

Coast Region FRPA Implementation Team

June 8, 2006

File: CRIT 2006 - 01

To: Members of Coast Region FRPA Implementation Team

“Silvicultural System and Partial Cut Harvesting Issues in the Coast Region Discussion Paper”

The attached document was endorsed by CRIT on May 4, 2006 and is provided as professional advice for use within the Coast Forest Region.

Sincerely,

Hal Reveley - co-chair

A handwritten signature in black ink, appearing to read 'Hal Reveley', with a large, sweeping flourish at the end.

Doug Meske - co-chair

A handwritten signature in black ink, appearing to read 'Doug Meske', with a large, sweeping flourish at the end.

**Silvicultural System and
Partial Cut Harvesting Issues
in the
Coast Forest Region**

DISCUSSION PAPER

**Silviculture Systems Issues Working Group
of the
Coast Region Implementation Team**

May 15, 2006

Contents

| | |
|--|----|
| 1. Introduction | 3 |
| 2. Professional Reliance | 5 |
| 3. Legislation and Timber Supply | 6 |
| 3.1. Partial Cut Harvesting under FRPA | 6 |
| 3.2. Timber Supply Implications | 8 |
| 4. Planning and Stocking Standards | 9 |
| 4.1. Silvicultural Systems and Stocking Standards | 10 |
| 4.2. Stocking Standards and FRPA | 12 |
| 4.3. Free Growing Obligations under FRPA | 12 |
| 4.4. Multi-storied Stocking Standards | 13 |
| 4.5. Circumstances with no Free Growing Obligations | 14 |
| 4.6. Stocking Levels for Dispersed Retention and Small Openings | 15 |
| 4.6.1. Dispersed Retention Stocking Levels | 15 |
| 4.6.2. Regeneration Requirements within Small Openings | 16 |
| 5. Sustainability | 17 |
| 5.1. High-grading and Devaluation of the Stand | 17 |
| 5.2. Species Shift | 18 |
| 5.3. Forest Health | 19 |
| 5.3.1. Dwarf mistletoe | 20 |
| 5.3.2. Root Disease | 20 |
| 5.3.3. Windthrow | 20 |
| 5.3.4. Stem Disease | 21 |
| 5.4. Wildlife Habitat | 21 |
| 6. Silviculture Systems Monitoring, Adaptive Management, and Surveys | 21 |
| 6.1. Monitoring and Adaptive Management | 21 |
| 6.2. New Stocking Survey for Partial Cut Stands | 23 |
| 7. Consistency between Appraisals and Site Plans | 23 |
| 8. Knowledge Gaps and Information Sharing | 24 |
| 9. Recommendations | 24 |
| 10. References | 27 |
| 11. Acknowledgements | 28 |

Appendix 1: Silvicultural Systems and Intermediate Cutting Definitions

Appendix 2: Silvicultural Systems Classification Key

Appendix 3: Amount of Partial Cut Harvesting within the Coast Forest Region

Silvicultural System and Partial Cut Harvesting Issues in the Coast Forest Region

1. Introduction

Since the early 2000s, within some forest districts of the Coast Forest Region, there has been an increase in the amount of timber harvested under a partial cut system. Partial cutting ideally involves cutting selected trees and leaving desirable trees for various stand objectives, although recent experience on the BC Coast suggests that the best trees are often taken and the less desirable trees are often retained. This includes single stem harvest which is the removal of individual stems or small groups of trees using either “standing stem” harvest by helicopter, or conventional falling and yarding by helicopter or other equipment.

Licensees are also using partial cut systems in constrained areas to address objectives contained in higher level plans, wildlife habitat areas, as well as cutblock adjacency, terrain class, and visual values. In areas that are heavily constrained, licensees may also consider a single pass intermediate harvest where only a portion of the stand is removed. In these unusual situations, harvest is not associated with a silvicultural system, as no future stand entries are planned.

The most common silvicultural systems being prescribed for partial cutting are the retention silvicultural system, associated with either even or uneven-aged management depending on the levels of tree retention and pre-existing stand structure, and what has been termed the single tree selection silvicultural system, associated with uneven-aged management. There has also been an increase in the number of stands prescribed for intermediate harvest with no regeneration requirements. In some cases, selecting and harvesting groups of trees, or creating small openings are being used with patch cuts or two-pass group shelterwood systems. There are concerns about the silvicultural systems being prescribed in all of these circumstances and whether they are appropriate for achieving the regeneration requirements in the short term, and the stand structural objectives in the long term. Questions have been raised over the minimum opening size for reforestation obligations, applicable stocking standards and stocking surveys suitable for partial harvesting on the coast.

In the context of this discussion paper, a partial cut system is considered to be the harvesting phase of either a retention silvicultural system for either even or uneven-aged management, the selection silvicultural system for uneven-aged management or an intermediate cut treatment. Also, in this context, a silvicultural system is defined as a planned series of treatments carried out through the life of a stand to achieve the desired stand structural objectives. A silvicultural system is designed to integrate harvesting, regeneration and other silvicultural

treatments to achieve a number of prescribed benefits over time. It covers these activities for the entire length of the planned rotation or cutting cycle. Appendix 1 provides definitions for Silvicultural Systems and Intermediate Cutting, while Appendix 2 consists of a Silvicultural Systems Classification Key.

Many partial cut harvesting applications submitted to forest districts in the early 2000s involved the use of the retention silvicultural system with dispersed tree retention, group tree retention or a combination of both, resulting in over story tree retention levels of approximately 10–20 percent. During this period, there were also increasing numbers of partial cut applications received in the Chilliwack (DCK), Queen Charlotte Islands (DQC), North Coast (DNC) and North Island Central Coast (DNI) Forest Districts that included cutblocks with significantly higher overstory tree retention levels ranging from 30–70 percent. Most were associated with the single tree selection silvicultural system, retention silvicultural system and intermediate cut treatments. Appendix 3 provides additional information and statistics regarding the recent level of partial cutting in the Coast Forest Region.

The *Forest and Range Practices Act* (FRPA) and related legislation are based on a professional reliance model that depends on professional judgment when prescribing and applying silvicultural systems. Forest districts and licensees have requested clarification on the supporting information requirements for uneven-aged stocking standards, even-aged stocking standards associated with the retention silvicultural system, and post harvest stand structure for areas with no regeneration objectives. For partial cut proposals, forest districts have raised concerns related to the silvicultural systems prescribed, including those related to stocking standards, high-grading, species conversion, forest health, timber supply, operability, growth and yield, appraisals, wildlife habitat and administration issues.

The Coast Forest Region Leadership Team of the Ministry of Forest brought forward these issues to the Coast Region Implementation Team (CRIT) for resolution. CRIT reviewed and refined the relevant issues and formed a Silviculture Systems Issues Working Group to address the issues, develop recommendations and report back to CRIT. The purpose of this discussion paper is to review the issues, develop possible solutions to address the issues and provide recommendations pertaining to the identified silvicultural system issues that may serve as a framework for further regional guidance which balances economic benefits with long-term forest management. This discussion paper is not intended to provide a legal interpretation of legislation or provide the basis for review of operational plan submissions. It is intended to provide a series of guiding principles that may help government and industry foresters resolve issues related to partial cut practices and the associated silvicultural systems.

The issues identified by CRIT fall into the following general themes:

- Professional reliance
- Legislation and timber supply
- Planning and stocking standards
- Sustainability and long-term value and forest health
- Silviculture systems monitoring and adaptive management
- Consistency with appraisal information
- Knowledge gaps and information sharing

2. Professional Reliance

Professional Reliance plays an important role under the current legal frame work of FRPA. Foresters are trying to grasp how the new professional reliance model fits into the decision making process related to the use of partial harvesting and application of various silvicultural systems. Foresters are also trying to understand what is expected of them professionally under this new model.

The Association of BC Forest Professionals (ABC FP) has developed a working definition of professional reliance that was approved by Council in September 2004. To review the full document please visit http://www.abcfp.ca/regulating_the_profession/policies_guidelines.asp

In the context of this discussion paper, a forest professional must recognize the following ABCFP professional reliance principles from a silvicultural systems perspective:

- recognize environmental, social and economic interests in forests, forest lands and forest ecosystems and the range of values they offer for both present and future generations;
- actively engage in dialogue with interested parties to build trusts and understanding;
- be committed to continually improving their profession by modifying their practice to reflect what they have learned from both successes and failures; and
- accept responsibility for their decisions and the advice they give fully recognizing that society expects their decisions and advice will be rendered in the public interest to ensure sound forest stewardship.
(ABC FP 2004)

Currently the ABCFP Professional Reliance Task Force (PRTF) has the following purpose: “to develop and communicate agreed-upon description and model for application of the professional reliance principles to forest, range and environmental management in British Columbia (PRTF Update December 2005). The PRTF tentatively expects to complete the description and working model for professional reliance guiding principles by March 2006.

For the purposes of this discussion paper the following guiding principles related to the development and implementation of silvicultural system prescriptions and

Guiding Principles:

- A professional is knowledgeable of all aspects of silvicultural systems, understands what distinguishes one system from another, and does not overlook historic and well founded silviculture principles of even and uneven-aged management.
- Professionals will maintain the necessary combination of knowledge, training, and experience related to silvicultural systems and stocking standards to prepare sound and technically-accurate site plans and prescriptions.
- Professionals will document their supporting rationale.
- The professional maintains competency with respect to silvicultural systems by continuously learning and improving skills through adaptive management and monitoring.
- Professionals who acknowledge their own limitations with respect to new or expanding areas of practice such as complex silvicultural systems and stocking standards issues (e.g.: uneven-aged management, intermediate cuts) will seek advice and information from appropriate published sources, and colleagues as required.
- Professionals will maintain and practice sound silviculture principles..

stocking standards should be considered.

3. Legislation and Timber Supply

3.1. Partial Cut Harvesting under Forest and Range Practices Act

Concerns have been raised by district staff of the Ministry of Forests and Range (MoFR) regarding the increased use of the retention silvicultural system and the single tree selection silvicultural system, and the potential long-term implications on timber supply. Licensees are proposing silvicultural systems, both even aged and uneven-aged management, with high levels tree retention (30-70%) in order to effectively manage resource values such as objectives in higher level plans, adjacency, visuals, wildlife, windthrow, biodiversity, riparian and resource features.

Under FRPA, licensees must write results and strategies consistent with objectives set by government. In order to be consistent, the results and strategies must conserve values without unduly impacting the supply of timber. For example, the objective set by government for riparian areas is, without unduly reducing the supply of timber, to conserve (at a landscape level), water quality, fish habitat, wildlife habitat and biodiversity associated with those riparian areas.

If partial cut harvesting systems provide consistency with conserving values, how will it be balanced against timber supply impact?

Direction to delegates regarding government objectives are outlined in sections 5 to 10 of the *Forest Planning and Practices Regulation (FPPR)*. The delegate is required to consider the objective qualifier of “*without unduly reducing the supply of timber from British Columbia’s forests.*” Also, guidance is required to Delegated Decision Makers (DDM) to assist them in reviewing results and strategies proposed by licensees as per the tests of FRPA.

The Chief Forester has quantified the “without unduly reducing the supply of timber from British Columbia’s forests”, by making a comparison to TSR II impacts. For the most part TSR II identifies impacts associated with the Forest Practices Code (FPC) that was introduced in 1995. TSR II should be used as the base line levels of timber supply on TSAs. Any impacts above what was modeled for the FPC could be perceived as unduly impacting the timber supply. The Chief Forester goes on to state it is a difficult task of balancing values.

When developing stocking standards, consideration must be given to timber supply implications. Historical timber supply reviews have been based on even-aged growth and yield curves. As more and more companies commit to a wide variety of silvicultural systems, the implications to timber supply are an important consideration. In many cases uneven-aged management is being practiced in already constrained areas, which is recognized in timber supply modeling. These constraints can be associated with, but not limited to, visually sensitive areas or riparian management areas.

Forest management is not solely influenced by ecology and timber production but also by social and economic factors. Partial cut harvesting does have biological reasons associated with its practice but it also has a social aspect to it as well. Much of the partial cut harvesting that is practiced today is motivated by society’s desire, expressed through higher level plans or other methods, to practice silvicultural systems other than clear cutting. It is important for timber supply reviews (TSRs) to model current practices as accurately as possible. Since TSRs are backward looking and are only done on a five year cycle, they can be outdated with current practices. FPPR Section 26(5) allows the minister to approve stocking standards that are not consistent with timber supply analysis and forest management assumptions. In these cases future TSRs and management plans must recognize on the ground practices and make the appropriate adjustments.

The Chief Forester provided a statement to accompany FRPA training, and it is excerpted as follows:

“And finally we wanted to maintain a balance between environmental conservation and timber supply. To that end we have introduced new timber objectives, which are fair enough, but it’s still about

balance. Balancing values is difficult and complex at the best of times. The objectives in the forest planning and practices regulation for several non timber values include a statement that the objective should not unduly reduce the timber supply from BC's forests. The intent of this language is to ensure the conservation of non timber values is undertaken and balanced with the socio economic benefits associated with timber values. FRPA is intended to be guided by the same timber supply impacts that aided the implementation of the Forest Practices Code. I raise this point to help you understand why this language is there. The language in the regulation is not intended to reduce the environmental standards of the Code but in fact to help ensure that they are maintained at the same level as in the past. Under the FPC the adequately managed and conserve test for plan approval was guided by government's timber supply impact targets. To make this same linkage and ensure that this works in the FRPA this needed to be rewritten into the objectives themselves. That is why the objectives specifically refer to not unduly reducing timber supply. I hope this provides clarity on this point." (December 2002)

3.2. *Timber Supply Implications*

There is the issue of the impacts of silvicultural systems associated with high levels of overstory tree retention on future harvest yields and stand values. Studies indicate that increasing overstory tree density has a negative relationship with regeneration and growth. High tree retention levels may lead to a productivity loss beyond that considered in recent timber supply analyses. This could result in an over estimation of the timber supply in the mid and long-term. This is of particular significance and concern in the northern coastal forest districts where overstory tree retention levels are between 30 and 70 % or higher.

The report titled *Variable Retention Yield Adjustment Factors for TIPSY* (Di Lucca *et al.*, 2004) outlines the development of variable retention volume adjustment factors for use in yield tables applied to variable retention cutblocks, polygons and analysis units. In the modelling study group tree retention had less effect than dispersed tree retention in view of it having less total edge length per hectare. The variable retention adjustment factors in the study were developed for retention levels up to 30% for Douglas-fir (Fdc) and western hemlock (Hw). The program can extrapolate up to 40% crown area retention which for Fdc will represent approximately 25 m²/ha retained. There are plans to extend this limit to higher tree retention levels in the next TIPSY version (Di Lucca pers.comm.).

In order for growth and yield modelling to provide reliable estimates for timber supply analyses the forest cover inventory of partial cut stands has to be accurately described. Survey training in the future should emphasize the correct methodology for classifying these stands and the importance of assigning the correct multi-storied inventory labels.

Licensees are selecting the retention silvicultural system, the selection silvicultural system and intermediate cut harvests in constrained areas to address cutblock adjacency, terrain class and visual issues which may increase the operable land base but also to increase financial return. These constrained areas have inherent net downs in timber supply modeling. The implications and magnitude to timber supply above current net downs are not known at this point.

4. Planning and Stocking Standards

The following guiding principles should form the starting point when developing

Guiding principles:

- Ensure that the proposed stocking standard is designed to meet the key objectives.
- Ensure that the proposed stocking standard articulates the key objectives on which it is based. For example stocking standard to meet visual quality objective.
- Identify the situations and circumstances as to where a particular stocking standard will be applied. For example – stocking standard associated with a visual quality objective will be applied in visual corridors.
- Consider the timber objective for the basis of the situations and circumstances where there are no other objectives identified as part of the Forest Stewardship Plan (FSP).
- Consider the type of management and range of silvicultural systems available when designing and proposing a stocking standard.
- Consider all options available to meet the key objectives when designing and proposing a stocking standard.

stocking standards for silvicultural systems associated with partial cut harvesting:

4.1. Silvicultural Systems and Stocking standards:

Silvicultural systems

For Professional Foresters specializing in silviculture, it is imperative to understand the concepts involved with silvicultural systems. The Silvicultural Systems Handbook for British Columbia (March 2003) - “the handbook” - is an extremely useful and valuable compendium of information on the management of forests in our province. It was created by working professionals from industry, government and academia. The handbook represents a first reference point when developing and implementing a silvicultural system prescription. The primary focus of the handbook is on Partial Cutting Silvicultural Systems. This handbook is a must read for any forester contemplating the implementation of a partial cutting silvicultural system. The terminology and definitions used in the

guidebook form the basis for understanding and are generally consistent with other literature relating to silvicultural systems.

Retention Silvicultural system

The concept of the retention silvicultural system was developed to address management scenarios that retain stems for purposes other than regeneration. Any of the classic silvicultural systems can be modified with tree retention. Wildlife Tree Patches are aggregate tree retention units for the objective of managing wildlife habitat. Tree retention units can be described as either aggregate or dispersed throughout a stand. The tree retention can be for long or short term depending on the objective the tree retention is prescribed to achieve. Tree retention will have an impact on the growth and development of the regenerating stand. This impact must be addressed in the selection of the silvicultural system or the expected outcomes of the system. The prescribing forester must evaluate the projected impacts from the tree retention and decide if the impacts are consistent with the management objective for the stand. Higher tree retention levels can reduce the growth potential of regeneration. Therefore, high density dispersed tree retention should only be considered where there are specific non timber objectives which require this.

Single Tree Selection Silvicultural system

The single tree selection silvicultural system is reputed to be the most complex and onerous of all uneven-aged silvicultural management systems. The Silvicultural Systems Handbook for British Columbia (March 2003) expands upon this system and contains a detailed section on the implementation of the Single-Tree Selection System. The system has been primarily used in the interior portion of the province for the management of drybelt Douglas-fir. The principles are that individual trees or groups of trees are removed more or less uniformly through out the stand to achieve or maintain a balanced regulated uneven-aged stand structure. This system does not have a free growing component rather it requires a long term commitment to management of the stand. Currently there is no legislation or regulation governing future stand entries.

For successful implementation continuous periodic stand entries and the management of all diameter classes is required. Complications associated with the tenure system, access management liability, and financial investment into future crop trees; lead this system to being a challenging choice for forest professionals. An evaluation of other silvicultural systems should be pursued prior to attempting to manage a stand via a Single Tree Selection Silvicultural system.

Intermediate Cutting cycles

Once developed, the silvicultural system and management plan for a stand can be implemented. The prescription may identify more than one cutting entries into a stand. These multiple scheduled entries maybe identified as intermediate cuts. Intermediate cuts are commonly used as a second or third entry into a stand. A shelterwood silvicultural system may have an intermediate cut scheduled to open

the canopy up to allow additional growing space for development of the regenerating stand. Intermediate cuttings are scheduled treatments as part of a silvicultural system.

Stocking Standards

Stocking Standards are a legal requirement as defined in the *Forest Practices Code of British Columbia Act* (FPC of BC Act) and FRPA. They are legal milestones used to evaluate the achievement of an obligation created through legislation. This milestone achievement should not be confused with being a silvicultural system or an end product goal. A stocking standard is a subset of a silvicultural system that has a targeted outcome. A stocking standard is a measurable description of a stand at a prescribed point in time. This point in time is a defined part of a silvicultural system prescription that has been prepared by a professional forester for the stand. This prescription is created in the context of managing the forest resources with the objective of creating prescribed stand conditions, generally in the short term. The more complex silvicultural systems such as single tree selection will require repeated stand entries (every 10-20 years) to achieve and maintain the desired stand structural goals.

For an even aged, single layer system (clearcut) stocking standards are usually grouped together and presented by site series for cutblocks. For more complicated silvicultural systems the presentation of milestone obligations often need to be site specific as the grouping possibilities are dependent on stand conditions and the silvicultural system being employed. The Establishment to Free Growing Guidebook, Vancouver Forest Region presents a generic tool for the development of a Single Stem Silvicultural System. This generic tool is not a set of stocking requirements; it is used to develop the milestone obligation. The *Silvicultural Systems Handbook for British Columbia* (March 2003) expands upon this topic and contains a detailed section on the Single Stem Silvicultural System. The prescribing forester must have a silvicultural system and stand structural goals of some sort defined for a stand in order to rationalize any proposed stocking requirements. A working knowledge of the autecological and silvical characteristics of the desired crop tree species being managed is critically important when creating a silvicultural prescription.

4.2. Stocking standards and FRPA

Unlike the FPC legislation, FRPA, has no requirement to specify the silvicultural system. However, the person designing stocking standards for particular situations and circumstances may consider the factors included in section 6 of Schedule 1 of FPPR. The factors specify what is to be addressed for stocking standards for even or uneven-aged management as well as intermediate cuts with no regeneration requirements. The prescribing forester must not lose sight of the silvicultural system selected when choosing stocking standards to meet the stand structure goals presented within a site plan.

It can be inferred from Section 1, Section 16(2) and the factors in Schedule 1 of the FPPR that the term *stocking standards* specifically means species, quantities, and characteristics of trees which are either established or retained following harvesting.

Stocking standards for the selection and retention silvicultural systems have both regeneration establishment and tree retention components.

4.3 Free Growing Obligations under FRPA

As summarized in the *Draft guide to the Evaluation of FSP Stocking & Related Standards, (February, 2005)*, in situations or circumstances where trees are established or retained to form either an even-aged or an uneven-aged stand after timber harvesting, a free growing stand is a stand of trees which at the date of the free growing declaration, based on the applicable stocking standards, will have the following criteria apply:

(a) Trees required to be **established or retained**

- Are **healthy** and **minimize forest health risk** related to **species selection**, e.g.
 - FSP rationale must address both the short and long-term forest health issues,
- Are of **commercially valuable and ecologically suitable species**, e.g.
 - species, densities or basal area are to be consistent with timber supply analysis and maintain or enhance economically valuable supply of timber (FPPR s. 26 (3)); FSP could describe how the overall species value profile will be maintained or enhanced,
 - Implies a certain proportion of more valuable species must be retained over the landscape, and may include a minimum valuable species % component (stems/ha or BA/ha),

Meet the requirements as to **species, numbers or quantity, and distribution** as specified in the applicable stocking standards, e.g.

- numbers established – could include minimum, target and upper density,
- distribution established – may be described by minimum inter tree distance, and M value for survey purposes,
- quantity of retained trees - may be described in basal area (m²/ha) and/or stems per ha.
- distribution of retained - assumed to be uniform unless otherwise specified, is measurable and verifiable; and can be described in terms of voids,

(b) Trees required to be **established**

- Are at or above the applicable free growing heights,

- Will, more likely than not, on a date that is 20 years from the applicable commencement date, conform to the applicable stocking standards and be unimpeded in their growth as a result of vegetative competition or forest health concerns,
- Will, more likely than not on a date that is 5 years after a brushing or spacing treatment is carried out more than 15 years from the commencement date, be unimpeded in their growth as a result of vegetative competition; and,

(c) Trees required to be **retained**

- Are consistent with the **required characteristics** for retained trees, as specified in the applicable stocking standards, e.g.
 - form – % live crown, crown shape, stem shape, stem taper, (trees selected may be affected by existing stand condition),
 - vigour – potential to release, height increment and age,
 - health – acceptable amounts of wounding; preferred species that minimizes risk,
 - other - dbh and or height range, stand table, stock table, representative of stand profile in species and value, meet special requirements of other resource values (wildlife habitat, ecology, biodiversity) and for what duration.

4.4. Multi-storied stocking standards

Any silvicultural system (even-age or uneven-aged) with a significant density of dispersed tree retention may require multi-storied stocking standards (*Silviculture Systems Handbook of BC 2003, Section 3.6*). It will be up to the prescribing forester to decide at which point, or amount of dispersed tree retention, a multi-layered stocking standard may be required.

For example retaining of 5-10 mature trees per hectare may not require a multi-story stocking standard where as retaining of 50-100 uniformly dispersed mature trees per hectare may. The Silviculture Systems Handbook suggests that multi-storied stocking standards are appropriate where there is more than 6 % crown closure in the silviculture layer 1 and 2 trees combined and a minimum of three layers present or one of the following combinations:

- layer 1 and 4,
- layer 2 and 4,
- layer 3 and 4.

Where a partial harvest is the cut phase of a single tree selection system meant to develop an uneven-aged stand of three or more age classes over several planned harvest entries then detailed supporting information will be retained on file such as a stand table, stock table, leave tree potential including vigour classes, planned stand cut/leave targets and where appropriate inverse J-curves (*Silviculture Systems Handbook of British Columbia 2003, Part 4*). This

information may serve to support the choice of stocking standards. For volume based tenures such as forest licences there likely will be problems associated with long-term planning and ensuring that future harvest entries occur on schedule.

To avoid additional stocking in the understory that will never attain acceptable growth and vigour, the stocking standards developed should allow for the growing space taken up by the larger trees retained in the mature layer 1 (>12.5 cm dbh) and pole layer 2 (7.5cm to 12.5 cm dbh). The uneven-aged stocking standards in the Ministry of Forests and Range's FDP reference guide may serve as a starting point. As these were designed for use in dry belt Douglas-fir stand types they may need to be modified to fit the particular situations and circumstances. Development and evaluation of multi-storied stocking standards for the coast is required. Stocking standards that are not locally and regionally developed represent an inherent risk of ignoring ecosystem viability, landscape diversity, stand dynamics and the ecological role of species.

4.5. Circumstances with no Free Growing Obligations

A residual stand that remains following an intermediate cut does not have a free growing requirement; however, there are to be stocking standards specified in the FSP which describe the retained trees in terms of value and ecologically suitable species, and their characteristics, quantity and distribution. The characteristics of retained trees may be similar to that specified above under section 4.3 (c) above. The quantity and distribution of trees retained must be to a level that will ensure the area will remain adequately stocked for a period of 12 months after completion of harvest (FPPR s. 44 (4)) such that a stand optimizes timber growth potential considering the objective of the site and the health and vigour of the existing stand.

For stands that are to be intermediate cut or harvested for special forest products the proposed density or basal area of retained trees would be considered consistent with maintaining an economically valuable supply of commercial timber if the proposed residual stocking level meets the following FRPA requirements and measurements:

- Is measurable and verifiable,
- Includes acceptable leave tree characteristics,
- Does not create a regeneration obligation,
- Leaves a residual stand where there is a future opportunity,
- Is supported by a description of the situations and circumstances as to where the standard would apply,
- Is supported by acceptable rationale in the FSP.

Possible approaches to describing the quantity of retained trees in an intermediate cut stand are as follows:

- A minimum basal area to be retained in the mature layer 1 (which consists of trees > 12.5 cm) e.g., 25 m² per ha to be retained,
- A minimal residual site occupancy, e.g., retain 80% of existing site occupancy,
- A maximum reduction in pre-harvest stand basal area or volume e.g., maximum 40% reduction in basal area or maximum 50% reduction in merchantable volume.

4.6. Stocking levels for dispersed retention and small openings

There is concern that partial cut harvesting associated with the single tree selection and retention silvicultural systems is causing species shifts and reduced mean annual increment.

4.6.1. Dispersed Retention Stocking levels

Some guiding principles to consider when developing stocking standards with regeneration requirements in stands with dispersed tree retention and/or small openings is as follows:

Guiding principle:

Evaluate the impact of the dispersed retention trees on stand site occupancy and potential growth of regeneration. Consider the following as part of the evaluation at the site plan level:

- Distribution and quantity of retained layer 1 and 2 trees
- Shade tolerance of species to be managed for
- Height of dominant and co-dominant trees to be retained
- Age, stand structure, and site quality of existing stand.
- Objectives of the silvicultural system prescribed

Some examples of a minimum stocking level where there may be no regeneration requirements:

- Commercial thin example: > 300 stems/ha or 50% of pre harvest stocking of healthy, well distributed (with no gaps exceeding twice the normal spacing for a given density), dominants and co-dominants, whichever is less, for second growth Douglas-fir (Fdc) 20 to 30 meters tall with a site index of greater than 30. The objective being to thin from below with a final harvest planned within the next 20 years.
- Intermediate cut example: >200 stems /ha or 50% of pre harvest stocking of healthy, well distributed (with no gaps exceeding twice the normal spacing for a given density) dominants and co-dominants, whichever is less, for old growth Fdc 40-50 meters tall with a site index of greater than

25. Objective being to remove some volume while maintaining a fully stocked stand for adjacency reasons with a final harvest planned within the next 20 years.

Note: Twice the normal spacing for 300 stems/ha is approximately 2 x 6m.

4.6.2. *Regeneration requirements within Small Openings*

There is also a concern that partial cut harvesting associated with single tree selection and retention silvicultural systems is causing reduced mean annual increment. A study reported by Coates (2000) on conifer growth response in gaps in the Interior Cedar-Hemlock zone in northwest BC (interior-coast transition), indicated that opening size need not be large (0.1 ha to 0.2 ha or larger) in order for most species in that zone to achieve growth rates similar to those found in the open conditions of clearcuts. Results of a ministry trial involving single tree and group selection in the Queen Charlotte Islands suggests that gaps greater than 0.3 ha are required if growth rates are to be comparable to clearcuts. (D'Anjou 2000).

Some guiding principles to consider when determining the opening or gap size where a stocking standard for establishing regeneration may be required are as follows:

Guiding principle:

Evaluate a minimum opening or gap size where site occupancy is such that stocking standards for establishing regeneration may be required. Consider the following as part of the evaluation:

- Objectives of the silvicultural system prescribed
- Regeneration performance requirements of the stocking standard prescribed.
- Height of dominant and co-dominant trees adjacent to the small opening or gap
- Shade tolerance of species to be managed for
- Age, stand structure, site characteristics (slope, aspect etc) and site quality of existing stand.

Some examples of a minimum opening or gap size when stocking standards may have a regeneration requirement are as follows:

- Openings which are 0.25 ha and larger prescribed for root disease management with no plans for a follow-up harvest within the next 20 years may have a regeneration requirement.
- Openings between 0.1 ha and ≤ 0.25 ha may not have a regeneration requirement if they are isolated and surrounded by tall standing timber and

- not part of an uneven aged management silvicultural system. A regeneration requirement may be appropriate if adjacent to a road.
- Openings ≤ 0.1 ha should not have a regeneration requirement, unless part of an uneven-aged management silvicultural system.
 - This does not preclude the licensee doing a best effort to avoid not satisfactorily stocked areas where there is sufficient growing space to allow for reforestation.

5. Sustainability

5.1. High-grading and Devaluation of the Stand

The single biggest concern of district staff is high-grading, or the removal of only the best trees from the stand often resulting in a residual stand of lower value. This issue relates to quantity, quality and species of tree being retained as well as species of trees being regenerated. If harvesting is done improperly, partial cut harvesting has a high potential to degrade a future stands genetic material, retain trees of least commercial value, impede regeneration, increase disease incidence and leave stems damaged by harvest operations and / or affect other biological and ecological non-timber values. The likelihood of this degradation occurring increases when the best trees are removed and lesser quality trees are retained. A similar degradation is likely to occur in areas outside the timber harvesting land base and in areas that are deemed inoperable, however this is considered biological high-grading rather than timber high-grading.

To avoid high-grading in stands where partial harvesting is proposed the following guiding principles should be considered:

Guiding Principles:

- Maintain volume and timber values at a level such that future stand entries are feasible within the rotation.
- Ensure future regeneration is comprised of healthy, ecological suitable species with good growth potential and representative of the species and grade profile at the landscape level.
- Achieve productivity and quality expectations over time.
- Avoid a decline in stand health.
- Consider all values and the trade offs between these values.
- Ensure that adequate information is available when developing a prescription.

5.2. Species Shift

Partial cut harvesting practices associated with single tree selection and retention silvicultural systems may promote species shifts if these practices target specific

species for removal. Species shifts may also occur where residual overstory conditions promote the regeneration and growth of aggressive shade tolerant species such as western hemlock (Hw) over more valuable species such as coastal Douglas fir (Fdc) and western red cedar (Cw).

One approach to dealing with species shift may be to set acceptable percentage limits such that if it is less than a minimum amount of the THLB for the management unit then the silvicultural system should not be constrained by potential species shifts. Recommend regular monitoring to see how the application of silvicultural systems is occurring annually and the degree to which it is resulting in species shifts.

Another approach to address potential species shift is to apply FPPR sections 45 (1) and (2) [free growing stands collectively across cutblocks] and manage for a specific species at the landscape level. Sections 45 (1) and (2) state that if a person specifies stocking standards, under Section 16 (1), which include regeneration and free-growing dates for a group of cutblocks, in a forest stewardship plan then that person must establish stands on the net areas to be reforested that conform to the applicable stocking standards by the applicable date as identified. The Chief Forester (FPPR s 16 (3) (d)) approves the free growing date and stocking standards where free growing stands are to be managed collectively across cutblocks.

To avoid species shift on sites where heavy browse pressure limits cedar establishment and cedar is a major species of the harvested stand, a possible solution might be to include a variance which sets a minimum percentage of the preferred species of layer 4 for a standards unit as cedar e.g., 20% to 30+%.

For example, under section 45 of FPPR, a dispersed tree retention stocking standard may be similar to a conventional stocking standard except that the requirement to achieve a minimum stocking of preferred species (MSP) will apply to the landscape level rather than to the block level, i.e., minimum species percent limits are set by cutblock and landscape level. The shading caused by the overstory may promote the establishment of shade-tolerant species, such as Hw and challenge the establishment of more shade-intolerant species such as Fdc and Cw. In situations where Fdc and Cw are preferred and Hw is not preferred, for example, the option to meet the MSP requirement at a landscape level for all blocks harvested in a licence in a calendar year would eliminate the need for unrealistic standards (and high costs) for the partial harvest blocks and deal with concerns of a species shift.

5.3. Forest Health

The forest health issues associated with high levels of overstory tree retention levels relate to the occurrence of endemic disease in the mature stand and the potential affects on the quality of the future crop from dwarf mistletoe, root

disease, windthrow, and stem disease entry following any wounding during harvest operations.

Under Section 26(3) of the FPPR, the species included in stocking standards and to be established under even-aged or uneven-aged management should be chosen to address the immediate and long term forest health issues of the area. As listed in Schedule 6 of FPPR, the forest health issues can be inferred to be “long-term forest health risks that are relevant to species selected” and the “occurrence and extent of forest health factors” which are defined as biotic and abiotic influences that have an adverse effect on the health of trees and plants. Also the characteristics of retained trees included in stocking standards for even-aged and uneven-aged management should address the forest health issues.

Under Section 26(4) of FPPR for intermediate cuts, the species to be retained is to address the immediate and long term forest health issues on the area. The FSP can contain rationale as to the suitability of the species retained to address the short and long term forest health issues including disease potential associated with harvest activities such as scarring, root damage and top damage or if the licensee uses the preferred/ acceptable format for species in its proposed FSP stocking standards, the minister will be satisfied that a species proposed in an FSP for a particular BEC site series adequately addresses the forest health issues typically associated with the species and site (*Draft Guide to the Evaluation of FSP Stocking and Related Standards, 2005*). Forest health damage criteria are determined based on knowledge that exists at the date the requirement must be met, such as guidebooks, and recent research.

5.3.1. Dwarf mistletoe

Partial cut harvesting systems in stands with high levels of dwarf mistletoe infected Hw in the overstory will likely perpetuate the disease in the regenerated stand. Partial cut harvesting systems are not recommended where susceptible tree species comprise more than 50 % of the total stems and more than 20% of the susceptible overstory trees are visibly infected. One option is to leave non-host tree species as border trees and plant or rely on natural regeneration of non-host tree species (*Dwarf Mistletoe Management Guidebook*).

Management and treatment options to reduce the incidence of dwarf mistletoe in stands prescribed for partial harvest include:

- Planting of alternate species such as Cw, Fdc and Balsam (Ba) within 15-20 m of infected edges.
- Feathering edges of groups of retained trees by removing Hw within 15-20 m of the edge.
- Girdling highly infected Hw trees on retention edges before regeneration is 2m tall (SPs for VR, BC Coastal Group, 2002).

5.3.2. Root disease

A partial cut or intermediate harvest of any root disease infected site should be carefully reviewed before proceeding with this type of stand entry (*Root Disease Management Guidebook*). The objectives of the treatment need to be carefully considered.

Management and treatment considerations where timber management is the primary objective include:

- Inoculum removal, stumping and push over harvesting are generally not suitable for areas that are partially cut.
- Retain advanced regeneration and plant seedlings of less susceptible species.
- On accessible openings greater than .5 ha plant and manage red alder intensively (where suitable) on a short rotation to reduce inoculum levels.

5.3.3. Windthrow

Disturbance of stand structure or retention of poorly adapted trees can leave a stand vulnerable to extensive windthrow damage.

Management and treatment considerations to help avoid excessive windthrow include:

- Consider completing windthrow hazard assessments in areas known for moderate to endemic high winds.
- Use partial and intermediate cuts cautiously in high and moderate windthrow hazard sites.
- Thin from below with intermediate cuts. Where possible avoid creating gaps greater than about one half tree length.
- Choose leave trees with windfirm characteristics.
- Leave an untreated buffer between an adjacent clearcut opening and the treatment unit (*Windthrow Handbook, 1994; Silviculture Systems Handbook of BC, 2003, Part 3.5*)

5.3.4. Stem disease

Mechanical damage and stem wounding of residual trees during harvesting can increase their susceptibility to various stem diseases.

Management and treatment considerations:

- Forest damage criteria and treatment strategies are described in the current *Establishment to Free Growing Guidebook*, (2000), and the *Tree Wounding and Decay Guidebook*, (1997).

5.4 Wildlife Habitat

Depending on the area and wildlife species present, partial cut harvesting may improve or degrade wildlife habitat, and in the latter case has potential to compromise wildlife habitat areas (WHAs), old growth management areas (OGMAs) and riparian areas.

Guiding principle:

Partial cut harvesting within WHAs, OGMAs and riparian areas must be consistent with objectives set by government. Results or strategies will have to be developed as part of the FSP submission to be consistent with these objectives.

6. Silviculture Systems Monitoring, Adaptive Management, and Surveys

6.1. Monitoring and Adaptive Management

Monitoring can play an important role, as one step in the adaptive management process, to help forest practitioners determine if various goals and objectives of the silvicultural systems being implemented are being achieved. Monitoring is one of six steps in the adaptive management process that allows forest practitioners to assess whether key response indicators are being met.

Generally, a silvicultural system should have the following basic goals:

- Meet specified higher level goals and objectives such as objectives set by government
- Provide for timely availability of a wide range and type of forest resources
- Produce predictable long term harvest levels that are consistent with TSR assumptions.
- Balance social, biological, ecological and economic concerns to help ensure sustainability.
- Provide for regeneration of preferred and acceptable species.
- Utilize growing space and maintain or enhance site productivity.
- Maintain a healthy forest by attempting to minimize the risks from stand-damaging agents.

As we move away from a prescriptive approach to forest management and towards a results-based approach there is a greater need for Regions and Districts to monitor silvicultural systems to ensure that the above goals are being met. As the legislation no longer makes specification of a silvicultural system mandatory it is important to determine the scope and scale of various types of silvicultural systems being implemented on the ground. Regions and Districts need to have some idea as to the extent and impacts of the various even-aged and uneven-aged silvicultural systems being implemented. By implementing a monitoring process Regions and Districts may be able to answer a number of critical questions with respect to meeting the general goals.

Are the silvicultural systems being prescribed and implemented on the ground doing the following?

- Meeting the objectives set by government?
- Providing for a wide range of forest resource values, including timber, fish, wildlife, recreation, soil, water and visual quality?
- Providing for predictable long-term harvest levels that are consistent with TSR as well as growth and yield assumptions?
- Maintaining, increasing, or reducing site productivity?
- Minimizing or increasing the risks from potential stand-damaging agents such as insects, disease or windthrow?
- Resulting in species conversion to less desirable species or maintaining the species profile at the stand or landscape level?
- Resulting in fully-utilized growing space and site occupancy?
- Increasing or decreasing tree quality, vigour and value?
- Providing for long-term stand maintenance such as additional stand entries for cutting cycles
- Resulting in sufficient regeneration of ecologically preferred and acceptable species that meet the free growing criteria?
- Retaining overall stand value?

Monitoring of silvicultural systems will also provide for a mechanism for the next phases of adaptive management of evaluation and adjustments. If for example silvicultural systems being implemented are not consistent with TSR assumptions then adjustments can be made to either the silvicultural systems being implemented or the TSR assumptions. This can be referred to as the feed back loop in the monitoring process. Results have to be communicated to the field practitioner to complete the adaptive management cycle.

There is a need for an effectiveness evaluation project to be conducted on partial harvesting within the region to set benchmarks for future value comparisons.

6.2. New Stocking Survey for Partial Cut Stands

The deviation from potential (DFP) survey procedure was developed for the interior of the Province to assess stocking in mountain pine beetle infested stands that have been salvaged by partial cutting. The existing even-aged and multi-layer survey procedures do not provide a reliable indication of stocking in stands with high variability in the amount, size and spatial arrangement of retained trees. DFP stocking procedures measure understory density of total well spaced acceptable trees in a regeneration plot. The amount of overstory is measured using basal area per hectare around a sample point. Understory stocking is quantified in terms of productivity loss (the deviation from potential understory yield) that a measured regeneration density represents (*A New Approach to Stocking Assessment in Stands Resulting from MPB Salvage Partial Cutting, 2004*).

On the Coast this survey procedure may be used to measure and verify stocking standards developed for stands with both regeneration and overstory tree retention requirements. This survey methodology may also be used to determine the potential impacts on timber supply. In order for the survey procedure to have application to the coast it will require a calibration project for coastal species on a variety of sites and a testing of the results.

7. Consistency between appraisal and site plans

One of the issues consistently raised by District staff is the need to ensure that the timber harvested is accurately appraised and adequately valued. There is concern that the appraisal submission on stands planned for partial harvest may not adequately reflect the species, quality and grade of timber to be removed. In some instances the net down factors applied in appraisal submissions may be based on a uniform removal of basal area from the stand profile rather than on the specifics identified within the site plan or prescription.

To ensure consistency between site plan and appraisal the following guiding principles should be considered:

Guiding Principles:

- Ensure that the appraisal accurately articulates what timber is to be removed from a stand.
- Ensure that the appraisal submission is consistent with the stand and stock tables and cutting rules specified within the site plan

8. Knowledge Gaps and Information Sharing

Specific themes included in the Timber Growth and Value Program Advisory Committee of the Forest Sciences Board are directing research into the areas where knowledge gaps related to partial harvesting and retention systems exist.

Stakeholders should be canvassed annually for input into research needs and priorities in this area.

In order for practicing professionals to be apprised of the latest information relating to partial harvesting and silvicultural system issues the communication process has to be improved. Information must reach field practitioners in a timely manner and a regularly-updated regional and district distribution list is essential. Those on these lists should be periodically advised of new hot links and additions to web pages on subjects relating to stocking standards and silvicultural systems.

More specific field-related training on the use of alternative silvicultural systems should be available for practicing professionals. As we move away from traditional clear-cut even-aged forestry we need to improve our understanding of the application of these various silvicultural systems. Training such as that provided by the now defunct Silviculture Institute of BC (SIBC), is essential to ensure that foresters have all the knowledge and information necessary to plan, and implement, silvicultural systems which prescribe high levels of overstory tree retention across the landscape.

9. Recommendations

9.1. Legislation and timber supply

1. Develop plans to monitor results and, where necessary, modify stocking standards to minimize timber supply impacts when multi-storey stocking standards are proposed for partial cut harvesting situations that are not consistent with the timber supply analysis or forest management assumptions.
2. Develop a methodology that more consistently tracks retention characteristics in the inventory for improving information entered into growth models.
3. Ensure that, when stocking standards which are not consistent with TSR assumptions are approved by the delegated decision maker, under FPPR Section 26 (5), the impacts of these standards are quantified and considered for the next TSR.
4. Timber supply review analysis for management units should include modeling and sensitivity analyses based on the latest growth and yield information that evaluates the effects of existing levels of high retention harvesting over the mid and long-term. To provide reliable forest cover inventory estimates for timber supply analyses, future survey training should emphasize the correct methodology for classifying these stand types.

9.2. Planning and stocking standards

1. Where partial harvest is the cut phase of a single tree selection system that is meant to develop an uneven-aged stand of three or more age classes over several planned harvest entries, licensees should retain on file supporting information such as stand tables, stock tables, leave tree potential including vigour classes, planned stand cut/leave values and, where appropriate, inverse J-curves or other quantified stand structural goals. The information may serve as rationale for the stocking standards.
2. Ensure that proposed stocking standards for partial cut harvesting applications are linked to key objectives and adequately describe the sites and circumstances to which they will be applied.
3. Develop multi-storied stocking standards for the coast using the Deviation from Potential survey procedure or some similar approach, and evaluate their effectiveness in achieving the anticipated results.
4. Evaluate a minimum acceptable stocking level of layer 1 and layer 2 for dispersed retention when a stocking standard for established regeneration is not required. The distribution of retained trees is to be uniform, and where this is not the case the type of distribution should be described.
5. For partial cut harvesting, a minimum opening or gap size when stocking standards for established regeneration is required is suggested to be 0.25 ha and larger; and for openings adjacent roads any gaps 0.1 ha or larger where adjacent residual trees are to be retained for greater than 20 years. This does not preclude the licensee doing a best effort to avoid not satisfactorily stocked areas; it simply means that there would not be compliance and enforcement action on these small openings.

9.3. *Sustainability and long-term value and forest health*

1. Standing stem harvesting focuses on the more valuable species and grades in the stand. The operational cruise for this type of harvest measures and grades the trees selected for removal with limited description of the characteristics of the surrounding leave trees. This makes it difficult to evaluate whether high-grading is occurring. Review the operational cruise standards for this type of harvest to ensure the appropriate information is also collected, such as species, grade and vigour classes of the retained trees to allow an evaluation of shifts in species and stand value.
2. Consider setting acceptable percentage limits such that if it is less than a minimum amount of the THLB for the management unit then partial cut harvesting and the associated silvicultural system should not be constrained by potential species shifts. Recommend regular monitoring to see how much partial cut harvesting is occurring annually and the degree to which it is resulting in species shifts.
3. Consider applying FPPR Sections 45(1) and (2) to manage for a specific species at the landscape level. Sections 45(1) and (2) state that if a person specifies in a FSP that the standards to be met by the regeneration date and free growing date relate to a group of cutblocks, the person must establish stands on the net areas to be reforested that conform to the

applicable stocking standards by the applicable date as identified. Meet the minimum stocking preferred species requirement at a landscape level for all blocks harvested in a licence in a calendar year.

4. To avoid species shifts on sites where heavy browse pressure limits cedar establishment and cedar is a major species of the harvested stand, consider including a special stocking standard variance as part of the stocking standards which sets a minimum percentage of the preferred species of layer 4 for a standards unit as cedar e.g., 20% to 30+%.
5. The FSP should contain an acceptable rationale as to the suitability of the species and characteristics of the retained trees to address the short- and long-term forest issues associated with harvest activities. Suggest that proposed FSPs include a strategy to ensure more valuable species will be regenerated to a level comparable to the existing stand profile.
6. Forest practitioners should be aware of available forest health related guidebooks and latest research information to ensure that forest health damage criteria used agrees with the existing knowledge base.

9.4. *Silviculture systems monitoring and adaptive management*

1. Develop a silvicultural systems monitoring plan for the region to evaluate high-grading, species shift, forest health and other issues. Monitoring of silvicultural systems will provide for a mechanism for the next phases of adaptive management of evaluation and adjustments.
2. Develop a methodology for quantifying the number of stands where tree retention is dispersed vs. aggregate.
3. An effectiveness evaluation project of partial harvesting should be conducted within the region to set benchmarks for future value comparisons.
4. The deviation from potential survey procedure may be applied to the assessment of stocking on coastal sites with some minor modifications. This survey procedure may be used on the Coast to measure and verify stocking standards developed for stands with both regeneration and overstory trees and determine the potential impacts on timber supply. In order for the survey procedure to have application to the coast complete a calibration project for coastal species on a variety of sites and evaluate the results.

9.5. *Knowledge gaps and information sharing*

1. Where knowledge gaps exist related to partial harvesting and retention systems, stakeholders should be canvassed annually for input into research needs and priorities in this area. The Forest Investment Account *Land Base Investment Rationale* updated each year includes a section for identifying research knowledge gaps by TFL or T SA and the person responsible for its preparation should request annually input from field staff.

2. Ensure that a regularly updated regional and district distribution list is maintained, so that information reaches field practitioners in a timely fashion. Those on these lists should be periodically advised of new hot links and additions to web pages on subjects relating to stocking standards and silviculture systems.
3. Conduct as required field sessions at the local level to discuss identified silviculture systems issues, develop possible solutions, share new information and improve consistency in application.

10. References

Association of British Columbia Forest Professionals, September 2004. Definition of Professional Reliance.

Association of British Columbia Forest Professionals, December 2005. Professional Reliance Task Force Update.

BC Coastal Group, 2000. SPs for VR Guidelines for designing variable – retention layout and silviculture prescription.

British Columbia Ministry of Forests. 1995. Dwarf mistletoe management guidebook. Victoria, B.C. Forest Practices Code of British Columbia Guidebook.

British Columbia Ministry of Forests. 1995. Root disease management guidebook. Victoria, B.C. Forest Practices Code of British Columbia Guidebook.

British Columbia Ministry of Forests. 1997. Tree wounding and decay guidebook. Victoria, B.C. Forest Practices Code of British Columbia Guidebook.

British Columbia Ministry of Forests. Canadian Forest Service. A new approach to stocking assessment in stands resulting from MPB salvage partial cutting. 2004.

British Columbia Ministry of Forests. 1997. Tree wounding and decay guidebook. Victoria, B.C. Forest Practices Code of British Columbia Guidebook.

British Columbia Ministry of Forests. 2000. Establishment to free growing guidebook. For. Prac. Br., Victoria B.C. Forest Practices Code of British Columbia Guidebook.

British Columbia Ministry of Forest, 2002. Stocking and free growing survey procedures manual. For. Prac. Br., Victoria, B.C.

British Columbia Ministry of Forests, 2003. Reference Guide for FDP Stocking Standards. For. Prac. Br., Victoria, B.C.

British Columbia Ministry of Forests. 2003. Silviculture systems handbook for British Columbia. For. Prac. Br., Victoria, B.C.

British Columbia Ministry of Forests. 2005. Guide to the evaluation of FSP stocking and related standards. Timb. Harv. and Silv. Prac. Sect., For. Prac. Br., Victoria, B.C., Forest and Range Practices Act Guide.

Coates, K.D. 2000. Conifer seedling response to the northern temperate forest gaps. Forest Ecology and Management. Vol. 122 pp 249-269.

D'Anjou, B.N. 2000. Alternate silviculture systems on steep-slope old-growth on the Queen Charlotte Islands. Project 13.3 – EP 862.34

Di Lucca, C.M., J.W. Goudie and S.C. Stearns-Smith. 2004. Variable retention yield adjustment factors for TIPSYS. Min. For., Res. Br., Victoria, B.C. Exten. Note 69.

Forest and Range Practices Act, SBC 2002, c69. last amendments 2004 Bill 3

Forest Planning and Practices Regulation, effective January 31, 2004. last amendments B.C. Reg. 102/2005

Strathers, R.J., T.P. Rollerson and S. J. Mitchell. 1994. Windthrow handbook for British Columbia Forest. BC. Min. For., Res. Br., Victoria, BC. Work. Pap. 9401.

Zeglan, S. 1997. Tree wounding and partial-cut harvesting – a literature review for British Columbia. BC. Min. For., Vancouver, B.C. Pest Manage. Rep. No. 14.

11. Acknowledgments

Members of the Silviculture Systems Issues Working Group (2004-2006).

| | |
|-----------------|--|
| Paul Barolet | North Island Central Coast Forest District |
| Bob Brash | Husby Forest Products Ltd. |
| Bernie Chapman | Cascadia Timber |
| Bob Craven | International Forest Products Ltd |
| Scott Dunn | Campbell River Forest District |
| Jevan Hanchard | Queen Charlotte Islands Forest District |
| Joe LeBlanc | International Forest Products Ltd |
| Bill McMullan | North Island Central Coast Forest District |
| Rick Monchak | TFL Forest Ltd |
| Rod Negrave | Ministry of Forests, Coast Forest Region |
| Chuck Rowan | Ministry of Forests, Coast Forest Region |
| Larry Sigurdson | Ministry of Forests, Coast Forest Region |

Craig Wickland Ministry of Forests, Coast Forest Region

Edit completed by Jennifer Turner, North Island Central Coast Forest District

Appendix 1

Silvicultural Systems and Intermediate Cutting Definitions

Silvicultural Systems

A silvicultural system is a planned program of treatments designed to achieve specific stand structural goals to meet specific objectives over the whole life of the stand.

Even-Aged Systems: These systems have one or two age classes, assuming 20 yrs per age class. Stands created by these systems develop a single canopy of uniform height.

Clearcut System: This system is characterized by removal of all trees comprising a stand in a single logging operation. To be a clear cut, this area must be at least one hectare in size and two tree lengths in width. The clear cut system is designed to manage for even-aged stands. Clearcuts are managed as distinct even-aged units. Reserves may be used with clearcutting.

Patch Cut System: This system is similar to the clearcut system except that the area of each opening is less than one hectare in size. Each opening is managed as a distinct even-aged unit.

The main functional difference between the patch and clearcut systems is that patch cuts continue to experience forest influence over most of their area. The key differences between a patch cut and a group selection opening (see below) are that: 1) the patch cut is wider than two tree lengths in size, while the group selection opening is two tree lengths or smaller and 2) all the openings from a single harvest entry in a group selection forest are managed as a single cohort or age class.

Strip System: Similar to a small clearcut or patch cut, except the cut areas are narrow and oriented to maximize wind firmness of the residual stand. Cutting progresses to windward about every 3-5 years.

Seed Tree System: This system is identical to the clearcut except that, for a short period, superior trees of a desired species are left on the site to deposit seed and attempt to recruit natural regeneration. Seed trees are typically removed after no more than five years of post-harvest site occupancy.

Shelterwood System: With this system, the old stand is removed in a series of two or more cuttings. This staggered removal assists with

regeneration by allowing the old stand to buffer environmental conditions and protect the new stand during its regeneration period.

Originally designed to secure natural regeneration, shelterwoods are often combined with planting to achieve regeneration goals. A key feature of this system is to leave to old stand (overstory or overwood) just long enough for it to protect the new stand (understory) but not reduce its growth through competition. Removal of the old stand is completed before 20 years (i.e. one age class period).

- **Uniform Shelterwood:** Removal of the overstory is applied in an even pattern. This is the classic shelterwood that allows for valuable release increment to be captured by the overstory.
- **Group Shelterwood:** Overstory removal is accomplished as a series of successive thinnings, usually beginning from patches of natural regeneration that expand and coalesce.
- **Strip Shelterwood:** Overstory thinning and removal is applied in linear patterns to achieve wind firmness in the residual stand i.e. into the wind but other patterns can be used. Variations include group-strip systems and wedge systems.
- **Nurse-tree Shelterwood:** The overstory is of a different species than the regenerating understory.
- **Natural Shelterwood:** Where the over- and understories have formed naturally, typically with a rapidly-growing pioneer species in the overstory and a slower growing, more shade tolerant species in the understory.

Hybrid Systems: These systems are characterized by extended periods of tree cover in stands, the irregular nature of the resulting canopy and the indistinct nature of the mix of age classes produced. These systems do not fit well in either the even- or the uneven-aged classification due to the extended period of overstory influence and the lack of regulation and regularly scheduled harvest entries.

Irregular Shelterwood System: Similar to the group shelterwood except the overstory removal period is greater than 20 years.

The literature notes that this system is akin to the group selection system (see below) and is similarly difficult to regulate. However, this system is much more flexible in application than selection systems and may be much more applicable to extensive forest management conditions in BC. The key difference between this and the group selection system is that the overstory is finally removed before the understory is mature, unlike the group selection where there are always some mature trees left in the stand.

Retention System: A key element of the retention system is that residual trees of the old stand are kept on site for at least one rotation. These residuals may be retained in groups or as single trees. A second characteristic of this system is the amount and distribution of residual stems. By definition, over 50% of the stand area must be within one tree length of residual stems. The residual stems must be distributed throughout the stand and not confined to a small portion of the area, as with reserves in a clearcut.

What distinguishes the retention system from clearcutting is the greater amount of residual stand and its influence and distribution over the whole area. What distinguishes the retention system from shelterwoods is that the residual stand is retained for at least one rotation i.e. at least until the regeneration is mature. What distinguished the retention system from selection systems is the greater amount of regulation and management input needed to implement selection systems and their emphasis on stand improvement for timber purposes. The retention system is unique in that its focus is on maintenance of pre-logging stand structure, rather than on regeneration and timber quality. The retention system is the only silvicultural system not to have been developed in Europe.

Retention systems are different from retention management. In the latter case, a combination of partial cutting and reserve strategies are used to retain forest structure across the landscape. In contrast to this, retention systems used the elements described above to manage structure over the long-term at the stand level. Retention management may involve silvicultural systems that do not recruit or retain more than two age classes and may therefore assume a clearer even-aged management approach.

Uneven-Aged Systems: These systems have three or more distinct age classes, at 20 yrs per age class, with clear differences in height, diameter and age. Stands created by these systems have uneven and irregular canopies, often with identifiable gaps (2.1-5). Universally noted characteristics of these systems are that: 1) they will degrade stand values unless carefully regulated 2) they emphasize improvement of stand value through the disciplined cutting of the worst first and the best last 3) they require ongoing inventory and maintenance in order to succeed i.e. there needs to be a frequent 'boots on the ground' presence.

Selection Systems: These systems remove trees as individuals or small groups, throughout the stand, at regular or semi-regular intervals. Regeneration pulses are associated with harvest entries throughout stand life. These systems are designed to maintain a sustained yield of timber indefinitely.

- **Single-Tree Selection:** This system involves cutting and regeneration in small areas that are theoretically no larger than 2-3 times the size of the largest trees being managed for. Some system of active regulation is essential to ensure that a suitable mix of regeneration, saplings and mature trees are present to meet objectives. An imbalance to smaller stems reduces capture of growing space while imbalance to mature trees reduces regeneration. Mathews (1989) cautions that selection cutting is not a silvicultural system but merely exploitation (highgrading) unless thinnings amongst the various size/age classes are made to: 1) maintain size classes in their regulated proportions 2) maintain species composition 3) release smaller saplings 4) remove defective stems. Single-tree selection has been designed to improve stand quality for timber objectives and for environmental protection.
- **Group Selection:** Similar to single-tree selection system but felling and regeneration are conducted in small groups of about one to two tree length in size. These groups are small but traceable over time. Unlike group shelterwoods, cutting in any entry is light enough for uneven-aged structure to develop. The main difference between this system and the irregular shelterwood is that mature trees are always maintained in the stand over the long term. This system was originally designed to convert even-aged stands to uneven-aged structure. An advantage of this system is that it can be used to grow species with low shade tolerance.
- **Strip Selection:** A form of the group selection with the innovation of arranging groups in strips to increase wind firmness of the residual stand.

Cutting Entries

Biological Highgrading: Removal of the best trees from a stand without commensurate and mitigating regeneration strategies such that the biodiversity value and capacity of the stand is degraded. Trees that show signs of decay and damage can be valuable for certain wildlife species and their retention may be appropriate. However, unless a residual structure that is representative of the pre-logging structure is maintained, including some of the largest trees of all species present in the stand before logging, retention has little value for promoting wildlife and biodiversity values.

Commercial Thinning: A silviculture treatment that 'thins' out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts. It is carried out to improve the health and growth rate of the remaining crop trees.

Highgrading: The removal of only the best trees from a stand, often resulting in a residual stand of poor quality trees. Essentially, this practice sacrifices future values that may flow from a stand for short term economic gain.

Improvement Cutting: The removal of trees of undesirable species, form or condition from the main canopy of the stand to improve the health, composition and value of the stand.

Intermediate Cutting: A partial cutting stand entry with no regeneration standards associated with it. Intermediate cuts can be incorporated as treatments in a silvicultural system, for example the seed cut in a shelterwood. A commercial thinning operation with the intention of eventually logging the residual stand is also an intermediate cut. However, intermediate cutting also includes isolated partial cut entries into a stand to remove a portion of its trees, with no concrete intention to harvest in the stand at a latter date. In this latter, case, intermediate cutting is not a silvicultural treatment.

Pre-Commercial Thinning: A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased. This may also be termed juvenile spacing.

Sanitation Cutting (Treatment): Tree removal or modification operations designed to reduce damage caused by forest pests and to prevent their spread.

Single-Tree Removal (Cutting, Harvesting, Logging): Removal of certain trees in a stand as defined by specific criteria (species, diameter at breast height, or height and form). It is analogous to highgrading if the sole criterion is removing the highest value stems and species. Not to be confused with the selection silvicultural system.

Appendix 2 Silvicultural Systems Classification Key

| | |
|---|------------------------------|
| 1a) Target stand structure will clearly be even-aged..... | 2 |
| 1b) Target stand structure will not clearly be even-aged..... | 6 |
| 2a) Merchantable trees will be removed in a single harvest operation..... | 3 |
| 2b) Merchantable trees will be removed in more than one harvest operation..... | 4 |
| 3a) Harvest openings will be least one hectare in size and greater than two tree lengths in width; may include dispersed single-tree reserve.... | Clearcut System |
| 3b) Harvest openings will be less than one hectare in size but larger than two tree widths across..... | Patch Cut System |
| 4a) Merchantable trees will be successively removed in strips, at 3 to 5 year intervals, proceeding into the wind, with openings less than two tree lengths wide..... | Strip Clearcut System |
| 4b) Residual trees will be left for up to about 5 years to cast seed but not in sufficient density to affect microclimate..... | Seed Tree System |
| 4c) Residual trees will be left in sufficient density to modify microclimate..... | 5 |
| 5a) Cutting and regeneration will proceed in an evenly spaced pattern throughout the stand..... | Uniform Shelterwood |
| 5b) Cutting and regeneration will proceed as strip patterns perpendicular to the prevailing wind..... | Strip Shelterwood |
| 5c) Cutting and regeneration will proceed in an expanding group pattern..... | Group Shelterwood |
| 6a) Harvest trees removed in a single or limited number of operations over less than one age class period in time and will not continue on a cyclical basis; at least 50% of harvest area within one tree length of retained stems; residual stems distributed throughout the harvest area..... | Retention System |
| 6b) Harvests continue over an extended period of at least one age class or indefinitely on a cyclical basis..... | 8 |
| 7a) Overstory will be removed over an extended period of more than one age class period but will completely remove the original overstory..... | Irregular Shelterwood |
| 7b) Harvests will continue on a cyclical basis indefinitely; a distinct overstory will | |

always be present as part of the stand.....9

8a) Tree removal and regeneration proceed as small groups about 1 – 3 times the area filled by a mature tree, distributed throughout the stand and untraceable as individual groups.....**Single-tree Selection System**

8b) Tree removal and regeneration proceed as small groups of at least one tree length in size but not exceeding two tree lengths in size.....9

9a) Group size not exceeding two tree lengths across and irregular in shape**Group Selection System**

9b) Group size not exceeding one tree length across; elongated strips with their long axis located perpendicular to the prevailing wind direction.....**Strip Selection System**

Note: Except for the retention system, all of these systems may be modified with the addition of group or dispersed single-tree reserves.

Appendix 3

Amount of Partial Cut Harvesting within the Coast Forest Region

The Reporting Silviculture Updates and Landstatus Tracking System (RESULTS) data base was queried for the period of 2000 to 2004 to quantify the area harvested in each forest district that is identified by a silviculture method code as selection, retention or intermediate cut; this is shown as a percent of annual harvest for a district for a given year. Selection refers to the selection silvicultural system and includes both group and single tree selection. Retention refers to the retention silvicultural system and intermediate cut refers to intermediate cut treatments including commercial thinning. During this time period, timber harvest was reported under a number of other silvicultural systems within the region including clear-cut, clear-cut with reserves, seed tree, patch cut, and both uniform and irregular shelterwood. **Note:** Information presented within this appendix may not be entirely accurate as it relies upon information reported into RESULTS, which has not been verified for accuracy. It is assumed that the information within RESULTS, with respect to silvicultural systems, is based on a consistent and common understanding of the various silvicultural systems being prescribed and implemented. This may not be the case in all circumstances

Hectares under the Selection Silvicultural System

For the Coast Forest Region during the period from 2000 to 2004 the percent of total harvest categorized as harvested under a selection silvicultural system ranged from 0.2% to 3.1% and for the five years averaged 1.5%. In 2003 there was a downward trend in all districts except DNC and DSI and if the DNC harvested area is excluded only in that year, 0.3% of the total area harvested for the region was done under a selection silvicultural system. To date, most applications of the selection silvicultural system have resulted in the best trees being removed without sufficient attention to reasonable selection, regulation and future follow-up.

Some reasons why the use of the selection silvicultural system in DNC increased to 606 ha in 2003 includes economics, poor markets for western hemlock, poor quality stands, protection of resource features, favorable public perception and maintaining visual quality objectives. There was a downward trend in the area harvested under a selection silvicultural system for most districts in 2004. From recent proposals received in some northern forest districts in the region the amount of harvesting done under the selection silvicultural system in those districts is expected to increase in 2005 and 2006. The data may not be entirely accurate for all districts due to reporting problems or incorrect silvicultural systems codes being identified. For example, although DQC does not report any area being harvested under the single tree selection silvicultural system in 2004, it is believed that this may be inaccurate due to errors in the reporting system.

With the introduction of the market pricing system on February 29, 2004, the special appraisal allowance of \$8/m³ was removed from stands under single tree selection or group selection (also for helicopter operations where trees were felled). Some licensee representatives do not anticipate a change in the level of helicopter harvest despite the change in appraisal allowance. The standing stem harvest by helicopter receives a special appraisal allowance to handle the additional costs associated with preparing the stem for yarding.

Table 1: Area reported as harvested under a Selection Silvicultural System:

| Districts | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | |
|-----------|------|-----------|-------|-----------|------|-----------|------|-----------|------|-----------|
| | ha | % harvest | ha | % harvest | ha | % harvest | ha | % harvest | ha | % harvest |
| DCR | 8 | 0.1 | 113 | 2 | 17 | .2 | 2 | 0 | 24 | 0.4 |
| DCK | 46 | 1 | 33 | 1 | 123 | 6 | 0 | 0 | 7 | 0.2 |
| DNC | 0 | 0 | 0.8 | 0.1 | 69 | 6 | 606* | 43 | 0 | 0 |
| DIC | 378 | 4 | 3 | 0 | 103 | 1 | 5 | .1 | 0 | 0 |
| DQC | 0 | 0 | 145 | 7 | 207 | 11 | 6 | .5 | 0 | 0 |
| DSI | 32 | .6 | 22 | .5 | 0 | 0 | 34 | .8 | .3 | 0 |
| DSQ | 44 | 2 | 6 | .4 | 75 | 5 | 26 | 3 | 9 | .8 |
| DSC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | .2 |
| total | 508 | 1.5 | 322.8 | 1.1 | 594 | 2.2 | 679 | 3.1 | 44.3 | .2 |

* Amount of single tree selection reported for DNC in 2003. It is possible that some of this area was harvested under retention or an intermediate cut treatment and not reported correctly within RESULTS.

Hectares under the Retention Silvicultural System

For the Coast Forest Region during the period from 2000 to 2004 the percent of total harvest categorized as being harvested under a retention silvicultural system ranged from 13% to 44% and for the five years averaged 30%. There has been a general upward trend in region and across most districts in the area harvested under a retention silvicultural system during this five year period. Generally tree retention levels have been higher in the northern forest districts. It is estimated that approximately 10% of the area harvested under a retention silvicultural systems maintain overstory tree retention levels of greater than 30 %, although this has not been quantified. It will be important in the future to obtain accurate information on how much dispersed vs. aggregate overstory tree retention is actually being retained on blocks harvested under the retention silvicultural system. This trend of timber being harvested under a retention silvicultural system is expected to continue to increase.

Table 2: Area reported as being harvested under a Retention Silvicultural System

| Districts | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | |
|-----------|------|-----------|------|-----------|------|-----------|------|-----------|-------|-----------|
| | ha | % harvest | ha | % harvest | ha | % harvest | ha | % harvest | ha | % harvest |
| DCR | 273 | 3.6 | 2062 | 27 | 1124 | 18 | 1583 | 31 | 2894 | 44 |
| DCK | 96 | 3 | 437 | 16 | 502 | 23 | 732 | 39 | 809 | 29 |
| DNC | 213 | 28 | 316 | 31 | 434 | 35 | 548 | 39 | 618 | 52 |
| DIC | 530 | 6 | 890 | 12 | 1372 | 18 | 1298 | 23 | 1618 | 27 |
| DQC | 746 | 34 | 907 | 46 | 802 | 42 | 682 | 61 | 1145 | 83 |
| DSI | 1782 | 35 | 2042 | 48 | 2389 | 56 | 2450 | 59 | 2308 | 57 |
| DSQ | 164 | 9 | 296 | 21 | 308 | 22 | 66 | 8 | 399 | 38 |
| DSC | 551 | 19 | 1077 | 44 | 1217 | 49 | 703 | 41 | 1431 | 59 |
| total | 4355 | 13 | 8027 | 28 | 8148 | 30 | 8062 | 37 | 11222 | 44 |

Hectares under Intermediate Cut treatment

For the Coast Forest Region during the period from 2000 to 2004 the percent of total harvest categorized as being harvested under an intermediate cut treatment averaged 1.5%. During the early part of the time period, most of the areas, especially in the southern districts, reported as being harvested under an intermediate cut treatment were actually commercial thinning treatments. The area of land where commercial thinning was applied has decreased through the time period. Based on recent partial cut harvesting proposals the amount of timber harvested under an intermediate cut treatment is expected to increase.

Table 3: Area reported as being harvested under an Intermediate Cut treatment.

| Districts | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | |
|-----------|-------|-----------|------|-----------|------|-----------|------|-----------|-------|-----------|
| | ha | % harvest | ha | % harvest | ha | % harvest | ha | % harvest | ha | % harvest |
| DCR | 415 | 5 | 235 | 3 | 310 | 5 | 59 | 1 | 86 | 1 |
| DCK | 0.5 | 0 | 16 | 0.6 | 45 | 2 | 206 | 11 | 194 | 7 |
| DNC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DIC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95 | 2 |
| DQC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DSI | 114 | 2 | 83 | 2 | 30 | .7 | 0 | 0 | 5 | .1 |
| DSQ | 0 | 0 | 0 | 0 | 27 | 2 | 80 | 10 | 0 | 0 |
| DSC | 0 | 0 | 81 | 3 | 7 | .3 | 0 | 0 | 6.5 | .3 |
| total | 529.5 | 1.6 | 415 | 1.4 | 419 | 1.5 | 345 | 1.6 | 386.5 | 1.5 |