Gitx̱san house group (*huwilp*) had several named and maintained "destination" berry patches. In the southeastern corner of traditional Gitx̱san territory, the trail connecting Hazelton with Fort Babine was frequently used to access berry patches. Neil Sterritt Jr. recalls that sometimes berries were picked at a spot near a home cabin, but frequently whole families would trek out along the Babine Trail to good huckleberry patches and spend two to three days picking. Berries were gathered in lard pails, coal oil cans and bentwood boxes (Appendix I). According to Mr. Sterritt, they were usually dried at the site on drying racks:

> *Drying racks were made with long splinters of cedar wood, made in an A-frame, lashed together. Thimbleberry leaves were placed on top of the rack and then the huckleberries were crushed on the leaves and placed above a slow fire. More thimbleberry leaves were put on top of the crushed berries and after a while the leaves were turned over. When the berries were dry they were removed from the leaves, rolled into cakes and hung in long houses.*
>
> (N.J. Sterritt, interview conducted February 2, 2000).

Berries preserved in this way were used throughout the winter and were also traded with coastal peoples for oohlican grease, seaweed and seafood (E. Hilbach, interview conducted January 13, 2000).

3.3 BERRY PATCH MANAGEMENT

Since berries were such an important food supplement, it was important to First Peoples to maintain or manage their good patches so there would always be an adequate supply. Patches were maintained mostly by low intensity burning at regular intervals to halt encroaching vegetation and to burn off old woody bushes, allowing the growth of new shoots. It is well known that native people were very adept at planning and managing low intensity fires (Parminter 1995, Spisak 1998, and others). We have gathered over 30 specific references of burning for land management by native peoples, many on the traditional territories of the Gitxsan and Wet'suwet'en peoples (Appendix I). Species managed in this manner include the *Vaccinium* species (black huckleberries and blueberries) and soapberry; highbush cranberry was not burned Men generally burned the patches in the fall after the berry crop was harvested while they were hunting for goats in areas above the berry patches (Gottesfeld 1994b). The reported periodicity of burning ranges from three to seven years and burning was carried out when the berries were sparse, small or "not sweet anymore." Because patches were burned repeatedly with a relatively light fuel loading, their behaviour and impact was much different than the broadcast burns used for slash removal and site preparation after logging.

Under the traditional Gitxsan model of land and resource management, berry patches were analogous to favored fishing sites in being inherited and valued geographic features of each *huwilp* territory (Anonymous 1999). In practice, each *huwilp* territory (averaging 29,726 ha in area) or portfolio of territories (averaging 66,731 ha in size) served as a sustained yield unit for the provision of fish, game, and botanical products. Familial sharing and exchange, along with trade among houses and Nations, made up for uneven distribution of resources. Territories were managed, primarily through the use of prescribed fire and periodic harvest restrictions, to provide a sustainable balance of resources (People of 'Ksan 1980, Anonymous 1999).

The adoption of a European diet (including refined sugar, rice, potatoes and other garden-grown vegetables and fruits) by the Gitxsan people occurred over 100 years ago (K. Rabnett, pers. comm.). Yet wild berries continue to be an important source of food, especially among families not well integrated in the cash economy. Lepofsky et al. (1985) assert that the diet and health status of First Peoples would be enhanced by encouraging the use of nutritionally rich indigenous foods. There is widespread disappointment that traditional berry patches, often located within walking distance of villages, have been allowed to deteriorate. Access to current berry harvesting areas (primarily in clearcut logging blocks) now requires use of a vehicle and extensive travel on dangerous logging roads. It was pointed out to us during the course of interviews that many people in the community do not have their own vehicles, relying on friends, family and hitchhiking for transportation. Though territorial access rights are not uniformly enforced among *huwilps* today, all Gitxsan house groups no longer have productive berry patches on their respective territories.

The recent deterioration of historically productive berry patches is reflected in the 1988 Delgamuukw testimony of V. Smith, with respect to a territory in the Cedarvale-Kitwanga area:

> *Q. Are there still blueberries on that Xsi Galii Gadsit territory?*
> *A. No.*
> *Q. Why not?*
> *A. The brush, too many brush for the blueberries to grow there. If there's any it's very few, it's not worth going up there.*
> *Q. And can you say about when that brush grew up to where you couldn't get those blueberries there?*
> *A. Until I was about 16 [ca. 1960], I guess we couldn't. We almost went up there for nothing that year.*
> *Q. So after you were 16 there was no point in doing that?*
> *A. Yes.*
> *Q. Okay. Is there any way of making that possible again?*
> *A. Yes. In our tradition we usually burn the place over again in order for the berries to come back. The berries usually come back about 3 years later after you burn it, 2 or 3 years after we burn it.*
> *Q. And why after you were about 16 did you no longer do that?*
> *A. We are restricted by the Province. If they know that we ... know we're burning it, we could be charged, so we didn't burn it.*
>
> (*Delgamuukw et al. vs. The Queen*
> Exhibit 429, pages 5665-5666]

There are some interesting ecological, anthropological and forest management issues associated with the traditional management practice of burning berry grounds. In particular, was fire used simply because it was the only tool at hand, or the most expedient tool available for killing trees over several hectares of land? Or are there mechanisms of prescribed fire which have a stimulatory effect above and beyond the removal of overhead shade? If so, what are the attributes of fuel loading and fire intensity which define the window of positive effects? Are traditional berry patches now so overgrown with trees and other non-crop (non-berry) species that they can no longer be restored using fire?

4.0 HISTORIC BERRY PATCHES AND BERRY MANAGEMENT IN AND AROUND THE STUDY AREA

4.1 METHODS OF DATA COMPILATION

The location of traditional berry grounds in the study area, and their management by First Peoples, has been inferred from a number of direct and indirect sources. Firstly, we consulted written compilations of the diaries and observations made by early European travellors in the area, such as G.M. Dawson (1881) and A.L. Poudrier (1891, 1893). These observers often commented on the extent of aboriginal burning, some of which we can infer was related to the management of berry picking areas. But they are largely silent on the location and value of discrete berry harvesting grounds.

More concrete information on locations of familial berry grounds and traditional harvesting areas has been obtained from oral histories and their various compilations. These ethnographic and placename compilations by local historians such as Neil Sterritt Jr. and Kenny Rabnett have been relied upon heavily. Another rich source of information was the many affidavits and trial testimony describing *huwilp* territories made by hereditary chiefs in support of the Delgamuukw court case in the late 1980's. While providing detailed textual information for some other territories, the court material was rather sparse in reference to the Suskwa study area, though map names and references provided important insights.

Oral history was also collected from local elders with personal knowledge of the study area. Using the same interview techniques described for the compilation of data on current berry picking activities (Section 5.1), we determined some pre-1950 berry picking locations and practices from discussions with Emma Hilbach, Neil Sterritt Jr., Arthur and Martha Ridsdale, and Leonard George.

Finally, we inferred the presence of berry grounds and berry processing camps from archaeological evidence such as the documented locations of old berry drying racks (e.g., Rabnett 1999). While most references to berry gathering areas are fairly general in their description, others are more specific and have been mapped as such.

4.2 GENERAL PATTERNS

Information compiled from the above sources has been summarized in Appendix I. We obtained evidence for nine historic berry gathering areas (generally defined) and four historic berry patches (with specific locations) in the project area (Map 1). Another historic berry area (or an extension of one within the study area boundaries) and documented berry patch was situated on the lower reaches of Harold Price Creek. Another two berry areas and two more berry patches were located closer to Hazelton, outside of our study area, on the slopes of Nine Mile Mountain. Within the study area, historic berry lands cover 6,193 ha in *Madii Lii* (17.7% of study area, 2,269 ha or 18.1% of THLB), 1,046 ha in *Am Djam Lan* (7.4% of study area, 244 ha or 6.6% of THLB), and 1,791 ha in *Sagat* (12.4% of study area, 753 ha or 16.3% of THLB). This means that 9,032 ha in total (14.1% of the study area, 3,268 ha or 15.6% of the THLB) was used for berry production and harvesting at one time or another in the past (Table 2). This area of 9,032 ha in historic berry patches is greater than the area of land in age classes 1 through 4 (<80 years of age) found in the study area today (Table 1). This suggests that historic berry gathering areas were not all used at the same time, and/or the current forest age class structure is incapable of supporting historic berry production levels.

The degree of specificity and reliability in historic references to traditional berry gathering areas varied considerably. For example, Neil Sterritt's notes in "Data Sheets, Topographic Surveys -- Gitksan Territories" (1979+) record that Mary Mowatt told Martha Brown in 1972 that "...on Babine Trail, She-wilth-baalth-it is a place for berry picking." Based on a knowledge of the study area's place names and the evolution of anglicized spellings for Gitxsan names, we can place this reference to Xsu Uux Bahlit, also known as Thirty-Three Mile Creek, on the north side of the Babine Trail as it approaches the Suskwa Pass. A traditional campsite near there, called "Main Camp," is known to have served as a berry processing camp, but the precise location of its berry gathering hinterland is unknown. So the portrayal of berry gathering area MM-1 is shown as a broad oval covering most of the drainage area of Thirty-Three Mile Creek below tree line.

In contrast, Kenny Rabnett quotes David Greene as referring to the same Thirty-Three Mile Creek, and that "Ants'Amlan is a lake at the head of a creek there; [above it is located] Luutguhabasxw, a grassy area with lots of groundhogs. We picked berries there at Uuxs Bahlit. It belongs to Ben Mackenzie or the Babines." That description of a lake at the head of a creek, immediately adjacent to an alpine area, allowed us to precisely locate the historic patch labelled KR-25, though the reference to picking berries may still be referring to the entire region, not just the spot identified in the previous sentence.

Other historic references were too vague or contradictory to be counted. For example, Anax Maiy is certainly a berry gathering area that is at least partly in the study area, and if maiy is equivalent to maa'y then the name may loosely translate to "true berry place" (Hindle and Rigsby 1973). The name shows up northwest of the Suskwa Pass on the territorial maps of Gitxsan placenames prepared by Marvin George and Neil Sterritt in 1989 (as shown on Map 1). But much of this area is rocky alpine terrain, and Ben Mackenzie (in a June 11, 1979, interview) reports that "East of Netalzul Mountain is a berry area, Anx Maii. It comes down to Babine Trail at Stump Camp." (N.J. Sterritt, unpublished manuscript). This indicates that Anx Maii is a berry patch and that it is somewhere to the south (or southwest or southeast) of Suskwa Pass. Another source cited by K. Rabnett says "Gitem Goldo owns the east side of Anax Maiy. The Carrier people call that place Gitnee Ts'ihl (Gitxsan Hill)." This implies that Anax Maiy is a hill, perhaps the one between Thirty-Three Mile Creek and Berry Camp Creek, as shown on the map, though ownership by Gyet'm Galdoo implies it must be on the southwest side of Suskwa Pass (as also implied in Delgamuukw court affidavits). So we do not identify Anax Maiy as a berry area for portrayal on Map 1 and for subsequent analysis, and its true identity and exact location remain a mystery for now.

The high elevation forests and meadows approaching the Suskwa Pass were a very important berry gathering area. There were three campsites in the area, known as Main Camp, Berry Camp, and Stump Camp, all of which probably served as bases for berry collecting or berry processing. This area represents the easternmost reaches of the ICHmc1 biogeoclimatic subzone, with ESSFwv on its western slopes, and the ESSFmc on the east side of the pass. There are references to four or five (counting the ambiguous one mentioned above) berry gathering areas in that general vicinity. The most complete description was provided by Mary Moore, referring to her childhood in the 1930's and 1940's:

> *"... we go past Xsu Uux Bahlit from our main camp to another camp at the other end of Uuxs Bahlit. We have to overnight there. We picked soapberries at the far camp, then we load them on the horse and bring them to Xsu Uux Bahlit. We were drying berries at Xsu Uux Bahlit one year and the men went to Babine to play ball. My grandfather had a big barrel at Xsu Uux Bahlit for cooking the berries in."*
>
> Unpublished manuscript on aboriginal boundaries in the Skeena drainage by Neil J. Sterritt Jr.

This quote provides the only reference to gathering soapberries at such high elevations.

It is noteworthy that all historic berry patches were accessed from the Babine Trail or the Moricetown-Hazelton trail. There is no record of berry picking occurring up Natlan Creek (previously called Skilokis Creek) or Iltzul Creek. The earliest European references to this area revolve around the Babine Trail and also mention its role in servicing berry-producing areas. A letter from William Downie to C.C. Douglas, dated Oct. 10, 1859, notes "a fine trail through beautiful country... We came across plenty of Indians loaded with berries..." (Rabnett 1998). This trail was clearly a prehistoric trade route between coastal and interior peoples, part of a widespread system of "Grease Trails." In addition, many references are made to the Suskwa Valley as a traditionally "rich country," considered the "breadbasket of the Gitx̱san" because it had been so productive in terms of wild game, berries, and other foodstuffs (Don Ryan, pers. comm.).

Another line of evidence comes from artifacts related to berry processing found at a number of locations in the study area. These artifacts typically include berry drying racks or the wooden strips used to assemble them, and bentwood boxes made of cedar wood. Neil Sterritt and Ben Mackenzie Sr. recall finding such materials in their youth. New archaeological sites containing these sorts of aboriginal artifacts, often intermixed with European trade goods made of metal or glass, are still being found (Rabnett 1999). It is interesting to note that the two such sites shown on Map 1 (DES-23 and KR-24) are found at relatively low elevations (500 m to 600 m) on north-facing slopes, and are dominated by dense even-aged conifer stands in age classes 6 and 7. This implies that the last fire through these areas occurred more than 120 to 140 years ago, and open conditions suitable for huckleberries or blueberries last existed from 1880 to 1900. It is unlikely that these sites retain berry plants in sufficient abundance to make it worthwhile rehabilitating these locations as berry production areas, but field checking will be needed to confirm this.

Finally, a number of historic berry gathering areas are inferred from a combination of local knowledge, historical documents and forest cover. For example, it is believed that the *Madii Lii* hillside (also known as The West Hills) was last burned in the 1920's. It is dominated by trembling aspen (*Populus tremuloides*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and paper birch (*Betula payrifera*), hardwood species which have the ability to resprout from root suckers and stumps and hence are known to rapidly recolonize burned areas. In their study of deciduous-dominated plant communities in the ICHmc2 and SBSdk subzones, Oikos Ecological Services Ltd. (2000) note that "the low numbers of conifers in many of these upland stands suggests a long history of repeated burning." We have designated the south-facing slopes of *Madii Lii* as KR-4 on Map 1, divided into three segments (A, B, and C) based on slope breaks and the likely berry species harvested on different terrain. Dawson (1881), reporting on his travels through the area in June, 1879, remarks that, "The hillsides generally have been almost denuded of trees by fire, and exhibit a rank growth of grass, wild pea, *Heracleum* and *Epilobium*, in some places already shoulder high, and offering very fine summer pasture for stock." Gavreau (1891) likewise reports that "...from the sixth to the twelfth, and from the twelfth up to the twenty-seventh [miles from the mouth of the Suskwa], the country is burnt and barren." Gauvreau (1891) also identifies the place labelled KR-2 as "...burnt and barren; on the north, from the sixteenth to the twenty-seventh [mile from the mouth of the Suskwa], it is the same." Poudrier (1893) makes similar comments about the wagon road between Hagwilget and Moricetown, also referred to as part of the Telegraph Trail.

It was the belief of Gauvreau (1891) and Poudrier (1893) that the widespread *brulé* (burnt timber) was due to abandoned campfires. Though it is now widely accepted that fires were more often then not set on purpose by First Nations People (Lewis and Ferguson 1988, Turner 1991, Gottesfeld 1994b), it would be a mistake to infer that all burnt areas were managed for berries. Huckleberries and oval-leaved blueberries are less abundant at lower elevations and are typically sparse in deciduous forests, making it unlikely that much of the burning along travel corridors was designed to promote these species. Early European travelers also remark on the lush growth of grass and other herbaceous species in these burnt areas. Trailside burning and open deciduous habitats undoubtedly promoted the productivity of some berry species (such as highbush cranberry, soapberry and red raspberry), but it is also possible that these areas were burned in the 19th Century to promote forage production for use by wild ungulates or by horses and mules. Trails through grizzly country (such as the Suskwa or "Bear River," where Art Ridsdale's grandfather was killed by a grizzly bear) may also have been fired regularly for safer travel. Some historical ecology, stand reconstruction and fire history studies remain to be conducted in the field to determine the fire frequency, fire intensity, and species which have benefited from the repeated burning of areas now covered with deciduous forest.

4.3 LEGISLATIVE AND POLICY FRAMEWORK FOR PROTECTION OF TRADITIONAL USE AREAS

Historic berry gathering areas, especially those used by First Nations People prior to the Second World War, can be considered "cultural heritage resources" for the purposes of forest planning. As such, traditional berry grounds may require special planning or protection according to the provisions of the Heritage Conservation Act (1996, Revised Statutes of B.C., Ch. 187), the Forest Practices Code of B.C. Act (1995) or the 1993 Supreme Court of Canada decision on the Delgamuukw case. Policy emerging from these three legal foundations include operational planning regulations in each Forest District, the Protocol Agreement on Cultural Heritage Resources Management (1996), the Ministry of Forests Protection of Aboriginal Rights (1997) policy, and the Memorandum of Agreement on Heritage Trails (1995). These legal considerations are also the basis for the Culturally Modified Tree (CMT) management procedures and archaeological resource management in general (Carlson and Mitchell 1997, Rabnett 2000).

Some berry gathering and berry processing areas may also constitute archaeological sites. An archaeological site exhibits physical evidence of the past activities by human beings. Archaeological sites are distinguished from other heritage sites by the presence of physical cultural remains and the necessity of interpreting them through the use of archaeological techniques of enquiry. Once encountered, an archaeological site can automatically be considered a traditional use site (TUS) as well, and must be reported to the B.C. Archaeology Branch and recorded with the Provincial Heritage Registration Database and the Canadian Heritage Information Network. Archaeological Overview Assessment sheets should also reference all recorded archaeological sites (Rabnett 2000).

Traditional Use Sites are geographically defined areas where aboriginal people conducted traditional activities such as fishing, hunting, gathering and ceremonies. When considering TUS it is the activities carried out at a particular place, and the living memories of those activities, more so than material remains, that are most important. The place may be or not be used at the present time, and there may be no physical evidence of the activity at the site. However, there is a direct connection between the living aboriginal people of the area, traditional use activities and the place (Rabnett 2000)

The presence of historic berry gathering areas has several implications to forest planning and management. Firstly, documented or expected traditional use sites (including traditional berry patches) signal the need for special diligence in searching for cultural artifacts while doing silvicultural prescriptions and block layout. Culturally modified trees, old berry drying racks, and even bentwood cedar boxes are often found in old berry gathering areas, including some of those documented in this study (Rabnett 1999). These Cultural Heritage Resources must be brought to the attention of the relevant First Nation and the Archaeology Branch; decisions will then be made as to how best to document, protect or salvage the material. Secondly, former berry gathering areas indicate the presence of potential habitat for modern berry use and management. Old berry patches may sometimes be restored through canopy opening and/or the use of prescribed fire. Alternatively, the berry-producing shrub community may have been so suppressed for such a long time that considerable effort would be needed to reestablish a viable stand of the same species at the same site. Options to maintain, enhance or restore the berry-producing potential of these sites may depend on their cultural importance, accessibility, local rarity and other social issues in addition to habitat suitability. On-site inspections of the current condition of historic berry gathering areas must be made before the most prudent management option can be determined.

5.0 CURRENT BERRY PATCHES AND BERRY PICKING ACTIVITIES IN THE STUDY AREA

5.1 METHODS OF DATA COMPILATION

Information regarding the location, quality and use of modern berry patches was obtained primarily through oral interviews, following the questionnaire included as Appendix II. A A total of 17 people were interviewed, including:

- members of the Wilp Sa Maa'y Harvesting Co-operative (semi-professional berry pickers who sold berries to the Co-op in 1998);
- representatives of the Gitxsan houses of Luutkudziiwus, Gyet'm Galdoo, and Djogaslee and other First Nations people familiar with the area, as suggested by the GTO;
- current and former residents of the Suskwa Valley vicinity;
- recreationists who have explored trails and mountainsides in the area; and
- other people recommended by those to whom we spoke.

Interview methods generally followed the recommendations of Turner and Peacock (1998) and Bate (1999). We asked interviewees to locate the places they have recently picked berries on a 1:20,000 scale map (either forest cover or topographic, with roads, streams and cutblocks coloured with highlighter pen). Most people were quite capable of reporting precise location berry gathering areas, especially once they could retrace their travel route for accessing each site. As indicated on the interview form (Appendix II), we also asked for a description of each site, its access, and the berry species harvested there. We further asked about harvesting methods, patch quality, berry uses, site dynamics, site management, and any other additional insights and comments. We offered respondents the option of keeping berry patch locations confidential, in which case they would not be shown on plotted maps. In practice, such confidentiality was requested by only a few people, and then only for one or two favorite berry picking spots.

Each berry harvesting location described by each person was assigned an identification number (generally based on the person's initials, with a sequential numbering of patches reported by each person) and was entered as an independent database record. Several reports by different people referred to some of the same areas. These overlaps had to be identified and resolved before calculating the net area of berry patches, but each patch is reported independently on Map 1 and in the summary of responses provided as Appendix III.

A second source of information used to identify the location of extant populations of berry species was the relevé data recorded in support of biogeoclimatic and ecological research. Not shown on Map 1, and having no estimates of berry production, these plot locations and the cover of various berry-producing species provided additional quantitative data on the site-specific abundance of the species under study. These field plots often had site and soil descriptions as well. A total of 68 relevés sampled by the Research Section of the Prince Rupert Forest Region (Banner 1994) and by Oikos Ecological Services Ltd. (2000) were used in the analysis.

A third and final source of information for the distribution of berry species was the silvicultural survey records conducted in cutblocks as part of pre-harvesting silvicultural prescriptions, stocking surveys, free-growing surveys, etc. We manually went through the individual opening files and field notes associated with all cutblocks logged by Skeena Cellulose (Carnaby) and the MoF Small Business Enterprise Program (Kispiox Forest District). A number of other cutblocks managed by Bell Pole Co. of Terrace also exist in the study area, but their records were not inspected. Where separate survey results were reported for different strata within a cutblock, only data for the most extensive stratum were used unless the strata could be accurately mapped and recorded separately. These surveys often included estimates of the percent cover of dominant understory species or brush species competing with conifer regeneration. So, like the relevé data, these records for 79 cutblocks (or strata within cutblocks) help confirm the presence and abundance of different berry-producing species across the study area and at different stages of stand development.

Berry patch locations were digitized as a PAMAP (Version 5.2b) geographic information system (GIS) layer (Anonymous 1998). These patches were then overlaid with information from a number of other GIS layers as well:

- forest cover data (stand age, crown closure, tree species composition, etc.)
- topographic information (TRIM coverage, with elevations, slope, and aspect summarized into 8 compass directions);
- biogeoclimatic (zone, subzone, and variant) and ecoregion classification; and
- prototype predictive ecosystem mapping (PEM) estimates of soil saturation index, provided by the MoF Research Section (Morgan 2000).

Some locations, such as those containing cutblocks and relevé plots, were also linked to tabular information on site series, silvicultural treatments and percent cover by different plant species. All of these layers and datasets were then merged, with the smallest polygons resulting from the combined overlays being output as individual records. All analysis and output procedures were based on a minimal 20m x 20m pixel size, as per MoF standards. Of 281,937 resulting records/polygons for the map area, 54,769 records contained berry information and were then imported into SAS (Version 6.12) to statistically summarize the distribution of patch areas by various site attributes (SAS Institute 1988). Only general descriptions of current berry patch distribution are provided here, because all site attributes were not available for all locations, and because some features were not well correlated with the abundance of specific berry species (see Section 6).

5.2 GENERAL PATTERNS OF BERRY HARVESTING

Oral interviews resulted in the identification of 102 locations worth traveling to in recent years for berry picking (Map1). Of these, 11 are outside of our study area, and several overlap with each other. Another 7 locations in the study area were firmly identified as not being worthwhile for berry picking. Not all patches are shown on Map 1, as per the confidentiality requests of a number of people interviewed.

Current berry harvesting areas were approximately one-half to one-third the size of the historical harvesting areas in each House Territory (Table 3). Principal berry gathering areas include the flat lands south of the lower Suskwa River, on the upper north-facing slopes on the Hamblin Main Forest Service Road (FSR), and throughout the cutblocks on the Denison Main FSR. The greatest number of identified patches was found in recently logged areas, but the greatest overall area of berry picking was in mature or old forest (Table 3). Within the study area, current berry patches cover 3,099 ha in *Madii Lii* (8.8% of the study area, 2,158 ha or 17.2% of the THLB), 430 ha in *Am Djam Lan* (3.0% of the study area, 360 ha or 9.8% of the THLB), and 658 ha in *Sagat* (4.6% of the study area, 223 ha or 4.8% of the THLB). This sums to 4,187 ha (6.6% of the study area, 2,740 ha or 13.1% of the THLB) being actively harvested for berries in recent years (Table 3).

Table 3. Distribution of historic and current berry patches in the study area.

Attribute	House Territory			Total**
	Luutkudziiwus	Gyet'm Galdoo	Djogaslee	
Historic Harvesting Areas, ha	6,192.9	1,046.0	1,790.8	9,032.4
Historic Harvest Area, % of total study area	17.7%	7.4%	12.4%	14.1%
Historic Harvesting Areas in THLB*, ha	2,268.8	244.3	752.7	3287.9
Historic Harvest Area, % of THLB area	18.1%	6.6%	16.3%	15.6%
Current Harvesting Areas, ha	3,098.6	429.8	658.3	4,186.9
Current Harvesting, % of total study area	8.8%	3.0%	4.6%	6.6%
Current Harvesting Areas in THLB, ha	2,158.4	360.1	222.6	2,740.0
Current Harvesting, % of THLB area	17.2%	9.8%	4.8%	13.1%
Current Harvesting in Mature Forest, ha	2,325.4	167.7	459.1	2,952.2
Current Harvesting in Cutblocks or Open, ha	959.8	334.7	44.9	1,339.4

* THLB = Timber Harvesting Land Base
** values may differ slightly from the sum of territory areas because of slivers from unmatched boundaries.

Summarized throughout the study area and for all berry species harvested, a number of trends related to site and forest cover are evident. Area-weighted means, ± standard deviations and lower 5th percentiles and upper 95th percentiles for a number of continuous site and stand factors are as follows:

(Variable)	(mean ± standard deviation)	(90% of patches fall in the range of:)
• elevation, m:	898 ± 200	342 to 1354 m
• slope, %:	23.1 ± 10.4	3.7 to 53.0 %
• predicted soil saturation:	1.24 ± 0.67 (subhygric),	0.06 to 3.00 (submesic to hygric)
• stand age, years:	122 ± 69	0 to 296 years
• tree density, stems/ha:	670 ± 927	0 to 3,110 stems/ha
• crown closure, %	31 ± 13	0 to 60 %
• tree height, m	16.8 ± 8.9	0 to 36 m
• site index, m @50 yrs	12.9 ± 3.7	0 to 22.3 m @ 50 yrs

These descriptive statistics indicate a wide range of conditions under which berries are found, partly due to the large number of berry species being summarized. But inspection of the distribution of patches by site factors indicates that certain features are more important than others, as a whole. For example, the following sites and stands are more likely to be support harvestable species and quantities of berries:

- those between 800 m and 1,100 m in elevation (Figure 1);
- those with slopes of between 2.5 % and 22.5% (Figure 2);
- locations for which predicted soil saturation index is "mesic' (Figure 3);
- stand age class 1 (0 to 20 years old, especially in the 7 to 17 year old range) or age class 8 (140 to 250 years old; Figure 4);
- stands with approximately 50 % crown closure (Figure 5);
- stands with site indices of 7.5 to 17.5 m @ 50 years of age, generally "poor" sites for this area (Figure 6);

Figure 1. Association of current berry patches (all species) with elevation.

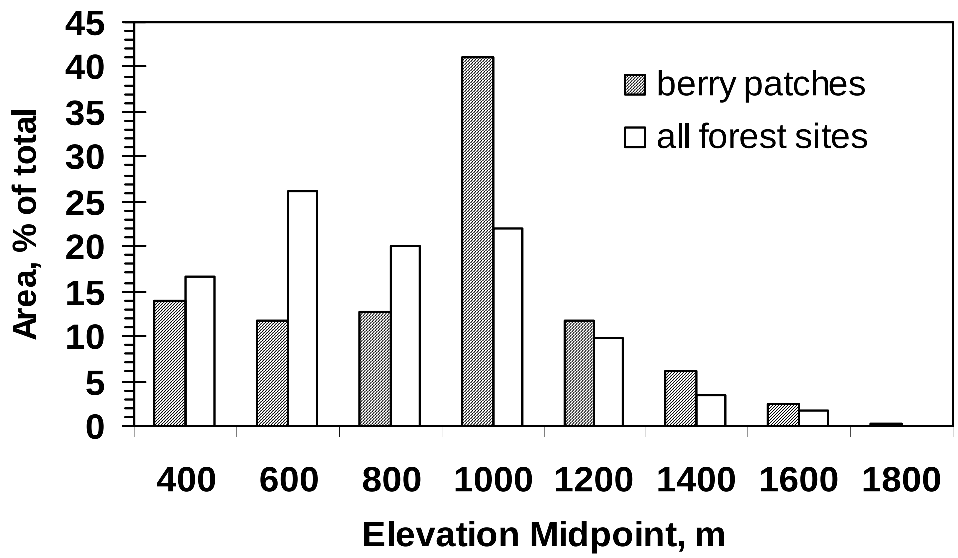


Figure 2. Association of current berry patches (all species) with slope steepness.

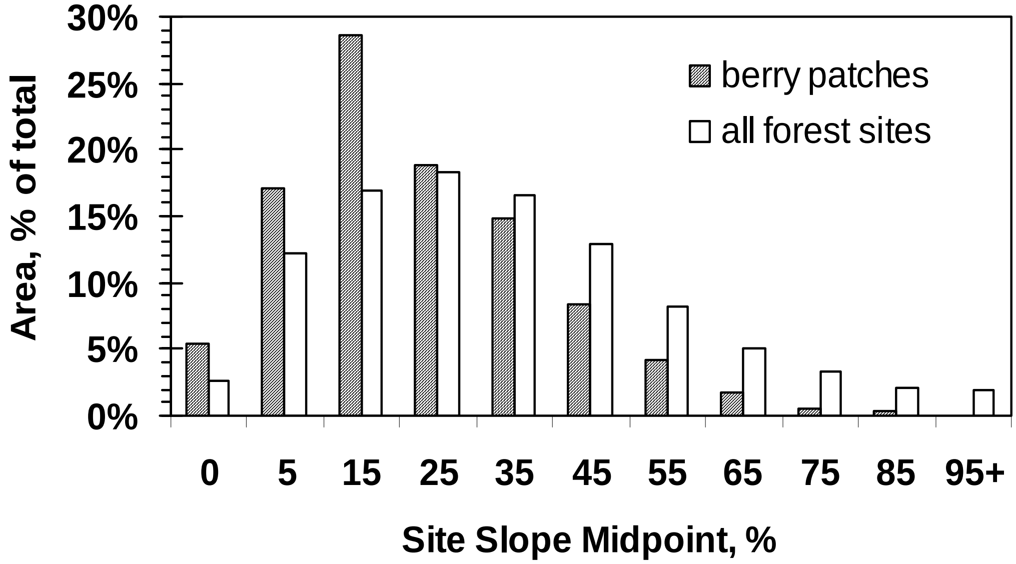


Figure 3. Association of current berry patches (all species) with predicted saturation index class.

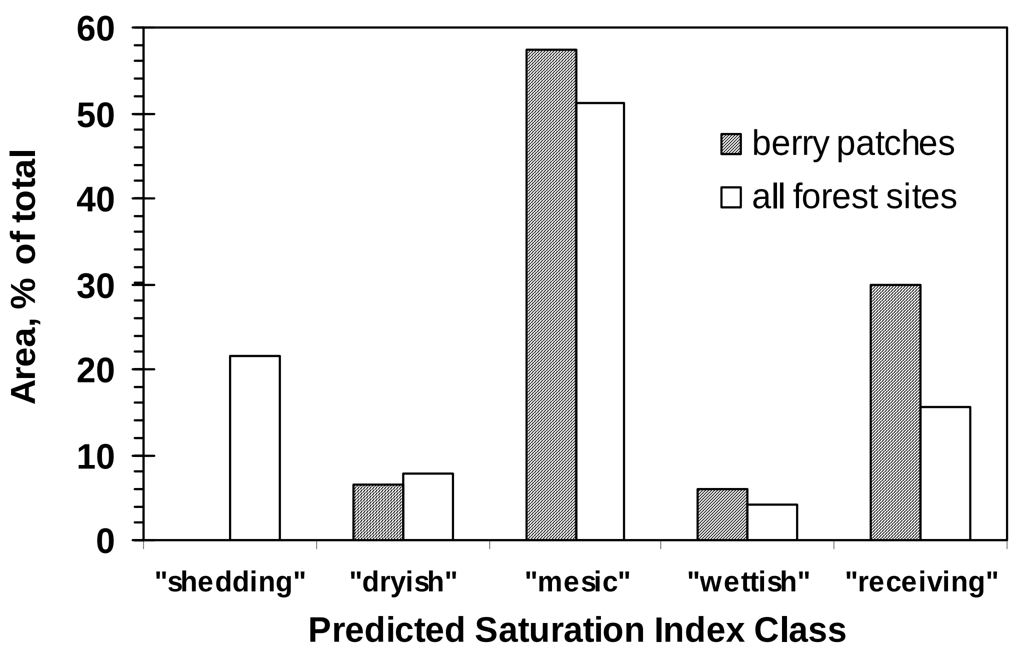
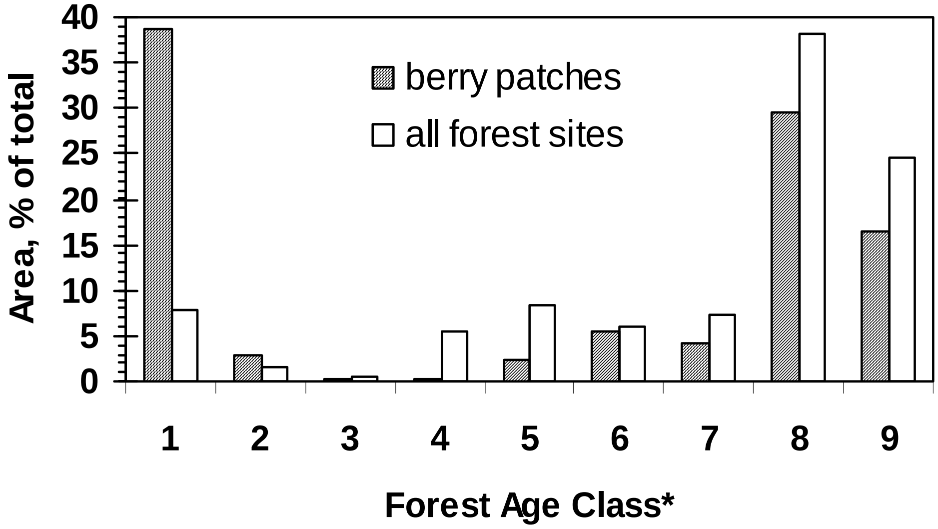


Figure 4. Association of current berry patches (all species) with forest stands of different ages.



* where age classes are: 1 = 1-20 years old, 2 = 21-40 years, 3 = 41-60 years, 4 = 61-80 years, 5 = 81-100 years, 6 = 101-120 years, 7 = 121-140 years, 8 = 141-250 years, and 9 = 251+ years.

Figure 5. Association of current berry patches (all species) with different degrees of forest canopy closure.

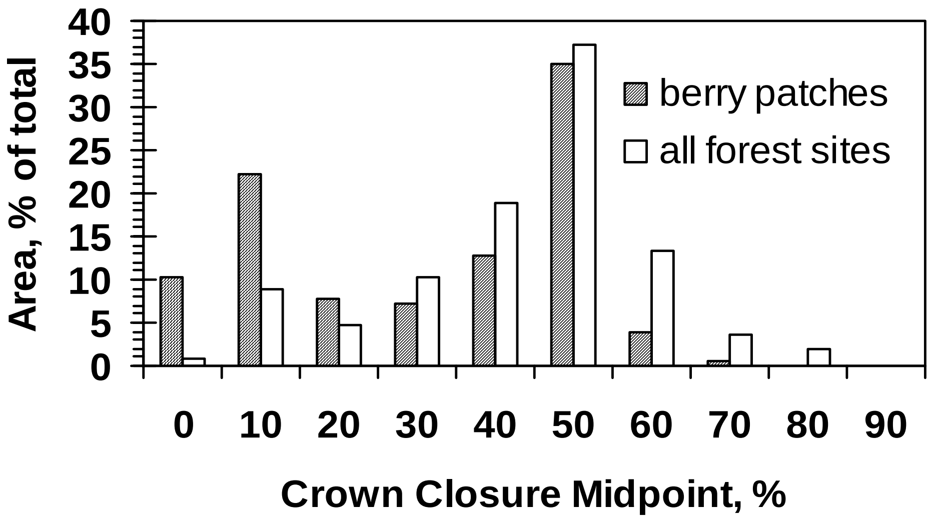
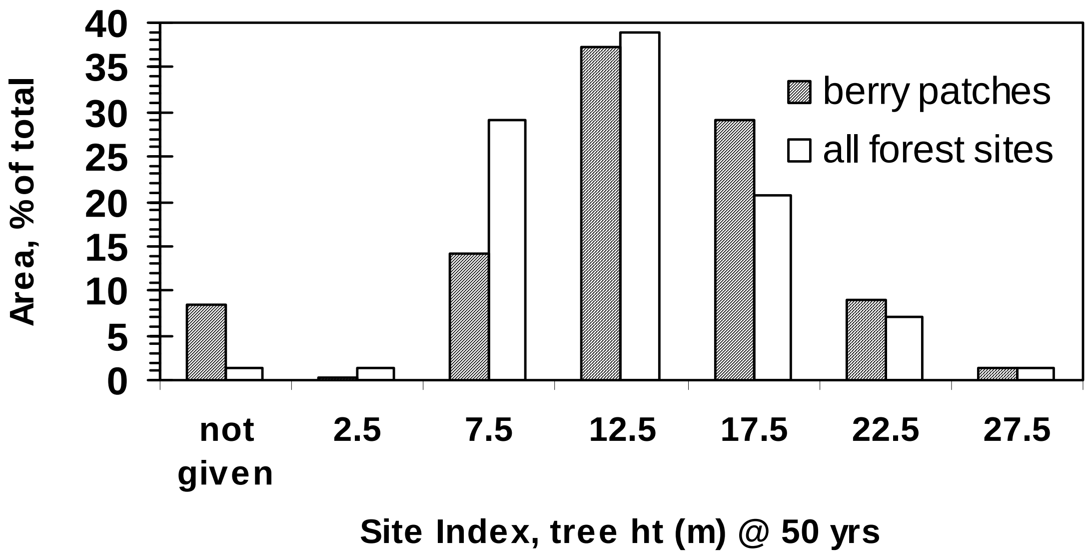


Figure 6. Association of current berry patches (all species) with sites differing in estimated productivity.



Cross-tabulation of current berry patch areas by categorical site factors further reveals the following associations:

- greater abundance on south-facing slopes (Figure 7);
- greater abundance in the ICHmc1 BEC variant (Figure 8);
- greater abundance in stands dominated by subalpine fir in old-growth, or by hybrid white spruce in cutblocks; and
- most berry patches found in cutblocks are identified as being on sites that have been prepared for planting through the use of fire.

Figure 7. Association of current berry patches (all species) with site aspect.

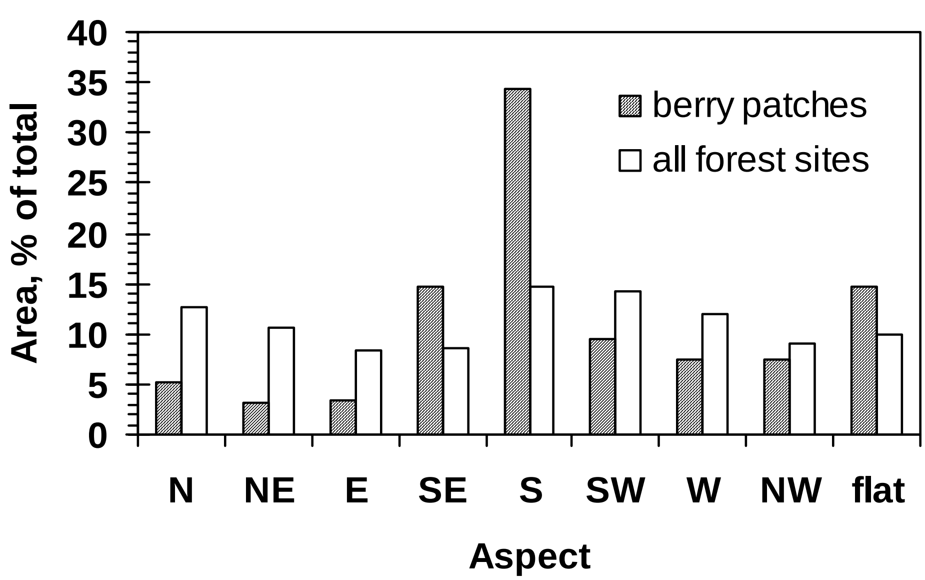
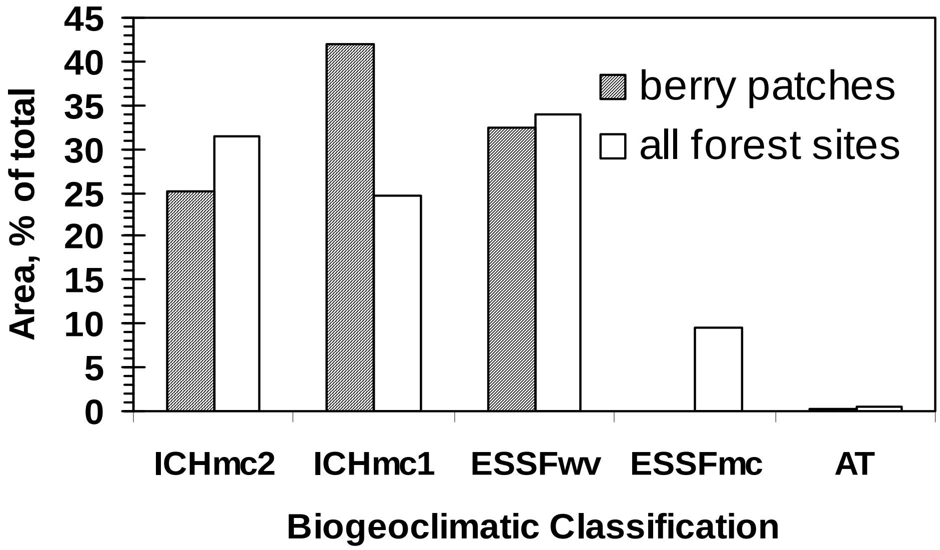


Figure 8. Association of current berry patches (all species) with biogeoclimatic subzones and variants.



descriptive. They do not imply a greater than random affinity of berry patches for certain site attributes, because those site attributes vary in their abundance across the landscape as well (as noted by the white bars in Figures 1 to 8). Only if a stippled bar is taller than the corresponding white bar for a given site attribute is there a greater than random association of berry patches with that particular type of site. These affinities are explored further, on a species by species basis, in Section 6.

6.0 PREDICTING BERRY HABITAT SUITABILITY

6.1 METHODS OF MODEL CONSTRUCTION

Berry habitat suitability consists of two broad considerations: (1) site attributes related to local climate and soils; and (2) stand attributes, related to forest cover, local vegetation, and successional status of a site. We have therefore divided the prediction of habitat suitability into two components, first to identify high and medium capability sites for four identified berry species, and secondly to identify optimal stand attributes that can serve as the basis for stand management options outlined in Section 7.

6.1.1 Predicting Site Suitability

Prediction of site suitability for each species drew upon information from the mapped locations of 102 current berry patches (derived from oral interviews, Section 5), from 68 biogeoclimatic or ecological relevés (Banner 1994, Oikos 2000), and from 125 silvicultural surveys and ISIS records (silvicultural prescriptions, regeneration surveys or free-growing surveys conducted in cutblocks by the Kispiox Forest District Small Business Forest Enterprise Program, or by Skeena Cellulose, Carnaby Division). Only documented, recent berry stands within the area shown by Map 1 (though not necessarily restricted to the study area) were used in the analysis. The extent of historic berry gathering areas was generally considered too vague or too great to be a reliable source of data on site requirements. Historic berry gathering areas can be considered traditional use features of the landscape as much as ecological features. It was beyond the scope of this project to predict the probable locations of additional historic berry patches, traditional use areas or archaeological sites associated with pre-1950 berry gathering activities.

We took a very empirical approach to predicting the berry habitat potential, conducting an independent analysis for each of the four species identified previously. The areas of the polygon records (derived from GIS overlays, as described in Section 5.1) were summarized using SAS proc UNIVARIATE for continuous data, and proc FREQ for categorical data (SAS Institute 1988). Since we are trying to predict "low," "medium" and "high" capability for berries, and since data for most attributes are normally distributed, we were able to use SAS proc UNIVARIATE to identify three levels of data percentiles (weighted by area) for each available site variable as follows:

rank	percentile floor	percentile ceiling	% of obs.
"high"	33.334	66.666	33.33%
"medium"	16.667	33.333	
	66.666	83.333	33.33%
"low"	minimum	16.666	
	83.334	maximum	33.33%

Likewise, areas of land tabulated into site categories by SAS proc FREQ were grouped into bins containing at least one-third, two-thirds, and all of the observations for documented berry plant locations. In other words, for all site variables tested, we were able to identify the thresholds or site classes associated with the most abundant 33.3%, the most abundant 66.7%, and all of the species' range in the study area. These thresholds and site classes were then used for the independent assignment of "low," "medium" and "high" site classifications for a number of variables. Variables were selected on the basis of visual inspection of data distributions, mapped information being available across the study area, and their overall independence from each other. Numerical variables included mean elevation (m), slope steepness (%), predicted saturation index, and site index (m@50yrs) for the polygon; categorical variables included site aspect (8 compass points or flat), biogeoclimatic variant, and leading forest cover species.

Some of the ecological and silvicultural survey data indicated trends in the distribution of berry species according to site series, but terrestrial ecosystem mapping (with site series classification) has not been done for the study area, making such relationships unsuitable for predictive purposes. Though dynamic over the history of any given site, the leading tree species is here considered indicative of some broad site distinctions. Weighting the analysis by percent cover or qualitative ratings of berry abundance resulted in no improvement to the resolution of optimal habitat. This analysis involved no testing of hypotheses, factor correlation or factor interaction, but served merely to identify a set of habitat thresholds. When grouped into high, medium and low habitat classes, all seven variables resulted in highly significant ($p<0.001$) habitat distinctions according to berry patch areas (as tested by chi-square analysis).

The thresholds identified in this analysis were then applied to the study area as a whole, i.e., to areas beyond those known to support berries. To derive an overall habitat rating for each berry species, the separate habitat rankings (1=low, 2=medium, and 3=high) generated from each of the seven independent site variables in each individual polygon were then averaged. Since all variables were highly significant predictors for each of the four berry species, we chose not to weight one independent variable over another. Some polygons lacked information on one or more attributes, making it important to give more weight to the remaining variables rather than to just imply a "0" score for missing data. We also took the conservative approach of assigning a "low" score for a polygon if it had any habitat attribute beyond the range encountered for that attribute on any of the sites known to support the berry species in question. Separate maps were produced showing "medium" and "high" quality habitat for each of black huckleberry, oval-leaved blueberry, highbush cranberry and soapberry.

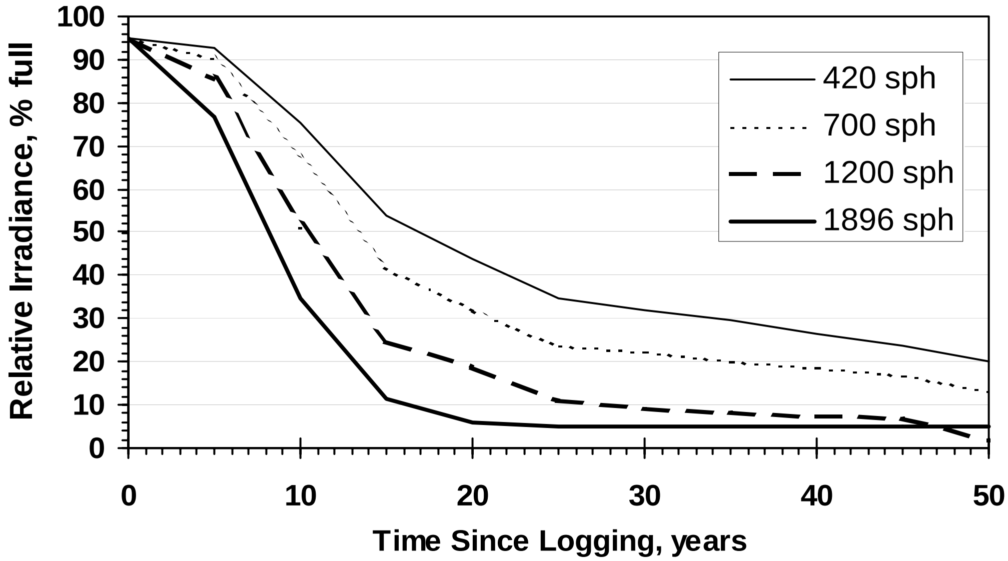
6.1.2 Predicting Stand Suitability

A similar analysis was used to explore forest stand traits for a range of conditions suitable for the maintenance or enhancement of berry production. Descriptive data analysis (SAS proc UNIVARIATE and proc FREQ) was undertaken for stand age and age class, for crown closure, and for stem density. It could be argued that stand composition also represents a potential management objective, but (as indicated above) we here chose to consider leading forest cover species as more an indicator of site.

The dynamics of forest stand development and its effects on berry productivity were explored with a simulation model. SORTIE is a multiple species, spatially explicit, resource mediated, individually based stand model (Pacala et al. 1993, 1996). This model has recently been calibrated for the Interior Cedar-Hemlock (ICHmc) forests of Northwestern B.C. (Kobe and Coates 1997, Wright et al. 1998, Canham et al. 1999, LePage et al. 2000). SORTIE-BC is still under development and has not been released for general use, being not well calibrated for timber volumes and for growth rates in open-grown plantations (presumably because the growth driver is calibrated by the optimal growth of light-limited seedlings and saplings). Nevertheless, it is a multi-species model that explicitly calculates light availability throughout the canopy profile, making it the most suitable tool available for predicting understory productivity. Dave Coates and Phil LePage of the Prince Rupert Forest Region Research Section made a beta version of SORTIE-BC available for this exploratory analysis, with the caveat that the growth and yield implications of the model are inadequately verified for use in operational planning.

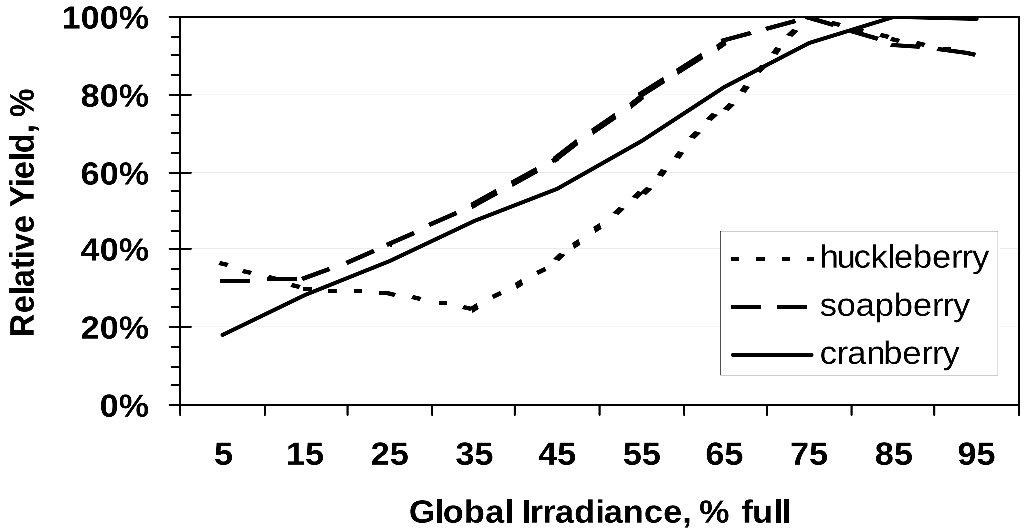
SORTIE-BC was initialized to have an average species composition and stocking level for cutblocks currently regenerated in the study area. Based on ISIS records, we estimate the average density of trees to be 1896 sph, consisting of 22.9% hybrid white spruce, 20.7% western hemlock, 20.3% lodgepole pine, 11.1% trembling aspen, 9.5% paper birch, 8.2% black cottonwood, 6.4% subalpine fir, and 4.7% western redcedar. These same proportions were then run for stocking densities of 1200 sph (generally the target level of stocking for these sites), 700 sph (minimum allowable stocking), and 420 sph (a 40% reduction from "minimal" stocking standards, sometimes permitted on "backlog" sites or to favour other resource values such as wildlife). The model was run over a simulated 4 ha area for 100 simulation years, with canopy closure and dense understory shading generally occurring in less than 50 years. A typical old-growth stand was first harvested so that the effects of simulated logging activities would be evident in the forest floor dynamics before the stand was regenerated by planting; no additional natural regeneration is assumed. The model was requested to output estimated light levels ("gap light index") at a height of 0.8 m at points on a 50 m grid every five simulation years. Figure 9 shows the predicted course of understory irradiance under four stocking levels. Since output consisted of a complete list of 1000 sampled light predictions (not just a mean), the frequency of different light levels binned in 10% increments was used to predict the full range of shrub responses.

Figure 9. Mean subcanopy light levels, simulated for ICHmc stand development.



A two-year research project into the biology of berry-producing shrubs in the ICHmc was specifically undertaken to provide data suitable for use in SORTIE-BC so that stand management options for some non-timber forest resources could be explored (P. Burton 1998). Relativized light response functions were generated from the average (in bins of 10% irradiance increments) of vegetative and reproductive response curves determined for black huckleberry and for soapberry in the P. Burton (1998) study; more sampling would be required to generate quantitative yield functions for fruit production. No empirical light response data were available for highbush cranberry, so as a broad-leaved deciduous shrub, it was arbitrarily modelled as the average of soapberry, red-osier dogwood and thimbleberry in its light response. Oval-leaved blueberry was not modelled, but can be considered very similar to black huckleberry. The functions used in modelling berry response to SORTIE-predicted light levels at 0.8 m above the ground are shown in Figure 10. With the distribution of predicted light values (also in bins of 10% irradiance, as shown in Figure 9) imported into a spreadsheet, light values were multiplied by these light response functions to predict relative habitat suitability for each berry species over the course of stand development under different management scenarios.

Figure 10. Yield response functions used for three berry species.



Current stand suitability for berries, based on forest cover estimates of stand age, crown closure and species composition, in combination with site suitability classes, could have been mapped in low, medium and high categories. But such determinations would be temporary (dependent on the state of the forest at the time of inventory), are not required for the management options developed in Section 7, and would require plotting another four map sheets. So mapping was not done for current habitat conditions.

6.2 MAPPING HABITAT CAPABILITY

6.2.1 Species Association With Site Factors

Most individual berry species exhibited normal (parabolic) levels of abundance across a range of continuous site attributes, much as portrayed in Figures 1 to 8. Species showed distinctive affinities with some site conditions, such as the prevalence of soapberries at elevations of 300 to 700 m, in contrast to the association of huckleberries with elevations between 900 and 1100 m (Figure 11). This elevational affinity is also portrayed as a differential association of each species with biogeoclimatic variants. Other site attributes (such as slope steepness, predicted saturation index, site productivity and aspect) were more uniform in the range of conditions which described identified habitat for all four berry species. For example, all species showed an affinity for south-facing slopes (Figure 12).

Figure 11. Distribution of huckleberry and soapberry stands with elevation.

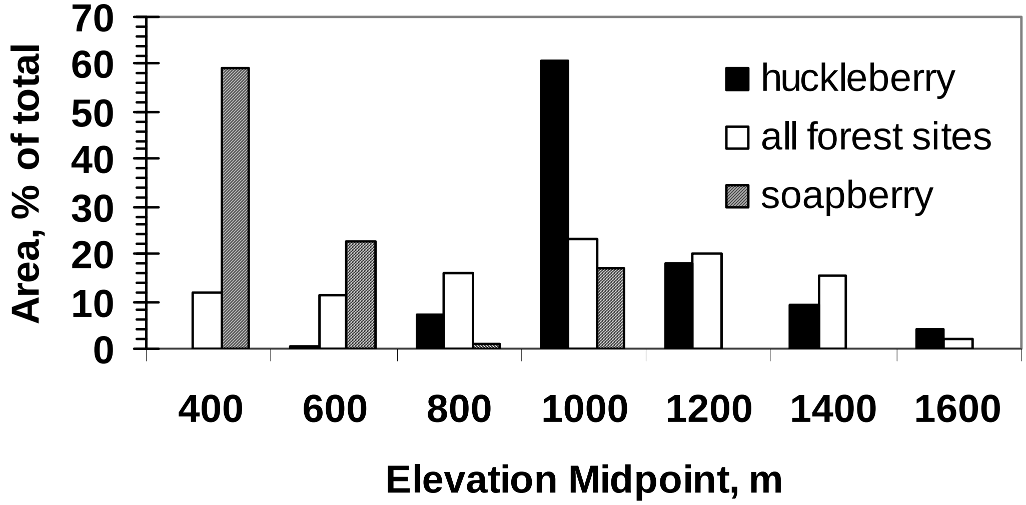
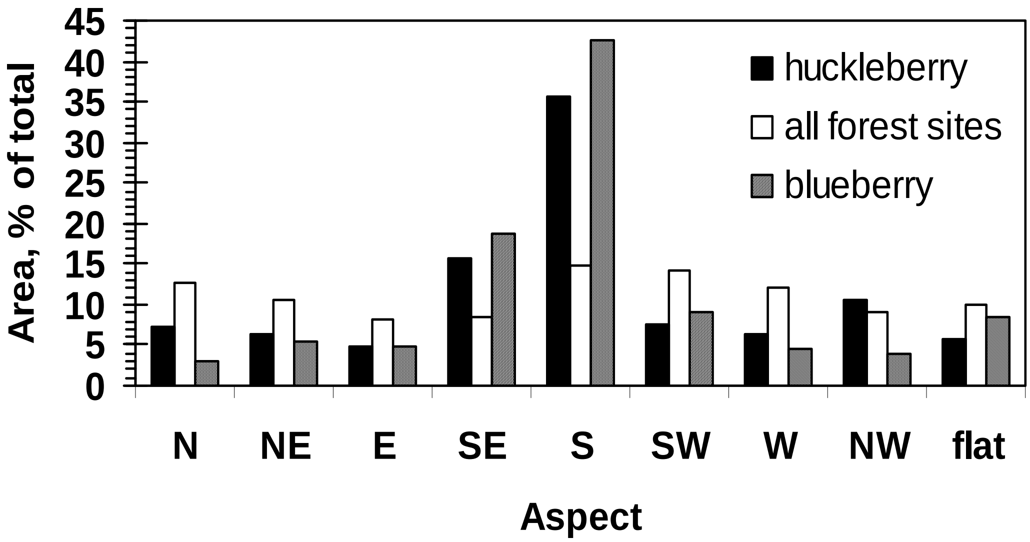


Figure 12. Distribution of huckleberry and blueberry stands with site aspect.



The association of black huckleberry stands with a number of site attributes, grouped into low, medium and high ranking categories, is shown in Table4. Based on the percentile rules explained in Section 6.1, high quality huckleberry habitat is found in the relatively narrow range of elevations between 931.5 m and 1047.1 m, with slopes of 16.1 % to 28.0 %, predicted saturation index of 0.317 to 2.000, having estimated site indices of 11.2 to 15.0 m at 50 years, on south-facing slopes, in the ICHmc1 BEC variant, and with subalpine fir as the leading species. This means, for example, that at least one-third of the area of all documented huckleberry locations are found in that particular elevational band, on those slopes, or in that BEC variant, etc. Very few stands, however, are actually found on sites optimal for all seven attributes. The sites with moderate huckleberry potential were less frequently encountered, are defined by broader ranges and (for continuous variables) usually bracket the optimal conditions. For example, moderate huckleberry habitat is found from 863.3 m to 931.5 m, from 1047.7 m to 1140 m elevation.

Table 4. Association of current black huckleberry patches and documented locations with various mapped site attributes, as used in predicting habitat suitability.

	Habitat Ranking			
Variable	"nil"	"low"	"moderate"	"high"
score:	0	1	2	3
Elevation*, m	< 312.4 or >1787.5	312.4-863.3 or 1140-1787.5	863.3-931.5 or 1047.7-1140	931.5-1047.7
Slope*, %	>106.1	<10.78 or 37.18-106.1	10.78-16.10 or 28.03-37.18	16.10-28.03
Predicted Saturation Index*	-	<0.09038 or 2.9444-3.0	0.09038-0.31748 or 2.0 - 2.94444	0.31748-2.0
Estimated Site Index*, m @ 50 yrs	>22.6	0.1 - 9.8 or 16.0 - 22.6	9.8 - 11.2 or 15.0 - 16.0	11.2 - 15.0
Aspect**	-	W, N, W, NE or flat	SE, SW, NW	S
Biogeoclimatic Variant**	-	ICHmc2, AT or ESSFmc	ESSFwv	ICHmc1
Leading Species**	Ep or Cw	Ac, At, Hw or Pl	Sw	Bl

* continuous variables, for which thresholds define the site attributes associated with the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.

** categorical variables, for which labels define the site attributes associated with at least the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.

Table 5 describes the habitat rankings determined for oval-leaved blueberry. Similar to black huckleberry in its habitat in many respects (e.g., associated with the ICHmc1, south-facing slopes, and subalpine fir dominated sites), oval-leaved blueberry has a slightly narrower range of elevational preference (942.8 to 1045.4 m), is more often found on slightly gentler slopes (15.6 to 26.9 %), sites predicted to be slightly less shedding (0.349 to 2.000) but perhaps slightly less productive (site index 11.2 to 14.0 m at 50 years). Blueberry distribution may be characterized more by some of the extremes beyond which it was never found in the study area: e.g., it was never encountered on sites under 400.5 m elevation, or >100% slope, or with >24.2 (m@50yrs) site index. For the purposes of mapping habitat capability, such sites would receive a score of 0, deemed to have no chance of supporting blueberry stands. Other distinctions include the fact that NW-facing slopes constitute low-quality habitat for blueberry, but moderate habitat for huckleberry. But in general, blueberry and huckleberry habitat preferences and potential are very similar, and could probably be managed together.

Table 5. Association of current oval-leaved blueberry patches and documented locations with various mapped site attributes, as used in predicting habitat suitability.

Variable	Habitat Ranking "nil"	"low"	"moderate"	"high"
score:	0	1	2	3
Elevation*, m	< 400.5 or >1787.5	400.5-879.5 or 1139.2-1787.5	879.5-942.8 or 1045.4-1139.2	942.8 - 1045.4
Slope*, %	>100	<10.33 or 36.04-100	10.33-15.57 or 26.88-36.04	15.57 - 26.88
Predicted Saturation Index*	-	<0.09198	0.09198-0.34928 or 2.00001-3.0	0.34928-2.0
Estimated Site Index*, m @ 50 yrs	>24.2	0.1-8.2 or 15.0 - 24.2	8.2-11.2 or 14.0-15.0	11.2-14.0
Aspect**	-	W, NW, N, NE, E or flat	SE or SW	S
Biogeoclimatic Variant**	-	ICHmc2, AT or ESSFmc	ESSFwv	ICHmc1
Leading Species**	Ep or Cw	Sw, At, Hw, Ac or Pl	-	Bl

* continuous variables, for which thresholds define the site attributes associated with the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.
** categorical variables, for which labels define the site attributes associated with at least the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.

Highbush cranberry and soapberry have different habitat affinities than the two *Vaccinium* species. High quality cranberry habitat is described as 521 to 646 m in elevation, slopes of 10.1 to 31.8%, predicted saturation index from 0.442 to 2.203, site index 12.8 to 16.4 m@50yr, sites with no or south-facing slopes, in the ICHmc2, and dominated by subalpine fir or western hemlock (Table 6). Soapberry prefers even drier and lower elevation habitats (Table 7). Like highbush cranberry, it is also most affiliated with the ICHmc2, and with flat and south-facing slopes. But soapberry shows a clear association with lodgepole pine stands, unlike any of the other berry species surveyed. High-quality soapberry habitat is further defined as elevations between 459 and 512 m, slopes 6.9 to 19.1 %, predicted saturation index 0.286 to 2.000, and site index 16 to 20 m@50yr. Its elevational distribution shows an interesting disjunction, with most documented stands found between 300 and 600 m, but others found from 800 to 1100 m (Figure 11). This likely represents an artifact of a small sample size, but may also be due to factors of access or historical use, or may indicate sporadic availability of suitable soils.

Table 6. Association of current highbush cranberry patches and documented locations with various mapped site attributes, as used in predicting habitat suitability.

Variable	Habitat Ranking "nil"	"low"	"moderate"	"high"
score:	0	1	2	3
Elevation*, m	< 300 or > 1678.8	300.0-494.6 or 1020-1678.8	494.6-521 or 645.9-1020	521.0 - 645.9
Slope*, %	>106.1	<5.17 or 46.64-106.07	5.17-10.13 or 31.83 - 46.84	10.13 - 31.83
Predicted Saturation Index*	-	<0.145754	0.14754-0.44163 2.20265-3.0	0.44163- 2.20265
Estimated Site Index*, m @ 50 yrs	>31.9	<8.9 or 20.0 - 31.9	8.9 - 12.8 or 16.4 - 20.0	12.8 - 16.4
Aspect**	-	W, NW, N, NE or E	SW or SE	S or flat
Biogeoclimatic Variant**		AT,ICHmc1, ESSFwv, or other	ESSFmc	ICHmc2
Leading Species**	Cw	Ac, Sb, Ep, or Pl	Sw or At	Bl or Hw

* continuous variables, for which thresholds define the site attributes associated with the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.
** categorical variables, for which labels define the site attributes associated with at least the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.

6.2.2 Distribution of Berry Habitat

The thresholds portrayed in Tables 4 to 7 were used to define habitat potential for each of the four species across the entire map frame. As explained in Section 6.1, each smallest GIS polygon (resulting from an overlay of forest cover, topographic facets, and other maps) was scored for each of the 7 attributes summarized in Tables 4 to 7 and assigned a score of 0, 1, 2 or 3 according to the thresholds identified for each species. A final determination of habitat capability was made for each species by averaging the seven component scores for each smallest polygon, with average scores of 1 and 2 being the cutoff between "low," "medium" and "high" potential. These final ratings were then mapped separately for black huckleberry (Map 2), oval-leaved blueberry (Map 3), highbush cranberry (Map 4) and soapberry (Map 5). All berry species except soapberry have a very wide distribution of moderate or high quality habitat throughout the study area. As indicated from the habitat affinities discussed above, Maps 2 and 3 show huckleberry and blueberry having the greatest potential at higher elevations and on south-facing slopes in the ICHmc1. Highbush cranberry (Map 4) also reaches down into lower elevations and onto a lot of flat and deciduous-dominated sites. High-quality soapberry sites are rarer, found at lower elevation ICHmc2 sites on south-facing slopes dominated by pine.

Table 7. Association of current soapberry patches and documented locations with various mapped site attributes, as used in predicting habitat suitability.

	Habitat Ranking			
Variable	"nil"	"low"	"moderate"	"high"
score:	0	1	2	3
Elevation*, m	< 300 or > 1080.9	300.0-401.8 or 892.1-1080.9	401.8-458.6 or 512.0-892.1	458.6 - 512.0
Slope*, %	>62.5	<4.87 or 30.09-62.5	4.87-6.89 or 19.06-30.09	6.89 - 19.06
Predicted Saturation Index*	-	<0.09961	0.09961-0.28648 or 2.0 - 3.0	0.28648 -2.0
Estimated Site Index*, m @ 50 yrs	>31.7	0.1 to 15.0 or 22.3-31.7	15.0-16.0 or 20.0 to 22.3	16.0-20.0
Aspect**	-	W, NW, N, NE or E	SE or SW	S or flat
Biogeoclimatic Variant**	AT, ESSFmc or ESSFwv	ICHmc1	-	ICHmc2
Leading Species**	Hw or Cw	Bl, Ac, Ep or Sw	At	Pl

* continuous variables, for which thresholds define the site attributes associated with the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.
** categorical variables, for which labels define the site attributes associated with at least the most abundant 1/3 ("high"), 2/3 ("moderate") or all ("low") berry patch areas.

A few anomalies are evident in these capability maps because we did not have time to fully explore site quality interactions, and these weaknesses have not yet been corrected. First, a number of cutblocks are shown to have a lower habitat potential than the surrounding forest (e.g., Map 2), an error due primarily to the fact that the "leading species" in cutblocks is usually spruce or pine rather than subalpine fir; all cutblocks should really be considered to have the same habitat potential as the areas contiguous with them. Secondly, we think many high elevation limits have been over-estimated on north-facing slopes (e.g., Maps 2 and 3), because the greatest elevation at which a species was found (usually on south-facing aspects) was used to generate the thresholds applied across the map sheet. Finally, low elevations are often shown to have low habitat capability (Maps 4 and 5), not because highbush cranberry and soapberry are not found there, but because our database included no samples from the lower reaches of the Bulkley River.

The total areas assigned to each habitat capability class for each berry species in each of the three Gitxsan house territories in the study area are summarized in Table 8. Across the entire area of interest, 33.0% of the total land base is predicted to be high quality habitat for black huckleberry, 29.2% should be high quality habitat for oval-leaved blueberry, 27.2% is high quality for highbush cranberry, and only 14.5% is likely to be high capability terrain for soapberry. As also shown in Table 8, only about one-half of this high quality berry ground is on the timber harvesting land base (THLB), with management that might have to be coordinated with timber harvesting and silviculture. The thousands of hectares of high potential berry habitat off the THLB represents a significant opportunity to maintain and enhance berry production without altering existing timber management practices. On the other hand, 47% to 54% of the THLB is potentially high quality habitat for huckleberry, blueberry and cranberry (though only 19% is high quality for soapberry), suggesting that any special management practices to promote wild berries might be worthwhile on every second cutblock in this area. Furthermore, because non-THLB berry habitat is typically at higher elevations (see the THLB boundary shown as a thick red line on Maps 1 through 5), on steeper slopes or without developed access, non-THLB berry grounds may not be as suitable for berry picking as more accessible sites.

High quality berry habitat is not evenly distributed among the three Gitxsan house territories constituting the study area. Firstly, the Luutkudziiwus territory of *Madii Lii* is 35,075 ha in area, compared 14,135 ha for the Gyet'm Galdoo territory of *Am Djam Lan*, and 14,414 ha for that portion of the Djogaslee territory of *Sagat*. So Luutkudziiwus has a greater absolute area of high quality berry habitat for all species except soapberry, for which Djogaslee has a greater area of high quality habitat. Djogaslee has only 16% of its lands predicted to have high suitability for black huckleberry, while 41% of the entire Luutkudziiwus territory (north of the Suskwa River) is predicted to be high quality huckleberry habitat; Gyet'm Galdoo lands are typically intermediate between the other two. This imbalance suggest that more attention might have to be paid to the conservation of soapberry potential on Luutkudziiwus land, and for the conservation of huckleberry potential on Djogaslee territory (for example). Such a policy presumes that it would be desirable for each territory to be managed for each berry species, yet it may be more expedient to designate only one or a few berry crops (i.e., not necessarily all species) for active management in any given territory. Historically, such territorial imbalances were addressed by marriages and trade among Gitxsan houses, and by food distribution at feasts.

Table 8. Distribution of potential berry habitat (ha) within the study area by berry species and Gitxsan house territory.

		Habitat Potential, Entire Area			Habitat Potential on THLB*		
Species	**House**	**low**	**medium**	**high**	**low**	**medium**	**high**
black huckleberry	*Luutkudziiwus*	2,539	18,059	14,477	289	3,902	8,361
	Gyet'm Galdoo	1,653	8,264	4,218	120	1,800	1,772
	Djogaslee	2,726	9,428	2,260	399	3,069	1,142
	total**:	6,972	35,857	21,062	809	8,790	11,342
oval-leaved blueberry	*Luutkudziiwus*	2,187	19,672	13,216	242	4,690	7,621
	Gyet'm Galdoo	1,868	8,660	3,607	110	2,295	1,287
	Djogaslee	5,009	7,650	1,755	1,042	2,736	832
	total**:	9,134	36,081	18,677	1,401	9,745	9,794
highbush cranberry	*Luutkudziiwus*	3,578	20,231	11,267	24	4,971	7,558
	Gyet'm Galdoo	2,622	9,246	2,267	18	1,948	1,727
	Djogaslee	2,280	8,354	3,781	59	2,494	2,058
	total**:	8,529	37,981	17,381	100	9,457	11,383
soapberry	*Luutkudziiwus*	26,402	4,593	4,081	7,299	3,264	1,990
	Gyet'm Galdoo	11,200	2,038	897	2,067	1,066	559
	Djogaslee	7,706	2,478	4,230	2,001	1,183	1,426
	total**:	45,503	9,149	9,240	11,431	5,529	3,980

* THLB = timber harvesting land base
** values may differ slightly from the sum of House areas due to slivers from unmatched boundaries.

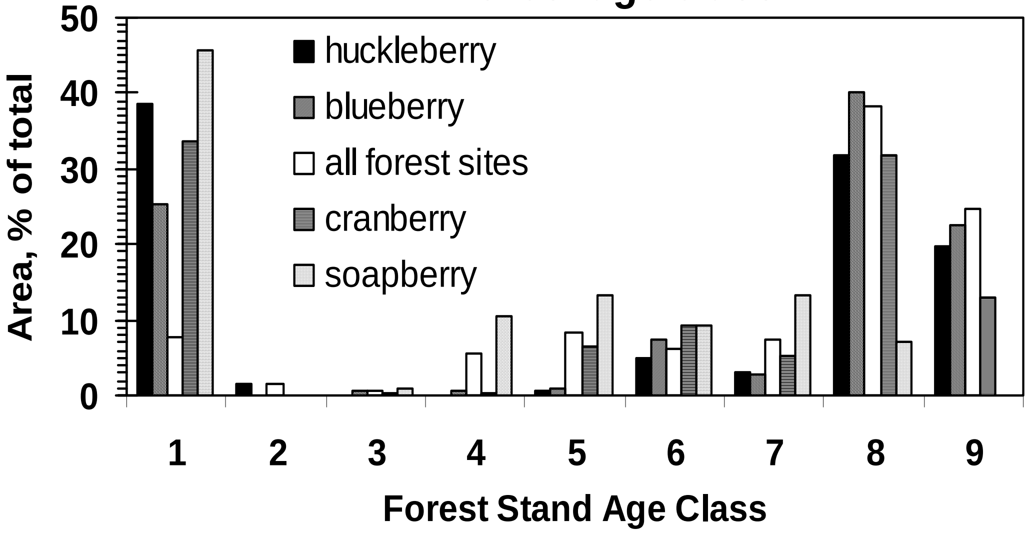
6.3 SPECIES ASSOCIATION WITH STAND FACTORS

6.3.1 Relationships With Current Stand Attributes

Section 6.2 dealt with fixed site factors, those elements of habitat that represent the inherent ability of local climate, topography and soils to support a given species. This does not mean that all high-potential sites necessarily support dense stands of berry-producing shrubs right now. In most cases, the ability of a site to express its berry-growing potential also depends on light availability, namely a suitable openness of the forest canopy. Other factors, such as the availability of propagules (seeds or rootstocks) to colonize a site, or competition from non-crop vegetation, are considered less limiting than overstory conditions. These additional factors, however, may have to be evaluated on sites to be managed for enhanced berry production. Forest canopy conditions are typically determined by disturbance (such as wildfire, windthrow and logging), management actions (such as brushing and spacing), time since disturbance (stand age), and by some site factors (such as soil moisture regime and soil nutrient regime) that may contribute to dense or sparse stocking by large trees.

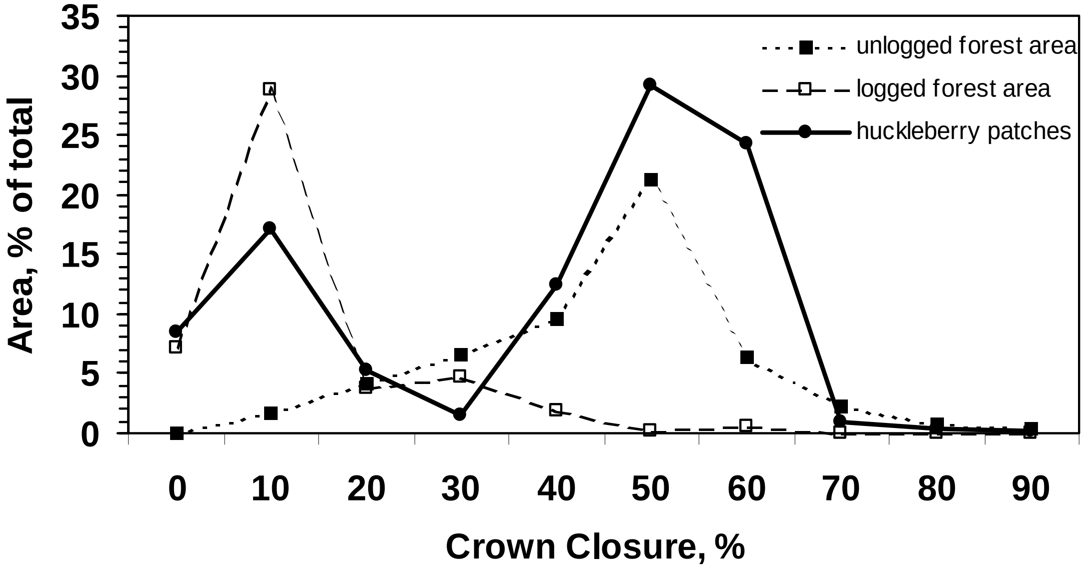
All four of the berry species that we assessed in detail show a strong affinity for young forests, primarily recent clearcuts. As shown by the ratio of vertical bars (Figure 13) for each species in age class 1 to the size of the bar for the overall abundance of age class 1 forest, there is a greater than expected abundance of berry patches in these cutblocks and burned areas. The association with young forest is strongest in soapberry, followed by huckleberry, then cranberry, and finally blueberry. It is worth noting that oval-leaved blueberry is more abundant in old (>140 years old) stands than black huckleberry is: 62.7% of all blueberry stands are in old growth forest, compared to 51.4% of all huckleberry stands. All species show a strong avoidance of forest age classes 2 and 3 (ages 21 to 60), presumably because of shading by trees. Soapberry is a little different from the others (Figure 13), in that it is quite abundant in stands of age class 4, 5, 6 and 7 (ages 61 to 140 years), though many of these stands are pine- or deciduous-dominated, and presumably have fairly open understories.

Figure 13. Association of berry stands with forest age class.



The association of berry plants with younger, open forests is further reflected in their relationship to stand density and crown closure, both of which vary with stand age as well. Unlogged forest in the study area is almost exclusively more than 60 years old, with most of it over 140 years of age. These older forests typically have 500 to 1000 stems per ha (sph), and >50% crown closure. Logged forests (mostly < 30 years old) consist almost exclusively of recent clear cuts, with a high (1200 to 2500 sph) stem density and low (<45%) crown closure. So most berry species such as black huckleberry (Figure 14) are very abundant in young forest prior to canopy closure, and in the more open segments of old forest as well. Figure 14 shows that the relative abundance of huckleberry patches is less than would be expected in logged forest lands (crown closure 15 to 25%), as indicated by the line for proportional huckleberry patch area being lower than the one for proportional land area at these low crown closure levels. Conversely, the relative abundance of huckleberry patches is greater than would be expected (on the basis of land area distribution alone) in unlogged lands having crown closure of 45 to 65% (Figure 14). Our data show some berry stands of most species persisting across a full range of crown closures, but many of these (i.e., those recorded in ecological relevés) may not be producing berries. Berry patches are likewise found across a broad range of stand density, but there are very few widely spaced young stands in the study area that would permit us to identify the degree to which low stocking could prolong the suitability of early successional habitat for various berry species. In general, the more carefully controlled results described by P. Burton (1998) and summarized in Figure 10 probably do a better job of describing the response of these species to overstory shading.

Figure 14. Association of huckleberry patches with forest stand crown closure.

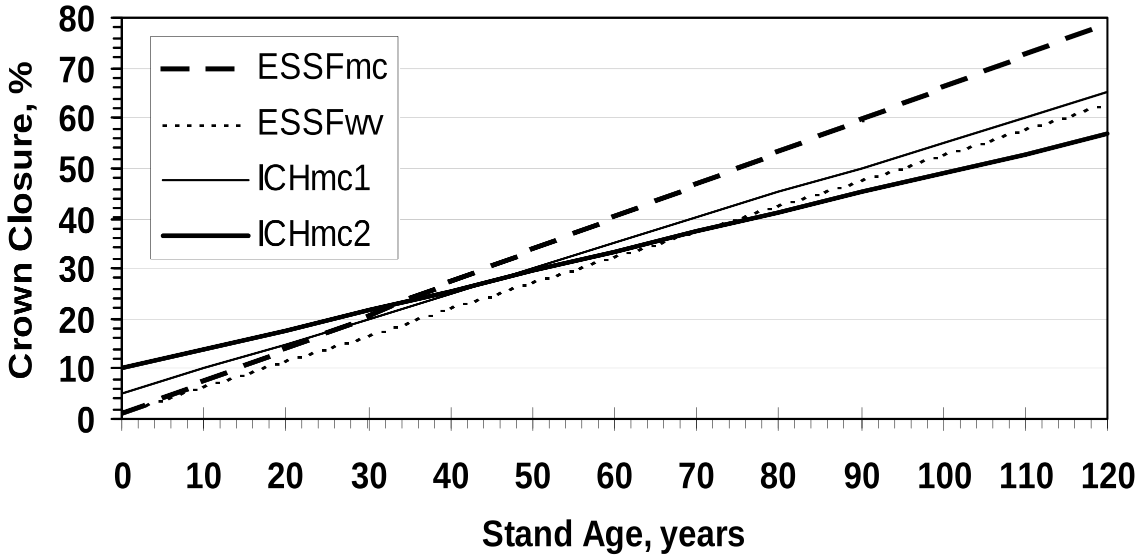


6.3.2 Forest Stand Dynamics and Canopy Closure

Successional dynamics of forest understory species could not be determined from an examination of silvicultural survey data. Firstly, these data are only collected until the free-growing stage, not until crown closure; secondly, survey cards and records are inconsistent in the degree to which brush species have been identified and their cover estimated. A broader survey of records collected throughout the Kispiox Forest District would probably be able to extract some site series-specific successional trajectories, at least for the ICHmc2. Silvicultural interpretations have identified "vegetation potential" (low, medium, high, or very high) and "vegetation complexes" (a list of likely species) for each site series in each biogeoclimatic variant (Banner et al. 1993). But these interpretations are largely subjective and descriptive, and provide no guidance for interpreting the degree to which berry-producing shrubs may dominate successional vegetation or, in turn, be suppressed by other species in the complex.

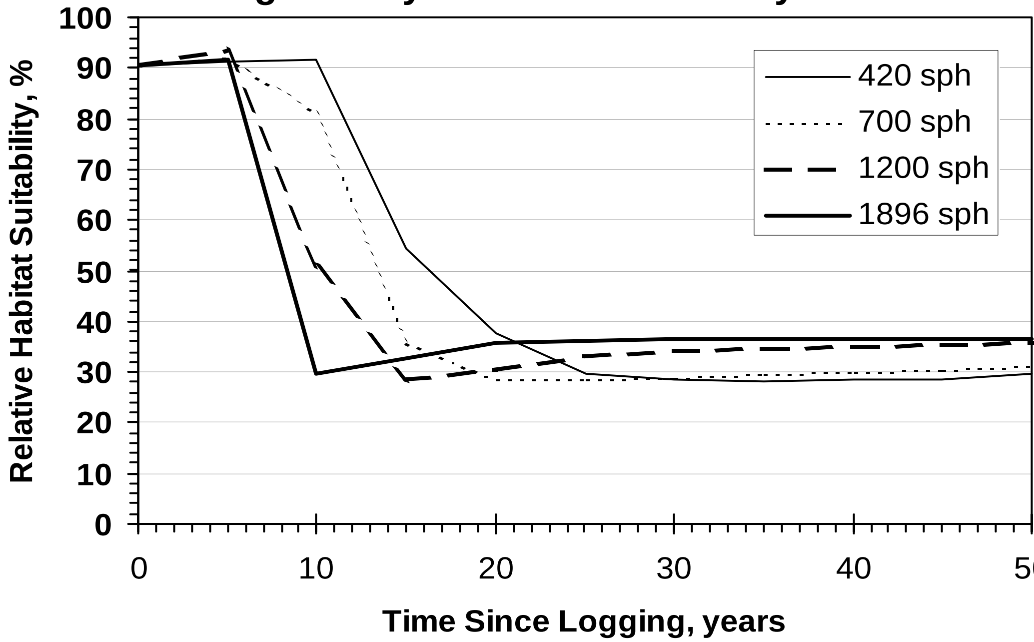
Forest inventory data were used to derive crown closure vs. stand age relationships for each biogeoclimatic variant in the study area (Figure 15). Though crown closure was subjectively estimated to the nearest 10% from air photos, the data combine managed and unmanaged stands dominated by a variety of different tree species, and the confidence limits are very wide, these trends reflect a conservative estimate of the overall rate of canopy development that can be expected in each variant. Beyond ages of 70 to 110 years, crown closure generally starts to decline, except in the ESSFmc where it continues to increase linearly with stand age.

Figure 15. Empirical relationships for crown closure as a function of stand age for different BEC variants.



SORTIE-BC simulations probably over-estimate the rate at which the forest canopy closes in open-grown stands (and recalibrations should be tested against the trends shown in Figure 15). Stand development simulated for a wide range of stocking levels was combined with the light response curves for three shrub species (Figure 10) to generate the likely course of relative habitat suitability for those shrubs over time. Figure 16 shows the results simulated for black huckleberry; highbush cranberry and soapberry projections (not shown) were similar, but with less abrupt declines with stand age. Using the huckleberry example, and an arbitrary goal of keeping conditions suitable for 50% berry productivity, natural stand development may compromise that goal at 9 years of age. Stocking stands to only 700 sph can extend that level of habitat suitability to year 13 or 14, or to year 16 with stocking reduced to 420 sph. With stocking reductions to 420 sph, suitable habitat conditions can be extended from 10 years to 23 or 24 years for highbush cranberry, or from 11 years to 28 years in soapberry. Even if these exact times are not accurate because of biased tree growth in SORTIE-BC, the relative effects on berry habitat are likely robust.

Figure 16. Simulated effects of stand development and stocking density on habitat suitablity for huckleberry.

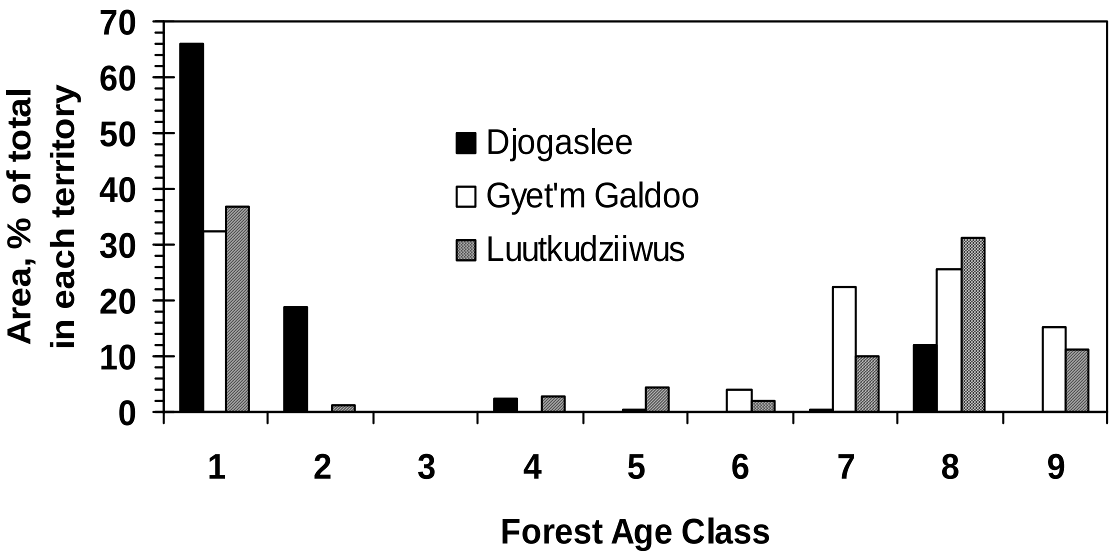


6.3.3 Forest Age Class Structure

Of probably greater importance to the sustainability of berry production in the long run is the age class structure of commercial and non-commercial forests across the study area and in each house territory. Berry production in the Suskwa vicinity may currently be at levels which cannot be sustained, since little or no new habitat is being opened up by wildfires and prescribed burning; furthermore, cutblocks (which constitute much of the current habitat) cannot continue to be created at the same rate they have in the last two decades (Figure 17).

Each Gitxsan house territory has its own opportunities and challenges in terms of balancing its forest age class distribution to promote berry production. For example, almost all of the high quality huckleberry land in Djogaslee territory has been recently logged (Figure 17), suggesting that efforts should be made to prevent canopy closure in those lands as much as possible, as little more high-quality berry habitat can be created by timber harvesting; even so, there will be a bottleneck in the availability of suitable habitat within a few decades as that young forest matures. In contrast, Gyet'm Galdoo and Luutkudziiwus have much of their high-quality huckleberry land still dominated by old forest, which could be logged to release more berry production. Huckleberry production in those two territories could be sustained primarily by harvesting the high-quality land in age classes 7, 8 and 9 (see Figure 17) at a rate not to exceed approximately one-fifth of the combined area of those age classes every twenty years. Assuming most current plantations will be logged at 120 years of age (and no disturbances other than timber harvesting), this would prolong the creation of new open habitat for a period equal to the age class gap. In the case of Luutkudziiwus land, for example, this would mean logging the 2661 ha of remaining high quality old huckleberry habitat (much of which might currently be supporting some level of berry production) at a rate not to exceed 532 ha per 20-year interval. This ceiling on the rate of cut might be offset by extensive spacing of existing plantations, or by enhancement of that portion of high-quality berry lands found off the THLB, as explained in more detail in Section 7.

Figure 17. Forest age class structure for all high-potential huckleberry lands in each house territory.



7.0 WILD BERRY MANAGEMENT OPTIONS

Information on berry autecology, historic use patterns, and habitat suitability provides the basis for developing management rules for berry production. In this section, a number of guidelines have been proposed to steer the management of berry resources. A berry management plan which identifies specific areas to treat, and when and how to treat them, however, cannot be provided until yield targets have been determined and yield curves have been produced for various berry species and habitats. The species and quantity of berry production to be targeted (in terms of assigning a "management emphasis" as per Section 7.3.2) will also vary with the balance of resource emphasis options determined for a given landscape unit or territory.

7.1 STRATEGIC OBJECTIVES

Ultimately, berry management must be integrated with higher level planning for other forest resources. The only approved higher level plan (HLP) in the Kispiox TSA is the Land and Resource Management Plan (1996). Sections 6.6 and 6.16 of the LRMP provide direction on cultural resources and botanical forest products which pertain to berry management. A stated objective in Section 6.6 of the LRMP is to "recognize the significance of house territories and associated resources to First Nations." Section 6.16 further states that it is an objective to "maintain and use botanical forest products including wild berries." No specific strategies for berry management were provided in either section.

While the objectives stated in the LRMP provide broad guidance, more detailed planning is necessary to guide operations. This level of detail is normally found in operational plans such as the Forest Development Plan (FDP) or Silviculture Prescription (SP). Suggestions for incorporating berry management into operational planning havebeen provided below.

7.2 PLANNING GUIDELINES

7.2.1 Landscape Level Planning

It is recommended that berry management objectives be incorporated in Landscape Unit Plans (LUP) and in Forest Development Plans.

An example of a possible objective and associated strategies for an LUP might read something like the following:

Objective: Ensure that sufficient berry habitat is maintained to satisfy traditional use levels.

Strategies:

- *In areas highly suited to berry production, ensure that a minimum of x % of the operable landbase is between 6 and 17 years of age at all times.*
- *In areas highly suited to berry management, use silvicultural systems that ensure that light levels are at least 60% of full sunlight for a minimum of 20 years.*
- *Undertake harvesting and silviculture practices that protect berry plants from damage in areas highly or moderately suited to berry production.*

It is also recommended that berry resources be recognized in Forest Development Plans in areas highly suited to berry production. Berry resources should also be recognized for moderate capability areas in landscape units or house territories where suitable habitat is rare, or where forest age classes are especially unbalanced. The text of the plan should have a brief description of the relative importance of berry management, target yields if known, and general strategies that will be used to achieve stated objectives in HLPs. A map showing the relative suitability of the area under the plan for berry production should be provided as an overlay. An example of the kind of statement that might be appropriate for an FDP is:

> *A sufficient area of berry habitat will be maintained to satisfy traditional use levels without compromising seral stage targets or green-up requirements. In areas identified for berry management, silviculture systems suitable to berry management will be implemented, and harvesting and silviculture practices that protect existing berry patches will be used. A suitable silviculture system is one in which light levels are at least 60% of full sunlight for the first 20 years on 75% of the area. Examples of acceptable silviculture systems are clearcut, coppice, seed tree, and some irregular or group selection systems.*

In the project area, approximately 4187 ha (or 12.1% of the THLB area) has been used for berry picking in recent decades, while up to 9032 ha (26.1% of THLB area) may have been used historically. If similar levels could be established for other areas within the TSA, they would serve as guidance in landscape level planning. For example, these levels suggest that (all other conditions being equal) between 1 in every 8 and 1 in every 4 cutblocks might be considered for berry management emphasis.

7.2.2 Stand Level Planning

Berry management considerations should also be incorporated in stand level plans. The most appropriate documents for addressing berry management concerns on the THLB are the Silviculture Prescription (SP) and Free Growing survey (FG). During SP data collection, it is recommended that the following information be collected for berry-producing species at each sampling point on a survey grid in areas previously identified as highly (or sometimes moderately) suitable for berry production:

- percent cover (to the nearest 5%),
- plant health and vigour (good, moderate, or poor), and
- fruit (berry) abundance on bushes (high, moderate, or low).

In the project area, this information should be collected for black huckleberry, oval-leaved blueberry, highbush cranberry and soapberry; other species (such as saskatoons or Alaska blueberry) might be designated for information collection and potential management in other drainages. It is recommended that all areas with more than 10% berry bush cover (all berry species combined) be shown on a large-scale map. This level of cover is tentatively considered to be the threshold below which berry abundance is likely too low for intensive use or management. Information on percent cover could be shown on a separate berry abundance map, or could simply be stated by unit on the ecological unit or standard unit maps prepared for the area under prescription.

In accordance with the Forest Practices Code Operational Planning Regulation (1998) the SP should also state berry management objectives and describe the desired future condition of the area with respect to berry management. Additionally, the silviculture treatment regime associated with the SP and required under the Forest Act (1998) should describe treatments that will be used in managing the berry resource.

Percent cover, plant health, and berry abundance information should also be collected for the same species during FG surveys conducted for high (and sometimes moderate) berry capability lands on the THLB. During FG surveys, it is tentatively recommended that all areas with more than 25% cover (all berry species combined) be shown on a map. Berry communities must be well established at the free growing stage to justify intensive use or special management and, therefore, a higher threshold for management has been recommended at the FG stage than at the SP stage. Again, information on percent cover could be shown on a separate berry abundance map or could simply be stated, by unit, on the ecological unit map or treatment unit map produced as part of the free growing survey. Berry management treatments should be incorporated with the silviculture treatment recommendations for the block. The minimal area for treatment will depend on berry production objectives for that management unit, access, cutblock size, the size of other treatment strata, and the nature of treatments being considered.

Currently there is no legislated or policy requirement that stand level planning be done off the THLB. Consideration should be given, however, to conducting a periodic berry reconnaissance in areas outside the THLB which have been identified as highly suited to berry management. Information on berry abundance and yield would help planners decide if berry needs can be met off the timber harvesting land base, possibly eliminating the need to undertake special berry management practices on the THLB. Again, an estimate of percent cover, plant health, and berry yield, along with a map and specific treatment recommendations for identified areas, would be sufficient to allow planners to make management decisions.

7.3 TREATMENT GUIDELINES

7.3.1 The Treatment Decision Framework

Treatment recommendations provided below are organized under the headings "Harvest Practices," "Silviculture Practices," and "Cultural Practices." Whether a particular treatment is implemented will depend on the *management emphasis* for a particular area. Management emphasis is a function of resource use objectives in the area, site suitability, abundance of berry plants, and whether the site is within the THLB. The derivation of management emphasis is explained in Section 7.3.2. Potential treatments, including possible limitations, are described in Section 7.3.3. Guidelines on which treatments are appropriate under what circumstances are depicted in a treatment matrix in Section 7.3.4.

When considering which treatments may be appropriate, it must be remembered that the modern management of naturally occurring berry communities in B.C. is in its infancy. The collection of naturally produced non-timber forest products (sometimes known as wildcrafting; Anonymous 1995) is rarely associated with the active management or enhancement of those resources. Many of the proposed treatments are expensive and their impacts on berry yield are poorly understood. Treatment recommendations must, therefore, be regarded as experimental until more experience with them is obtained.

It should also be remembered that the level of management input will ultimately be supply driven. Once supply targets have been established, it will be necessary to determine which areas should be managed to meet these targets and how they should be managed. It is likely that this will be done using a spatially explicit optimization model in much the same way that modern analyses of timber supply are being conducted. To date such tools are not available for berry supply analysis or full rotation planning.

7.3.2 Management Emphasis

Three management emphasis options are proposed: **(1) "Minimize Damage"** to existing berry stands and communities; **(2) "Maintain"** existing berry stands and communities; or **(3) "Enhance"** berry stands and communities. A definition for each has been provided in Table 9 along with a description of when they would be applicable.

Table 9. Management emphasis options for protecting and enhancing wild berries.

	Definition	Application
Minimize Damage	Damage to berry stands and communities will be minimized during operational activities. Berry management will be subordinate to other resource uses.	Applicable on the THLB, where areas have been identified as moderately (or sometimes highly) suitable, and plant abundance exceeds the established threshold (see sec. 7.2.2).
Maintain	Operational activities will be modified where necessary to maintain existing berry stands and communities. Other resource uses will not be substantially compromised, and existing operating standards need not be varied.	Applicable on the THLB, where areas have been identified as highly (or sometimes moderately) suitable, and plant abundance exceeds the established threshold.
Enhance	Cultural practices or operational activities that revitalize or improve existing berry communities and/or result in the establishment of new communities will be undertaken. Berry objectives may require variance from current operating guidelines, while balancing other resource use objectives.	Applicable on both the THLB and off the THLB, in areas identified as highly suitable, and plant abundance exceeds the established threshold.

The process for determining area suitability is described in Section 6.0. The outcome of that process is a series of maps with "high", "moderate", and "low" suitability ratings. In the absence of detailed, quantitatively derived habitat suitability information in areas outside the pilot project area, the 1:1,400,000 scale maps of Haeussler (1987) can provide guidance, or, alternatively, the default emphasis option could simply be set at "maintain." Access has not been considered in the definitions for management emphasis because it is assumed that areas that don't have access will have low suitability for berry harvesting. Plant abundance thresholds described in Section 7.2.2 are, at this point, based on expert opinion only. Further research is required to accurately determine what levels of cover are sufficient, in both mature and immature stands, to merit management activity and/or berry harvesting. In the absence of information on plant abundance, the default emphasis option would be maintain.

7.3.3 Treatment Options

Potential treatments that may be appropriate, depending on management emphasis, are listed below. It is implicit that treatments listed under harvesting practices are only relevant in a mature forest. With the exception of burning, treatments listed under silvicultural and cultural practices are applicable in immature forests, including recently established plantations. Controlled burning could be conducted in mature forest in areas where timber values are low or subordinate to berry management objectives.

Cultural practices and silvicultural practices are similar, but with an important distinction. Whereas silvicultural practices are undertaken primarily to improve tree growth, cultural practices are specific to management of the berry crop. It is important to recognize that most cultural practices have not been widely used in B.C. except on artificially established berry farms and must, therefore, be considered experimental and used with caution.

Harvesting Practices

1. Use Appropriate Silviculture Systems.
Treatment Description: Use a silviculture system which ensures that the site will receive a minimum of 60% of full sunlight for a period of 20 years on at least 75% of the area. Suitable silviculture systems include clearcuts and patch clearcuts, coppice systems, seed tree systems, and irregular and group shelterwood systems that result in a substantial, uniform canopy reduction or large gaps in the canopy.
Rationale: Berry species generally require near full light to achieve optimum production. Silviculture systems that do not open the canopy substantially will not result in a vigorous berry community. However, since several berry species exhibit high levels of growth and fruit production in the range of 60% to 80% full sunlight (P. Burton 1998), the option exists to maintain some mature tree cover while maintaining or enhancing berry production. Coates and Burton (1997) predict that gaps measuring 30 to 75 m in mature ICHmc2 forest will be dominated by light levels between 50% and 75% of full sunlight.
Limitations: Old growth seral stage objectives may conflict with the need to reduce overstory levels. Basal area removal levels severe enough to achieve berry management objectives may not be adequate to meet to other objectives (e.g., green-up, adjacency, visual quality).

2. Use Low Impact Harvesting Methods.
Treatment Description: Use low ground disturbance systems such as hand falling and cable logging or conventional mechanical falling and skidding on a sufficiently deep snowpack (~ 75 cm) in identified high value berry patches.
Rationale: Eliminating overstory shade without disturbing the understory vegetation (particularly the root systems of berry producing shrubs) appears to be most effective for encouraging berry production.

Limitations: Both cable systems and deep snow packs are constraints on harvesting that may be expensive and will need to be assessed carefully against the relative value in creating temporary berry harvesting opportunities.

Silviculture Practices

3. Low Intensity Broadcast Burn.
Treatment Description: Conduct a light broadcast burn (Trowbridge et al. 1987 impact rank 2) as a site preparation treatment or in non-commercial areas, to stimulate resprouting of vigorous plants, encourage higher and sweeter berry yields, and to release locked nutrients.
Rationale: Burning removes senescing stems with minimal damage to roots and rhizomes. Old, less productive stems are removed and vigorous regrowth occurs, leading to increased berry yields approximately three years after burning.
Limitations: If burn impact exceeds that prescribed, burns can kill plants and reduce or eliminating the berry community. Delays in berry production may also occur. If original berry stem densities are insufficient, there is also a risk that burning will stimulate other vegetation (e.g. fireweed, thimbleberry) which will compete with the berry plants and retard recovery and/or plant development.

4. Restock at Low Densities.
Treatment Description: Reestablish trees at low densities (~420 stems/ha [minimum stocking standard on backlog sites] to 700 stems/ha) or cluster plant at intermediate densities (for example 250 clusters of 4 or 5 trees spaced 1.5 m apart, with 4.8 m between clusters) to extend the longevity of the berry community.
Rationale: Berry species generally require high light to achieve optimum production. Depending on the species, a uniform distribution of 420 stems/ha may extend the longevity of berry patches by 5 to 10 years over that which would prevail at 1200 conifer stems/ha (default target stocking standards). See Figure 16.
Limitations: Timber objectives may be compromised with low stocking. Cluster planting may mitigate this but the benefits of cluster planting for berry production are largely untested.

5. Avoid Cutting Berry Plants During Brushing.
Treatment Description: During brushing treatments, or brushing/spacing treatments, treat stems of the desired berry species as "ghosts" (i.e. don't cut them).
Rationale: By avoiding the cutting of berry plants, productivity levels can be maintained. None of the species identified for potential management in the project area (huckleberry, blueberry, soapberry and highbush cranberry) tend to compete significantly with conifer trees anyway, and highbush cranberry is rarely found in dense stands (Haeussler et al. 1990).
Limitations: It may cost slightly more to include a ghost shrub clause in a brushing contract, and it means extra crew training will be required.

6. Use Sheep for Vegetation Management.
Treatment Description: Where the mix of species competing with conifers is suitable, and where environmental factors allow for it, use sheep to reduce competing vegetation.

Rationale: Sheep will reduce competition for both crop trees and berry plants and, more importantly, sheep can stimulate new, more productive growth through partial browsing.
Limitations: This treatment will rarely be feasible because of the many factors that make the use of sheep for vegetation control difficult, and because of the fact that a vegetation community that includes both high levels of grasses and herbs (ideal for sheep) and berry producing plants will be a rare combination. This treatment is more likely to be applicable at the regeneration survey stage. Vegetation control using sheep may not be less expensive than other more easily implemented brush control methods. Berry production may be reduced for 2 or 3 years.

7. Juvenile Space to Low Densities.
Treatment Description: During spacing treatments, reduce tree stocking to low levels (~ 700 stems per hectare) or space leaving clusters of trees with large gaps between (as described under treatment 4).
Rationale: By increasing light levels in the stand, the longevity of the berry community will be extended.
Limitations: Spacing to 700 stems per hectare may compromise timber yield objectives and increases the risk of losses to pests. Spacing may cost more and extra crew training will be required.

Cultural Practices

8. Prescribed Burning
Treatment Description: Conduct a low intensity prescribed burn to kill older, respiring parts of berry plants, kill overtopping trees and larger shrubs, stimulate resprouting, and release locked nutrients.
Rationale: Burning removes senescing stems with minimal damage to roots and rhizomes. Vigorous regrowth will lead to increased berry yields approximately three years after burning.
Limitations: If burn impact exceeds that prescribed, burns can kill plants and reduce or eliminate the berry community. The same effect may be achieved with less damage using pruning. Burning is only recommended if significant delays in berry production are acceptable and existing trees are not important. There is also a risk that burning will stimulate other vegetation (e.g. fireweed) which will compete with the berry plants and prevent or retard colonization and/or plant development.

9. Plant Cuttings
Treatment Description: Increase the abundance of berry plants by planting cuttings from productive phenotypes in the fall or spring.
Rationale: In areas that have historically been very important, and have a high suitability rating, yield could be improved by increasing site occupancy using cuttings (root and rhizome) from plants with demonstrated high berry yield.
Limitations: This treatment would be very expensive and cuttings must be selected and tended carefully if they are to be successfully established. The treatment would only be applicable in high value berry patches on an experimental basis.

10. Brush and Weed
Treatment Description: Manually remove species of non-berry vegetation from around berry plants for a radius of 1.5m.
Rationale: Competing shrubs and herbaceous vegetation can reduce berry plant vigour and yield.
Limitations: This treatment would be expensive and its benefits are unproven. It would only be applicable in very high value berry communities on an experimental basis.

11. Prune Berry Plants
Treatment Description: Prune senescing and malformed or diseased stems and branches to encourage more vigorous growth and larger berries.
Rationale: Pruning will generally result in more productive plants with better quality fruit.
Limitations: This treatment would be very expensive and the benefits have not been quantified in a natural setting. It would only be applicable in very high value berry communities on an experimental basis.

12. Fertilize
Treatment Description: Fertilize huckleberry and blueberry stands.
Rationale: Fertilization, both with and without nitrogen, has been shown to improve blueberry yields in wildcrafted settings in the northwestern United States.
Limitations: This treatment would be expensive (though aerial applications may cost less than other treatments such as prescribed burning) and its efficacy is unknown in northern B.C. There is little or no information about the viability of this treatment for highbush cranberry or soapberry. There is potential with nitrogen fertilizers to increase vegetative growth without increasing berry yield. The treatment would only be applicable in very high value berry communities on an experimental basis.

7.3.4 A Berry Management Decision Matrix

Guidelines on which treatments are appropriate under what circumstances are depicted below in a treatment decision matrix (Table 10). In using the matrix, the first step is to determine whether the area is on the THLB (timber harvesting land base) or not, what the habitat suitability is, and whether existing plant cover exceeds threshold levels. The next step would be to refer to applicable planning documents, forest age class structure, berry production targets, and records/maps on historic use to determine how important it is to manage for berries on the site and whether berry management is subordinate to, compatible with, or supercedes other resource uses. In the absence of supply targets, historic use levels will provide some guidance on the possible importance of berries in the area. This process will help in identifying which management emphasis should be used. If there is insufficient information to choose a management emphasis option, it should be assumed to be Maintain. Once management emphasis is determined, and it is known whether the area is on or off the THLB, the most appropriate treatment is chosen. It is important to note that "no treatment" is an option in all cases, and that treatments may be designated for relatively small strata within cutblocks.

Table 10. A wild berry management decision matrix.

MANAGEMENT EMPHASIS	TREATMENT OPTIONS		
	Harvest Practices	**Silviculture Practices**	**Cultural Practices**
Minimize Damage *Applicable Conditions:* on THLB, Suitability Rating: Moderate – High, Abundance > threshold	• Use Low Impact Harvesting	• Avoid Cutting Berry Plants	• Not Applicable
Maintain *Applicable Conditions:* on THLB, Suitability Rating: Moderate – High, Abundance > threshold	• Use Appropriate Silviculture System • Use Low Impact Harvesting	• Low Intensity Broadcast Burn • Avoid Cutting Berry Plants • Use Sheep for B&W* • Space to Low Densities	• Not Applicable
Enhance *Applicable Conditions:* on or off THLB, Suitability Rating: High, Abundance > threshold	(on THLB only) • Use Appropriate Silviculture System • Use Low Impact Harvesting	(on THLB only) • Low Intensity Broadcast Burn • Restock at Low Densities • Use Sheep for B&W* • Space to Low Densities	• Prescribed burn (off the THLB) • Plant Berry Cuttings (off the THLB) • Brush Around Berry Plants • Prune Berry Plants • Fertilize

* B&W = brushing and weeding

The berry management decision matrix (Table 10) provides a framework for integrating management objectives, habitat suitability, and treatments. It allows the forest manager to make decisions about where and how berry management might be undertaken, even when no berry supply targets have been defined. It is only one example of how decision rules for managing berry habitat in the Kispiox District might be organized. As more berry inventory information becomes available, berry demand is quantified, and more data on treatment effects are obtained, it will be possible to model yield and set supply targets. New information in any one of these areas will mean that the decision matrix will have to be revisited.

8.0 FURTHER INFORMATION NEEDS

8.1 GUIDELINES FOR PHASE TWO OF THE PILOT PROJECT

The extent of wild berry resources, their association with site factors, and suggested management options as described in this report are based solely on available map products, and on local and expert knowledge. Many of the relationships and suggested options are based on loose correlations and a number of assumptions, making the collection of field data important as a next step prior to the implementation of wild berry management activities. In order to narrow future research and management activities, we suggest that field activities should concentrate primarily on black huckleberry (*Vaccinium membranaceum*), the most important berry species in much of the region. The habitat and biology of oval-leaved blueberry (*V. ovalifolium*) is very similar, so findings will likely promote blueberry stewardship too. Other berry species are neither so widely sought after nor so concentrated on the timber harvesting land base.

Based on our experience with Phase One, and guidelines provided in the request for proposals, we recommend that Phase Two of this pilot project consist of the following components; suggestions for methodology and emphasis are also provided:

1. Verification and quantification of berry production in representative areas mapped as current berry patches.

- a random subset of current black huckleberry patches should be selected from those listed in Appendix III, covering a range of stand ages, elevations, and quality ratings;
- at each site, a structured (grid-based) survey of the extent and density of berry-producing shrub cover should be conducted, with percent cover (by species), plant vigour, and fruit density (none, low, medium or high) rated at each sampling station; this will also test the survey methods recommended in Section 7.2.2;
- calibrate these descriptions in terms of actual fruit yield (grams or millilitres of fresh berries harvested from the same square metre in which shrub cover, vigour and fruit density are estimated); perhaps conduct in conjunction with professional berry pickers;
- classify each sampling station to site series; use data to construct yield curves by site series;
- the extent of each patch should be mapped at a large scale and then portrayed in strata of patch quality;
- an appropriate sample size will depend on time and funds available, but should probably include at least 15 to 30 sites.

2. Quantification of berry shrub abundance and fruit production in representative areas predicted to have low, medium and high huckleberry habitat capability.

- this survey will use the same techniques described above, but will target random locations according to habitat potential predictions shown on Map 2;
- three to five sites should be sampled in each of the three prediction categories, in both old and recently harvested (6 to 17 years old) forest, for a total of 18 to 30 sampling

sites; it will be important to derive reliable estimates of berry yields per unit area in high quality cutblock vs. old-growth environments;
- items 1 and 2 should be conducted in mid-August, when berry crops are at their peak; not all years have weather suitable for berry production, so results will vary from year to year; ideally, such field surveys would be repeated over several years.

3. Determination of the extent and fire history of representative locations mapped as historic berry patches.
- we recommend that patches KR-6, KR-3, KR-24, and KR-5 (see Map 1) would provide good, accessible representation of a range of site types and stand ages;
- objectives would include mapping the perimeter of the most recently burned area, and determination (through the use of fire scars on living trees, charcoal layers in the soil, etc.) of the frequency and intensity of past fires;
- where a history of repeated burning is confirmed and is interpreted to likely be of anthropogenic origin, the vegetation and soils of the site should be fully described and classified.

4. Plan for operational field trials to be initiated in Phase Three.
- at least three locations in 12 to 16 year old cutblocks on the THLB, on high quality huckleberry ground (Map 2), suitable for the application of wide spacing treatments to maintain berry production levels;
- at least three locations off the THLB, preferably in or near historic berry gathering areas such as near the Suskwa Pass, where berry enhancement techniques such as prescribed burning might be tested;
- develop prescriptions suitable for implementation and monitoring as randomized, replicated adaptive management trials for test a variety of wide spacing (on the THLB) and prescribed fire (off the THLB) treatments.

5. Refinement of habitat potential mapping, projection of successional trends, and berry supply planning.
- based on results from the activities listed above, in conjunction with a consideration of the interaction effects identified in Section 6.2.2, the rules (Table 4) used to predict huckleberry habitat capability should then be revised accordingly.
- use the same field information, in conjunction with silivicultural survey records and information from other locations in the Kispiox Forest District (e.g., Date Creek Research Forest) to describe likely successional pathways for vegetation development prior to crown closure on different site series in the study area;
- combine habitat capability ratings and successional trajectories into quantitative estimates of the likely abundance and yield of black huckleberry after logging, over time, for a range of representative locations in the study area;
- a stakeholder meeting with Gitxsan chiefs (or their representatives) and berry pickers (such as those interviewed for this project) should be convened sometime in Phase Two or Three in order to set resource management priorities in each house territory;
- use refined habitat estimates and quantitative yield estimates, along with berry and other resource priorities, to develop berry supply targets and a draft management plan (based on the existing forest age class structure and habitat suitability) for each Gitxsan house territory in the study area.

8.2 BASIC RESEARCH

Not all uncertainties regarding the biology and management of wild berries in the Kispiox Forest District can resolved through field surveys and the installation of operational field trials. A number of questions which arose during Phase One of this project could be tacked on to the management questions to be pursued in Phase Three, or should be referred to outside researchers and funding agencies. These questions include the following:

1. How reliable are the light response curves reported by P. Burton (1998)? Can they be verified or improved across a broad range of sites in the study area?
- reduced productivity of black huckleberry at light levels between 40 and 60% full sunlight is especially suspect;
- more data could be brought to bear on this issue if all sampling points described in Section 8.1 items 1 and 2 were also quantified for light availability using hemispherical photographs to be analyzed for relative irradiance using appropriate software.

2. Can the performance of SORTIE-BC be improved for open-grown conditions?
- this model remains the most promising in terms of its ability to predict the development of overstory shading and its effects on the productivity of understory species such as berry plants;
- what if the driving light-response functions were recalibrated to capture mean light response rather than optimal possible light response?
- can/should shrub dynamics be internalized as a separate module within the model, so as to incorporate feedback effects on conifer regeneration?

3. Can we obtain quantitative light response information for the growth of oval-leaved blueberry (*Vaccinium ovalifolium*), highbush cranberry (*Viburnum edule*), saskatoon (*Amelanchier alnifolia*), red raspberry (*Rubus idaeous*) and other little-studied berry species commonly found in the study area?
- conduct a refined program of retrospective field sampling and growth ring analysis, much as done by P. Burton (1998), but with greater emphasis on berry production and indices of vegetative growth rather than pure biomass productivity.

4. How much does competition from non-crop, non-tree species (such as fireweed, thimbleberry, dogwood, bluejoint, alder, etc.) inhibit growth and berry production in black huckleberry?
- start with a correlational study, testing for any relationships between crop ratings and surrounding vegetation encountered at sampling points described in Section 8.1, items 1 and 2;
- follow up with neighbourhood competition studies, controlling for competitive identity and abundance.

5. How successfully can black huckleberry (and other berry species of interest) be propagated from cuttings taken and replanted directly in the field?

- test shoot and rhizome cuttings, with and without rooting hormone, planted in the spring or the fall.

6. How variable are berry yields (of black huckleberry first and foremost, of other species secondarily) from year to year, and what are the critical weather events which allow one to predict annual berry production?

- establish permanent sample plots for commercial berry pickers to visit and report on annually;
- use existing anecdotal data and new sampling information as available, relate it to weather station records in search of critical predictors;
- look for interactions of site and stand conditions with weather in terms of their effects on annual berry yield.

Finally, there is need for the development of a suite of planning tools (both aspatial and spatial) for the evaluation of long-term scenarios for the joint management of timber and non-timber forest products. Issues of resource sustainability are often best addressed at different scales in space and time for different forest values. While managing forest composition and age class structures will always be central to forest management planning, habitat suitability for different plant and animal species is usually not a simple function of forest cover. These issues of multiple scales, multiple habitat requirements, and multiple treatment options (e.g., to evaluate the effects of partial cutting or spacing, not just resetting stands to age class 1 through clear cut harvesting) will become increasingly more important considerations in integrated forest management planning.

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