Silviculture Practices for Enhancing Old Forest Stand Structure in Red- and Blue-Listed Plant Communities in the CDFmm: Interim Document

Version 2.0

May 10, 2010

Prepared by:
Roderick Negrave, R.P.F., P.Ag., Coast Forest Region
Dean Stewart, R.P.F., South Island Forest District

Acknowledgements:

We would like to acknowledge and thank the following people for their assistance through the planning and review of this document:

Carmen Cadrin, Conservation Data Centre, Ministry of Environment
Mary Jo Hamey, Ministry of Environment
Andy MacKinnon, Coast Forest Region, Ministry of Forests and Range
Dr. Sari Saunders, Coast Forest Region, Ministry of Forests and Range
Kevin Telfer, Ministry of Environment
Craig Wickland, Coast Forest Region, Ministry of Forests and Range

Contents:

A. Introduction

This document has been prepared and released as an interim document to provide guidance to practicing professional foresters who are tasked with preparing plans and prescriptions for clients with tenure under the Forest Act in the Coastal Douglas-fir biogeoclimatic zone (CDFmm). These foresters are tasked with professional responsibilities for developing plans and prescriptions on crown land which balance the needs and tenure rights of their clients with that of public expectations and species at risk.

It is not intended that this document provide legal advice or details towards a conservation strategy, nor to apply a prescriptive approach to any plans or prescriptions. Neither is it intended to suggest that further land use decisions are or are not required in the CDFmm. This document is solely intended to provide advice on retaining the ecological functions of older and mature forest conditions and to suggest methods for increasing the representation of older and mature forest structures within the CDFmm on provincial forest lands.

The document was first presented as a draft in October 2007. Comments were received until October of 2009 and the document was refined from these.

B. CDFmm RED AND BLUE LISTED PLANT COMMUNITIES BACKGROUNDER

The Ministry of Environment (MOE), Conservation Data Center (CDC), considers 29 plant communities (or "ecological communities") in the Coastal Douglas-fir (CDFmm) biogeoclimatic zone as red listed. The CDC conducts conservation status assessments on species and ecological communities in BC, and has determined that these 29 associations have a status rank of S1, S2 or range S1S2. The information for the entire list of ecological communities can be found on the CDC website at: www.env.gov.bc.ca/cdc/ and the BC Species and Ecosystems Explorer http://www.env.gov.bc.ca/atrisk/toolintro.html. Included in that list are the zonal plant association of Douglas- fir/ dull Oregon-grape and the Douglas-fir / oniongrass association. These communities have both been listed under the *Forest and Range Practices Act* (FRPA) Identified Wildlife Management Strategy (IWMS).

The CDC, Forest Practices Board, Registered Professional Biologists, Registered Forest Professionals and members of the public have raised concerns that these red listed plant communities are at risk of extirpation due to a variety of activities including forest harvesting. According to the Draft Status of Biodiversity in B.C. (May 2007) the ecosystem loss of the CDF zone is measured at almost half of the mapped zone (e.g. 1310 km2 remaining). Within the CDFmm there is a lack of adequate biodiversity representation of mature or old forest condition. Less than 1% of this biogeoclimatic zone meets these conditions. These red-listed plant communities are largely restricted to mature and old forests: with only the current 1% of the land base as mature and old forest, these plant communities will continue to be listed as 'at risk'. Private lands account for 90% of the zone, 3% is contained in parks and protected areas and the remaining 7% are fragmented parcels of crown land. The 1987 Brundlandt Report made a general recommendation that 12% of land be protected from use for biodiversity conservation. Protecting all of the remaining Crown lands and allowing them to become mature and old forests

would provide a maximum of 10% towards biodiversity representation. Further assessments are required to evaluate those crown lands as being suitable for meeting a conservation strategy. Private lands are threatened by urban and rural development, agriculture, forest harvesting, and the introduction and spread of invasive plant species. Long term survival of non-tree biodiversity and non-forested ecosystems is dependent on the ecological integrity of the forest matrix. Stewardship of the remnant forests in the CDF and recruitment of older forest is critical and needs to be accompanied by strategies on the private land base.

In 2005 the Forest Practices Board (FPB) complaint investigation and subsequent report, 040555, addressed Logging and Conservation of Endangered Plant Communities on Vancouver Island. In their report the FPB concluded that ***"it was not reasonable for the district manager to be satisfied that the plan amendment would adequately manage and conserve red-listed plant communities in the CDF without a site assessment"***. The report, recommendations, and government agency responses can be found at: http://www.fpb.gov.bc.ca/news/releases/2005/08-16.htm.

Previously the *Forest Practices Code of BC Act* (FPC) and now the *Forest and Range Practices Act* (FRPA) establish the legal framework for the content of plans and prescriptions, and establishes the criteria for the Delegated Decision Maker (DDM) to evaluate and approve operational plans. One of the recommendations arising from the FPB report was that the ***"South Island Forest District should ensure that assessments are conducted on proposed cut blocks in RMZ 34 within the CDF, before further harvesting is approved in this ecosystem"***. Where determinations are pending South Island Forest District staff has been working with the MOE and the CDC to undertake assessments for the two plant communities listed under IWMS. While there are no legal requirements for a licensee to conduct these assessments a licensee may voluntarily complete an assessment in support of the decision making process. A copy of the Assessment Protocol will be posted to the web site as soon as possible. The protocol is completed for only two site series, (01 and 03), and should be adapted for the other site series associated with natural ecosystems. In general, parcels that are assessed as FAIR and GOOD through the protocol are the highest ranked element occurrences present in the provincial forest. CDF element occurrences are locations that contribute to the survival of the CDF by providing places that are re-establishing natural ecological communities. Foresters are encouraged to retain existing element occurrences to develop naturally over the long term, and to use harvest opportunities in young dense stands to hasten the formation of mature structure to create element occurrences of CDF ecosystems.

The *Foresters Act* outlines the role of forest professionals in preparing plans and prescriptions. While there is no legal requirement for a licensee to complete an assessment for red listed plant communities, there may be a professional responsibility. Forest professionals should be aware that "Professional Reliance Guidance Papers" are posted on the Association of British Columbia Forest Professionals (ABCFP) website at: www.abcfp.ca/publications_forms/publications/committee_reports.asp. While not a complete list, ABCFP related bulletins are "Managing for Species at Risk: What are a Forest Professionals Responsibilities", and "Interpreting the Public's Interest".

There is a diverse range of opinions on how to manage forests for biodiversity within the CDFmm. Forest Professionals need to be familiar with the issues and the challenges associated

with forest management of red listed plant communities in the CDFmm. This silviculture practices paper is intended to give Forest Professionals a sense of the issue and provide some information of what to consider when preparing plans and prescriptions on Crown forest lands.

C. Planning

The fundamental planning issue about managing for red- and blue-listed plant communities in the CDFmm is that these communities are well developed in mature and old forests but are not well developed in younger second-growth forests. Most of the CDFmm landscape, and adjacent areas, such as the CWHxm1 and 2, is dominated by these younger second-growth forests. Very few mature and old forests still exist in the CDFmm. Therefore, in order to manage for red- and blue-listed communities, we need to make young forests resemble older forest more quickly. The key to this is to manage for structure. Although incomplete, a few important considerations include:

- Management objectives that aim to increase the structural diversity within second growth stands while coordinating with adjacent and local features, where possible.

- Extended rotations exceeding 80 years of age are more likely to recruit mature and old-growth features into stands (Blackwell *et al.* 2002). Priorities for WHAs are mature or old forests as described by Pojar, Flynn and Cadrin, described as structural class 6, or 7. Plant community characteristics are defined as structural stage 5 and greater, with a comment that more structurally complex stands, usually >80 years may qualify. Their recommendation is that in order to sustain the viability of this forested community and retain the wildlife habitat values, all of the remaining stands greater than 140 years should be protected as well as a large proportion of younger stands to provide recruitment for older forest. Maintain or restore occurrences to as natural a state as possible and practical. In this context, “natural” means that the plant community has few non-native plants, has not been recently disturbed by human activity, and cycles freely through successional stages in response to natural disturbances. The Ministry of Forests vegetation classification can be used to predict the natural species composition expected at climax in these ecosystems, with the exception of non-native plants. Most remaining occurrences of the Douglas-fir—dull Oregon grape communities within the CDF are younger secondary forests.

- Stands with existing vertical complexity that are serving as element occurrences should be retained for CDF representation over the long term.

- Harvest opportunities, such as commercial thinning or other non-clear-cut harvesting systems, should be sought in young, dense, homogenous stands to hasten the development of mature structure with an objective to maintain a CDF element occurrence over the long term.

- Invasive species need to be monitored and controlled.

- Fewer roads and larger road less areas are better than dense road networks

- Coordinate with existing natural features. The ideal conservation situation is a series of protected areas linked continuously by lightly-impacted areas through which core areas can "communicate" with each other.

- Structural attributes provide only some of the habitat that is needed for biodiversity. There is no substitute for time in development of old forest species composition, which takes long periods of time to develop.

D. Practices

1) Target structural traits

The CDF zone was settled by Europeans in the mid 19th century. Fort Victoria was established in the mid 1840s, Nanaimo in the late 1840s and agricultural settlement of the Saanich peninsula in the 1850s. . Logging and fire suppression accompanied settlement and almost all CDF stands post-date logging activities of some sort (Nuszdorfer *et al.* 1991). Detailed description of plant communities only dates from the 1960s and 1970s e.g. Krajina (1965, 1969), Roemer (1972), McMinn, et al, 1976. Some evidence that can be used to infer old forest structure in the CDFmm is from areas known to have not been logged in a variety of areas, although this is limited. A few of the parks that have been sampled in the CDF that are known to have never been, such as Mount Douglas park in Victoria and some properties of the Department of National Defence, including parts of Rocky Point. The effect of suppression of the fire regime on the current versus historic structure of these areas is unclear. Consequently, any description of pre-contact plant community structure is likely speculative.

The role of fire in the CDF is uncertain but may be significant. Some CDF forests were clearly established from huge fire events around the turn of the last century e.g. Dinner rock area on Sunshine Coast south of Lund. Similarly, areas of adjacent CWHxm transition areas such as the Victoria watershed show evidence of fire establishment (SEI, 1997 and 2004). Wildfires were thought to be common in the pre-contact CDF, and there is evidence that major fire 300 – 400 years ago, burned most of the east side of Vancouver Island from Saanich Peninsula to Campbell River (Min Forests, 1999). Directed aboriginal burning on the east side of Vancouver Island has been documented as far north as the Pentlach River near Courtenay. This pre-contact burning culture combined with the dry season that the CDF experiences during the summer months suggests that fires may have been a common pre-contact occurrence. The degree to which these fires were stand--initiating or stand-maintaining, aside from Garry oak communities, is unknown. The presence of old or mature forests with old-growth structure on unsettled lands, parks, and on military reserves is currently assumed as a model and conservation goal for management of red and blue-listed plant communities by the CDC.

Generally speaking, the current dominance of juvenile, even-aged stands with homogenous structure fails to meet conservation expectations due to lack of structural development and species composition. Simply put, old-growth forests have a degree of structural and compositional variations that younger second-growth stands rarely have. Key elements of

this include high species diversity in understory plant species, canopy invertebrates and non-vascular plants, greater variation in tree sizes; variable canopy structure that included frequent gaps; well-developed understory of non-timber species and significant amounts of coarse woody debris. Coarse woody debris is valuable both standing, as snags, and on the forest floor. A number of plant species are restricted to growing on coarse woody debris in old-growth forests (Feller 2003).

Forest representation is a principle of forest management that requires protection of sufficient unmanaged stands to provide natural ecosystem function as a prerequisite to any other kind of forest management including forest harvesting. Site series in the CDF that are on the red lists, and their associated ecological communities, are there due to an insufficient area of unmanaged stands protected in a mature or old state. The biodiversity guidebook defines mature stands as 80 years old in the CDF.

In summary, the structure of pre-contact CDF forests is not known with a high degree of accuracy but residual evidence suggests that old-growth structural features were at least present and that large, old, often widely-spaced, trees were a pivotal characteristic of the landscape. Much of the CDF has been permanently lost to urban development, agricultural conversion and industrial activity. Other loss is the result of fragmentation due to rural development, forest harvesting on private and crown lands and transportation corridors. Current stands in the CDF tend to be younger second growth stands that lack the traits of mature or older forests. However, also present are stands with a complex disturbance history that have a range of tree sizes and ages along with variable-sized gaps. These latter stands are often associated with historic diameter limit logging and root-rot occurrence. Such stands often contain individual trees that are at least 80 years of age and support complex vertical and horizontal structure. Therefore, to maintain or enhance the conservation value of existing stands in the CDF landscape, mature and old-growth structural features need to be preserved, where found, and enhanced through silviculture where absent. However, although structure can be recruited to a certain degree, long periods of minimal or no disturbance appear to be necessary to establish the full range of old-growth structural and compositional components.

2) Strategies for maintaining structural diversity in stands with high conservation value.

Stands with high conservation value are those with greater amounts of species diversity, tree size differentiation; coarse woody debris; gaps; understory abundance. These stands should be considered a priority for conservation where they are found.

Stands with existing vertical complexity and Element Occurrence assessments of FAIR or GOOD conservation value are likely functioning already as element occurrences, with a good chance of developing into natural ecosystems on their own. All second growth stands require a conservation evaluation assessment to determine their level of ecological integrity. Areas with potential for core conservation areas should be reserved. It must be recognized that the conservation value of these stands will be reduced as a result of harvest.

a. Wildlife tree patches and other reserves

The designation of wildlife tree patches, or other types of permanent reserves, can be an effective method of conserving populations and mitigating the effects of development on ecosystem integrity at the stand level. The following description by Hunter (1997) provides the basis for an overview of dispersion and the effectiveness of reserves.

A landscape may be viewed as a group of interacting ecosystems. Movement of organisms is a key process, because this is one of the principle ways in which ecosystems interact. Types of movement include short-term home-range movements by animals, migration over annual time scales, dispersal of young organisms (including plant seeds and other propagules), and geographic range shifts in response to environmental change. Development that affects any of these four types of movement could impact a species, community, ecosystem, or plant communities.

Landscape development proceeds through several stages of intensity. Dissection is the creation of linear corridors, such as roads, that may limit the movement of smaller animals and clonal plants. Perforation is the creation of small openings, such as fields or settlement areas, usually connected by linear corridors. Fragmentation occurs when developments aggregate and begin to isolate undeveloped areas. The fragmentation stage is pivotal, as it tends to affect at least the home ranges of most animal species. Attrition occurs when residual natural areas are reduced in size to a minor component of the landscape. The CDF landscape and adjacent areas are in the fragmentation and attrition stage of development.

Fragmentation and attrition put populations at risk, and decrease the resilience of communities, thereby increasing the chance of extirpation and extinction. This may occur due to problems arising from an unbalanced age or sex structure in the population, genetic imbalance due to inbreeding and genetic drift, or random fluctuations in habitat quality e.g. weather, and catastrophic events, such as droughts and destructive storms. Management planning that allows the greatest amount of contact and movement between undeveloped areas or retains the greatest size of undeveloped area are the most effective from a conservation standpoint. Practices that retain the greatest degree of natural structure between undeveloped areas may also be effective, depending on the organism. Edge is also a factor. Some organisms, both plant and animal, prefer edge environments but many do not. The importance of edge as a conservation factor increases with the size of undeveloped reserves. A single large patch of old forest will have less edge per area than a similar sized area divided into a number of small pieces. The importance of edge increases with the amount of fragmentation and the attrition of undeveloped areas.

To be the most effective, wildlife tree patches and other reserve areas must be as large as possible with as much undeveloped contact between each other and undeveloped portions of the landscape as possible. A 5 ha wildlife tree patch is more effective than five one ha patches. A wildlife tree patch immediately adjacent to a park or another patch of intact forest is more effective than if the patch is situated inside a clearcut. Integration with other features is key to the effectiveness of reserves. Locating reserves adjacent to areas with little or no value for timber production, such as wetlands, riparian areas, or rocky knolls, increases the size, internal structure and overall utility of undeveloped areas. Contact, through intact natural or semi-natural

vegetation, increases the conservation value of undeveloped reserve areas because they allow movement between these areas.

Undeveloped corridors, such as continuous belts of intact riparian vegetation or unlogged strips of forest, which connect reserve areas are better than no contact but are not the best strategy. Such corridors are vulnerable to disturbance, such as windthrow, because of their shape and allow the passage of alien species and diseases. They are often difficult to establish compared to more compact areas of the same size. Semi-natural areas that retain features such as snags, copses of advanced regeneration and retained trees are likely to form more effective connections between reserve areas than intact corridors surrounded entirely by developed areas. Silvicultural systems featuring permanent tree cover or extended rotations would work well in this regard. The ideal situation would be a combination that includes undeveloped corridors connecting reserves surrounded by a zone of semi-natural area.

b. Silvicultural systems options

Logging of high-conservation-value CDF stands may result in species extinctions and further degradation of the forest ecosystems. However, the effects of logging these stands on community structure and populations can be mitigated by maintaining some sort of permanent tree cover of semi natural vegetation. This strategy will be most effective as a conservation measure when combined with the use of permanent reserves. The concept is to maintain the original stand structure and species diversity over the majority of the area in question at all times.

Several silvicultural systems may be appropriate for this and include: true single-tree selection systems, group selection systems, irregular and group shelterwood systems with reserves or extended rotations and retention systems with low removal levels. It must be noted that these silviculture systems should be applied with caution, as they can easily degenerate into high grading. All of these systems should be implemented using clearly defined and implemented cutting rules and post harvesting structural targets expressed as stand and stock tables. Use of these concepts and systems is described by Franklin et al. (1997) and Matthews (1991).

c. Silvicultural treatments to recruit structure

A number of silvicultural treatments are useful for recruiting structure. Silvicultural treatments can increase the structural complexity of stands but they cannot totally substitute for time in the development of old-growth structural features.

Stand-level structure can be increased by preferentially increasing the growth of some trees to give variation in sizes and canopy level. The structure of individual trees may also be modified. The attractiveness of these options is that, in addition to promoting greater within-stand structure, they also can increase stand value by accelerating the growth and value of crop trees. For stands that currently have high conservation value, these treatments would be applied to the post-harvesting regeneration cohorts to allow them to blend with the existing stand. However, although the effect may be mitigated by these activities, logging will likely still degrade the conservation value of current high-conservation-value stands. Useful descriptions of

the theory and application of these techniques are given by Curtis (1997), DeBell et al. (1997), Curtis et al. (1998) and Zobrist and Hinkley (2005) and are outlined below.

Commercial Thinning is generally regarded as being the most useful tool to enhance structural diversity amongst the tree layer. Some current CDF stands with high structural heterogeneity show evidence of past diameter-limit logging, which suggests that thinning is a very effective technique for enhancing structural diversity. The key concept here is for the thinning to be irregular, not uniform. This would include leaving some dense, unthinned areas and allowing some open glades to recruit. Heavier thinnings that allow increased light penetration to the forest floor can promote regeneration of tree species and non-timber understory recruitment. Thinning can be applied at variable intervals to recruit the desired stand structure. Snags may be recruited by girdling, or there may be areas of *Phellinus weirii* (laminated root rot) that may be reserved from harvesting for snag recruitment. Thinning of commercial-sized trees also has the advantage of creating interim cash flows to defray the cost of operations.

Juvenile Spacing or pre-commercial thinning has a similar effect as commercial thinning, but is applied earlier in the rotation. Juvenile spacing treatments can be applied to achieve structural diversity but also to allow for growth to be concentrated on fewer remaining stems/ha which will allow for an improved economic opportunity for a commercial thinning at an earlier age. Commercial Thinning and juvenile spacing can also be used to favour a desired species mix.

Pruning can be employed to give irregularity to the canopy. As with other treatments, pruning should be selectively and variably applied, rather than in a uniform manner.

Aerial fertilization applied after spacing or commercial thinning treatment can help promote growth and increase structural diversity over a shorter period of time. The results are dependant on the spacing or commercial thinning treatment regime that was applied. Single-tree fertilization can also be used to promote differentiation within the stand. In this case, individual trees are selected for their desired characteristics and are fertilized to promote their growth further.

Extended rotations, greater than 120 years, allows for the recruitment of larger trees and more structural diversity than would necessarily be managed for under shorter rotations. Commercial thinning offers and opportunity to harvest timber values while still be able to meet or achieve structural diversity objectives of mature or old forests.

An entire area or stand does not have to be put on an extended rotation. Over areas that are being managed on shorter rotations, small groups of trees and individuals should be retained for longer periods of time Individual trees will grow in size and eventually become veterans, snags, and then CWD. Small groups of trees have been shown to provide greater biodiversity on an area than scattered individual trees.

d. Retention of existing features

Perhaps one of the easiest and most intuitive ways to retain structure during logging is simply to leave it where it is. Snags and large woody debris are a good example of this. Leave woody debris and cull trees in place during logging rather than removing them to a landing. Snags typically pose a safety hazard and are usually felled during logging. Therefore, snag

retention must be facilitated by their inclusion in small reserves or retention patches. This should not present a major complication in systems with higher retention levels, such as the selection systems, irregular shelterwoods, or retention systems

Leave scattered groups or Individual trees after harvesting. Groups contribute to the overall biodiversity and structural diversity of the area and provide for areas of red listed plant communities to become established and populate other areas over time. Individual stems provide for structural diversity, future veteran trees, snags, and CWD over the area. Wind firm trees should be selected where possible. Strategies for optimizing the utility of existing features through their retention are discussed by Curtis et al. (1998), Franklin et al. (2002) and Zobrist and Hinckley (2005)

Vernal pools (transient pools of water that only occur in the winter and spring) are a special feature of the CDF. These temporary spring pools are critical for the reproduction of a number of amphibian species, notably salamanders, newts and frogs, a number of which are red and blue-listed species. Include these areas in reserves and retention areas, as a high priority. If surrounding trees cannot be retained, care should be taken to retain any deciduous species, including tall shrubs, to shade them.

3) Strategies to recruit structural diversity and old-forest traits in structurally homogenous stands.

a) Silvicultural systems options.

To increase the conservation value of plantations, their structure needs to be made more variable. This does not have to significantly compromise the value or productivity of stands but it does increase management inputs. Many of the classical silvicultural systems were designed around increasing wood value or saving money through the promotion of regeneration. The silvicultural systems listed here are suggested for converting existing plantations into more structurally diverse stands.

The group selection, variable retention and irregular shelterwood with permanent reserves are suggested as appropriate silvicultural systems for the recruitment of increased structure into uniform second-growth stands. The use of these systems is described by Matthews (1991) and Franklin et al. (1997). The group selection system is easier to design, apply and regulate than the single-tree silviculture system. Group selection has been used to successfully convert “plantation forests” to a more ‘natural’ irregular forest in Europe, North America and the Tropics. Openings created by this system are approximately one tree length in diameter. Entries through successive cutting cycles eventually create an uneven-aged stand. An advantage of this system, over the single-tree selection system, is that the larger openings allow for more light penetration and the ability to recruit and grow shade intolerant species, such as Douglas-fir.

Irregular shelterwood system is similar to group selection, in that multiple entries are used to expand the size of small groups over a period greater than 20 years. Unlike the group selection system, the irregular shelterwood system eventually may remove all mature trees before new ones have been recruited. However, unlike uniform shelterwood systems or clearcutting, mature trees are retained

in the stand for a greater period of time. The advantage of irregular shelterwood systems is that they create quite irregular stands, allow for valuable wood to accrue on larger residual trees and allow a more concentrated flow of timber from a stand than do selection systems.

Variable retention systems may also be used to retain mature trees in a stand longer than traditional clearcuts. However, variable retention stands are more likely to result in two-storied stands, rather than having a greater range of sizes, than the other two systems.

The conservation value of all three of these systems can be used to increase structural diversity through the inclusion of permanent leave trees or small permanent reserves e.g. around vernal pools.

c. Silvicultural treatments to recruit structure

These treatments would be similar to those described in section 2. The main difference would be that more of a stand's area would likely need to be treated to significantly have an impact. Treatments should be used in combination for an additive effect that will improve structural diversity over a shorter time frame. Curtis et. al. (1998) is an excellent reference on this subject. The use of extended rotations should also be considered for modifying structure in plantation forests.

Much of the forested CDFmm on Crown lands consists of age class 3-4stands that are 60-80 years of age. The stands are generally characterized as uniform in age with homogenous stand structure. For these conditions, preference should be given to:

1. Extending rotation ages through commercial thinning. This will allow for an older or mature forest stand structure to develop. Applying a variable density thinning regime is also preferential to diversifying the stand structure.

2. Aerial or single tree fertilization should be considered on areas that have the ability to respond to treatment. Preference should be given to areas that have been commercially thinned, and secondly to areas that have been juvenile spaced and pruned, and thirdly to areas that have been juvenile spaced.

3. Clearcutting root disease centres or areas of forest health concerns will assist with promoting regeneration to Douglas-fir and provide early seral stage development. Allowing some smaller root disease centres will allow for snag recruitment and potentially course woody debris. Retaining root rot areas within riparian reserves may also serve this purpose without unduly impacting timber supply.

4. Harvesting of offsite or deciduous species and reforestation to Douglas-fir. Consideration must be given to the amount of deciduous stands within a forested area and the biodiversity values and role that they contribute.

5. Harvesting areas using an irregular shelterwood system, group selection, or retention system. Plans and prescriptions should include the retention of 10 dominant Douglas-fir stems/ha to develop into large veteran trees, snags and eventually course woody debris. In areas that are not being managed on longer rotation ages, retain individual trees and patches and apply an irregular commercial thinning regime within the patches.

6. Juvenile spacing and pruning of selected areas to promote larger stems and greater structural diversity. Preference should be given to applying irregular thinning regimes. Juvenile spacing can play a key role in improving stand conditions and economic opportunities for future commercial thinning entries while also promoting greater stand structure. Consideration should be given to areas that will be managed on longer rotations.

d. Retention of existing features

Suggestions here are similar to Section 2. Typically, second-growth stands that have previously been clearcut logged lack the structural diversity of old or mature forests especially if they have burned as well. The retention of any coarse woody material in second-growth stands or plantations is thus a very necessary step for enhancing the structure and diversity of these areas. The retention of any features that have survived past disturbance, such as veteran trees and snags, will also provide increased structural diversity in these stands.

E. References

Blackwell, B.A., Hedberg, H.A. and J.A. Trofymow. 2002. Stand structure and species composition in chronosequences of forests on southern Vancouver Island. Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-395. Victoria, BC. 61 p.

Curtis, R.O. 1997. The Role of Extended Rotations. *In:* Kohm, K.A. and J.F. Franklin (eds.), Creating a Forest for the 21st Century, Island Press, Washington, D.C. p 165 - 170.

Curtis, R.O. DeBell, D.S., Harrington, C.A., Lavender, D.P., St. Clair, J. B., Tappeiner, J.C. and J.D. Walstad. 1988. Silviculture for Multiple Objectives in the Douglas-fir Region. Ge. Tech. Rep. PNW-GTR-435. Portland, OR: U.S. Dept. of Agriculture, Forest Service, Pacific Northwest Research Station. 123 p.

DeBell, D.S., Curtis, R.O., Harrington, C.A. and J.C. Tappeiner . 1997. Shaping Stand Development Through Silvicultural Practices. *In:* Kohm, K.A. and J.F. Franklin (eds.), Creating a Forest for the 21st Century, Island Press, Washington, D.C. p. 141 - 150.

Egan, B. The Ecology of the Coastal Douglas-fir Zone. 1999. Ministry of Forests. Research Branch, Victoria, B.C.

Franklin, J.F. and C.T, Dryness. 1973. Natural Vegetation of Oregon and Washington. U.S. Dept. Agric. For. Serv., Gen. Tech. Rep. PNW-8. Portland, OR. 427 p.

Franklin, J.F., Berg, D.R., Thornburgh, D.A. and J.C. Tappeiner . 1997. Alternative Silvicultural Approaches to Timber Harvesting: Variable Retention Harvest Systems. In: Kohm, K.A. and

J.F. Franklin (eds.), Creating a Forest for the 21st Century, Island Press, Washington, D.C. p 111 - 140

Franklin, J.F., Spies, T.A., Van Pelt, R., Carey, A.B.,Thrornburgh, D.A., Berg, D.R., Lindenmayer, D.B., Harmon, M.E., Seeton, W.S., Shaw, D.C. Bible, K., and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implication, using Douglas-fir forests as an example. For. Ecol. Manage. 155: 399 – 423.

Feller, M.C. 2003. Coarse woody debris in the old-growth forests of British Columbia. Eniron. Rev. 11: S135 – S157.

Hunter, M.L. 1997. The Biological Landscape. *In:* Kohm, K.A. and J.F. Franklin (eds.), Creating a Forest for the 21st Century, Island Press, Washington, D.C. p 57 – 67.

Krajina, V.J. 1965. Biogeoclimatic forest and classification of British Columbia. Ecol. Of Western N.A. 1:1-17.

Krajina, V. J. 1969. II. The Biogeocoenoses of British Columbia. In The Ecology of Forest Trees in British Columbia. Ecol of W. N. America. p 41-44.

Matthews, J.D. 1991. Silvicultural Systems. Clarendon Press, Oxford, UK. 284 p.

McMinn, R.G., et al. 1976. Native Vegetation in British Columbia's Capital Region. Environment Canada. Canadian Forestry Service. Pacific Forest Research Centre, Victoria B.C. Report BC-X-140.

Nuszdorfer, F.C., Klinka, K. and D.A. Demarchi. 1991. Coastal Douglas-fir Zone. *In:* Meidinger, D. and J. Pojar (eds.), Ecosystems of British Columbia, BC Ministry of Forests, Special Report Series 6. Victoria, BC. p. 81 – 93.

Roemer, H.L. 1972. Forest vegetation and environments of the Saanich Peninsula, Vancouver Island. PhD. Thesis, University of Victoria. Victoria, BC. 405 p.

Sensitive Ecosystems Inventory: Sunshine Coast and Adjacent Islands. 2004. Maps.

Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth and C. Cadrin. 1998. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands 1993 – 1997. Volume 1: Methodology, Ecological Descriptions and Results. Technical Report Series N. 320, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia. Maps. 2007.

Zobrist, K.W. and T. M. Hinckley. 2005. A literature review of management practices to support increased biodiversity in intensively managed Douglas-fir plantations. Final Technical Report to the National Commission on Science for Sustainable Forestry, Seattle, WA. 14 p.