Ski Resort Planning Considerations

- Breakdown of the skier marketplace
- Tourist expectations
- The tourist contradiction
  - They all want to stay in log lodges and complain about the brutal cutblocks
- Economic diversification
  - Forestry, tourism and sustained prosperity

Ski Resort Planning

- The creation of master plans to guide in the development mountain resorts
- Planning process
  - Vision, goals and objectives
- Mapping
- Inventory
- Analysis
- Range of opportunities
- Stakeholder consultation
- Concept development
- Public review
- Interagency review including visual impact analysis
- Concept refinement
- Resort master plan

Mike Wiegele Helicopter Skiing

- Largest single base Heli-skiing resort in the world
- 1,600 square miles of operating area
- 10 helicopters transporting 100 skiers per day
- Economic mainstay of the region
- Strong repeat visitation
  - 90% sold out for next year (2002)
  - 50% sold out for the following year (2003)
- Winter and summer operations
Heli-skiing

- For dedicated skiers, Heli-skiing is their dream come true
- Helicopters act as ski lifts, accessing virgin slopes of powder snow
- High end and expensive sport

Heli-skiing and Crown Land

- Very highly regulated
- Operators in B.C. may only ski within their tenure area
- Heli-skiing operators share the crown land with other licensees including forest companies

Issues and Opportunities

- Male dominated, macho, expensive, powder skiing skills
- Highly weather dependant
- Fat skis and snowboarding
- More facilities: Down Days & families
- Demand for high end real estate
- Employee base needs more facilities
- Sense of obligation to local population
- Visual impact from logging

Goals and Objectives

- Develop lift serviced powder skiing
- Improve the quality of living for locals
- Develop a wide range of year-round facilities
- Reinforce the environmental attractiveness of the area
- Reduce the negative visual impact of logging

Saddle Mountain Development Potential

- Excellent mix of terrain
- Close to existing Heli-Resort
- Opportunity to improve visual impact of logging

Development Potential

- Site inventory and analysis
- Digital mapping
- Digital Terrain Model
- Slope analysis, elevation analysis, aspect analysis, fall-line analysis
- Environmental audit
- Opportunities and constraints
Design Parameters

- Opportunities and constraints
- Maintain environmental sensitivity
- Emulate Heli-skiing
- Utilize the 4,300 feet of vertical
- Limit skiing to 300 skiers per day
- Integrate developable base area lands
- Maximize solar access
- Improve visual impact from the Heli- Resort

Saddle Mountain Master Plan

- Comfortable carrying capacity: could hold 5,000 skiers per day, limited to 300
- High speed, low capacity lifts
- Wide trails to replicate open bowl skiing
- Differing degrees of glading to replicate tree skiing and to soften the visual impact of the “vertical cutblocks”
- Revegetation to improve visual quality of the existing cutblocks

Interagency Review Process

Master plan is submitted for commentary and approvals by various Government Agencies including:
- BC Assets and Lands Corporation
- Regional District
- Ministry of Environment
- Ministry of Highways
- Ministry of Health
- Ministry Forests

Public Review

- The public is invited to view and comment on the Master Plan through a series of open house stakeholder meetings
- Visual impact is always an issue

Saddle Mountain Master Plan

Visual Impact Analysis
- Key part of the consultation process
- The objective is to illustrate the proposed impact, and in the case of Saddle Mountain to hopefully show improvements
- The challenge was to complete the visual impact analysis in a timely, cost efficient fashion
Visual Impact Analysis

- The mountain plan is digitized and draped over the Digital Terrain Model
- We used a combination of Quicksurf and Autocad
- We then were able to view the mountain from any vantage point or angle
- Critical views are photographed
- Digital Terrain Model views were created, exactly matching the photos in scale and angle
- The computer generated view were superimposed over the photos
- The photos were modified using Photoshop

Saddle Mountain Approvals

- Submitted expression of interest in 1996
- Successfully moved through the approvals process
- Master plan was approved in November 2000
- Master development agreement is currently being negotiated
- Phase One construction summer 2001

Implementation Program

- First Phases are designed to:
  - improve Saddle Mountain for Heli-skiing
  - improve the visual quality of the mountain
  - reduce the number of Down Days
- First lift and Heli-lots in Phase Three
- Lift service to the Summit in Phase Five
- Golf course in Phase Seven
- Nine sequential phases; each phase is a finished product
- Development will be financed by the Mike Wiegele Heli-skiing operation
Benefits to the Resort

- More diverse offering of skiing packages
- Powder skiing academy
- Down Day availability
- Expanded range of facilities
- Improved livability for the staff and the community
- Improved visual quality

Whistler/Blackcomb

Five Year Development Plans
- Visual impact analyses using World Construction Set
- Using Trim data, detailed topographic and planimetric data, air photos and oblique photos

As good as the product is, so far, we are still trying to make sense of the process and make it less cost prohibitive for resort planning projects

Heli-skiing “Vertical Cutblocks”

Mike Wiegele Heli-skiing
- Digital Terrain Mapping
- Slope analyses to identify skiable terrain
- Work with the local forestry companies to identify areas of mutual interest
- Work together to develop vertical cutblock plans
- Work together on the approvals with the Ministry of Forests
- Economic diversification and sustained prosperity
- Ptarmagan Mountain is currently being cut based on this planning process
- Improved product for both Mike Wiegele Heli-skiing and Weyerhaeuser
- Economic diversification to the region

London Mountain Lodge

- New resort facility in Whistler
- Concerns about the visual impact from Whistler Mountain
- Required a simple visual impact analysis to get the project approved

Conclusions

- Visual impact analysis is playing an increasingly more important role in resort planning
- Utilizing computer technologies is key
- The trick will come in making these technologies as accessible as possible to answer “What if” questions as quickly and economically as possible
- Through consultation and careful planning, a balance between tourism and forestry is being achieved.
Good afternoon, It’s a great pleasure to be here. I have been working on this conference since last fall and it’s great to see everything has come together.

As a speaker I am here today to talk to you today about partial cutting and visual quality, and how our research results suggest that it can reduce impacts on timber supply. As most of you know, forestry is the number one industry in this province and still drives our provincial economy.

This being said, today’s forests are under extreme pressure to deliver more than just timber. Forest managers must also ensure that sensitive species and ecosystems are protected, natural diversity is maintained, water quality and scenic values are not degraded, and the goals of many other forest users are accommodated.

Visual quality of forested landscapes has become an increasingly important issue, as competition intensifies for the limited forest resources in British Columbia.

Tourism, British Columbia’s second largest industry, requires spectacular scenery to compete in a highly competitive global market. Within the tourism industry, the eco-tourism and adventure tourism sectors are experiencing rapid growth and require natural and well-managed landscapes for their businesses to succeed.

The Challenge

How do we ensure a vigorous, efficient and world-competitive timber processing industry and yet maintain visual quality for our number two industry? We know that we can manage for scenic values using Visual Quality Objectives and landscape design.
However, it is fact that clearcutting is still the most widely applied silvicultural system in British Columbia. In 1997–98, for instance, 91.6% of the land that was logged in British Columbia was clear-cut. This being said, it is often difficult to meet more restrictive Visual Quality Objectives (VQOs) using this system. Furthermore, the small-scale openings associated with restrictive VQOs usually mean reduced volumes, which ultimately translates into impacts on timber supply.

How can we manage for visual quality and not unduly constrain timber supply? One strategy has been to encourage the use of alternative silvicultural systems. It has been speculated that the public would find the visual result of partial cutting more acceptable. In addition, it thought that partial cutting could free up greater volumes of timber from scenic areas in the short term with restrictive Visual Quality Objectives as compared to clear cutting.

The Forest Service undertook three different studies to examine these questions. I am here to discuss these studies and share the results and findings with you.

**Visual Impacts of Partial Cutting**

The *Visual Impacts of Partial Cutting* report has been published and is available through the Queen’s Printer.

Its objectives:

- To determine if there were any site or stand variables that could be used to predict the impacts of partial cutting on the visual quality of a scene.
- To determine the public response to scenes that have been logged using partial cutting.

This was a complex study involving a number of elements and steps, including:

- Collecting pre- and post-harvest field data,
- Photographing sites,
- Classifying the sites’ visual quality,
- Analyzing the data,
- Conducting a public perception survey, and
- Analyzing the survey results.
Field work for the study involved collecting pre- and post-harvest site and stand data and taking photographs within the stand and from a distance. After this had been done, provincial landscape experts assigned, for analysis purposes, the landscape level photographs a Visual Quality Class (VQC).

A visual quality class describes an existing level or potential level of visual alteration on the landscape. It is defined by the same criteria as a VQO. There are five classes: Preservation, Retention, Partial Retention, Modification and Maximum Modification. Once photographs had been calibrated, logistic regression analysis was undertaken to determine the relationship between site and stand variables and VQC. This analysis revealed that percent volume and percent stems by average height of residual trees used together were a good predictor of VQC.

A prediction table has been developed so the practitioner can evaluate the visual quality to be expected after partial cutting a stand, given a specific volume removal in a particular tree height class. The values in this table are estimated to have a 90% confidence rating in predicting a VQO, so long as the stand is within the parameters of the study.

Before I move on, let me share with you a few examples of the partial cuts sampled and the resulting visual quality.

<table>
<thead>
<tr>
<th>Location</th>
<th>Forest District</th>
<th>VQO</th>
<th>Tree Ht. (m)</th>
<th>Vol Removed</th>
<th>Stems Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 Goldstream</td>
<td>South Island</td>
<td>R</td>
<td>40</td>
<td>10%</td>
<td>?</td>
</tr>
<tr>
<td>15 Skwaam Bay</td>
<td>Kamloops</td>
<td>R</td>
<td>29</td>
<td>46%</td>
<td>?</td>
</tr>
</tbody>
</table>
A public perception survey was also carried out as part of this study to determine the public’s views with respect to partial cutting.
The public, for the purposes of this study, is defined as a sample of the population that matches the socio-economic profile of the provincial population as a whole.

In general, the sample study was reasonably close to the general population, although participants were somewhat younger (more individuals in the 30–49 age group and fewer over 49), with slightly better education and higher income than for the province as a whole.

We administered a slide show containing 65 slides (36 partial cut scenes, plus 29 clearcut and non-harvest scenes) to 465 people in eight communities across the province. Participants were asked to view and rate the appearance (“visual quality”) of each of the 65 slides as it would affect their enjoyment of it.

During the public perception survey, respondents showed no clear preference for partial cuts over clearcuts in photos classed as Retention.

However, partial cuts were preferred slightly more often than clearcuts in slides with visual classifications of Partial Retention or Modification.

Respondents preferred the appearance of clearcuts over partial cuts in scenes classified as Maximum Modification.

The public response regarding clearcutting and partial cutting was not decisive. The public seemed to respond more to visual quality class than to silvicultural system.

One thing that became very clear is that the public did not like Maximum Modification partial cuts. Other studies have found that people like things neat and orderly.

| Moose Creek | Clearwater | MM  | 30 M | 83% | 80% |

- Perhaps Maximum Modification partial cuts look messy and consequently the public dislikes them.

While the *Visual Impacts of Partial Cutting* study identified those attributes we could use to predict visual quality and provided some insight as to the public response, it did not evaluate the implications of partial cutting on timber supply.

**Two Additional Studies**

Consequently, two additional studies have been carried out. Theses are entitled *Evaluation of Merchantable Volume in Areas Subject to VQOs*. One study was carried out in the Robson Valley TSA and a second study was carried out in the Strathcona TSA.

The Robson Valley in central-eastern British Columbia is a good example of an area with high scenic values. The Yellowhead Highway runs through the valley and Mount Robson Provincial Park is a dominant feature.
The Strathcona TSA covers central Vancouver Island, from the south end of Strathcona Park to Brooks Peninsula in the north. The East Coast of the island is extensively populated and the west coast has extremely high scenic values.

The Robson Valley was chosen because it represented the interior of the province, while Strathcona represented the coastal area of the province.

The objective of both studies was to utilize our newly developed volume/stems by tree height table in a timber supply study to determine if any benefits would be accrued by using partial cutting over clearcutting. We did not want this study to be just another number-crunching exercise. We wanted the study to be as thorough as possible and the analysis to be carried out as accurately as possible. Our first task was to determine which stands within each Timber Supply Area (TSA) could be partial cut. A list of criteria was developed after considerable consultation with operational foresters with experience in selective harvesting in other parts of the province.

The list for the Robson Valley is shown at right.

This information was entered into a GIS along with the forest cover information and analysed. Ultimately the computer produced a map of those stands suitable for partial cutting based on the criteria submitted.

The identified stands were then run through a timber supply analysis process.

First the merchantable volume available through clearcutting was derived. Next the volume made available through partial cutting was derived. The difference between these two numbers represented the gain by or loss through partial cutting.

The implications on long-term AAC of partial cutting were determined through a timber supply analysis. The results of the two studies are shown below:
How Is It Possible to Get More Wood Through Partial Cutting?

Partial cutting allows you to make repeated cuts over the whole area in a shorter time, and it doesn’t affect the scenic values because you are only taking out a portion of the stand each time.

Furthermore, Forest Practices Code regulations exempt cutblocks harvested by partial cutting from adjacency or green-up requirements where 40% or more of the area to be harvested is retained. That’s because the trees remaining after harvesting—or the residual stand structure—will satisfy the green-up requirements.

Given these results, one must ask why are we not doing more partial cutting in scenic areas. There have been a number of reasons:

- Predicting visual results has been difficult.
- The cost to log each cubic metre of wood is higher than for clearcutting.
- Historical emphasis has been timber vs. other resources.
- Equipment and expertise is not readily available.
- Silviculture concerns exist concerning the partial cutting of decadent stands, post-harvest blowdown, and difficulties re-establishing the stand.

Many of these barriers are obsolete, as research and development activities have produced new equipment and methods to implement partial cutting. Increased cost is a reality, but has been a bitter pill to swallow. The Ministry of Forests does will not allow stumpage rates to be adjusted until industry provides hard data showing increased costs. Industry has been reluctant to open their books, not wanting to adjust stumpage allowance without some actual hard data showing the higher costs.
It may be that in order to manage for the multiple objectives society wants from our forests, the benefits of partial cutting may outweigh the drawbacks. Partial cutting can result in:

- Less visual impact
- More volume short term
- Elimination of adjacency constraints
- A landscape referred by the public
- Multiple objectives addressed more readily than when using clearcutting.

There is also a new awareness that our forests provide us with far more than just wood products. And this new awareness has led to a different kind of forest management: integrated resource management based on sustainable forest practices. By sustainable, I mean sustainable environmentally, sustainable socially and sustainable economically. Partial cutting is an example of how, with efficient management, we can meet more than one objective on a single piece of land. And in the long term, partial cutting can provide the same amount, or more, timber.
Data-driven Visualization of Forest Management Alternatives
Using EnVision

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Outline

• Brief overview of visual simulation and data requirements
• Importance of vegetation data
• Envision overview
• Examples
• 3D digitizing
• Better data

Elements of Visual Simulations

• Terrain
• Surface features
• Cultural features
• Vegetation
• Rendering effects

Data Required For Simulations

• Terrain
  • digital terrain models
  • contour data
• Surface features
  • imagery (Photos or satellite coverage)
  • GIS layers
• Cultural features (roads, buildings, etc)
  • GIS layers
• Vegetation
  • stem mapping
  • measurement of representative plots
  • stand characteristics by polygon
  • attributes of individual plants
• Rendering effects
  • lighting
  • atmospheric effects (clouds, fog, haze)
  • water surfaces
  • camera characteristics
How Do We Generally Represent These Elements?

- Terrain
  - lighted-shaded surfaces
  - texturing
  - bump mapping
- Surface features
  - textured onto terrain surface
  - rendered using primitives
- Cultural features
  - textured onto terrain surface
  - rendered using primitives
- Vegetation
  - rendered using procedural models
    - stems, branches, and needles or leaves
  - rendered using pictures of trees
    - many methods
  - rendered as polygons with texture to represent vegetation
- Rendering effects
  - heuristic light models
    - approximations to the rules of optics and thermal radiation
    - point and object lighting
  - global illumination models
    - ray tracing
    - radiosity methods
  - fog and haze
    - color attenuation based on distance
  - clouds
    - imagery
    - modeled clouds

Elements of Visual Simulations

- Terrain
- Surface features
- Cultural features
- Vegetation
- Rendering effects

Note: Vegetation has the most significant effect on visual simulations (at least in forested areas)

Vegetation

- Significant component of simulations
- Requires large amounts of data to do well
- Easy to misrepresent
- Hard to represent in an unbiased manner
Hard to manipulate to show changes in conditions

Note: For large areas, general vegetation data may adequately describe conditions to produce simulations. However, when you zoom in to show detail for small areas, generalized data does not contain enough detail (species and size variety, regeneration, understory vegetation).

Types of Vegetation Data

- Artificial…based on ecosystem placement models
  - based on elevation, aspect, soil type, etc.
- Polygon or cell based
  - general description of species composition and size classes
  - inventory or stand exam data
- Individual tree data

How Do You Model and Show Prescription Effects?

- Prescription
  - general statement of desired stand condition
  - may not be enough to drive visualization
- Marking rules
  - specific guidelines to select trees for removal
  - work at an individual tree level
    - even when specified as stand target
    - facilitates data-driven visualization

Note: Difficult to model prescription effects, especially when you only have general vegetation descriptions. More detailed data allows better modeling of treatment effects.

EnVision

- Public domain
- Designed to portray plot, stand, and landscape conditions
- Overall goals:
  - provide a close linkage to data representing areas and individual objects in a scene
  - produce images using a variety of representation methods
    - image draping, simple geometric objects, photo-realistic ground surface and object textures
  - link with existing spatial and vegetation databases

EnVision Features

- Reads data from GIS (shapefiles and databases)
- Renders perspective views that include:
  - terrain
  - surface features using textures on ground surface
  - overlays (polygons, lines, walls, markers)
  - vegetation
  - objects (buildings, powerlines)
• Represents trees using a variety of rendering methods
• Provides ways to represent spatially explicit treatments without “shattering polygons”

**EnVision Features**

• Developed to address a “scale gap” in existing tools
  • Stand Visualization System (SVS): <1 to 5 ha
  • UTOOLS/UVIEW 500+ ha
• Rendering via OpenGL
• English or metric units or combinations

Note: Very few tools like EnVision exist. EnVision uses data typically stored in forestry GIS databases. EnVision produces images that range from simple abstractions to near photo-realistic renderings.

**Basic Data Needs**

• Terrain model
• Stand polygons
• Stand data
  • inventory (per acre/ha stand table)
  • SVS file for each stand

Note: Other data can be incorporated depending on the user’s needs.

**Draped Polygon and Line Overlay**

Note: GIS polygon overlay with colors based on stand structure classification scheme.

**Polygon Overlay with Textures**

Note: Textures clipped from aerial photograph used to fill polygons. The resulting “synthetic image” is draped over the terrain model.

**Stand Data**

• Inventory data
  • stand identifier, species, dbh, height, crown ratio, expansion factor
  • ASCII text file
  • DBASE format database file
  • SVS stand file for each polygon
  • Stand area doesn’t matter (1 acre/ha typical, larger or smaller OK)
  • Stand file will be used to fill stand polygon with optional rotation and mirroring to minimize pattern artifacts
Note: Inventory data can be measured tree records from a detailed inventory or diameter class tables for each species. Working with SVS stand files allows better representation of harvest patterns. Especially those that involve partial retention where retained trees are clumped. When using inventory data, harvest patterns must be developed by changing the stand polygon layer and assigning appropriate vegetation data to the treated and untreated portions of the original stand.

**Tree Rendering Methods**

<table>
<thead>
<tr>
<th>Simple geometric shape</th>
<th>Solid geometric model</th>
<th>Textured geometric model</th>
<th>Complex stick model (SVS realistic tree)</th>
<th>Photo icon component icon (bark texture and separate image for crown)</th>
</tr>
</thead>
</table>

Note: EnVision provides a variety of methods for rendering individual trees.

**Examples**

- Retention level and harvest pattern alternatives
- Mechanical fuel reduction treatments
- Stand development
- Inventory driven simulations

**Retention Level and Harvest Pattern Alternatives**

- Vary the retention level
  - base retention on basal area
  - apply treatment proportionally across diameter classes
- Vary the spatial pattern
  - Evenly distributed retention
  - Leave small patches (several per acre)
  - Leave one large patch per acre

**Modeling Stand Treatments**

- Initial stand condition based on inventory
- Treatments simulated using the Stand Visualization System (SVS) and a one-acre stand plot
- SVS plot used to fill polygon in EnVision
- Untreated portions of the landscape are populated using the untreated stand

Note: All treatments were modeled on a 1-acre plot using the Stand Visualization System
Note: Treatments that remove less than 50% of the basal area do not change the appearance of the stand very much.

**Mechanical Fuel Reduction Treatments**

Pre-treatment:
- 32 tons/acre down logs 3” and larger
- Lots of standing dead trees

Post-treatment:
- 10 tons/acre down logs 3” and larger
- All standing dead trees removed
- Regeneration reduced by equipment activity

Note: Fuel reduction treatments from Blue Mountains in Oregon. Goal was to show the effect of mechanical fuel removal. Mortality due to bark beetle damage and overstocked conditions. Very high pre-treatment fuel loadings.

**Stand Development**

Treatment designed to create a two-aged stand
- Initial cut resembles a shelterwood leaving less than 20% of “full” stocking
- Some underplanting to encourage Douglas-fir in understory
- End goal is Douglas-fir overstory with hemlock-cedar understory
Using Forest Inventory Data

- Stands delineated from aerial photos
- Inventory designed to characterize conditions in every stand polygon
- Inventory data consist of one record per measured tree
  - 2,700 ha area…13,500 tree records
  - for each tree record: stand identifier, species, dbh, height, crown ratio, expansion factor
  - tree expansion factor based on inventory plot size

**Ground Surface and Simple Trees**

**Comparison to photograph**

Note: Tree species, size, and density from inventory data
Tree locations are generated
Trees represented using solid models that accurately reflect the inventory data

**Textured Ground and Photo-Trees**

**Comparison to photograph**

Note: Tree species, size and density from inventory data, trees represented using photo-derived tree icons. No additional data is added to support the higher level of realism. Rendered scene is more realistic but doesn’t necessarily match reality

The big question is…Which rendering method best communicates the data?
The question should not be “which image looks most real?”
Digitizing On Perspective Views

- EnVision allows you to digitize features from the perspective view
- Features can be saved as ARC-INFO generate files (points, lines, polygons)
Note: Points are displayed using X, Y, and elevation as you move the mouse. Selecting a point, saves the point and draws a point marker in the scene. Features can be saved in formats suitable for input to GIS.

Better Data = Better Simulations

- LIDAR technologies are providing better terrain data
- Same technologies may provide vegetation data
  - overstory characteristics
  - maybe overstory tree locations and attributes

LIDAR (Light Detection And Ranging)
- active airborne sensor emits several thousand laser pulses per second
- many sensors can record multiple returns from a single laser pulse
- recorded pulse returns are post-processed and delivered as X-Y-Z coordinates

Light detection and ranging (LIDAR) shows tremendous promise for creating data for use in visualization (and other
LIDAR Returns Colored by Elevation
(~1km wide by 2km tall)

Comparison to aerial photo

Note: Small section of raw return data colored by elevation. Blue points generally represent the ground surface.

Very Accurate Ground Surfaces

- LIDAR returns processed to produce ground surface with 5 foot cells

Note: This is the ground surface (different area from previous slides) extracted from the return data.

LIDAR Penetrates Canopy (usually)

Note: Important thing to remember...LIDAR penetrates canopy in all but the heaviest cover. Photo shows the area when the LIDAR data were collected...arrows highlight common features

For More Information

- Web site: http://www.fs.fed.us/pnw/envision