LSCR Big Tree Inventory

Old Growth Trail

Prepared for:
GVRD

Prepared by:
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2000

Summary

Our group conducted an inventory of large trees (minimum 120 cm diameter at DBH) in the Old Growth Trail area of the Lower Seymour Conservation Reserve (LSCR) in North Vancouver. The work was conducted from September 2000 to March 2001. Most of our original objectives were met, including laying out a methodology for future groups doing the same work in other areas of the LSCR, practicing field work and the use of various equipment, and honing our writing and mapping skills. A set of instructions for performing the field work and computer procedures is included with the report. Normal cruising procedures were followed as we collected the following data: tree number, height, species, diameter at DBH, tree class, pathological indicators, and location. The area studied contained 168 large trees. The data was entered into an Access spreadsheet, mapped, analyzed, and graphed. There were 90 sitka spruce, 42 western red cedar, 33 western hemlock, 2 amabilis fir, and one douglas fir greater than 120 cm diameter at DBH in the area studied. Most of the diameters were below 180 cm, with the largest being 293 cm. There were 67 trees between 50 and 60 m tall, 47 that were 60-70 m, 31 that were 40-50 m, and 23 in other height classes.

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Introduction

Background

The Lower Seymour Conservation Reserve is located in North Vancouver, minutes from downtown Vancouver (see appendix 1). It serves as a popular recreation destination for people who enjoy cycling, hiking, in-line skating, and nature in general, and is easily accessible by the public. It represents a typical coastal forest in Southern British Columbia. The LSCR contains the following biogeoclimatic zones: CWHdm, CWHvm1 and 2, MHmm1, MHmmp, and ATc (see appendix 2).

The Lower Seymour Conservation Reserve was formerly known as the Seymour Demonstration Forest, and was once part of the Greater Vancouver Water District's closed watershed lands. This area was opened to the public in 1987 to provide educational and recreational opportunities. The lower part of the reserve is not currently being used for water supply but may one day be a major contributor to the Greater Vancouver water supply. The LSCR provides a perfect example of how a forest can be managed while still ensuring the long-term sustainability and natural beauty.

Our large tree inventory of the Lower Seymour Conservation Reserve is focused on answering the question: How many old (large) trees are present, and what condition are they in? Our project looks at a small portion of the Seymour Valley. The study area is beside the Seymour River's western bank just south of the dam, and stretches west for 300 metres and down river (south) for 600 metres. A complete large tree inventory has never been done in the area, and that is what we have done. With this project, we have developed a blueprint producing instructions on how to complete a large tree inventory for the remainder of the forested area in the valley.

Objectives

Our objectives, as stated in our original proposal, were:

"To create a clear and easy to understand plan for completing a large tree inventory that can be passed down for use by future groups. We do not expect to complete the large tree inventory of our entire area. We will create maps with overlays, an othophoto with overlays, and a professional quality report… Upon completion of the project we will be confident in the use of GPS, criterion, Microstation, Maps3D, Arcview, Microsoft Access, Excel and Word."

All of the original objectives were not met. We were unable to meet the objective of creating an orthophoto with overlays for the map we made. We obtained the orthophoto too late, and we did not have the resources to make overlays. We used a vertex for calculating the tree heights instead of the criterion, thus we were unable to gain experience in the use of the criterion.

We did manage to delineate the area with an Abrams stereoscope so we could exclude areas with no large trees visible. This enabled us to complete the field data collection for the polygon including the old growth trail where most of the large trees are located. In addition, we did some simple data analysis, instructions for mapping, and experimenting with different data collection methods to see which would be most effective. See Appendix 4 and 5 for the field procedure and computer work instructions.

Methods

This project consisted of three main phases: preparation, field data collection, and mapping and data analysis. The preparation and field data collection portions of the large tree inventory were conducted from September 2000 through February 6, 2001 (see appendix 3). The preparation included setting objectives, researching the definition of the term “old growth”, a reconnaissance of the study area, delineation of the project area, and the establishment of GPS benchmarks. The field data collection included the testing of a variety of data collection techniques in order to determine the best methodology, on which we based our instruction manual (see appendix 4). The mapping and data analysis was done in the last three weeks of February and the first two weeks of March. The data collection in the reconnaissance and field data collection were conducted according to normal timber cruising procedures.

Preparation

Researching the Definition of “Old Growth” and Setting Objectives

One of our first tasks was to decide on the criteria for determining which trees would be considered “old growth”. We searched publications and consulted BCIT instructors but got different information from each source. Our contact person at the LSCR, Heidi Walsh, gave us some publications to search through: “Background Information on Greater Vancouver’s Capilano, Coquitlam & Seymour Watersheds” (GVRD 1999), and “From the Speculative to Spectacular: The Seymour River Valley 1870’s to 1980’s: A History of Resource Use” (Kahrer, 1979).

We came to the conclusion that tree age data would likely have been very time consuming to obtain, and inaccurate due to rotted wood in the middle of the trees. Estimating age would be even less accurate. We consulted with Norm Shaw (BCIT), and he told us to consider using different minimum diameters for different tree species. For example, in order for Spruce to be considered old growth it would have to be at least 200cm in diameter. Douglas fir and hemlock would have to be 150cm in diameter. He also suggested that we do a reconnaissance of the study area to assess the size and density of the trees there, in order to help us with our decision.

Reconnaissance

The reconnaissance (recce) process was fraught with difficulties and consisted of three main phases: the initial walk-through, the first recce and the second recce.

The initial walk-through of the study area, and meeting with our Lower Seymour Conservation Reserve liaison, Heidi Walsh, was conducted in September. This involved walking the length of the Old Growth Trail with Heidi pointing out various points of interest. The walk-through enabled us to get a feel for the scope of the project including the terrain and size of the study area.

The first reconnaissance was done in the west part of strip 108, 84m east of the benchmark (see appendix 6). The strip and distance were randomly selected. A minimum diameter of 10 cm diameter at DBH was used, and the trees were cored at DBH to determine age. A lot of trees were sampled but few were over 100 cm in diameter. When we were satisfied that this method was not worth the work, we consulted Norm Shaw on ways to improve our efficiency.

The second reconnaissance was completed on November 12. Norm Shaw advised us to do a one-day recce using a higher minimum diameter, and only measuring diameter and record species. A minimum diameter of 50 cm was used, and no core samples were taken. The information from the recce was used to identify the minimum diameter (at DBH) for our project data collection.

Based on the information gathered we concluded that there were very few trees large enough to meet Norm Shaw's criteria for trees of interest for each species. After making charts (see appendices 7 and 8) we decided to group the different species together and use a minimum of 120cm diameter at breast height. The common minimum diameter was chosen because the project is based on tree size, with less importance placed on species. It also simplified the project, especially when collecting data. For example, in the event that a tree's species could not be identified, the tree would still be measured if above 120 cm at DBH. One hundred twenty centimetres was chosen because there appeared to be relatively few trees above this size according to the charts (appendices 7 and 8). We estimated approximately 100 trees.

Delineation of the Project Area

As mentioned previously, the use of air photos (BC87066 no. 5-140 and 5-141; see appendices 9 and 10) was required to find the area that contained the largest trees. The air photos were delineated and stratified several times as the project evolved. The initial stratification was completed on November 7th. The main problem that materialized from the air photo work was the inability to locate large scale colour photos. The scale problem was addressed by obtaining an Abrams stereoscope. This stereoscope doubled the magnification, thus correcting the problem effectively. Peter Yanciw was also able to provide our group with a larger scale map of the Lower Seymour region to work with which helped us put the focus area into perspective

Establishment of GPS Benchmarks

We realized how important GPS benchmarks were to our project before conducting any field work. They were by far the best way of determining our exact position. Unfortunately, we did not have access to a high quality GPS unit while doing data collection, so we had to use benchmarks. With the help of Heidi Walsh, GPS benchmarks were created along the road, every 50 m (on the 50 and 100 m UTM northings) north from the south end of our chosen polygon. In addition, benchmarks were put in along the existing old growth trail. Some were on the 50's and 100's and some were not. A few benchmarks were put in along the river using BCIT's hand held Trimble GPS unit. Our largest problem was that the hand held GPS unit that we obtained from the BCIT survey store was limited in its ability to pick up satellites in the study area. This was due to the dense forest cover and mountainous terrain.

Field Data Collection

The data collection began on November 22, after analyzing the data from the reconnaissance. For each tree we collected the following data: diameter at DBH, species, height, location, pathological remarks, tree class, and tree number. It was decided that we would collect all of the information at once, instead of first determining heights then returning for the other information. Earlier in the project we did not know if the data should all be collected on multiple days for each tree. Time was the deciding factor when deciding whether to collect the data all at once or in separate trips to each tree. We also decided to use cruise cards for the data collection, and to keep using 50 metre wide strips.

Laying out strips

The east-west strips were always laid out before gathering the information along them. A few times the strips were laid out and data was collected at the same time, but it was not as efficient do so. Strips were laid out by chain unless there was a water body in the way. If this occurred then the Vertex was used to get horizontal distance. Horizontal distance was taken and stations were established every 30-50 metres, depending on visibility and terrain. The strips went straight east - west and are named after the tag number at the benchmark at the west end of the strip. Back bearings were used to ensure the accuracy of the northing of the strip line. The GPS benchmarks were referenced at the beginning and end of each strip. Benchmarks along the river were put in at the same time as the ones along the trail, but were seldom used because the trail and the river meet up approximately 200 m north of the southernmost strip.

Division of Labour

One person was responsible for note taking while a second scouted for trees that were over 120cm in diameter. Person two would walk strips that were already laid out and mark off each tree with red tape and write its measurement in black felt. If the tree was very close or looked like it might be added to the inventory data then he would mark it off in yellow tape. The third person took the tree heights using the Vertex and tied each tree to a station on the strip. We tried having all three of us do the data collection together at each tree but found it to be inefficient. When laying out strips, one person would head chain and establish stations while the tail chainman would take station notes and flag the strip with yellow flagging.

Equipment Used

The following equipment was used:

Vertex	field notebooks	corque boots	diameter tapes
clinometers	felt pens	rain gear	GPS unit
nylon chain	eslon tapes	calculators	hammers
cruise vests	hard hats		

Materials Used

For completing the field work we used yellow and orange flagging tape, 2-inch nails, four-digit random number tags for tagging trees, cruise cards, blank waterproof note paper, and three-digit tags for benchmarks.

Tree Numbering System

The trees were numbered at random using aluminium tags acquired from BCIT and contained a four-digit number that was recorded in the notes. We hammered the tags into the north side of each tree with aluminium nails. Trees near trails had their tags located facing away from the trail, out of sight. It was important not to put the nails all the way into the tree because annual moss and bark growth would cover the tree, preventing anyone from ever finding the tags again. The tree numbering system was the best way to look up trees and their corresponding data any time required.

Once At The Tree

Work progressed faster once we had sufficient practice in the data collection techniques, and when all three members were present. Our group started from the south end of our polygon and made our way north. For each tree with a minimum diameter of 120 cm at DBH we gathered the following data: tree number, height, tree class, pathological remarks, species, and location. Data for dead standing trees over 120 cm DBH and 20 m in height was also collected.

Post Data Collection

After each day out in the field or after a weekend of work, the data was recorded in an Access database and saved on a zip disk. The data collection was completed on February 6th.

We also went out and re-measured six of the tallest trees, which were all over 70 m tall. We went 80 m out on the ground in order to get a more accurate Vertex reading.

Mapping and Data Analysis

Set Up of Access Database

We did all of our data input in Microsoft Access. Categories included: Tree Numbers, Strips, DBH, Height, Species, Location, Northing, Easting, Tree Class, all eight pathological indicators, Date and Comment. For each of these a description was given and assigned a data type.

Data Input

After entering, reviewing, and proof reading the data, it was exported as a .dbf (VI) file for input into ArcView.

GPS Points

The GPS points were given to us by Heidi Walsh. To use them in Microstation we entered the tag number, northing, easting, and elevation of all the points into NotePad as a .txt file. In Maps3D we used Point2DGN to turn a .txt file into a .dgn file.

MicroStation

We chose cells for trees, tie points and stations and set up the program for what we were doing. We used a total of 15 levels. They are:

Base Map Tree Lines	Roads	Station Lines
Station Symbols	Station Numbers	TiePoint Symbols
Tie Point lines	Healthy tree Numbers	Healthy Tree Symbols
Unhealthy tree Numbers	Unhealthy tree Symbols	Legend Chart
Legend Data	North Arrow	Trails

We added our stations by using inputting the bearings and distances of our traverses and at each station we inserted a station symbol. Tree symbols were entered using the same method.

The levels were checked to make sure everything was where it was supposed to be. Any corrections were made with change element attributes. Finally, all levels were separated into their own .dgn file using a fence so that they could be turned on and off separately in ArcView.

ArcView

In Arcview we turned on the extensions we needed, added all our themes, and adjusted colours and text sizes. We then turned our map of tree numbers into a table and linked it to our Access data. After that, all files were changed to .shp files to enable use by the GVRD.

Layout

Finally, we did our final preparation on our ArcView map.

Results

One hundred sixty eight trees were measured within the polygon. Attached is a print-out of all of the data collected (see Appendix 11). The diameters, species, and heights are summarized in the following table:

Diameter Class (cm)	Frequency	Species	Frequency	Height (m)	Frequency
120-125	17	Amabils Fir	2	0m-20m	2
125-130	11	Douglas Fir	1	20m-30m	1
130-135	17	Western Hemlock	33	30m-40m	5
135-140	13	Western Red Cedar	42	40m-50m	31
140-145	11	Sitka Spruce	90	50m-60m	67
145-150	16	Total	168	60m-70m	47
150-155	11			70m-80m	13
155-160	11			80m+	2
160-165	12			Total	168
165-170	12				
170-175	10				
175-180	5				
180-185	5				
185-190	3				
190-195	4				
195-200	5				
200-210	2				
210-230	1				
230-275	1				
275+	1				

Table 1: Summary of diameters, species, and heights of trees surveyed

The largest diameter tree in the study area was a 293 cm cedar, and the tallest was an 82 metre sitka spruce. The diameter data is summarized in table 2:

Upper Diameter Limit (cm)	Diameters by Species				
	Sitka Spruce	Western Hemlock	Western Red Cedar	Amabilis Fir	Douglas Fir
125	10	5	2		
130	5	5	1		
135	5	5	7		
140	8	3	2		
145	6	4	1		
150	9	0	6	1	
155	5	4	2		
160	6	3	2		
165	8	1	2		1
170	8	2	2		
175	5	0	4	1	
180	4	0	1		
185	3	1	1		
190	2	0	1		
195	3	0	1		
200	2	0	3		
200 +	1	0	4		

Table 2: Summary of diameters by species

All pathological remarks were assessed, but only mistletoe in two thirds or all of the total height of the tree, dead or broken top, large rotten branch, conk, and blind conk were used to determine the health of the trees. The other pathological remarks pertain more to wood value. The tree health indicators are summarized in the following table. Note that some trees had more than one remark.

Mistletoe in 2 or More Thirds	Dead or Broken Top	Large Rotten Branch	Conk	Blind Conk
43	29	7	1	1

Table 3: Tree health indicators

The full size map shows trees with one or more tree health indicators as a lighter green colour. The following map is similar to the full size one, but includes the orthophoto data.

Discussion

Expected Accuracy of Results

Tree Height Data

Due to ground level visibility problems, changes in ground profile, and problems with chaining due to obstacles and underbrush, the tree heights may vary up to 3 metres from actual heights. A maximum slope distance of 50 m was generally used, so the angle to the tops of the trees was often well over 100%. This practice reduces the precision of the equipment used.

Tree Location Data

The tree locations were recorded in the field to the nearest metre, using the middle of the tree. We recorded the distance and bearing to the nearest station or benchmark, and later converted the location to UTM coordinates. The benchmarks along the road were accurate to the nearest tenth of a metre due to the high quality of GPS used. The ones along the trail were subject to interference from the surrounding trees, thus we estimate their accuracy to be two metres. The strips were tied to the benchmarks, but there were errors in chaining due to changes in topography, underbrush, north-south swing, and local attraction at the west end of the strips where the water main ran underground. The ends of the strips were tied to the benchmarks on the trail, and found to swing up to 15 metres. This was not corrected for, due to the amount of work that would have been involved.

Diameter

Few problems were encountered in obtaining accurate diameter readings, thus they are likely accurate to approximately one centimetre. Several of them required two people because of water bodies, obstacles, and high germination points. The height of germination on two or three had to be estimated, and moss was sometimes present on the lower bole, which could make the reading slightly high. When estimates were made, they were noted on the cruise card.

Species

The species designation likely improves the farther north the data was collected, as experience was gained. The biggest problem at first was in distinguishing between sitka spruce and hemlock. Many of the tree trunks were covered with moss. It is also possible that the two amabilis fir recorded were in fact misidentified. Interestingly, only one douglas fir was found on the site. This is probably because of the wet soil in the area. It should also be noted that some large fir stumps were found.

Pathology Remarks

Due to the dense canopy and the height of the trees, the upper bole of the trees was often difficult to see. Therefore we could have missed some forks, crooks, or other indicators. Due to our inexperience, there also could have been blind conks, rotten branches, or mistletoe that were overlooked. Standard cutting permit cruising procedure was used in recording pathology remarks, as well as diameter and height data.

Discussion of Findings

Largest Diameter Trees

Figures 1 and 2 show the diameter breakdowns of the data, with the species combined and separate.

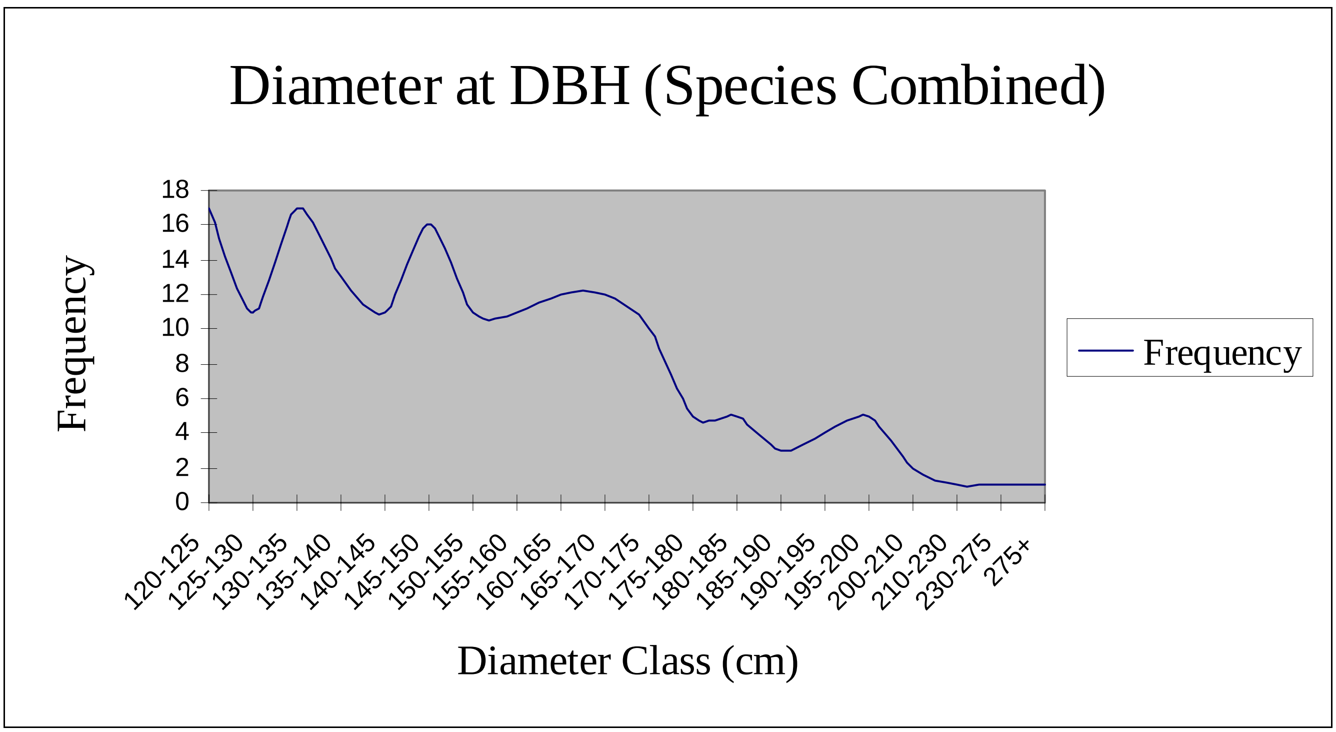

Figure 1

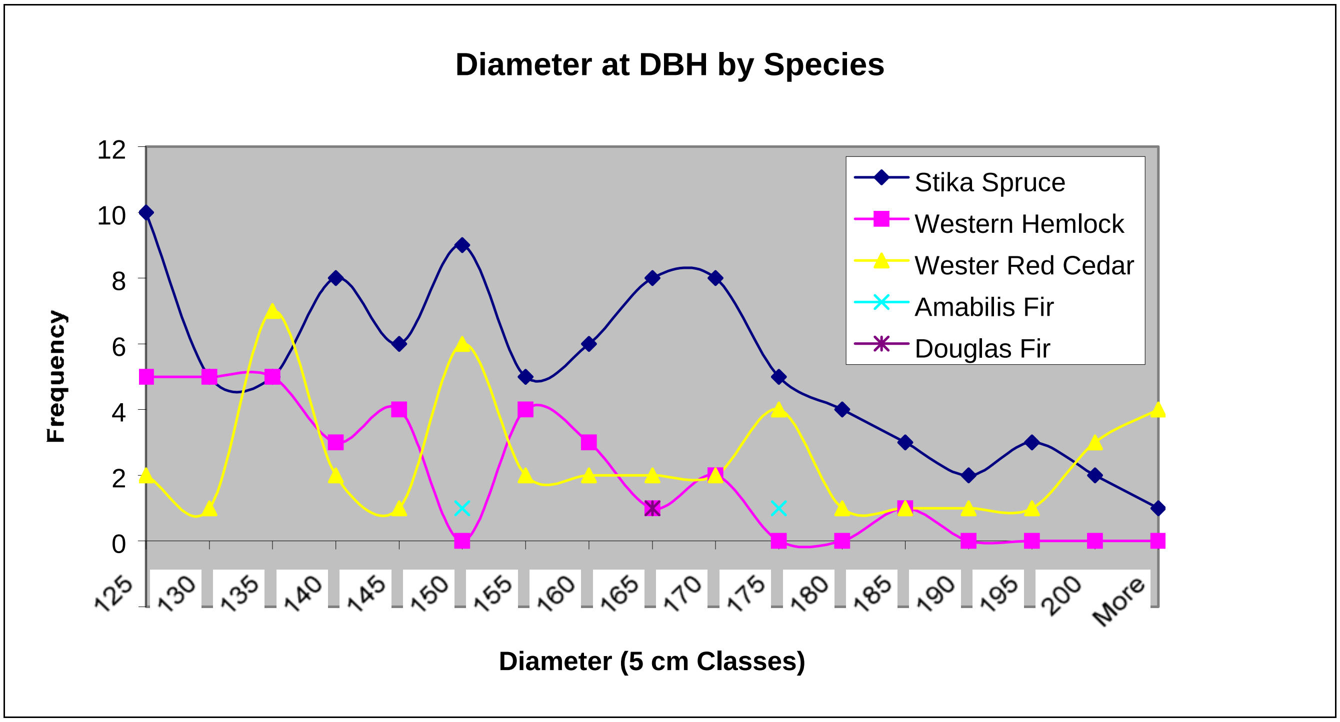

Figure 2

The sources of the peaks and dips of the line graph in figure 1 can be seen in figure 2. Because of the high number of sitka spruce found in the polygon, this species had the most impact on the line graph in figure 1. Amabilis fir and douglas fir had very little impact due to their scarcity. It is difficult to say with certainty why the peaks and dips in figure 2 are where they are.

The diameters of the western hemlock decrease after the 155-160 cm diameter class, which is likely due to their shorter lifespan. The largest hemlock is in the 180-185 cm class. The increase in the diameters of cedar found above 195 cm is deceiving due to the three outliers that were more than 200 cm in diameter. A graph with 20 more diameter classes would better illustrate the diameter distribution, but would be more than twice the width.

Species Composition

The species composition for the polygon is charted in figure 3. Sitka spruce was the most abundant at 90 trees, followed by western red cedar, western hemlock, amabilis fir, and finally, douglas fir. The ground in the area was very wet, and the rainfall in the area is very high. These conditions are ideal for sitka spruce and red cedar.

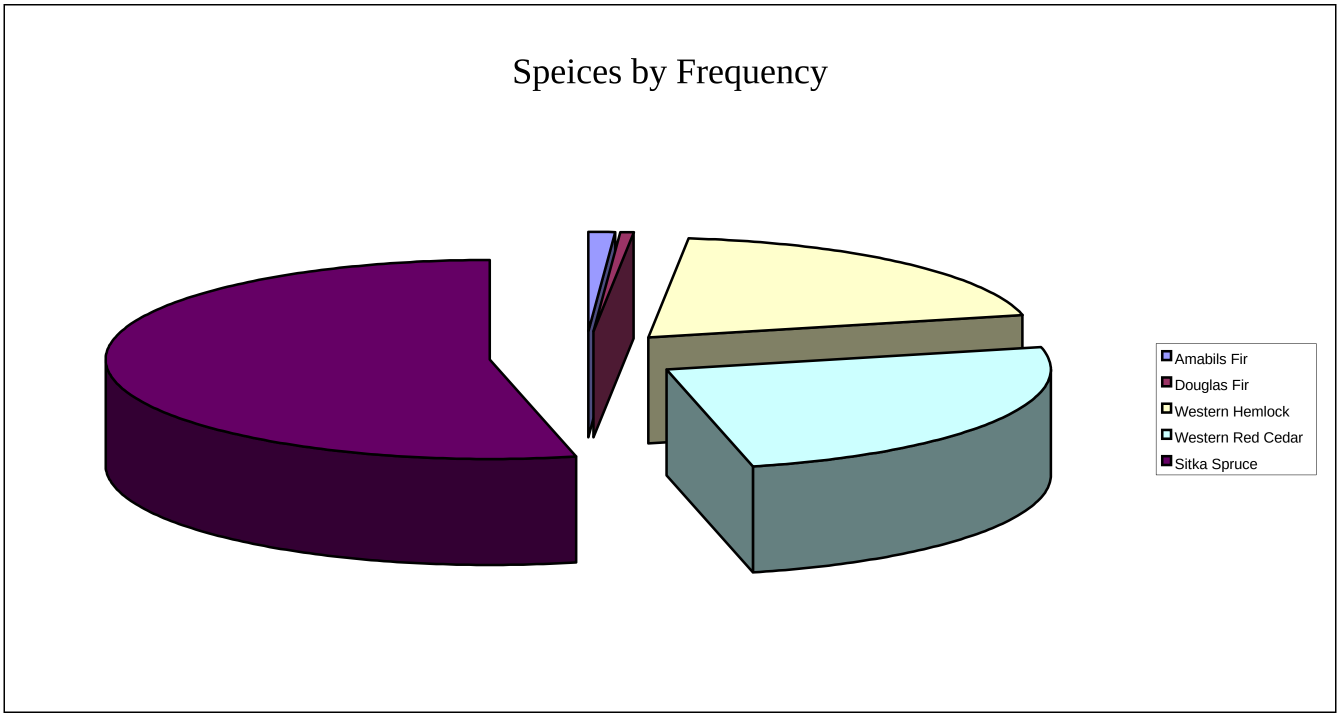

Figure 3

Heights

The heights of the trees found in the polygon are found in figure 4. The largest number of trees was found between 50 and 60 metres. The second largest class was 60-70 m, followed by the 40-50 m class. Note that the lowest height class ranges from 0-20 m.

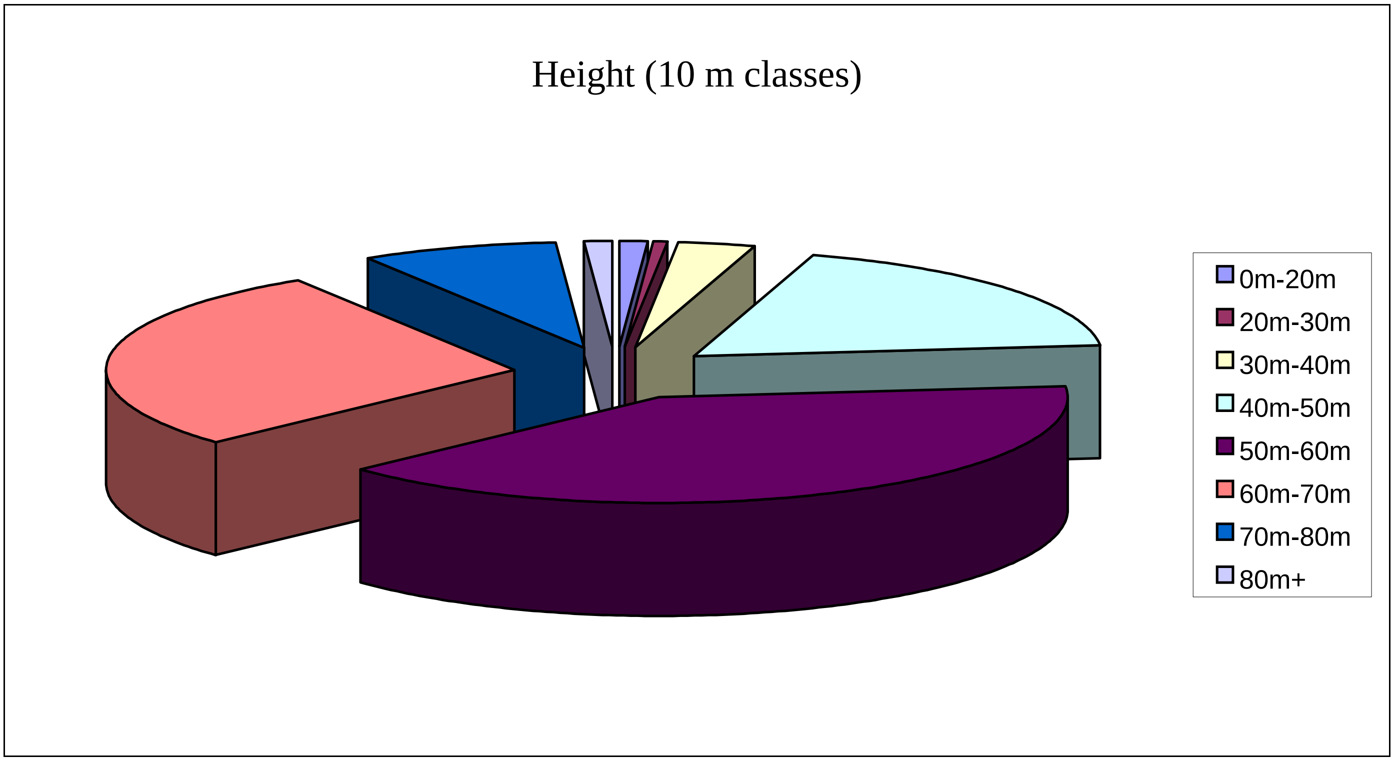

Figure 4

Pathology Remarks

The most abundant health-related pathological indicator found in the study area was mistletoe. This is likely due to the age, structure, and species composition of the stand. The many small openings in the area create ideal conditions for mistletoe. Dead and broken tops were the second most common, with 29. The tops had to be dead for at least five years to be recorded, as per normal cutting permit cruising procedure. Given the age and size of the trees, it is not surprising that there were so many dead or broken tops. Seven large rotten branches were noted, which are signs of decay and / or mistletoe. Only one conk and one blind conk were found.

Conclusions

Not all of the original objectives of the project were met (see page 6); changes were made as the project progressed. We did not create any overlays for maps or orthophotos, but the maps (full size and Appendix 6) turned out very well and more than adequately convey the information. Although the entire length of the Old Growth Trail was not surveyed, we did cover a very large area. There are a few remaining trees along the trail to the north of our study area and on the other side of one of the larger creeks, but we finished what we set out to do.

The project allowed us to hone our timber cruising, writing, air photo, and mapping skills. We did field work in all kinds of weather conditions, including snow, while managing to avoid serious problems such as injury or getting lost in the forest.

We also learned a lot about group dynamics, including the importance of establishing rules and consequences at the start of the project. We were reminded of the importance of good communication among ourselves and with other project stakeholders, as well as the benefits of high quality, daily journal writing.

Recommendations to Future Groups

Instructions

A set of instructions has been created for the field procedures and computer work (see Appendix 4 and 5). It explains the entire process as we would have carried it out if we knew then what we know now. We experimented with different methods in order to find the most efficient ones. They may not be ideal for all types of terrain and forest makeup.

Equipment

Besides ensuring that all equipment is present for conducting the field work, it is important to know the equipment's limitations and have back-up plans. We originally intended to use a five-year-old hand-held GPS unit to find tree locations and create benchmarks, but the unit would not even provide an accurate location in open areas (along the road). We used our back-up plan of chaining to create benchmarks, but local attraction from the water main made that method impossible as well.

It is also important to know what equipment is available. We were able to have Heidi Walsh put in GPS benchmarks, and we borrowed a Vertex and an Abrams stereoscope. An orthophoto and colour air photos were also located during the course of the project.

Know How To Do The Work Properly

It is easy to waste time in the field debating where DBH should be or trying to remember the minimum diameter of a crook. Be sure to know the details of data collection in order to maintain high efficiency and accuracy.

Plan Ahead

Planning the day's work ahead of time saves field time and reduces unnecessary work. Know what you intend to do and give the other group members plenty of notice. It is usually not easy to get people to do project work on short notice. Planning ahead can also help avoid unforeseen problems. For example, the tags for the benchmarks we established along the road were nailed into the ground. Any amount of snow made them impossible to find.

Divide Tasks Well

Once you know your group members' strengths and weaknesses, you can save time by allocating tasks according to ability and preference. This is not to say that everyone should have certain jobs and not learn every aspect of the project. If people are strong in certain areas, the quickest way to get the work done is to let them do most of the work in those areas of strength.

What Data to Collect

We were generally happy with the depth of data collection we went into. In hindsight, the general health of the tree could have been assessed without looking at scars, forks and crooks, or frost cracks. The age of the trees would be nice to know but coring the trees would be very slow, and inaccurate due to rot. Estimating ages would be hampered by factors such as microsite variability, genetic makeup, and history of stand development.

Define Clear Objectives

It is important to work out the objectives of the project early on so that it is easier to stay focused. They can also serve to keep the group motivated. The objectives in our proposal were somewhat vague, and we did not know at first how much field work we would do.

Annotated Bibliography

Personal Communications:

Jonathan Smyth: October 2000
After encountering a Spruce that had a germination point at 2.5m above the ground, we needed advice. Our project advisor referred us to Jonathan. Jonathan showed us how to measure a tree diameter from a distance similar to using a prism.

Norman Shaw: October 2000 – January 2001
Norm was often consulted on measurement dilemmas and reconnaissance techniques (3P technique with two people). Norm's advice was very crucial to the project.

Peter Barss: October 2000
Before commencing the data collection, we needed to get a rough estimate of how long it would take to complete the traversing part of the data collection.

Norman Caldicott: October 2000
Norm Caldicott, the renewable resources Silviculture instructor, was consulted mainly regarding our lower DBH limit. He helped us in creating a J-curve after several things went wrong in the reconnaissance.

Robert Laird : October 2000
Robert Laird was consulted both before and after the reconnaissances to determine an appropriate size to use for our lower diameter at DBH limit.

Rick Chester: October 2000- March 2001
Rick, the Renewable resources Computers and Mapping specialist, answered all of our questions relating to GPS, Maps3D, Microstation and ArcView. These include:

- How to transfer GPS data from the GPS unit to the computer.
- How to transfer GPS base station from Pathfinder to Microstation.
- How to effectively use Microstation.
- How to transfer Microstation layers into ArcView.
- How to attach a database file to an ArcView Layer.

Steve Finn: February 2001
Steve was consulted primarily when Rick was not available. The questions he answered were mainly related to Microstation.

Scott Stuart (GVRD GPS): March 1, 2001
Scott Stuart is the LSCR's GPS expert. He was the person we had to refer to when our map was ready to be produced. He also helped us decide on what exactly needs to go on the final map.

Trina Nair (GVRD GIS): March 02, 2001 – March 19 2001
Consulted on programs used by the GVRD, and what format our map needs to be in. Trina is a GIS technologist with the GVRD. She helped us by telling us exactly how our data was going to be used at the GVRD and who else is going to use it. This enabled us to make the necessary adjustments to make it easy for them to incorporate it into their database.

Heidi Walsh: October 2000 – March 2001
Heidi was our contact for the Lower Seymour Conservation Reserve. She helped us in the following ways:

- Creating GPS benchmarks along the trail and road
- Explaining the goals of the LSCR regarding this project
- Contacting Scott and Trina for additional assistance

Carman Heaver: March 2001
Carman is an assistant GIS instructor at BCIT. She helped us with making our "area covered" polygon .shp file transparent, and turning our tree numbers .dgn file into an annotated .shp file. This is something neither Rick Chester nor Trina Nair could help us with.

Peter Yanciw: September 2000 – March 2001
Peter was our advisor for the project and was consulted excessively throughout the duration of the project. Some of Peter's contributions included:

- Helping with group dynamics
- Repeatedly telling Jeff not to worry
- Gathering: maps, photos, equipment, and digital data.
- Keeping the group on the right track

Publications:

Greater Vancouver Regional District: Background Information on Greater Vancouver's Capilano, Coquitlam, & Seymour Watersheds. Burnaby. GVRD: 1999
Background information on the Seymour Watershed was gathered from this publication.

Greater Vancouver Regional District: The Lower Seymour Conservation Reserve. (pamphlet) Burnaby. GVRD: 1999
Background information on the Seymour Watershed was gathered from this publication. It is also included in the Appendices as a reference map.

Kaher, Gabrielle: From Speculative to Spectacular: The Seymour River Valley 1870's to 1980's, a history of resource use. Vancouver: University of British Columbia Press, 1979.
Background information on the Seymour Watershed was taken from this publication.