Master's Thesis:

Analysis of Interrelationships and Interactions between Helicopter Skiing, Forests and the Forestry Industry in British Columbia, Canada

Submitted in partial fulfillment of the requirements for the Degree:
Master of Science in Mountain Forestry

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Abstract

Helicopter skiing in British Columbia, Canada is intricately intertwined with forested landscapes and therefore the forest industry. Helicopter skiing is carried out on forested terrain for many reasons, but mainly due to snow safety and quality. Forested slopes are desirable to skiers because forests have beneficial impacts on the quality of the snow pack for skiing. Operators of helicopter skiing businesses depend upon forested terrain to provide stable and therefore safe snow packs with regard to avalanches. The provincial government owns nearly all forested land in British Columbia. The government grants harvesting rights for the timber on that land to forest companies and also grants use rights to recreational tourism businesses. Due to the overlapping nature of land use rights in the province, helicopter skiing takes place on land that is managed for timber production. Forestry is the most influential industry in British Columbia and therefore takes precedence over helicopter skiing in government policies. This is the root of land use problems between helicopter skiing operators and forest licensees since foresters have different interests and management objectives than those held by the helicopter skiing operators. The goal of this thesis is to analyse and describe the interrelationships and interactions between helicopter skiing, forests and the forestry industry in British Columbia, Canada and to identify issues with and suggestions to improve those interrelationships and interactions.

Deutsch

Helikopter-Skifahren in British Columbia, Kanada steht mit bewaldeten Landschaften und deswegen mit der Forstindustrie in starken Zusammenhang. Skigefahren wird zu einem guten Teil im bewaldeten Gebiet hauptsächlich auf Grund von sichereren Schneedeckenverhältnissen in Bezug auf Lawinenabgängen und der besseren Schneequalität bezogen auf den Skigenuß. Das Bundesland vergibt Rechte einerseits für die forstliche Nutzung der in dessen Besitz befindlichen Wälder und andererseits Rechte für die touristische Nutzung. Daher findet Helikopter-Skifahren auf Flächen intensiver Forstbewirtschaftung statt. Die Forstindustrie ist der bedeutendste Industriezweig für das Bundesland British Columbia und wird daher in der Gesetzgebung bevorzugt behandelt (auch im Vergleich zum Helikopter-Skifahren). Dieser Umstand bringt Interessenskonflikte zwischen der Forstindustrie und der Helikopter-Skiindustrie mit sich. Das Ziel dieser Analyse ist es, die Zusammenhänge und Wechselwirkungen zwischen der Helikopter-Skiindustrie, dem Wald und der Forstindustrie in British Columbia zu beschreiben, Problemfelder aufzudecken und Lösungsvorschläge für die Zukunft zu erarbeiten.

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Definitions

To ensure the reader interprets the text of this thesis correctly, a list of definitions is provided. The following are the definitions that have been used in the writing of this document.

Adventure tourism
The British Columbia Ministry of Tourism, Sport and the Arts (2008) used this term interchangeably with 'commercial recreation'. It refers to tourism activities; including sports, leisure, wildlife viewing and any other activity one may undertake for pleasure, that are carried out for the purpose of gaining economic profit. This term includes, but is not exclusive to helicopter skiing.

Commercial recreation
Recreation activities; including sports, leisure, wildlife viewing and any other activity one may undertake for pleasure, that are carried out for the purpose of gaining economic profit. This term includes, but is not exclusive to helicopter skiing. The British Columbia Ministry of Tourism, Sport and the Arts (2008) used this term interchangeably with 'adventure tourism' and 'nature-based tourism' (not used in this thesis).

Crown land
Land that is owned by the British Columbia provincial government. All land "whether or not it is covered by water, or an interest in land, vested in the government" is termed 'Crown land' (Government of British Columbia 1996). This term refers to the, mostly historic, relationship between Canada and the United Kingdom of Great Britain. Although Canada is no longer a British colony, it is a member of the British Commonwealth and the Queen of England continues to hold a small, mostly ceremonial, role in Canadian affairs. Therefore the term 'Crown land' refers to land associated with the British monarchy.

Forests
An extensive collection of trees with varying spaces between, but that are close enough together to have a defined canopy cover.

Forest stands or tree stands
These words are used interchangeably to refer to small groupings of trees with similar characteristics, for example similar species composition, similar age-structure etc.

Forestry
Management of forests. Management is usually, but not always, carried out for the purpose of cutting trees to obtain financial profit (otherwise referred to as commercial timber production). Generally used to refer to the activities carried out by businesses which harvest trees.

Forest Industry
Forestry businesses are collectively referred to as the forest industry.

Helicopter skiing
The sport of downhill, or alpine, skiing that specifically uses helicopters as mechanisms to transport skiers to the start of the terrain that is to be used to ski down (the ski run). Within this thesis it is assumed that all helicopter skiing is carried out by a business, which operates for profit, since it is assumed that very few individuals have the resources available to undertake this without commercial services.

Helicopter skiing operator
A commercial business and the individuals who run that business, which offers services to facilitate helicopter skiing.

Tourism operator
A commercial business and the individuals who run that business, which offers tourism related services. This term includes, but is not exclusive to helicopter skiing operators.

Tenure
Property rights. For the purpose of this thesis this term specifically refers to the rights granted by the British Columbia provincial government to citizens or companies for the use of Crown land.

Treeline
The altitudinal upper limit of tree growth on a mountain. The line on a mountain above which trees cease to exist.

Timberline
The altitudinal upper limit of trees on a mountain that are viable for use as commercial timber. Generally slightly lower than the treeline.

1 Introduction and Background

1.1 Geography of British Columbia

Canada is the second largest country in the world and British Columbia is one of ten provinces and three territories that together make up the country, for a map of Canada see figure 1. British Columbia is Canada's western most province and encompasses a relatively large land area of 948 600 km^2 (British Columbia Ministry of Forests 1991). Although it occupies just ten percent of Canada, only thirty countries in the world are larger than the province of British Columbia (Forestry Innovation Investment Ltd. 2007) and it is eleven times larger than Austria (Helicat Canada 2007). The province stretches across eleven degrees of latitude and twenty-five degrees of longitude (British Columbia Ministry of Forests 1991). There are approximately sixty million hectares of forest in British Columbia, which encompass approximately two thirds of the province's total area of nearly ninety five million hectares (Forestry Innovation Investment Ltd. 2007). As stated by the Ministry of Forests (now the Ministry of Forests and Range) (1991), "[b]roadly speaking, British Columbia is a cool, moist, mountainous, forested region. However, the province also has areas with Mediterranean-type, semi-arid, subarctic, and alpine climates. It has extensive plateaus, plains, and basins" in addition to the roughly parallel mountain groups. Topography of the land is mostly mountainous, with many different mountain groups in the province. As illustrated by the generalized physiographic regions in figure 2, a map from the Ministry of Forests' report, the province can be divided into the following five main regions: the western Coast Mountains and islands, central interior plateau, eastern Columbia and southern Rocky Mountains, northern and central plateaus and mountains and the north-eastern Great Plains.

Figure 1.
Map of Canada indicating forest types and the location of the province of British Columbia, the study area. (Canadian Forest Service 2004)

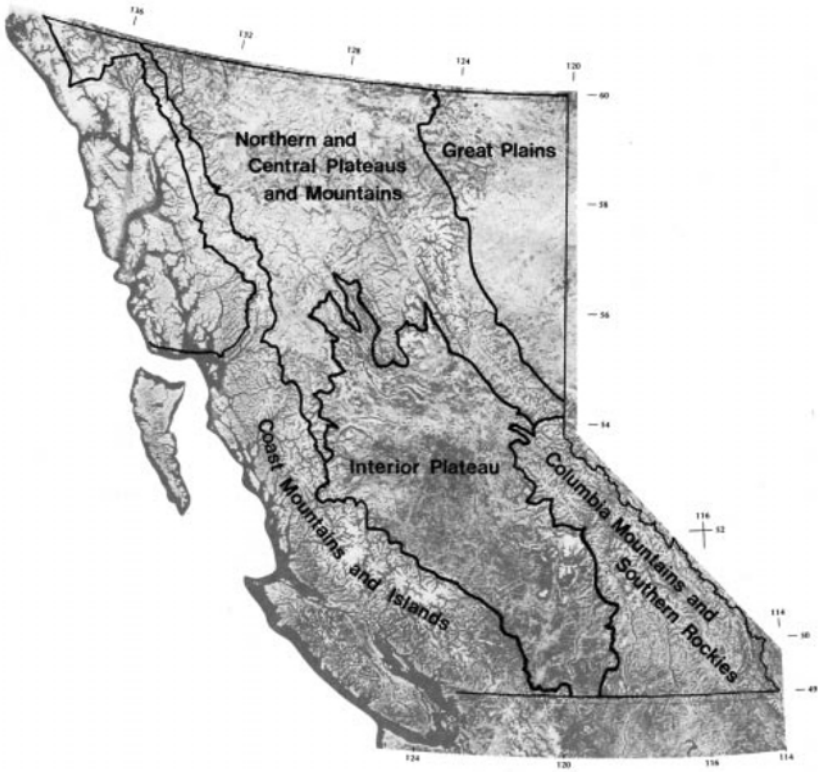

Figure 2.
Generalized physiographic regions of British Columbia (Valentine et al. 1976 in British Columbia Ministry of Forests 1991).

1.2 Ecology of British Columbian Forests

Forests in British Columbia are comprised of forty species of trees that are native to the province in addition to minimal amounts of other species. The concept of ecoregions is sometimes used to describe different types of forests within the province. According to the *Ministry of Forests* (1991) the ecoregion classification "provide[s] a systematic view of the broad geographical relationships of the province". The forests of British Columbia were described by the BC Market Outreach Network (2007) to fall into four main categories (ecodomains) of ecoregions: the temperate rainforest on the west coast, high elevation spruce, willow and birch in the northwest, boreal forest in the northeast and spruce and lodgepole pine on the interior plateau. The most common system used to describe the different ecosystem types in British Columbia is the biogeoclimatic zone system, which combines data on climate, vegetation and soil to describe the different zones. This system was used by the Ministry of Forests (1991) to describe the differences between forest types. The system consists of fourteen classifications, twelve of which describe the forested biogeoclimatic zones of British Columbia: Coastal Douglas-fir Zone, Coastal Western Hemlock Zone, Mountain Hemlock Zone, Ponderosa Pine Zone, Interior Douglas-fir Zone, Interior Cedar – Hemlock Zone, Montane Spruce Zone, Sub-Boreal Pine – Spruce Zone, Sub-Boreal Spruce Zone, Engelmann Spruce – Subalpine Fir Zone, Boreal White and Black Spruce Zone and Spruce – Willow – Birch Zone (two additional zones categorizing non-forested areas are the Bunchgrass Zone and Alpine Tundra Zone). Figure 3 shows the spatial distribution of the various zones throughout the province. From viewing Figure 3, one can notice that more biogeoclimatic zones are present in the south-central region of the province. The southern interior of British Columbia has more species than any other ecological zone in the province, since both desert and rainforest can be found in this area. The species include: subalpine fir, lodgepole pine, ponderosa pine, Engelmann spruce, white spruce, western larch, white pine, western hemlock, balsam poplar, Douglas fir, grand fir and western red cedar (BC Market Outreach Network 2007).

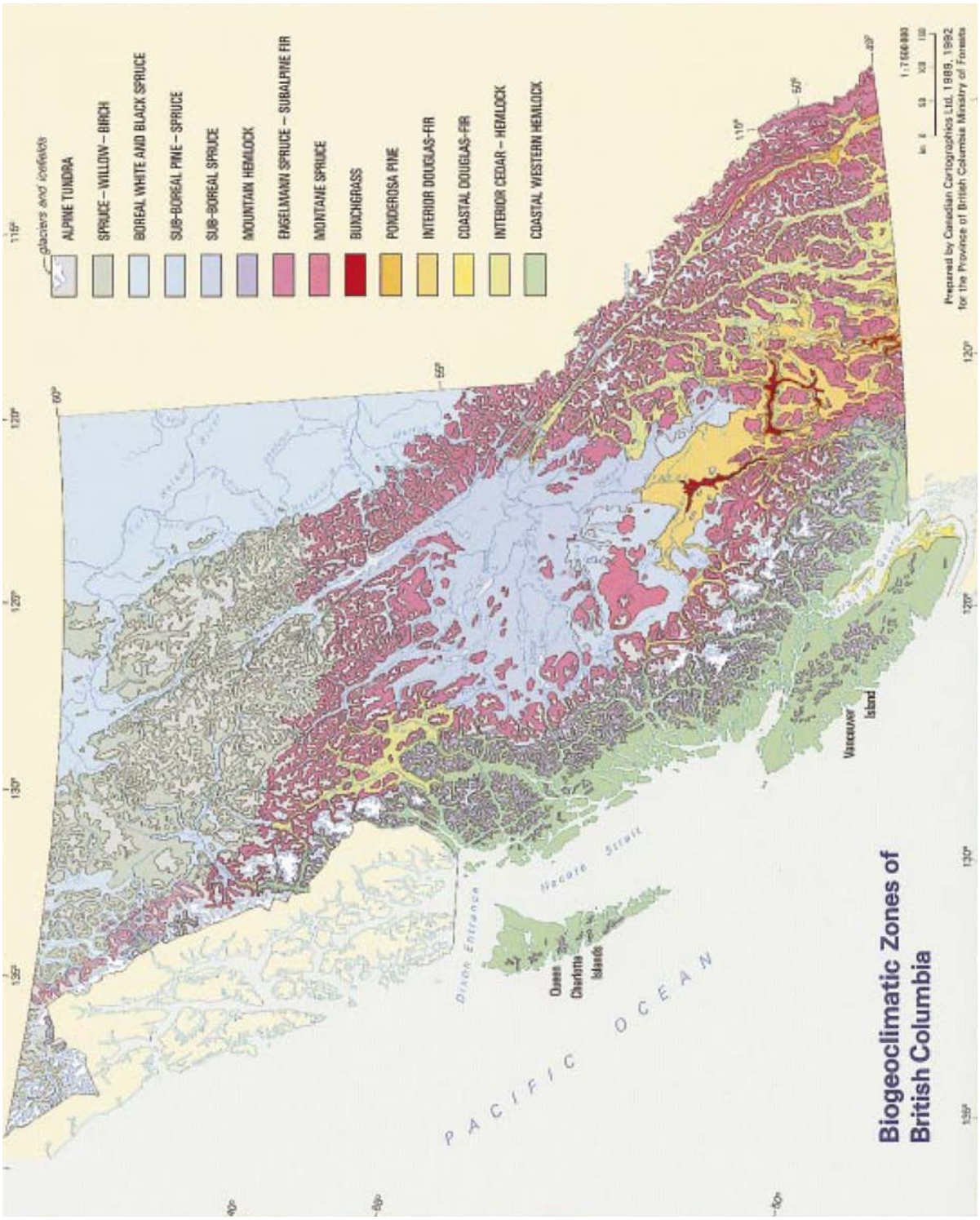

Figure 3.
The fourteen biogeoclimatic zones of British Columbia (British Columbia Ministry of Forests 1991).

1.3 The Forestry Industry in British Columbia: Overview and History

Forestry is the most influential and prosperous of all industries in the province if British Columbia (BC Market Outreach Network 2007), contributing an estimated $1.37 billion to provincial revenues in the current year (British Columbia Ministry of Forests and Range 2007). The importance of the forestry industry in British Columbia is explained by the massive amount of forested land and the ownership structure of that land. There are approximately sixty million hectares of forest in British Columbia, which encompass approximately two thirds of the province's total area of ninety five million hectares (Forestry Innovation Investment Ltd. 2007). Nearly all, ninety-four per cent (Integrated Land Management Bureau 2007a), of the forested land in the province of British Columbia is owned by the provincial government, called Crown Land[1]. This percentage of state owned forests is only exceeded by four nations in the world: India with ninety six per cent and Democratic Republic of the Congo, China and Indonesia each with one hundred per cent (Cashore 2004). Forest management on Crown land is carried out by forest licensees in accordance with government regulations under the *Forest and Range Practices Act*. Forest companies, licensees, pay the British Columbia government for the right to harvest trees on a given area of land as well as stumpage fees for each tree that is harvested.

Forestry's influence in British Columbia is not only demonstrated in terms of economics, but also in terms of social factors such as employment, history, tradition and reputation. Many communities in British Columbia were founded as a result of forestry operations and depend upon forests for their survival. The "Super Natural British Columbia" trademark (Tourism BC 2008a), is a tool used to brand the province with a reputation of being a haven of natural landscapes and since most of the province is naturally forested, this reputation is directly influenced by forest practices. In the Speech from the Throne at the opening of most recent parliamentary session, lieutenant-governor honourable Steven L. Point stated that

[1] See definition on page iv

British Columbia's "forest management practices and environmental management are second to none" (Legislative Assembly of British Columbia 2008), however not all sources agree with that statement. Silvicultural practices with regard to natural hazard reduction and natural regeneration seem to be lagging behind those of European nations, as pointed out by McClung (2001).

Since Europeans came to settle in Canada two per cent of the forested land has permanently been converted to other uses such as housing, transport routes and agriculture) (BC Market Outreach Network 2007). Approximately ninety-five percent of forested land in British Columbia is owned by the provincial government (Cashore 2004). This is a relatively unique ownership structure in comparison to other countries. In fact only four countries in the world have a greater percentage of government owned forested land: India with ninety-six percent and Democratic Republic of the Congo, China and Indonesia each with one hundred percent (Cashore 2004).

Although in the other countries with high percentages of governmental ownership forestry operations may be carried out by government staff for the benefit of the government, this is not the case in British Columbia. Despite the fact the province owns nearly all of the forested land in British Columbia, forest operations are carried out by private enterprises in alignment with governmental regulations. Perhaps it is understandable that a government which owns, and therefore controls, approximately ninety-five percent of its total forested land would exert its control by implementing regulatory measures that bring a great amount of benefits to the government. To assure integrity in both industry practices and governmental regulations, an independent monitoring organization exists in the province; further details about this organization can be found in sections 4.1.1.

1.4 The Tourism Industry in British Columbia- Overview

The tourism industry, which also uses Crown land, produces the second greatest economic profits in British Columbia (COTA 2007). In 2006 British Columbia hosted more than twenty-three million visitor nights and revenues of all businesses in the tourism industry totalled ten billion dollars (British Columbia Ministry of Tourism, Sport and the Arts 2008a, COTA 2007), which is the greatest figure to date (COTA 2007). Helicopter skiing belongs to the sub-sector of the tourism industry referred to as either: adventure tourism, nature based tourism or commercial recreation (British Columbia Ministry of Tourism, Sport and the Arts 2008a). This sub-sector is growing at a rate twice as fast as other sub-sectors of the tourism industry (Undisclosed source 2007), reflecting that helicopter skiing represents an important contribution to the success of the tourism industry as a whole. Adventure tourism operators hold land use rights on more than 15 000 000 hectares (COTA 2007), approximately one sixth of British Columbia's Crown land and bring in approximately 1.4 billion dollars in annual revenues (Undisclosed source 2007), approximately one seventh of total tourism revenues. Both the lieutenant-governor of British Columbia and the Minister of Tourism, Sport and the Arts have committed to a goal of nearly doubling the revenues brought in by the tourism industry to eighteen billion dollars by the year 2015 (Heidt and Williams 2005, COTA 2007). This is quite an ambitious goal while challenges including a low American dollar, widespread mountain pine beetle damages, and indirectly new forestry legislation, and the softwood lumber agreement between Canada and the United States (COTA 2007) are currently being faced by the tourism industry and could inhibit its growth. To achieve its goal, the government will likely need to recognize and cater to the needs of tourism operators within the province. Such a target set by the province therefore provides greater likelihood that the voices and interests of helicopter skiing operators will be heard and that policy measures could be altered to ease land use problems between helicopter skiing operators and forest licensees.

1.5 Helicopter Skiing in British Columbia: Overview and History

Starting with the basics, helicopter skiing is defined (for the purpose of this thesis) as the activity of alpine skiing assisted by the use of a helicopter for transportation to and from the terrain that is skied. Many individuals are allured by the sport due to the possibility of skiing endless untracked powder snow that is light and fluffy. British Columbia is especially known in the international skiing community for its 'champagne powder', lighter and fluffier than any other snow that can be experienced. This is why ninety-five percent of all helicopter skiing takes place in British Columbia (Helicat Canada 2007) and why people from all over the globe travel to British Columbia for a helicopter skiing adventure.

British Columbia is both the birth place of helicopter skiing and home to nearly all, 95 per cent (Helicat Canada 2008), of the world's helicopter skiing companies. This adventure sport and tourism activity dates back to the nineteen fifties when Mr. Hans Gmoser, a mountain guide of Austrian decent, moved to Canada to explore the magnificent wilderness of the Rocky Mountains. On November 26, 1959 after saving some money, he started a very small company called Canadian Mountain Holidays in Banff, Alberta. At first he just led tours with clients in the area surrounding Mount Assiniboine, a very spectacular mountain and World Heritage Site which is 3 618 metres tall, using traditional backcountry touring techniques. A few years later and leading up to the birth of helicopter skiing, on May 5th, 1962 CMH used a plane with skis on the bottom to transport skiers into the Cariboo mountain range. Helicopter skiing was born in the same place, the Cariboo mountains, the following year on April 28th, 1963, when CMH used a helicopter to transport skiers for the first time. The evolution of helicopter skiing continued for the next couple of years as CMH took skiers to different areas that were previously inaccessible to backcountry skiers, the Bugaboo mountains. This idea was very successful since areas such as the Bugaboo mountain range exhibited the potential to offer some spectacular skiing terrain, but were located very far away from any form of civilization making traditional touring a very long and uninviting access method to say the least. (Canadian Mountain Holidays 2007)

It wasn't long before other people caught on to this business idea and started their own companies throughout British Columbia. As the industry expanded and "various operators started their businesses, a natural partitioning of the [British Columbia] mountain areas occurred" (Helicat Canada 2007). The partitioning occurred along geographical borders along with logistical considerations and a "gentleman's agreement" not to interfere with each others terrain (Helicat Canada 2007). Currently, there are approximately 30 helicopter skiing operators in the province, which are scattered across British Columbia, from the west coast to the east coast and from the far north to the southern border. The distribution and location of companies can be seen in figure 4. A wide variety exists in the services provided in addition to helicopter skiing by each individual operator. For example, some only offer single flights or day trips, while others specialize in multi-day or more than a week long vacations. Most offer accommodation in remote or semi-remote lodges with fine cuisine, some offer luxury suites and gourmet pastry chefs, while there is even the possibility of accommodation on a ship from where the helicopter takes off.

Although it can be considered a relatively expensive activity, since one could practically spend an unlimited sum each day if accommodation, meals, entertainment and travel expenses are also involved; helicopter skiing can also be done as a single days activity costing as little as a couple hundred dollars. Although fuel for the helicopter, equipment, guides and snow safety staff as well as lodge amenities are quite costly, helicopter skiing has the potential to produce significant revenues.

According to BCHSSOA (2002), helicopter skiing is carried out on slopes with gradients ranging from twenty-five to eighty percent. The average vertical drop of a ski run ranges from six-hundred to nine-hundred metres, according to BCHSSOA (2002).

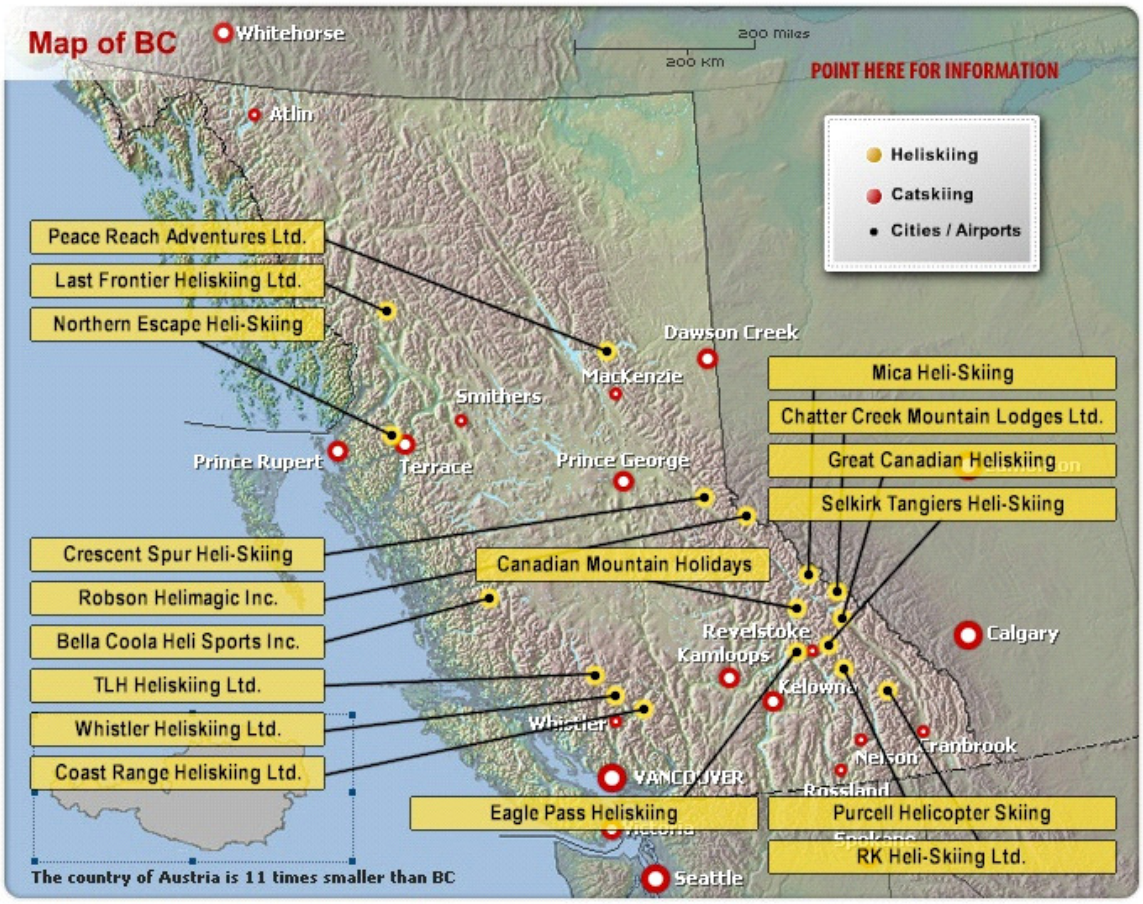

Figure 4.
Helicopter skiing operators in British Columbia who are members of Helicat Canada. (Helicat Canada 2007)

2 Objective

The objective of this thesis is to analyse the manners in which helicopter skiing, forests and therefore forestry are related and how helicopter skiing, forests and therefore forestry interact. This objective is to be obtained by answering the following research questions:

- What are the manners in which helicopter skiing, forests and therefore forestry are related?
- What are the reasons for the relatedness of helicopter skiing and forests?
- How does helicopter skiing influence forests?
- How do forests interact with helicopter skiing?

3 Methodology

The methodology used to complete this thesis work included a literature search, empirical data collection, analysis of findings, conclusions and recommendations. The first step taken was to search the available literature and review previous findings related to the subject matter. The literature search and review was followed by empirical research to extend knowledge that was found in the literature and to investigate issues that have not yet been addressed by formal scientific study. The empirical research consisted of interviews, questionnaires and snow profiles. Findings from the empirical research were subsequently analysed to describe relationships and interactions between helicopter skiing and forests. Finally, conclusions were drawn from the findings and recommendations were made based upon the conclusions.

The topic of study is composed of two main aspects, helicopter skiing and forests. The interactions and interrelationships between those aspects can be divided into two categories: those related to natural science and those related to social science. Interrelationships and interactions that fall into the social science category include those that exist as a result of the land use system, while natural science based interrelationships and interactions include features of snow stability and the influences of forests on the snow pack, as well as those resulting from the physical geography of British Columbia.

3.1 Project Initiation and Topic Definition

This thesis topic was chosen based upon the interests of the researcher and the multiple-disciplinary nature of the topic, which encompasses nearly all subjects; ecology, engineering, risk analysis, economics and social science; included in the course work portion of the international Mountain Forestry Master's program at BOKU, the University of Natural Resources and Applied Life Sciences, Vienna. The thesis portion of the master's program is an opportunity for students to apply what has been learned during three semesters in the classroom to scientific study of a relevant situation or subject matter in their home countries. Analysing the interrelationships between helicopter skiing and forests requires knowledge of both natural and social science principles - both of which are stressed in the Mountain Forestry curricula. Furthermore, the topic was chosen to include elements of both natural and social science because it is believed that both are necessary to thoroughly analyse situations that occur on landscapes used by humans.

3.2 Literature Research

The interviews were followed by an extensive search and review of literature relating to interactions between forestry and helicopter skiing companies and snow and avalanche research. Literature sources encompassed a variety of media including: peer reviewed journal articles and reports; industry, stakeholder and governmental reports, books, unpublished documents, stakeholder association and governmental websites and news releases.

3.3 Empirical Data Collection

During the literature research phase it was noticed that there was a lack of information describing the interactions between helicopter skiing, companies that facilitate helicopter skiing, the forests in which helicopter skiing occurs and the forestry companies that manage those forests. Insufficiencies and biases found in the available literature during the literature research phase of the project, guided the direction of empirical research that was required to conduct a complete analysis of the relationships between helicopter skiing and forests. Literature related to land use rights and over lapping tenure areas between helicopter skiing operators and forest licensees who manage the forests used by helicopter skiing was found to be biased towards one particular study. Literature on the topic of snow quality and texture differences between forests and open areas was found to be lacking. Thus, empirical data was gathered via interviews, questionnaires and snow profiles that were examined in the field.

3.3.1 Questionnaire

To gain comprehensive information regarding the interrelationships and interactions occurring between helicopter skiing and forests across the whole province, it was determined that input from more and from diverse helicopter skiing companies was necessary. Almost thirty helicopter skiing companies were found to exist in the province of British Columbia, which represent the target population for questioning.

Telephone Interviews

In order to formulate an appropriate and effective questionnaire, telephone interviews were conducted to test possible questions before disseminating the questionnaire. To obtain a more complete understanding of the interactions between helicopter skiing and forests a helicopter skiing company was contacted to conduct a telephone interview. In an effort to obtain the greatest amount of information from a single company, the oldest and the largest helicopter skiing company in the industry was chosen. The individual interviewed was Mr. Hank

Krawczyk, Forest Resource Manager for Canadian Mountain Holidays Inc.. A semi-structured interview was carried out on November 18th, 2007. The interview consisted of approximately fifteen questions with a significant amount of discussion stemming from most questions. The interview lasted one to one and a half hours in length. A follow-up interview was conducted on December 6th, 2007 with Dave Butler, Director of Land Resources for Canadian Mountain Holidays Inc.. This second interview was unstructured and lasted approximately half an hour in length.

Questions Posed

Questions posed within the questionnaire were developed from questions that were tested during the telephone interviews. Some subtractions and additions were made to the original questions based upon discussions and information gained in the telephone interviews as well as information, or lack thereof, found during the literature research phase. The questionnaire consisted of twenty open- and closed-ended questions. The number and type of questions were chosen as a balance between posing enough questions to obtain the desired information without requiring so much time and energy that the targeted population would not complete the questionnaire at all. The latter factor was weighed carefully because it was known that the questionnaire was being distributed during high season for the targeted companies and therefore staffing resources would be low. As a result, the questions were designed to provide the opportunity for both short and concise answers or long and more detailed responses depending upon the amount of time and effort that a given respondent was willing or able to donate to the questionnaire. It was the goal of the student that by designing the questions in the previously stated manner an optimum response rate would be obtained, acquiring information and view points generally representative of British Columbia's helicopter skiing industry.

Method of Deployment

The questionnaire was distributed via email. Email was determined to be the best method of deployment, rather than via traditional mail service or telephone interviews, based upon logistical and economic factors. Logistically, email was the

best method because all of the companies it was distributed to were located in British Columbia, Canada, while the researching student was located in Vienna, Austria. Therefore traditional mail would take far too long to be delivered and returned, plus returning it via traditional mail would increase the resources required of those companies being surveyed and hence likely decrease the response rate. Additionally, it was determined that the number of target helicopter skiing companies was too many to conduct a telephone interview with each and every one. Cost was a key factor for the researching student since she did not receive any funding whatsoever for carrying out this project and therefore no funds were available for covering postage fees or telephone bills associated with distribution to or telephone calls to all of the targeted helicopter skiing companies.

Timing and Response Rate

The questionnaire was distributed on February 5th, 2008 with the objective of obtaining a response rate of at least fifty percent. A deadline of February 15th was attached to the return of questionnaires. This deadline was determined based upon the timeline required for this project as well as the anticipated amount of time after which potential respondents would not return the questionnaire because they either forgot about it or would continue to put it off to an infinitely further date. If the number of questionnaires returned by the deadline was determined to be insufficient, follow-up telephone calls would be made as reminders and to request the unresponsive companies either to return the questionnaire or to answer the questions over the telephone. The questionnaire document follows in figure 5.

Helicopter Skiing/Forestry Questionnaire

For the purpose of gathering information for a master's thesis.

Please return via email to:
cris.delaney@gmail.com

Christina Delaney
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1. **How often do you use forests as terrain for helicopter skiing? (expressed as an approximate percentage of skiing time would be best)**

2. **If skiers are dropped above the tree line do they usually pass through a forest on the decent?**

3. **What type(s) of forests do you mainly operate in? (Species, spacing, age structure etc.)**

4. **Who manages those forests? (name(s) of individuals and/or a forest company whom I could contact in order to complete an objective analysis)**

5. **What type of silvicultural system(s) is/are used in the area(s)?**

6. **What type of silviculture proves to be most compatible with skiing?**

7. **Have you tried working with the forestry industry on a rotation plan that suits both interests?**
   - **If yes, how did it work out? Do you still operate in such a manner?**
   - **If no, why not?**

8. **Do forest roads interfere with your operations?**

9. **Are land use rights a big problem for your business?**

10. **What type of land tenure do you hold?**

11. **Has anything changed since you started operations regarding the way skiing and forestry interact?**

12. **How do the following factors influence skiing in forested terrain:**
    - **Aspect** (North, East, South, West) –
    - **Slope steepness** –
    - **Exposure** (open vs. protected)-
    - **Tree species -**
    - **Diameter -**
    - **Stump height -**
    - **Size of cut block -**
    - **Shape of cut block -**
    - **Stand density (initial vs. cut) -**

13. **What type of harvest block/silviculture poses the least risk for avalanche initiation?**

14. **How great is the risk of hard clumps of snow falling off trees onto skiers?**

15. **How great is the risk of skiers hitting stumps which are only partially covered with snow?**

16. **Has the mountain pine beetle destruction affected your skiing operations at all?**

17. **Can you suggest any relationships between forestry and helicopter skiing that I have not mentioned?**

18. **What are the typical demographics of your clientele? (E.g. nationality, age, skiing ability, profession, gender etc.)**
19. **How long to guests typically stay and what is the average number of days they spend helicopter skiing during that time?**

Figure 5. Questionnaire.

3.3.2 Field Work: Snow Profiles

Research into the qualitative differences in the texture of snow under forest canopies and in open areas was not found in the literature. In an attempt to gain some knowledge regarding the textural differences in snow caused by forest canopies, snow profiles were dug both in open areas and in forested terrain to assess the influence of forests on the snow pack. Field work was conducted in Austria during February of 2008. Field work was carried out in a location different than that of the topic area, based upon logistical factors. The student was located in Austria during the time of research and with the absence of travel funds, conducting field work in British Columbia was not feasible. The specific site chosen was Thomaseck, a mountain face accessed by the Sport Gastein ski area in the Austrian province of Salzburg.

Thomaseck is a north facing slope in the Gastein valley. Measurements were taken between an altitudinal range of approximately 1800 to 2200 metres above sea level. Profiles representative of open areas were dug above the timberline at 2200 metres above sea level on a mountain face almost entirely free from trees. One or two very small trees, less than half a metre above the snow surface, were present on the slope, but were more than twenty metres from the profile locations and can be assumed not to influence the findings whatsoever. Profiles representative of forested areas were dug lower down on the mountain at approximately 1800 metres above sea level in sparsely space stands of Norway spruce forest. The exposition of all profiles was the same, north facing. Photographs of areas chosen for open and forested profiles can be seen in figures 6 to 9 below.

Figure 6. Forested profile 1.

Figure 7. Forested profile 2.

Figure 8. Open profile 1.

Figure 9. Open profile 2.

The exact profile locations were chosen by measuring the snow depth across the slope using a probe. Profiles were dug at spots where depth was representative of the surrounding area to avoid micro-site influences. Using a shovel, snow was removed down to the ground surface over an area large enough to stand in and manipulate measuring equipment. A flat, vertical wall was cut on the upslope side of the hole. The probe was used as a height indicator and layers within the snow pack were assessed. Measurements of the following parameters were taken for each layer found within the snow pack:

- layer depth
- crystal form
- crystal size
- hardness
- moisture content
- temperature
- density

In addition to the measurements taken for each layer, the air temperature and humidity were also measured. Comments regarding any special features of the layers or profile as a whole were recorded.

4 Results of Literature Research

The following section describes information gathered in the literature search stage of research. First the actors and stakeholder groups involved are identified and described. Then an explanation of the institutional framework within which those actors and stakeholders interact is provided. The ways in which actors and stakeholder groups are interrelated and interact are then described with regard to the institutional framework governing those interrelationships and interactions. Inhibiting and fostering factors are identified and described with reference to examples. Then a summary of recommendations to improve the manners in which helicopter skiing and forests interact is presented.

4.1 Actors and Stakeholder Groups

The following section outlines the various actors which are directly involved in interactions between forests, forestry and helicopter skiing; as well as those which are currently or have previously been influential in those interactions. For clarity, this section has been divided into two subsections of actors: those related to forests and forestry and those related to helicopter skiing.

4.1.1 Actors and Stakeholders Related to Forests and Forestry

Forest Ecosystems

The most relevant stakeholder to this topic is forests themselves. While this may be an unlikely actor, since forests are not human, their livelihood depends upon the ways in which humans interact with them. Forest ecosystems are composed of a plethora of living organisms including plants, animals, fungi and ascomycetes. Plants include trees, shrubs, grasses, forbs, moss and lichen. Animals vary from tiny one celled organisms, to worms, insects, amphibians, reptiles, rodents, birds, and mammals. Fungi and ascomycetes found in forest ecosystems fall into an array of further categories that will not be discussed here. The specific types of forest ecosystems that are used as helicopter skiing terrain in British Columbia are described in the introduction and background section of this thesis. (British Columbia Ministry of Forests 1991)

Forestry Licensees

Holders of forest licenses in British Columbia range encompass individuals, small forest companies and large integrated forest products companies. Large integrated forest products companies, however, hold licenses for the majority of forested Crown land. "[T]he top twenty companies… collectively hold more than seventy four percent of the committed allowable annual cut in the province" (Zhang and Pearse 1997). As a result, large integrated forest companies are the main actors for the forest industry in the majority of interactions with helicopter skiing operators.

British Columbia Ministry of Forest and Range

The division of the provincial government of British Columbia with authority over forests and range land is called the Ministry of Forest and Range. This ministry is a product of recent restructuring within the provincial government; forests used to be dealt with by the *Ministry of Forests*, while range land fell under the umbrella of another ministry.

The *Ministry of Forests and Range* strives to "protect, manage and conserve forest and range values for the economic and social benefit of all British Columbians" through "a high-performing organization" (Ministry of Forests and Range 2007). Those forest and range values that are to be protected by the ministry fall into the three categories usually associated with sustainability: social, economic and environmental. As described in the current Ministry of Forest and Range Service Plan, economic values include timber resources that contribute to the British Columbia economy; environmental values include soil, water, fish, biodiversity and wildlife; and social values include recreation resources, visual quality, resource features and cultural heritage resources. Legislation regulating British Columbia forest practices is called the *Forest and Range Practices Act* and is a product and responsibility of the *British Columbia Ministry of Forests and Range* (Ministry of Forests and Range 2007).

Minister of Forests

Rich Coleman has been the minister in charge of forests since June 16, 2005 (British Columbia Ministry of Forests and Range 2008). A minister is a person who represents the interests of a particular ministry in the legislative assembly of the provincial government. Therefore Rich Coleman is effectively the leader of the ministry of Forests and Range and oversees all activities that occur within the ministry.

Compliance and Enforcement Program

This is the law enforcement arm of the *Ministry of Forests and Range*. It is the body responsible for ensuring that forest licensees comply with the *FRPA*. The Compliance and Enforcement Program aims to ensure the province brings in ample revenue from its forested land and upholds the public's interests regarding management of provincial forests. The main purpose of this arm of the ministry is to ensure the forestry laws, *FRPA*, are adhered to on all forested Crown land throughout the province and to take action in cases in which the laws are broken. Each year, compliance and enforcement officials conduct more than sixteen thousand inspections to assess forest law compliance. Investigations are conducted when evidence of infringement is suspected. If a party is found guilty of infringement, violators are punished with tickets, penalties or other means of enforcement depending upon the particular circumstance and the most serious forest crimes are prosecuted within the court system. (British Columbia Ministry of Forests and Range Compliance and Enforcement Program. 2007)

The *Ministry of Forest and Range*, its minister and Compliance and Enforcement Program have ultimate authority over the public forested land base that is used for helicopter skiing. Therefore this ministry is an important actor in the interactions that occur between forests, forestry and helicopter skiing in British Columbia.

Forest Practices Board

The Forest Practices Board (FPB) is an independent public supervisory body for forestry in British Columbia. Its role, and legal obligation, is to monitor both government policy and forest industry practices and to deal with complaints regarding the industry. The FPB performs audits of the forest practices carried out by government as well as private individuals and companies who hold forest licenses for public lands. The FPB also audits governmental enforcement of British Columbia forest laws, the FRPA. Additionally, the FPB investigates public complaints and undertakes special investigations of forest issues that are brought to light. The FPB participates in administrative appeals and produces reports to

inform the public, industry and government about its activities, findings and recommendations. (Forest Practices Board 2008)

The FPB brings integrity to the provincial government of British Columbia. Although the FPB was set up by the government it works independently of any governmental interference, for instance decisions as to which operations are audited are made solely by the FPB and it publishes reports and findings of its investigations without any governmental revision. Holding the government and forest industry accountable for their forest practices is a mandate of the FPB. Determining or laying punishment for infractions made in relation to the FRPA is not a role or responsibility held by the FPB. The FPB does however make recommendations for possible resolution of issues and methods of improvements.

Since poor forest policy and non-compliance are factors that influence relationships and interactions between forests, forestry and helicopter skiing, the Forest Practices Board provides valuable information to facilitate informed discussions and brings legitimacy or lack thereof to forest management practices.

Council of Forest Industries (COFI)

The Council of Forest Industries is an association that represents the forest industry specific to the interior region of British Columbia. It represents forestry companies that operate many production mills and processing plants in more than 60 communities in the interior region. The association offers its member companies "enhanced levels of services in the areas of forest policy, quality control, international market and trade development, public affairs, and community relations." It is run by a board of directors, composed of individuals who are elected from within the member companies. The mission of the COFI is to "be a strong advocate for the forest sector" by positively influencing the competitiveness and sustainability of the forest industry, as well as the economic contributions of the forest industry to the economic growth and stability of the province. (Council of Forest Industries 2007)

The role of COFI as an actor in the relationship between forestry and helicopter skiing is significant because it could act to represent the interests of forestry companies in discussions of cooperation with interior helicopter skiing companies or associations representing interior helicopter skiing companies.

Coast Forest Products Association (CFPA)

The Coast Forest Product Association represents the interests of the forestry industry specifically in the coastal region of British Columbia. It works with both government and industry stakeholders in efforts to create forest policies that benefit the forest sector and to promote products produced from tree species that are distinctive of the coastal region of British Columbia. Furthermore, CFPA interacts with all; local, provincial and federal; levels of government to address coastal forest industry issues. (Coast Forest Products Association 2005)

The role of CFPA as an actor in the relationship between forestry and helicopter skiing is significant because it could act to represent the interests of forestry companies in discussions of cooperation with coastal helicopter skiing companies or associations representing coastal helicopter skiing companies.

Private Forest Landowners Association (PFLA)

This is an association dedicated to representing the few, in comparison to those owned by the Crown, privately owned managed forests in British Columbia. The PFLA works to balance private property rights, landowner objectives and public values. The PFLA administers a Best Practices Management Program for its members. Members of the PFLA encompass individuals, families and investors in companies. The association works with the provincial government to “maintain an innovative regulatory model for B.C.’s private forested lands”, in order to enhance investment and generate more economic activity, jobs and expanded benefits for British Columbians. (Private Landowners Association Unknown Year)

Since most helicopter skiing occurs on provincially owned land, the PFLA plays a relatively minor role in the interrelationships of forests, forestry and helicopter skiing. But in certain circumstances in which an owner or owners of private forest land are affected by helicopter skiing, the PFLA can act to represent and protect the interests of that owner or owners.

Forest Alliance of British Columbia

This alliance is "a coalition of more than 10,000 citizens and 300 organizations from all areas of the province and walks of life." The alliance strives to achieve "both environmental protection and economic stability in the use of B.C.'s forest resources." The Forest Alliance of British Columbia is directed by a Citizen's Board comprised of 30 people coming from different regions and who have different view points on issues. The alliance conducts studies, fact-finding missions and offers education and information services to make facts about current forest issues in B.C. available to the public and industry. (Forest Alliance of British Columbia 2008)

Clayoquot Sound Scientific Panel

This organisation is not a direct actor in current relations between forests, forestry and helicopter skiing; but it played a significant role in altering the nature of forest policy and management resulting in development of the new set of forest laws in British Columbia, the FRPA. In the late 1980s and early 1990s on the west coast of British Columbia in the region of Clayoquot Sound, erosion and other negative environmental effects of clear-cut logging and other forest management practices that were frequently employed at the time brought public attention to the need of developing improved land and resource management practices. It was suggested that the historical approach of using top-down governmental policy instruments to regulate forest practices were failing to protect the natural resources associated with forests. This failure "spurred experimentation with alternative planning approaches that involved greater community participation" (Fraser et al. 2005). The Clayoquot Sound Scientific Panel was established "to develop a new strategy

for land and resource management in Clayoquot Sound" by making recommendations based on current scientific knowledge (Fraser et al. 2005). Many groups of stakeholders such as local citizens, the forest industry, government and environmental groups were also involved with the panel to develop the new strategy. This situation although particular to a small region, brought significant international attention to forest policy and forest practices in British Columbia and was a major contributing factor to the creation of a new set of forest laws in the province.

4.1.2 Actors and Stakeholders Related to Helicopter Skiing

Helicopter Skiers

Individual skiers have the most direct interaction with forests. These individuals come from a wide variety of backgrounds and skiing abilities. They are clients of the many helicopter skiing operators in British Columbia. A helicopter brings the skiers to mountain slopes and they ski down under the watchful eye of trained and certified guides.

Helicopter Skiing Operators

There are approximately thirty helicopter skiing operators in British Columbia. They range from very new to very old companies with a great variety in the type and number of services provided by each operator. Some offer snowcat skiing as well as helicopter skiing and many offer helicopter hiking in the summer months. Accommodation and meals of varying types are often included in packages offered by many companies, while some companies only offer single day or single ride experiences. The environmental setting in which each company operates also varies greatly across the different mountain ranges and ecological zones in the province of British Columbia.

British Columbia Ministry of Tourism, Sport and the Arts

This is the division of the provincial government of British Columbia with authority over tourism, sport and the arts. As with the Ministry of Forests and Range, the

Ministry of Tourism Sport and the Arts is also a product of recent restructuring within the provincial government. The ministry works to coordinate investments, address challenges and build strong relationships across the tourism sector. Its mission is to "build strong partnerships that will foster sustainable tourism, sport and arts sectors, healthy lifestyles, and creative active communities where people want to live, visit and invest." (Ministry of Tourism, Sport, and the Arts 2007)

Minister of Tourism, Sport and the Arts

The minister in the legislative assembly of British Columbia in charge of Tourism, Sport and the Arts is Stan Hagen.

Tourism British Columbia (Tourism BC)

Tourism British Columbia is a Crown corporation responsible for marketing the tourism registered trademark brand of "Supernatural British Columbia". In addition, its mandate is to "promote development and growth in the tourism industry, to increase revenues and employment throughout British Columbia, and to increase the economic benefits for all British Columbians" (Tourism BC 2008a). This is to be achieved via "innovative programs and industry development initiatives" (Tourism BC 2008b). Tourism BC works with members of the tourism industry to support economic growth and diversification of the industry (Tourism BC 2008a). The organisation provides information to industry, media and other interested stakeholders (Tourism BC 2008b).

The Ministry of Tourism, Sport and the Arts, its minister and Tourism British Columbia hold regulatory authority over the tourism industry. This ministry is therefore an important actor in the interactions that occur between forests, forestry and helicopter skiing as it influences the specific helicopter skiing sub-sector of the tourism industry in British Columbia.

Integrated Land Management Bureau (ILMB)

The Integrated Land Management Bureau (ILMB) is an entity within the provincial government with authority over management of Crown land. The mandate of the ILMB is "to provide British Columbians with access to integrated Crown land and resource authorizations, planning dispositions and resource information services" (Integrated Land Management Bureau 2007d). The ILMB is responsible for initiating new management plans for Crown land and for maintaining the previously developed planning framework (British Columbia Ministry of Tourism, Sport and the Arts 2008b). It coordinates and manages tenure tourism operators' applications for land use rights and provides guidance to commercial recreation businesses. (Integrated Land Management Bureau 2007c)

Helicat Canada

Helicat Canada is an association representing a society of commercial recreation businesses offering backcountry skiing using mechanized modes of transport – helicopters and snowcats. Full members of the association include twenty eight helicopter and snowcat skiing operators, almost all of which are located in British Columbia. The association was formed around a mandate to "promote, encourage and maintain the industry of wilderness and high mountain skiing by helicopter or snowcat". Helicat Canada strives to attain this mandate by establishing and enforcing minimum standards for industry practices; acting to represent the nature, scope and professional standards of the industry in relationships with government and other regulatory bodies; providing opportunities for members to strengthen relationships between each other and to share information; and by establishing a code of ethics for all members to adhere to. (Helicat Canada 2008)

Although the name is relatively new, it was renamed in 2005; the association was formed three decades ago in 1978 under the name of the British Columbia Helicopter and Snowcat Skiing Operators Association (BCHSSOA). Besides being much shorter and catchier, the new name is also inclusive of the few members who

are not located in British Columbia, but are slightly east of the border in the province of Alberta or are slightly north of the border in Yukon Territory.

Helicat Canada is the most significant actor on the helicopter skiing side of interactions between forests, forestry and helicopter skiing in British Columbia. The association committed itself to ”work with senior levels of government…to develop standardized processes and unique documents specifically designed for managing the timber cutting needs of [the helicopter skiing] industry” (BCHSSOA 2003).

Canadian Avalanche Association

The Canadian Avalanche Association is a non-profit society that exists to promote avalanche safety across Canada. It does that by acting as a liaison and promoting communication between individuals and organisations in the avalanche community to expand the understanding of and knowledge related to avalanches and to offer high quality education. As listed on the Canadian Avalanche Association’s website, its’ specific purposes include:

4. “To represent persons who are professionally engaged in avalanche work in Canada.
5. To establish and maintain high standards of professional competence and ethics for persons engaged in avalanche safety programs.
6. To exchange technical information and to maintain communications between persons engaged in avalanche safety programs.
7. To establish and maintain standards of education in avalanche safety.
8. To organize training courses in all aspects of avalanche hazard control for professionals.
9. To promote and to act as a resource base for public awareness programs about avalanche hazards and safety measures.
10. To promote research and development in avalanche safety."

The organisation has been in existence since 1981 and it has more than eight hundred members, which are composed of individuals working in avalanche related disciplines spanning from hazard control and mitigation, to education and research. The association has assisted in creating Canada’s avalanche programs and services that are currently in place. Functions performed by the Canadian

Avalanche Association include: establishing standards for all types of technical work done in the Canadian avalanche community; developing and providing technical education programs for training individuals working in the avalanche field; providing services to support businesses working in avalanche prone environments such as a network to facilitate sharing of meteorological data, access to special weather forecasts and a directory of contacts that can assist with avalanche emergencies; acting to represent members of the avalanche community to resolve conflicts and promote issues and values held by the community. The long-term vision of the Canadian Avalanche Association is to "be a world leader in avalanche awareness, education and safety services". (Canadian Avalanche Association 2008)

Association of Canadian Mountain Guides

Guides who lead helicopter skiing experiences must be certified as professional mountain guides. The association representing professional mountain guides in Canada is called the Association of Canadian Mountain Guides. It is both an advocacy organisation and certifying body for mountain guiding in Canada. The non-profit association was established in 1963 and is "dedicated to protecting the public interest". The objectives of the association are to:

1 "Protect the public interest by advocating the highest standards of risk management for mountain guiding and climbing instruction.
2 Represent our members in dealings with official bodies, both public and private.
3 Advance the guiding/climbing instructing profession by advocating for industry best practices.
4 Establish and maintain a high standard of professional competence and ethics for our members within Canada.
5 Act as the accountable body for the guiding/climbing instructor profession by maintaining an objective conduct review process.
6 Act as a public relations body to promote the sport of mountaineering in a safe and educational manner.
7 Strengthen cooperation and promote cordial relations between its members."

The association is led by an executive of volunteers that receives assistance form a team of other individuals. Technical standards for certification and for membership are determined by the association. Training and certification

programs are offered in collaboration with Thompson Rivers University. The International Federation of Mountain Guides Associations recognizes the Association of Canadian Mountain Guides as a member, meaning that individuals certified as mountain guides by the Association of Canadian Mountain Guides "are entitled to reciprocal guiding rights in all [International Federation of Mountain Guides Associations] member countries". Members, often in association with helicopter skiing companies that they work for, contribute snow pack observation data in partnership with several other organisations to assist in widespread access of up to date avalanche related information available on the internet. The information may be used by professionals as well as the general public to make informed choices when planning backcountry activities. Another tools to assist in the planning of backcountry activities are bulletins produced for individual ski routes that provide local information to be used by the general public. (Association of Canadian Guides 2008)

Council of Tourism Associations (COTA)

The Council of Tourism Associations (COTA) is an advocacy organization that represents a broad range of tourism operators in British Columbia. More than 18,000 tourism operators are members of COTA. It uses both proactive and reactive advocacy and communication with "all levels of government, media and businesses to ensure that the interests of tourism operators are heard and recognized in a meaningful way." COTA envisions "a vital [British Columbia] tourism industry, which is sustainable, organized, cohesive, has a powerful voice and plays an essential role in the [British Columbia] economy." Its mission is to achieve that vision by advocating to and educating government, the business community, media, tourism industry and the public on behalf of the tourism industry." COTA is run by a board of directors and four staff members, which are directed by that board. (COTA 2008)

COTA is an important actor in interactions that occur between forests, forestry and helicopter skiing mainly due to the large amount of effort that it has put into

creating informative reports and lobbying government regarding issues important to British Columbia tourism.

Wilderness Tourism Association (WTA)

The Wilderness Tourism Association represents all operators of wilderness tourism activities, which are mainly also adventure tourism operators. It "exists to ensure the ongoing viability of our industry by protecting the wilderness tourism landbase." It is an advocacy and education based organisation that aims to enhance wilderness experiences by working with government, the public and private enterprises. "The WTA believes that wilderness tourism is a viable and sustainable economic enterprise, and that [British Columbia's] wilderness tourism operators must have a strong voice in determining how the lands upon which they depend are planned and developed." One function of the WTA is to make sure that land use decisions that affect tourism operators are only made after recognising wilderness tourism interests and requirements. To do that the WTA is promoting the economic contributions made by this sector of the tourism industry to the provincial economy. The WTA is managed by a Board of Directors, which is elected by its members, and the current president is Brian Gunn. (Wilderness Tourism Association Unknown Year)

The WTA plays a role very similar to that of COTA in interactions that occur between forests, forestry and helicopter skiing since both have created informative reports and have lobbied government regarding tourism issues. Although the WTA is a more direct actor for helicopter skiing than COTA is because helicopter skiing falls into the wilderness tourism sector of the overall tourism industry and WTA actions and issues are more specific to those directly affecting helicopter skiing.

4.2 Institutional Framework

As with the actors involved, the institutional framework within which forests helicopter skiing interact can be subdivided into a) the laws, regulations and policies relating to forests and forestry and b) those relating to helicopter skiing, with the additional category of c) those that relate to both a) and b). Forests in British Columbia are managed within the institution framework set out in the *Forests and Range Practices Act* and the *Land Act*. Helicopter skiing businesses are subject to the Adventure Tourism Policy and the *Land Act*. In addition, most helicopter skiing companies are members of Helicat Canada and therefore must meet the minimum standards required to qualify as a full member, as well as adhere to the organization's Best Practices for Sustainability. Helicopter skiing operators employ professionals certified by the Canadian Avalanche Association and the Association of Canadian Mountain Guides who make choices as to what terrain to ski on based on current scientific findings to minimize the risk associated with avalanches.

4.2.1 Management and Regulation of Crown Land – The Land Act

Both forest licensees and helicopter skiing operators use land that is owned by the provincial government of British Columbia. Crown land is an asset to the public (Integrated Land Management Bureau 2007d); an asset that may be enjoyed by using it for personal recreation or by simply appreciating its presence. As stated by the Integrated Land Management Bureau "the Province has a responsibility to make sure they [the Crown land base and values associated with it] are managed to maximize and sustain the flow of economic, social and environmental benefits to British Columbians now and in the future" (Integrated Land Management Bureau 2007d). The approach taken by the government to manage Crown land aims to balance the competing types of use and supports the three pillars of sustainability: environment, economics and society (Integrated Land Management Bureau 2007d). Crown land is regulated by British Columbia's *Land Act* (Government of British Columbia 1996) under the authority of the Minister of Agriculture and Lands. According to the *Land Act* "[t]he minister may…(a) sell Crown land, (b) lease

Crown land, (c) grant a right of way or easement over Crown land, or (d) grant a license to occupy Crown land" (Government of British Columbia 1996). The previously mentioned use rights are referred to as tenures. Types of tenure specific to forestry and helicopter skiing are described in the following subsections.

4.2.2 Institutional Framework Regulating Forests and Forestry

4.2.2.1 Forestry Crown Land Use Rights

The government grants rights, usually in the form of licences, to harvest trees from Crown land to Canadian citizens and forestry companies, hereafter referred to as licensees, for a specified area of land or for a specified volume of timber for a specified period of time. In return for harvesting rights, or tenure, licensees must pay the government a certain fee. Licensees must additionally pay the government a fee, called a stumpage fee, for the volume of wood that is harvested. The stumpage fee is determined by market prices obtained from an auction process. The following are some different forms of forest tenure:

Tree Farm License

Tree farm licenses are a form of tenure that is based on a specific area of land on which a specified volume is allocated to be harvested each year. An annual allowable cut is determined for each tree farm licence and management is carried out to maintain sustainable yields. Tree farm licenses can consist of a combination of both privately owned and Crown land (British Columbia Ministry of Forests and Range 2004, 2006b). This is the most secure form of private land use rights on provincial Crown lands (Zhang and Pearse 1997). The standard term for a Tree Farm License is twenty-five years (British Columbia Ministry of Forests and Range 2004).

Timber License

Timber licenses are based on specific sites irrelevant of the amount of timber harvested. This is a relatively old form of tenure that grants the holder the right to plan and harvest the timber that exists on a given area of land when the license is

issued. After the activities outlined in the plan are carried out the license expires. If the Timber License falls within a Tree Farm License, the land joins all the other Crown land within the Tree Farm License when the Timber License expires (Zhang and Pearse 1997).

Forest License

Forest Licenses are a form of tenure based on timber quantity rather than a site. This type of tenure grants the holder the right to harvest a certain volume of timber within a large geographical area each year and the specific area in which the holder is to harvest can change within the term of the license (British Columbia Ministry of Forests and Range 2004, 2006b, Zhang and Pearse 1997). This form of tenure is granted for a shorter period of time than Tree Farm Licenses and can be effectively renewed by obtaining a new license before the existing one expires (Zhang and Pearse 1997).

4.2.2.2 Forest and Range Practices Act (FRPA)

Forest licensees must harvest the timber in accordance with the provincial *Forest and Range Practices Act (FRPA)*. As a measure of streamlining forest practices and remaining competitive with other nations, the new set of forest laws replaced the previous *Forest Practices Code* and began to be implemented in British Columbia early in 2004 (Forest Practices Board 2006) and is now in full effect. The purpose of this new set of regulations was to streamline the system by decreasing the prescriptive nature of the previous *Forest Practices Code* and by giving forest professionals the power to make decisions based upon their expert assessment of individual situations. This new concept of forest regulation is held together by a set of government objectives. "Those objectives are statements of the ends to be achieved for a series of forest resources" and continue to be a work in progress (Forest Practices Board 2006). There are three sources the objectives can come from, as described in the *Forest Planning and Practices Regulation* (FPPR). They can either be set out in FPPR itself and would apply to the whole province, objectives can also be authorized or enabled by another regulation or set out in

land use plans (Forest Practices Board 2006). The Forest Practices Board (2006) gave the example that objectives could be set under the *Government Actions Regulation (GAR)*, which gives ministers the opportunity to establish objectives for values specific to either the given region or community. Objectives can also be set by the Minister of Agriculture and Lands and would only apply to specific plan areas (Forest Practices Board 2006), on a sub-community scale. The forest laws in British Columbia were redesigned as *FRPA* to perform the mandate of the Ministry of Forests and Range in a better manner than previously occurred with the *Forest Practices Code*. *FRPA* was developed with the following intentions:

- "Maintain high levels of protection for forest values, including watersheds and wildlife habitat;
- Create efficiencies for both government and industry through streamlined planning processes;
- Encourage innovation by skilled resource professionals;
- Hold industry responsible for outcomes;
- Involve rigorous compliance and enforcement; and
- Contribute to high quality forest management and sustainable environmental values for future generations."

(Forest Practices Board 2006)

The following section describes regulations contained within *FRPA* as they pertain to different aspects of forest management that may interact with helicopter skiing in British Columbia.

Planning of Harvesting Operations within FRPA

The previous *Forest Practices Code* was described as being based on planning, while the current *Forest and Range Practices Act* is results-based (Forest Practices Board 2006). To say that the *FRPA* is not planning-based is not to say, however, that no planning is required, but rather less planning and more flexible planning occurs under the new system. The *FRPA* stipulates that a *Forest Stewardship Plan (FSP)* is created and approved before any harvesting operations are carried out. The FSP describes the outer boundaries of the area within which harvesting operations are to take place. "Section 5 of *FRPA* requires that licensees, in their FSPs, include results to be achieved, or intended strategies to be carried out, for each government objective...except [the objective for production

of] timber" regardless the source of the objective (Forest Practices Board 2006). Default practice requirements are suggested in the FPPR, which licensees can, and many do, adopt instead of setting out their own results or strategies. An interesting point worth noting here is that all of the default results and strategies include the condition that timber supply must not be unduly reduced (Forest Practices Board 2006). Of specific interest to helicopter skiing operators, such practice requirements have not been developed for the visual quality objective and licensees must therefore propose their own result or strategies.

After approval, more specific site plans are created from the more generalized FSP. The less prescriptive nature of the *FRPA* is demonstrated by the fact that it only requires one plan; the forest stewardship plan (FSP), to go through a public review and government approval (Forest Practices Board 2006) the site plans need not undergo that process.

Increased Responsibility for Forest Professionals

Less planning is required under the *FRPA* than was previously the case with the Forest Practices Code based upon the reasoning that forest professionals have the capability and responsibility to "devise effective means to achieve those objectives [set out by *FRPA*] in the course of planning, road building, logging and reforestation" (Forest Practices Board 2006). Forest professionals' responsibility was also increased based on the reasoning that the community of professional foresters set their own standards and guidelines which they must adhere to in order to maintain professional integrity. For example, "[s]ection 4.1 of the British Columbia *Foresters Act* makes Registered Professional Foresters legally bound to "serve and protect the public interest" (DesRoches 2007). If guidelines and regulations are set at that level and are continuously being updated by the professional associations, then governmental regulations are unnecessary and redundant. The government anticipated the new *FRPA* legislation would "[e]ncourage innovation by skilled resource professionals" and "hold industry

responsible for outcomes" (Forest Practices Board 2006 and the Ministry of Forests and Range 2007).

Silvicultural Practices in British Columbia

The *FRPA* does not stipulate particular silvicultural practices that must be adhered to, because that depends upon the individual conditions and management goals of the site to be determined by the professional judgement of the forester in charge. However, British Columbia is world renowned for, and quite proud of, its management practices. Forests are managed in such a manner as to mimic natural processes. As a result of those management practices, Cashore (2004) pointed out that no forests in British Columbia have been categorized as forest plantations by the United Nations Food and Agriculture Association. Cashore (2004) also mentioned the *FRPA* stipulates that forest licensees are required to maintain forest diversity; perhaps that is an effort to prevent British Columbian forests from becoming plantations in the future.

Although the *FRPA* does not specifically lay out silviculture practices to be followed, limits on such things as, for example, the size of clear cuts that are permitted are conveyed within the document. In British Columbia clear cuts are limited to 40 or 60 hectares depending upon the size, type and region of the forest (Cashore 2004). Those limits are extremely large in comparison to limits in other developed nations, such as two hectares in Austria for example (Schima 2004). However there is a fundamental difference in scale when comparing European forests and forestry practices to those of British Columbia, since many forest holdings in British Columbia cover hundreds of thousands of hectares (Cashore 2004), while it is not uncommon in Europe for holdings to be just a few hectares (Schima 2004).

Although it has been and still is a controversial issue, there are many reasons to explain why clear cuts are chosen as a silvicultural practice. As mentioned by Cashore (2004), it is argued that larger clear cuts are an optimal harvest technique

since they reduce road development and edge effects, while having similar effects as large natural disturbances. Clear cuts are also argued to be effective in stands such as lodgepole pine which thrives in full sunlight conditions and does not regenerate as quickly under selection systems.

Since clear cutting has been such a prominent practice in British Columbia, especially as a result of the liquidation type logging that has occurred within the past century, the language used in forest policies as well as the policies themselves reflect clear cutting as a sort of standard practice. Most policies refer to cutblocks and describe details about how they should be used, timing of harvesting activities etc. As stated by Zhang and Pearse (1997), "a cutblock…is a tract of forest designated by the Ministry of Forests for harvesting. Each cutblock is a separate obligation of the tenure holder, who is required to report, annually and sometimes every four months, all preharvest silviculture prescription information, harvesting and silvicultural activities on each".

Harvest Volumes

"A long term goal of British Columbia's Ministry of Forests is to maintain sustainable forest harvests" (Bergerud 2002). Although the province is likely to be most concerned with that goal to receive the greatest amount of revenue from its' forested land, the province works diligently to attain that goal in such a manner that also brings socio-economic benefits to the population of British Columbia. This was described by Cashore (2004), who described the amount of timber that is permitted to be harvested is continuously assessed and updated according to "sustained-yield principles, considering community-based land use planning, public input, and the latest science, information, practices and policies". Annual allowable cut is the term used to describe the amount of timber that is permitted to be harvested on a certain area of land and/or by a certain party in a given year. The independent chief forester of British Columbia regularly sets the annual allowable cuts for all forested Crown land in the province.

Stocking Standards for Regeneration

FRPA, as with most nations in the world (Cashore 2004), regulates regeneration of forests after harvest. Since "September 1987… all licensees and owners [have been] responsible for ensuring reforestation by natural or artificial means after logging, and for bearing the cost" (Zhang and Pearse 1996). Furthermore, forest licensees are responsible for the given area until it reaches a stage at which there is assurance that it will develop into a healthy, mature forest (Cashore 2004) this stage is referred to as 'free growing'.

FRPA uses specified timeframes and stocking levels as indicators in silviculture surveys to ensure harvested areas are regenerated effectively. During the regeneration phase following harvest, a specific system of silvicultural surveying is used to determine whether or not the site has regenerated sufficiently enough to reach a free growing state (Bergerud 2002). The survey is designed with the objective of making a decision as to whether a given section of forest, referred to as a stratum, has or has not attained a density that is at least as great as the minimum stocking standard that is outlined in the silviculture prescription (Bergerud 2002). A free-growing density is defined as "the well spaced density of a stand that includes only those acceptable trees that have reached a minimum height", expressed as free-growing trees per hectare (fgph), and well-spaced density is defined as the number of acceptable trees with no height restrictions that are at least a minimum inter-tree distance apart, expressed as well-spaced trees per hectare (wsph) (Bergerud 2002). In young stands, the free growing density is often low because a large proportion of the trees are not tall enough yet to meet the minimum height requirement to be counted in the survey (Bergerud 2002).

Until a survey indicates the stand has reached a free growing state, forest licensees must maintain minimum stocking levels and after that point responsibility for maintaining and developing the stand is transferred to the provincial government (Bergerud 2002). It is therefore in the best interest of the government not to accept a stratum as free growing until it truly meets the given requirements,

because any earlier acceptance would result in greater governmental management efforts after the transfer of responsibility. The Ministry of Forests and Range carries a risk of accepting a stratum as free growing which has actually not yet reached that state. The Ministry of Forests and Range control this risk by using a well designed silviculture survey (Bergerud 2002), which measures a certain number of trees selected based upon inter-tree distance. On the other hand, licensees must trust the Ministry of Forests and Range to control their risk of the probability that the stratum will be incorrectly identified as not free-growing when it really is (Bergerud 2002).

Stocking standards as defined in Section 1 of the *FRPA* apply when "(a) establishing a free growing stand; or (b) meeting the residual stand requirements following an intermediate cutting or the harvesting of special forest products" (Forest Practices Branch 2006). "A licensee who has an obligation to establish a free growing stand must establish a stand that (a) meets the applicable stocking standards by the regeneration date, and (b) meets the applicable stocking standards by a date that is no more than 20 years from the commencement date" (Forest Practices Branch 2006). In conjunction with efforts to be less prescriptive, flexibility exists for new innovative stocking standards to be approved under *FRPA* (Forest Practices Branch 2006). Innovative new standards must adhere to the stipulation in *FRPA* that all stocking standards in FSPs must meet the requirements of the approval tests contained in the legislation (Forest Practices Branch 2006).

Forest Road Networks

Other, less direct, impacts of forest practices are also regulated in British Columbia. One of the most damaging legacies left behind after harvesting operations is the forest road network. This is especially traumatizing for a landscapes such as those found in British Columbia which are in a wilderness setting. Therefore "[British Columbia] has mandatory, detailed rules and specifications for both building and decommissioning roads on public lands

(Cashore 2004). Roads must be decommissioned after harvesting operations and management for regeneration have ceased. Decommissioning a road involves replanting and establishing sufficient vegetation to stabilize the soil.

Forest roads are often used by the general public, legally and illegally, to access remote areas for recreation purposes. When the roads are being actively used for forest operations they are maintained by clearing away brush, debris and tree branches to ensure safe use as well as maintenance to ensure the integrity of the road itself. However if an accident were to occur due to poor road conditions after forestry operations have ceased, victims could hold the builder of the road or the party responsible for the road liable for damages. Road decommissioning is therefore a risk management tool as much as it is an environmental protection tool. In some areas, where the public and/or commercial recreation operators express interest in recreational access, roads are maintained for that purpose even after forest operations are finished. Responsibility for road maintenance must be identified and accepted by either a governmental ministry or by an organization. In the past, roles and responsibilities have been very unclear for this issue. Hopefully this has and will improve with the recent formation of the *Ministry of Tourism, Sports and the Arts (MTSA)* which was said by the Forest Practices Board to "consolidat[e] many previously fragmented responsibilities in public and commercial recreation…This should help clarify which ministry is responsible for addressing public access issues".

The Canadian approach to forest access roads is very different than that taken in Europe for example. Forest road networks in Europe are planned and built with very high quality standards, with the intention they will last for an extended and indefinite time period. The costs of European roads may outweigh the benefits of building such access routes for the entire first rotation of the area. This is because European forests are much closer to civilization, much more forested land is privately owned and managed by farmers who live nearby and use the forest roads on a regular basis. In addition, many European countries have laws stating that

forests are allowed to be used by the public for recreation purposes and since the forests are generally much closer to civilization, the forest roads are often used to access hiking terrain.

Monitoring and Enforcement of FRPA

One of the purposes of *FRPA* was to make the forest regulations less complex and prescriptive than was the case with the previous Forest Practices Code. "[*FRPA*] was intended to reduce administrative and operational costs for both industry and government while continuing to maintain high levels of environmental stewardship, public confidence and a strong compliance and enforcement regime" (Forest Practices Branch 2006). *FRPA* is combined with rigorous enforcement of compliance (Ministry of Forests and Range 2007). This is carried out by the Compliance and Enforcement Program, the law enforcement arm of the Ministry of Forests and Range as described in section 4.1.1. In addition to governmental monitoring and enforcement, a multi-faceted regime is carried out in partnership with an independent organisation, the Forest Practices Board. The Forest Practices Board is responsible for monitoring government policy and forest practices that are carried out by Crown land forest licensees and reporting findings of those monitoring activities to government and the public (Cashore 2004) as described in section 4.1.1. The Forest Practices Board accomplishes this by performing routine and random audits, the results of which are publicly posted.

Another non-governmental policy instrument used to monitor forest practices in a manner consistent with the purpose of *FRPA* is forest certification. Of all the jurisdictions studied by Cashore (2004), Canada has the greatest percentage of certified forest land. In 2004 nearly 60 per cent of Canadian forests are certified to be sustainable; while British Columbia alone had 22.4 million hectares certified under the Canadian Stewardship Council, Sustainable Forestry Initiative or Forest Stewardship Council (Cashore 2004).

4.2.2.3 Institutional Framework Regulating Helicopter Skiing, Forests and Forestry

Helicopter Skiing Operators' Input into Planning of Forest Management Practices

As pointed out by COTA (2007), the British Columbia Ministry of Agriculture and Lands' Integrated *Land Management Bureau (ILMB)* defines strategic land use planning as "[a] process for determining how our land will be used, both now and in the future". The framework for provincial land use planning is a hierarchical system consisting of different types of plans depending on the scales of application. The province has adopted an inclusive, participatory and consensus based approach to land use planning. According to the *ILMB* (2007a), "strategic land use plans help ensure that resource management decisions take into account the needs of communities, the economy and the environment. The planning process is open and community-based. It is structured to encourage participation by the public, stakeholders and various levels of government. The process goes through a number of stages: consultation, planning, preparation, decision-making, implementation, monitoring and amendment". The *Ministry of Forests and Range* has also attempted to adopt the philosophy of *ILMB*. According to the *Ministry of Forests and Range* (2007), "[t]he ministry pursues its goals for sustainable forest and range resources and socio-economic benefits in a consultative manner with the public, industry and other Crown agencies".

Although at the province level attempts have been made to include the public and stakeholders in land use planning, the institutional framework includes very little in the way of specifically providing helicopter skiing operators opportunities to be involved in the planning and management of the Crown forests for which they hold tenures. Helicopter skiing operators are treated in the same manner as any other group or individual with an interest in forested Crown land; they fall into the category of 'general public' when it comes to involvement in forest management and planning. As a result, the following section is not specific to helicopter skiing operators, but rather describes mechanisms in the institutional framework to

include any member of the public in the planning and management of Crown forests.

Policy Instruments for Public Participation in Forest Management

In a province where forestry is incredibly influential in the economy, culture and history; the population feels connected to forests and it is understandable for that that population to have an interest in being involved in forest management. On many occasions the citizens of British Columbia have expressed desire in having the opportunity to participate in forest planning activities and have pointed out the need for such participation in order to bestow integrity in the political system. British Columbians have been involved in forest planning activities for many years now and understand the importance of including all stakeholders when making decisions regarding the future of forests that are used and enjoyed by many groups of people with a wide variety of interests. History attesting to this point is described in section 4.1.2 regarding forest management in Clayoquot Sound.

If the public is not involved in the process of forest planning or is not given the opportunity to understand the reasons for which forest managers make certain decisions, it is possible that forest managers could be scrutinized for making decisions that counter the public's interests. According to DesRoches (2007) "British Columbians believe increasing public education and participation are the most effective ways to enhance the credibility of forest managers" (Bredin 2003, and BC Statistics 2005 in DesRoches 2007). As by DesRoches (2007) pointed out, forests growing on publicly owned land are intended to be managed in the public interest. This notion is supported by the British Columbia *Foresters Act*, which within Section 4.1, legally binds Registered Professional Foresters to "serve and protect the public interest" (DesRoches 2007). One would interpret that to mean that foresters should request input from the public and then design management strategies that are in accordance with the interests expressed in the input they received. Planning policy in British Columbia reinforces that concept.

Land and Resource Management Plan (LRMP)

As described in section 4.1.1, the *ILMB* oversees land use planning as it relates to provincial natural resources. Land use planning takes a few different forms depending upon scale; general planning is completed on a province-wide scale, while Land and Resource Management Plans (LRMPs) are used for sub-regional scale planning and Sustainable Resource Management Plans are used for landscape scale planning. The main components of and LRMP are generally the following: "broad land use zones defined on a map; objectives that guide management of natural resources in each zone; strategies for achieving the objectives; and, a socio-economic and environmental assessment that evaluates the plan" (Integrated Land Management Bureau 2007a). The LRMP is one policy instrument that has been used to provide the public with opportunities to participate in planning and management of forested Crown lands. The concept of LRMPs and the policies behind the plans were developed in the 1990s, after a large amount of attention was drawn to British Columbian management policies and their failure to protect natural resources in Clayoquot Sound. Participation by the public and interested stakeholders is an integral component of LRMPs – in fact it is a requirement in the development of the plans (Integrated Land Management Bureau 2007b). Not only are the public and stakeholders required to be present in the planning process, but they influence the plans that are to be produced by being involved in making decisions. As stated by the *ILMB*, LRMPs promote "decision making on the basis of the principles of sustainability and consensus" (Integrated Land Management Bureau 2007b). All participants present have the opportunity to express ideas and information related to the sustainable management of natural resources in the planning area. Decisions are made in such a way as to maximize agreement among all parties. If any of the parties do not agree on a matter, further information should be exchanged with the goal of finding some common ground among all participants upon which to base the decision. This form of decision making is inclusive of all participants' interests, it represents a policy mechanism that assures forest resources are managed in accordance with the public interest,

including the interests of helicopter skiing operators. This form of planning is beneficial to stakeholders that would suffer under a government (and possibly industry) dominated planning process and it also creates comprehensive plans which are unlikely to be contested and therefore represents an effective and efficient policy instrument. Aside from the plan that is produced and the contents of it a key outcome of the LRMP process "is the sense of legitimacy experienced by participants" (DesRoches 2007). The processes used to include stakeholders instils a sense of worth for those parties and calms frustrations that can be associated with government procedures and agendas by recognizing the stakeholders' interests as being important. This not only satisfies the particular stakeholders involved, but also increases public trust in the legitimacy of governmental operations. In fact it has been stated (Mascarenas and Scarce 2004, DesRoches 2007) that "the legitimacy of the decision-making process is far more significant than the actual plan itself".

British Columbia has come to be known for its advanced and sustainable forest management (BC Market Outreach Network 2007b); DesRoches (2007) claimed "the traditional consensus-based, multi-stakeholder LRMP process in particular has been praised by several sources for reducing conflict and establishing durable land-use plans through consensus-based public participation". Unfortunately as DesRoches (2007) stated the LRMP process is not likely to continue for very long into the future. The LRMP process has been restructured and simplified since 2001 and new LRMPs will no longer be initiated (DesRoches 2007). Even though most of the province is already covered by an LRMP and it is mainly just updating that would need to occur, the "decision stemmed mainly from the high financial cost involved with SLUP and the new direction of the "government's strategic values," which entails providing certainty to users of the landbase and ensuring that government retains its role as the final decision-maker" (DesRoches 2007).

It has been recommended that "consensus-based strategic processes [as with LRMPs] be officially replaced by a government-led decision-making process that is

exclusive to key stakeholders (DesRoches 2007). Moreover, these select stakeholders are to have an "advisory capacity" only". He also noted "the decision to transform the strategic-level decision-making process from a stakeholder-led, consensus-based process to one that is government-led and restricted to key stakeholders is questionable, particularly given the public's continual insistence to participate in forest management" (FPB 2002, BC Statistics 2005, DesRoches 2007). Government-led policy has already proved to be ineffective in British Columbia, which is why the move to more inclusive policy occurred in the 1990s. "The failure of the top-down approach to prevent significant erosion on clear-cut areas [in Clayoquot Sound] spurred experimentation with alternative planning approaches that involved greater community participation" (Fraser et al. 2005). That experimentation resulted in the creation of the Clayoquot Sound Scientific Panel, which made land use recommendations by working "closely with various stakeholder groups including local populations, industry, and government, as well as international environmental groups" (Fraser et al. 2005). Eliminating LRMPS would represent a step backwards for policy development by reducing opportunities for public participation, opportunities that set the province at the forefront of forest management policies and made British Columbia special on an international scale.

Sustainable Resource Management Plan (SRMP)

While an LRMP covers planning on a sub-regional scale, more specific planning is completed in a Sustainable Resource Management Plan, which is used for landscape scale planning. SRMPs also fall under the umbrella of ILMB and are very similar to LRMPs. Interest must be put forward for an SRMP to be initiated; without a push from interested parties, a plan will likely not be created for a given area (Wilderness Tourism Association 2007). The SRMP process can and has been used to address conflicts between helicopter skiing and other uses of Crown land (Forest Practices Board 2005).

Forest Stewardship Plan (FSP)

The LRMP and SRMP are two policy instruments used for planning sustainable use of all natural resources and while forests and timber fall under those plans, the planning is not specific to forestry management practices. Forest Stewardship Plans (FSPs) are an instrument under the authority of the Ministry of Forests and Range used to regulate planning of forest management in British Columbia. As described earlier in this section, FSPs describe the outer boundaries of the area within which harvesting operations are to take place and must be completed by forest licensees and approved before harvesting can be carried out. A mechanism for providing public and stakeholders opportunity for involvement is included in the policy behind FSPs, however that involvement is restricted to review and comment on plans that are produced by forest licensees rather than full participation in the development of the plan as with LRMPs and SRMPs. As pointed out by COTA (2007), section 21(1)c of the *Forest Planning and Practices Regulation (FPPR)* requires licensees to "provide a person whose rights may be affected by the plan with an opportunity to review the plan in a manner that is commensurate with the nature and extent to which the person's rights may be affected". Detailed instructions regarding exactly what the reviewing opportunities should consist for different stakeholders are not laid out. As a result this takes many different interpretations when put into practice (COTA 2007). In any case, after the plan is reviewed by stakeholders, they may make comments to the forest licensee regarding its contents. Comments received must be addressed by the licensee either by changing the FSP to accommodate the stakeholder or by providing reasoning for not changing the FSP. The comments, responses are then forwarded with the FSP to the District Manager, the delegated decision maker, who decides whether or not "the FSP is consistent in addressing the legal objectives identified in *FRPA*… in addition to other objectives identified in land use plans" (COTA 2007).

Site Plan

Forest Stewardship plans are an instrument used to regulate forest management practices on an unspecified scale that in practice tends to cover large geographical areas with little detail. Site plans are an instrument used to regulate planning of forest management practices on a smaller scale and consequently include more detailed information regarding exactly what activities are planned to occur where. Under Part 2, Division 2 of FRPA, before harvesting is permitted to begin in one or more cutblocks or construction of one or more roads is permitted to begin a site plans are required to be completed by the holders of the relevant FSP (except in certain circumstances) (Government of British Columbia 2002). A requirement that must be included in site plans is identification of approximately where cutblocks and roads will be located within forest development units specified in the FSP. In addition, site plans must be consistent with the FSP as well as *FRPA* and must describe how the results and strategies from the FSP apply to the specific site (Government of British Columbia 2002). Site plans must be made available for public viewing upon request (Government of British Columbia 2002), but no opportunities are laid out in the policy for the public or stakeholders to participate in site plan development or even to comment on their contents.

4.2.3 Institutional Framework Regulating Helicopter Skiing

Crown Land Use Rights Related to Helicopter Skiing

Clearly defined rights to use Crown land are necessary for helicopter skiing businesses to exist. Rights to use Crown land in British Columbia are administered through the *Ministry of Agriculture and Lands* under the *Land Act* and the *Ministry of Tourism, Sport and the Arts* under the *GATP* for commercial recreation businesses. Contracts that convey land use rights to a party other than the government are called tenures. The *Land Act* defines the term tenure as “a disposition of Crown land under the *Land Act* as a specific form of land allocation”. Commercial recreation businesses have been using Crown land for more than one hundred years (British Columbia Ministry of Tourism, Sport and the Arts 2008b). The *Adventure Tourism Branch* of the *Integrated Land Management Bureau* is the

specific body with authority over commercial recreation businesses which operate on Crown land (British Columbia Ministry of Tourism, Sport and the Arts 2008b).

Helicopter skiing was one of the first commercial recreation activities for which policy was developed to grant use rights to operators (British Columbia Ministry of Tourism, Sport and the Arts 2008b). In the year 1983, the BCHSSOA (which is now called Helicat Canada) facilitated the creation of a specific type of license of occupation for helicopter and snowcat skiing operators that was based on parcels or strips of land used for ski runs. The licenses of occupation were initially given for a ten year period. After the term of those licenses most were changed to a type of tenure based on a defined, usually large, area and renewed for an additional period of twenty years (Helicat Canada 2007). Following the reorganisation of ministry jurisdictions that has occurred in recent years and creation of the new *Ministry of Tourism, Sport and the Arts* (Forest Practices Board 2005), a new policy concerning to helicopter skiing land use rights on Crown land was developed in October, 2007. Aspects of this policy, called the *Guided Adventure Tourism Policy*, which relate to helicopter skiing land use rights are described below.

The provincial government grants three different forms of land tenure to guided adventure tourism (GAT) businesses, such as businesses offering helicopter skiing. Those three possible tenure types are: investigative permits, licenses of occupation and leases. Each type of tenure consists of different terms and conditions as described in the *Guided Adventure Tourism Policy (GATP*), they are summarized below. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

Investigative Permit

An investigative permit is not a type of tenure that grants operators the right to carry out helicopter skiing, but rather is a preliminary type of tenure that allows one to conduct investigations for example to determine if an area is suitable for helicopter skiing. Investigative permits have a maximum term of two years are not

usually renewed. This tenure does not allow construction of buildings or any other improvements on the land. Permits can be granted for land that is already under a form of tenure for one or more adventure tourism businesses and must inform such businesses of their investigation as well as minimize impact to those businesses. Public access to the land must remain interference free during the investigations being conducted with the permit. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

Licence of Occupation

A license of occupation is a form of tenure that is set up individually for each business to allow operators to carry out their business on a given area of land for a given time period. Licences of occupation are subdivided into two categories: either for intensive or extensive use of an area. Intensive use of a site is defined in the Guided Tourism Policy as "site specific uses of Crown land that are integral to the GAT tenure holder as staging areas for dispersed GAT operations conducted within an extensive use tenure. Three types of intensive-use areas exist based on the purpose and nature of the land use" including: primary sites, secondary sites and temporary sites. The policy defines extensive use as "the generalized use of Crown land by a GAT tenure holder. It involves pursuits dispersed over large areas". It is the form of tenure usually issued to operators who use a large amount of land in an extensive manner. Although this type of tenure is most frequently issued for extensive use of large areas, licences of occupation "can also be issued for intensive use sites such as primary sites and secondary (satellite) sites". As described in the policy, primary sites are "the main business location or staging area for a GAT operation" and secondary or satellite sites "are those areas used by GAT tenure holders that may be accessed and supplied from a primary site". Licences of occupation are issued for either a single area of land or more than one area of Crown land, which are physically separated from each other and may or may not be in the same administrative region of the Integrate Land Management Bureau. The type of use for which the licence is issues can either be motorized or non-motorized, however helicopter skiing is clearly a motorized use. The standard

term for which a licence of occupation is initially granted is thirty years. Licences may subsequently be replaced with a new licence valid for an additional thirty year term. This type of licence is granted to operators for areas upon which "minimal improvements are proposed, where there are multiple users of a site… and in remote areas where survey costs are prohibitive". Licenses of occupation can also be issued to operators as a temporary form of tenure while requirements are still being completed to obtain a form of tenure providing greater use rights, such as a lease or right of way. The government retains the authority to grant tenures, either of a different type or other licences of occupation, to other organisations that either partially or completely overlaps with licences of occupation. A licence of occupation allows non-exclusive use, rather than exclusive use as described above, of the given area of land – meaning that other parties may hold tenures for the same piece of land (or a portion thereof) and the general public may use the land as well. Access to the land by the general public must not be restrained unless interference occurs to the point that the operator's ability to use the land in accordance with the tenure is obstructed. This tenure type is not eligible to be registered under the *Land Titles Act* and therefore operators are not able to financial support such as mortgages for licences of occupation. Licences of occupation do not require a survey of the land to be completed prior to issuance. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

Lease

Leases are a second form of tenure that allow operators to carry out their operations on a given area of land for a given time period. Leases are granted for intensive use on small areas of Crown land. Primary sites, where lodges are located or where preparations for the activity occur, are the standard areas for which leases are granted. Leases are issued to operators when "long-term tenure is required, where substantial improvements are proposed, and/or where definite boundaries are required in order to avoid conflicts". The standard term for which leases are granted is 30 years. A lease grants the right to "modify the land and/or construct improvements as specified in the tenure contract". An operator with a

lease holds the “right of exclusive use”, however what that exactly means is not described. Rights of the general public to access the land or whether or not overlapping tenures are permitted on leased areas are two issues that are not addressed with regard to leases in the *GATP*. Leases are a form of tenure that can be registered under the *Land Titles Act*, which allows holders of leases the opportunity to obtain financial support such as a mortgage. Leases are only granted upon completion of a legal survey to accurately define the boundaries of the area to be tenured. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

For a more complete description and comparison of the terms associated with each tenure type see Table 1, a summary table on the following page. The differences in the terms of each tenure type translate into different levels of use rights. Differences include the type of land use that is permitted, size of the land area, the degree to which land modifications and structures are allowed to be constructed, the levels of public access and use rights, the possibility of overlapping areas with other tenure holders, the ability or not to obtain financing, and the precision of geographical boundary definitions. As a result of those different levels of use rights, variations in the level of future tenure security exist. Length of time for which a tenure is valid is important for tourism operators seeking economic support from financial institutions. As mentioned in Heidt and Williams (2005), short term tenure contracts are often subject to long term financing. This adds a risk that the operator could cease to hold use rights for an area, but would still be required to make payments on a loan for a purpose that can no longer be fulfilled. In general no tenure types that are granted to commercial recreation businesses restrict the issuance of non-compatible tenures that overlap the same area (Heidt and Williams 2005).

	INVESTIGATIVE PERMIT	LICENSE OF OCCUPATION	LEASE
Purpose	Authorizes short-term investigative uses.	Authorizes GAT use over extensive areas and/or intensive use of small sites. If uses cover extensive area, they may be in one polygon or multiple polygons; within one ILMB administrative region or across boundaries of more than one ILMB administrative region. Can be used to authorize primary, secondary, temporary, or no-trace campsites.	Authorizes intensive GAT use of small sites. Can authorize primary campsites.
Applicability	Uses are low impact and have low potential for conflict: • Low usage levels (below limits of acceptable change) • No modification required as part of the investigation • No construction or placement of improvements or permanent or semi-permanent structures • Does not permit GAT activities for compensation or reward	Uses may involve some impact and may have potential for conflict: • Some modification or disturbance of the land • May involve construction or placement of improvements/ structures • Motorized and non-motorized uses	Uses require construction or placement of permanent improvements/ structures, or need for defined boundaries and quite enjoyment of land.
Example	Investigating a given area to assess ability to meet business needs.	Heli-ski operations; general mountaineering; sea-kayaking; river rafting; areas which include trail systems.	Remote lodge

	INVESTIGATIVE PERMIT	LICENSE OF OCCUPATION	LEASE
Rights and Responsibilities	• Right to carry out specified investigative activity(ies) for short term • Must permit public access without interference • Overlapping and layering of tenures may occur • Insurance may be required • Security may be required	• Right to carry out specified activity(ies) for long term • Right to modify land, and/or construct improvements as specified in the TMP • Overlapping and layering of tenures may occur • Insurance/security required	• Right to carry out specified activity(ies) for long term • Right to modify land, and/or construct improvements as specified in the TMP • Right of exclusive use • Insurance/ security required • Survey required
Tenure term	Up to 2 yrs	Up to 30 yrs	Up to 30 yrs
Replacement	GAT manager can allow replacement if more time is required for investigation	At mid-term for up to 30 years	At mid-term for up to 30 years
Tenure Management Plan	Generally not required	Required	Required
Referrals	Not generally required. Must contact existing GAT tenure holders.	Required. Extent depends on nature of proposal.	Required. Extent depends on nature of proposal.
Advertising	Not required	Required	Required
Assignment	Not permitted	May be permitted	May be permitted
Sub-tenuring	Not permitted	May be permitted	May be permitted

Table 1.
Summary of permit, license of occupation and lease rights and responsibilities. From the GATP document (British Columbia Ministry of Tourism, Sport and the Arts 2007a).

Permits represent the lowest level of use rights and the most temporally insecure form of tenure. That is logical however, since permits are meant to provide access for investigative purposes rather than for regular business operations. On the other hand licenses of occupation and leases are both meant to provide use rights with which businesses carry out their normal operations. Licences of occupation

represent a mid-range of both use rights and temporal tenure security, while leases represent the greatest level of use rights and the most temporally secure form of tenure. Since leases are normally used for primary sites that are small areas of land upon which significant modifications or structures are constructed it is also logical that this form of tenure represents the greatest amount of use rights and the greatest temporal security since most businesses require access to financing in order to obtain the resources necessary to facilitate construction of necessary infrastructure. Licences of occupation can be said to represent a balance of temporal security and use rights that facilitate the holder's business operations without restricting public access to the land and the possibility that government can also allow other businesses activities to occur on the same or a portion of the same piece(s) of land. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

4.2.3.1 British Columbia Guided Adventure Tourism Policy

The *Guided Adventure Tourism Policy (GATP*) is a product of the *Ministry of Tourism, Sport and the Arts* and is additionally associated with the *Integrated Land Management Bureau*. The policy defines land use regulations and tenure possibilities pertaining to all guided adventure tourism (GAT) activities, including helicopter skiing, in the province of British Columbia. This policy grants operators of adventure tourism businesses "general permission to operate on extensive areas Crown land for a specific purpose" as well as "authority to build improvements… on [a] specific site to support the operation" (Integrated Land Management Bureau 2007d).

Many helicopter skiing operators hold more than one tenure and tenures of different types. This can occur, for example, in situations where an operator uses more than one parcel of land in different geographical locations on which they carry out their business and/or because they have a lease for an area where a lodge/lodges is/are located and licence(s) of occupation for the skiing terrain used. In such cases the operator faces the risk that the tenure valid for the shortest period of time could not be renewed or that the least secure form of tenure could

be revoked by the government to allow other resource activities to occur on the land – therefore limiting the operator's business at that time. These are examples of situations in which the operator may request modification under the *GATP* to the tenures to convert all or some of the tenures into one tenure encompassing all or some of the tenured areas. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

Requirements for Obtaining Land use Rights within the GATP

Businesses which wish to obtain tenure(s) for using Crown land must submit an application to Front Counter British Columbia, a newly created body that simplifies administrative procedures for applicants and tenure holders, to be reviewed by the Integrated Land Management Bureau. Tenure decisions are made on a competitive basis with regard to all applications received (British Columbia Ministry of Tourism, Sport and the Arts 2007a). Applications are subjected to an initial screening before detailed processing commences. The screening is based upon the compliance of the proposed use with government laws and regulations, compatibility of the proposed use with public recreation and other tenures in the area, suitability of the proposed use on the particular area of land as determined by criteria such as "levels of acceptable change", which can be determined from sources such as Land Use Plans (British Columbia Ministry of Tourism, Sport and the Arts 2007a). After applications make it through the initial stage and are accepted for processing, staff at Front Counter British Columbia, acting on behalf of the Integrated Land Management Bureau, "undertake a detailed land status [to determine if the area(s) qualify to be tenured] ; solicit comments from recognized agencies and groups; notify the applicant of advertising requirements [to publicize the proposed land use activities]; consult with First Nations; and, where applicable, conduct field inspections" (British Columbia Ministry of Tourism, Sport and the Arts 2007a). If the area for which tenure is desired borders land that is owned by private parties, those parties must be informed of the land use activities proposed in the application. Applicants applying for licences of occupation and leases are required to advertise their intended use of the area, including a description of the

proposed location, type of land use activity/activities and the land use rights that would be granted should the application be accepted. After applications for licences of occupation and leases makes it through the initial screen stage, in additional to the general application requirements, these tenure types also require a completed tenure management plan (TMP) to be included in the application.

Tenure Management Plan

A tenure management plan, as described in the *GATP*, includes specific information and justification for the purpose, terms and conditions of the area(s) of Crown land; describes the level of intended use; includes descriptions of methods to "eliminate or minimize conflicts with existing interests in the area"; describes how the environment, public access and the interests of affected parties will be maintained and how impacts to other users of resources associated with the land are minimized and/or mitigated. Completed tenure management plans could be subjected to review by interested stakeholders and other parties holding tenures for the given area before final approval of an application and issuance of tenure.

As well as outlining specifics regarding the proposed use of the land for the application procedure, tenure management plans are also used as a tool to guide monitoring of the area throughout the term of the tenure after its issuance. Monitoring is conducted based upon specific indicators and standards that are developed for each tenure management plan (British Columbia Ministry of Tourism, Sport and the Arts 2007a), similar to those required under *FRPA.*

Avalanche Risk Management Plan

An additional requirement is necessary for commercial recreation operators which offer backcountry snow related activities. An Avalanche Risk Management Plan must be developed and be kept available for ILMB staff to see upon request. No details are mentioned in the GATP regarding what this plan is to include and no guidance is provided as to how it should be structured. However the Canadian Avalanche Association (2002b) made some statements regarding risk assessment

and mitigation with regard to forestry operations. The first step is to conduct a preliminary analysis to identify potential harvest areas that are likely to have sufficient snow depths and slope angles, greater than thirty degrees, to facilitate initiation of destructive avalanches as well as to identify the expected magnitude and frequency of previously know avalanche paths (Canadian Avalanche Association 2002a and 2002b). Expected avalanche risk can be divided into three categories: low, moderate of high for two different applications: danger only to forests or danger to down-slope transportation routes, community watersheds, other resources or concerns (Canadian Avalanche Association 2002a). Those areas should be then be marked as dangerous zones on a map. A more detailed assessment should follow by using key variables to calculate risk at selected sites. Locations where protective forests are to remain should be identified as polygons on a map. Harvesting of timber should not be carried out in the dangerous zones, which may require modification of harvest plans. If it is important for harvesting to occur in one of the dangerous zones, a further assessment by an avalanche consultant may be conducted to possibly deem an area appropriate for harvest. Under any and all circumstances it is unacceptable to conduct forest practices that are likely to result size four or greater avalanches, because avalanches of this size that initiate in cutblocks have the ability to modify the existing terrain in such a manner as to create permanent avalanche tracks.

4.2.3.2 Environmental Protection Policies within the Institutional Framework

Environmental Protection Policy Instruments within the GATP

Since helicopter skiing depends upon a seemingly undisturbed environment, healthy, natural looking and old growth forests, protecting and maintaining the environment is both beneficial and necessary to helicopter skiing operators. The *Guided Adventure Tourism Policy* contains several instruments for preventing and managing environmental impacts caused by helicopter skiing on Crown land. The document states that “ILMB will endeavour to develop tenure terms and conditions that balance use with environmental protection”. One such measure is the designation of “sensitive areas” in order to mitigate disturbance caused by activities

such as helicopter skiing that either occur or are proposed to occur on Crown land under tenure. The significance of designating an area as being particularly sensitive is that it subsequently leads to special management of the given area to protect the integrity of the land. "Where appropriate, ILMB may establish specific management requirements and use limits for sensitive areas, or segments thereof in consultation with industry representatives and other stakeholders" (British Columbia Ministry of Tourism, Sport and the Arts 2007a). Those limits can consist of either a restriction on the number of client days that may occur on the area within a certain timeframe or the number of tenures that are granted for the given area.

Another instrument to limit and/or manage environmental impacts that is included in the *Guided Adventure Tourism Policy* is the *Resource Corridor Management Strategy*. These strategies can be created through consultation with the tourism industry when concern is expressed regarding overuse of a geographically defined corridor or area such as a whole mountain range. As in areas deemed as "sensitive areas", limitations may be placed on use within the corridor for which a *Resource Corridor Management Strategy* is implemented. In cases where tenures for the designated corridor, or part of the corridor, are held by more than one individual or organization; limitations are divided among all tenure holders on a proportional basis taking the diligence of current use practices related to environmental impacts of each tenure holder into consideration.

Less specifically designed to be used to address environmental impacts in particular, *Project Review Teams* are another instrument mentioned in the Guided Adventure Tourism Policy that may be established and used to assess "complex applications" for tenure. An example of a tenure application that could require and/or benefit from a *Project Review Team* is one that proposes use levels of Crown land that could be above and beyond that which is sustainable for the particular area of land or an application for use that, if accepted, could combine

with current use of the land by other parties to amount to unsustainable use of the area. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

Helicat Canada Best Practices for Environmental Sustainability

In 2003, before being renamed Helicat Canada, the BCHSSOA created a document which indicates 'Best Practices for Sustainability' that must be adhered to by every member of the association. BCHSSOA (2003) described that "Best Practices… are normally defined as the most effective environmental management practices which are either (a) currently in use in any company within the sector; or (b) could reasonable be adopted in the near future be at lease one company within the sector. These are operational tools of practices that allow tourism operators to meet a range of sustainability management objectives". The BCHSSOA did not only include best practices that have an effect on the natural environment, it took a three fold approach that also included practices for economic and social sustainability. This section only addresses the best practices related to the environment, since forests are part of the environment; for information regarding the economic and social sustainability best practices see the BCHSSOA (2003) document. The overarching policy on sustainability is described below in figure10.

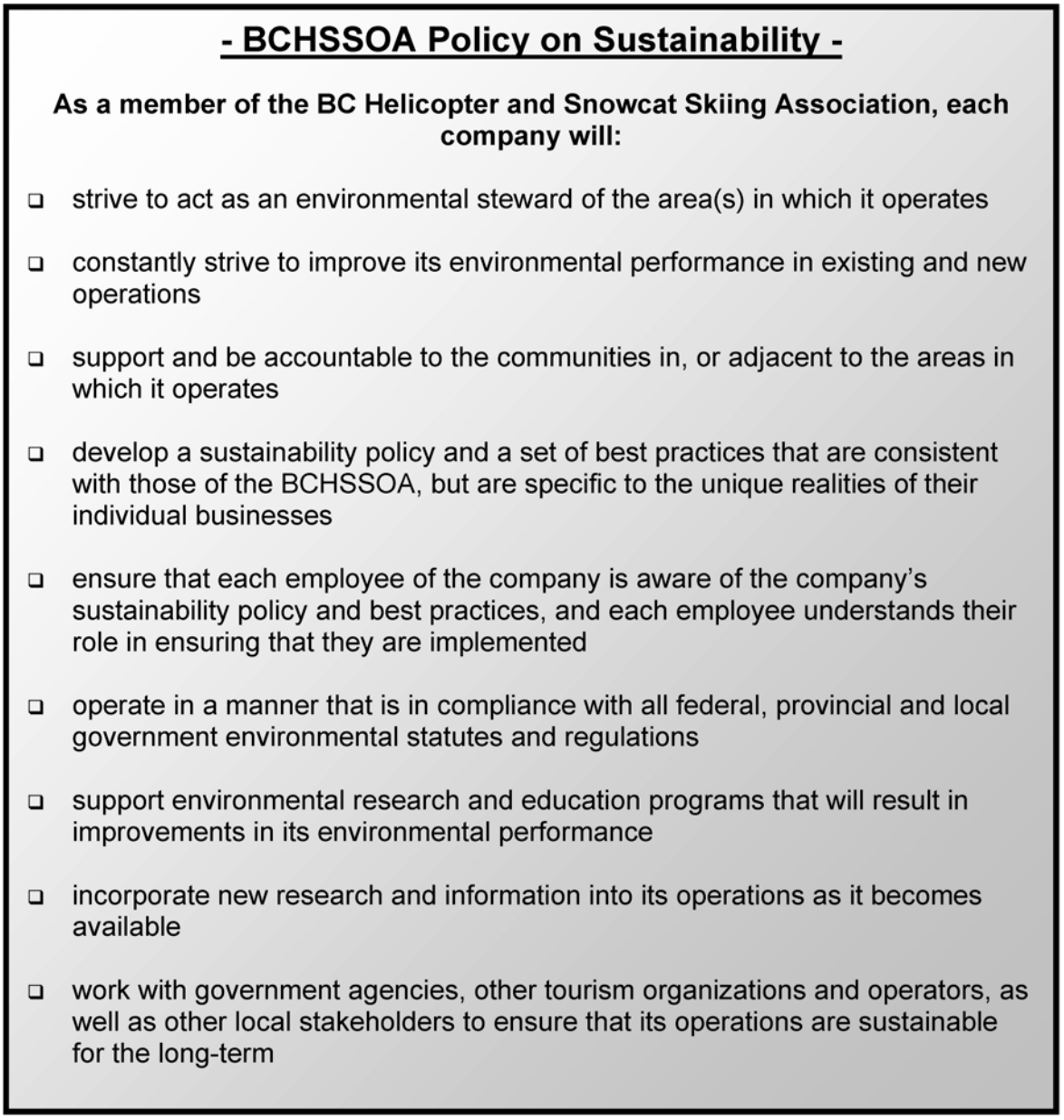


Figure 10.
Helicat Canada (formerly British Columbia Helicopter and Snowcat Skiing Operators Association) sustainability policy. (BCHSSOA 2003)

The best practices for environmental sustainability contained within the BCHSSOA document are divided into categories based upon minimizing impacts to different aspects of the environment including: wildlife, vegetation, fisheries and watersheds; other categories address waste and fuel management issues and practices related to forest harvesting and trail construction. It must be noted, that

some of the impacts the best practices aim to address are not actually related to helicopter skiing. That is because many operators offer helicopter hiking in the summer months, which has different environmental impacts requiring different prevention and mitigation strategies since at that time the ground is exposed rather than being covered with snow. In particular, the practices relating to vegetation, and trail construction are mainly only applicable to summer operations and therefore are not discussed in this thesis.

That is not to say, however that helicopter skiing and businesses offering helicopter skiing do not interact with vegetation or construct clearings. Activities affecting vegetation that are carried out by helicopter skiing operators, and usually carried out in the summertime, include removing underbrush and thinning dense stands, called glading, as well as clearing of areas for pick-up and drop-off sites, called heliports. Many helicopter skiing businesses consist of running some sort of accommodation, often located in a backcountry setting below the timberline. Construction of such accommodation facilities, often called lodges, can involve removal of trees and other vegetation on the site. Maintenance of the site and reduction of the risk of structures being damaged by falling trees can also require the removal of trees and other vegetation. The BCHSSOA (2003) “is committed to managing all cutting activities in a manner that minimizes and mitigates any potential negative impacts to wildlife, wildlife habitat and critical vegetation communities.” The BCHSSOA best practices related to forests are outlined in table 2.

Forest Harvesting and Trail Construction Best Practices		
Goal	**Minimum Standards for BCHSSOA Best Practice Compliance**	**Additional Recommendations**
Manage forestry activities throughout our operations in a manner that minimizes environmental impacts, respects forest licensee businesses and maintains safe access to commercially viable ski terrain.	❑ Full compliance with all appropriate legislation related to the management of Provincial Forest Resources. ❑ Develop an Access Management Plan for the responsible development and maintenance of all operational access routes. ❑ Actively work with forest licensees to co-ordinate harvesting plans with commercial recreation operations. ❑ Ensure that forest health, wildlife and environmental issues are considered in all applications for heliport and glading development by co-ordinating all timber cutting activities with the best practices outlined in the Wildlife, Vegetation and Watersheds sections of this manual.	❑ Share forest health information and observations with forest licensees. ❑ Conduct heliport operations consistent with the recommendations outlined in *Table 2. Phased Recommendations for Heliport Developments.* ❑ Utilize danger tree assessors to allow for the retention of important wildlife snags within glading treatment areas. ❑ If soil excavation is required, avoid crossing slopes steeper than 60% for snow road construction. ❑ Highlight sensitive regeneration areas during guides meetings, and ensure the avoidance of sensitive areas until snow depth increases.

Table 2.
Helicat Canada best practices for forest harvesting and trail construction (BCHSSOA 2003).

4.3 Interrelationships and Interactions Found in the Literature

4.3.1 Physical Interrelationships and Interactions between Helicopter Skiing, Forests and Forestry

"Many operators' ski runs begin at the tree line and culminate in the open cutblocks of the valley below" (BCHSSOA 2003). Helicopter skiing occurs in forested terrain due to: the geography of many mountain catchments which are mainly forested, restrictions to helicopter travel imposed by poor visibility due to weather events, optimal snow quality for skiing under forest canopies, and snow stability for management of avalanche risk. Helicopter skiing businesses significantly interact with forests on a visual level as well as a physical level. The scenery provided by the landscape around areas in which helicopter skiing occurs is a very important resource for helicopter skiing participants and hence the businesses that offer helicopter skiing activities. In addition, helicopter skiing often requires clearing and possible modification of forested areas to be used as landing sites for pick-up and drop-off.

4.3.1.1 Impacts of Helicopter Skiing on Forested Environments

Most helicopter skiing operators "recognize that the Provincial Crown Lands on which [they] operate are unique treasures" and that by obtaining the rights to operate on those lands they hold moral, legal and ethical responsibilities to "act both as diligent environmental stewards, and as good corporate citizens" (BCHSSOA 2003). Before being granted land use rights, helicopter skiing companies must provide detailed information on the resource and environmental values of the firm as well as ways of minimizing negative impacts caused by the business' operations in the application for land tenure (Integrated Land Management Bureau 2007d). That information is described in the Tenure Management Plan, which must be completed for licences of occupation and leases as described in section 4.2.3.1 of this thesis.

Helicopter skiing occurs in high mountain environments including "the alpine and sub-alpine components of the Alpine Tundra, Engelmann Spruce-Sub-alpine Fir,

Interior Cedar-Hemlock, Mountain Hemlock and Montane Spruce biogeoclimatic zones throughout British Columbia" (BCHSSOA 2003). Mountainous environments are especially susceptible to damage by human influence. "Harsh biogeoclimatic conditions that play a major role in these ecosystems make them less durable and less resilient than other zones within the province" (BCHSSOA 2003). A major contributing factor to the delicate nature of mountainous environments is that higher elevations experience colder temperatures for longer periods of time than do lower elevations. Greater amounts of precipitation can fall as snow at high elevations (McClung and Schaerer 2006), creating deeper snow packs, which last for longer than at lower elevations in the valley below. As a result, the ground is frozen for longer periods of time and the growing season for mountainous vegetation is consequently shorter than at lower elevations. In addition, soil processes of decomposition and nutrient cycling are significantly slower in mountainous environments; this causes vital nutrients to be less available to vegetation in mountainous environments than in low lying areas (Körner 2003). The limitations to growth that are experienced in mountainous terrain can be easily seen on any vegetated mountainside by a distinctive line (treeline and/or timberline[2]) above which the density of trees drastically drops off and trees eventually cease to grow. In addition, the special environmental conditions that are found at high elevations on mountains provide habitat for species of vegetation that are rare at lower elevations; possibly as a result of being out-competed by other species in lower elevations and being specially adapted to mountainous conditions. Since the focus of this thesis is the interrelationships and interactions between forests and helicopter skiing, the vegetation discussed herein will be limited to trees and other vegetation with woody stems.

Although the helicopters make quite a lot of noise, helicopter skiing has a relatively low impact on the natural environment in comparison to other mechanized activities. The most destructive environmental impact that is directly related to helicopter skiing occurs to newly regenerating trees that are not completely

[2] See Definitions on page v

covered with snow by skiers damaging the tree tips as they pass. This can have a negative impact on the growth of the young trees. The cells in the tips of tree tops, called leaders, are specially designed to grow upwards. These cells therefore are the main factor that causes trees to grow taller in the vertical direction. When these cells are damaged, for example by being severed or damaged by the ski edges of a passing skier, the tree has trouble growing. This rarely results in death of trees, but causes significant stunting of growth especially in the vertical direction. "The most dangerous stage for the trees occurs when the tree leaders are just barely covered with snow. This stage limits the ability of the skiers to see the trees, and therefore limits their ability to avoid skiing over them, and potentially exposes... the tree leaders to impact damage" (BCHSSOA 2003).

Trees are generally not cut down solely for the purpose of helicopter skiing (except perhaps to create landing sites), but rather slopes are used that have previously been logged by members the forest industry; deforestation is not an issue with regard to helicopter skiing. In fact deforestation has negative impacts on helicopter skiing, due to increased risk of avalanches and suboptimal snow conditions for skiing. Removal of brush species and thinning the density of tree species is, however, a common practice carried out by helicopter skiing operators. Thinning is carried out within most forest management operations to allow optimal light and nutrient conditions for a certain density of trees and although this may be done more thoroughly and possibly sooner in stands that are used for helicopter skiing, it is not necessarily an activity associated with helicopter skiing in particular.

Many environmental impacts are related to the other business activities of helicopter skiing operators including: accommodation and food services, ground transportation and management of helicopter as well as other types of fuel. However those impacts that are less directly related to forests will not be discussed in this thesis.

Impacts Caused by Glading Practices

Forests with sparsely space trees are called glades. Glades are ideal forests to ski in because there is ample room to manoeuvre between trees. The process of converting a densely stocked tree stand into a glade by removing non-commercial timber is referred to as 'glading' (BCHSSOA 2003). This is conducted to increase the skiable area between trees, to decrease the area covered by canopy to allow a greater amount of snow to reach the ground and to decrease the risk of unstable trees and branches falling onto skiers. The impacts of glading on the forest environment are not all negative. By increasing the space between trees, or inter-tree distance, sunlight is able to reach a greater portion of the leaf surface area and allows greater rates of photosynthesis to occur than under dense forest conditions. Therefore glading done by helicopter skiing operators actually benefits trees that were previously being limited by crowding. According to BCHSSOA (2003), "the optimum tree spacing [to facilitate skiing] in mature forests should be approximately seven meters. This spacing opens the terrain to a broader range of abilities and managed properly, should be designed in a way that a minimal amount of tree removal will yield a maximum amount of skiing".

Although glading involves cutting trees, branches and other brush down, it does not necessarily involve removal of trees or other vegetation from the forest. In certain cases however, glading can involve that. Since it is usually very small trees and underbrush that is cut during glading activities, there is no motivation for operators to remove the material from the site. Trees and brush are usually laid on the forest floor to be covered with snow in the winter and as long as the material is laid flat it does not cause any further problems for skiing and in face helps to stabilize the snow pack. Removing any type of vegetative material from a forest has negative environmental effects, no matter how minor because should the organic matter be left there it would decompose on the forest floor and would eventually be returned to the soil system.

Impacts Caused by Creating and Maintaining Heliports

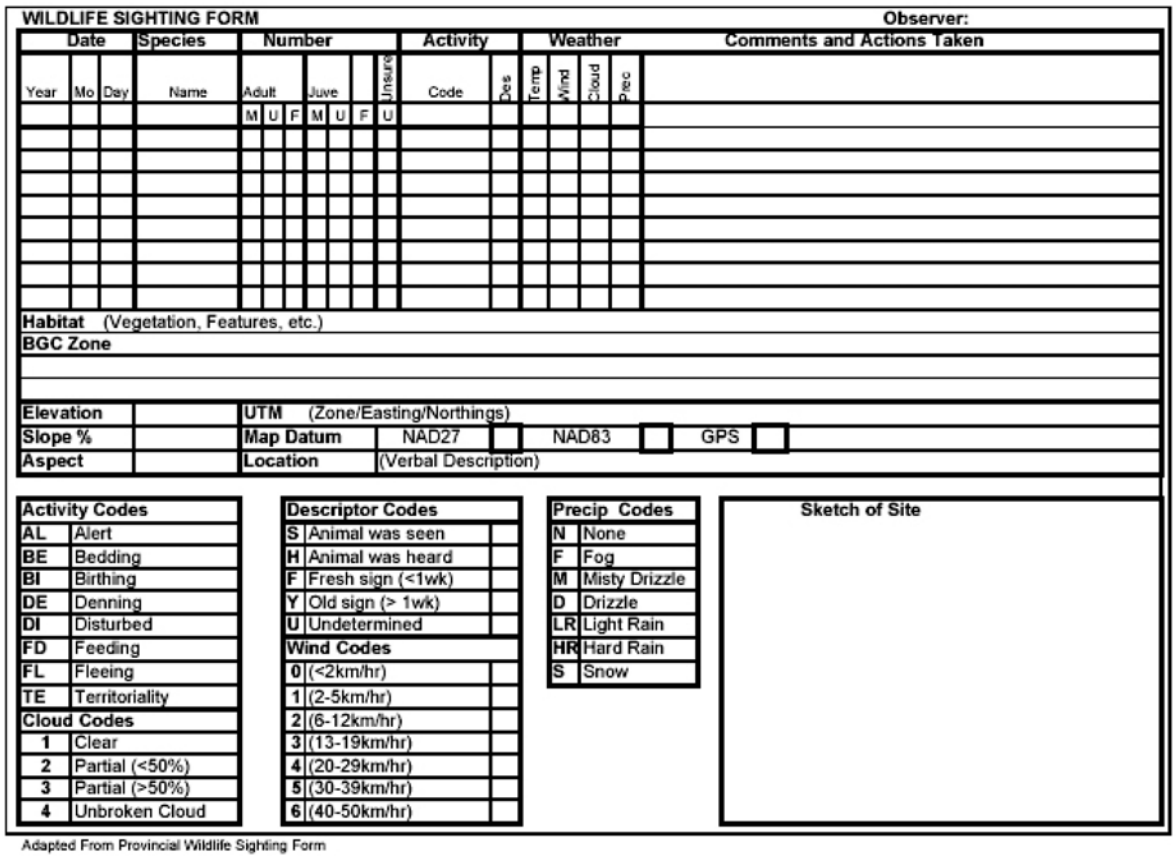
As defined by BCHSSOA (2003), "[h]eliports are designated areas used to land helicopters, and to allow skiers to disembark or embark the aircraft". Landings above the tree line do not usually require any development. Heliports are usually necessary in areas where skiing occurs below the tree line. Not every helicopter skiing operator uses heliports and those that do require them use heliports more frequently during times of bad weather, when helicopters cannot fly above the tree line. In order to land safely, helicopters require clear areas up to 0.75 ha in size for the actual landing site itself as well as the approach to the site (BCHSSOA 2003). Areas used as heliports are permanent forest openings and require ongoing maintenance to keep them as such (BCHSSOA 2003). Maintenance of heliports include cutting of: regenerating brush species, regenerating tree species, trees that pose a danger by being susceptible to falling over and old stumps" (BCHSSOA 2003). For a detailed list of tasks required to develop a heliport and a description of the regulatory measures required see Table 3.

Phase	Recommendations
Selection	❑ Base heliport site selection on detailed assessments of the environmental and operational characteristics of each potential site ❑ To minimize the amount of timber cut, natural openings and high points of land should be favoured. ❑ Riparian areas should be avoided for heliport development
Approvals	❑ All planned heliport development along with all glading, cat trail construction, and plantation modification projects should be outlined in the Management Plan for the operator. ❑ Include a letter of support from the forest licensee(s) in your application for any cutting approvals. ❑ Detail the development location on a map base consistent with your tenured terrain location maps. Useful information for this mapping includes the location of forest licensee operating areas, existing run locations and sensitive wildlife habitats.
Development	❑ All falling must be done by certified and experienced personnel. A Certified Wildlife Danger Tree Assessor should be part of the falling crew. ❑ To reduce fire hazards, all trees are to be bucked, limbed, topped and have their debris scattered so as not to create piles. ❑ Trees shall not be felled or pushed into standing timber at the edge of heliports. ❑ All timber shall be felled away from any creeks. If due to safety reasons timber is fallen into a creek it must immediately be bucked up and removed so as not to affect water flow. ❑ To avoid the potential for spruce bark beetle, all susceptible spruce should be either cut into blocks and stood up ,or bucked flat with continuous scaring by a chainsaw. ❑ Cutting of timber for heliports should be done in the summer months to ensure the lowest possible stumps are cut and that all stems are removed. ❑ If heliports are cut in the winter then they should be reviewed again in the summer to ensure all hazards are removed. ❑ A plan to address forest health concerns needs to be place – there is potential for cutting to be completed in conjunction with insect abatement trap tree programs.
Follow-up	❑ Annually, information on the volumes and grade of each species cut must be recorded for each site and submitted for stumpage considerations. ❑ Offer to tour the development sites with government personnel and/or forest company licensees to review sites the completed, compliance to development criteria and harvest plans as well as future site development opportunities. ❑ In consultation with the Ministry of Forests, forest health inspections should be carried out to monitor the condition of the sites.

Table 3.
Outline of requirements for heliport development. From Helicat Canada (previously called British Columbia Helicopter and Snowcat Skiing Operators Association) Best Practices for Sustainability (BCHSSOA 2003).

Impacts of Helicopter Skiing on Wildlife

A healthy forest is habitat for many species of animals as well as trees, other forms of vegetation and fungi. Animal populations can be used as an indicator for a healthy forest ecosystem. While vegetation is most at risk to damage caused by human influences in the spring, summer and fall when the protection of snow cover is not present, wildlife are most vulnerable during the winter season when food is difficult to find and exposure to the elements require significant amounts of energy. Consequently, helicopter skiing can have adverse impacts on wildlife populations, therefore decreasing the vitality of the forest ecosystems in which skiing occurs. This is partially due to the noise associated with helicopters and partially due to the presence of humans in the vicinity of the animals. Impacts caused by helicopter skiing pose an additional threat to species which already have limited population numbers and are at risk of further decline. One particular species at risk in British Columbia that inhabits mountainous regions is the mountain caribou. The mountain caribou has been observed to be negatively affected by helicopter skiing. Over many years helicopter skiing operators noticed that mountain caribou ceased to exist in areas where they were previously viewed. Some helicopter skiing operators document wildlife sightings and use the information gathered to avoid the areas that are most frequented by wildlife in efforts to protect the species (Wilderness Tourism Association 2007). The BCHSSOA Best Practices for Sustainability document provides a template, figure11, for staff of helicopter skiing companies to use when documenting wildlife sightings.



WILDLIFE SIGHTING FORM — Observer:

Date			Species	Number							Activity		Weather				Comments and Actions Taken
Year	Mo	Day	Name	Adult			Juve			Unsure	Code	Des	Temp	Wind	Cloud	Prec	
				M	U	F	M	U	F	U							

Habitat (Vegetation, Features, etc.)

BGC Zone

Elevation		**UTM** (Zone/Easting/Northings)				
Slope %		**Map Datum**	NAD27 ☐	NAD83 ☐	GPS ☐	
Aspect		**Location**	(Verbal Description)			

Activity Codes	
AL	Alert
BE	Bedding
BI	Birthing
DE	Denning
DI	Disturbed
FD	Feeding
FL	Fleeing
TE	Territoriality
Cloud Codes	
1	Clear
2	Partial (<50%)
3	Partial (>50%)
4	Unbroken Cloud

Descriptor Codes		
S	Animal was seen	
H	Animal was heard	
F	Fresh sign (<1wk)	
Y	Old sign (> 1wk)	
U	Undetermined	
Wind Codes		
0	(<2km/hr)	
1	(2-5km/hr)	
2	(6-12km/hr)	
3	(13-19km/hr)	
4	(20-29km/hr)	
5	(30-39km/hr)	
6	(40-50km/hr)	

Precip Codes	
N	None
F	Fog
M	Misty Drizzle
D	Drizzle
LR	Light Rain
HR	Hard Rain
S	Snow

Sketch of Site

Adapted From Provincial Wildlife Sighting Form

Figure 11.
Template for staff of helicopter skiing companies to use when recording data to monitor wildlife. (BCHSSOA 2003)

The population of mountain caribou has been exhibiting drastic decline in recent years. Efforts to protect habitat for the species, hopefully leading to population growth or at least stabilization have been put into effect province wide by the provincial government under the title of the Mountain Caribou Recovery Strategy. An influential actor/organisation in implementing efforts to protect the mountain caribou was the Forest Practices Board, which in 2004 published a Backgrounder that made recommendations for the conservation of Mountain Caribou. The Backgrounder outlined several possible means of implementing regulatory measures, best practices and provincial leadership strategies to protect the species. Regulatory recommendations included setting government objectives within FRPA for which results and/or strategies would be included in future forest stewardship plans and ensure “operational effectiveness” of those results and

strategies; as well as requiring compliance with certain “best practices for backcountry access and recreation as ‘conditions’ of future land use tenures granted to recreational businesses by the provincial government (Forest Practices Board 2004).

Although not all recommendations made in the previously mentioned publication of the Forest Practices Board, one was already in the process of being put into effect by the provincial government. That was a recommendation made by MCTAC that was reiterated by the Forest Practices Board to “appoint a provincial recovery Program Coordinator”. The government of British Columbia created the Species at Risk Co-ordination Office (SaRCO) in the fall of 2004 to help plan recovery efforts for wildlife species at risk (Government of British Columbia 2005), to provide recommendations on how the province addresses species at risk issues and to coordinate and accelerate recovery planning for three broad-ranging species; Marbled Murrelet, Mountain Caribou, and Spotted Owl” (Government of British Columbia Species at Risk Coordination Office 2007). One initiative that has been put into practice is a memorandum limiting new tenures for commercial recreation, such as helicopter skiing, that was placed on 1 million hectares of land known to be habitat to mountain caribou in areas falling under the Kootenay-Boundary and Revelstoke Land Use Plans (Government of British Columbia 2005), both areas encompassing terrain that would otherwise be optimal terrain to use for helicopter skiing. Both of which are areas that Another initiative is a memorandum of understanding (MOU) that was signed by both the British Columbia provincial government and Helicat Canada in November of 2005 (Government of British Columbia 2005). After several years of monitoring and avoidance programs being carried out by helicopter skiing operators, as well as many other organisations, it became evident that such practices should be implemented industry wide. A list of voluntary guidelines to be complied with by helicopter skiing companies is set out within the document. The MOU states that “[e]ach member of Helicat Canada must:

- Suspend activities for at least 48 hours, when caribou are in an area;

- Proactively highlight specific areas where the probability of encountering mountain caribou is high and to ensure these areas are not used for skiing until the animals are no longer in the vicinity;
- Document all actions to demonstrate due diligence so no displacement of mountain caribou occurs;
- Receive a minimum 2-hour training on the relevant aspects of mountain caribou biology, behaviour and habitat use; and
- Regularly work with government to ensure operators are up-to-date on current recovery actions so activities can be adapted based on the best information available;" (Government of British Columbia 2005)

As the association representing the helicopter skiing industry, Helicat Canada was an obvious and necessary actor organization to initiate actions of responsible business practices executed by the entire helicopter skiing industry.

As previously mentioned, other wildlife species at risk in British Columbia that could also be affected by helicopter skiing include the Marbled Murrelet and Spotted Owl (Government of British Columbia Species at Risk Coordination Office 2007). Mountain goats, although not a species at risk, are also affected by helicopter skiing. One helicopter skiing company has been monitoring goat populations and actively avoids areas where they are present (Wilderness Tourism Association 2007).

4.3.1.2 Influences of Forests on the Snow Pack and Protection against Avalanches

A snow avalanche was defined by the Canadian Avalanche Association (2002) as "[a] volume of snow, usually more than several cubic metres, moved by gravity at perceptible speed". On average, over three hundred thousand avalanches greater than size two in the Canadian Classification System occur every year in western Canada (Stitzinger et al. 2001), see appendix A for a table outlining the Canadian classification system. Avalanches are the number one danger and source of liability for helicopter skiing operators. Forest cover in the start zone is an important terrain factor that influences avalanche initiation (Stethem et al. 2003, McClung and Schaerer 2006, McClung 2001, Wier 2002). It is commonly known within the avalanche community and helicopter skiing industry that the risk of

avalanche initiation can be less in forests that surrounding open terrain. It is mainly for this reason that up to seventy percent of helicopter skiing occurs within forested terrain.

The concept of risk with regards to avalanches was explained well by Smith and McClung (1997) as being a combination of "consequences, chance of occurrence and exposure in time and space". Removing trees from a slope increases avalanche risk and can introduce the risk of avalanches to an area that had no previous danger of such hazards (Canadian Avalanche Association 2002b, Stitzinger et al. 2001, Weir 2002). The increased risk of avalanches caused by removal of trees from slopes presents a greater risk to helicopter skiers than would otherwise be the case. Most avalanche fatalities that occur in Canada are associated with skiing (Scott 2003, Stethem et al. 2003). Between the years 1990 and 2000 one hundred and twenty-five people died as a result of avalanches in Canada, one hundred and nine of those deaths were related to some sort of recreation (self-guided private individuals engaged in alpine skiing, snowboarding, snowmobiling, snowshoeing, cross country skiing etc.) and nineteen occurred during commercial backcountry skiing operations (in which cases helicopter and snowcat skiing were responsible for the accidents) (Stethem et al. 2003, Jamieson and Stethem 2002). While the reality is that avalanche risk cannot be fully eliminated (McClung and Stethem 2006), the helicopter skiing industry takes many precautions, including the use of forested terrain, to reduce the risk of clients and staff being caught in avalanches. Some mitigation options used by helicopter skiing operators, as described by the Canadian Avalanche Association (2002), include: "operational safety plans, intermittent avalanche control and route selection by professional guides." The limit of acceptable avalanche risk for helicopter skiing operations is suggested to be avalanches of size two or greater at a return period of one in ten years (Canadian Avalanche Association 2002a), see appendix A.

Avalanches are detrimental to both the tourism industry and the forestry industry. Data covering a time period of more than thirty years indicated that avalanches have affected, either by starting within or passing through, approximately 10 000 clear cut areas in British Columbia (Stitzinger et al. 2001, McClung 2001). Valuable timber can be removed from the ground and destroyed by avalanches, resulting in economic losses of several millions of dollars in forest damages each year (Jamieson and Stethem 2002, Stethem et al. 2003, Weir 2002) to forest licensees and the province. A photograph of a forest damaged by an avalanche which started in a clear cut can be seen in figure 12. The increased risk of avalanches caused by removing trees from slopes results in dangerous conditions for forest workers. Avalanche risk restricts the use of forest roads and therefore access to harvest sites as well as the actual harvesting operations due to worker safety; additionally, avalanches can damage standing timber and regenerating stands (Jamieson et al. 1996, Weir 2002). Stethem et al. (2003) stated that “snow avalanches are an increasing concern in the forestry sector”. The risk of helicopter skiers being injured or killed in avalanche events combined with impacts to the forestry industry makes avalanche avoidance a mutual goal of both industries. Clear-cut harvesting should not occur on mountain slopes and helicopter skiing generally does not occur in cutblocks.

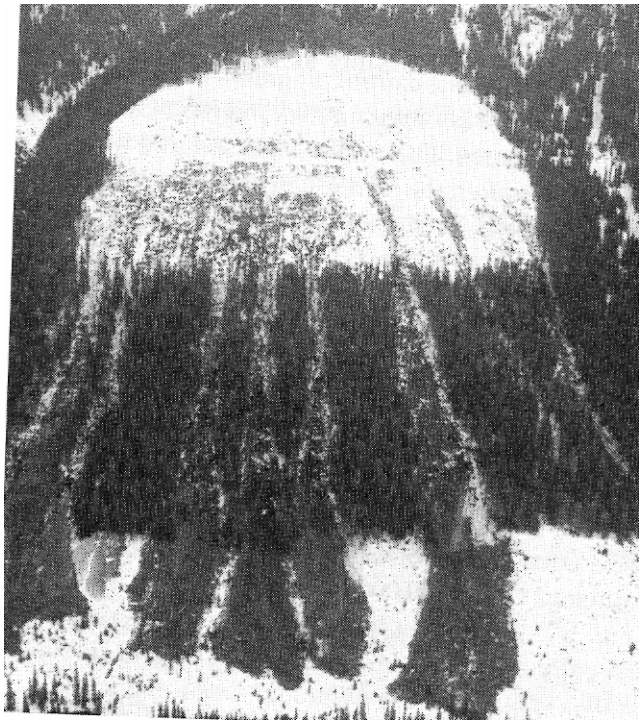


Figure 12.
Forests damaged by avalanches which started in a clear cut on the slope above. (Photo by Jim Bay in Canadian Avalanche Association 2002)

It has been know for a long time that “the manner by which forests receive, intercept, hold, and dispose of snowfall is not a simple unitary phenomenon but a series of events or processes which require independent study” (Bunnell et al. 1985, Miller 1966). Research initiatives are continuously evaluating the different processes and effects that cause forests to influence falling and fallen snow, but a point to consider, as stated by Bunnell et al. (1985), is that “the whole is qualitatively more than the sum of all the parts”. That is to say that each of the influential processes and effects is in turn influenced by other processes and effects. For example, “one cannot simply sum the processes documented for individual trees to predict interception by a stand”, because the emergent qualities associated with forests would be missed. Keeping this point in mind, the following section describes many individual processes and effects that are related to the influence of forests on avalanche risk and attempts to describe the relationships

between them, for a schematic diagram presenting an overview of this section see figure13.

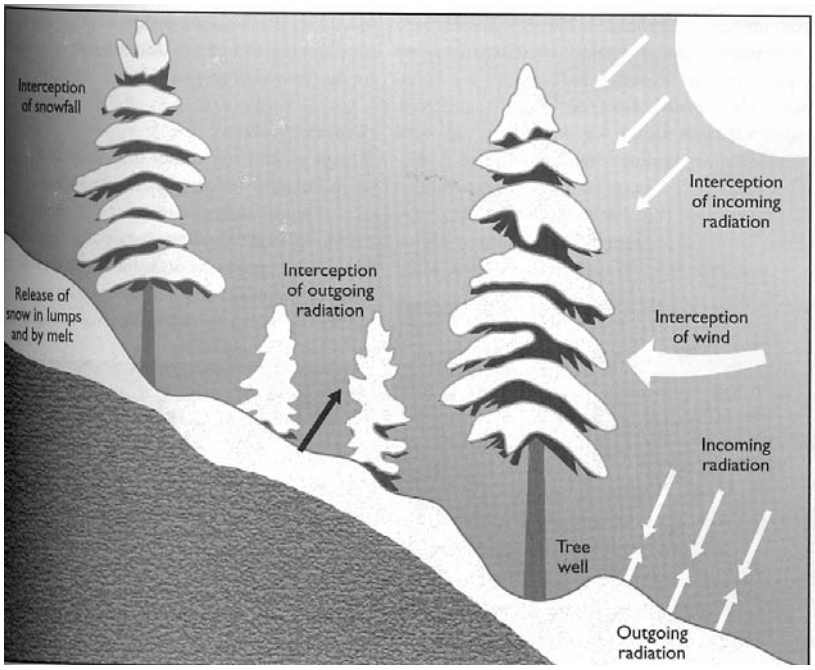


Figure 13.
"Effects of forests on the snow pack" (McClung and Schaerer 2006).

Trees as Anchors for the Snow Pack

It is widely known both in the helicopter skiing industry and in the scientific literature that avalanche risk is generally lower in forests than in open areas, but this is not always true (Avalanche.org 2008, McClung and Schaerer 2006, Munter 2003, Tremper 2001). As one of his "thirteen fatal mistakes", Munter (2003) pointed out the false concept that forests protect against avalanches and below the timberline there is no avalanche risk. He corrected this concept by stating more precisely that forests which are specifically designed as protection measures do protect villages and infrastructure from avalanches, as in figure 14, but the situation for single skiers is much different.

Figure 14.
A protection forest specifically designed to protect houses from avalanches. (Photo by Bruce Jamieson in Canadian Avalanche Association 2002)

As soon as the density of a forest stand is great enough to allow space for skiers it is dangerous regarding avalanches. If the density is low enough that when standing in the forest and looking vertically upwards you can see big patches of sky through the crown, as shown in figure15, the forest is not protecting against avalanches (Munter 2003). The false belief that all forests prevent avalanches is a common mistake and many individuals may be ignorant to the reality that the protective function is dependent upon density, it is widely known in the scientific community that beyond a certain density tree stems do act as stabilization mechanisms for the snow pack (Avalanche.org 2008, McClung and Schaerer 2006, Munter 2003, Tremper 2001). The most stabilizing density has been found to be approximately five hundred stems per hectare on gentle slopes and one thousand stems per hectare on steep slopes (McClung and Schaerer 2006). Trees that are spaced too sparsely do not offer protection against avalanches (McClung and Schaerer 2006), as depicted in figure 16 and figure 17.

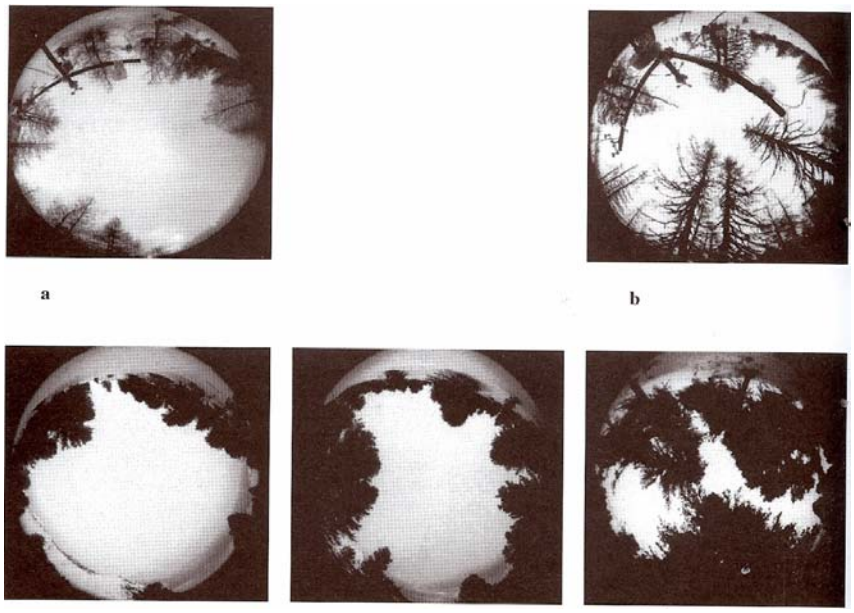


Figure 15.
Photographs looking vertically upwards from inside different forests; clearings of three different sizes in forests with a density that is too sparse (left and centre) and two types of dense forests (larch top right and spruce bottom right). (Höller 2001)

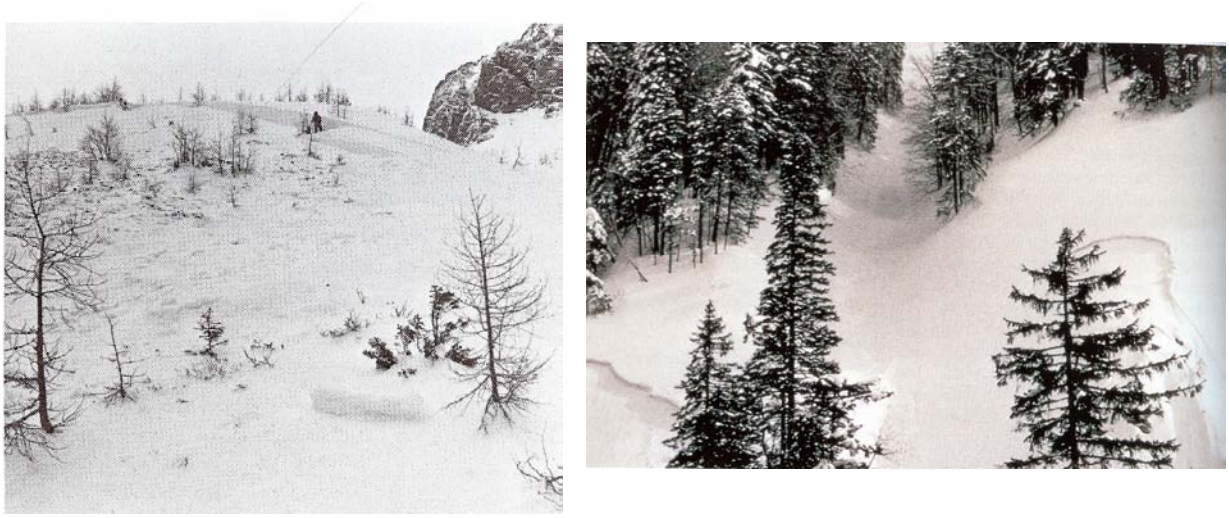


Figure 16.
Examples of tree stands that are not dense enough to effectively protect against avalanches. Notice the initiation of slab avalanches. Photos: Left (R. Ludwig in Herausgeber Land Tirol 1996) Right (Munter 2003).

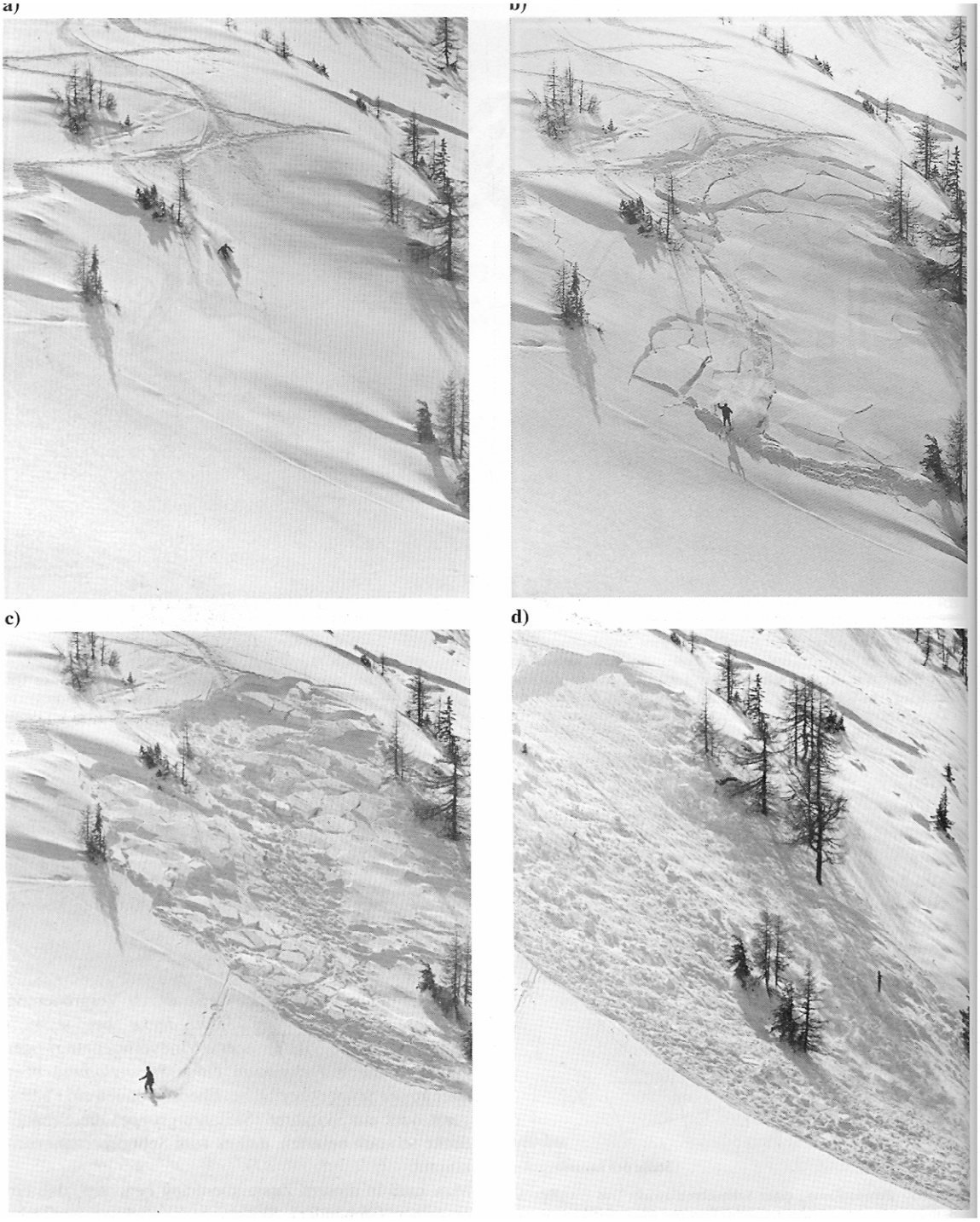


Figure 17.
Sequential depiction of a skier triggering a slab avalanche[3] in a tree stand that is not dense enough to effectively protect against avalanches. (R. Ludwig in Herausgeber Land Tirol 1996)

[3] Slab avalanche refers to the mechanism of triggering by failure in a weak layer at depth in the snow pack. Fractures propagate to cut out a block of snow above the weak layer which then slides down the slope. (McClung and Schaerer 2006)

Not only do they fail to protect against avalanches, but sparsely spaced trees have in fact been documented to act as triggering points because the stress of the snow pack is concentrated on only a few points and can increase the chance of fractures occurring (McClung and Schaerer 2006). Fractures tend to occur in a connect-the-dots manner, from one tree to the next, as illustrated by figure18.

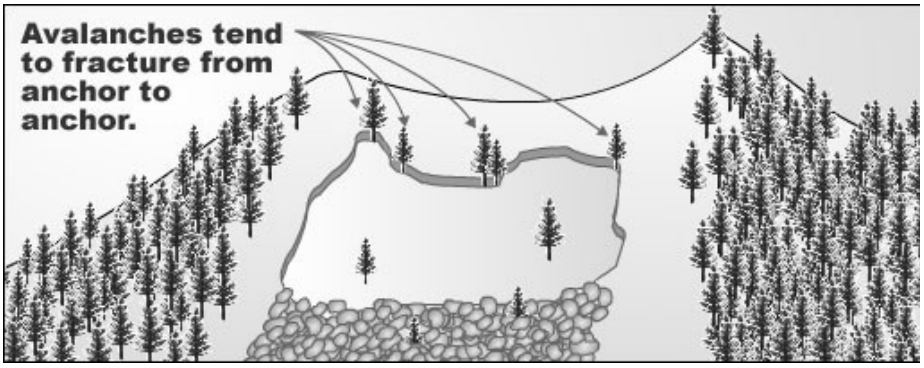


Figure 18.
Fracturing of an avalanche from one tree to the next in a stand with very low density. (Avalanche.org 2008)

It must be considered that the effective density of a stand at any given point is determined by the inter-tree distance. Therefore randomly spaced trees that are distributed in a patch-like pattern are less effective as a protection mechanism than regularly spaced trees with a nearly constant inter-tree distance. Luckily forests in British Columbia tend to have regularly distributed trees with a nearly constant inter-tree distance since most regeneration is conducted by individuals hand planting trees in horizontally oriented rows. Trees provide more protection against the initiation of slab avalanches than loose snow avalanches. This is because slab avalanches occur when the snow pack is held together enough to begin to slide as one cohesive sheet and stabilizing the sheet in one point helps to prevent it from starting to move as a whole, whereas trees in loose snow that is not held together with much cohesion would only have a stabilizing influence in the immediate

vicinity of any given tree and loose snow avalanches could easily initiate in the inter-tree spaces. This concept is depicted in figure19, as the difference between pinning cardboard and tissue paper to a cork board using a push-pin.

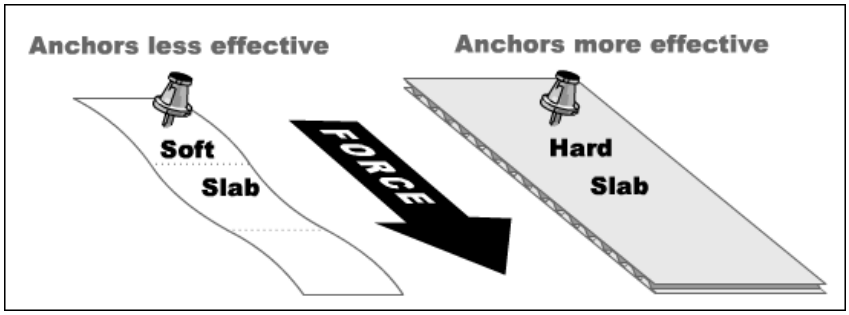


Figure 19.
Anchors have a greater stabilizing effect in snow packs that are held together as hard cohesive sheets (right) than loose snow forming soft snow packs (left). It is "like the difference between cardboard and tissue paper when affixing them to a bulletin board with a thumbtack". (Avalanche.org 2008)

It must be kept in mind that anchoring of the snow pack only decreases the risk of avalanches starting within the forest or other anchoring zone and offers little or no protection against avalanches starting upslope and running into forests (McClung and Schaerer 2006). In fact, in the latter case forests can increase the destructive potential of avalanches if trees are broken and become entrained within the flow (McClung and Schaerer 2006).

Surface Roughness and Snow Pack Stability

Areas of land with smooth surfaces are more prone to avalanche activity than are areas with irregularities on the surface. Smith and McClung (1997) found that the frequency of avalanches in any given area is significantly correlated with the roughness of the path. Surfaces with roughness features three metres in height were found to be effective in protecting against avalanches by Stitzinger et al. (2001), while McClung (2001) found that two metres could be sufficient. The effective height of roughness features is dependent upon the height of the snow

pack in any given area. Roughness features must reach almost to the snow surface in order to be effective at preventing avalanche initiation. Roughness features are only effective at stabilizing the snow pack within the height they protrude; protection is not provided against avalanches initiating within the height of snow overlying the roughness features.

One practice that can be used by the forest industry to reduce the risk of avalanches is to leave tall stumps to act as anchors after cutting the trees. Tall stumps, when the same height as the expected snow pack, or perhaps two of three metres as suggested by McClung and Schaerer (2006) and Stitzinger et al. (2001) respectively, act as effective roughness features to anchor the snow pack to the slope. A problem with this practice is the added danger to skiers at times when the actual snow height is less than the height of the stumps, leaving partially covered obstacles that are difficult for skiers to identify and avoid.

Interception of Snow by Forest Canopies

In addition to the stabilizing effect provided by tree stems, interception of snow by tree canopies also decreases the risk of avalanches. A significant proportion of precipitation is captured in forest canopies, figure20. Miller (1955) stated that approximately twice as much snow as solar radiation penetrates a forest of the same stem density. McClung and Schaerer (2006) stated that fifty to ninety percent of falling snow reaches the forest floor, while the remaining ten to fifty percent is intercepted by the canopy. The manner in which forest canopies intercept snow is explained by a number of micro-scale factors including the dimensions and texture of the intercepting surfaces of the canopy; the tendency of snow to stick to tree surfaces (determined by cohesive and adhesive forces which are highly dependent on temperature); the vector of incoming snow crystals, which is influenced by the terminal velocity of the falling snow crystals (determined by their shape, size, density, water content and aggregation), slope angle, wind velocity (decreased by forests) and turbulent flow (increased by forests) (Bunnell et al. 1985). On a slightly larger scale, factors such as the angle of incoming snow

crystals with respect to the orientation of the forest canopy, canopy completeness, canopy depth, also influence the amount of intercepted snow (Bunnell et al. 1985. According to Koivusalo and Kokkonen (2002) “[i]nterception during the winter is mainly explained by advection of energy due to turbulence within and above the forest canopy”.

Figure 20.
Snow interception in a spruce stand.

Bunnell et al. (1985) described the following points regarding the manner in which snow crystals fall over forest canopies and over open ground. Trajectories taken by snow crystals falling over forest canopies differ from those taken by snow crystals falling over open terrain. Kuz’min (1963 in Bunnell et al. 1985) found that snow crystals falling over open terrain tend to assume an incoming angle of four degrees to the horizontal caused by the horizontal force of wind and influenced by wind speed. That angle becomes more vertical when snow crystals enter the zone of slower wind speeds that is present over forest canopies. The speed of wind greatly influences the amount of intercepted snow as a result of this angle alteration. However that simple relationship is complicated by eddies that are created by the impacts on wind caused by the rough surfaces of forest crowns and small openings. When disregarding the counterbalancing effect of eddies, the

vertical alteration in approach angle has the potential to increase throughfall of snow crystals to the forest floor. Factors affecting interception can be summarized by the following two points:

- Interception of snow on simple, sloping surfaces will decrease with increasing wind speed.
- Interception of snow by complex surfaces (e.g. tree crowns) will increase with moderate increases in wind speed. (Bunnell et al. 1985)

Snow that is intercepted by forest canopies can have three possible fates: (1) blow away in the wind either to be deposited in nearby exposed areas or on top of the adjacent forest canopy; (2) eventually fall to the forest floor, often in hard clumps; (3) return to the atmosphere via the processes of evaporation or sublimation.

Interception only influences the quantity of snow accumulated on forest floors until the physical limit of canopy storage is reached, the point beyond which the forest canopy cannot accumulate any more snow, called the maximal snow load (Bunnell et al. 1985, Winkler and Moore 2006). The maximal snow load is reached when the cohesive and adhesive forces are overcome by the forces of gravity and wind and are influenced by the roughness of leaf/needle and branch surfaces, temperature as well as the flexibility of leaves/needles and branches (Bunnell et al. 1985). As a result of the many influencing factors, maximal snow load is determined by tree species, morphology of individual trees and specifics of weather parameters associated with any given snowfall event (Bunnell et al. 1985)

Influence of Forests as Wind Shelters

Wind exposure has a significant influence on the frequency of avalanche events in any given area (Smith and McClung 1997). More specifically, McClung (2003) found that while forest and vegetation are also significantly correlated with avalanche frequency, wind is the most significant variable in relation to the frequency of avalanches occurring in different types of terrain and land cover. A secondary factor that must be considered is that terrain features and vegetation affects the speed and direction of wind. Areas where wind loses velocity, or decelerates, are more likely to be avalanche initiation zones than are areas

exposed to high velocities of wind (McClung and Schaerer 2006). This is because high wind speeds pick snow up from the surface and transport it to deceleration zones where snow is deposited. Since quantity of snow is a significant factor determining initiation of avalanches (McClung and Schaerer 2006), deposition zones are likely initiation zones. As a result, wind significantly influences the distribution patterns of snow and the amount of accumulation in any given area. This effect is complicated by forests, which "interrupt and prevent snow transport by wind" (McClung and Schaerer 2006). Forests, in comparison to low lying vegetation or open ground, increase the roughness of Earth's surface and the resultant friction causes the velocity of wind to decrease when it blows over forested areas. Forest cover thus both reduces wind velocity and generates turbulent flow at low wind velocities. Roughness coefficients of forests are extremely large, varying from 30 to 290 cm, in comparison to that of a snow surface in an open area, which is 0.001-0.07 cm (Bunnell et al. 1985). Forest edges can also deflect the direction of incoming wind, altering the path wind would take if the forest did not exist in a location (Bunnell et al. 1985).

Snow Evaporation and Forest Canopies

Interception causes a greater surface area of snow to be exposed to the air; hence evaporation is greater over forests than over clearings. Interception and subsequent evaporation and sublimation of the intercepted snow significantly decrease the net amount of snow that reaches forest floors (Koivusalo and Kokkonen 2002, Lundberg 1993, Lundberg et al. 1998, McClung and Schaerer 2006, Nakai et al. 1999, Pomeroy et al. 1998). This is significant because the snow water equivalent (SWE) of the snow pack in a given area is a significant factor determining avalanche frequency (Smith and McClung 1997) because snow load is a factor that contributes to failures in the snow pack leading to initiation of avalanche events (McClung and Schaerer 2006). Koivusalo and Kokkonen (2002) found that an average of twenty-six percent of intercepted precipitation evaporated during winter seasons. Since the net quantity of precipitation is greater in open areas, snowfall events cause the quantity of snow to increase more rapidly in open

areas than in forests. However melting of snow is more intense in open areas, which causes the quantity of snow to decrease faster than within forests (Koivusalo and Kokkonen 2002). Since snow melts more rapidly in open areas the ground is often free of snow there while snow is still present within forests. This point is illustrated by figure21, which shows the quantity of snow (SWE) that is present in open areas (exposed) and forested areas (sheltered) for each month. It can be seen that the SWE is greater in open areas at the beginning of the winter, while it is greater in forested areas at the end of the season.

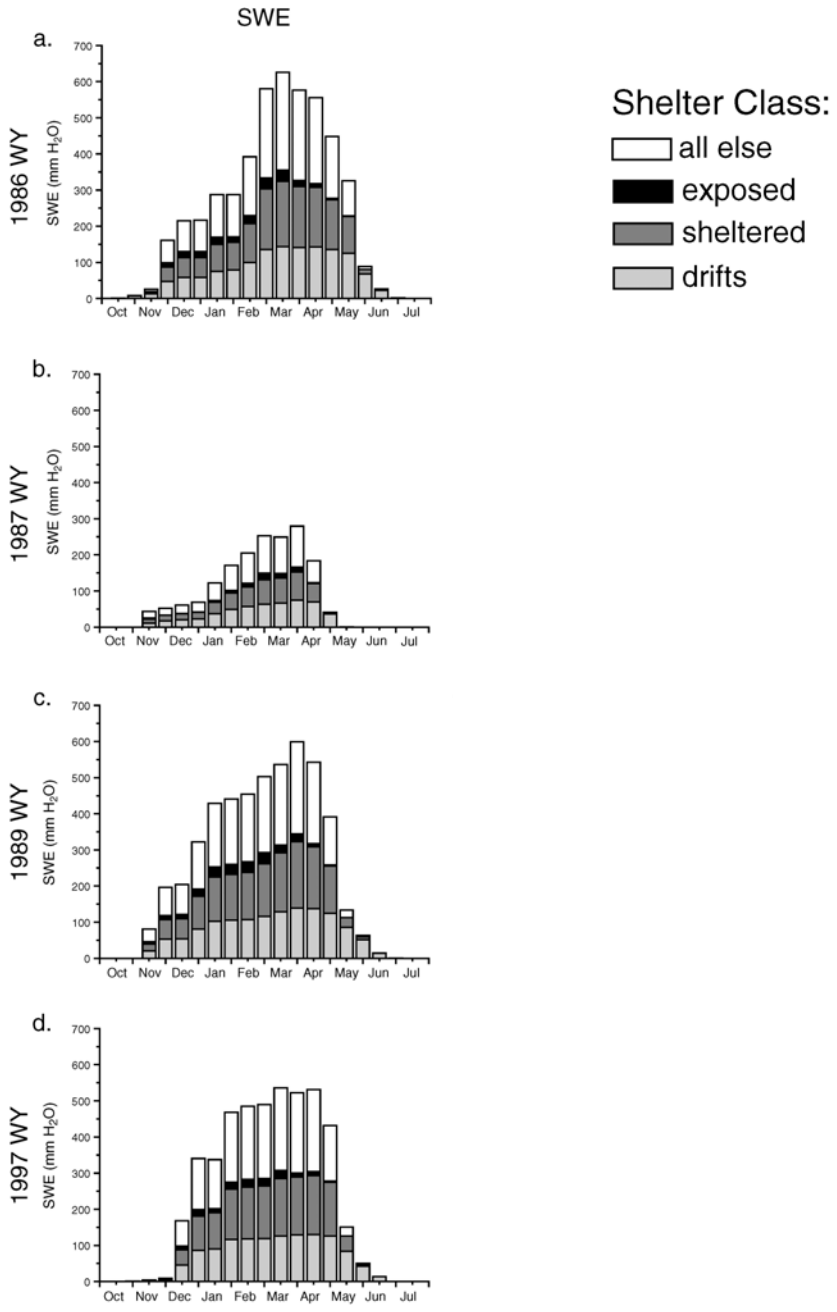


Figure 21.
Bi-weekly area-normalized snow water equivalent (SWE) by terrain and vegetation shelter class (Marks et al. 2002). Note that forested areas (sheltered) have greater a greater amount of snow during springtime than open areas (exposed).

Forest Impacts on the Energy Balance of the Snow Pack

The crowns of trees influence the intensity of both incoming and outgoing radiation (McClung and Schaerer 2006). Koivusalo and Kokkonen (2002) found that since the sensible heat flux, and therefore the turbulent flux, is greater in open areas than within forests, during the middle of the winter season the main source of energy to drive the process of snow melt in open areas is sensible heat, while within forest stands sensible heat and net radiation equally contribute to snow melt. It can be seen in figure 22 that turbulent flux (sensible heat plus latent heat) is moderated in forested areas and more drastic in open areas. This concept was contradicted by a statement made by Suzuki and Ohta (2003) claiming that net all-wave radiation is the most important energy component that affects snowmelt. Lack of agreement suggests that further investigation into the driving energy forces responsible for snow melt differentiations between forests and open areas is needed. During the middle of winter forest canopies significantly decrease the amount of long-wave radiation that is lost from a given area. Trees absorb short-wave radiation from the sun and then emit it as long-wave radiation that is partially absorbed by the snow pack. This effect is somewhat counterbalanced by the shading effect provided by forest canopies, which causes the albedo of the snow surface to be much less than is the case in areas without forest cover, figure 23. As a result, net radiation is significantly lower in forests than in open areas (Koivusalo and Kokkonen 2002, Marks et al. 2002) as demonstrated by figure 24. Suzuki and Ohta (2003) found that the density of a forest has a strong influence on the energy used for melting snow under the forest canopy. Additionally, Suzuki and Ohta (2003) found that the albedo of the snow surface decreases as the density of a forest stand increases.

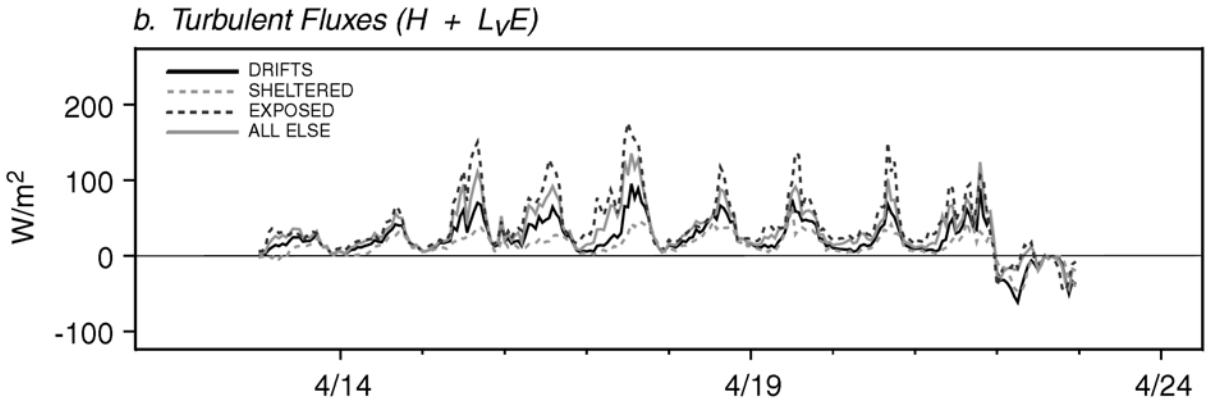


Figure 22. Area averaged sum of simulated turbulent fluxes [sensible heat + latent heat] by shelter class" (Marks et al. 2002). Note that the flux is significantly greater in open areas (exposed) than in forested areas (sheltered).

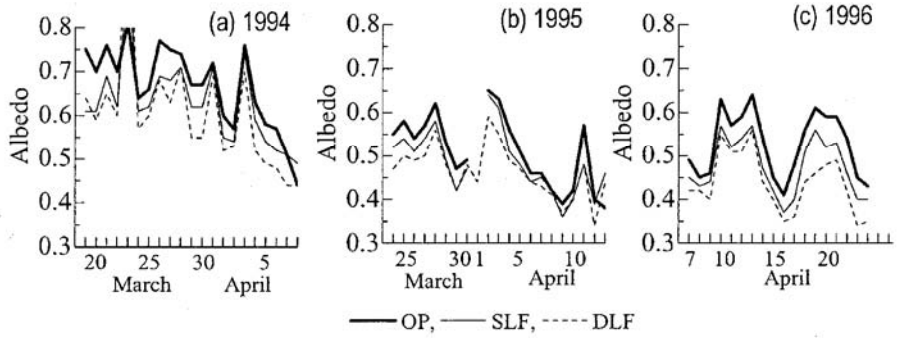


Figure 23. Snow surface albedo as a function of time. Snow albedo is lowest in dense forests (DLF), second lowest in sparse forests (SLF) and highest in open areas (OP) (Suzuki and Ohta 2003)

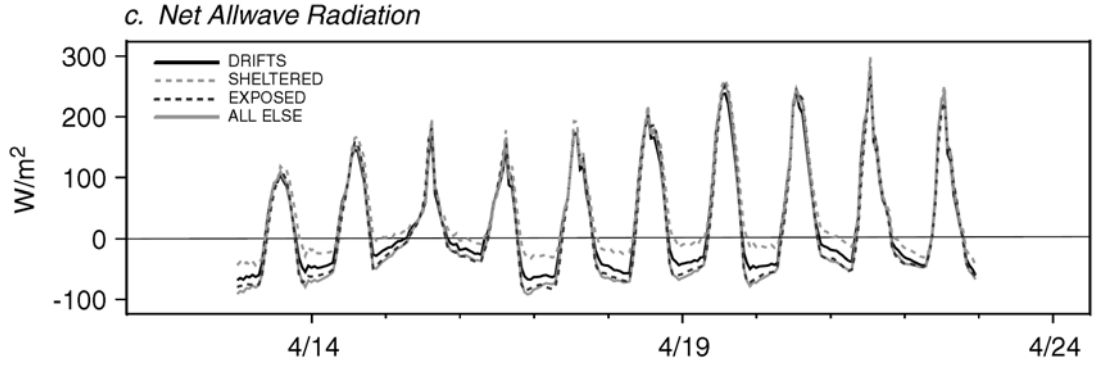


Figure 24. "Simulated net all-wave radiation at the snow surface" (Marks et al. 2002). Note that less radiation is lost in forested areas (sheltered) than in open areas (exposed).

Impact of Forests on Surface Hoar and Depth Hoar Formation

Temperature moderation prevents the formation of two dangerous types of snow crystals for avalanche initiation that form under conditions of large temperature gradients: surface hoar and depth hoar (McClung and Schaerer 2006, Höller 2001). Surface hoar develops on the surface of the snow pack during windless nights when the snow surface temperature falls below the dew point (Höller 2001). When the temperature of the snow surface is less than that of the overlying air and the water-vapour pressure gradient is great enough to condense moisture held in the air, the moisture freezes on the snow surface in the form of thin, flat, featherlike crystals referred to as faceted crystals or surface hoar. These crystals are dangerous in terms of avalanche initiation when they are buried within a snow pack because the crystals are flat and loose and form unstable layers. Buried surface hoar is a likely location for failure to occur within the snow pack due to its shear instability and it offers a slippery surface upon which the snow above can slide. Surface hoar develops when there is a large temperature gradient between the snow surface and overlying air, therefore the moderated temperature caused by the presence of trees in an area decreases the chance of surface hoar formation. (Höller 2001, McClung and Schaerer 2006, Tremper 2001)

Depth hoar is a term used to describe faceted crystals, similar to those of surface hoar, which are formed within the snow pack. A large temperature gradient, ten degrees Kelvin per metre, is additionally needed for depth hoar to form within the snow pack. The moderating effect that forests have on temperature also helps to reduce the temperature gradient within the snow pack and therefore the chance of depth hoar formation. (Höller 2001, McClung and Schaerer 2006, Tremper 2001)

It has been found that tree crowns influence both incoming and outgoing radiation in a manner that moderates the temperature of the snow surface. A study by Höller (2001) found that forest density significantly affects snow surface temperature. Forests cause the snow surface temperature to be warmer than in clearings during both day and night. Forest density was found to affect the degree

to which temperature is moderated; more dense stands had warmer temperatures than less dense stands, figure 25. This point is attributed to absorption and reemission by tree crowns of longwave radiation caused by cooling of the snow surface (Höller 2001). The greater the extent of crown closure, affected by tree species and stand density, the greater the proportion of longwave radiation that is kept within the forest. The influence of densely spaced trees on the temperature of both air and snow surface decrease large temperature gradients from facilitating development of faceted snow crystals. This interaction between forests and snow therefore decreases the risk of avalanche initiation in forested areas and makes skiing in such terrain safer.

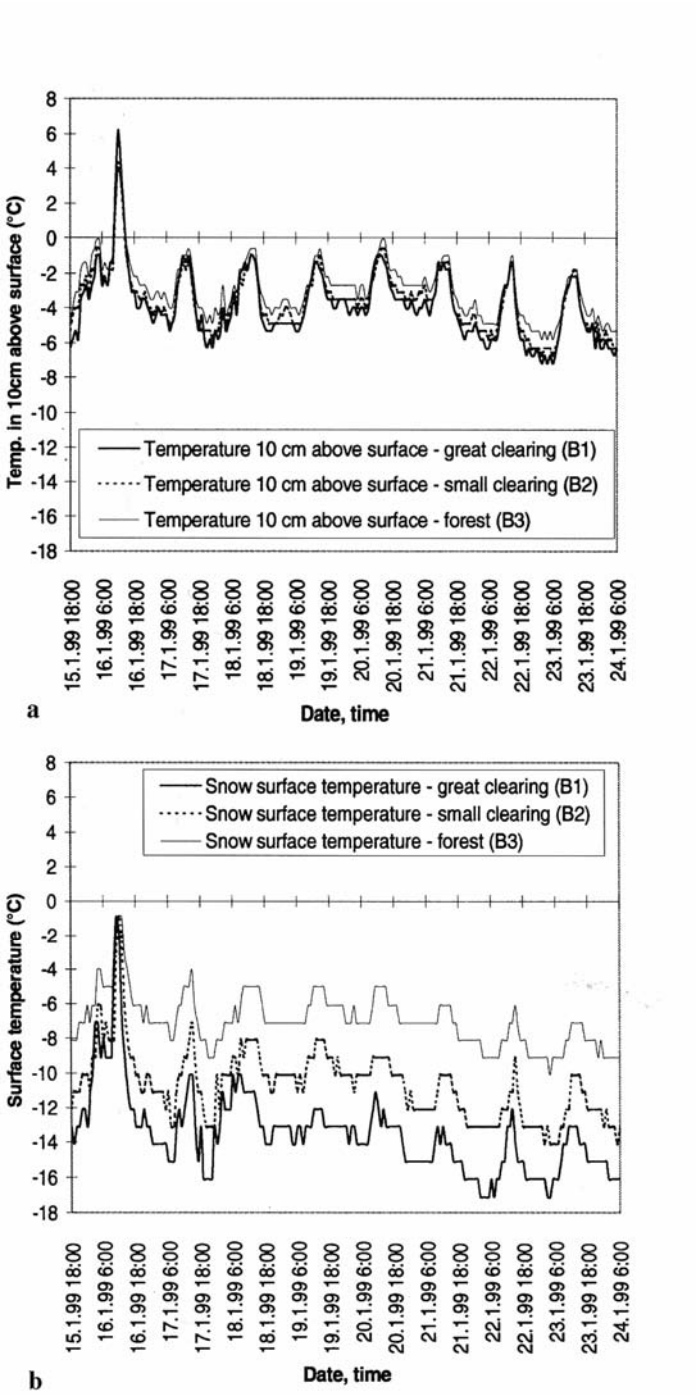


Figure 25.
Temperature of the snow surface and 10 cm above the snow surface are greatest in forested areas and decrease with clearing size. Temperatures are also moderated in forested areas in comparison to large clearings. (Höller 2001)

Impacts of Forests on Snow Accumulation and Distribution

Forest canopies have been proven to decrease the quantity of snow that accumulates in forests (López-Moreno and Latron 2007, Pomeroy et al. 2002, Winkler and Moore 2006). Although not studied and proven scientifically until much more recently, this concept has surely been observed for throughout history and formal documentation dates to at least 1912 (Church 1912). López-Moreno and Latron (2007) stated that maximum accumulation within forests was only half that found in clearings. While interception reduces the risk of avalanches within forests, if too much snow is intercepted by a canopy the forest could be unusable for helicopter skiing due to insufficient snow quantity on the ground and/or the presence of too many hard clumps of snow that have fallen from tree tops. In a study to characterize the variability of snow accumulation patterns within forest stands in British Columbia, Winkler and Moore (2006) found that the greatest inter-annual differences in snow water equivalent were observed in forests rather than in clear-cuts, which indicates that the effect of the forest canopy on snow accumulation is not proportional to snowfall. That leads to the suggestion that beyond an upper limit, interception no longer influences the quantity of snow that reaches the forest floor, a point previously made by Bunnell et al. (1985).

Snow distribution is quite heterogeneous under forest canopies, while the accumulation pattern is relatively homogeneous in clearings (López-Moreno and Latron 2007). It has been proven that variations in the quantity of snow that accumulates in different types of forest are associated with the specific climatic conditions at any given site (López-Moreno and Latron 2007) and the structure of any given forest (Talbot and Plamondon 2002, Winkler et al. 2005, Winkler and Moore 2006). Studies conducted on the scale of a forest stand indicate that variables associated with the structure of a given forest can explain approximately seventy percent of the spatial variability in the average quantity of snow, measured as snow water equivalent (SWE), among different forest types (Talbot and Plamondon 2002, Winkler et al. 2005, Winkler and Moore 2006). Important

structural characteristics include the age of trees and extent of canopy coverage. López-Moreno and Latron (2007) found that snow accumulation decreases with increasing density of a forest stand. Crown closure together with study year were shown by Winkler and Moore (2006) to explain forty-three to forty-five percent of the variability in snow quantity (SWE) within juvenile pine stands. The stands studied exhibited significant consistency in the year-to-year pattern of snow distribution, indicating that snow distribution is strongly influenced by forest structure (Winkler and Moore 2006).

While snow accumulation has been proven to correlate with forest stand characteristics, the variability of snow accumulation within individual forest stands was found to be difficult to predict or associate with the particular characteristics of a stand (Winkler and Moore 2006). Attempts by Pomeroy et al. (2002) to relate snow water equivalent to local canopy characteristics within a forest stand to failed to provide any useful conclusions. A new measurement method that could be used to study this issue was developed by Prokop (2007 and Prokop et al. 2008). The method is the use of a terrestrial laser scanning device to measure the spatial snow height distribution. Furthermore, airborne laser scanning has been used to map the spatial distribution of snow pack depth beneath a variable forest canopy (Hopkinson et al. 2001).

While the generally accepted and most prevalent relationship between snow accumulation and forests is that more snow accumulates in clearings, however this is not always the case. Suzuki and Ohta (2003) found a situation in which forested areas accumulated more snow than open areas. If open areas are exposed to severe wind and sunlight, this mainly occurs on south facing slopes, adjacent forested areas can accumulate greater quantities of snow, especially if the trees are sparsely spaced.

Influences of the Size of Forest Clearings on the Snow Pack

The amount of snow accumulated in forest clearings is a function of the height of surrounding trees and size of the open area (Bunnell et al. 1985, Golding and Swanson 1986). Golding and Swanson (1986) compared snow distribution patterns in forests and clearings. They found that maximum snow accumulation occurs in forest openings that are between two and five times as wide as the surrounding trees. Large openings, greater than 20 times the height of surrounding trees, were found to have less snow accumulate in them than in the surrounding forest. This is because surrounding trees protect clearings from wind and incoming sunlight, but the shelter effect is diminished in large clearings. The wind speed at the snow surface in large clearings is much greater than is the case in small clearings. Winds in open areas with greater force than within forests have a greater ability to pick up snow from large openings and deposit it in another location – possibly in the adjacent forest. In circular clearings that were between one and six times the height of surrounding trees Swanson (1980) found that the speed of wind two metres above the ground surface was ninety-five percent less than the wind speed ten metres above the forest canopy. The intensity of incoming solar radiation increases as the winter season progresses due to the solar altitude. Larger clearings receive direct shortwave radiation before smaller clearings due to the length of shadow caused by trees in the surrounding forest, on the southern side of clearings in the northern hemisphere. A visual depiction of this effect is provided in figure 26. As a result of the seasonality in incoming solar radiation, Swanson and Golding (1986) found that as the winter season progressed, a decrease in snow height, from that found in clearings, was found to be progressively farther past the edge of forests. Swanson and Golding (1986) also found that "if no direct sunlight reaches the floor of a clearing…the snowpack is reasonably uniform within the clearing and in the forest surrounding it.

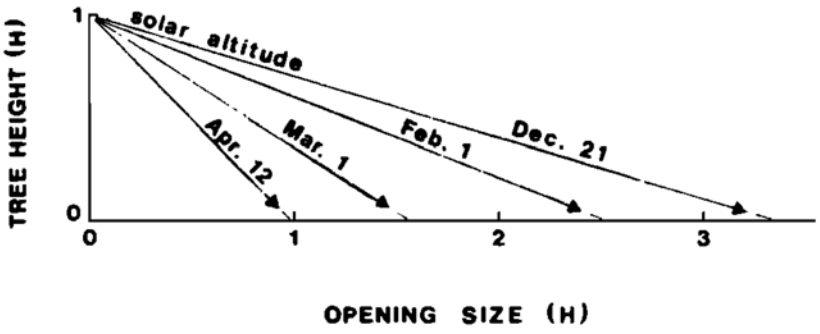


Figure 26.
Shadow length at solar zenith as a function of date of year, by clearing size" at 52 degrees north latitude (Golding and Swanson 1986).

An additional situation in which forest canopies significantly influence the quantity and melt rate of snow is when precipitation falls as rain on top of a snow pack. A simulation by Marks et al. (2001) found that areas exposed to wind with low lying vegetation lost almost one third of the SWE that was present prior to a rain event. Forested areas on the other hand were shown to increase SWE from the rain event. The increase was explained by the rain water being held and refrozen in the snow pack.

4.3.1.3 Forest Industry Influences on Avalanche Risk

It is generally agreed within the scientific community that forest harvesting can lead to increased avalanche activity (Germain et al. 2005, McClung 2001, McClung and Stethem 2006, Wier 2002). This effect is greatest when clear-cuts are chosen as the harvest method and since that is the most prominent harvest method used in British Columbia (McClung 2001) the forest industry often increases the risk of avalanches. The influences of tree removal on avalanche risk are exacerbated by the trend of cutblocks being located at increasingly higher locations on mountain sides (Krawczyk 2007, Redfern 1998). As described in section 4.2.2.2, the liquidation and renewal forestry scheme that has been used in the province first targeted forest stands near mountain valleys rather than higher up mountain sides. As resources at lower altitudes have been depleted however, forest harvesting is

increasingly occurring at higher altitudes. As harvesting operations move further up mountain sides, trees are being removed in increasingly sensitive areas on increasingly steep slopes (Stitzinger et al. 2001). It has been observed in Europe that after forests have been cut at high altitudes on steep slopes, trees have been unable to regenerate due to the extreme conditions of the resultant exposed slope (McClung and Schaerer 2006).

As stated by Stitzinger et al. (2001), destructive avalanches initiated in cutblocks tend to occur within the slope range of thirty to fifty degrees. They also tend to be initiated in cutblocks with "moderate cross slope concavity and moderate to high down slope concavity" (Stitzinger et al. 2001). McClung (2003) suggested that large avalanches tend to be initiated in areas that are adjacent to large open areas of un-forested terrain.

Not only is forest harvesting on steep slopes a problem due to the clearing that is left behind without sufficient anchors to stabilize the snow pack, but the creation and existence of forest roads also increase avalanche risk. Shallow bowls that are located below the steepened berms at the edge of logging roads have been observed as frequent start zones for avalanches (Stitzinger et al. 2001). Avalanche risk can be managed by carefully choosing sites on which to harvest timber. Harvesting certain areas of forest is only avoided in backcountry situations where an avalanche path is expected to only damage the forest with estimated size two avalanches at a return period of one year or less, or size three avalanches at a return period of one in ten years or less (Canadian Avalanche Association 2002b). Choices made by forest licensees could be improved by research that is currently in progress. McClung along with some other individuals has been developing the theoretical groundwork for a risk-based decision support system for forest harvesting in steep terrain (Stitzinger et al. 2001). When used in the planning of cutblock locations to mitigate avalanche risk, this decision support system could have the potential of decreasing avalanche damages associated with forest harvesting.

4.3.1.4 Danger to Skiers Caused by Forests

There are a few risks that forests and single trees pose to skiers (Bourg 1997, Cadman 1999, Wiegele 2007). The literature suggests that the most serious danger is tree wells (Bourg 1997, Cadman 1999). Due to the radiational influences that trees have on the snow pack and interception of incoming snow by tree tops, the snow is much shallower directly at the base of trees. This hollow is referred to as a 'tree well'. As previously mentioned; trees, particularly tree stems, absorb long wave radiation and reemit it to the snow pack. The warming influence caused by this effect is realized greatest immediately next to the tree stem, resulting in melting and sublimation of snow in the immediate vicinity of tree stems. This, combined with the fact that tree crowns do not allow snow to reach the ground immediately surrounding the stem, results in an effective hole in the snow pack under trees. This effect is demonstrated by figure 27 and can also be seen in figure 13. Tree wells are dangerous for skiers because if the skier passes too closely to a tree they could fall into them. Not only could skiers be severely injured during the process of falling into the well, but depending upon the depth of the snow pack tree wells can be quite deep and difficult to climb out of, especially with ski equipment. Tree wells are especially dangerous when the tree has low branches that could tangle and trap victims in the well, make it extremely difficult to get out. (Bourg 1997, Cadman 1999)

Figure 27.
Example of the beginning of tree well formation in a shallow snow pack.

4.3.2 Visual Relationships and Interactions between Helicopter Skiing, Forests and Forestry

Forestry management practices have a significant impact on the look of a landscape. Clear cutting, for example, is very pronounced and easily visible when viewing a landscape from above ground in a helicopter or from high up on a mountain. Visual qualities also interact with helicopter skiers as they pass through forests on their decent of a mountain. Forests that appear highly managed, and therefore unnatural, conflict with the "Super Natural British Columbia" trademark conveyed by Tourism British Columbia. On the other hand, one helicopter skiing operator described the interaction helicopter skiers have with old growth forests to be a "magical experience" (Krawczyk 2007). Since the majority of individuals participating in helicopter skiing are tourists in British Columbia, the landscape they observe has an impact on the perception of the province they take home with them.

4.3.3 Economics Associated with the Use of Forested Crown Land

The provincial economy is dependent upon sustainable management of Crown land. The *GATP* demonstrates this point since it "aims to support the management

of Crown land for commercial recreation purposes to support British Columbia's commercial tourism industry, which plays a key role in the sustainable economic diversification [rather than a forestry centered economy] of British Columbia" (Integrated Land Management Bureau 2007d).

4.3.3.1 Costs of Land Tenure for Helicopter Skiing

According to a respondent of a survey carried out by Heidt and Williams (2005), the only benefit of tenures for commercial recreation operators "is the right to pay for the use of public land". The various payments to be made by helicopter skiing operators in exchange for the right to use Crown land are described below.

Costs associated with land tenures are charged for the application process, annual rent on the tenure, modification of a tenure or tenure replacement. Information regarding costs in this section was obtained from the Guided Adventure Tourism Policy document dated October 2007; within which many of the costs were said to be under review and therefore may be out of date as of the time this thesis was printed. For more detailed pricing descriptions see the summary table taken from the Guided Adventure Tourism Policy document in appendix B.

Tenure applications for the purpose of a mechanized guided adventure tourism activity are charged a fee of $3 300 (Canadian dollars). Every tenure holder is charged rent on an annual basis, the amount of which is dependent upon the type of tenure. Rent for investigative permits is $250 per year. For extensive use licences of occupation annual rent is determined by using the system of 'client days'. This is a method of rent determination used under the Guided Adventure Tourism Policy and is used by the Ministry of Tourism, Sport and the Arts to quantify the intensity of guided adventure tourism activities such as helicopter skiing. A client day is defined in the Guided Adventure Tourism Policy as "a single client, participating in any type and any number of GAT activities on Crown land, guided by a tenure GAT operator, for any calendar day or portion thereof". For the purpose of activities "where motorized modes of transport are either used

repeatedly through a guest's visit or are an integral part of the experience" the annual rent is $4.00 per client day and it subject to a minimum payment of $500. Intensive use licences of occupation are charged annual rent depending on the classification of the site for which the tenure is valid. Licences of occupation involving intensive use on primary sites are charged 7.5% of the value of the tenured land area if that exceeds the minimum payment of $500. Intensive use licences of occupation on secondary sites are charged 4.5% of the value of the area of tenured land if that exceeds the minimum payment of $100. Intensive use licences of occupation for temporary sites are charged annual rent of $100. Annual rents for leases of primary sites are the greater amount of either 8% of the value of the tenured land or $500. For leases of secondary sites, annual rent is the greater amount of either 5% of the value of the tenured land or $100. Modification of tenure for a mechanized activity requires a fee of $100 for minor amendments and $250 for major amendments. All fees associated with administration of land tenure are to be paid to the British Columbia Minister of Finance.

In addition to the previously mentioned fees associated with Crown land tenures for helicopter skiing operators, in situations where construction of structures or land modification is proposed the Integrated Land Management Bureau may demand a security deposit or bond from the operator in an amount decided by the ILMB. The purpose of the deposit or bond is to provide money for remediation of the land if the tenure holder fails to meet the use standards required in the tenure agreement. (British Columbia Ministry of Tourism, Sport and the Arts 2007a)

4.3.3.2 Economic Benefits of Helicopter Skiing for British Columbians

All of the above mentioned fees represent revenue for the government of British Columbia. According to the BCHSSOA (2002), helicopter and snowcat skiing contributed twenty-four million dollars to the provincial government for the 2000-2001 ski season, a year of abnormally low client numbers due to poor snow conditions. Total direct spending in British Columbia as a result of helicopter skiing amounted to more than ninety-two million dollars in 2001 (BCHSSOA 2002).

When combined with snowcat skiing, helicopter skiing directly impacts the socio-economic situation in at least thirty-three communities in British Columbia (BCHSSOA 2002). Most of those communities primarily receive their economic input from the forest industry (BCHSSOA 2002). Helicopter skiing operators themselves support economic diversification of nearby communities by purchasing supplies there, working with other local businesses and by providing jobs and training opportunities for community members (BCHSSOA 2002). Spill-over effects of helicopter skiing businesses impact the economies of nearby communities via clients stopping before, during or after their helicopter skiing experience at local shops, restaurants or places of accommodation. According to BCHSSOA (2002), forty-one percent of helicopter skiing operators' direct expenditures were made in local communities and eighteen percent was spent respectively within the operators' region and within British Columbia as a whole. While forestry is likely to remain the industry which provides the greatest revenues to the government of British Columbia, it is important for the province to stimulate other industries' contributions to community economies to provide stability and insurance for times of decreased vitality in the forestry industry.

4.3.3.3 Costs of Crown Land Use for Forestry

The Government of British Columbia receives economic benefits from forestry mainly in the form of stumpage fees, while it also receives money from the industry via payments for Crown land tenure the amount of money paid for that purpose is incomparable to stumpage fees and therefore insignificant for the purpose of this thesis. Stumpage is the term given to the type of fee that is required to be paid to the provincial government by forest licensees when they harvest timber on Crown land. The fee is set at a certain amount of money per volume of wood harvested, ($/m^3). Licensees receive an invoice from the government for the total amount of timber after it is cut (Forest Practices Board 2005). The rate of stumpage fees differ depending upon the region of the province, the type of timber harvested and the market conditions at any given time. Regarding the historical method of stumpage fee determination, the Forest Practices Board (2005) stated that

“[s]tumpage is determined through a complex appraisal of each stand or area of trees that will be harvested for a given timber mark”. However in 2005-2006 changes in the economic structure of the industry and stumpage rates occurred (Council of Forest Industries 2008) due to the Softwood Lumber Agreement signed with the United States. Those changes included the implementation of a market pricing system, causing the determination of stumpage fees to be less imposed by government and are now determined by market prices obtained from an auction process. The rate of stumpage fee for any given area is a continuously changing value, based on market conditions. Average stumpage fees paid by region and provincial average are shown in figure 28 from the council of Forest Industries (2008). It can be seen in the graph that stumpage fees increased steadily throughout the late nineteen eighties and into the early nineteen nineties with a sharp increase between 1992 and 1994. The increase in stumpage fees came to a plateau between 1994 and 1997 and has been steadily declining for the past ten years. Governmental revenue from stumpage fees has consequently followed a similar trend over the same time period. A temporal depiction of fluctuations in total average stumpage fees received by the government for the whole province is provided in figure 29, created from data in the most recent, at the time of printing, Quarterly Stumpage Update by the Council of Forest Industries (2008). One can see from this graph that revenue from stumpage fees increased dramatically during the early 1990s, reached a plateau in the mid-late 1990s, drastically decreased in 1998-1999 and has been following a fluctuating pattern with a general decreasing trend ever since. In 2006-2007 the provincial received slightly more than one billion dollars in forestry revenue from stumpage fees alone.

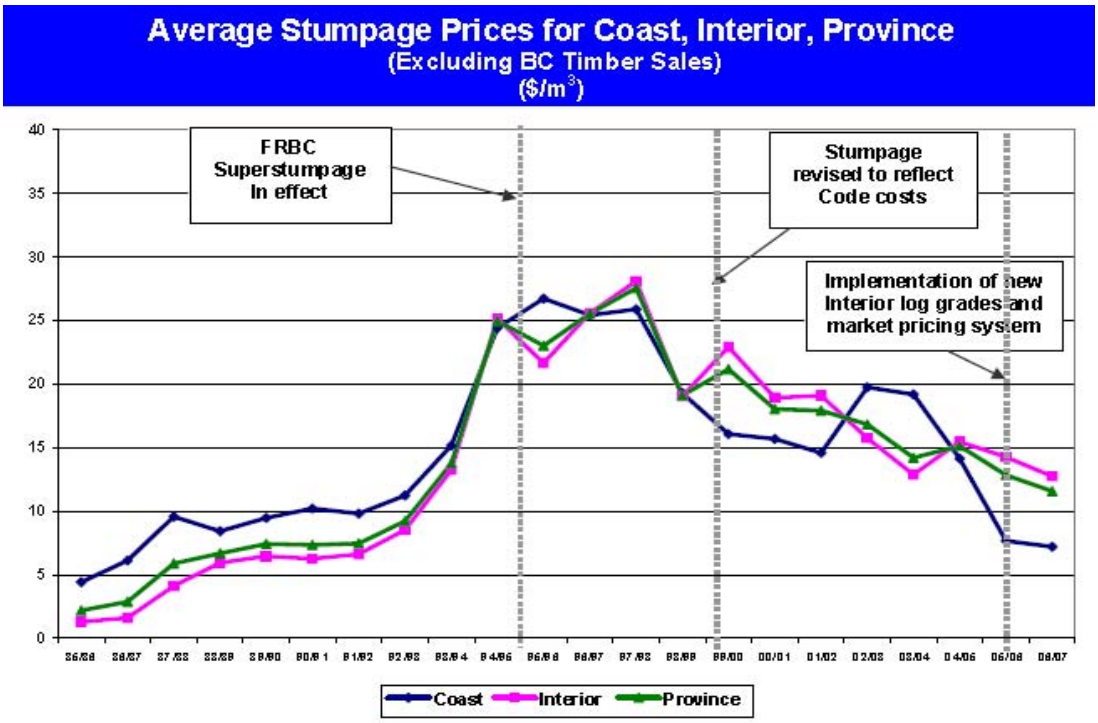


Figure 28.
Stumpage prices as a function of year by region **(**Council of Forest Industries 2008).

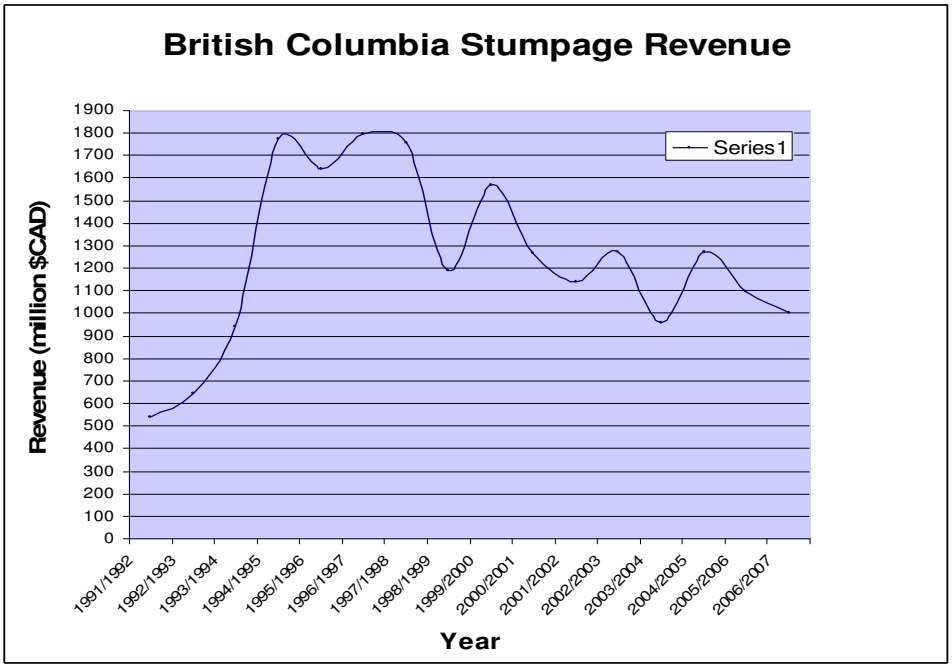


Figure 29.
Annual revenue received by the British Columbia provincial government from forestry stumpage fees. Data taken from the Council of Forest Industries' Quarterly Stumpage Update (Council of Forest Industries 2008).

4.3.3.4 Economic Benefits of Forests and Forestry to British Columbians

After analysing the *Land Act*, it is obvious that as a result of economic benefits to the provincial government from the forestry industry, forestry operations receive special treatment regarding use of Crown land. This is demonstrated by the following examples. All Crown land is inventoried within a registry. Entries into the registry are recorded by each governmental ministry regarding Crown land administered by the respective ministry. According to section 7(5)(c) of the *Land Act* however, land use rights granted for the purpose of harvesting timber are not required to be included in the registry. The best example of the government's special interest in the forestry industry is section 23 in the Land Act entitled "Timbered land", which stipulates that "[u]nless in the opinion of the minister, Crown land is required for agricultural settlement and development or other higher economic use, Crown land that is suitable for the production of timber and pulpwood must not be disposed of by Crown grant under this Act" (Government of British Columbia 1996). The government makes it very clear with section 23 that forested land is to remain under governmental control. The following section, section 24 entitled "Payment for timber", states "[a] disposition of Crown land under this Act may provide for payment to the government of the value of the timber or a royalty on the timber on that land" (Government of British Columbia 1996). This section makes it clear that the reason the government has a special interest in forested land is due to economic benefits received by the government as a result of its control over Crown land. Additional clauses supporting the previous notion of governmental special treatment for forestry operations include section 50(1)(a)(iv), which allows government to remove timber to construct, maintain or repair a road, ferry, bridge or other public work.

4.3.4 Land Use Interrelationships and Interactions within the Institutional Framework

In the case of helicopter skiing and forestry, however, there is generally one situation in which the two parties communicate or at least there is the opportunity for communication. That opportunity is the Forest Stewardship Plan (FSP). Every

forest licensee is required by law under the *Forest and Range Practices Act (FRPA)* to complete a FSP for all tenured areas. Although there is no law requiring the licensee to notify those with overlapping or adjacent land tenures, a notice must be put into a local newspaper notifying the public of the FSP and it must be available for review in the licensee's nearest place of business for at least 60 days.

Spill over effects of forest management practices affect tourism businesses in urban areas such as: hotels, restaurants and other attractions since tourists usually enter the province via airports or by driving through cities before and/or after visiting the mid- or back-country (COTA 2007). More significantly however, changes to the forested land base due do management practices directly affect tourism businesses such as helicopter skiing operators which operate in the mid- and back-country (COTA 2007). Regardless of the fact that they pay for and hold tenures for land they use, helicopter skiing operators have no legal right to manage the land for their purposes. The forested land is managed by forest licensees and the only opportunity that helicopter skiing operators have to influence the management decisions made by forest licensees is by participating as a regular member of the public in reviewing and commenting on FSPs. As a result, it is important for of helicopter skiing operators to ensure that the forests their businesses depend on will be managed in such a way so as to account for their interests in addition to the interests of the forestry industry.

"Tourists are less accepting than B.C. residents of significantly altered forest landscapes, especially those with clear-cuts" (British Columbia Ministry of Forests and Range 2006a). But it is not only the scenery of forests that is important for tourists, the most important service provided by forests is rather the actual wilderness experience they provide (COTA 2007). When tourists have an impression of being amongst an untouched wilderness and that impression is suddenly revealed to be false or not completely true it causes negative ramifications on their memories and overall experiences, which will then be shared with other potential tourists. A magnification effect occurs via this information

sharing process, causing significant losses to the tourism industry as a whole and a degraded reputation for the province.

4.4 Communication and Quality of Relationships between Helicopter Skiing Operators and Forestry Licensees

The only literature found that addressed communication between tourism operators and forest licensees and the quality of relationships between the two sides was developed by British Columbia's COTA. According to the discussion paper written by COTA (2007), there currently tends to be "relatively positive and proactive engagement" in relationships between the tourism and forestry industries. However, this has not always been the case. Approximately twenty years ago relations were much worse and actions were taken to heal the historically poor relationship between the forestry and tourism industries in the 1990s. In 1996 COTA, Council of Forest Industries (COFI) and the Forest Alliance of British Columbia signed a Memorandum of Understanding (MOU). As described by COTA (2007) the purpose of the MOU was "to help foster ongoing dialogue and proactive relations between the two industries". COTA also engaged in an effort to improve relationships with companies and individuals who own private forested land. That effort was an agreement between COTA and the Private Forest Landowners Association (PFLA), which included a mechanism for resolving disputes that occur between the two actors (COTA 2007). These actions "help encourage a results-oriented and respectful exchange of dialogue" (COTA 2007). They are not, however, replacements for legally binding legislation mandating identification and management of the two industries respective interests (COTA 2007). Some believe that the relationship between the two industries is again on rocky ground and that changes in attitude and staffing are needed to ensure ongoing cooperation (Undisclosed source 2007).

Many tourism operators are not satisfied with communication and notification from forest licensees. Dissatisfaction is mainly because they do not receive information that is necessary for them to understand what is being planned by forest licensees, to determine how it will affect their operations and to relay any concerns and/or suggestions they may have to the licensees with respect to how they might change their approach to better meet the needs of the tourism operator (Undisclosed

source 2007). Forest licensees who have had previous conflicts with tourism operators, “often do the bare minimum required to satisfy their regulatory requirements”. Consequently, the standards and competitive bar are lowered for other forest licensees, who must ensure their forest planning and harvesting costs are not greater than their competitors’ in order to remain in the business (COTA 2007). Despite the many problems and conflicting interests between the two industries, reports of instances in which tourism operators have had continuing, productive relationships with local forest licensees and local District Manager’s offices do exist.

4.4.1 Problems, Conflicts and Policy Gaps within the Institutional Framework

There are many reasons to explain the instances in which relationships between the forestry industry and helicopter skiing operators are currently and have previously turned sour. Many issues and problems stem from ineffective policy instruments. Some main policy categories and gaps therein are described below.

4.4.1.1 Problems, Conflicts and Policy Gaps Related to the Guided Adventure Tourism Policy (GATP)

One problem with the current *GATP* is that completed tenure management plans are sometimes, but are not always, subjected to review by interested stakeholders and other parties holding tenures for the given area before final approval of an application and issuance of tenure. The plans must only go through the review stage unless the ILMB decides it is necessary, which means that forest licensees are not necessarily notified of the activities planned by helicopter skiing operators. The GATP already covers some issues that could help to foster more efficient use and management of forested Crown land and better relationships between helicopter skiing operators and forest licensees. Something that is not included in the current policy however is a stipulation requiring tenure holders to interact with forest licensees by informing each other of how each respective operation will or could make mutually beneficial management decisions related to the Crown land

that is used by both parties. This is an ideal pathway for the two actors to be legally required to exchange information regarding land use that is carried out by each respective actor. Conflicts and issues could potentially be highlighted in such an information exchange and could be subsequently dealt with by the two parties.

4.4.1.2 Problems, Conflicts and Policy Gaps Related to the Objectives of Forest Stewardship Plans (FSPs)

Thorough analysis of the regulations regarding the Forest Stewardship Plans (FSPs) that are required under *FRPA* brings to light some weak points in the legislation that result in practices failing to actually achieve the specified objectives of the plans. As brought to light by the Forest Practices Board (2006), although the *FRPA* requires FSPs to include results and strategies for the planned harvesting operations, there is no requirement stating that both results and strategies must be realized. Either the results of the plan must be achieved or the strategies must be carried out, but not both. Additionally, the result or strategy does not even need to be effective in achieving the related objective in order to meet the requirements. The result or strategy must only be "consistent with the objectives", but does not actually need to contribute to achieving one of the government's objectives. Exactly what is meant by being consistent with the objectives is left to the imagination of the individual reader. "Therefore, an FSP could contain only verifiable, un-measurable strategies and no expected results or outcomes at all, and it would meet the requirements of FRPA". (Forest Practices Board 2006)

To the disadvantage of helicopter skiing operators and to the benefit of forest licensees, "[i]f a land use objective conflicts with an objective set out in the regulation [FRPA], the land use objective prevails" (Forest Practices Board 2006). Moreover, land use objectives may not be carried out in practice since "the land use objectives may not even be legally binding, if the SRMP objectives are not signed into law" (COTA 2007). The Minister of Agriculture and Lands has the authority under the Land Act to legalize the objectives of FSPs (Wilderness Tourism Association 2007). Unless that is done there is no legal obligation for

licensees to meet the objectives. The objectives of FRPA make it clear that production of a maximum amount of timber for harvest is the first and foremost priority. One factor in maintaining maximum forest production is restocking to at least the minimum required density of trees after harvest. In its' 2007/08-2009/10 Service Plan, the Ministry of Forests and Range (2007) stated that forest licensees are meeting their legal obligations to reforest after harvest. This is advantageous to forest licensees who benefit from maximum timber production, but is disadvantageous to helicopter skiing operators whose businesses depend upon forests which contain less than the maximum amount of timber

4.4.1.3 Problems, Conflicts and Policy Gaps Related to Participation in Land Use Planning

One vague link between helicopter skiing operators and forest licensees related to planning is the Adventure Tourism Branch of the ILMB, one responsibility of which is to "participat[e] in strategic land use planning initiatives to ensure tourism and recreational values are given appropriate consideration" and to "ensur[e] the interests of adventure tourism tenure holders are considered in relation to other Crown land tenure decisions" (British Columbia Ministry of Tourism, Sport and the Arts 2008b). However it is not known exactly how and to what extent this responsibility is carried out.

There is a lack of specific policy instruments contained within the current framework to specifically link helicopter skiing operators with forest licensees in the planning phase of forest management, concerns regarding land use planning as it relates to helicopter skiing and forestry operations are mainly focused on the issue of public participation throughout the development of different planning procedures. Despite many provincial policy advancements in the way of providing public and stakeholder participation in large scale planning processes (LRMP and SRMP), many problems and policy gaps exist in the framework; particularly in relation to planning of local and site specific forest management activities (FSP and site plan).

One of the most frequent types of complaints the FPB receives from the general public are those referring to a lack of participatory opportunities (DesRoches 2007). In addition to the general public's dissatisfaction, tourism operators are particularly not satisfied with the communication and notification they receive from forest licensees, because they generally do not receive information that is necessary to them (Undisclosed source 2007). Issues that often cause conflict, or at least lack of cooperation, between helicopter skiing operators and forest licensees were stated by COTA (2007) to include:

- the location of cut-blocks to minimize impacts on skiable terrain (both above and in areas used for skiing) and viewscapes
- viewscape management, legally binding or not
- timing of harvesting activities
- development and deactivation of forest roads

Conflict on those and other issues could be avoided by the two sides working together on management strategies. If cooperative management is to occur under the current policy situation, individual helicopter skiing operators and forest licensees must take it upon themselves to initiate working with each other, something that forest licensees are not especially interest in since the current policy framework is to their benefit.

The current land use planning policies that are in place do offer possibilities for public participation, but it must be considered that it is not solely the number of opportunities that matters, but rather the quality of participatory opportunities is a fundamental concern (DesRoches 2007). According to COTA (2007), "land use plans…are critical tools for identifying and managing land-based values and interests". However, the current institutional framework fails to bring about cooperation in land use planning to produce management strategies that are mutually beneficial to all parties holding tenures for a given piece of Crown land. From the tourism operators' viewpoint cooperation is "the pro-active engagement of two parties balancing out the interests of each and arriving at a mutually satisfactory agreement" (COTA 2007). Both the quality of involvement and quantity of opportunities for helicopter skiing operators to participate in

management of their tenured Crown lands appear to be areas for which current policy instruments are ineffective and lacking specific mechanisms. An effective consultation process, according to COTA (2007), is one that includes the following key attributes:

- full and fair consideration of the affected party's position
- reporting back to the regulatory body on comments received and measures to be taken to address the affected party's concerns
- inform those consulted about how their input/concerns were incorporated and if concerns were not addressed, reasons why.

When the previously mentioned criteria for consultation are considered in comparison to the requirements under the *FRPA*, it is clear that *FRPA* requirements are inadequate (COTA 2007). Some specific inadequacies with respect to different land use plans are described below.

Land and Resource Management Plans (LRMPs)

Participatory mechanisms that are currently included in LRMPs work well. There do not appear to be any policy problems or gaps with regard to this level of planning. In fact, LRMPs could be used as a benchmark for including stakeholder interests in the other types of plans. "In the context of managing tourism and forestry interests, land use plans [namely LRMPs and SRMPs] that identify tourism values can be utilized by forest professionals when drafting FSPs, providing tourism businesses with the tenure certainty and security they require" (COTA 2007) for such necessities as mortgage financing.

Sustainable Resource Management Plans (SRMPs)

SRMPs were mainly created to resolve land use conflicts between users. Some were specifically developed to manage land access and use between different recreations user groups" while some are "comprehensive" and cover several different issues such as First Nations rights or old growth forest protection (COTA 2007). The tourism industry believes that "the existing land use plans do not adequately identify and manage tourism values" (COTA 2007). This notion is backed up by COTA's (2007) statement that "[o]nly thirty-two of the one hundred

and ninety-five SRMPS [Sustainable Resource Management Plans] in the province are defined as either 'comprehensive,' 'recreation,' or 'commercial recreation' plans, which means that tourism interests are excluded, in whole or in part, in roughly eighty-four percent of the plans". These figures are disappointing because since the SRMPs provide more detail than LRMPs COTA (2007) stated they are the ideal tool to be used to identify and manage tourism values and interests within forested terrain. Aside from some of the objectives in regional land use plans, SRMP is the only type of planning that at least in some cases adequately addresses tourism operators' concerns and interests.

Forest Stewardship Plans (FSPs)

Forest planning falls under the umbrella of land use planning for the province as a whole. Therefore decisions made at the general land use planning level for the province and for a given region influence decisions made by forest licensees when FSPs and site plans are created. The many gaps, which are in the umbrella system, leave "much of the province without binding legal objectives for the management of tourism values" (COTA 2007). FSPs are a type of plan that is required to be completed by forest licensees regarding the area of Crown land for which they hold harvesting rights. Upon completion the plans are to be publicly available for review and comment by any interested parties. However, FSP policy does not include a provision for affected stakeholders, let alone the general public, to be involved in the actual creation of FSPs. While a clause in the policy states that forest licensees should consult parties who also hold tenures for the given area, the clause is very unclear as to how it should be carried out in reality (Wilderness Tourism Association 2007). As a result forest licensees tend to take it to mean what is most convenient to them, which is likely to invest the least amount of effort possible into consultation.

"It is estimated that approximately twenty-five to thirty-three percent of all public complaints received at the [Forest Practices] board relate to the inadequacy of opportunities to participate in FSPs" (DesRoches 2007). While opportunity to

review and comment on completed plans before they are approved does exist, according to the Forest Practices Board, “the public generally needs an opportunity to access plans and provide input at several levels, from strategic through to operational, depending on their specific interests and how they are affected by forest operations” (Forest Practices Board 2006).

Not only do FSPs provide comparatively little opportunity for stakeholder or public involvement, but the nature of FSP policy results in barriers that effectively prevent many interested parties from effectively reviewing the plans and hence inhibiting those individual from making useful comments. As stated by the Forest Practices Board (2006), “effective and meaningful comment requires that the public obtain sufficient information to understand what is proposed in the way of stewardship of forest values”. Common issues that prevent public and stakeholder involvement in reviewing FSPs are a lack of detail, often a result of the plans having a large scale and use of technical terminology that is incomprehensible to the general public.

Although sufficient information may be provided within an FSP it is of little use if that information is incomprehensible to an individual. The forest licensees who create FSPs tend to use technical and legal terminology that is understood by forestry and/or policy professionals, but can be extremely difficult for the general public or tourism operators to make sense of. When the Forest Practices Board reviewed some of the first FSPs completed after FRPA was introduced it “found that the plans are written in a legal and intricate manner that makes them difficult for the average person to understand and, therefore, particularly unsuitable for public review and comment” (Forest Practices Board 2006). Terminology used in FSPs was also expressed to be a problem by Tourism operators (Wilderness Tourism Association 2007).

Furthermore, details of exactly where the roads and cutblocks are planned within the forest development units do not appear on FSPs because such details are not required and because the plans are completed on a scale that is too large to

capture such details. As described by the Forest Practices Board (2006), "FRPA does not require a great deal of content for FSPs". FSPs are not required to show the locations of roads or cut blocks, just the locations of areas called "forest development units", which are the outer boundaries of areas that encompass all the roads and cutblocks that are planned over the five year term covered by the plan (Forest Practices Board 2006). In addition to the requirements for FSPs, the scale on which FSPs are created has a great influence on the level of detail contained within each plan. Since there is not a predefined scale for the maps and the details described in plans, the party/parties that create each plan determine how detailed or vague it is. The Forest Practices Board reviewed fifteen FSPs in 2006 as part of an investigation into the effectiveness of how FRPA was working in its initial stages of implementation. Of the fifteen FSPs reviewed, forest development areas varied in size from five thousand hectares (an area of approximately seven by seven kilometres) to one million hectares (an area of one hundred by one hundred kilometres), with the average being three hundred thousand hectares (an area of approximately fifty-five by fifty-five kilometres) (Forest Practices Board 2006). One can imagine that it would be difficult to provide detailed planning information within forest development areas of such a large size. Due to the prevalence of vague plans it is no wonder why some helicopter skiing operators do not know what management activities are planned to occur in their tenured areas.

Since direct participation in the creation of FSPs is not an opportunity under the current policy and as a result of the above mentioned barriers to effective review and consultation, it is "up to individual members of the public to make extra efforts to ensure that their interests are addressed and accommodated" (Forest Practices Board 2006). Even though helicopter skiing operators hold and pay for land use rights, they do not hold any management rights for that land. Helicopter skiing operators are not treated any differently than the general public, which has little opportunity to influence management decisions. "[T]he special consultation provisions of the FPPR Section 21(1)c [the FSP section] are often not interpreted

and implemented as requiring direct consultations, much less strategic considerations to manage for the assets of the affected operator. This is one of the most pressing concerns of nature-based tourism operators, as the insecurity and unpredictability of land tenures continues to be a major impediment to attracting investment and capitalizing on investments in the sector" (COTA 2007). In addition to the tourism industry's concerns, the Forest Practices Board described further problems with FSP policy:

- "FSPs provide very little detail about how, when and where logging will take place on Crown land. The plans cover huge land areas with not details of exactly where logging is proposed.
- FSPs are written in complex legal language that makes it very difficult for the public to understand and comment on.
- Most FSPs do not make commitments to measurable results or outcomes.
- Except for default practices required by legislation, the commitments in FSPs tend to be vague and non-measurable, which will be challenging for government staff to enforce." (FPB 2006b in COTA 2007)

Site Plans

Site plans allow even less opportunity than with FSPs for helicopter skiing operators to influence management decisions made by forest licensees. While FSPs must be made available for the public to review and the opportunity exists for the public and stakeholders to have their comments heard and addressed prior to approval, site plans must only be made available for viewing with no further provisions. It is not mandated that the forest licensee consult the public or tourism operators with land tenures affected during the development and approval of site plans (COTA 2007). COTA recognizes that the lack of public and stakeholder inclusion in site plans puts more emphasis on the importance of plans higher in the hierarchy. "Site plans must be publicly available under FRPA… but there is no opportunity for public or stakeholder comment on site plans. For this reason, it is critical that tourism values and interests are identified and considered prior to development of site plans" (COTA 2007).

4.4.1.4 Problems, Conflicts and Policy Gaps Related to Scenic Area Identification and Protection

As previously mentioned, the appearance of forested landscapes is a valuable resource for helicopter skiing operators as well as other tourism related businesses. This is an issue that has only been found to be addressed by COTA, which brought to light the following points in its 2007 report. It is important to COTA for there to be "adequate coverage of officially designated scenic areas throughout the province". COTA also believes that such designations should not be made by the government alone, but that stakeholders having interests in the tourism industry should be involved in the process. Furthermore, COTA is interested in ensuring that viewscapes are managed in a manner suitable to tourism operators by maintaining visual quality objectives (VQOs). However in the past the problem has not been so much with the management, but rather with a lack of scenic area designations, especially of areas that affect tourism properties and tenure areas. Once designated as a scenic area or viewscape, COTA states that areas are managed with "one of the most sophisticated VQO development mechanisms in the world". (COTA 2007)

4.4.1.5 Problems, Conflicts and Policy Gaps Related to Small Scale Tree Removal

The only literature that addressed possible problems or gaps in the institutional framework relating to small scale tree removal is COTA, the following points are therefore only from the perspective of that organization. According to COTA, the existing institutional framework is lacking an effective policy instrument that provides helicopter skiing operators the right to fell trees which inhibit their business activities or prevent otherwise possible activities from being carried out. This is another issue that was only found to be addressed by COTA. Operators often need or want to remove trees from their tenured area for the following reasons among others: to create or maintain heliports to facilitate safe drop-offs and pick-ups, to glade forest stands that are otherwise dense and contain dangerous underbrush, to protect facilities from unstable trees or to create and

maintain openings near lodges that provide a view of the surrounding landscape. COTA (2007) stated that an "outstanding issue that is raised repeatedly by tourism operators is the need for forest-based tourism operators to have the ability to remove a limited number of trees in order to facilitate the development of their businesses".

Even though the scale of such tree removal is much smaller than that of harvesting operations carried out by forest licensees to obtain merchantable timber, the policy procedures that must be followed to obtain felling rights are nearly the same as those for large-scale industrial harvesting. The procedures involve obtaining a license, planning and even performing environmental assessments. Some of the procedures are completely irrelevant when only a handful or two of trees are being discussed. Despite the irrelevancy of the current policy procedures, there are yet to be rules established for such small scale situations. Rather than becoming more efficient under the new forest laws it has been suggested that the process of obtaining a license to cut has become more difficult with FRPA (Undisclosed source 2007). Further inconsistencies regarding this issue exist in the fact that other industries have received special harvesting rights to allow their operations to be carried out, but this has not been extended to include the tourism industry (Undisclosed source 2007).

This policy gap has been recognized in some cases that have been put forward by tourism operators and those have been dealt with on an individual basis depending on the discretion of staff in the particular district office receiving the request. Other tourism operators have been advised to follow the policies as they apply to large scale forest harvesting for profit (COTA 2007). "Recreation operators have experience[d] some difficulties around accessing permits to carry out activities for business needs. Members have reported inconsistencies from district to district" (Undisclosed source 2007).

4.4.2 An Example of Co-operation Regarding Crown Land Use

The SRMP process can and has been used to address conflicts between helicopter skiing and other uses of Crown land. An example of a situation in which SRMP was used for this purpose, is the Valemont/Blue River Winter Recreation SRMP Case Study as documented in the Forest Practices Board's special report number 23, "Access Management in British Columbia: Issues and Opportunities". The conflict in this case study was between helicopter skiing operators holding tenure rights for Crown land and members of the general public who use the same area of Crown for snowmobiling. Both sides of the conflict participated in creating an SRMP that designated specific areas for use by snowmobilers and for helicopter skiing. For the SRMP to be effective, however, enforcement by the Ministry of Environment is needed to ensure that designations of areas off limits to certain user groups are respected. The process of SRMP was beneficial in improving cooperation between snowmobilers and helicopter skiing operators. (Forest Practices Board 2005)

4.4.3 Literature Recommendations for Improving Interactions

4.4.3.1 Minimizing Environmental Impacts of Helicopter Skiing

The BCHSSOA proposed a tactic to be used by helicopter skiing operators to minimize leader damage to the tips of regenerating trees. The tactic is for helicopter skiing operators to establish sample plots to monitor the height of regenerating trees in comparison to snow depth in each of the regenerating stands are used as ski terrain (BCHSSOA 2003).

4.4.3.2 Land use planning: Consultation and review

Many recommendations have been made regarding the fact that the current policy instruments for land use and forest planning result in plans being created that do not address issues that are important to the public and stakeholders. An issue of major concern not only for helicopter skiing operators, but for the general public and other types of tourism operators as well, is the lack of inclusion of stakeholders in planning processes and therefore management strategies that do not

acknowledge their interests. A priority for many tourism industry representatives (as determined by COTA) is to "[e]nhanc[e] the capability of tourism businesses and forest licensees to identify and manage tourism interests in forest planning and practices, through the development of requirements and supports that promote fair and effective consultation and cooperation between representatives of the two industries, in addition to strategic land use planning materials that provide clear guidance to forest licensees" (COTA 2007). Heidt and Williams recommend that a clear and fair consultation policy be developed in conjunction with CR industry stakeholders that should include:

1. "Consultation with stakeholders before decisions are made;
2. Procedures for participation
3. Directives requiring information exchange;
4. Methods which ensure government and industry understanding of the potential effects on interests;
5. Listings of circumstances where mediation or dispute resolution is appropriate; and,
6. Commitment to an agreeable outcome."

Some recommendations COTA made regarding the consultation process for land use management:

- "That tourism property owners, tourism licensees and forest licensees have access to enhanced government assistance to support the identification and management of tourism values on the land, including adequate Tourism Land Planners to assist with planning, mapping, and facilitation of tourism-forestry dialogue and conflict resolution.
- That the Ministry of Forests and Range enhance the existing *Forest and Range Practices Act (FRPA)* Section 149 legal objectives to better identify and manage tourism values. The existing "recreation" objective could be amended for these purposes. Include in the appropriate regulations and guidance documents that where a tourism property owner or licensee's tenure areas are impacted, FSPs must include results and strategies that manage for these interests – including access management, viewscapes, recreation use areas, harvesting schedules, and others.
- That the Ministry of Forests and Range amend Section 20 of the Forest Planning and Practices Regulation to require automatic notification/referral of harvesting plans to tourism property owners and licensees within or adjacent to planned harvesting areas. A registry of tourism property owners and licensees should be maintained and updated by the Government of British Columbia, and referrals should be

> undertaken by the appropriate government agency or agencies (not forest licensees)." (COTA 2007).

To address lack of inclusion of specifically the tourism industry in land use planning COTA (2007) recommended "[t]hat the *Government of British Columbia* consider ways of enhancing the identification and management of tourism values through land use plans, particularly *Sustainable Resource Management Plans*, in order to provide forest licensees with clear guidelines for identifying tourism interests and managing tourism values". Guidance for how the government can make enhancements was also provided in COTA's (2007) discussion paper. After consulting representatives of the tourism industry, COTA identified the following priorities:

1. Establishing a framework that mandates and supports consultation and cooperation between forest licensees and tourism operators in the identification of tourism's forest-based interests, including but not limited to scenic areas, access road deactivation, harvesting schedules/times…
2. Better identifying and protecting tourism values in light of threats to forest health…
3. improving the identification and management of tourism scenic areas throughout the province

In addition to including interests of tourism operators in SRMPs, FSP policy should include a further mechanism to effectively include affected tourism operators with planning in FSPs. An undisclosed tourism stakeholder group (2007) stated in discussion with government representatives that "there needs to be a way to have the tourism value considered in FSPs, to ensure there is equity and fairness in balancing public interest values". It is also important to helicopter skiing operators that policy to be improved to include a stipulation requiring forest licensees to consult the public and tourism licensees with land tenures affected during the development and approval of site plans (COTA 2007). An undisclosed tourism stakeholder group stated in discussion with government representatives that "there needs to be a way to have the tourism value considered in FSPs, to ensure there is equity and fairness in balancing public interest values" (Undisclosed source 2007).

Lack of inclusion of helicopter skiing operators and other stakeholders in the process of forest planning is seen differently from the perspective of forest licensees. Hindrance to stakeholder participation caused by problems with the level of detail being provided in FSPs is not solely the fault of forest licensees. From the perspective of the forest licensees, it is impossible to create FSPs that address the concerns and interests of helicopter skiing operators unless the forest licensees are informed of those concerns and interests beforehand. It has been stated that sufficient information is not being provided by tourism operators for forest licensees to produce FSPs that thoroughly address their concerns and interests (Wilderness Tourism Association 2007). If further information is provided by tourism operators during the existing review and consultation phase, after the FSP has already been developed, it counteracts the purpose of the *FRPA* to be an efficient policy because in order for that new information to be incorporated into the plan, the whole plan could likely need to be re-worked. Therefore in order for FRPA and FSPs to be truly efficient, forest licensees must work together with tourism operators from the outset.

The consultation process alone is not sufficient; it must be followed by management actions that promote the identified interests of the tourism operator (COTA 2007). It is very important for tourism businesses such as heli-skiing to know that the actions of the forest licensees will not negatively affect their ability to carry out their operations. That security is only possible if the forest licensee consults the tourism operator to identify their interests and subsequently acts in a manner to ensure those interests are realized. An additional issue that was identified within COTA's (2007) report regards ensuring that agreements made as a result of consultation between tourism operators and forest licensees are really put into practice and that those practices are continued after sale or transferal of harvest licenses. Agreements made outside of policy requirements between helicopter skiing operators and forest licensees are not lasting measures since forest companies sometimes change their license areas, resulting in new licensees

with which a helicopter skiing operator must attempt to come to a new agreement with.

4.4.3.3 Tenure

The future security of commercial recreation businesses "is determined by the degree to which tenure holders trust the socio-political system in which their tenure rights have been granted" (Haley and Luckert 1990 in Heidt and Williams 2005). Helicopter skiing business security in particular would benefit from policy enhancements that provide equal "rights, respect and consideration as [received by] other Crown tenure users in [British Columbia]" (Heidt and Williams 2005), such as forest licensees. According to a survey conducted by Heidt and Williams (2005) "[o]nly four percent of respondents strongly or somewhat agreed that 'the government treated the various resource industries with equality in matters related to tenure arrangements'". Even though Heidt and Williams were referring to the previous legislation for commercial recreation contracts, which has since been amended and replaced with the current *GATP* as described in section 4.3.2.1 above, their recommendations are still relevant since the current *GATP* has many of the same underlying problems as the previous legislation.

All types of tenure that are granted to helicopter skiing operators include a provision that puts their rights to use the land behind those of forest companies who also hold tenure for the same piece of land. This is made clear in the *Land Act*. This policy causes problems for those who operate helicopter skiing businesses because it leaves a certain amount of uncertainty as to whether the tenure will actually be carried to term. If the government decides to revoke the operators tenure rights prior to the end of the term for which it was issued or changes the contract to the disadvantage of the operator, helicopter skiing operators could be left with no land, less land or unusable land with which to carry out their business activities. This could result in the operator being forced to offer a lower quality of product or even prevent the operator from continuing business all together. Regarding this issue Heidt and Williams (2005) recommended that "the

government's ability to make tenure decisions at their sole discretion must be removed from the tenure contracts". In any case, "[g]reater clarity and security is needed for helicopter skiing operators' property rights on public lands" (Heidt and Williams 2005). To alleviate barriers for tourism businesses, Heidt and Williams (2005) recommended that the clause in commercial recreation tenure contracts which places tourism operators' tenure rights secondary to any other grants or rights under the *Forest Act* should be amended to provide more secure tenure rights for tourism operators. Heidt and Williams (2005) additionally recommended that commercial recreation contracts should be amended to restrict the government to only be allowed to terminate a contract due to public interest after a successful consultation and accommodation process and that "[t]he Commercial Recreation Land use policy should make in-term changes to the contract contingent on agreement by both parties".

To compound the problem of uncertainty associated with commercial tourism tenure contracts, regulations state that the government is not required to offer any sort of compensation to the operator for reclaiming the land. Regarding this point, Heidt and Williams (2005) recommended "[t]he government's ability to terminate a contract due to public interest should be contingent on a successful consultation and accommodation process, and fair compensation". These two situations alone make the current institutional framework highly disadvantageous to helicopter skiing business, yet the policies result in more grave financial implications for operators. Terms of any type of tenure that is granted to helicopter skiing operators do not exceed 30 years. When businesses seek financial support for high cost expansion and/or investment projects undertaken to increase the quality and quantity of services provided, this time period is not always deemed sufficient by lending institutions. This factor combined with the previously mentioned uncertainty that is embedded in adventure tourism tenure contracts cause financial institutions to be quite reluctant or unwilling to offer lending services to helicopter skiing companies. When this situation is brought into the larger picture of business reality, as stated by Heidt and Williams (2005) "[w]ithout changes to existing tenure

arrangements [British Columbia's] CR industry may not be positioned to successfully compete in the highly competitive tourism market place". They suggested that "[a] more flexible and longer duration to tenure contracts will alleviate unfavourable security issues and improve possibilities for acquiring financial support from conventional lending institutions" (Heidt and Williams 2005).

4.4.3.4 Protection of Scenic Areas through Management

An important issue for helicopter skiing operators, as with many other types of tourism operators, is the visual quality of a natural landscape. COTA's (2007) report is the only literature source that has made many comments and recommendations regarding this issue, which are summarized below. After consulting representatives of the tourism industry, COTA (2007) identified "improving the identification and management of tourism scenic areas throughout the province" as a priority. It is important to COTA for there to be "adequate coverage of officially designated scenic areas throughout the province". The organization also believes that such designations should not be made by government alone, but that stakeholders related to tourism should be involved in the process. Furthermore, COTA is interested in ensuring appropriate management of scenic areas by maintaining visual quality objectives (VQOs). However, in the past the problem has not been so much with management of scenic areas, but rather with a lack of designations, especially of areas that affect tourism properties and tenure areas (COTA 2007). Once designated as a scenic area, or viewscape, COTA stated that areas are managed with "one of the most sophisticated VQO development mechanisms in the world". To address the apparent lack of areas officially designated as being scenic, COTA recommended "[t]hat the provincial government immediately dedicate the required financial and staffing resources to commence an update of scenic areas throughout the province. The agency responsible for supporting and promoting tourism development in the province – *the Ministry of Tourism, Sport and the Arts* – should have a lead role in identifying scenic areas throughout [British Columbia]".

While COTA made recommendations focused on the designation and protection of scenic areas, Heidt and Williams suggested a policy instrument to be used when scenic areas fail to be protected. They stated "the security of CR operations can be enhanced by providing compensation for the loss of extensive wilderness resources", such as scenic areas (Heidt and Williams 2005). Compensation could also be provided when forest licensees operations negatively affect tourism businesses. This could be accomplished by creating a clear policy "in conjunction with industry representatives, which includes compensation for takings associated with: material impacts on natural resources, intensive improvements, trail networks and smaller infrastructure improvements, business start-up costs, and the current value of future earnings" (Heidt and Williams 2005).

4.4.3.5 Small Scale Tree Removal

Since COTA's 2007 report was the only literature source found to address this issue, the following recommendations are all from the perspective of COTA. A specific policy should be created to address felling of small quantities of trees on Crown land by tourism operators. Such a policy would decrease the amount of energy, time and money that is spent by both helicopter skiing operators and government officials to acquire the rights to fell a small quantity of trees that interfere with helicopter skiing operations. COTA made the following suggestion regarding this issue, "[t]hat the provincial government extend special non-commercial rights to all forest-based tourism operators, similar to the rights already granted to all-season resorts under the *Resort Timber Administration Act*. If the harvesting area is within the bounds of a forest license (Tree Farm License, Forest License, woodlot, etc.), there should be an appropriate consultation requirement between the tourism operator and the forest licensee" (COTA 2007).

5 Results of Empirical Research

5.1 Relationships and Interactions Revealed by Questionnaire

Transcripts of notes taken during the telephone interview with Mr. Krawczyk can be found in appendix C. The response rate obtained from the questionnaire was less than optimal, however the respondents represented a small cross-section of the helicopter skiing industry and responses revealed some relationships and interactions between helicopter skiing and forests that were not found in the literature. The questionnaire was completed by eight different individuals from helicopter skiing companies across British Columbia. Tables comparing responses from all respondents for each question posed in the questionnaire can be found in appendix D. Analysis of responses provided in the interviews and questionnaires provided the following results.

Up to seventy per cent of helicopter skiing is carried out within forested terrain. The proportion of skiing time spent in forested terrain is dependent upon weather conditions at the time of departure and the geographical location within the province of the respective business. Forested terrain is more frequently used for helicopter skiing in the interior of the province, where it accounts for fifty to seventy percent of skiing time; forested terrain is used less frequently in the coastal region, where it is used during twenty to fifty percent of the time. In the interior, skiers often start at or below and finish within the treeline. Skiers are also frequently dropped above the treeline in the interior region, but they nearly always pass through a forest during their decent. In all parts of the province forested areas are used most frequently during times of poor visibility when helicopters can use forests as a point of reference when they at low elevations below the clouds to drop skiers below the timberline, but cannot fly high enough to reach the alpine zone.

Forests used in the interior mainly consist of the Englemann Spruce – Subalpine Fir and Interior Cedar – Hemlock biogeoclimatic zones. Forests used in the

coastal region consist of Coastal Hemlock and Mountain Hemlock biogeoclimatic zones. The Alpine Tundra zone is used more frequently in the coastal region than in the interior. This is because the treeline is lower in the coastal region than in the interior. Many mountain tops in the interior do not reach above the treeline, something that is more uncommon in the coastal region.

The age structure and density of forest stands that are used for helicopter skiing varies greatly, with few clear trends. Ages range from newly planted regenerating stands in recent clear-cut blocks to old growth more than six hundred years old. Perhaps one trend that can be extracted from the results is that forests grown for commercial purposes are not generally used. Exceptions to that trend in the first ten to fifteen years when the trees are small enough to be covered by snow or are small enough that their branch spread allows ample space for skiers to pass through and when the forests are quite mature with large boles and branches that are well above head height of skiers. Old growth and sparse subalpine stands seem to be more usable for helicopter skiing than stands managed for timber production.

Most of the forests used by helicopter skiing operators are managed by forest companies for profit, while some are managed be community forests. Some operators did not know who conducts management in the forests they use. Some operators claimed it was the British Columbia Ministry of Forests that managed the forests – which is interesting because they used an out of date title for the ministry; therefore is has been concluded that those individuals did not know who managed the forests either.

Silviculture practices that are undertaken in forests used by helicopter skiing operators mostly consist of clear-cut harvesting. Selective cutting is used in some areas, but is not a common practice. Some operators prefer to use terrain where vertically aligned clear cuts have occurred. Most clear-cut harvest blocks are horizontally oriented on slopes. This is not ideal for helicopter skiing because

horizontally oriented blocks offer a shorter length of ski run and at the end of the clear-cut the forest below is often too dense to ski through. Clear-cuts which are vertically oriented offer ski runs of greater length and may be long enough that skiers may be picked up at the bottom of the clear-cut, making dense forests below less of a barrier. Areas managed for clear-cut harvesting can be used from the time of harvest until approximately ten to fifteen years after replanting, as described above. Selective harvesting offers beneficial terrain for helicopter skiing since it decreases the density of stands and allows skiers to pass through forests that would be too dense before selective cutting took place. Stands in which selective harvesting occurs can potentially be used for longer periods of time than those managed for clear-cutting.

Some of the respondents stated that they have contacted forest licensees and discussed working with the forestry industry on a rotation plan that suits both interests. One operator stated the following regarding the outcome of attempted projects “we have tried the “skiing through forest rotation” concept but it’s not very realistic. Most often landscapes are already fragmented far beyond what is workable. As well, even in an untouched drainage, the differences in needs between harvesting and skiing are very dissimilar. Removal of first pass volumes can often fulfill the concept but second or third pass most often fail to hit the mark.” Another operator stated that “[w]e maintain a relationship with the local forestry office and different logging permit holders. We try to be proactive in where cut blocks and roads are put in, so as to make them useful for skiing. This however, is really not accomplished as they pretty much put log where the trees are most dense and valuable. Communication and planning could be better between heli skiing and forestry.” Not all respondents have been so proactive, one respondent stated “I do not know what a rotation plan is- we are heli skiers not foresters.” More initiatives have been undertaken by interior based operators, because use of forested terrain is not as necessary for operators in the coastal region.

The type of tenure that is currently held by nearly all helicopter skiing operators is a license of occupation, which is issued for the specified purpose of mechanized skiing over a given area under the *GATP* by the *Ministry of Tourism, Sport and the Arts*. Issues with forestry companies' tenures overlapping with helicopter skiing operators' tenure areas are a problem for some, but not every, helicopter skiing company in British Columbia. Land use rights are a slight problem for many helicopter skiing operators, a severe problem for some operators and no problem at all for other operators. One operator stated that land use right are "the biggest problem we face in the industry." However that statement was not supported by the other respondents since none of the others stated it was a severe problem for them. Forest roads are a feature in managed forests that interact with many helicopter skiing companies. One respondent stated that forest roads pose a danger for helicopter skiers. Two respondents stated that forest roads are problematic for helicopter skiing because they provide access to snowmobilers whose tracks make the snow unusable for skiing. Three respondents stated that forest roads are beneficial because they provide access for ground vehicles to meet helicopters for pick-up and drop-offs, therefore decreasing flight time and expense.

Multi-use management of forests including commercial recreation benefits rather than solely for the production of timber may be making baby-steps in a positive direction for helicopter skiing operators. When asked if anything has changed since they have been involved in the industry with regard to the way helicopter skiing and forestry interact, one respondent stated that "[w]hat has changed is years of interacting with forest harvesting licensee's has created a bit of awareness that the forest resource isn't just a fibre farm. They know we're out there and that we have some very real needs within the harvestable landscape as well. Commercial recreation is a big player in our provincial economy, however Ministry of Forests and forest harvesting licensees are mandated to manage the forest resource, largely for fibre, first and foremost. We have fairly good results at the local levels, dealing directly with licensees but are a long ways away from having

our issues addressed at a provincial level." Another respondent was less optimistic in stating "[t]here is no management and never has been." Other respondents either stated that interactions between helicopter skiing and forestry have remained the same since their involvement or did not respond to the question at all.

Regarding the type of terrain that is chosen for helicopter skiing, the following trends emerged. North facing slope aspects are preferred, especially in spring. This is because north slopes are the most shady and therefore less melting and refreezing occurs there. The quality of snow for skiing on north faces is said to be the best, lighter and fluffier than on slopes facing the other directions. South slopes present a high risk of wet snow avalanches in the springtime and poorer snow quality for skiing, heavy and hard, therefore this aspect is generally avoided. Slope steepness generally varies from fifteen to thirty-five degrees for most companies, with a maximum of forty-five degrees reported by one company.

Regarding open and exposed versus forested and protected terrain, "[o]pen slopes provide easier skiing for weaker skiers, however protected forested slopes generally have deeper powder and are world renowned for ski quality." Open stands of mature trees seems to be the preferred choice for helicopter skiing. Regarding the ideal species of trees within the stands there is some agreement that hemlock is least ideal; spruce is neither good nor bad; fir is slightly better than spruce; cedar, tamarack and larch are best. Hemlock has a "wide spreading canopy [that] captures lots of snow keeping it from reaching the ground and creating death cookies (tree bombs)." Spruce and balsam fir have "narrow crowns [that] shed snow and compress with snow loadings over the winter" and cedar also sheds snow well. While spruce, fir and cedar stands are functional as ski terrain, tamarack and larch allow a greater amount of snow to reach the forest floor because they shed their needles in the winter and also facilitate greater visibility for skiers. The ideal age of forest stands for skiing is mature old growth. This is because they have large enough crowns to have positive influences on the snow quality, but spacing is wide and branches are well over the heads of skiers allowing

clear visibility and easy manoeuvrability. One operator stated that avalanche tracks were ideal ski terrain and indicated that they use areas for their operations (unfortunately the operator seemed to be serious with this statement) .

Silvicultural practices have several influences on helicopter skiing. Some respondents stated that the size of stumps left after harvest does not affect skiing, while others stated that high stumps present collision danger and one respondent stated that high stumps create uneven snow conditions that prevent skiing. Most respondents stated that the size of cutblocks is not important, while one respondent gave a detailed explanation of how cutblock size is important. "Two different perspectives here. 1) Proposed harvesting overlaps ski terrain and 2) Proposed harvesting does not overlap ski terrain. In the case of 1) smaller is better, mostly to minimize the loss of what is already great ski terrain in the natural forest. And because the plantations will ultimately eliminate skiing opportunities. In case 2), if harvesting opens up terrain that has not been skied before then bigger would be better. In both cases there is somewhat of a minor issue with visuals. We would prefer to see blocks of a size that fit the landscape. Particularly if they are visible from a Lodge." The optimal density of a forest stand for helicopter skiing was stated to be between three hundred and fifty to four hundred and fifty stems per hectare or four to five metres apart.

When asked what type of forest harvesting presents the least risk of avalanches, operators seem to understand that avalanche risk increases with any type of tree removal, but that selective cutting is better than clear-cutting. Hard clumps of snow falling from tree canopies onto skiers are not a great danger to skiers. Collision with tree stumps is a moderate to low danger for skiers, as is becoming caught in partially buried tree branches.

While not specifically interactions between helicopter skiing and forestry, the following trends were found in the type of individuals that partake in helicopter skiing and therefore the type of individual skiers who interact with forests. There is

a clear trend in the demographics of helicopter skiing clientele. All respondents stated that the majority of their clients are male, seventy-five to greater than ninety-five percent. The few women who participate in helicopter skiing are generally travelling along with male partners. Typical Client nationality varies by company, but fits into two trends: 1) nearly half European and nearly half American with a small percentage of other nationalities; .2) approximately ninety percent European and ten percent other nationalities. The most common minority nationalities mentioned were Canadian and Japanese. Extent to client participation depends upon the specific services being offered by each operator. Helicopter skiing operators offer multi-day packages or single day experiences. Packages generally range from three to seven days. Clients participating in multi-day packages tend to prefer longer packages, five to seven days rather than three to four days.

Since many of the helicopter skiing operator respondents were not aware of who managed the forests they use as ski terrain, finding contact information for forestry licensees with overlapping tenures and therefore the ability to question those forestry licensees was extremely difficult. One forestry licensee with tenure area over lapping that overlaps with two different helicopter skiing companies was contacted. This is not, however, a representative sample by any means and can not be used to describe the general situation in the province.

5.2 Interactions Between Forests and Snow Packs Revealed by Snow Profiles

Surprisingly, there was not a significant amount of information to be found regarding the differences in stratigraphy and snow density between snow packs in forested and un-forested areas in the scientific literature, at least to the best of my knowledge. The field work conducted for the purpose of this thesis did not consist of enough repetitions to be considered a study of quality. However, the following results support expected results as determined from what literature is available and statements from interview and questionnaire respondents.

The following relationships were observed in all profiles:

- It was found that a greater amount of snow was present in the open test sites than in the forested test sites.
- All snow profiles exhibited at least slightly greater snow density in open areas than in forested areas.

The findings from one set of snow profiles, 1 in forested terrain and 1 in open terrain, are summarized here and diagrams follow in figures 30 and 31. For further reference, an additional set of snow profile diagrams can be found in appendix E.

As can be seen in the profile diagrams below, the amount of new snow that has been decomposed and fragmented is significantly less in the forested area than in the open area. Comparing the second layer in the forest to the second and third layers in the open, it is visible that the rounded crystal forms were formed by decomposition processes with greater speed in the open than in forested areas due to the greater influence of radiation. Furthermore, it can be seen in the fourth layer of the open profile that depth hoar was present, while this was not present at the forested site. This could be due to the fact that the temperature gradient is greater in the open than in the forest as a result of longwave radiation that is emitted by the snowpack and reflected by trees in the forest, but is lost to the atmosphere in the open areas. It is also visible that the snow pack is colder in the

open terrain than in the forest. Below the fourth layers of each of the two profiles, it can be seen that there are clustered crystals from snow that fell in the early part of the winter season which was melted and subsequently refrozen. This crystal form is found in both profiles and no significant influences from the forest occurred with respect to this factor. This interpretation of the snow profiles is only meant to show that there are differences in the layering of the snow pack between forested areas and open areas. This is not meant to be a quality or in depth study, but indicates an interesting topic for further investigations.

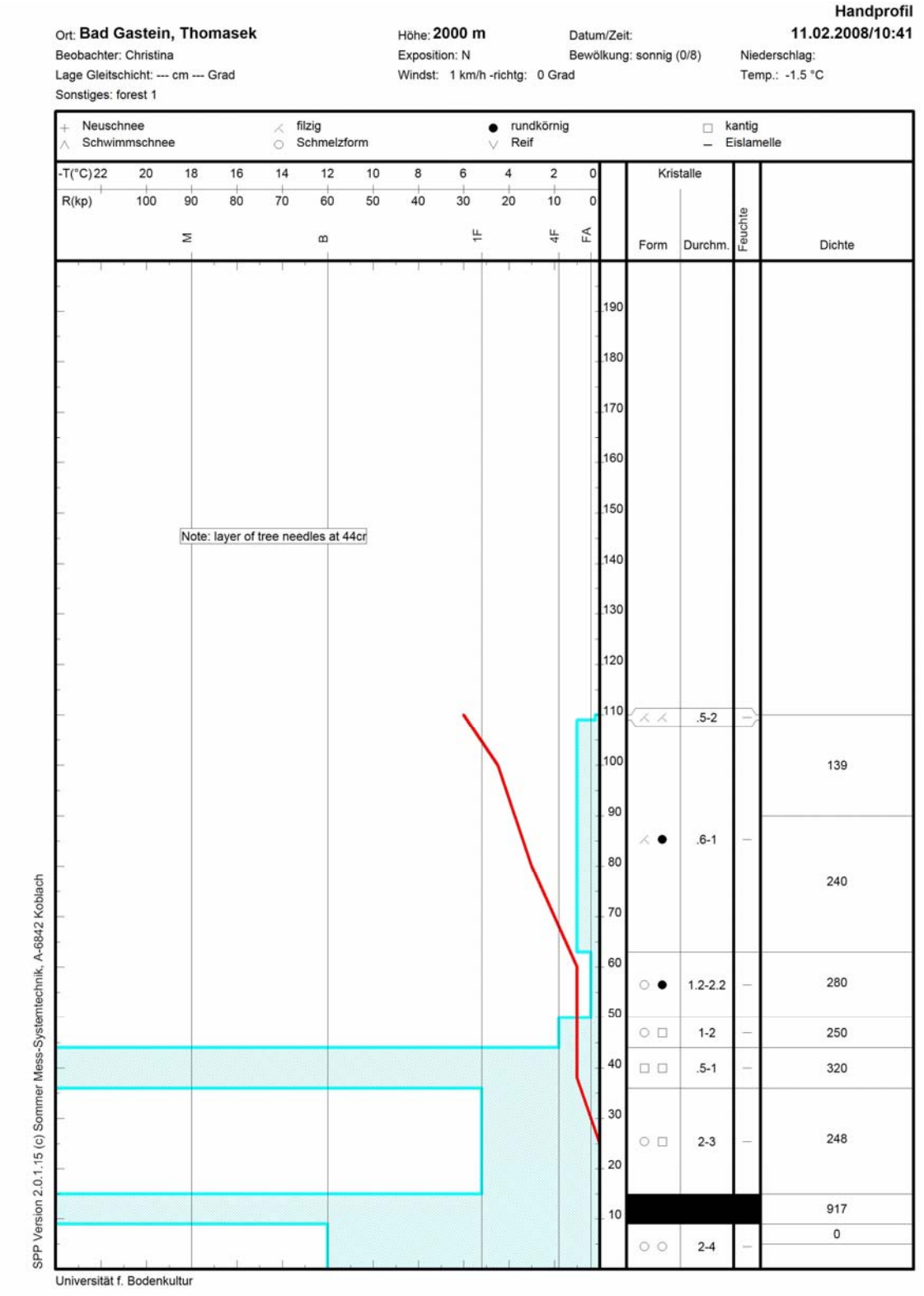


Figure 30. Snow profile diagram: forest 1.

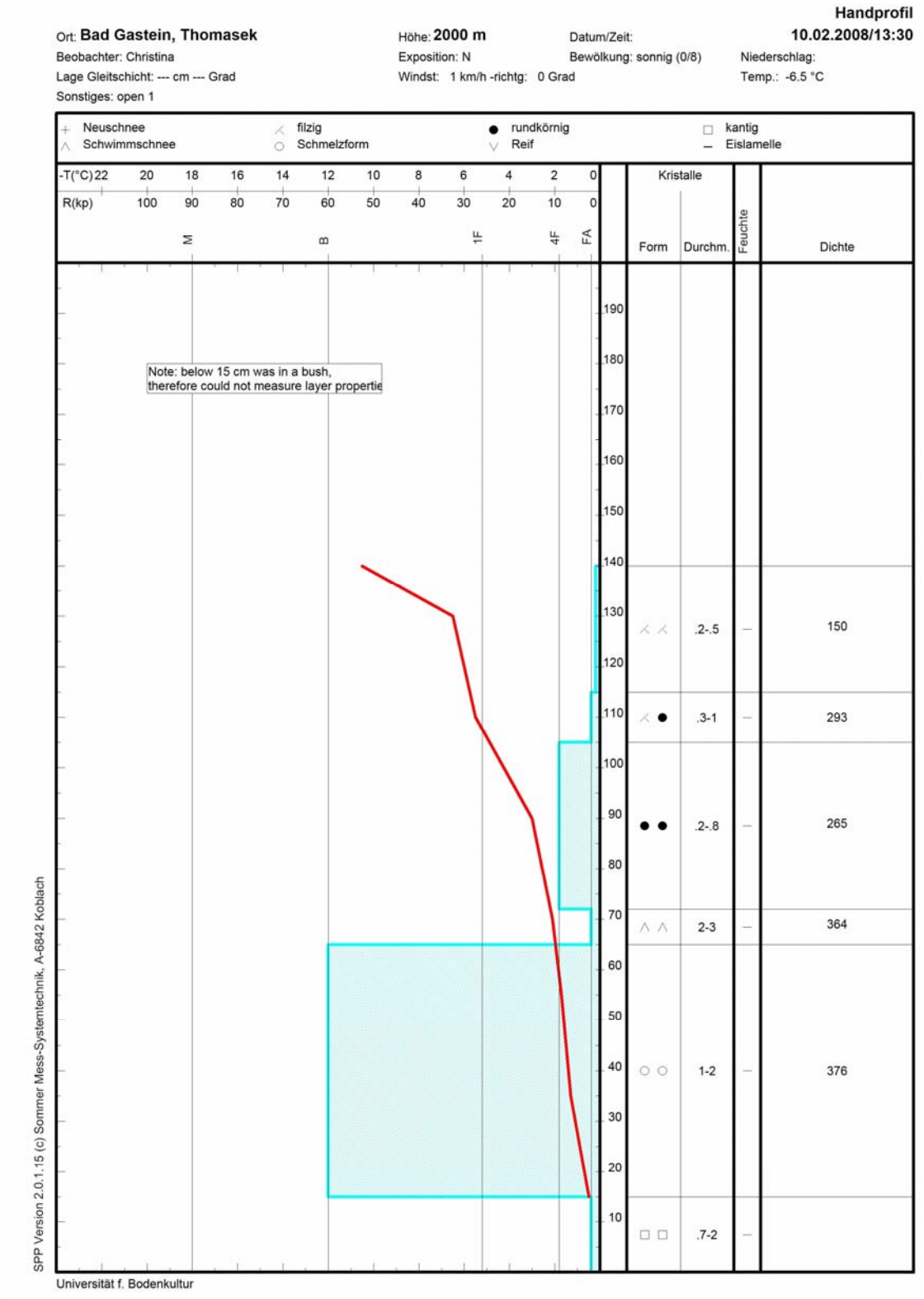


Figure 31. Snow profile diagram: open 1

6 Discussion

After completing a thorough search of the available published literature, the following conclusions have been made regarding natural science based studies of trees and snow. Peer-reviewed literature on study topics related to the influences of forests or trees on snow and avalanches were found to be biased toward hydrological investigations specifically looking at maximum runoff during spring melt (Davis et al. 1997, Faria et al. 2000, Gelfan et al. 2004, Hardy et al. 1997, Lundberg 1993, Lundberg et al. 1998, Marks et al. 2001, Marks et al. 2002, Montesi et al. 2004, Nakai et al. 1999, Pomeroy and Granger 1997, Pomeroy et al. 1998, Pomeroy et al. 2002, Suzuki et al. 2006, Talbot and Plamondon 2002, Tribbeck et al. 2004, Whitaker et al. 1998, Winkler and Moore 2006, Winkler et al. 2005). Furthermore, there appears to be a lack of research into topics such as the micro-scale influences of forests on snow interception and snow texture. The most comprehensive study into these topics that was found (Bunell et al. 1985) was completed twenty three years ago and the only investigation into snow texture that was found to be completed more recently was aimed at improving methods of modelling snow texture for the purpose of avalanche simulations (Pielmeier et al. 2001). A study topic that would help to close this gap in the available literature and would be beneficial to helicopter skiing operators who attempt to plan forest management with forest licensees is the effect of tree species on snow accumulation patterns. Another study topic that could be further investigated is the relationship between forests and snow texture. Several respondents of the questionnaire suggested that the quality of snow is better for skiing in forests than in open areas because it is more powder-like, lighter and fluffier. However no scientific literature was found to support this concept. A small field study was carried out to fulfill the requirements for this thesis project and to attempt to investigate this topic. Although the field study carried out as part of this thesis project was not a thorough investigation, it did provide some interesting results that further studies could investigate more thoroughly. Forests were observed to influence the layering of a snow pack. The snow pack observed in a forested area did not exhibit faceted crystals, or depth hoar, as was observed in an open area.

Since depth hoar is known to act as weak layers in the snow pack, this suggests that there is a potentially lower risk of avalanches initiating in forested areas than in open areas. In addition, it was found that the density of snow was greater in open areas than in forested areas, which supports the claim made by helicopter skiing operators, that the snow is lighter and fluffier in forested areas than it is in open areas.

Although very dense forest stands, greater than fifteen hundred stems per hectare, offer excellent protection against avalanche initiation, it is impossible to ski in such stands with little distance between trees. These two considerations must be balanced for the purpose of skiing in relatively avalanche safe terrain. The optimal situation would consist of a density of approximately seven hundred stems per hectare (Krawczyk 2007), with a mixture of coniferous and deciduous tree of different species, as well as a range of heights and ages within a given stand. Other than standing trees, logs left on the forest floor, tall stumps, shrubs and boulders can also help to stabilize the snow pack when present at sufficient densities.

While the following dangers to skiers passing through trees and forests were not found to be discussed in scientific literature, documentation from one helicopter skiing operator was found (Wiegele 2007). A danger to skiers passing through forests is the possibility of intercepted snow falling onto skiers or onto the snow pack from tree canopies. This was said to be an unlikely danger, although real. After melting and refreezing of snow in the canopy it can become very hard and fall in clumps rather than individual or clusters of crystals. Skiers could be injured by being struck by a hard clump falling or by falling as a result of skiing into large clumps lying on top of the snow pack. One helicopter skiing operator refers to this phenomenon as “tree mushrooms” and specifies this danger in the information provided with the waiver that must be signed by participants, figure 32 (Wiegele 2007). For the purpose of this thesis this phenomenon is referred to as ‘flying tree mushrooms’ to avoid confusion with the next danger to be described.

These next two dangers are specific to forests, or what were previously forests, that have been harvested by forestry operations. Tall stumps left after harvest can pose a collision danger to skiers. When the height of the snow pack is just below that of tree stumps the stumps can be partially covered and appear to look like a button mushroom. This phenomenon is referred to as 'standing tree mushrooms' for the purpose of this thesis. Skiers may perceive the rounded snow form to be merely an irregularity in the snow surface, but not realize that it is a stump. Collision with such a rigid object could cause severe injury to skiers. Forest roads present a danger to skiers as well. This is because the upslope and down-slope sides of roads, called berms, can be significantly steeper than the natural slope of the surrounding terrain. The sudden increase in slope angle that skiers encounter when crossing a road is immediately followed by the flat road surface and then the steep down-slope berm. The compression experienced by skiers can cause them to fall, which could be exacerbated by standing trees in the forest below. The same helicopter skiing operator also specifies this danger with their waiver form (Wiegele 2007). More obvious dangers to skiers that are related to trees and forests that are highlighted by the helicopter skiing operator include skiing directly into a tree, falling and hitting trees standing down-slope in a forest or falling on a fallen log (this last danger is suspected to be highly unlikely since fallen logs would likely be covered with snow).

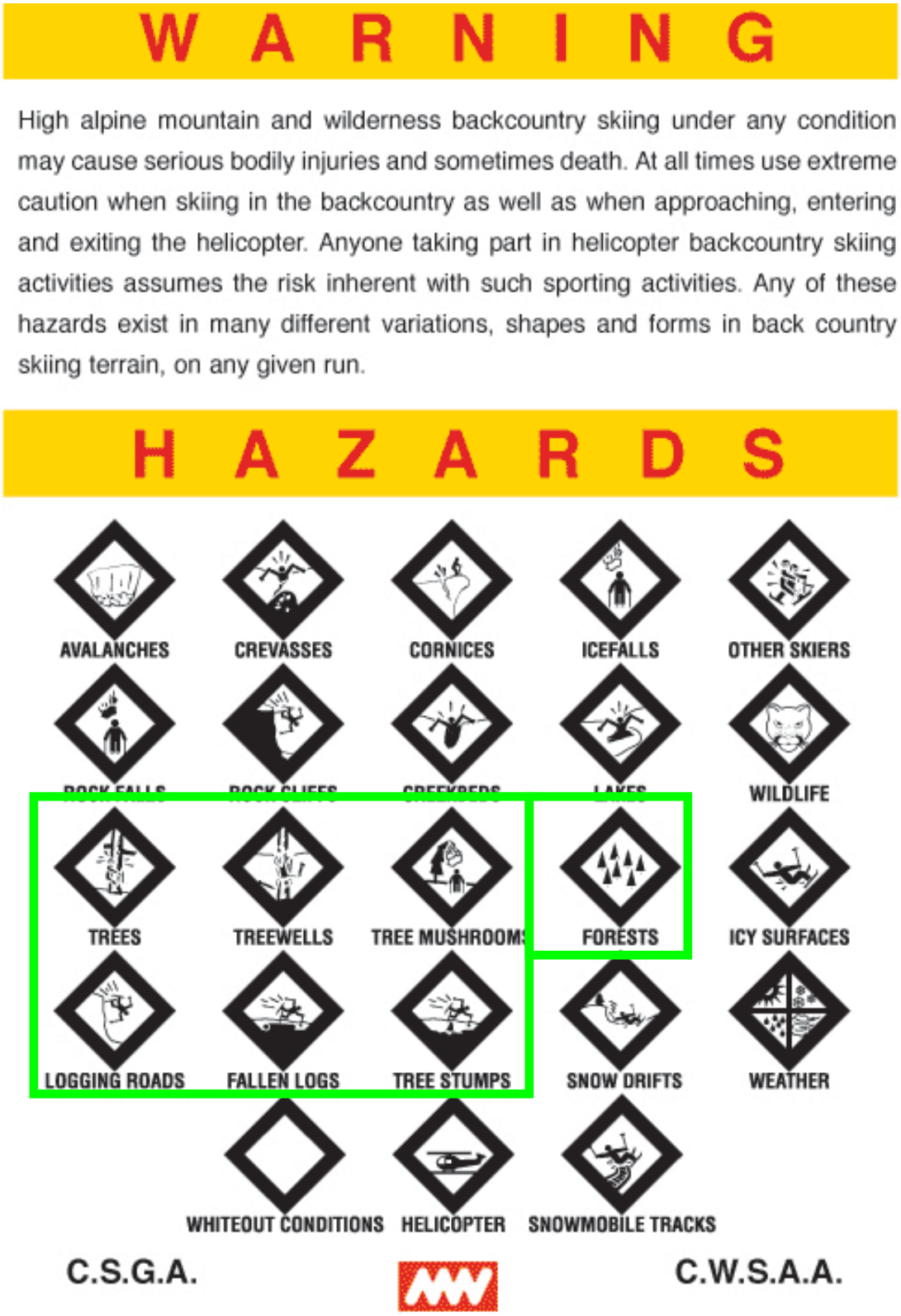


Figure 32.
Hazard information provided with waiver documents by one helicopter skiing operator. (Wiegele 2007)

An influence on relationships and interactions between helicopter skiing and forests that was not mentioned in any literature but was evident in the questionnaire responses is the way in which geographical location of individual businesses determines the extent of relationships and interactions. The degree to which helicopter skiing and forestry management practices are related and therefore interact mainly depends upon the geographical region and elevation zone of the businesses. From the results of the questionnaire conducted for the purpose of this paper it is evident that the two are more loosely related and therefore interact less on the west coast of the province than in the interior where the two are more strongly related and interact more. Helicopter skiing occurs more frequently within forested terrain in the interior of British Columbia, than on the west coast. This is explained by the fact that the timberline is lower and the average distance between mountain peak and treeline is greater in the coastal region than in the interior, therefore the relative proportion of mountain sides encompassed by the alpine biogeoclimatic zone is greater on the coast than in the interior. Since coastal helicopter skiing operators have access to abundant alpine terrain, they ski more frequently above the tree line in the alpine biogeoclimatic zone than in lower elevations below the tree line where forestry practices take place. This causes interactions with forests and forestry licensees to be minimal in comparison to the situation in the interior of the province. Although the risk of avalanche is greater in open terrain within the alpine biogeoclimatic zone, with sufficient risk control measures employed by the operator the alpine region is ideal terrain for helicopter skiing. Alpine regions provide a sense of endlessness to the ski run for clients. The high altitude region can be perceived as being inaccessible without helicopter transport and therefore makes the experience very satisfactory to clients. Consequently, helicopter skiing businesses located in the Coast Mountain range are less related to forests and forest licensees than their counterparts in the interior region.

In all regions of British Columbia, forested terrain is used during weather conditions that are severe at high altitudes, but acceptable at lower altitudes under the

treeline. Mountainous topography often causes wind to be stronger at mountain peaks than at mid-slope locations (McClung and Schaerer 2006). As a result, wind could prevent helicopter transport to high altitude locations, but is still possible lower down a slope. Cloud formations and precipitation are also significantly influenced by mountainous topography. Clouds form and precipitation occurs more frequently at higher altitudes (McClung and Schaerer 2006). Therefore poor visibility caused by cloud conditions and precipitation could potentially also restrict helicopter flight at high altitudes, but permit flight to mid-slope locations. Due to this geographical influence, relationships between helicopter skiing operators and forest licensees with overlapping tenures are less of an issue near the west coast of British Columbia and more of an issue in the interior region. Results gained from the questionnaire conducted for this thesis support this conclusion.

Literature on the topic of relationships and interactions between helicopter skiing and forests related to land use was found to be exceptionally biased toward the views of tourism operators and stakeholder groups. The existence of studies and reports by various tourism related stakeholder groups suggests that land use rights, especially with regard to overlapping tenures with forestry licensees, are a grave problem for many helicopter skiing operators and other types of commercial tourism businesses. It must be noted, however that the report created by COTA (2007), was found to be the only piece of literature available that addresses several issues, such as land use planning policies as they relate to stakeholder participation and scenic area designations. While other reports also stated that land use rights are a problem for some operators (BCHSSOA 2002, 2003; Forest Practices Board 2005; Heidt and Williams 2005; Wilderness Tourism Association 2007) and suggested proactive steps that tourism operators can take to alleviate land use problems (BCHSSOA 2002, 2003; Heidt and Williams 2005; Wilderness Tourism Association 2007), no other report went into as much detail on specific issues, reasons for problems or recommendations for alleviating land use problems as COTA did.

Many of the problems experienced by helicopter skiing operators regarding overlapping tenure areas with forest licensees could likely be improved by greater personal interaction between respective operators. Personal interaction between individual helicopter skiing operators and corresponding forest licensees is generally minimal. There are no laws in the institutional framework that stipulate holders of overlapping tenures on forested Crown land must engage in interactive, two way communication. Therefore it is possible for different business operations to take place on the same piece of land without any of the individuals or companies having any knowledge of the other's business activities.

The fact that no literature was found to have been produced by forest licensees or groups representing the forestry industry regarding their interactions, or lack thereof, with commercial recreation operators on Crown land suggests they do not have a problem with the current situation. To investigate the situation an additional questionnaire was created, however only one forest licensee holding overlapping tenure area with helicopter skiing operators was identified and completed the questionnaire, see responses in Appendix F. That attitude was reflected by the forestry licensee that was interviewed for this thesis as well. This is not surprising since forest licensees clearly sit in a position of greater power with regard to the provincial government and many aspects of the institutional framework place land use rights of forest licensees above those of commercial recreation operators.

The *Ministry of Forests and Range* has proven to attain its mandate to "protect, manage and conserve forest and range values for the economic and social benefit of all British Columbians" (Ministry of Forests and Range 2007), by producing a maximum amount of timber to obtain maximum economic returns. While this does result in a large sum of economic benefits for British Columbians and while this does result in social benefits via jobs; it is possible that other avenues could be taken to obtain the same amount of economic and social benefits. One such avenue could be to manage forests primarily for the purpose of commercial recreation. The Ministry of Forests and Range has not attempted and does not

appear to be willing to attempt to experiment with this method of forest management. The majority of clientele for helicopter skiing companies are highly wealthy individuals for whom money is likely not an object and management for helicopter skiing could benefit other sectors and citizens more so than forestry. If the provincial government were to provide a greater amount of land use rights to helicopter skiing operators and other commercial tourism operators, perhaps it is possible that those businesses could produce economic and social benefits equal to or greater than with the current land use rights that are biased to the forestry industry.

It would be extremely difficult to compare the difference in economic and social benefits from those two types of management on a single piece of land for many reasons, but mostly due to temporal differences in revenue cycling. Helicopter skiing operators and other commercial recreation operators work on a revenue cycle of one year; they receive relatively constant revenue on an annual basis. Forestry companies on the other hand obtain drastically different revenues on an annual basis because their revenue cycle is based on harvest rotation, usually sixty to one hundred years. Attempting to assess the differences in revenue would require averaging revenues from both industries over the time scale of one harvest rotation. That may seem simple in practice, but this calculation would be further complicated by the decision as to how long the harvest rotation should be determined to be. A further complicating factor is how to determine the extent of social benefits. Quantifying uneconomic benefits is a difficult and often arbitrary. This type of analysis is clearly beyond the scope of this thesis, but would be an interesting topic for future study. The point that is meant to be made here is that British Columbia's provincial government, and perhaps a large portion of British Columbian society, has made the decision that forests provide the greatest amount of economic and social benefits when managed in a manner that maximizes timber production for the forestry industry, whether or not other industries are hindered as a result. That decision however may not be benefiting society in the best possible way.

7 Conclusion

The objective of this thesis was to analyse the manners in which helicopter skiing and forests are related and how helicopter skiing and forests interact with respect to each other. To evaluate whether or not this objective was attained, the following responses are provided for the research questions that were set out:

1) What are the manners in which helicopter skiing and forests are related?

Helicopter skiing is mainly carried out within forested terrain. Skiers pass through stands of trees along their descent of mountains. Most forested terrain in British Columbia that is used for helicopter skiing is also used for timber production.

2) What are the reasons for the relatedness of helicopter skiing and forests?

Helicopter skiing is mainly related to forests via the forestry industry as a result of land use rights as defined in the institutional framework. Tenures for commercial recreation overlap with those for forest harvesting and timber production.

3) How does helicopter skiing interact with forests?

Helicopter skiing causes damages to forest ecosystems. Damages consist of reduced or ceased tree growth, alterations to forest structure caused by glading and creation of heliports and reduced and relocated wildlife populations.

4) How do forests interact with helicopter skiing?

Forests provide a reference point for helicopter pilots during poor weather, decreased avalanche risk, pleasing visual surroundings and possibly increased snow quality for skiers. Indirect relationships include forest roads created for forest management activities, which pose a danger to helicopter skiers and provide access to meet helicopters with ground vehicles at pick-up and drop-off locations.

The information gathered in this thesis, from a literature search, interviews, questionnaires and snow profiles supports the conclusion that Helicopter skiing in British Columbia, is intricately intertwined with forests and therefore the forestry industry via forestry licensees who manage the forests within which helicopter skiing takes place.

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Appendices

Appendix A. Canadian classification system for avalanche size (McClung and Schaerer 1981 in Canadian Avalanche Association 2002)

Size	Destructive potential (definition)	Typical mass (t)	Typical path length (m)	Typical impact pressure (kPa)
1	Relatively harmless to people.	<10	10	1
2	Could bury, injure or kill a person.	10^2	100	10
3	Could bury a car, destroy a small building*, or break a few trees.	10^3	1000	100
4	Could destroy a railway car, large truck, several buildings, or a forest with an area up to 4 ha.	10^4	2000	500
5	Largest snow avalanches known; could destroy a village or a forest of 40 ha.	10^5	3000	1000

* e.g. a wood frame house.

Appendix B. Summary of Guided Adventure Tourism Tenure Pricing. From the GATP document (British Columbia Ministry of Tourism, Sport and the Arts 2007a).

Tenure	Term	Valuation	Pricing
Lease	30 years	Appraised market value, BCA's actual land value, or fair market value as estimated by ILMB staff.	**Intensive use** Primary sites – 8 percent of land value or $500, whichever is greater. Secondary (satellite) sites – 5 percent of land value or $100 per site, whichever is greater. **Extensive use** – not available with a lease.
Licence of Occupation	30 years (initial) 30 years (replacement)	**Intensive use** appraised market value, BCA actual land value, or fair market value as estimated by ILMB staff. **Extensive use** • Revenue sharing	**Intensive use** Primary sites - 7.5 percent of land value or $500, whichever is greater. Secondary (satellite) sites - 4.5 percent of land value or $100 per site, whichever is greater. Temporary sites - $100 per site. **Extensive use** Non-motorized: $1 per client day. Motorized Experience (main experience is the operation of a motorized vehicle): $6 per client day. Mechanized experience*: $4 per client day. $500 minimum rent in all cases.** Plus temporary sites - $100 per site.
Investigative permit	2 years	Fixed amount	$250 for terms up to one year, or $500 prepaid for two years

* Motorized experience where motorized modes of transport are either used repeatedly or an integral part of the experience (e.g., heli-skiing, heli-hiking, boat tours).

** The minimum rent will be remitted at licence commencement. The actual per client day fees will be paid at the end of season when submitting annual activity reports as per Section 7.4.3

Appendix C. Notes taken during telephone interview.

Interviewee: Hank Krawczyk

Forest Resource Manager, Canadian Mountain Holidays

Question: How is helicopter skiing related to forests and how does helicopter skiing interact with forests?

Silvicultural aspects and their implications for ski terrain are hot topics for heli-ski operators.

BC land and forest management issues:

- overlapping tenures with forest licensees
- The ski industry needs the forests just as much as the forest industry, but the ski industry does not have any management rights.
- Since the tourism industry has no capacity to manage forests, they must coordinate their needs with the needs of the licensees and the forest laws.
- Licensees have a legal obligation to reforest within strict guidelines.
    - Those guidelines stipulate greater than 700 stems per hectare for a cut block to be "free growing". That density must be maintained for at least 15yrs.
        - But in order for a forest to be skiable the density cannot exceed 450 stems per hectare.

How could you solve this problem?

- CMH would like guidelines allowing replanting with less density (~400 stems/ha)
- Can't use terrain on a rotating basis with forest licensees because the "free grow" regulations prevent a waiting period before replanting.
- One thought CMH has is to diminish density at a young age.
    - (something about 1400-1600 stems/ha) if 800 stems/ha were planted, natural mortality would decrease density a bit, then CMH could do some thinning a few years later to get the ideal 400 stems/ha.
        - (my thought: but this causes a lot of money to be lost in the planting and thinning efforts, just to overcome a legality issue)
        - (side note: Hank has been doing this for ~18 years)

How does the BC government affect the situation?

- Tourism is not a mandate because forestry is the primary industry in the province.

- Local district governments are not receptive to the concept that there are social and economic values of skiing because they are not really realized at the district level.
- That argument would have more pull at the provincial level.

This is a “land use” issue rather than a “forestry” issue.

- **Why doesn’t CMH set up a subsidiary body that is a forest licensee and can have the harvesting rights in some terrain?**
    - **Are the laws restricting the use of government land for skiing purposes?**
    - The government does not want to give heli operators harvesting rights because they will incur a loss of annual allowable cut, therefore they will bring in less profit. This is due to the stumpage fee system.
        - perhaps that could be overcome with a long term lease and proving that tourism is more profitable in a long time frame.

How much more valuable would the harvested wood be if it were grown at a lower density?

No easy answer – yes increased growth, but more branches make lower quality.

Any other points?

The forestry industry is advantageous for heli operators because they gain access to terrain via forest roads and cut blocks can serve as heli-pads for drop-off and pick-up.

How often does CMH use forests for skiing?

70% of heli skiing is done in operable forested terrain

- Land use problems have become a much more pertinent issue in the past 15-20 years.
- Before that time it wasn’t as big of a problem because the harvesting mainly occurred lower down in the valleys, where the timber is more valuable because it grows faster and bigger and is easier to harvest.
- Now, harvest is occurring increasingly more in the drainage areas and valleys they operate in.
- They used to be picked-up at the bottom of a valley, where they would ski to heli-pads that were built in cut-blocks, providing the forests were not too dense.
    - That may no longer be necessary.

He has attempted projects where they do some “glading”:

- Eliminate suppressed understory and ground material
- Only possible in very limited cases.

How does slope aspect affect skiing terrain?

North slopes are generally more appropriate and not for any one particular reason.

- Better snow quality
- Holds snow longer
- Skiing quality is better

Best tree species for heli-skiing?

Larch

- Because they lose their needles which makes it easier to ski through and allows more snow to fall to the ground.
- Many stands have a leading component of larch.

Spruce, white/Englemann

Balsam

- Their shape sheds the snow well and allows a lot of snow to reach the ground.
- Their limbs compact against the bole
- Snow falling to the ground tends to compact the snow and avoid surface hoar.

Worst tree species for heli-skiing?

Hemlock

- Because it has a large crown and therefore holds more snow
- Less snow reaches the ground
- The snow on the crown melts, refreezes and eventually drops to the ground as very dangerous “death cookies”

Douglas fir is ok, Not good, not bad

They operate in some areas of cedar, but very little

How does stem diameter affect skiing terrain?

It is not an issue.

- CMH has a few places they ski in that are “ancient forests”, but only used sometimes.

- They are very magical and provide a very special atmosphere, but not necessarily the best skiing terrain because the old trees hold a lot of snow on the crown.

- For stability of the snowpack it is only the density of trees, not the girth that is an important factor.
    - That's because if a tree has a small enough girth to possibly not have a hole in the snow at its base, it is likely too short to even be above the snow pack in the middle of winter.
        - 3-5 m snow pack and by the time it is 10 m tall or 20 cm dbh it will have a "tree well" due to heat sink (spruce/balsam because of shedding snow too).

1 E.g. very sparse stands near the alpine pose stability risks because wide spaces between trees can cause slabs to fracture at the points where trees are located because the stress from the snowpack over a large area is exerted on a confined point, rather than spread across many trees as would be the case in a more dense forest.

Are clumps of snow falling from tree tops (flying tree mushrooms) a danger to skiers?

No, but CMH uses the term 'tree mushrooms' to describe something else that is a danger: high stumps with snow built-up looking like a mushroom. Cause collision problems when

What about working with forestry to cut blocks in a certain rotation that can be used for skiing?

2 Requires expansive area of uncut forest, managed specifically for heli-skiing

2.1 Long, vertically oriented strips of sparse density harvested areas.

2.2 Then move adjacent and harvest again.

Not practical due to:

3 Fragmented drainage basins, usually the whole drainage is not skiable due to creeks, cliffs, etc.

4 No long term access to terrain

5 e.g. 30% removal in the first logging pass

6 Some more in the second pass, and then whatever is left in the third (or fourth) pass(es).

6.1 Skewed pattern because they actually take more than the allotted 30% in the first pass. The real first harvest is 40-50%, which leaves much less for the subsequent harvests.

6.2 Works well for skiing at the first pass. After the second pass there is very little skiable terrain and after the third pass it is no longer skiable.

Could maybe work on a micro-site, but is not applicable on a macro-site basis.

- Because it would require development of an entire drainage, which would require lots of road construction, and lots of landing sites. Plus the cut blocks would need to be placed to match timber volumes as well as skiable terrain.
- They tried it in one area where you landed on a ridgeline and ended at the valley floor, but it required crossing 11 roads!
    - Side cut and fill of the roads is not conducive to skiing.
    - Very dangerous in flat light.
        - They attempted to fill the ditch line in the form of a ramp with ~1300 hay bales. However once the snow covered them up, the guides couldn't find them in the ~250 m wide area where 4-5 groups were skiing side-by-side.

Is any size and/or shape of cutblock more beneficial for skiing?

The most advantageous factor for heli-skiing is visual appeal for the clientele.

BC has moved away from cubes placed erratically on slope sides.

Simon Bell's research (UK) on natural blocks is widely used today.

Blocks are designed so they fit more naturally to the mountainside.

Cut blocks are useless for heli-skiing due to surface hoar, so forested areas are better.

Heli-ski requires management designed to increase skiability.

- That is achieved with vertically oriented strips and harvesting the higher value timber at the valley floor.
- Although long vertical strips may mimic the shape of an avalanche path, it hasn't happened yet.
- Likely because they are very proactive at managing avalanche risk with bombs, cutting the area with skis and bringing guests to the area before it becomes dangerous. Therefore, instable layers won't be a problem later in the season. They do this in all terrain, not just long strips.

Appendix D. Questionnaire summary table.

1. **How often do you use forests as terrain for helicopter skiing? (expressed as an approximate percentage of skiing time would be best)**

1	~50%
2	Speaking in general we terms, we ski in forested terrain approximately 70% of the time. This is also a function of weather and snow conditions as well as guest expectations. To a large degree tree skiing is our product.
3	50%
4	50
5	70
6	20%
7	20%
8	Depends upon the weather: low cloud cover = forest we ski west of Revelstoke where weather is generally good, so it isn't required too often.

2. **If skiers are dropped above the tree line do they usually pass through a forest on the decent?**

1	Not necessarily. Depends on the time of year and weather.
2	Absolutely, most of our ski runs land in the alpine or very close to it and ski through the forest to valley floor. Of course our glacier skiing is the exception.
3	50%
4	90%
5	Yes usually
6	No
7	Commonly, but not always (50%)
8	Not always, but usually close to the tree line. Sometimes we stop at the tree line.

3. **What type(s) of forests do you mainly operate in? (Species, spacing, age structure etc.)**

1	No response
2	Most of our ski terrain falls into the bio-geo zones of Englemann Spruce – Subalpine Fir Zone (ESSF) and the Interior Cedar – Hemlock Zone (ICH) and of course the Alpine Tundra Zone (AT). These forests are probably better described by the authors of this link. http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/provincial/index.html
3	Old growth or avalanche paths
4	Varied. Some mature, largely spaced. Pine and spruce. Both multi-aged and single aged stands
5	some of the younger forests can be very dense (1-2 meters between trees) age between 0 and 600 years old

6	Coastal forest, tight spacing, large trees, 6,500 feet to 4,000 feet
7	Mostly Sub Alpine, with no commercial value; On bad weather days with low enough freezing levels, we also ski more mature commercial forests, consisting of predominantly spruce, hemlock, Douglas fir, and red cedar. Age of trees vary from new growth in logging scars to trees greater than 200 years old.
8	No response

4. Who manages those forests? (name(s) of individuals and/or a forest company whom I could contact in order to complete an objective analysis)

1	Logging has subsided in the past 10 years. Community forest with New hawk nation. Look up Hans Granander in the bella coola telephone book. He's worked with forest companies in the area.
2	The forests are basically managed by the forest harvesting licensees who are directed by the Ministry of Forests.
3	BC government – Ministry of forests – Kalum district
4	Carrier
5	British Columbia ministry of forests
6	No one
7	British Columbia Ministry of Forests
8	Kamloops division of yale district Oakanagan sushwap land use management plan Timber tenure:4 forest companies

5. What type of silvicultural system(s) is/are used in the area(s)?

1	No response
2	The most common system in place is clear cutting. We do see some partial cutting taking place but it is not all that common.
3	Don't know
4	No harvesting for a long time previous clear-cuts
5	Replanting of all cut blocks is required, then brushing, thinning and spacing of the regrowth is performed by forestry over the first 18 years
6	Do not understand the question
7	Traditional clear cut logging, helicopter logging and selective logging.
8	Don't know

6. What type of silviculture proves to be most compatible with skiing?

1	No response
2	Partial cuts are most compatible for skiing needs. But the real silviculture issue is around planting densities, discussed a little further along.
3	Not sure
4	Selective logging Regrowth, causes to great density
5	New tree plantations are the best for skiing because the small trees are completely covered by the snowpack in winter making smooth open slopes. After about 10-12 years, the new trees are very dense and make for difficult

	skiing
6	We do some limited thinning. We glade trees, taking out smaller, 6 inches diameter, and leaving larger. We do not take out any merchantable timber, only non merchantable. The trees are left on the ground. The merchantable timber in this area is below our normal skiing elevation. Too warm in the valley for good snow, but good growing conditions for trees.
7	Vertically aligned clear cut logging.
8	Don't know

7. Have you tried working with the forestry industry on a rotation plan that suits both interests?
- **If yes, how did it work out? Do you still operate in such a manner?**
- **If no, why not?**

1	Discussed it, but elevation too high where skiing happens In discussions at pantheon, also in process of community forest. Not for commercial but for empl.
2	Yes we have tried the "skiing through forest rotation" concept but it's not very realistic. Most often landscapes are already fragmented far beyond what is workable. As well, even in an untouched drainage, the differences in needs between harvesting and skiing are very dissimilar. Removal of first pass volumes can often fulfill the concept but second or third pass most often fail to hit the mark.
3	Ample other terrain
4	No response
5	We maintain a relationship with the local forestry office and different logging permit holders. We try to be proactive in where cut blocks and roads are put in, so as to make them usefull for skiing. This however, is really not accomplished as they pretty much put log where the trees are most dense and valuable. Communication and planning could be better between heli skiing and forestry.
6	I do not know what a rotation plan is- we are heli skiers not foresters.
7	No, Because our operation is coastal (higher freezing levels) and consists of daily heliskiers (ski resort based as opposed to lodge based), the majority of our tree skiing is not in marketable timber and not a huge issue for us.
8	Not aware of it.

8. Do forest roads interfere with your operations?

1	no
2	Yes, forest roads can have a serious impact to skiing operations. Steep, large side cuts present a very serious hazard to skiers, particularly on flat light days when it's virtually impossible to see a road bank ahead of time and a skier inadvertently ski's off and onto a flat landing (the road). The result can end up in injury.

	As well, forest roads can also provide access to other recreational users, snowmobiles, which can also cause havoc to the ski program.
3	No
4	Forestry helps out a bit. Roads are useful to meet helicopters for drop-off and pick-up, but snowmobilers are a problem
5	On a positive note, they provide a place for us to land our helicopter to pick up our skiers. On a negative note, the roads provide access for snowmobilers and they can have a negative impact on our operation by marking the snow that we use as fresh powder runs.
6	No, but they provide easy access to snowmobiles, who do interfere with our skiing.
7	No, in fact the roads commonly provide a useable helicopter pick up.
8	No response

9. Are land use rights a big problem for your business?

1	no
2	Land use rights have not been a particularly big problem for us in CMH, but I have no doubt that it has been a serious difficulty for other backcountry operators. If we were to discuss the rights of those whom harvest timber and the management of those rights, simply for the production of timber fibre with little concern for the commercial recreation activities then my answer would be totally different. But I don't' think that's the question you're asking.
3	Not with respect to forestry users as our time of use does not overlap
4	No issue
5	Not on a commercial level as we hold a commercial tenure which is exclusive use. The recreational use of the land can be an issue as snowmobilers and ski tourers might want to access the same land as we use. This overall is a farily small problem as our tenure is so big and much is too remote for non helicopter access. Perhaps 5 % of our terrain has land use issues.
6	Yes, the biggest problem we face in the industry
7	No
8	Not aware of it.

10. What type of land tenure do you hold?

1	Mechanized heliski tenure, specific license of occupation
2	Our land tenure is a Licence of Occupation authorized by the Ministry of Tourism, Sport and the Arts and Integrated Land Management Bureau (MTSA/ILMB).
3	Commercial recreation
4	Licence of occupation
5	Commercial exclusive use rights
6	License of occupation
7	License of Occupation, Heli-ski Tenure through the British Columbia Ministry of Tourism, Sports and the Arts.
8	No response

11. Has anything changed since you started operations regarding the way skiing and forestry interact?

1	ILMB and governnment reorganization No conflicts to speak of regarding forestry.
2	What has changed is years of interacting with forest harvesting licensee's has created a bit of awareness that the forest resource isn't just a fibre farm. They know we're out there and that we have some very real needs within the harvestable landscape as well. Commercial recreation is a big player in our provincial economy, however, Ministry of Forests (MoF) and forest harvesting licensees are mandated to manage the forest resource, largely for fibre, first and foremost. We have fairly good results at the local levels, dealing directly with licensees but are a long ways away from having our issues addressed at a provincial level.
3	No
4	No response
5	Not really
6	No- There is no management and never has been
7	Not Really
8	No response

12. How do the following factors influence skiing in forested terrain:

- **Aspect** (North, East, South, West) –
- **Slope steepness** –
- **Exposure** (open vs. protected)-
- **Tree species** -
- **Diameter** -
- **Stump height -**
- **Size of cut block** -
- **Shape of cut block** -
- **Stand density (initial vs. cut)** -

1	No response
2	• **Aspect** (North, East, South, West) – Aspect is a key influence in skiing forested terrain, or any terrain for that matter. North aspects hold the snow better, are less affected by the sun and generally offer better snow quality. However, prevailing and localized winds may negatively impact ski terrain regardless of aspect. • **Slope steepness** – This is not much of an issue other than having enough slope and not too much. An ideal for our ski program is somewhere's around 30° to 35°. The range would be from 25° to 45° • **Exposure** (open vs. protected)- Protected (ie forest covered) are usually safer skiing, from an avalanche perspective. And often ski quality is better. Open terrain is open to

	the vagaries of wind and sun, affecting snow quality and stability. • **Tree species** - Hemlock is the worst. The wide spreading canopy captures lots of snow keeping it from reaching the ground and creating death cookies (tree bombs). Spruce & Balsam work fine. Narrow crowns shed snow and compress with snow loadings over the winter. Tamarack & Larch. We like these guys for obvious reasons. They shed their needles, allowing snow to accumulate on the ground with good visibility through the stand. • **Diameter** - Is not much of an issue for us. • **Stump height -** Legal stump height (30 cm on the uphill side) is not an issue for us. However, on occasion we will see variances authorized for winter logging shows leaving huge stumps (2 m plus!). This does not work for us!!!! • **Size of cut block** - Two different perspectives here. 1) Proposed harvesting overlaps ski terrain and 2) Proposed harvesting does not overlap ski terrain. In the case of 1) smaller is better, mostly to minimize the loss of what is already great ski terrain in the natural forest. And because the plantations will ultimately eliminate skiing opportunities. In case 2), if harvesting opens up terrain that has not been skied before then bigger would be better. In both cases there is somewhat of a minor issue with visuals. We would prefer to see blocks of a size that fit the landscape. Particularly if they are visible from a Lodge. • **Shape of cut block** - Generally speaking we would like to see cut block shape and design follow the principals of good Visual Landscape Management Guidelines. Largely to address the aesthetics which have already been seriously impacted. We believe that these guidelines also address many other issues at the same time. In the event that proposed harvesting will create new ski terrain we would like to see the harvesting upslope as high as is possible and oriented vertically (using the above principals) allowing for maximum vertical skiing. • **Stand density (initial vs. cut)** - The issue with stand density is post harvesting. Most planting programs are planting to densities of 1200 to 1600 stems per hectare (sph), sometimes higher. This and natural ingress will ultimately preclude ski use, requiring that these areas have to be thinned. At a substantial cost to the operator. We are finding that the appropriate sph for skiing use range between 450 and 350 sph.
3	• **Aspect** (North, East, South, West) – North and East better • **Slope steepness** – 25-40 degrees best

	• **Exposure** (open vs. protected)- both valuable depending on weather • **Tree species** – Old growth best • **Diameter** – Bigger the better • **Stump height –** Doesn't matter • **Size of cut block** – any is good • **Shape of cut block** – doesn't matter • **Stand density (initial vs. cut)** -
4	• **Aspect** (North, East, South, West) – various • **Slope steepness** – varies 15-35 • **Stand density (initial vs. cut)** – 4-5m
5	• **Aspect** (North, East, South, West) – Generally All aspects are good skiing from December to late February, then southerly aspects become too affected by the sun to offer good powder skiing • Slope steepness – Slopes between 20 and 45 degrees are best • **Exposure** (open vs. protected)- Open slopes provide easier skiing for weaker skiers, however protected forested slopes generally have deeper powder and are world renowned for ski quality • **Tree species** - Mature old growth is the best as the spacing is wider in between. Generally cedar and fir is the best, while hemlock is generally much tighter forest and sometimes difficult to ski in • **Diameter** - The bigger the better, cause then the space is wider • **Stump height -** Low stump height is best as it creates smoother slopes. Areas that are logged in late winter with high stumps, then are much rougher in future and not as good for skiing • **Size of cut block** - Doesn't really matter • **Shape of cut block** - Vertically oriented is better, but most are horizontally oriented • **Stand density (initial vs. cut)** -
6	• **Aspect** (North, East, South, West) – We usually ski north terrain only in trees, sun and wind affect other aspects • **Slope steepness** – We ski up to about 35 degrees, Too difficult for clients after that • **Exposure** (open vs. protected)- Best tree skiing is open glades, not clear cut like ski runs. • **Tree species** -

	No affect • **Diameter** - Large trees are better; branches are higher, give more room to skiers • **Stump height -** No a factor, stumps covered by snow • **Size of cut block** - Not relevant • **Shape of cut block** - Not relevant • **Stand density (initial vs. cut)** - Less dense the better
7	• **Aspect** (North, East, South, West) – • Important for snow quality (North generally being the best) • **Slope steepness** – 20 to 35 degree terrain is ideal • **Exposure** (open vs. protected)- Open or widely spaced terrain is ideal • **Tree species** – Not important • **Diameter** – Not important • **Stump height –** Should be minimal, high stumps and poor clean up of clear cuts leaves too many obstacles for good skiing • **Size of cut block** – Not important • **Shape of cut block** – Vertically aligned • **Stand density (initial vs. cut)** - widely spaced trees is ideal, replanted clear cuts need to be thinned out, many of our older clear cuts are no longer skiable because the young trees are no longer buried and are too closely spaced.
8	No response

13. What type of harvest block/silviculture poses the least risk for avalanche initiation?

1	No response
2	One that's not logged! But seriously, we find that harvested areas are often "surface hoar farms". Once the forest cover has been removed, exposing the snow pack to sun and wind, it is not uncommon to experience a substantial increase in surface hoar formation. Of course this often becomes a buried instability in the snow pack and subject to avalanche initiation. This situation is exacerbated by elevation, aspect and localized winds. Partial cuts, cut block configuration are not
3	It's "all or nothing," leaving a few trees does not decrease risk.
4	No response
5	Harvest on slopes less than 30 degrees
6	Clear cuts highest risk. Least risk is low elevation partial cuts

7	Selective Logging
8	No response

14. How great is the risk of hard clumps of snow falling off trees onto skiers?

1	More a problem if a skier skis into a tree and subsequently snow falls from branches onto them so they can't breath.
2	The risk of snow falling off trees onto skiers is minimal. Yes it is possible but not of serious concern for us. More importantly, snow falling off trees is what we refer to as "death cookies". These frozen lumps of snow are a hazard to skiers, often tripping them up even causing injury. They can also minimize available ski terrain as they can remove otherwise skiable terrain from outside the drip line to the bole of the stem. This often happens after a warming spell when these lumps are released from the tree and most prominent on He leading forests.
3	significant
4	Minimal, no problem
5	Not a huge risk
6	Not significant, we have never had an issue
7	Not great.
8	No response

15. How great is the risk of skiers hitting stumps which are only partially covered with snow?

1	In thick forests (where they hardly ever ski), branches under snow can be a problem if tips get caught. Danger of knee injury or flying forward head first, possibly into a tree.
2	This can be a very real hazard and one of concern. Particularly in early season when stumps do not have adequate snow coverage to ski over. But most often the hazard is minimized mid-season when we have full snow cover.
3	Great
4	No issues
5	Not a huge risk
6	Not an issue, we have lots of snow- stumps buried
7	Not great
8	No response

16. Has the mountain pine beetle destruction affected your skiing operations at all?

1	No response
2	Mt. Pine Beetle is not much of an issue for us. Largely because we do not operate in area's where Pl is a leading species.
3	Not yet but we are in the coast mountains and most of the pine beetle is to the east of us
4	no
5	no

6	No
7	No, very little pine in the coastal forrest.
8	No response

17. Can you suggest any relationships between forestry and helicopter skiing that I have not mentioned?

1	No response
2	One aspect you have not touched on is planning. This is a very important part of sharing the forest landscape. It affords the opportunity to discuss our concerns, offer solutions and seek reasonable resolution. Unfortunately our strength of position (as a non revenue generator in forestry terms) and sometime conflicting needs are not always to seen as complimentary to the objectives of forest licensees or MoF. Particularly through the new Forest Stewardship Plans (FSP's) which forest licensees have to prepare and submit to MoF for approval.
3	No
4	No response
5	As a company we could be more involved with our local forestry office and logging permit holders to be more proactive as to the location etc of potential cut blocks
6	Yes, easy permitting process for cutting helicopter landings and tree thinning
7	No.
8	No response

18. What are the typical demographics of your clientele? (E.g. nationality, age, skiing ability, profession, gender etc.)

1	35-55 years old 45% european 45% American 10% Other nationalities Generally very wealthy Good jobs: doctors, lawers, heads of companies More than 95% male, women only come with boyfriends/husbands.
2	Nationality 55% North American, 40% European, 5% others. Age Average age 48 Skiing Ability Strong intermediate to expert Profession No info. on this. Gender 80% Male, 20% Female Repeat Clientele 70% Snowboarders 7%
3	Middle aged, professional, mixed nationality, mostly male
4	Male 95%, female 5% (usually wives and girlfriends with men) Euro 90%, 10% other nationalities
5	American, German, Swiss, English majority (Canadian, Italian, Norwegian minority) age generally between 30-60
6	50% expert, 25 % advanced, 25% intermediate. European, 50%, American

	20%, Canadian 15%, Japanese 10%, Men 75%, women 25%, skiers 75% snowboarders 25%
7	American, European, Japanese, 30 to 50 years of age, strong intermediate to expert skiers, professionals, 80% male
8	american, german, canadian 50-60 years old mostly (~95%) male

19. How long to guests typically stay and what is the average number of days they spend helicopter skiing during that time?

1	Stay one week, ski 5-6 of the 7 days
2	Most of our packages are a week long, from one Sat. to the next. We do offer 3, 4 and 5 day packages as well but the week program is the most popular. Given weather conditions guests will ski every day.
3	7 days stay, 7 days skiing
4	5 DAYS, 5 days
5	We offer packages from 2-7 days. Most popular are the 5,6,7 day packages. On average we ski every day except one during a week (due to poor weather)
6	One day of heli skiing, the rest of the time skiing on Whistler Blackomb Mountains regular skiing
7	Majority of clients heli ski one day with WHS, in their ski holiday in Whistler. We do have multi day clients, but it is not the norm.
8	3days, 4 days and 7days Slightly more 3 and 4 day stays. Ski all days.

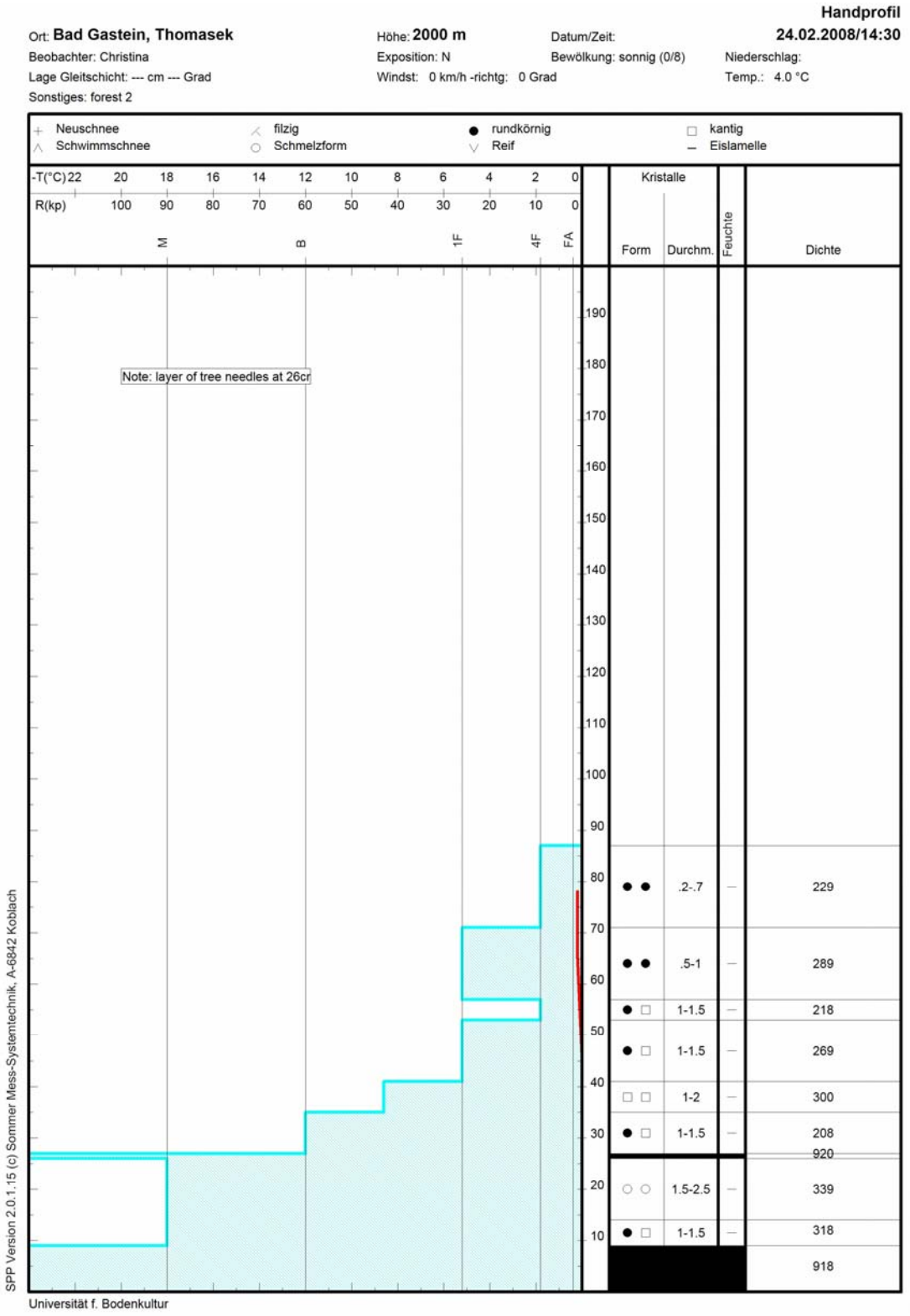
Legend:

1 Bella Coola
2 CMH
3 Northern Escape
4 Robson Helimagic
5 Tangiers
6 Whistler Heli Skiing
7 Whistler Heli Skiing 2
8 Coast Range

Region:

Coast = 1, 3, 6, 7, 8
Interior = 2, 4, 5

Appendix E. Additional set of snow profile diagrams.



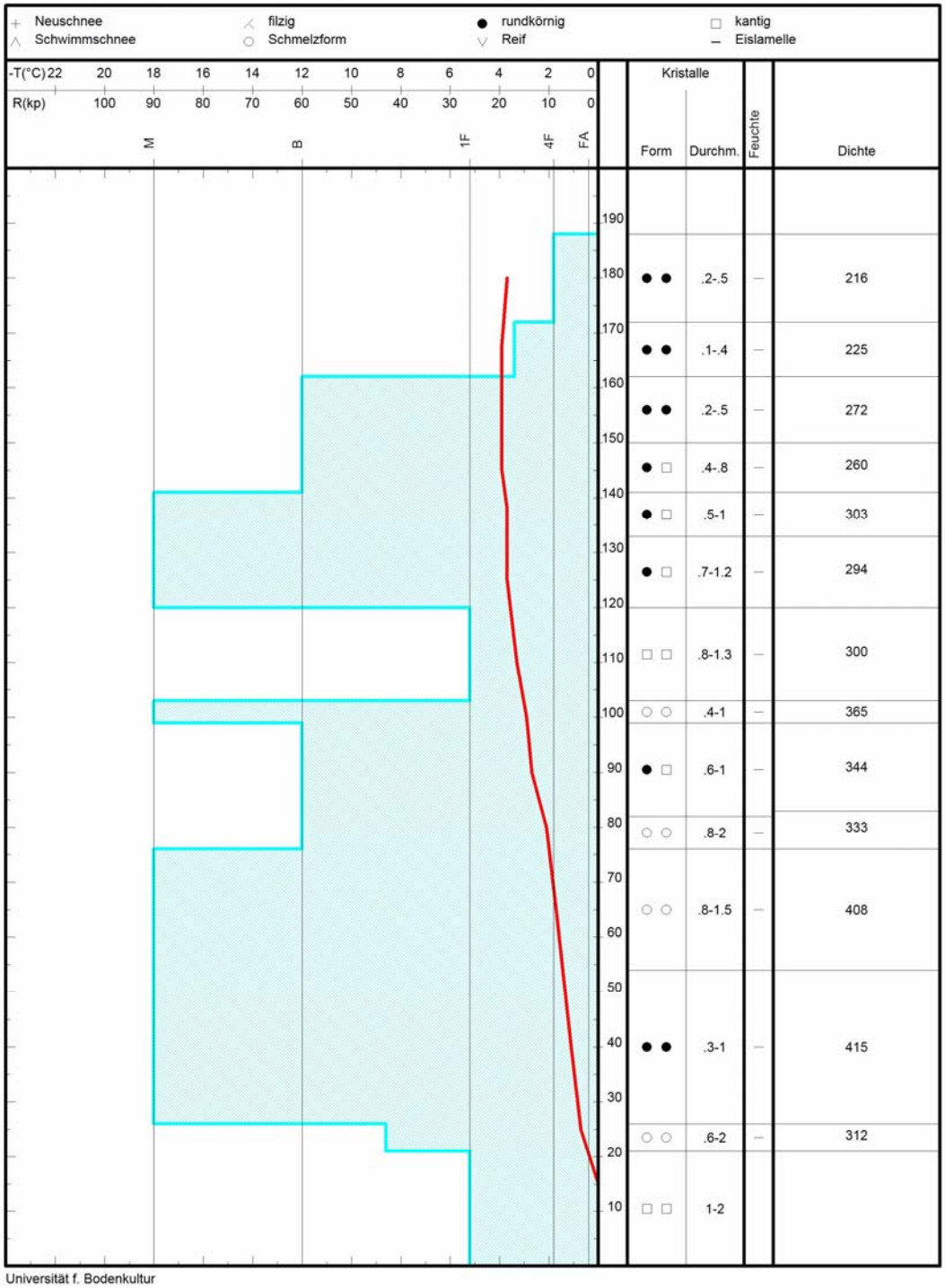
Handprofil

Ort: **Bad Gastein, Thomaseke** Höhe: **2000 m** Datum/Zeit: **24.02.2008/12:35**

Beobachter: Christina Exposition: N Bewölkung: sonnig (0/8) Niederschlag:

Lage Gleitschicht: --- cm --- Grad Windst: 0 km/h -richtg: 0 Grad Temp.: 7.0 °C

Sonstiges: open 2



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Universität f. Bodenkultur

Appendix F. Responses from forestry licensee questionnaire.

What types of forests are in the area(s) of overlapping tenure? (Species, spacing, age structure etc.)
We have mostly old cedar-hemlock stands at the lower elevations, and old mountain hemlock-Englemann spruce-subalpine fir at the upper elevations. By old, I mean150 years plus.

What type of silvicultural system(s) is/are used in the area(s)?
(clear-cut, size of cutblock, selective logging, shelterwood etc.)

On steep areas we clearcut while anywhere we can work with ground-based equipment, we will do group selection, shelterwood or some other system that retains some forest cover. Average clearcut size is around 15-20 ha

Have you had any interactions with the helicopter skiing company/companies?
General discussions initiated by your side or by the helicopter skiing side?
Yes, frequently with CMH, infrequently with Selkirk Tangiers.

Have you discussed planning with them (FSPs, site plans)?
We are in frequent contact when working on Plans.

Any conflicts?
Few conflicts although I think that they would prefer that we were not there!
What is your opinion on including stakeholders such as helicopter skiing operators in your planning process? We encourage it

Have you tried working with the helicopter skiing industry on a rotation plan that suits both interests? We have talked about this, but have not got to the stage where we are planning our logging to produce a supply of heli runs over time.
If yes, how did it work out? Do you still operate in such a manner?
We do try to create vertically oriented blocks that can be used for skiing, and we try to spread the blocks over time however, we have a difficult time planning for this because there are so many other vagaries to plan for
If no, why not?

Are land use rights a problem for your business? No

What type of land tenure do you hold? Tree Farm License
What is the most common form of forestry tenure?
Forest Licence – this is volume based

What type of tenure is most desirable to forestry businesses? Area-based tenure like a TFL is good. Private land is best, but around 95% of land in BC is crown land

What is your impression of the FRPA in comparison to your ideal set of regulations and in comparison to the previous forest Code? BC is a lad of contracts both in geography and politics. Both the Code and FRPA are a result in political gyrations. The Code was excessively rule-oriented, there was a rule for everything. FRPA is the other way. There are few rules and more "professional-reliance" It is easier to work within, but it likely does not give the public enough control over their forest resource

Is it difficult to plan and meet results and strategies for FRPA objectives?
It is easy since there are so few results and strategies. There is no avenue for results and strategies for things like heli ski run planning being tied to forest management

Can you describe the different types of fees that forest licensees must pay to the government?
Tenure Annual rent for the licence (not much money)
Stumpage This is calculated for each cutting permit (usually 3 or 4 cut blocks together) and can range from $0.25/m3 to over $50/m3. This mounts to hundreds of thousands of dollars annually for us.

What is the usual/average density to which you are obligated to restock a stand? Minimum 500-700 trees/ha Target 1000-1200

Is that density different than the ideal density for your business?
It is suitable for forestry, but too thick for skiing

How would it affect your business if you were to restock to and manage forests with a density of 400-700 stems per hectare?
It would reduce our lands productivity slightly and result in limbier trees of perhaps lower value.

What are the "key approval tests" that must be met for stocking standards in FSPs?
We have used the forest service's recommended stocking standard. To use stocking standards that allow target stocking at the level desired by heli ski companies would cause a long approval process. CMH and Licnsees in the Revelstoke area are working on this now.

Do you know the current status of LRMPs? Are they still being created?
We operate under the Revelstoke Plan:
http://ilmbwww.gov.bc.ca/lup/lrmp/southern/revelstoke/index.html
I think that they are still being worked on – much of the province is covered by one and they are constantly being revised.

What is the maximum slope angle that you would harvest on?
We don't have a maximum. Anything over around 50% slope will be reviewed by a qualified geotechnical professional and logged if it is stable and if snow avalanches will not become a problem

Has anything changed since you started operations regarding the way skiing and forestry interact?
It has been remarkable stable over the last 10+ years since I have been here.

Has the mountain pine beetle destruction affected the area(s) at all?
Not for us.

Can you suggest any relationships between forestry and helicopter skiing that I have not mentioned?
We have 2 CMH heli-ski lodges adjacent or in our TFL. Viewscapes are important for these lodges and we have worked on visually sensitive harvest techniques within the viewscapes.

I mentioned earlier that there was an ongoing process CMH and licensees were engaged in to have reduced stocking standard densities. These would apply to select areas that were important for CMH – it would lengthen the time that cutblocks could be skied. Skiing through cutblocks is unimpeded by regen for the first 10 to 15 years after harvest. Then the trees start to become an obstacle for skiers. Thinning down to 400 or so stems per hectare would add another decade or so to the time the cutblock could be used as a ski run.