Best Management Practices

For

Managing Spotted Owl Habitat

A component of the Spotted Owl Management Plan 2

Chilliwack Forest District
Squamish Forest District

Prepared for: Ministry of Environment and Ministry of Forests and Range

July 7, 2009

The Spotted Owl Best Management Practices Working Group

Based on the April 2006 BC Spotted Owl Recovery Action Plan and direction provided by the Interagency Northern Spotted Owl Steering Committee (INSOSC) and the Spotted Owl Habitat Team, the Spotted Owl Best Management Practices Working Group (BMPWG) developed best management practices for managing Northern Spotted Owl habitat within the Chilliwack and Squamish Forest Districts.

The BMPWG benefited from discussions with many people in government, the forest industry and environmental community and thank those who have provided feedback and support in the development of these BMPs.

Prepared by the Spotted Owl Best Management Practices Working Group:

Ian Blackburn, Ministry of Environment, Lower Mainland Region
Brian D'Anjou, Ministry of Forests and Range (MoFR), Coast Forest Region
Jeff Fisher, Garibaldi Forest Products Ltd., Squamish
Christine Galliazzo, MoFR, Cascades Forest District
Jan Jonker, Tamihi Logging Ltd., Chilliwack
Ann Peter, MoFR, Chilliwack Forest District
Louise Waterhouse, MoFR, Coast Forest Region

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1 Introduction

In May 1997, the provincial government approved the Spotted Owl Management Plan (referred to in this document as SOMP 1) for the Chilliwack and Squamish Forest Districts to provide a reasonable probability that the Northern Spotted Owl (*Strix occidentalis caurina*) population would stabilize and possibly improve its status over the long-term without significant impacts on timber supply and forestry employment. SOMP 1 was considered a balanced approach between the socio-economics of forestry and Spotted Owl habitat protection needs. Under SOMP 1, Special Resource Management Zones (SRMZs) were established throughout the known range of the Spotted Owl within the Chilliwack and Squamish Forest Districts. The management strategy within each SRMZ was to maintain a minimum 67% of the gross forested area as suitable Spotted Owl habitat.

Within five years of implementing SOMP 1, it was discovered that the Spotted Owl population in British Columbia, as well as several populations in the United States, experienced an unexpected precipitous decline in numbers. To address this decline, a renewed Canadian Spotted Owl Recovery Team (2002-2007) was established to develop a recovery strategy to identify additional recovery actions needed to prevent extirpation of the species. Pending the completion of the recovery strategy and further direction from government, additional habitat protection was afforded to Spotted Owls found after 1997 in the Cascades Forest District in 2004.

In 2005, the Recovery Strategy for the Northern Spotted Owl was presented to the federal and provincial governments for consideration. In response, the provincial government revealed in 2006 its Recovery Action Plan to prevent extirpation of the Spotted Owl. The Recovery Action Plan included:

- Initiating measures to re-build the Spotted Owl population, including captive breeding and release, moving owls to new locations, increasing food sources for Spotted Owls, and managing competing species such as Barred Owls,
- Evaluating and revising SOMP 1 to ensure better protection for Spotted Owls and their habitat, within existing timber supply impacts (no-net loss policy), and
- Protecting the known (2005) Spotted Owl locations by establishing nine Wildlife Habitat Areas (WHAs; approximately 23,000 ha) to protect 100% of the forests found within each WHA.

Chilliwack and Squamish Forest Districts

Under a no net loss policy to both Spotted Owl habitat and timber supply opportunities, the SRMZs established under SOMP 1 within the Chilliwack and Squamish Forest Districts were revised to provide better habitat protection for Spotted Owls (Figure 1; SOMP 2, 2009). Within SRMZs, two designations are identified to manage forests for Spotted Owl habitat within the Crown Forest: Long-Term Owl Habitat Areas (LTOHA) and Managed Future Habitat Areas (MFHA).

The primary purpose of the LTOHA is to recover and sustain the Spotted Owl population to prevent extirpation of the species. The management goal in the LTOHA is to achieve 100% suitable Spotted Owl habitat conditions by conserving the existing Spotted Owl habitats and creating additional Spotted Owl habitats. Over time, it is anticipated that the amount and quality of Spotted Owl habitat will increase and improve within the LTOHA through natural stand development or through habitat enhancement practices. Forestry activities within the LTOHA are only permitted with the purposes of enhancing and creating Spotted Owl habitat or protecting Spotted Owl habitat from catastrophic loss.

The primary purpose of the MFHA is to provide for timber harvesting opportunities while maintaining future options for all or portions of the MFHA to become Spotted Owl habitat, if necessary. The management goal of the MFHA is to allow for timber harvesting with the retention of structural attributes such as large diameter trees, snags, and large coarse woody debris that are not typically found in young and mature forest stands that are managed on a 60 to 100 year forestry rotation.

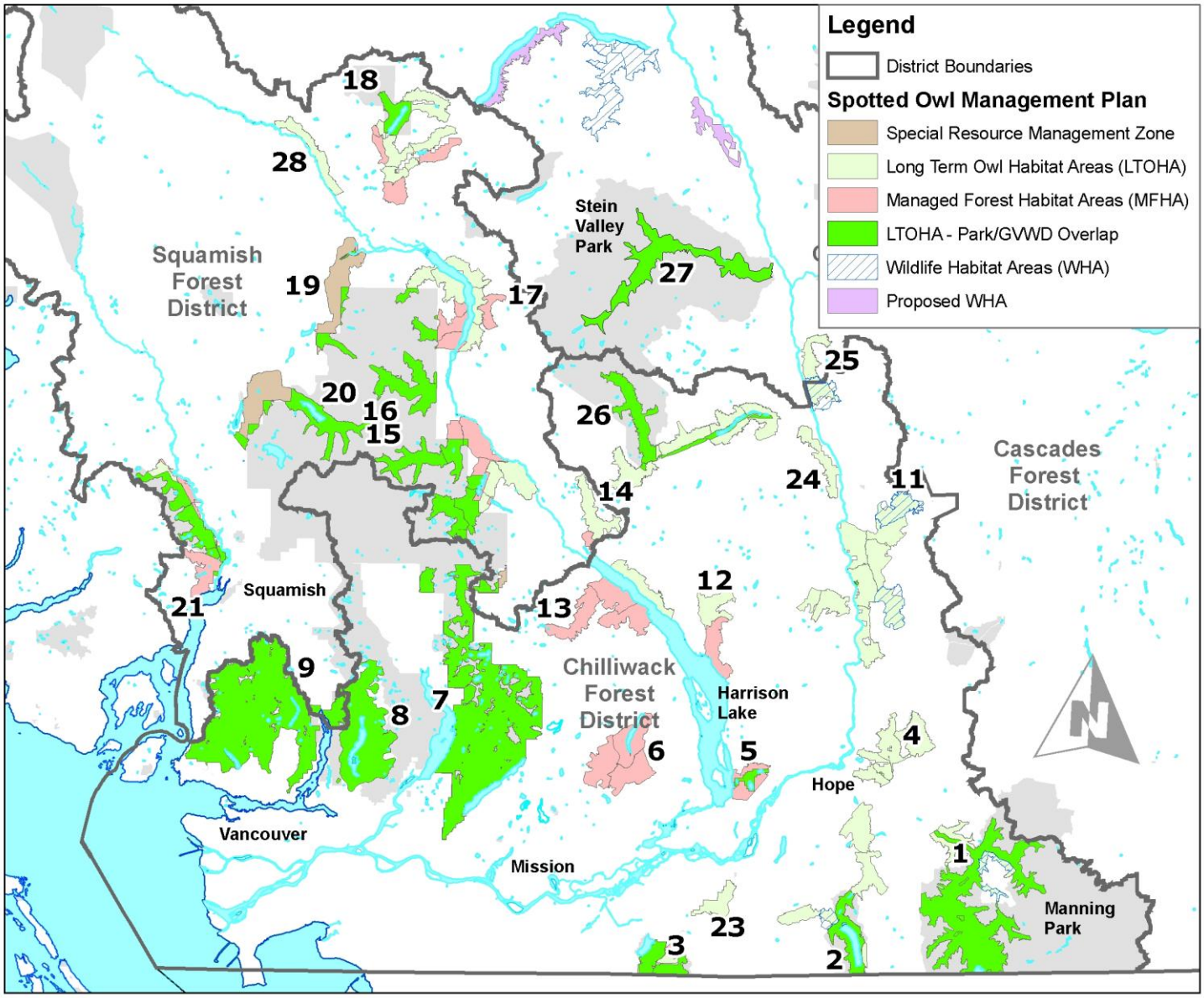
In addition to the habitat revisions of SOMP 1, the documents Managing Spotted Owl Habitat: Operational Guidelines Component of the Spotted Owl Management Plan (1997) and the Spotted Owl Resource Management Plans (1999) were also evaluated and revised to establish the following Best Management Practices (BMPs) to manage forests within SRMZs. The BMPs are based on the best available Spotted Owl ecology information, experiences learned under SOMP 1, and best professional judgment of the Best Management Practices Working Group. The Best Management Practices to manage forests within SRMZs replaces the two former documents in providing guidance to forestry activities within SRMZs.

Cascades Forest District

In the Cascades Forest District, Spotted Owl habitats are managed within Wildlife Habitat Areas (WHAs). The General Wildlife Measures currently do not allow timber harvesting or additional (mainline) road construction. Therefore, the **Best Management Practices do not apply**. Eventually, the BMPs presented in this document will be considered to address forest health issues and fire management that are specific to the various ecosystems found in the Cascade Forest District.

Figure 1: Map of Areas for Spotted Owl Management in the Chilliwack, Squamish and Cascades Forest Districts

Map is created on May 25, 2009 and the scale is approximately 1:1,160,000.
Note: Areas under Spotted Owl Management in the Squamish Forest District are under review and are in draft form.



2 Spotted Owl Habitat Attributes

Spotted Owls require forests with structural attributes that provides: protection from predators and the environment (e.g., inclement weather); structures for nesting and roosting; relatively high prey availability and accessibility to reduce energy demands when foraging and to ensure successful survival of adults and young; and forests that are open enough to allow easy movement within and beneath the canopy. The quality of suitable Spotted Owl habitat ranges from superior to poor and the structural attributes associated with quality varies between ecosystems and topography. Superior Spotted Owl Habitat provides for all of the life requisites of the Spotted Owl and includes nesting, foraging and dispersal habitats. Poor quality habitats generally only provide for dispersal. Superior Spotted Owl Habitats are strongly selected for by Spotted Owls in greater proportion than their availability in the landscape, and support higher densities of prey, and nests and roost structures than lesser quality habitats. Increasing the amount of Superior Spotted Owl Habitat available to the Spotted Owl is thought to result in an increase in productivity and survival of the Spotted Owl compared with the amount of poorer quality habitats available. As such, the BMPs are designed to accelerate the development of Superior Spotted Owl Habitat.

In general, suitable Spotted Owl habitat is at least 100 years old. Older forests (e.g. greater than 140 years old) typically contain most structural attributes associated with Superior Spotted Owl Habitat conditions. However, some forest younger than 140 years old may also possess the structural attributes associated with Superior Spotted Owl Habitat.

The following provides an overview of seven important stand level structural attributes associated with suitable and Superior Spotted Owl Habitat. The information is based on unpublished habitat use data for the sub-maritime region of BC (Blackburn, unpublished); nest site information for BC Spotted Owls (Manley et al. 2004) and follows earlier literature reviews (SOMP 1997). Variations in Superior Spotted Owl Habitat descriptions exist between the wetter ecosystems (maritime Coastal Western Hemlock [CWH] Biogeoclimatic Zone) and the drier ecosystems (sub-maritime CWH and interior Douglas-fir [IDF] Biogeoclimatic Zones). Table 1 summarizes the seven stand level Spotted Owl habitat attributes, and distinguishes the differences between the wetter and drier ecosystems. For further discussions on habitat attributes, see D'anjou et al. (2006).

Vertical and Horizontal Structural Diversity: Habitats used by Spotted Owls typically include a multi-layered tree canopies with high vertical and horizontal structural diversity. This allows the owls to fly within and beneath the canopy, and provides roosting and foraging perches at a variety of heights throughout the canopy. Vertical and horizontal complexity can be achieved by creating canopy opening to induce understory development and establish an additional canopy layer. As well, opening the stand may promote shrub and/or hardwood layers in the understory.

Tree Species Composition: Although Spotted Owls utilize a variety of tree species,

preference is given to stands dominated by conifer species (those species found below 1,200 meter in elevation), particularly Douglas-fir. The ectomycorrhizal fungi associated with Douglas-fir provides an important food source for the Northern Flying Squirrels. Tree species diversity promotes structural complexity and in turn supports a diversity of plants and animals, particularly prey species, that are associated with specific tree species.

Canopy Closure: Canopy closure includes the overhead coverage of dominant, co-dominant and intermediate trees, and generally excludes suppressed understory trees and shrubs. Canopy closure contributes to maintaining thermal cover and regulation, particularly at roost and nest sites, and provides protection from above canopy predators. Stands utilized by Spotted Owls generally exhibit canopy closures greater than 70%. Stands with average canopy closures of less than 60% and 50% in the wetter and drier ecosystems, respectively, are rarely utilized by Spotted Owls for nesting, foraging and roosting.

Stand Density and Tree Height: Spotted Owls require stand densities that permit the Spotted Owl to fly and maneuver through flyways. Large diameter, tall trees provide canopy lift and vertical layering that provides flyways underneath the canopy. Young stands with shorter, smaller diameter trees are not conducive for Spotted Owls to fly through. Some young stands may possess many lower limbs which may impede the capture of prey, while dense stands lack lower perches for roosting and foraging in the lower canopy.

Stand density and tree height can describe forests both open enough within and below the live crown to provide suitable conditions for Spotted Owl use. As the number and diameter of large trees within a stand increases over time, the number of stems (trees) per hectare will decrease.

Superior Spotted Owl Habitat typically is found in stands with tree height taller than 30 meters. However, stands as short as 20 meters may be used for foraging and roosting.

In general, Superior Spotted Owl Habitats exhibit:

- In wetter ecosystems, there are an average of 200 trees/ha (range 150 to 250 trees/ha) larger than 50cm dbh. Of these trees, approximately 100 trees/ha (range 37 to 185 trees/ha) are larger than 75cm dbh.

- In drier ecosystems, there are an average of 240 trees/ha (range 170 to 310 trees/ha) larger than 30cm dbh. Of these trees, approximately 100 trees/ha (range 58 to 166 trees/ha) are larger than 50cm dbh.

Snags, Deformed Trees and Cavity Trees (Wildlife Trees Classes 2 to 7): Spotted Owls utilize a wide variety of natural or pre-formed structures for nests. These are comprised of large cavities, abandoned goshawk nests, or large platforms created by

snags, broken tops of trees or trees affected by hemlock mistletoe. Since Spotted Owls do not create their own nests and have a relatively large body size, natural formed nest structures must be large in order to support nesting females and their young. In addition to Spotted Owls, flying squirrels, and other prey species, use cavities in snags and live trees as dens and nesting sites. In young stands, Spotted Owl nesting structures are likely absent or considerably less abundant than in older stands.

Superior Spotted Owl Habitats usually contain at least 10 wildlife trees (Figure 2 - Classes 2 to 7) per hectare.

- In wetter ecosystems, wildlife trees typically are greater than 75 cm dbh.
- In drier ecosystems, wildlife trees typically are greater than 50 cm dbh.

Large Coarse Woody Debris (CWD): CWD is typically composed of fallen trees, stumps, or large branches (greater than 20 cm diameter) that have fallen. Large CWD is especially important for a number of mammalian prey of the Spotted Owl, such as flying squirrels, voles, shrews, and mice, that inhabit the forest floor by providing moist microclimates, protective cover for movement, sites for nests and burrows, and food in the form of fungi, plants and invertebrates. Retention and recruitment of large CWD over time is important to the function of suitable Spotted Owl habitat.

In general, Superior Spotted Owl Habitats exhibit:

- In wetter ecosystems, there are accumulations of CWD greater than 250 m^3/ha (range 50-1,000 m^3/ha) with a high component that is greater than 50 cm in diameter and longer than 5 meters.
- In drier ecosystems, there are accumulations of CWD greater than 75 m^3/ha (range 50-1,000 m^3/ha) with a high component that is greater than 30 cm in diameter and longer than 5 meters.

Shrubs: Understory vegetation provides cover and food in the form of fungi, foliage, seeds, fruit, and insects for mammalian prey of the Spotted Owl, such as flying squirrels, voles, shrews, and mice. Fungi associated with shrubs are an important food source for the Northern Flying Squirrel, a main prey item of the Spotted Owl.

Typically, Superior Spotted Owl Habitat has a patchy distribution of understory vegetation over at least 40% of the stand. Shrubs comprise at least 25% of the vegetation in these patches.

Table 1: Typical Superior Spotted Owl Habitat stand attributes within the wetter and drier ecosystems. These stand attributes serves as a guide in describing Superior Spotted Owl Habitat and are not necessarily minimum 'targets' for forestry activities.

Superior Spotted Owl Habitat Stand Attributes	Wetter Ecosystems: **BECs: CWHdm, CWHvm1, CWHvm2, MHmm1** **NDTs 1 and 2: Rare to infrequent stand initiating events[1]**	Drier Ecosystems: **BECs: CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw and IDFww.** **NDTs 2 and 4: Infrequent stand initiating events to frequent stand maintaining fires[1]**
Stand Structure	Vertical and horizontal structural complexity with ≥ 3 canopy layers (may include a tall shrub layer)	Vertical and horizontal structural complexity with ≥ 3 canopy layers (may include a tall shrub layer)
Tree Species	Mixed conifer tree species composition, with preference for Douglas-fir. May contain a small component of Hardwood species.	Mixed conifer tree species composition, with preference for Douglas-fir. May contain a small component of Hardwood species.
Canopy Closure	≥ 70% (Range 60% - 85%)	≥ 70% (Range 60% - 85%)
Stand (Tree) Height	≥ 30 meters tall	≥ 30 meters tall
Large Trees	Average 200 trees/ha (range 150 to 250 trees) larger than 50cm dbh. Of these trees, approximately 100 trees/ha (range 37 to 185 trees/ha) are larger than 75cm dbh.	Average 240 trees/ha (range 170 to 310 trees) larger than 30cm dbh. Of these trees, approximately 100 trees/ha (range 58 to 166 trees/ha) are larger than 50cm dbh.
Wildlife Trees (Classes 2 to 7)	≥10 wildlife trees/ha (>75 cm dbh) with various defects (e.g., large cavities, broken tops, dwarf mistletoe infections, snag).	≥10 wildlife trees/ha (>50 cm dbh) with various defects (e.g. large cavities, broken tops, dwarf mistletoe infections, snag).
Coarse Woody Debris	Accumulations ≥ 250 m^3/ha (range 50-1,000 m^3/ha) of CWD with a high component that is ≥ 50 cm in diameter and ≥ 5 meters long.	Accumulations ≥ 75 m^3/ha (range 50-1,000 m^3/ha) of CWD with a high component that is ≥ 30 cm in diameter and ≥ 5 meters.
Understory Shrubs	Patchy distribution of understory vegetation over at least 40% of the stand. Shrubs comprise at least 25% of the vegetation in these patches.	Patchy distribution of understory vegetation over at least 40% of the stand. Shrubs comprise at least 25% of the vegetation in these patches.

[1] For more information on Natural Disturbance Types (NDTs), refer to the Forest Practices Code Biodiversity Guidebook (September 1995): http://www.for.gov.bc.ca/TASB/LEGSREGS/FPC/FPCGUIDE/BIODIV/biotoc.htm

Figure 2: Wildlife Tree Classes (adopted from the Forest Practices Code Biodiversity Guidebook, 1995)

Gradual death: conifers	General description of tree	Wildlife uses and users	Stages of decomposition
1	**live/healthy** – no decay	nesting; roosting; perching; territory; large–limb eagle and Osprey nests; raptors; scavengers; Great Blue Heron colonies; Marbled Murrelet	
2	**live/unhealthy** — internal decay or growth deformities (including insect damage, broken tops); dying tree	nests/roosts — PCEs[a] (strong excavators); SCUs[b]; large–limb nests; insect feeders	
3	**dead**[c] — hard heartwood; needles and twigs present; roots stable	nests/roots — PCEs (strong excavators); SCUs; bats; large–limb nests; hunting/ hawking perches; branch roots; insect feeders	
4	**dead** — hard heartwood; no needles/twigs; 50% of branches lost; loose bark; top usually broken; roots stable	nests/roots — PCEs (weaker excavators); SCUs; insect feeders	
5	**dead** — spongy heartwood; most branches/bark absent; internal decay; roots stable for larger trees; roots of smaller trees beginning to soften	nests/roots — PCEs (weakest excavators); SCUs; bats; insect feeders; salamanders	
6	**dead** — soft heartwood; no branches or bark; sapwood/ heartwood sloughing from upper bole; lateral roots of larger ones softening; smaller ones unstable	SCUs; insect feeders; salamanders; small mammals	
7–8	**dead** — soft heartwood; stubs; extensive internal decay; outer shell may be hard; lateral roots completely decomposed; hollow or nearly hollow shells	insect feeders; salamanders; small mammals	
9	**debris** — downed stubs or stumps	insect feeders; salamanders; small mammals; amphibians; drumming logs for grouse; flicker foraging, nutrient source	

a This classification system does not apply to downed logs and/or coarse woody debris.

b PCE = primary cavity excavator.

c SCU = secondary cavity user.

d The stability of dead trees is influenced by the cause of death. Dead trees can be unstable if killed by butt rot or root rot, depending on the species of the fungus. In general, *Phellinus* attack leads to instability; *Armillaria* attack must be assessed carefully on a site–specific basis.

3 Habitat Enhancement Practices (HEP): Best Management Practices for Creating and Enhancing Spotted Owl Habitat within the Long-Term Owl Habitat Area (LTOHA)

Long-Term Owl Habitat Areas (LTOHAs) are established to provide the primary habitat needs of the Spotted Owl to recover and sustain the Spotted Owl population and prevent extirpation. **The management goal in the LTOHA is to achieve 100% suitable Spotted Owl habitat conditions by conserving the existing Spotted Owl habitats and creating additional Spotted Owl habitats.** Over time, it is anticipated that the amount and quality of Spotted Owl habitat will increase and improve within the LTOHA through natural stand development or through habitat enhancement practices. **Forestry activities within the LTOHA are only permitted for the purpose of enhancing and creating Spotted Owl habitat or protecting Spotted Owl habitat from catastrophic loss.**

The following provides Habitat Enhancement Practices (HEPs) for creating and enhancing Spotted Owl Habitat within the LTOHA[2]. In developing these HEPs, the BMP Working Group recognized that forest stand structures can range from a uniform stand with similar size trees and tree heights (single canopy layered) to stands that are structurally complex with varying tree sizes and tree heights (multi-layered stand). HEPs are most appropriate for stands in the competitive stem exclusion stage (typically found in stands between 60 to 140 years old) where structural variability begins to increase within the stand. In some circumstances, some components of the following HEPs may not be achievable at the time of treatment due to the current state and structure of the stand to be enhanced. However, the prescription and rationale should address how the treatment will achieve the desired outcome and attributes associated with Superior Spotted Owl Habitat.

3.1 Implement HEPs to result in a net benefit to Spotted Owl habitat in the short-term (within 20 years)

Rationale: The desired outcome of HEPs is to create Superior Spotted Owl Habitat sooner than through natural succession by improving or accelerating the development of Superior Spotted Owl Habitat attributes. *The stand treatment should not focus on one attribute at the expense of the others, but represent a well balanced, optimized prescription rationalized on the current (pre-treatment) stand condition and the desired future (post-treatment) Spotted Owl habitat conditions*.

Stands that exhibit most of the attributes of Superior Spotted Owl Habitat are not good candidates for treatment because targeting improvement of one attribute could degrade quality of other attributes, and hence, may reduce the short-term benefit of the stand (e.g. in reducing stem densities, snag and crown closure can also be reduced). Treatments within Superior Spotted Owl Habitat will not result in a net

[2] HEPs for creating and enhancing Spotted Owl habitat may be applied to both the LTOHA and MFHA.

benefit to Spotted Owl habitat.

3.2 Use Inventory Procedures and Standards for Sampling Stand Attributes in Northern Spotted Owl Habitat (Appendix A) to determine the current Spotted Owl habitat attributes and to assist in HEP planning to create and enhance Spotted Owl habitat.

Rationale: Although a candidate stand may appear unsuitable or of lesser quality for Spotted Owls, some attributes of suitable habitat may exist and require protection. The evaluation will help guide prescription development by identifying high value attributes for retention and identifying those attributes that are lacking or potentially limiting Spotted Owl use. Furthermore, the evaluation will help determine if the stand is Superior Spotted Owl Habitat, and hence, not a good candidate for treatment.

3.3 Avoid road construction in the LTOHA, particularly within suitable and Superior Spotted Owl Habitat. Where no other practicable option exists, offset negative impacts of clearing road Rights-of-Way so that there is a no net loss to current and future Spotted Owl habitat. Limit road Rights-of-Way to a maximum 20 meters wide.

Rationale: Road construction results in the temporary (ROW clearing) and permanent (road surface and embankment) net loss of potential habitat for Spotted Owls. Constructing extensive road systems through the LTOHA to access a small prescribed area for treatment and/or to access timber beyond the LTOHA is not a net benefit to Spotted Owl habitat. If there are no other practicable options, limit road Rights-of-Way to a maximum 20 m wide. To offset road construction impacts it is recommended that each forested hectare of road Rights-of-Way that is cleared within the LTOHA be mitigated by creating or enhancing at least 3 hectares of maturing (e.g. 40 to 100 year old stands) forests (a 1:3 ratio of forest lost to habitat enhanced) so that the immediate impact results in a net benefit to Spotted Owls within 20 years. Where this is not possible, professionals should discuss with the appropriate MOE and MOFR staff (e.g. Ministry staff on the BMP Working Group) to find adequate mitigation alternatives.

3.4 Remove no greater than 40% of the stand basal area within the total area under prescription (TAUP)[3]. Trees removed from the road Rights-of-Way, landings, timber extraction corridors, and within the block all contribute to the 40% basal area removal.

[3] The total area under prescription (TAUP) includes the treatment area, timber extraction corridors, road Rights-of-Way, landings, natural non-productive (e.g. rocky outcrops, slides, wetlands), Wildlife Tree Retention Areas and other reserves.

Rationale: The maximum 40% stand basal area is to ensure that the treated stand remains functional for Spotted Owl use and to minimize any increased risk of windthrow. Although some minor windthrow is expected following treatment, a major windthrow event could result in a net loss to Spotted Owl habitat. The actual prescribed level of basal area removed is to be based on the current stand conditions and desired future Spotted Owl habitat attributes.

Harvest trees throughout the Treatment Area[4] (i.e. not concentrated in a single portion of the Treatment Area). Minimize disturbance to patches of existing Superior Spotted Owl Habitat, if present, within the Treatment Area.

3.4.1 In drier ecosystems (CWHds1, CWH ms1, CWH ms2, MHmm2, ESSFmw, and IDFww subzones), retain a minimum 275 trees/ha greater than 30 cm dbh. Tree retention density can vary between 240 to 310 trees/ha, but the average tree density across the entire Treatment Area[4] is a minimum of 275 trees/ha (excludes trees within the Wildlife Tree Retention Areas-WTRA).

In wetter ecosystems (CWHdm, CWHvm1, CWHvm2, and MHmm1 subzones), retain a minimum 225 trees/ha greater than 50 cm dbh. Tree retention density can vary between 200 to 250 trees/ha, but the average tree density across the entire Treatment Area[4] is a minimum of 225 trees/ha (excludes trees within the Wildlife Tree Retention Areas-WTRA).

Rationale: The minimum retention targets consider both stand densities of Superior Spotted Owl Habitat stands and the potential loss of trees due to mortality related to harvest following treatment.

If the pre-treatment stand lacks the minimum tree density of diameters specified above (i.e. conditions typically found in forests younger than 100 years old), then a diameter requirement may be lowered by 5 to 10 cm provided that the post-treatment stand will attain the desired tree density and diameter requirement identified above within 20 years after treatment.

3.4.2 Retain a minimum 100 of the largest 150 live trees/ha within the Treatment Area[4]. Large tree density can vary between 50 to 150 trees/ha, but the average density across the entire Treatment Area[3] is a minimum of 100 trees/ha (excludes trees within the WTRA).

Rationale: Superior Spotted Owl Habitat is associated with stands with large live trees averaging 100 trees/ha within both the wetter and drier ecosystems.

[4] The Treatment Area is the area where tree removal occurs and excludes road Rights-of-Way (the road prism: edge of cut bank to edge of fill slope), natural non-productive, Wildlife Tree Retention Areas and other reserves.

Retaining and/or creating an over-story of the largest live trees, particularly with the retention of wildlife trees, will promote the development of this Spotted Owl habitat attribute. Retaining 100 of the largest 150 live stems/ha is to provide operational flexibility and is not intended to permit the removal of the largest 50 trees as this may not result in a benefit to Spotted Owl habitat. Ideally, the distribution of retained large trees will represent a 2/3rd retention of the various diameter classes found in the largest 150 live trees/ha.

In uniform stands with similar size trees and tree heights (e.g. single canopy layered), identifying the largest 150 trees/ha will provide limited benefit. Therefore, this retention requirement may be not achievable at the time of treatment, however, the prescription and rationale needs to identify how this attribute will be achieved post-treatment (i.e. describe how 100 large over-story trees/ha will be developed).

3.4.3 Prioritize the retention of at least 10 large wildlife trees/ha within the minimum 100 largest live trees/ha retained. Where possible, retain veteran trees due to their high biological and wildlife habitat values.

Rationale: Wildlife trees provides for owl nests, provide for prey habitat and provide for staggered recruitment of CWD. The loss of these trees could be detrimental to habitat quality as natural recruitment of these trees takes many decades. Retention should vary across wildlife trees classes (or those rare in the landscape) as described in Table 2. Snags will be retained primarily within the WTRA as safety reasons may require snag falling throughout the harvested area. If wildlife trees are absent from the Treatment Area, then recruit live trees with deformities, if present, as potential wildlife trees.

3.4.4 Of the stand basal area removal within the Treatment Area, a minimum of 50% is to be harvested as single stems or as small groups of trees that would result in canopy gaps no greater than 50 m^2. No more than 25% of the basal area removal to be from timber extraction corridors (e.g. in linear features) and the maximum corridor width is 8 m. No more than 25% of the basal area removal to be from group of trees that would result in canopy gaps between 51 and 300 m^2.

Rationale: Operational constraints and maintaining a safe work environment may not permit emulating gap sizes in natural stands[5]. To avoid excessively large harvested openings, maximum canopy gaps size should be set at 0.03 ha[6]

[5] In mature Douglas-fir forests, 18% of the area (based on overstorey canopy cover) are gaps with a median gap size of 20 m^2 (approximately 5 meter diameter). See Spies et al. (1990).

[6] Gap size area will be defined based on crowns of dominant trees surrounding the harvested opening. Gap diameter will be defined as the average of the widest and narrowest distances between surrounding crowns as viewed from the ground.

(300 m^2 or if circular, 19.5 meter diameter). Gaps are expected to close over time as crowns of neighbouring trees expand into the gap. Gaps should be distinct harvest areas, distributed throughout the Treatment Area. Gaps should not be clustered to justify larger harvest openings.

3.5 Retain a minimum of 10% of the TAUP[3] as untreated Wildlife Tree Retention Areas (WTRA) to retain or recruit Spotted Owl habitat attributes.

Rationale: The purpose of the WTRA is to protect and recruit structural attributes associated with the Spotted Owl habitat (e.g. wildlife trees, large trees, and large CWD) and to provide for stand level biodiversity and habitat benefits for small mammals, including prey species for Spotted Owls. In Landscape Units and ecosystems with a higher than 10% WTRA requirement, the higher WTRA amount must be prescribed.

Where possible, WTRA should vary in size and be distributed in an effort to optimize the protection of structural attributes associated with Spotted Owl habitat. WTRA should be applied in areas where significant components of wildlife trees (classes 1 to 7) occur. Due to the requirement to fall dead wildlife trees (classes 3 to 7) within the Treatment Area, where possible, WTRAs should be located so that dead wildlife trees within the WTRA are retained and not felled as danger trees. If present, WTRA should prioritize the retention of at least 10 large (greater than 50cm dbh in the drier ecosystems and greater than 75cm dbh in wetter ecosystems) dead wildlife trees for each hectare of WTRA. If there are not enough wildlife trees that are above these diameters then the retained wildlife trees comes from the next largest available diameter.

3.6 Retain <u>all</u> pre-harvest and recruit post-harvest non-merchantable large CWD to provide habitat attributes to support prey populations of the Spotted Owl.

Rationale: Superior Spotted Owl Habitat contains at least 75 m^3/ha of CWD in drier ecosystems and 250 m^3/ha in wetter ecosystem. The retention and recruitment of CWD is important to support prey populations. Retaining all pre-harvest CWD will maintain a range of decay classes and sizes of CWD. If the Treatment Area contains less than the minimum CWD amounts above, then recruit post-harvest non-merchantable large woody material.

Consider the following to manage for CWD:

a) Preference for retention is woody material with diameters greater than 50 cm and 75 cm in the drier and wetter ecosystems, respectively, and is longer than 5 meters in length. If these CWD sizes are absent, then attempt to recruit the next largest available non-merchantable woody material.

b) Preferences for retention are tree species that decay slowly (e.g. cedar) so that they will still be present and functioning in 100 years or more post-harvest.

c) Long (> 10 m) woody material with diameters greater than 20 cm are most underrepresented in harvested stands compared to unharvested stands. Avoid breaking up CWD into smaller pieces during operations.

d) Distribute CWD throughout stands as single pieces and small piles. Logs should be processed at the stump so that non-merchantable CWD can be left throughout the stand and avoid concentrating CWD accumulations at landings and roads.

e) Manage the composition and arrangement of CWD within acceptable levels of risk of wildfire[7], insect pest and forest disease[8].

3.7 Utilize natural regeneration strategy in harvested openings (e.g. landings, yarding corridors and large gaps) within TAUP.

Rationale: Gaps and yarding corridors should be regenerated through a combination of advanced regeneration released after harvest and natural ingress. Development of both shrubs and deciduous trees within harvested portions of the block are also desired.

[7] Wildfire Act, Wildfire Regulation, Fire Hazard Assessment Guide [FS 117 HPR 95/7]

[8] Adopted from Ministry of Forests and Range Coarse Woody Debris (CWD) Website, CWD Policies: http://www.for.gov.bc.ca/hfp/values/wildlife/WLT/Policies/index.htm

4 Harvest with Retention (HWR): Best Management Practices for Timber Harvesting within the Managed Future Habitat Areas (MFHA)

Managed Future Habitat Areas (MFHA) are managed primarily for timber harvesting opportunities while maintaining future options for all or portions of the MFHA to become Spotted Owl habitat, if necessary. Under the current no net loss policy, portions of the MFHA may be converted to LTOHA in the future with an equivalent portion of LTOHA converted to MFHA provided that there is no net loss of timber supply and Spotted Owl habitat. These trade-offs may occur in the event that portions of the LTOHA are lost due to future disturbances, or, where some LTOHAs are deemed less important in the future to the overall recovery of the species than portions of MFHA.

The management goal within the MFHA is to provide for timber harvesting opportunities while retaining, creating or allowing the development of specific structural attributes associated with Superior Spotted Owl Habitat (e.g. large diameter trees, wildlife trees, and large coarse woody debris) that are not necessarily present in stands managed for timber on "normal" 60 to 100 year forest rotations. The retention, creation, or development of these structural attributes will maintain options for these stands to achieve Superior Spotted Owl Habitat sooner than stands managed under "normal" forestry rotations and practices.

The following provides the Best Management Practices for timber harvesting within the MFHA.

4.1 Retain a minimum of 10% of the TAUP[3] as untreated wildlife tree Retention Areas (WTRA) to retain or recruit Spotted Owl habitat attributes.

Rationale: The purpose of the WTRA is to protect and recruit structural attributes associated with the Spotted Owl habitat (e.g. wildlife trees, large trees, and large CWD) and to provide for stand level biodiversity and habitat benefits for small mammals, including prey species for Spotted Owls. In Landscape Units and ecosystems with a higher than 10% WTRA requirement, the higher WTRA amount must be prescribed.

WTRA should vary in size and be distributed in an effort to optimize the benefits of the WTRAs with respect to protecting structural attributes associated with Spotted Owl habitat. Candidate WTRAs should include a significant component of large dominant trees, similar to those retained in the Treatment Area, that possess wildlife Tree attributes such as broken tops, forks, large horizontal branches, cavities, mistletoe growth, and evidence of decay. Due to Workers Compensation Board requirement to fall unsafe dead wildlife trees (Classes 3 to 7) within the Treatment Area, where possible, WTRAs should be located so that dead wildlife trees within the WTRA are retained and not felled as danger trees.

4.2 In drier ecosystems (CWHds1, CWHms1, CWHms2, MHmm2 and IDFww subzones), retain at least 40 of the 80 largest diameter trees/ha in the TAUP, or

In wetter ecosystems (CWHdm, CWHvm1, CWHvm2, and MHmm1 subzones), retain at least 15 of the 30 largest diameter trees/ha in the TAUP.

The number of large trees retained per hectare can vary across TAUP, but the average large tree density retained across the entire TAUP is equal to or greater than the minimum large tree retention requirement for the specific ecosystem.

Rationale: Retaining large windfirm trees will provide potential future nest and roost structures for Spotted Owls, provide greater vertical (over-story) structural complexity within the regenerating stand, and have potential for developing into future snags and large downed CWD. The natural development of large diameter and tall trees can take well over 100 years to attain. As such, retaining these large trees at the time of harvest will reduce the timeframe required to attain these structures.

Priorities for the large tree retention requirement include:

a) Large diameter windfirm trees that are existing veteran and/or wildlife trees, as well as, conifer tree species that are early successional or preferred species for regeneration. Selecting Douglas-fir and western redcedar species is preferred as these tree species are more closely associated with habitats used by Spotted Owls. The windthrow potential of trees must also be considered in selecting retained trees.

b) Efforts should try to maintain the largest trees, where operationally feasible, as these trees may promote the best structures for Spotted Owl use and habitat in the future. The retention of the 40 (or 15) of the largest 80 (or 30) trees/ha is to provide operational flexibility, and is not intended to permit the removal of the largest trees.

c) Retained large trees within the Treatment Area should consist of a combination of single trees and small clusters of large trees (e.g. 5 large trees) to increase the structural diversity of retained large trees within the TAUP.

Appendix B provides examples on how to calculate and determine the number of trees to retain within the TAUP and Treatment Area.

4.2.1 Of the 40 (or 15) of the largest 80 (or 30) trees/ha requirement, no more than 40% of the large tree retention requirement for the TAUP may be retained within WTRAs and other reserves.

Rationale: Enabling a higher number of the large diameter tree retention requirement within WTRA to count towards the total large tree requirement for the entire TAUP may encourage establishing WTRA in stands with existing structural attributes desired for Spotted Owl habitat. The percentage of the large diameter trees/ha allowed to contribute from WTRA or other reserves within the TAUP is a maximum and is limited to ensure that some of large trees are retained and dispersed throughout the TAUP.
To calculate the maximum large tree contribution permitted from the WTRA, the following analysis should be performed. Using the drier ecosystem as an example, a cut block with a 10 ha TAUP requires a minimum 1 ha WTRA (i.e. minimum 10% of untreated area in WTRA). The minimum number of retained large trees within the TAUP is 400 trees (10 ha X 40 trees/ha). If the 1 ha WTRA has more than 40 large diameter trees, then up to a maximum of 160 large trees (0.40 X 400 trees/ha) may come from the WTRA provided that these trees meet the criteria as large trees defined within the TAUP.

4.2.2 The distribution of retained trees can vary within the TAUP, however, no locational point within the TAUP should be greater than 40 meters away from a retained tree (see Appendix C). Hence spacing between retained trees should not exceed 80 meters.

Rationale: A relatively even pattern of retained trees is desirable, but site and stand specific factors (e.g. large tree distribution, windthrow risk, topography, harvesting system requirements, and forest health) may influence the distribution of retained trees. Steeper and irregular terrain and cable-yarding systems may require a higher proportion of retained tree clusters to facilitate safe and efficient harvesting.

The 40 meters spacing is based on the average tree height of dominant trees. Maximum spacing of retained trees will effectively ensure 100% of the block area will be under the influence of retained trees as described by Keenan and Kimmins (1993).

4.3 Retain a component of all species and sizes of the pre-harvest CWD and recruit post-harvest non-merchantable large woody material to result in a combined minimum volume of 75 m³/ha of CWD over the Treatment Area.

Of the minimum 75 m^3/ha of CWD, retain at least 25 m^3/ha of pre-harvest large cedar CWD, if present in the Treatment Area.

Rationale: Superior Spotted Owl habitat contains at least 75 m^3/ha of CWD in drier ecosystems and 250 m^3/ha of CWD in wetter ecosystems. Large CWD [9] representing a range of decay classes are important to Spotted Owl habitat and prey species. If the pre-harvest Treatment Area contains less that the minimum amount of CWD, then retaining post-harvest non-merchantable woody material will improve the potential of the stand to attain Spotted Owl habitat conditions.

Consider the following to achieve the minimum retention requirement for CWD:

a) Preference for retention is woody material with diameters greater than 50 cm and 75 cm in the drier and wetter ecosystems, respectively, and is longer than 5 meters in length. If these CWD sizes are absent, then attempt to recruit the next largest available non-merchantable woody material.

b) Preferences for retention are tree species that decay slowly (e.g. cedar) so that they will still be present and functioning in 100 years or more post-harvest.

c) Long (> 10 m) woody material with diameters greater than 20 cm are most under represented in harvested stands compared to unharvested stands. Attempt to avoid breaking up long CWD into smaller pieces during operations.

d) Distribute CWD throughout stands as single pieces and small piles. Logs should be processed at the stump so that non-merchantable CWD can be left throughout the stand to avoid concentrating CWD accumulations at landings and roads,

e) Manage the composition and arrangement of CWD within acceptable levels of risk of wildfire[7], insect pest and forest disease[10].

[9] Large CWD is defined as greater than 5 m in length and greater than 75 cm diameter in the wetter ecosystems or greater than 50 cm diameter in the drier ecosystems.

[10] Adopted from Ministry of Forests and Range Coarse Woody Debris (CWD) Website, CWD Policies: http://www.for.gov.bc.ca/hfp/values/wildlife/WLT/Policies/index.htm

4.4 Reforest ecologically suitable early successional conifer species with consideration for variable density planting (See Appendix D)

Rationale: Planting early successional species allows for greater flexibility in species composition for future Spotted Owl management. As well, variable density planting, particularly with fewer stems per hectare, has been demonstrated to accelerate the development of suitable Spotted Owl habitat sooner than through traditional restocking standards.

If stands within the MFHA have serious forest health issues, consider the following:

Mistletoe Affected Stand: If large trees with mistletoe are left, regeneration should focus on Douglas-fir and western redcedar if ecologically appropriate.

Root Rot Diseases: For sites with root rot disease such as *Armillaria* and *Phellinus*, the best management practices suggest that areas of root rot be mapped, harvested and for stumps to be removed[11]. Furthermore for regeneration after harvesting, planting a variety of species is preferred with Douglas-fir seedlings comprising less than 20% of the planting density.

[11] Based on expert opinion.

5 Nests and Critical Roost Sites

Spotted Owls do not create their nests, but rely on pre-formed structures such as cavities, platforms and other raptor nests. In general, Spotted Owls utilize the same nest and roosting sites throughout their lives. Most of these roost sites tend to fall within an 80 ha area. It has been observed that new Spotted Owls that re-colonize recently vacated territories also utilize these nests and roosts.

5.1 Avoid timber harvesting activities, including salvage, within an 80 ha (ideally 500 m radius) reserve zone of habitat around known Spotted Owl nests and frequently used roost sites[12].

Rationale: The loss of these nests and frequently used roost sites may reduce the productivity of the resident Spotted Owls and could lead to the abandonment of the territory, which will not result in a net benefit to the Spotted Owls. Prior to the any forestry and non-forestry related developments, it is advisable to contact the Regional Spotted Owl Biologist (604-582-5200) to determine potential conflicts with known reserve zones.

6 Salvage Practices

Definitions

Major Salvage

Major salvage is generally defined as large scale salvage or harvesting operations that result in the removal of all or significant proportions of a stand. Major salvage generally occurs after significant stand level damage has occurred as a result of wind, fire, disease or insects.

Minor Salvage

Minor salvage is generally defined as the removal of small amounts of forest products including special forest products[13] from harvested areas after the completion of primary harvesting, or from standing timber when the salvaged materials come primarily from dead and down material. Small scale salvage generally results in the removal of less than $100m^3$/ha of forest products.

[12] Spotted Owls repeatedly use the same roost sites throughout the year. Most of these roost sites tend to fall within the 80 ha reserve zone.

[13] Special forest products is defined under the Special Forest Products Regulation as Christmas trees; firewood; mining timber; stakes and sticks; cants; posts and rails (split and round); shake and shingle bolts, blocks and blanks; and shakes.

6.1 Salvage Practices in the LTOHA

6.1.1 Consider major salvage only where damage exceeds 30% of the stand volume, or where retaining the damaged timber may result in further degradation of the remaining stand (i.e. spread of disease, increased fire risk, or the perpetuation of an insect outbreak) and the suitability of the Spotted Owl habitat.

Rationale: Natural disturbances caused by insect, disease, wildfire, windthrow or other catastrophic events can lead to forest, habitat and timber degradation within or adjacent to affected stands. Low levels of disturbance may contribute to the maintenance or enhancement of Spotted Owl habitat characteristics. However, high levels of disturbance may reduce timber and Spotted Owl habitat values and increase the risk of further natural disturbances. For this reason, forest managers, forest health specialists and Spotted Owl specialists should assess the extent of the disturbance, its effect on the remaining stands, and its impact on Spotted Owl habitat and management.

6.1.2 Avoid minor salvage within the LTOHA.

Rationale: The primary goal of the LTOHA is to retain Spotted Owl habitat. Minor salvage of CWD, wildlife trees, and live trees by removing attributes of Superior Spotted Owl Habitat would result in reduced rather than enhanced habitat quality.

6.2 Salvage Practices within the MFHA

6.2.1 Major and minor salvage are permitted provided that the minimum retention requirements specified in the Best Management Practices for Harvesting with Retention are retained.

Rationale: Given the intent of MFHA is to provide timber harvesting opportunities while retaining some structural attributes, it is acceptable to conduct salvage with retention. HWR are to be applied to the area within the planned salvage operation permit. Note: all WTRA salvage must be consistent with established landscape unit plan objectives.

7 Adaptive Management

It is expected that the BMPs will need to adapt as the practices are implemented and tested, and, as new information becomes available. Adaptive Management provides a systematic approach to learning from applied management practices. The adaptive management process begins with the Problem Assessment, Design (e.g. prescription development), Implementation, Monitoring and finishes with the Evaluation and Adjustment phase. Design follows a clear problem statement which will affect the monitoring program. The monitoring and evaluation determines if proposed management practices have achieved their objectives, whether or not those activities should be implemented again or how they should be modified. A long-term commitment of resources and monitoring is vital to institute and sustain the Adaptive Management Approach as the evaluation stage may follow implementation phase by several years.

8 References

D'Anjou, B., R. Parish, and L. Waterhouse. 2006. *Silvicultural Treatments for Enhancing and Recruiting Spotted Owl Habitat in British Columbia*. B.C. Ministry of Forests and Range, Coast Forest Region, Research Section, Nanaimo, B.C. Technical Report TR-033.

Brodie, Angus, Michael Bowering, Weikko Jaross, Don Reimer, and Bryan Lu. 2007. *Combining Management Goals Of Wildlife Habitat Conservation And Revenue On Washington State Trusts*. In Harrington, Timothy B.; Nicholas, Gretchen E., tech. eds. 2007. Managing for wildlife habitat in Westside production forests. Gen. Tech. Rep. PNW-GTR-695. Portland, OR: U.S. Department of Agriculture, Forest. Service, Pacific Northwest Research Station.

Keenan, R.J. and J.P. Kimmins. 1993. *The Ecological Effects of Clear-Cutting*. Environ. Rev. 1: 121-144

Manley, I., A. Harestad, and L.Waterhouse. 2004. *Nesting habitat of the Northern Spotted Owl in British Columbia*. Final Report submitted to Canadian Forest Products Ltd. And Canadian Spotted Owl Recovery Team.

Ministry of Environment, Lands and Parks and Ministry of Forests. 1997. *Spotted Owl Management Plan.* Prepared by the Spotted Owl Management Inter-agency Team (SOMIT).

Ministry of Environment, Lands and Parks and Ministry of Forests. 1999. *Spotted Owl Management Plan: Resource Management Plans: Chilliwack Forest District, Squamish Forest District*. May 1999. Prepared by the Spotted Owl Management Inter-agency Team (SOMIT).

Spies, T.A., J.F. Franklin, and M. Klopsch. 1990. *Canopy Gaps in Douglas-fir Forests of the Cascade Mountains*. Canadian Journal of Forest Research 20 (5): 649-658.

ACROYMNS

AM	Adaptive Management
BMP	Best Management Practices
CWD	Coarse Woody Debris
DBH	Diameter at Breast Height
HEP	Habitat Enhancement Practices
HWRP	Harvest With Retention Practices
LTOHA	Long Term Owl Habitat Areas
MFHA	Managed Future Habitat Areas
NDT	Natural Disturbance Type
SOMP 1	Spotted Owl Management Plan 1 (refers to the 1999 SOMP)
SOMP 2	Spotted Owl Management Plan 2 (refers to the 2009 SOMP)
SRMZ	Special Resource Management Zone
TAUP	Total Area Under Prescription
TSA	Timber Supply Area
THLB	Timber Harvesting Land Base
WHA	Wildlife Habitat Area
WTRA	Wildlife Tree Retention Area

Appendix A: Inventory Procedures and Standards for Sampling Stand Attributes in Northern Spotted Owl Habitat (1998)

GRAY CONSULTING

Inventory Procedures and Standards for Sampling Stand Attributes in Northern Spotted Owl Habitat

6231 Silvertherne Road

Chilliwack, British Columbia

Canada V2R 2W1

tel: (604) 824-8726

fax: (604) 824-8749

e-mail: wcegray@uniserve.com

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1.0 INTRODUCTION

The direction for developing a set of inventory procedures and standards for the collection of stand attributes in northern spotted owl (*Strix occidentalis caurina*) habitat comes from *Managing Spotted Owl Habitat: Operational Guidelines Component of the Spotted Owl Management Plan* (Spotted Owl Management Inter-Agency Team 1997). Specifically, "Step III: Forest Stand Inventory Requirements", outlines the need to collect forest stand attribute data in order to determine the type of owl habitat. There are three recognized habitat types, two of which are described in Figure 1. The third habitat type, Type C, is considered to be non-habitat (Hanson *et al.* 1993; Dunbar and Blackburn 1994) and is not described in the *Operations Guidelines* document.

Operational forest management plans within the Special Resource Management Zones, (SRMZ's) (Figure 2) which are designated for the spotted owl, currently require a variety of sampling procedures and field assessments. Timber cruising is carried out to determine forest stand timber volumes, vegetation resource inventories are conducted to determine Timber Supply Area (TSA) timber volumes as well as other resource values, and a variety of other sampling regimes are conducted to meet *Forest Practices Code* requirements. Unfortunately, no existing sampling protocol collects the stand attribute data needed to make owl habitat type determinations. The operational timber cruise plus the silviculture prescription field assessment collect some of the necessary information to make these determinations, in addition these processes are still required prior to operations in SRMZ's. In consultation with Ministry of Forest (MoF) and Ministry of Environment, Lands, and Parks (MoELP) staff, it was decided that the best way to approach the collection of owl habitat attributes was to integrate the additional inventory procedures with the operational timber cruise and the silviculture prescription field survey. The additional stand attributes to be sampled came from a variety of established sampling regimens, including the *Vegetation Resource Inventory* (RIC), various *Forest Practices Code* assessments, and other sources. Included in the source document are all attributes to be sampled, the procedure for sampling, the sampling standard (if one exists), the relevance of the individual attribute to spotted owl habitat, and the sampling intensity.

Standards for the collection of inventory data in both the operational timber cruise and the vegetation resource inventory are subject to periodic upgrades in sampling standards. The standards associated with the operational timber cruise were the most current (1997) check cruise standards at the time of project completion. Revisions are expected for check cruise standards for 1998. Updated cruise attributes standards can be obtained through the Valuation Branch of the Ministry of Forests.

The collection of spotted owl habitat attributes will require minor changes to existing field tally cards, the addition of one new field tally card, and minor changes to data base compilation programs. These issues were outside the realm of this project but are not considered to be difficult issues to overcome. Two examples of field tally forms intended

to augment existing cruise tally sheets are provided in Appendix 1 and 7.

The format for presenting analyzed inventory data was developed by Carla Lenihan of the Ministry of Environment, Lands, and Parks, and is included in Appendix 2. To help with the analysis of inventory data a compilation sheet is provided in Appendix 3.

Habitat type	Seral Stage: Mature and old **Type B - Moderate quality** (Foraging, dispersal, and roosting)	Seral Stage: Old **Type A - Superior quality** (Nesting, roosting, foraging, and dispersal)
	Wetter maritime ecosystems (CWHdm, CWHvm1, Mhmm1) (NDT 1, 2; Rare to infrequent stand initiating events)	
Suitable habitat characteristics	• few canopy layers, multi-species canopy dominated by large (51 cm dbh) overstory trees (typically 247-457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present). • moderate to high (60-80%) canopy closure. • some large trees (51 cm) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infestations). • large (51 cm dbh) snags present. • accumulations of fallen trees and other woody debris on the ground.	• a multi-layered, multi-species canopy dominated by large (76 cm dbh) overstory trees (typically 37 to 185 stems/ha). • moderate to high (60-80%) canopy closure. • a high incidence of large trees with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infestations). • numerous large (76 cm dbh) snags (typically 5 stems/ha). • accumulations of fallen trees and other woody debris on the ground.
	Dryer submaritime ecosystems (CWHds1, CWHms1, CWHms2, Mhmm2, ESSFmw, and IDFww) NDT 2, 4; Infrequent stand initiating events to frequent stand maintaining events)	
Suitable habitat characteristics	• a multi-layered, multi-species canopy dominated by overstory trees approximately 30 cm dbh. • stands must contain 20% Fd and/or Hw in the overstory. • approximately 50% canopy closure. • dominant live trees with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infestations). • snags and down logs, at least some of which are of similar dbh to dominant live trees.	• a multi-layered, multi-species canopy dominated by large (51 cm dbh) overstory trees (typically 173-247 stems/ha, although tree densities as low as 86 stems/ha are possible where large diameter trees are present). • moderate to high (>70%) canopy closure). • some large trees with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infestations). • large (51 cm dbh) snags present (typically 7 stems/ha). • accumulations of large (51 cm dbh) fallen trees and woody debris on the ground.

FIGURE 1. Type A and B habitat descriptions.

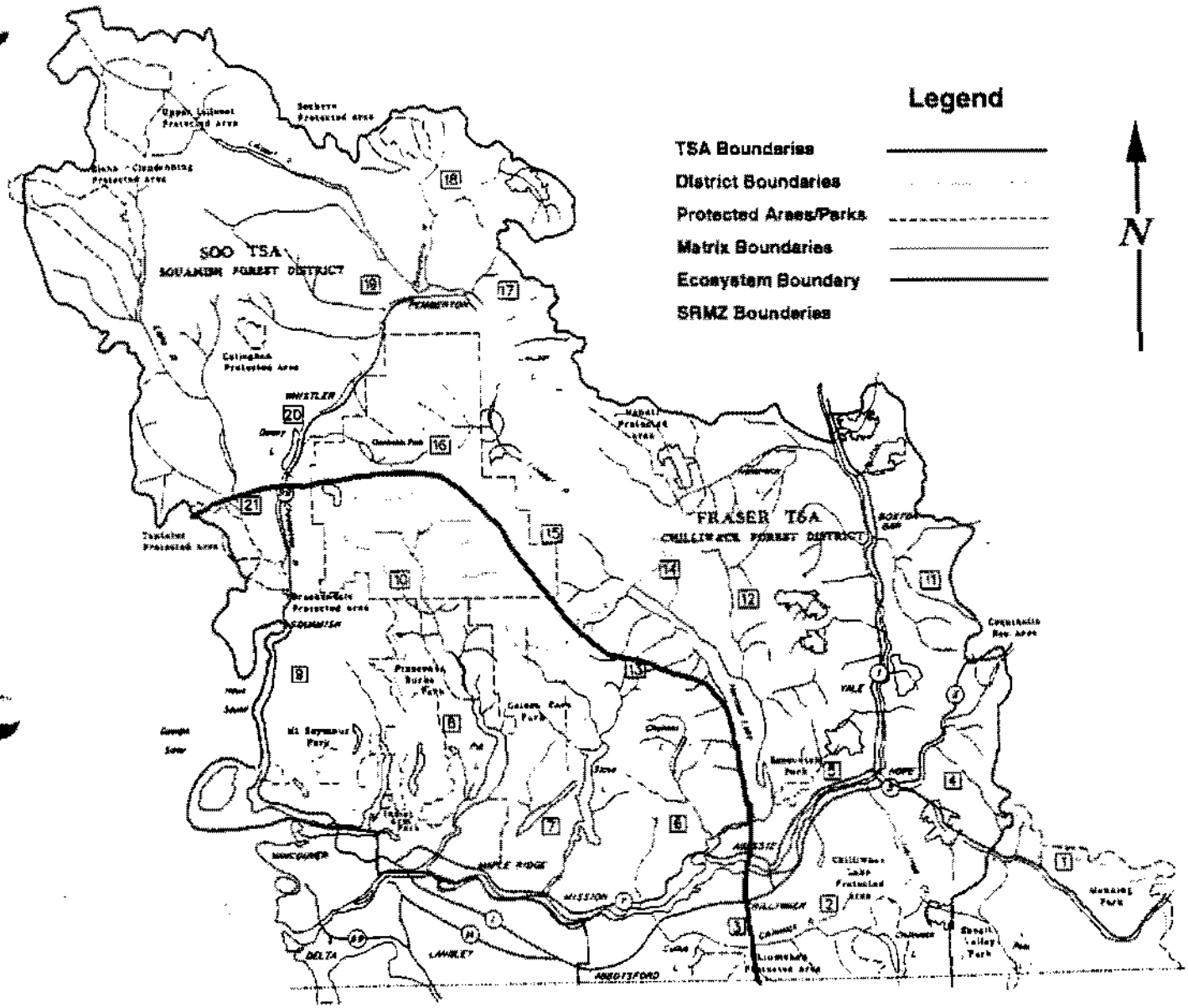


FIGURE 2. SRMZ's in the Chilliwack and Squamish Forest Districts.

2.0 STAND ATTRIBUTES SAMPLED DURING THE TIMBER CRUISE

Stand attribute data is intended to be collected during the operational timber cruise in spotted owl SRMZ's. It is suggested that the stand attribute inventory field form (Appendix 1) be used to augment existing cruise tally sheets.

2.1. Species Composition

Source: *Vegetation Resource Inventory* (RIC)

Procedure: Each live tree will be identified by genus and species within the confidence level of the crew. External features such as foliage, buds, and reproductive organs can be used to help in identification (Hitchcock and Cronquist 1973; Little 1980; Petrides and Petrides 1992; Parish 1994; Pojar and MacKinnon 1994; Parish *et al.* 1996).

The recording of tree species will follow the convention included in the *Vegetation Resource Inventory Sampling Procedures Manual*. Common names, scientific names and accepted codes are listed in Appendix 4.

Standard: All living and dead, standing and down trees which meet or exceed the utilization limit must be recorded when present in a plot. Not more than 2% of the trees in a cruise can be incorrectly identified.

Relevance to Owl Habitat: The northern spotted owl shows a preference for forest communities composed of specific tree species. Forests containing a certain composition of Douglas-fir, in addition to other conifer species, appear to provide a high number of habitat attributes (Forsman *et al.* 1984; Hamer *et al.* 1989; Thomas *et al.* 1990; Hanson *et al.* 1993; Buchanan *et al.* 1995). Owls have been observed in hardwood-dominated forest communities but it is not felt that these ecosystems provide much in the way of suitable habitat attributes (Hanson *et al.* 1993).

Sampling Intensity: Variable is sampled at each cruise plot.

2.2. Canopy/crown closure

Source: *Vegetation Resource Inventory* (RIC), and others.

Procedure: Overstory crown closure for those crowns above eye level can be derived using several methods and are always expressed in percent. As most methods for collecting canopy closure rely on optical estimates, it is recognized that values for percent canopy closure may vary slightly between individual samplers.

The first method involves directly measuring the canopy area of select trees in the plot by

measuring the radius of the tree from the bole to the drip line. Two radii should be taken and averaged then multiplied by πr^2 to get the area of a circle. Summing the areas of all the canopies in the plot is not efficient, so average tree canopies can be simply multiplied. Once all canopies have been added the total is subtracted from the area of the plot (J. Henderson pers. comm. 1993). Several issues become apparent with the application of this methodology. First, canopies tend to overlap in a forested stand. Inventory personnel need to be aware of this when estimating canopy areas. The second issue is the presence of gaps in the canopy. Gaps, like canopies themselves can simply be measured. The third issue is canopy overlap outside of the plot. This must be estimated and subtracted from the gross canopy area. The fourth issue involves variable radius plots. Variable radius plots, or prism plots, do not have a fixed diameter, so the sampler cannot calculate the gross area of the plot. Therefore, the inventory crew will need to establish a sub-plot of fixed diameter, measure the crown areas in the plot and subtract those from the gross plot area.

The second method involves the use of comparison charts (Appendix 5) (Luttmerding 1990). The examples provided in the comparison charts are used to guide the sampler in choosing the coverage that best suits what they are observing in the field.

Another method for collecting canopy closure estimates involves the use of a mirrored apparatus called a densiometer. This instrument is placed at plot center on a flat horizontal plain. Grids etched into the mirror are used in the addition and subtraction of either canopy or opening.

The preferred methodologies - in order of preference - for collecting canopy closure estimates is the use of the spherical densiometer, followed by the comparison charts. The measurement methodology is included as a back-up method in the event that either the densiometer or comparison charts cannot be used.

Standard: The standard for estimating the cover percentage of the "A" layer in the *Vegetation Resource Inventory Ground Sampling Procedures* is ±10%. In the event that the canopy measurement method is used the standard should be ±20%.

Relevance to Owl Habitat: Various studies throughout the Pacific Northwest have indicated that canopy closure is an important variable in habitat selection by spotted owls (Hanson *et al.* 1993; Everett *et al.* 1997). The measure of how open or closed a forest canopy is has been found to be associated with thermoregulatory benefits, optimal foraging efficiency, and predator avoidance strategies (Buchanan *et al.* 1995).

Sampling Intensity: Variable is sampled at each cruise plot center.

2.3. Stem defects

Source: *Vegetation Resource Inventory* (RIC) and *Cruise Manual*

Procedure: Stem defects are classified as being associated with one of the following external indicators of decay:

2.3.1. Conks (stem and root rot fungi)

Conks refer to the fruiting bodies (sporophores) of stem decay fungi and are definite and reliable indicators of decay. Typically conks are thick, hard, woody-like perennial structures. Fruiting bodies can occur anywhere on the main stem, branches, but they appear most frequently around knots and on the underside of dead branch stubs and live branches.

Root rot fruiting bodies are located on the roots and are associated with stem decay. Typically fruiting bodies are short-lived, soft, and fragile. Often you may be able to see an indication of root rot directly on the roots.

2.3.2. Blind conks

Blind conks are pronounced swellings or depressions around knots, usually caused by *Phellinus pini* on conifers, and *P. tremulae* on aspen. Blind conks are definite indicators that decay is extensive in the tree stem.

2.3.3. Scars

A scar is an injury caused by external forces that damage the cambium or heartwood of the tree exposing the tree to wood decay fungi. A scar can occur anywhere on the main stem or root collar of the tree. Scars on branches or candelabras are not recorded as stem decay indicators.

2.3.4. Fork

A fork is caused by damage to the leader of a tree that results in more than one branch (leaders) competing for apical dominance. The damage to the leader – from external forces, physiological factors, animals, or insects (weevil) – exposes the stem to potential wood or decay fungi.

2.3.5. Frost crack

Frost cracks result from deep radial splitting of the trunk, caused by uneven expansion of moisture in the tree after a sudden and pronounced drop in

temperature. The cracks usually originate at the base of the trunk and may extend many metres up the tree, following the longitudinal grain of the tree. The wound will often spiral up the tree following the movement of moisture.

Frost cracks are often reopened and extended by wind stresses or refreezing. Repeated healing of the cambium produces pronounced callous tissue, giving a ribbed appearance to the wound.

2.3.6. Mistletoe

Wood-rotting fungi gain entrance to the trunk through the dead hypertrophied branches or branch stubs where mistletoe swelling is on, or adjacent to the trunk.

Mistletoe on limbs, or limbs that are swollen only at some distance from the trunk should not be included as indicators of stem decay.

2.3.7. Large rotten branches

Large rotten branches are defined as those with a diameter inside the bark greater than 10 cm at the base. They have obvious signs of heart rot, and typically appear as short, rotten branches on overmature trees. They should not be confused with branches that died through normal causes.

2.3.8. Dead or broken top

A dead top can be caused by any number of external injuries, physiological stresses, insects, or diseases. The top should be obviously dead with no green needles or leaves present.

A broken top is the product of an external force or condition resulting in the top of the tree breaking away from the main bole. Broken tops are often the result of strong winds, heavy snow, mechanical damage from other falling trees, etc.

Standard: Pathological indicators and physical damage must be identified correctly. Plus or minus 1 external indicator on an individual plot is acceptable. The wrongly called indicator must move the tree from one risk group to another as described in *Metric Diameter Class Decay, Waste, and Breakage Factors*.

Relevance to Owl Habitat: Mature and old growth forests contain a higher incidence of mechanical damage and pathology than younger, healthier forests (Gutierrez 1985). Physical damage to trees as well as the effects of pathology contribute to suitable owl habitat characteristics. The presence of stem defects, especially in older stands, is correlated well with owl and prey nesting site characteristics (Hanson *et al.* 1993).

Spotted owls on the eastside of the Cascades in Washington State often utilize mistletoe brooms for nest sites (Thomas *et al.* 1990; Buchanan *et al.* 1995; Everett *et al.* 1997). On the westside of the Cascades cavities in snags and live trees, as well as broken tops, provide good nesting locations (Gutierrez 1985; Thomas *et al.* 1990).

Several important prey species of the northern spotted owl utilize cavities in live trees and snags for nest sites (Carey 1991).

Sampling Intensity: Variable is sampled at each cruise plot as per the cruising procedures.

2.4. Diameter distribution and stand density

Source: Adapted from *Cruise Manual.*

Diameter distribution by species will be derived from the cruise tally. Once a basal area factor (BAF) for the forest type has been chosen individual tree diameters will be collected.

The diameter of all trees of minimum diameter and larger will be measured with a diameter tape at a point 1.3 m above the "high side" of the tree. "High side" of the tree is defined as the highest area of the forest floor around the base of the tree. Any loose debris should be able to be removed with one or two kicks. Diameter will be measured and recorded to the nearest 0.1 cm (how to handle special situations encountered when collecting tree diameters are included in Appendix 6).

Stand density is computed from the tree tally in the operational cruise and the BAF. Under variable-plot sampling each tree chosen to tally has its own plot radius, and consequently, its own plot. By computing the plot radius of each tree in m^2 and dividing it into a hectare (10,000 m^2), the number of individual trees of a specified diameter per hectare is derived. The total of all species of all diameters expressed in hectares is the stand density.

Standard: For tree diameters, ≥ 90% of individual stems checked must be within 2% of true DBH. Height measurement for DBH must not exceed ± 5% (± 6.5 cm) from the true breast-height of 1.3 m above high-side. For stems/ha not more than ± 1 stem in 50 trees checked from the true number for all plots checked. The stem count will include all merchantable trees plus all live useless and dead useless trees in this check parameter. All borderline trees must be checked by actual measurement from the plot center and measurement of the diameter to determine whether the tree is "in" or "out".

Relevance to Owl Habitat: Diameter distribution and stand density has been closely correlated with specific types of spotted owl habitat. Buchanan *et al.* (1993), and King *et al.* (1997), found that spotted owls in the eastern Cascade Mountains selected nest tree

sites with a greater number of large diameter trees and a greater basal area of live trees, than sites without these characteristics. Everett *et al.* (1997), also studying spotted owl habitat characteristics in the eastern Cascade Mountains, found that owls utilized nine separate stand structural types for nesting. A common characteristic to the eastside (dryer) habitat being used is stand density; which ranges from 1.5 to 10 times greater than old-forest stands intensively used by owls in the western Cascade and Olympic Mountains of Washington State (Everett *et al.* 1997).

Thomas *et al.* (1990), found that stands intensively used by spotted owls on the Mt. Baker-Snoqualmie, Olympic, and Gifford Pinchot National Forests' in western Washington contained from 190 to 210 trees/acre with >32" DBH trees comprising from 11 to 20% of the tree total.

Habitat used by owls for dispersing is the least researched component of owl habitat. Dispersal habitat can include old forest, sub-mature forest, young forest marginal, and other younger forest conditions (Lujan *et al.* 1992; Hanson *et al.* 1993). Studies conducted specifically to address dispersal of spotted owls have concluded that when available, old growth and older mature stands were selected for roosting and foraging. Younger forest types were typically avoided (Forsman *et al.* 1984; Gutierrez *et al.* 1985).

Sampling Intensity: Each tree in the variable radius plot is sampled as per the cruising procedures.

2.5. Height to live crown

Source: *Vegetation Resource Inventory* (RIC)

Procedure: Canopy height, or the height to the live crown, is measured as the distance along the bole from the high side of the tree at ground level to the crown base. The crown base is normally located on the stem where live branches occupy about three-quarters of the stem circumference. In open stands with epicormic branching individual judgment will have to be used as to the location of the base of the crown.

Standard: The standard for height to live crown measurements ±2 m on crowns < 10 m, and ±20% on crowns >10 m.

Relevance to Owl Habitat: The amount of live crown in each canopy layer is linked to overall canopy closure estimates. The height to live crown, canopy closure, canopy gap, and tree height variables combine to give a multi-dimensional perspective of crown structure. An assessment of vertical crown layering comes from the combination of all four variables. Proposed advantages of a multi-layered canopy include summer and winter thermoregulation, increased foraging efficiency, and an abundance of prey such as northern flying squirrels (*Glaucomys sabrinus*) (Mills *et al.* 1993).

Sampling Intensity: Variable is collected on each height-sampled tree.

2.6. Canopy gaps

Source: Adapted from *Vegetation Resource Inventory* (RIC)

Procedure: Gaps are defined as openings, caused by natural tree mortality and natural site conditions, which are not yet occupied by trees > 10 m tall. Mortality refers to natural causes of death; for instance, trees that have blown over, snapped off, or died standing. Natural site conditions include natural stocking irregularities which may be caused by edaphic factors such as shallow soils, bluffs or rock outcrops, seepage or stream channels, wet depressional sites, colluvium, slide or avalanche tracks, and snow accumulation patches.

1. Record gaps in the canopy that are due to natural tree mortality and natural site conditions using codes in Table 1.
2. Do not count gaps if the cause of tree death appears to be related to harvesting or other human activities or if the gap is associated with landings, trails, and roads. It may be hard to decide, for example, where death is due to fire or other damage that could be related to human activities.
3. Do not include openings due to climatically drier or otherwise harsh regimes where trees are widely spaced.
4. Do not include successionally young sites where trees have not yet grown into the intermediate canopy layer.

TABLE 1. Canopy gap codes

Code	Description
N	None No apparently natural gaps
S	Some Smaller gaps amounting to <10 % of crown closure in 25 m^2 area
C	Common One or more larger gaps occupying 10 % or more of the potential canopy area

Standard: The standard is 94/100 correctly classified.

Relevance to Owl Habitat: Canopy spatial diversity and canopy closure provide indications of stand structure and canopy heterogeneity. For example, stands with a high level of canopy closure and low spatial diversity are typically classified in the stem exclusion stage of succession (Oliver and Larson 1996). An important stand characteristics of the stem exclusion stage is a forest floor mostly devoid of living plants. This type of stand structure provides few habitat attributes for spotted owls other than possibly dispersal

characteristics. A lower level of canopy closure and higher level of spatial diversity would allow more light into the understory and provide for more habitat attributes (i.e. understory vegetation provides cover and food for the prey of the spotted owl).

Sampling Intensity: Variable is collected at 50 m stations between cruise plots.

2.7. Tree heights

Source: *Cruise Manual*

Procedure: Canopy vertical diversity will be determined from the collection of tree heights for trees in four separate crown classes. For cruise purposes the measurements of height and dbh are required so that height dbh relationships can be developed. To accomplish this height sample trees must cover the range of heights and diameters in the stand. Without a reasonably dispersed selection of samples along the height/dbh curve, the best fitting mathematical equation will not be produced. Each height curve must represent only one species and have at least 2 sample trees for each 10 cm dbh class. The reference point for diameter and height is the high-side of the tree as described in section 2.4.

Individual tree heights will be measured from the ground on the high side of the tree to the tip of the tree using a clinometer in percent scale and a metric surveyor's tape. Many inventory personnel are using electronic measuring devices such as hypsometers (Forestor Vertex ™, or laser rangefinders (Criterion ™, Impulse ™). The total height of lodgepole pine and deciduous species is measured to the highest point of the crown, not at the point where the main bole commences natural forking. In general, the lower the percent reading, the more precise the measurement.

Standard: For measured heights, ≥ 90% of individual measured stems checked must be within 5% of their true height, and the average absolute variation must not exceed 3%. For estimated heights, ≥ 90% of individual estimated stems checked must be within 10% of their true height and the average absolute variation must not exceed 5%.

At least 20 sample trees from each species in each site class on the cutting permit or timber sale must be measured for height. These sample heights must be evenly distributed throughout each type or site-class (i.e., at least one sample height per plot).

Relevance to Owl Habitat: Tree heights function as indicators of canopy structure for flying and nest site heights. Short, dense stands are difficult to navigate, while stands with taller trees are easier to navigate and maneuver. Taller trees are often utilized by spotted owls for nesting and roosting. A study in the western Cascades concluded that 25 roost- and nest-trees had a mean height of 100 feet. Average tree heights in the eastern Cascades were 96 to 100 feet (Hanson *et al.* 1993).

Sampling Intensity: All tallied trees in the plot will be measured for total height. Crown classes(Table 2) will also be recorded.

TABLE 2. Crown class descriptions and the codes used in inventory

Code	Description
D	Dominant Trees with crowns extending above the general level of the crown canopy. They are somewhat larger than the average and have well developed crowns which may be somewhat crowded on the sides.
C-D	Codominant Trees with crowns forming the general level of the crown canopy. The crown is generally smaller than that of the dominant trees and usually more crowded on the sides.
I	Intermediate Trees with crowns below, but still extending into, the general level of the canopy. The crowns are usually small and quite crowded on the sides.
O or S	Overtopped or Suppressed Trees with crowns entirely below the level of the canopy.

2.8. Age

Source: Adapted from *Cruise Manual.*

Procedure: Age of stand layers will be determined by coring a variety of species from each canopy layer (i.e., dominant, codominant, intermediate, and suppressed) using an increment borer. Bored trees should also be sampled for height in order to determine site index. The following steps should be taken in collecting age data:

a) Bore the tree at DBH on the uphill side. Core as close as possible to the pith with the size of increment bore in use. The pith must be included in at least half the sample tree cores on each plot. In cases where the pith is not contained in the core, and is missed by an estimated three years, the tree must be rebored.
b) Determine the age by counting the growth rings from the last full increment inside the phloem to the pith, or to internal decay. If increments can't be counted in the field, cores should be labeled and stored in wide drinking straws and counted under a microscope in the lab or office.
c) When storing cores in straws masking tape can be used to seal straw ends but the seal shouldn't be complete or mold will get into the core. In the lab cores can be mounted on a tray, sanded, and analyzed for age.

Standard: For tree ages, 95% of all trees must be placed in the correct maturity class for loss factor deductions.

Relevance to Owl Habitat: In the western, and more maritime, part of the northern spotted owls' range the best habitat is provided by old growth forests (Forsman *et al.* 1984; Thomas *et al.* 1990; Ripple *et al.* 1991; Carey *et al.* 1992; Lujan *et al.* 1992, FEMAT 1993; Hanson *et al.* 1993; Zabel *et al.* 1995). Uneven-aged stands containing several individual trees >200 years old are an integral part of the working old growth definition (Thomas *et al.* 1990). Older trees on good sites are typically larger in diameter and contain structural attributes like large limbs and cavities that meet owl habitat requirements.

Stand age characteristics suitable to owl use in the eastern Cascade Mountains is more variable than in the western portion of its range. Stands may contain very few older individuals or many older-aged trees and still meet the superior habitat definition (Everett *et al.* 1997). Habitat characteristics other than age-class distribution appear to be more important for assessing habitat suitability.

Sampling Intensity: Variable is sampled at each plot according to cruise procedures.

2.9. Snag density

Source: *Cruise Manual*

Procedure: Snag density will be determined as part of the tree tally in the variable plot cruise. Each tree indicated as "in" in the prism sweep is tallied regardless of whether or not its alive at the time of inventory.

Standard: See the stems/ha portion of section 2.4.

Relevance to Owl Habitat: Snag density, species, diameter, and condition all provide data on the quality of structures used by both the spotted owl and its prey for nesting (Hanson *et al.* 1993).

Data on snag density has been collected as part of several studies conducted in spotted owl habitat. Densities appear to be similar in nest sites, nest stands, foraging and roosting sites, and old growth stands. Studies conducted in the western Washington Cascades found 42 snags/acre >4" DBH, and 18 snags/acre >20" DBH in nesting areas, and 33 to 41 snags/acre >4" DBH, and 7 snags/acre >20" DBH in roosting and foraging areas(Lujan 1992).

Fewer studies have been conducted on snag abundance in eastside forests, but values from two studies show a range of 22 snags/acre >9" DBH to 26 snags/acre >8" DBH (Hanson *et al.* 1993).

Sampling Intensity: Variable is collected at each cruise plot.

2.10. Snag species

Source: N/A

Procedure: Where possible snag species is to be determined and recorded on the tree tally using the tree species codes in section 2.1. Recently dead trees can be identified to species by using bark, foliage, and cone/seed characteristics (Parks *et al.* 1997). Trees that have been dead for some time can be identified to species by investigating bark and wood characteristics. Tree species should only be recorded where the species is clearly identified.

Standard: Variable is an estimate.

Relevance to Owl Habitat: Snag species hasn't been the focus of intensive sampling in spotted owl habitat. Because the owl doesn't excavate cavities, but uses cavities created by other wildlife or tree damage agents, specific snag species qualities are difficult to quantify. Tree species that are more prone to injury and pathological infection may provide nest structures in higher quantity than disease and damage resistant species.

Hamer *et al.* (1989), found that spotted owls primarily chose cavities in old growth western redcedar in the Baker Lake area of western Washington. In B.C. spotted owls have been recorded nesting in western hemlock, Douglas-fir, and western redcedar snags (C. Lenihan, pers. comm. 1998).

Sampling Intensity: Variable is collected at each cruise plot.

2.11. Snag diameter

Source: *Cruise Manual*

Procedure: Snag diameters will be measured the same as live trees. See section 2.4. for details on diameter measurement. In situations where measurements are dangerous to take or where decay reduces the circumference of the snag to something other than a cylinder shape snag diameter can be estimated.

Standard: The minimum standard for snag diameters is an estimate to the nearest 5 cm class.

Relevance to Owl Habitat: Snag diameter information is useful in determining the value of snags as cavity sources. Typically, large-diameter snags (>50 cm dbh) stand the longest, can accommodate large nest cavities, and have the most stable microclimate because of

wood thickness. The thickness of the wood surrounding a cavity is important for thermal regulation and protection from predators (Bull *et al.* 1997). Pileated woodpeckers (*Dryocopus pileatus*), whose abandoned cavities are often utilized by spotted owls, show a preference for large-diameter snags (Bull *et al.* 1997).

Few studies have detailed cavity dimensions and subsequent snag dimensions. Hamer *et al.* (1989), provides cavity dimensions for spotted owls in the Baker Lake area of western Washington. The mean cavity horizontal opening for spotted owls was 30 cm. The mean cavity vertical opening for spotted owls was 236 cm.

Snags are also important as cavity nest sites for prey species. Hanson *et al.* 1993, recommends at least 5 snags/ha >50 cm dbh in order to provide nesting sites for flying squirrels.

Large-diameter snags also provide important wildlife habitat functions once they fall to the ground because they tend to remain on the site longer than smaller-diameter snags.

Sampling Intensity: Variable is collected for each snag in the cruise plot.

2.12. Snag condition

Source: *Vegetation Resource Inventory* (RIC)

Procedure: Snag condition will be determined from a combination of visible appearance codes (Figure 3) and wood condition codes (Table 3).

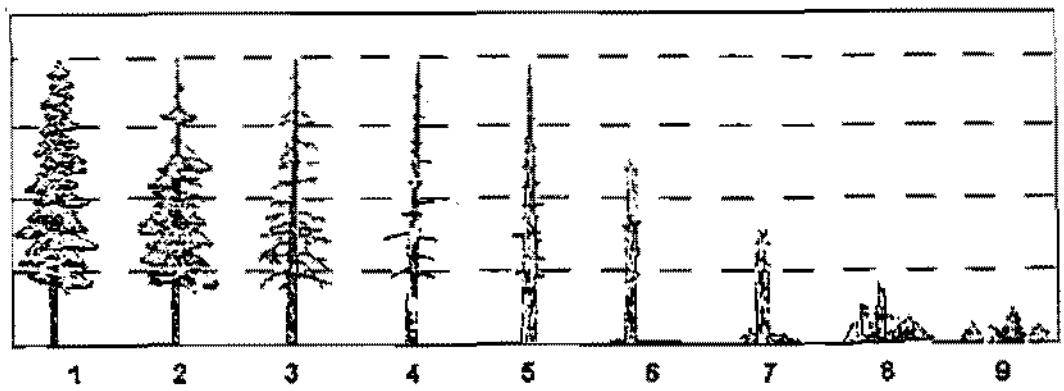


FIGURE 3. Visual appearance codes.

TABLE 3. Wood condition codes

Code	Description
1	No decay
2	Probable limited internal decay and/or deformities
3	Limited decay, wood essentially hard
4	Wood mostly hard but decay spreading, soft wood present
5	Balance of hard and soft wood, spongy sections
6	More soft and spongy wood than hard wood
7	No more hard wood, all soft or spongy, powdery sections
8	Hollow shell, outer wood mostly hard or firm

Standard: The standard for visual appearance is 85/100 in the correct class, and for wood condition is 85/100 in the correct class.

Relevance to Owl Habitat: Snag condition estimates provide valuable information concerning the use and longevity of snags. Well decayed snags may not be utilized by owls as nesting sites but may still be used by various prey species for nesting and foraging habitat. Snag decay rates are not constant over broad areas due to differences in species, site indices, and decay processes. Some general results on snag fall rates after 7 years from southern Oregon and northeastern California are presented in Table 4 (Bull *et al.* 1997).

TABLE 4. Snag fall rates after 7 years by diameter class.

Diameter class (cm)	Percentage
25 - 46	75
50 - 71	65
76 - 97	50
102 - 122	35
>127	30

Sampling Intensity: Variable is collected for each snag in the cruise plot.

2.13 Snag height

Source: *Vegetation Resource Inventory* (RIC) and *Cruise Manual*

Procedure: All snags tallied in the variable radius plot will have heights measured except where the measurement is physically obstructed, it is unsafe to make the measurement, or when an accurate measurement is impossible. In such cases estimate the snag height. Snag height will be measured from the ground on the high-side of the tree to the tip of the tree using a clinometer in percent scale and a metric surveyor's tape. Electronic measuring devices approved by the Ministry of Forests can also be used.

Standard: For measured heights, ≥ 90% of individual measured stems checked must be within 5% of their true height, and the average absolute variation must not exceed 3%. For estimated heights, ≥ 90% of individual estimated stems checked must be within 10% of their true height and the average absolute variation must not exceed 5%.

Relevance to Owl Habitat: Snags of differing heights provide habitat to a variety of species. Pileated woodpeckers typically nest 9.4 to 15.6 m above the ground in cavities ranging from 20 to 25 cm wide and 61 cm deep. A cavity of these dimensions located 16 m up a tree requires a large snag (Bull *et al.* 1997).

Northern flying squirrels show a preference for taller snags (>16 m) versus shorter ones (Hanson *et al.* 1993).

Sampling Intensity: Variable is collected for each snag in the cruise plot.

2.14. Coarse woody debris

Source: *Canadian Forest Service Technology Transfer Notes.*

Procedure: Coarse woody debris (CWD) will be estimated using a combination of line intersect transects and look-up tables. Each piece will be assessed for decay class (Table 5) and species. Determination of species will follow procedures outlined in section 2.10.

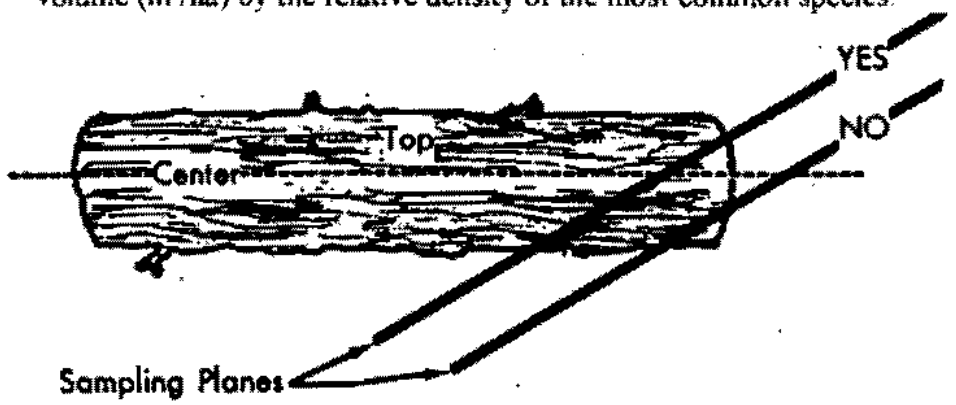
TABLE 5. Coarse woody debris decay codes.

	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
WOOD TEXTURE	**intact, hard**	**intact, hard to partly decaying**	**hard, large pieces, partly decaying**	**small, blocky pieces**	**many small pieces, soft portions**
Other associated characteristics					
PORTION ON GROUND	elevated on support points	elevated but sagging slightly	sagging near ground, or broken	all of log on ground, sinking	all of log on ground, partly sunken
TWIGS < 3 cm (if originally present)	twigs present	no twigs	no twigs	no twigs	no twigs
BARK	bark intact	intact or partly missing	trace bark	no bark	no bark
SHAPE	round	round	round	round to oval	oval
INVADING ROOTS	none	none	in sapwood	in heartwood	in heartwood

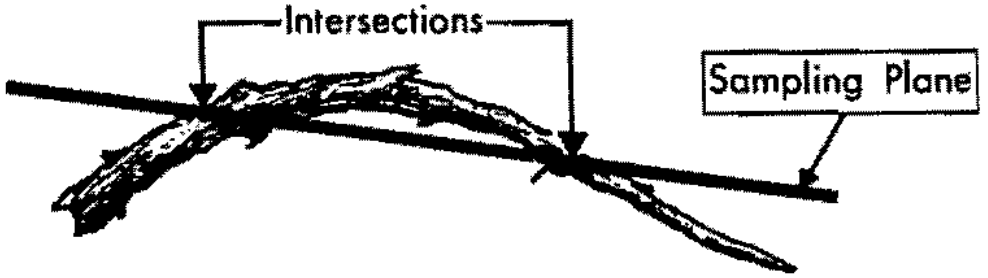
1. Establish a 30 m transect in a random direction from plot center.
2. Count the number of debris pieces along each transect greater than 7.5 cm, by 5 cm diameter class and/or length class using the sampling rules (Figure 4). A scale stick may be used to find the diameter class.
3. Enter the tally in the upper row of the worksheet (Appendix 7). For pieces greater than 50 cm in diameter or 20 m in length, enter the actual diameter in the 50+ cm or

20+ m column.

4. Find the volume and/or number factors corresponding to the number of pieces in each diameter or length class from the CWD volume table (Appendix 8) and CWD piece number table (Appendix 9). If the diameter is greater than 95 cm, then divide the diameter by two, read the corresponding volume, and multiply by four. Enter the value on the lower line of the worksheet.
5. Sum the results by transect.
6. The total is CWD volume (m^3/ha) or number of pieces/ha.
7. Determine the average volume or number of pieces for the site and/or the standard error if a measure of precision is required.
8. The mean piece volume is the total volume/number of pieces.
9. To obtain an estimate of the mass of woody debris on a site (tons/ha) multiply the volume (m^3/ha) by the relative density of the most common species.



An intersection at the end of a branch or log must include the central axis to be tallied.



Count both intersections for a curved piece.

FIGURE 4. Coarse woody debris sampling rules (Brown 1974).

Standard: Variable is an estimate.

Relevance to Owl Habitat: Coarse woody debris functions as forest floor habitat for a variety of spotted owl prey species (Spies *et al.* 1988; Carey 1991; Hanson *et al.* 1993; Carey and Johnson 1995; Bull *et al.* 1997). Uses include moist microclimates, protective

cover for travel, nest and burrow sites, and food in the form of fungi, plants, and invertebrates (Hanson *et al.* 1993).

Sampling Intensity: Variable is collected at each cruise plot.

2.15. Lichen presence/absence

Source: Adapted from *Vegetation Resource Inventory* (RIC)

Procedure: Assess all live and dead standing trees in the cruise plot for lichen loading on the branches within 4.5 m of the ground or root collar.

Assign a rating from 0 to 5 based on a comparison with the appropriate set of photos contained in *Estimating the Abundance of Arboreal Forage Lichens* (Armleder *et al.* 1992) (Appendix 10). A value of 0 indicates no lichens, whether it is a live tree with branches and foliage or a dead tree.

It should be noted that this rating system was developed primarily for *Bryoria* spp. and *Alectoria sarmentosa*; two epiphytic lichen species highly favored as forage by various ungulate species (Vitt *et al.* 1988; Armleder *et al.* 1992) and, in the case of *Bryoria* spp., forage and nesting for the northern flying squirrel. For the purposes of this inventory the same rating system will apply because the northern flying squirrel is using similar species as the ungulates originally targeted for this rating system.

Standard: The standard for lichen loading is 85/100 in the correct class..

Relevance to Owl Habitat: In the northern part of the spotted owl's range the northern flying squirrel (*Glaucomys sabrinus*) makes up the majority of the spotted owls diet (Carey *et al.* 1992; Hanson *et al.* 1993). The flying squirrel has a fairly specialized diet consisting of lichens and fungi (Maser *et al.* 1985; Maser *et al.* 1986; Carey 1991; Zabel and Waters 1997). Lichens also serve as nesting material for the flying squirrel (Hayward and Rosentreter 1994), Douglas' squirrel (*Tamiasciurus douglasii*), and the red tree vole (*Phenacomys longicaudas*) (Carey 1991).

Sampling Intensity: Variable is collected for each tree in the cruise plot.

2.16. Slope

Source: *Cruise Manual*.

Procedure: Record the slope gradient to the nearest percent. Slope measurement will be taken along the most severe gradient from the plot center to a point 15 m horizontal distance in any direction.

Standard: For cruise plots, ≥ 90% of the individual plots checked must be within ± 5 slope percentage points of the slope measured by the check cruiser. For block or cutting permit standards, the average variation of all slopes checked must be within ± 5 slope percentage points.

Relevance to Owl Habitat: No known correlation's exist between slope classes and spotted owl habitat types. Owls may prefer some slope classes seasonally and diurnally over others because of the effect that slope has on stand characteristics.

Sampling Intensity: Variable is collected at each cruise plot.

2.17. Aspect

Source: *Vegetation Resource Inventory* (RIC)

Procedure: Record the orientation of the downward slope (in degrees) using a compass bearing. Level ground (< 2% slope), has no aspect.

Standard: The standard for measuring aspect is ± 20°.

Relevance to Owl Habitat: No known correlation's exist between aspect and spotted owl habitat types. Owls may prefer some aspects seasonally and diurnally over others because of the effect that slope orientation has on stand characteristics. Northeast and north aspects retain snow longer than south and southwest aspects, which could have an effect on foraging strategy.

Sampling Intensity: Variable is collected at each cruise plot.

3.0 SITE ASSESSMENT DATA SAMPLED DURING SILVICULTURE PRESCRIPTION DEVELOPMENT

The site assessment data is collected as part of the silviculture walk-through prior to formulating the silviculture prescription.

3.1. Elevation

Source: *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region.*

Procedure: Record the elevation of the site assessment in meters.

Standard: N/A.

Relevance to Owl Habitat: Elevation data is used to determine plant community composition and subsequent spotted owl habitat suitability. In western Washington, specifically the Mt. Baker-Snoqualmie National Forest, spotted owls have been located in the Western Hemlock Zone and lower elevation limits of the Pacific Silver Fir Zone (Lujan 1992). In the east Cascades on the Okanagan National Forest spotted owls have been located grand fir, Douglas-fir, and ponderosa pine plant associations (Everett *et al.* 1997).

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.2. Microtopography

Source: *Vegetation Resource Inventory* (RIC).

Procedure: Microtopography describes the variability (or mounding) of the surface of the site (Table 6).

TABLE 6. Microtopography codes.

Code	Description
SM	smooth few or no mounds; if present, less than 0.3 m high and more than 7 m apart
MO	moderately mounded mounds 0.3 to 1 m high and 3 to 7 m apart
ST	strongly mounded mounds 0.3 to 1 m high and less than 7 m apart
EX	extremely mounded mounds more than 1 m high

Standard: The standard for microtopography is 94/100.

Relevance to Owl Habitat: There are no known correlation's between general terrain features and spotted owl habitat types. Owls may prefer microclimatic conditions created through terrain features seasonally and diurnally, but as of yet there are no strong correlations.

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.3. Landscape location (slope position)

Source: Adapted from *Vegetation Resource Inventory* (RIC)

Procedure: Meso slope describes the relative position of the treatment unit within a local catchment area, which affects surface and subsurface water flow to the block. Slope position relates to the segment of slope between prominent topographic irregularities (e.g., major slope breaks). Figure 5 shows the meso slope descriptive terms while Table 7 indicates the codes.

TABLE 7. Landscape location codes.

Code	Description
C	crest the generally convex upper portion of a hill.
U	upper slope the generally convex upper portion of the slope immediately below the crest.
M	middle slope the area of the slope between the upper slope and the lower slope where the slope is generally neither distinctly convex or concave.
L	lower slope the area towards the base of a slope, generally concave.
T	toe the area demarcated from the lower slope by an abrupt decrease in slope gradient.
D	depression any area that is concave in all directions.
F	flat any level area not directly adjacent to a slope (e.g., toe). The surface profile is generally horizontal.

Standard: The standard for slope position is 94/100 in the correct position.

Relevance to Owl Habitat: There are no known correlations between the general slope position and spotted owl habitat types. Owls may prefer microclimatic conditions associated with certain slope positions seasonally and diurnally, but as of yet there are no strong correlations.

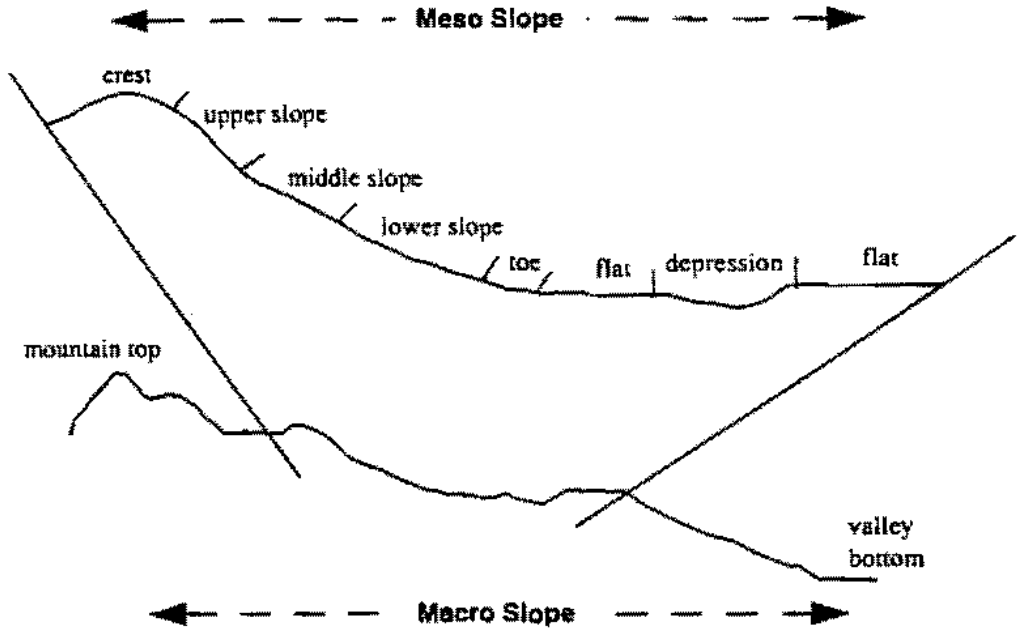


FIGURE 5. Landscape location codes.

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.4. Water source classification

Source: *Riparian Management Area Guidebook* (FPC)

Procedure: Record the proper water source classification as outlined in the *Riparian Management Area Guidebook* (FPC).

3.4.1. Streams

There are six stream riparian classes designated S1 to S6. Each stream reach receives a stream riparian classification based on:

- presence of fish
- occurrence in a community watershed
- average channel width.

A stream reach is a relatively homogeneous section of a stream having a sequence of repeating structural characteristics (or processes) and fish habitat types. The key physical factors used to determine reaches in the field are channel pattern, channel confinement, gradient, and streambed and bank materials. Stream reaches

generally show uniformity in those characteristics and in discharge. The characteristics of stream reaches are described further in the *Fish Stream Identification Guidebook*.

A key to the riparian classification of streams is provided in Figure 6. S1 to S4 streams are fish streams or streams in a community watershed. S5 and S6 streams are not fish streams and are not in a community watershed. The esturaine portion of a stream should be classified the same as the stream that has formed the estuary.

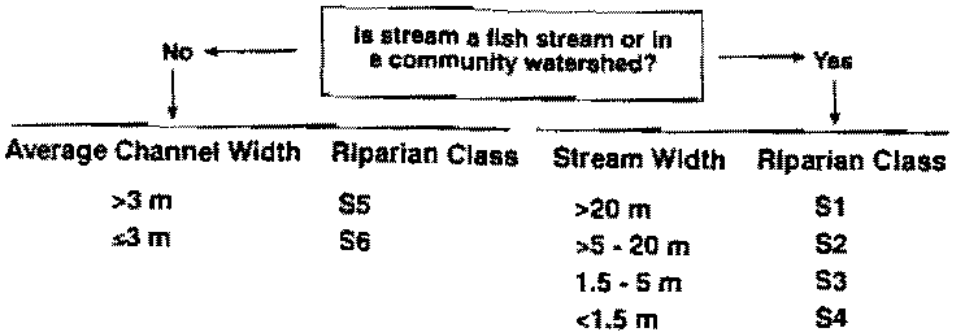


FIGURE 6. Key to the riparian classification of streams.

3.4.2. Wetlands

A wetland is a swamp, marsh, or other similar area that supports natural vegetation that is distinct from the adjacent upland areas. More specifically, a wetland is an area where a water table is at, near, or above the surface or where soils are water-saturated for a sufficient length of time that excess water and resulting low oxygen levels are principle determinants of vegetation and soil development.

Wetlands must have both:

- hydrophytic vegetation, characterized by the predominance of plant species that normally grow in standing water or in soils that are water-saturated for all or a major portion of their growing season
- subhydric or hydric soils, distinguished by free water or prolonged saturation, evidenced by dull gray gleyed horizons, within 30 cm of the mineral surface or by sedge or moss peat over mineral soils.

There are five riparian classes of wetlands (W1 to W5) based on:

- whether the wetland is a simple wetland or wetland complex

- wetland size
- biogeoclimatic unit in which the wetland occurs.

W1 to W4 wetlands are simple wetlands while W5 is a wetland complex. A key to riparian classification of wetlands is illustrated in Figure 7.

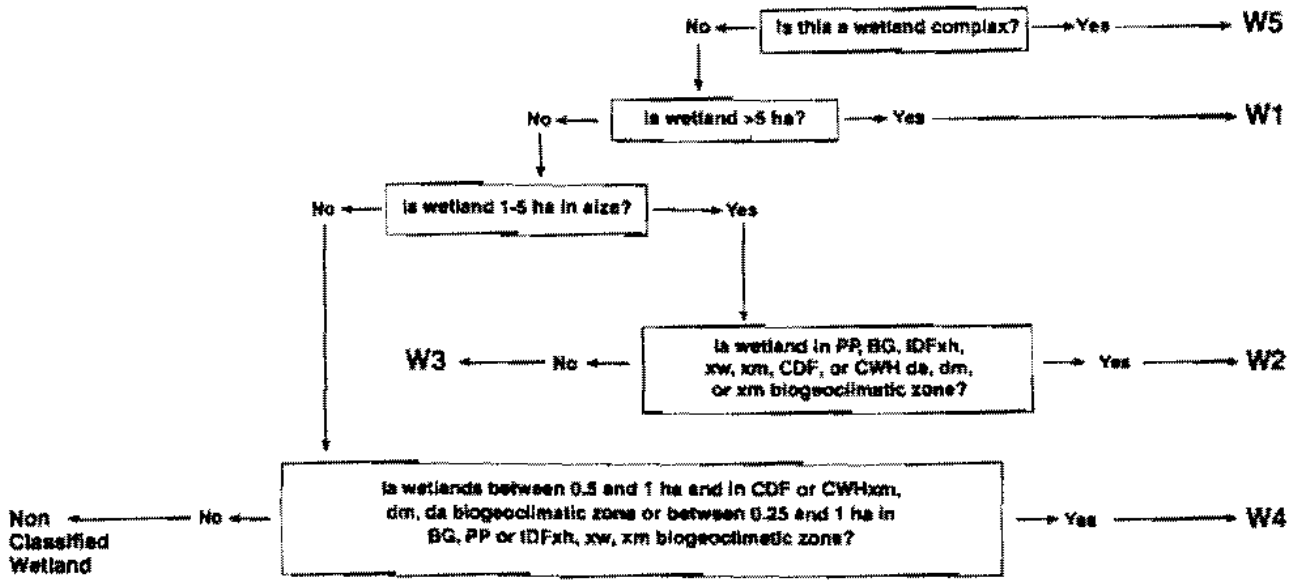


FIGURE 7. Key to the riparian classification of wetlands.

Simple wetlands include all classified wetlands that are not wetland complexes.

A wetland complex consists of two or more individual wetlands with overlapping riparian management areas and a combined wetland area of 5 ha or more. Two wetlands have overlapping riparian management areas if they are:

- separated by 60 m or less and both are < 5 ha, or
- separated by 80 m or less if one is < 5 ha and the other is > 5 ha, or
- separated by 100 m or less if both are > 5 ha.

The individual wetlands of a wetland complex should be sufficiently large that they would otherwise be classified as W1, W2, W3, or W4. Wetland complexes have a riparian class of W5.

3.4.3. Lakes

There are four riparian classes of lakes (L1 to L4) as determined by:

- lake size
- biogeoclimatic unit in which they occur.

Figure 8 provides a key to determine the lake riparian classification.

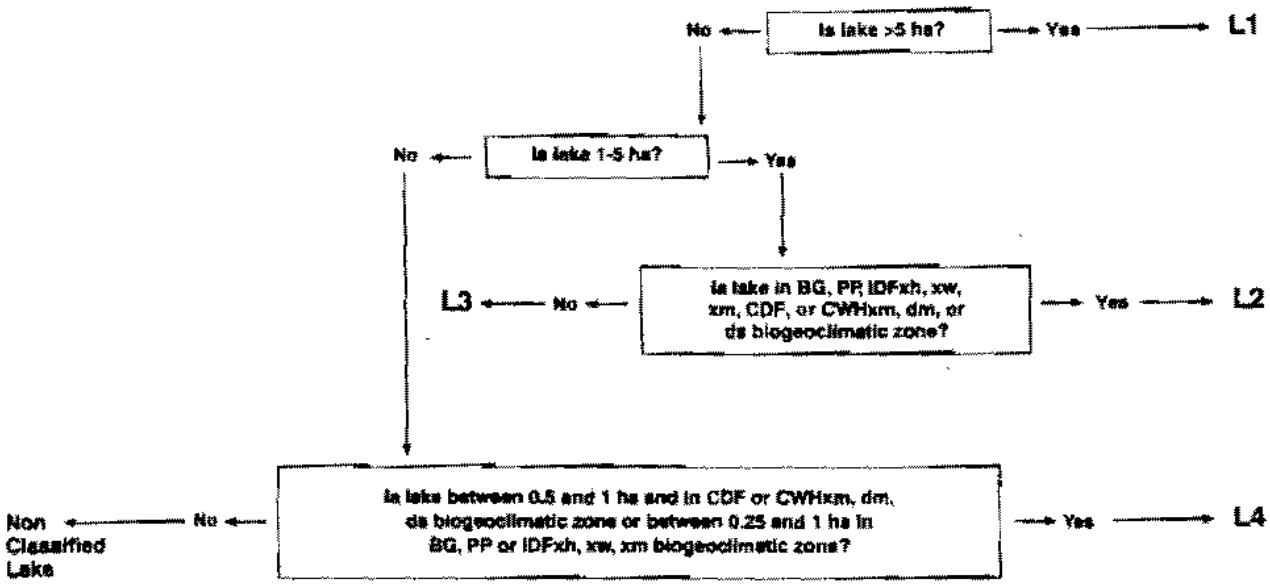


FIGURE 8. Key to the riparian classification of lakes.

Standard: Variable is derived from the riparian assessment completed as part of the silviculture prescription.

Relevance to Owl Habitat: No known correlation's exist between water source type and spotted owl habitat types. Owls may prefer habitats in close proximity to water but as of yet there is no strong correlation.

3.5. Water source width

Source: *Riparian Management Area Guidebook* (FPC)

Procedure: Record the water source width as per instructions in the *Riparian Management Area Guidebook* (FPC).

3.5.1. Streams

The average channel width for each stream reach partially determines the stream riparian class for that stream reach (along with fish presence and community

watershed status). Once a stream is broken into reaches the following methodology can be applied to determine the average channel width for the reach. Once the average channel width has been determined, it can be used to classify the entire stream reach.

Stream channel widths vary depending on where in a watershed the channel is located. Generally, channels are relatively narrow in headwater areas and relatively wide downstream, near the mouth.

Determination of stream riparian classes is based on normal, non-disturbed, channel widths. Recent debris torrents may cause oversized channels, resulting in a higher classification than is required.

Field indicators of channels recently affected by a debris torrent include:

- extensively eroded banks (over 80 % of both banks are eroded)
- complete loss of undercut banks
- extensive lengths of runs or riffles (channel consists of less than 20 % pool or deep water areas)
- expansive bars and relatively little flowing water (wetted width is less than about 20 % of the channel cross-section)
- large woody debris (LWD) levees lying along the channel margin
- minimal instream LWD
- woody debris incorporated in the sediment accumulations.

Average channel width is often obvious enough to make the stream riparian classification. Where the channel width is close to a stream riparian class break (i.e., 5 or 20 m) the following methodology should be employed.

- Stream channel width is defined as the horizontal distance between the tops of the streambanks on opposite sides of the stream, measured at right angles to the general orientation of the banks (Figure 9). The top of the bank is usually indicated by a distinct change in vegetation and sediment texture. Above the top of the bank, the soils and terrestrial plants appear undisturbed by recent stream erosion. Bank areas below the top of the bank typically have freshly moved sediment (e.g., clean sands, gravels, and cobbles) and show signs of both sediment deposition and scouring.
- Vegetated islands are not included. Where multiple channels are separated by one or more islands, the width is the sum of all separate channel widths.
- Unvegetated channel bars are included in the measured width.
- The average width of the stream channel is calculated from six width measurements within a homogeneous reach. Each measurement should be spaced

a distance approximately equal to the channel width from the previous one.

3.5.2. Wetlands

Since the outer edge of wetlands is often treed, it may not be possible to determine the wetland boundary, and thus wetland area, directly from forest inventory maps. Wetland boundary can be interpreted from 1:20 000 or larger scale stereoscopic aerial photographs or determined by on-the-ground surveys.

The outer boundary of a wetland can be closely approximated from 1:20 000 or larger scale aerial photographs by noting where:

- forest canopy (trees > 12.5 cm dbh) closure is greater than 15% or not distinguishable from that characteristic of the better drained uplands
- evidence of wetland processes, such as channels and surface water pools, and wetland vegetation are not present beneath the tree canopy.

The wetland boundary can be determined from on-the-ground surveys by mapping the upslope extent of the following combination of conditions:

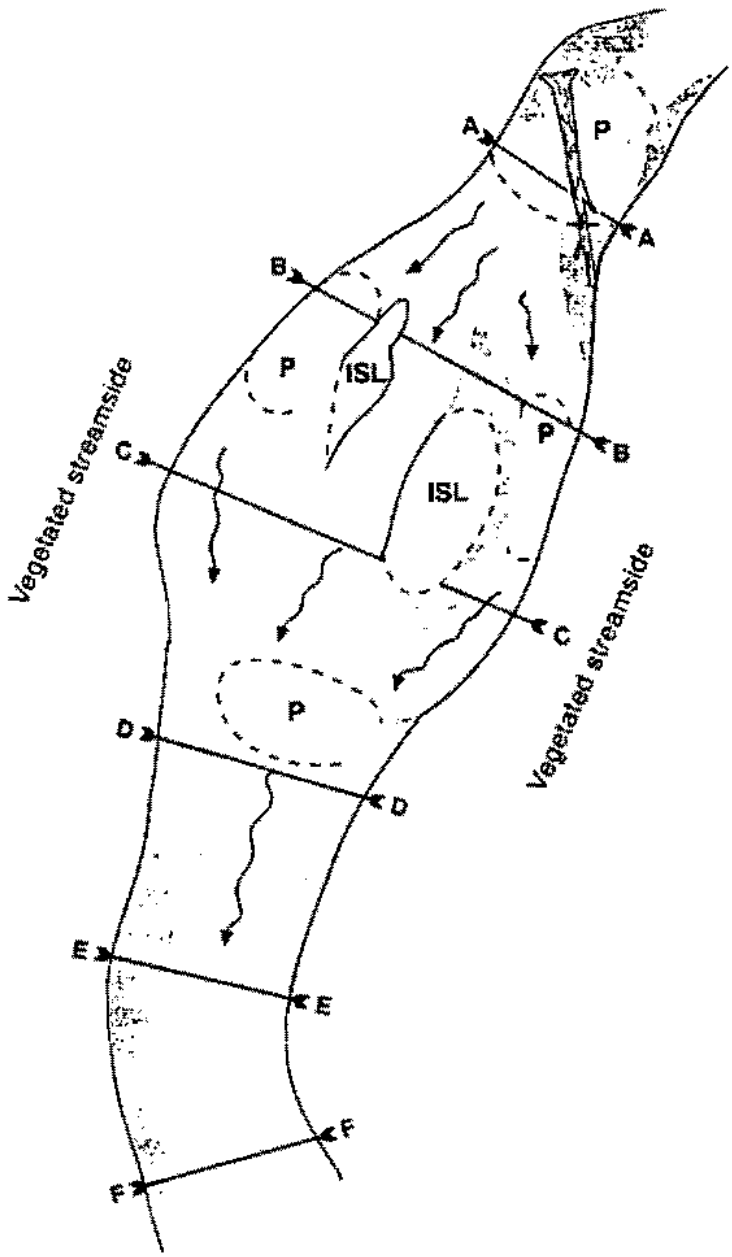
1. Predominance of plant species that normally grow in water or water-saturated soils or in peat soils (plant communities that indicate subhydric or hydric ecological moisture regime)
2. Soils that are water-saturated or show evidence of prolonged water saturation (gleying) within 30 cm of the surface or are peat soils
3. For shrub-carrs, the transition between shrub dominated and tree dominated vegetation.

3.5.3. Lakes

Lake area can be determined directly from 1:20 000 or larger scale aerial photos or maps. The outer edge of a lake can be determined in the field by the normal high-water mark.

Standard: Variable is derived from the riparian assessment completed as part of the silviculture prescription.

Relevance to Owl Habitat: There is anecdotal evidence suggesting spotted owl habitat preference for areas close to water sources (i.e., streams, wetlands, lakes). As of yet there are no strong correlations between habitat types and distances to water sources or habitat types and classification of water sources.



Example:

XS	Width	Total width (m)
A	19	19
B	14 + 4	18
C	18 + 4	22
D	20	20
E	18	18
F	19	19
E	116/6	19.3

Average channel width

Legend

- Cross sectional measurement of channel width
- ISL — Vegetated island
- Bar
- Riffle
- P — Pool
- Large woody debris

FIGURE 9. Process for measuring stream channel width.

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.6. Shrub species and coverage

Source: *Vegetation Resource Inventory* (RIC) and *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region.*

Procedure: Record all shrub species in a 10 m radius plot using the species coding system consisting of the first 4 letters of the genus and the first 3 letters of the species. There are, however, a number of instances which would result in the same code for two different species. For example *Vaccinium myrtilloides* and *Vaccinium myrtillus*. The species that comes first alphabetically is assigned the standard code, and the last letter of the code for the second species defaults to the fourth letter in that species' name. Thus *V. myrtilloides* = VACCMYR_ and *V. myrtillus* = VACCMYT_. This is a potentially serious error, which may be impossible to detect or correct. You should refer to master lists provided for biogeoclimatic units in your project area to ensure the code you use is correct.

If the genus is known but not the species, record all characters (up to 7) in the genus. For example, if an unknown lichen of the *Cladonia* genus is collected, it is coded as CLADONI_. A grass of the *Poa* genus would be coded as POA_ _ _ _. If the grass is known to be *Poa alpina*, it would be coded as POA_ALP_

Although not encouraged, an 8-character code may be used for special purposes to distinguish a variety or subspecies. For example, PINUCON1 versus PINUCON2, to differentiate *Pinus contorta* var. *contorta* (shore pine) from *Pinus contorta* var. *latifolia* (lodgepole pine).

3.6.1. Shrub Species Coding

1. Record all shrub species growing in the 10 m radius plot using codes based on scientific names. A list of indicator species with both common and scientific names with codes is included in Appendix 11. Collect samples of any unknown species, bag and label them for later identification by specialists. Record the item number from the field card on the tagged plant sample as a cross-reference.
2. Maintain a systematic method of recording the species in the plot. The results are much easier to read and compile. One common method is to record species by strata, starting with the uppermost stratum, and within stratum by abundance.
3. In some circumstances it may be necessary to collect the plant list at another time of the year to take advantage of peak floristic conditions.
4. Certain ecosystems are more difficult to sample (i.e. alpine, subalpine meadows, wetlands, riparian communities, grasslands, rock outcrops, and disturbed sites with introduced weedy and non-native species). It may be necessary to have these plots sampled by specialists.

3.6.2. Shrub Species Coverage

Percent cover is the percent of the ground area covered by a vertical projection of the crown of the plant onto the ground surface. When estimating percent cover, care must be taken not to bias estimates because of crown density. Except for distinct holes in the crown, the area within the perimeter of the crown is assumed to be fully covered.

To aid in assessing percent cover, a set of comparison charts (Appendix 5) can be used. Another method is to determine the ground surface area of the plot representing certain percentages (Table 8).

TABLE 8. Conversion factors from percent coverage to horizontal area.

Percent coverage	10 m radius plot
Horizontal surface area	314 m^2
25 % coverage	¼ of the plot pie or 78.5 m^2
1 % coverage	1.8 x 1.8 m or 3.14 m^2
0.1 % coverage	~ 55 x 55 cm or 0.31 m^2

Standard: Shrub species must be identified sufficiently to categorize the site to the site series level in the biogeoclimatic classification system.

Relevance to Owl Habitat: Understory vegetation provides cover and food (in the form of fungi, foliage, seeds, fruit, and invertebrates) for a number of prey of the spotted owl, such as voles, shrews, mice, and flying squirrels (Hanson *et al.* 1993).

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.7. Shrub layer height

Source: *Vegetation Resource Inventory* (RIC)

Procedure: Record the estimated height for each species in shrub layers (Table 9) in the 10 m radius plot. Include all woody shrubs as well as trees in the shrub layers.

TABLE 9. Shrub layer codes.

Layer	Description
B1	**Tall shrubs**: includes all shrubs and advanced tree regeneration between 2 - 10 m tall.
B2	**Low shrubs**: consist, with minor exceptions, of shrubs and established tree regeneration less than 2 m tall and at least 2 years old.

Standard: Variable is an estimate.

Relevance to Owl Habitat: Shrub layer height is an important variable affecting the ability of owls to access prey on the ground. Low, impenetrable shrub layers adversely affect owl hunting success.

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.8. Herb species and coverage

Source: *Vegetation Resource Inventory* (RIC) and *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region*.

Procedure: Record all herb species in a 5.64 m radius plot, nested within the 10 m radius shrub plot, using the species coding system consisting of the first 4 letters of the genus and the first 3 letters of the species. There are, however, a number of instances which would result in the same code for two different species. For example *Vaccinium myrtilloides* and *Vaccinium myrtillus*. The species that comes first alphabetically is assigned the standard code, and the last letter of the code for the second species defaults to the fourth letter in that species' name. Thus *V. myrtilloides* = VACCMYR_ and *V. myrtillus* = VACCMYT_. This is a potentially serious error, which may be impossible to detect or correct. You should refer to master lists provided for biogeoclimatic units in your project area to ensure the code you use is correct.

If the genus is known but not the species, record all characters (up to 7) in the genus. For example, if an unknown lichen of the *Cladonia* genus is collected, it is coded as CLADONI_. A grass of the *Poa* genus would be coded as POA_ _ _ _. If the grass is known to be *Poa alpina*, it would be coded as POA_ALP_.

Although not encouraged, an 8-character code may be used for special purposes to distinguish a variety or subspecies. For example, PINUCON1 versus PINUCON2, to differentiate *Pinus contorta* var. *contorta* (shore pine) from *Pinus contorta* var. *latifolia* (lodgepole pine).

3.8.1. Herb Species Coding

1. Record all herb species growing in the 5.64 m radius plot using codes based on scientific names. A list of indicator species with both common and scientific names with codes is included in Appendix 11. Collect samples of any unknown species, bag and label them for later identification by specialists. Record the item number from the field card on the tagged plant sample as a cross-reference.
2. Maintain a systematic method of recording the species in the plot. The results are much easier to read and compile. One common method is to record species by strata, starting with the uppermost stratum, and within stratum by abundance.
3. In some circumstances it may be necessary to collect the plant list at another time of the year to take advantage of peak floristic conditions.
4. Certain ecosystems are more difficult to sample (i.e., alpine, subalpine meadows, wetlands, riparian communities, grasslands, rock outcrops, and disturbed sites with introduced weedy and non-native species). It may be necessary to have these plots sampled by specialists.

3.8.2. Herb Species Coverage

Percent cover is the percent of the ground area covered by a vertical projection of the crown of the plant onto the ground surface (Table 10). When estimating percent cover, care must be taken not to bias estimates because of crown density. Except for distinct holes in the crown, the area within the perimeter of the crown is assumed to be fully covered.

To aid in assessing percent cover, a set of comparison charts (Appendix 5) can be used.

TABLE 10. Conversion factors from percent coverage to horizontal area.

Percent coverage	5.64 m radius plot
Horizontal surface area	100 m^2
25 % coverage	¼ of the plot pie or 25 m^2
1 % coverage	1 m^2
0.1 % coverage	~ 32 x 32 cm or 0.1 m^2

Standard: Herb species must be identified sufficiently to categorize the site to the site series level in the biogeoclimatic classification system..

Relevance to Owl Habitat: Understory vegetation provides cover and food (in the form of fungi, foliage, seeds, fruit, and invertebrates) for a number of prey of the spotted owl, such as voles, shrews, mice, and flying squirrels (Hanson *et al.* 1993).

Sampling Intensity: Variable is collected as part of the silviculture walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

3.9 Soil and humus description

Source: *Vegetation Resource Inventory* (RIC) and *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region.*

3.9.1. Soil Horizon Description

Record the main type of organic and mineral horizons through the profile noting the depth of rooting, any layers restricting water movement, and the total depth to unfavorable subsoil. The description should follow codes provided in Table 11, starting with the surface horizons and proceeding down through the profile. Differentiate subdivisions of the B or C horizons (e.g., B1_, B2_) if they differ substantially in color, texture, coarse fragments, or structure. Subordinate horizons of B and C (e.g., Bf_, Bf1, Bf2, Bfg, Bt_, and Bm_) may be recorded if the survey crew can confidently identify them. A complete list of subordinate horizons is available in the *Canadian System of Soil Classification* (ECSS 1987).

3.9.2. Soil Depth

Record the average distance from 'zero' depth for each horizon in the soil profile.

- For forest floor horizons (L, F, H) zero depth is the boundary between organic and mineral horizons. Depths are measured from the ground surface to 0 depth (e.g., in Figure 10, L:6, F:4, H:2).
- For mineral horizons, zero depth is the top of the uppermost mineral horizon, and lower boundary depths are measured in descending order (e.g., in Figure 10, A:3, B:10, C:60).
- For organic soils, zero depth is the top or the organic material. Organic soils are soils with greater than 60 cm of organic material (if surface horizons are Of_), or greater than 40 cm of organic material (if surface horizons are Om_ and Oh_), or greater than 10 cm thick if they overlie rock, as described on pp. 82-86 in the *Canadian System of Soil Classification* (ECSS 1987).

TABLE 11. Examples of important soil horizons.

Horizon Code	Description
L_ _	an upland organic horizon consisting of relatively fresh, undecomposed plant residues.
F_ _	an upland organic horizon consisting of partly decomposed plant residues which fragmented plant residues are generally recognizable as to origin.
H_ _	an upland organic horizon comprised of well-decomposed plant residues in which plant structures are generally not recognizable. *F_ _ and H_ _ can be combined and recorded as an FH_ horizon if they are difficult to distinguish.
Ah_	surface mineral horizons enriched with organic matter (darker colored than underlying horizon).
Ae_	surface mineral horizons leached (eluviated) of organic matter, Fe, Al, and other elements (lighter [usually light greyish] colored than underlying horizon).
B_ _	mineral horizons affected by pedogenic processes and characterized by enrichment in organic matter, Fe, Al, clay, or by development of soil structure, or by a change in color indicating gleying or oxidation.
C_ _	mineral horizons relatively unaffected by pedogenic processes except gleying, and accumulation or carbonates and salts. It represents the unweathered parent material.
Of_	a wetland organic horizon consisting of poorly decomposed plant residues that are readily identifiable as to origin (peat).
Om_	a wetland organic horizon consisting of partly decomposed plant residues which are at a stage of decomposition intermediate between of and oh horizons (peat).
Oh_	a wetland organic horizon consisting of well decomposed plant residues (black muck).
R_	bedrock or regolith.

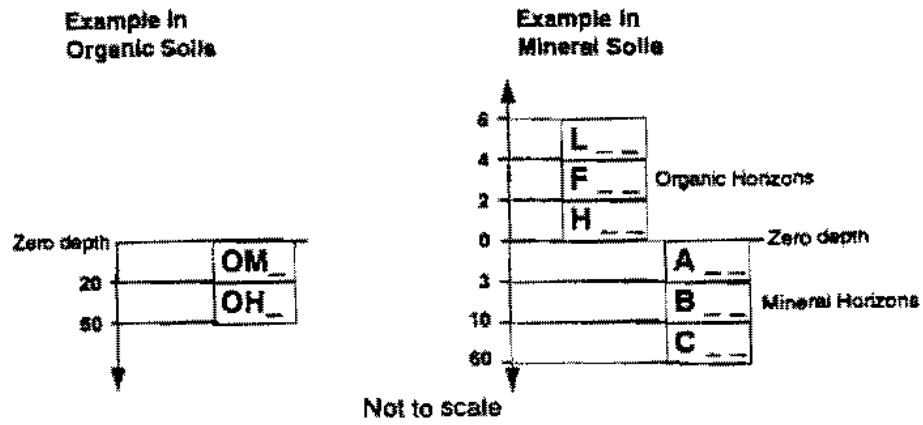


FIGURE 10. Example of recording horizon depth in organic soils and mineral soils.

Relevance to Owl Habitat: There are no known correlation's between soil characteristics and spotted owl habitat types. Owls may prefer microclimatic conditions associated with certain soil moisture and/or soil nutrient regimes, but as of yet there are no strong correlations.

Sampling Intensity: As per the *Silviculture Prescription Guidebook* (FPC).

3.10. Biogeoclimatic Classification

Source: *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region*.

Procedure: Biogeoclimatic units are identified using the maps available for the Vancouver Forest Region (contact the Regional Research Ecologist for copies) as well as vegetation features, elevation ranges, and other information presented in *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region*. The maps provide an initial identification of the biogeoclimatic unit for a particular area, and may be all that is necessary if the area falls well within a map polygon. Field verification is recommended, however, and is required in areas near biogeoclimatic unit boundaries or in complex, mountainous terrain. Identification in the field focuses on vegetation characteristics of late-seral or near-climax plant communities on zonal sites. Of particular importance are shade-tolerant tree species. Vegetation on non-zonal sites (e.g., wetter or drier than zonal) may also be useful in identifying some biogeoclimatic units. Use the vegetation summary tables for zonal sites, together with the biogeoclimatic subzone/variant descriptions to assist in field identification. As tree species are important in differentiating biogeoclimatic units, it is useful to observe changes in tree species composition while driving into the work area. These changes often indicate the approximate location of a subzone or variant boundary. Figure 11 summarizes the major steps for identifying biogeoclimatic units.

Standard: As part of the silviculture prescription the site must be correctly identified at the site series level (B.C. Ministry of Forests 1995).

Relevance to Owl Habitat: The biogeoclimatic classification of sites and elevation combine to provide data on owl habitat preferences. Data from National Forests to the west and east of the Cascade Mountains in Washington State provide a list of plant associations where owls have been located (Lujan 1992; Everett *et al.* 1997). Similar plant associations have been identified for British Columbia and are provided in Figure 1.

Sampling Intensity: As per the *Silviculture Prescription Guidebook* (FPC).

3.9.3. Soil Texture

Estimate the texture of the mineral soil (grains 2 mm or less in diameter) using the field estimation method as described in *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region.*

3.9.4. Coarse Fragments

For each mineral soil horizon, estimate the proportion of the total volume of soil material occupied by mineral particles larger than 2 mm in diameter. Record the total coarse fragment percentage. Coarse fragment size or diameter is measured along the b axis, where a = length, b = width, and c = height (a>b>c).

3.9.5. Soil Moisture Regime

Soil moisture regime (SMR) refers to the average annual amount of soil water available to plants. Relative SMR uses eight classes to rank the relatively driest soil (0) to the relatively wettest soil (7) within a particular biogeoclimatic subzone or variant. It can be inferred from selected physiographic and soil features (Appendix 12).

3.9.6. Soil Nutrient Regime

Soil nutrient regime (SNR) refers to the amount of essential soil nutrients, particularly nitrogen, that are available to plants (Klinka *et al.* 1987). Five classes are recognized, ranging from very poor with low amounts of available N and other nutrients and slow turnover of organic matter; to very rich with relatively large amounts of available N and other nutrients, and rapid turnover of organic matter (Table 12). Soil nutrient regime can be inferred using indicator plants or from selected soil properties (Appendix 13).

TABLE 12. Soil nutrient regime classes.

Code	Soil Nutrient Regime Class
A	very poor
B	poor
C	medium
D	rich
E	very rich

Standard: To current standards required for silviculture prescriptions (*Silviculture Prescription Guidebook* [FPC]).

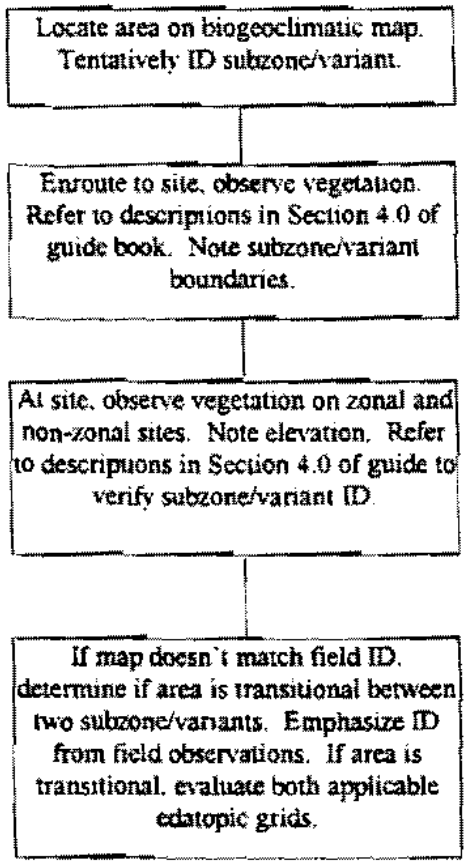


FIGURE 11. Flowchart for identifying biogeoclimatic units.

3.11. Forest health indicators

Source: *Vegetation Resource Inventory* (RIC)

Procedure: In addition to tallying indicators of stem decay for cull grading on individual trees in the variable radius plot, indicators of general stand health will also be noted. A tally will be made of biotic and abiotic indicators of forest health from Appendix 14 as an ongoing exercise through the entire project area as opposed to on a plot by plot basis. An assessment of general forest health isn't quantifiable so standards for assessment aren't available.

Standard: To current standards required for silviculture prescriptions (*Silviculture Prescription Guidebook* [FPC] and *Forest Health Surveys Guidebook* [FPC]).

Relevance to Owl Habitat: See section 2.3.

Sampling Intensity: A forest health assessment is carried out as part of the unit walk-through prior to compiling the silviculture prescription (*Silviculture Prescription Guidebook* [FPC]).

APPENDIX 1: Stand attribute inventory field form

STAND ATTRIBUTE INVENTORY FIELD FORM

Plot No.:	Slope %:	Aspect:	Crown Closure %:

Canopy Data				Snag Data					Age Data			
Tree No.	Height (m)	Crown Class	Height to live crown (m)	Tree No.	Species	Dia. (cm)	Condition Code	Height (m)	Tree No.	Species	Crown Class	Age at DBH

Canopy Gaps				Lichen Loading			
Dist. (m)	Code	Dist. (m)	Code	Tree No.	Code	Tree No.	Code

APPENDIX 2: Spotted owl habitat impact report for SRMZ's

ORIGINAL ☐	AMENDMENT ☐		DATE Y/M/D	
LICENSE NO.	CUTTING PERMIT	BLOCK NO.	LICENSEE	TIMBER MARK
AUTHORITY / OPENING NO.	LOCATION		TIMBER SUPPLY AREA / BLOCK	
REGION	DISTRICT	AIR PHOTO NOs.	LONGITUDE / LATITUDE / UTM GRID	
TOTAL AREA	NET AREA TO BE TREATED	FIELD WORK DONE BY	DATE COMPLETED	

A) Premise for Silviculture Prescription

a) Does more than 67% of suitable Spotted Owl habitat exist within the Activity Center?
☐ No ☐ Yes ☐ Unknown

b) Is the silviculture prescription within the 67% suitable Spotted Owl habitat?
☐ No ☐ Yes ☐ Unknown

(If YES, explain how the proposed logging operation will affect the 67% minimum spotted Owl suitable habitat mandate within the activity center).

c) What spotted owl habitat type exists within the proposed cutblock?

d) What spotted owl habitat type is intended to be created after the proposed silviculture prescription has been applied?
☐ Spotted owl habitat type A
☐ Spotted owl habitat type B
☐ Marginal spotted owl habitat
☐ Silviculture purposes

B) Elaborate on the Silviculture System Proposed

☐ Even Age
☐ Group Selection
☐ Clear-cut
☐ Clear-cut with Reserves
☐ Patch Cut
☐ Seed Tree
☐ Uneven Age
☐ Single Tree Selection
☐ Commercial Thinning
☐ Strip Selection
☐ Shelter Wood
☐ Other

Forest Stand Attributes	Current Stand Attributes before Proposed Silviculture Prescription	Post-Harvest Stand Attributes after Proposed Silviculture Prescription
Leading Tree Species % Composition		
Avg. Age Class		
Height Class		
Avg. Tree Height & Standard Deviation		
Stocking Class		
Crown Closure		
Site Index at Age 50		
Avg. dbh with Standard Deviation		
# Stems per ha. (Density)		
# Snags per ha.		
Coarse Woody Debris (m^3/ha.)		

APPENDIX 2: Spotted owl habitat impact report for SRMZ's (cont'd)

C) Type of Forest Development Plan within the SRMZ

C.1) Salvage Operation ☐ No ☐ Yes

a) If YES, what type of salvage operation is planned?
☐ Windthrow ☐ Insect ☐ Disease ☐ Fire ☐ Other _____

b) Does the damage exceed 30% of the stand volume?
☐ No ☐ Yes ☐ Unknown

C.2) Road Construction ☐ No ☐ Yes

a) Is the road construction proposed to occur between March 1 and July 31?
☐ No ☐ Yes ☐ Unknown

b) Is there knowledge of a Spotted Owl nest site in the area of the proposed road construction?
☐ No ☐ Yes ☐ Unknown

c) Is the known Spotted Owl nest site:
Within 200m of the proposed road? ☐ No ☐ Yes ☐ Unknown
Within 400m of the proposed road? ☐ No ☐ Yes ☐ Unknown

C.3) Enhancement or Maintainence of Spotted Owl Habitat ☐ No ☐ Yes

Answer the following questions with reference to the *Spotted Owl Operational Guidebook*.
Will the silviculture prescription:

a) enhance the forest community (regarding tree composition) for the Spotted Owl?
☐ No ☐ Yes ☐ Unknown
(If YES, describe the forest community before and after the proposed silviculture prescription and explain how this will enhance the Spotted Owl habitat)

b) modify the % canopy closure? ☐ No ☐ Yes ☐ Unknown
(If YES, describe the % canopy closure before and after the proposed silviculture prescription and explain how this will enhance the Spotted Owl habitat).

c) affect tree density and height within the stand? ☐ No ☐ Yes ☐ Unknown
(If YES, describe the average tree density and height before and after the proposed silviculture prescription and explain how this will enhance the Spotted Owl habitat).

d) affect the vertical diversity within the stand? ☐ No ☐ Yes ☐ Unknown
(If YES, describe the vertical diversity before and after the proposed silviculture prescription and how this will enhance the Spotted Owl habitat).

e) affect the density of snags? ☐ No ☐ Yes ☐ Unknown
(If YES, describe the density of the snags before and after the proposed silviculture prescription and explain how this will

enhance the Spotted Owl habitat).

f) affect the amount of course woody debris (CWD)? ☐ No ☐ Yes ☐ Unknown
(If YES, describe the amount of CWD (m^3 per ha) before and after the proposed silviculture prescription and explain how this will enhance the Spotted Owl habitat).

g) affect the density and species composition of the understory? ☐ No ☐ Yes ☐ Unknown
(If YES, describe the understory density and species composition before and after the proposed silviculture prescription and explain how this will enhance the Spotted Owl habitat).

D) Post-Harvest Activities

Are the post-harvest activities intended to enhance spotted owl habitat?
☐ No ☐ Yes

D.1) Site Preparation ☐ No ☐ Yes

What type of site preparation is proposed?
☐ Broadcast Burning ☐ Mechanical ☐ Chemical ☐ Other _____
What is the approximate date of the proposed activity? (M/Y)
With reference to the *Spotted Owl Operational Guidebook*, describe how the proposed activity will effect present and future spotted owl habitat:

D.2) Natural Regeneration ☐ No ☐ Yes

Describe what species are proposed to regenerate on the site, and the relative percentage of each in descending order.

Spp	%	Spp	%	Spp	%

D.3) Planting ☐ No ☐ Yes

Describe what species will be planted on the site, the relative percentage of each in descending order, an the approximate date of their planting

Spp	%	Date	Spp	%	Date

D.4) Vegetation Control ☐ No ☐ Yes

Which method of vegetation control is proposed?
☐ Manual ☐ Chemical ☐ Other _____
What is the approximate date of the proposed activity? (M/Y)
With reference to the *Spotted Owl Operational Guidebook*, describe how the proposed activity will effect present and future spotted owl habitat:

D.5) Thinning and/or Pruning ☐ No ☐ Yes

What method of thinning/pruning is proposed?

☐ Precommercial Thinning ☐ Commercial Thinning
☐ Pruning ☐ Other _____

What is the approximate date of the proposed activity? (M/Y)

With reference to the *Spotted Owl Operational Guidebook*, describe how the proposed activity will effect present and future spotted owl habitat:

D.6) Additional Post-Harvest activities

Does the post-harvest activity include one of the following:?

☐ Fertilization ☐ Conifer Release
☐ Stand Conversion

What is the approximate date of the proposed activity? (M/Y)

With reference to the *Spotted Owl Operational Guidebook*, describe how the proposed activity will effect present and future spotted owl habitat:

D.7) Projection of Forest Attributes

Complete the following regarding the forest structure and species composition, over time.

Target					Spp Composition							
# yrs after treatment	stand age	av. tree ht	av. DBH	Canopy Closure	Spp	%	Spp	%	Spp	%	Spp	%
10												
25												
50												
100												

should be per hectare not per plot.

APPENDIX 3: Inventory compilation sheet

STAND ATTRIBUTE DATA		
Attribute	Compilation Formula	Output Format
Species composition		List of species/plot
Canopy/crown closure		Crown closure % per plot
Stem defects		List of stem defects encountered per tree per plot
Diameter distribution		List of trees by species and diameter in 10 cm dbh increments
Stand density	Compute the plot radius of each tree in m^2 and dividing it into a hectare (10,000 m^2), the number of individual trees of a specified diameter per hectare is derived. The total of all species of all diameters expressed in hectares is the stand density.	Numerical value of the stand density per hectare
Height to live crown		List the height to live crown per measured tree per plot
Canopy gaps		List the canopy gap codes recorded between plots by location and indicate on map of unit
Tree heights		List tree heights by species and crown class per plot and project the data on a per hectare basis
Age		List tree ages by species and crown class per plot
Snag density	Compute the plot radius of each snag in m^2 and dividing it into a hectare (10,000 m^2), the number of individual snags/species of a specified diameter per hectare is derived. The total of all snags of all diameters expressed in hectares is the snag density.	Numerical value of the snag density per hectare
Snag species		List each snag/plot by species, diameter in 10 cm dbh increments, height, and condition code
Snag diameter		List each snag/plot by species, diameter in 10 cm dbh increments, height, and condition code
Snag condition		List each snag/plot by species, diameter in 10 cm dbh increments, height, and condition code
Snag height		List each snag/plot by species, diameter in 10 cm dbh increments, height, and condition code
Coarse woody debris	Compute volume (m^3/ha) and pieces/ha using look-up tables in the appendices	List volume and pieces/ha per plot and averaged for the unit

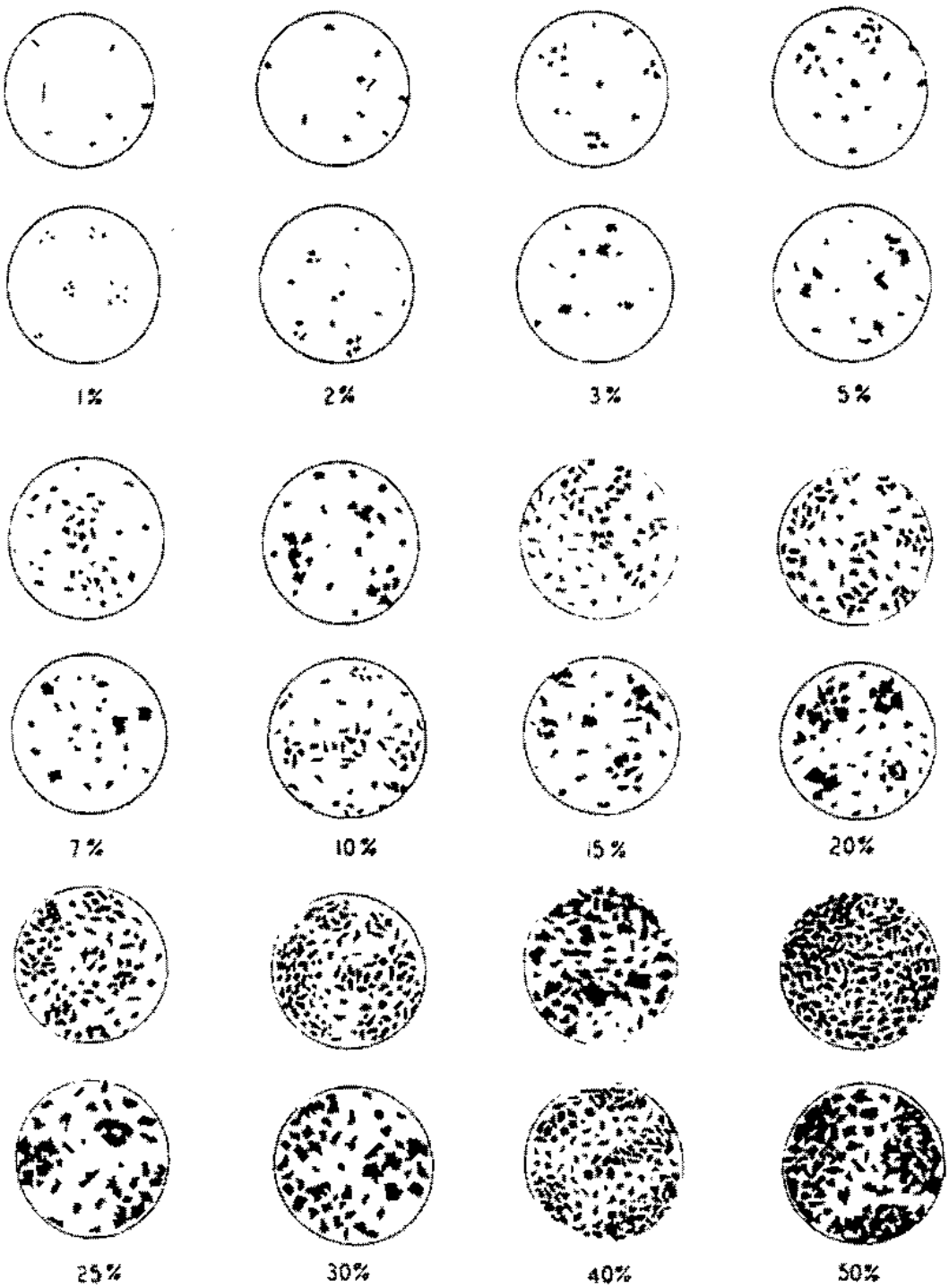
Lichen loading		List the lichen loading code per tree per plot
Slope		List the slope derived at the plot
Aspect		List the aspect derived at the plot
SITE ASSESSMENT DATA		
Attribute	Compilation Formula	Output Format
Elevation		List the general elevation range of the unit
Microtopography		List the general microtopography code for the unit
Landscape location		List the general landscape location code for the unit
Water source classification		List the nearest water sources by classification and width
Water source width		List the nearest water sources by classification and width
Shrub species & coverage		List the shrub species and their corresponding coverages from the representative plot in the unit
Shrub layer height		List the shrub layer heights in the representative plot
Herb species & coverage		List the herb species and their corresponding coverages from the representative plot in the unit
Soil & humus description		Describe the soil and humus layers found on the unit
Biogeoclimatic classification		Describe the biogeoclimatic zone for the unit
Forest health indicators		List all forest health indicators found on the unit

APPENDIX 4: Tree species code list

Common Name	Scientific Name	Code
Western Redcedar	*Thuja plicata*	Cw
Yellow-cedar	*Chamaecyparis nootkatensis*	Yc
Douglas-fir	*Pseudotsuga menziesii*	Fd
Coastal Douglas-fir	*P. menziesii* var. *menziesii*	Fdc
Interior Douglas-fir	*P. menziesii* var. *glauca*	Fdi
Amabilis Fir	*Abies amabilis*	Ba
Grand Fir	*A. grandis*	Bg
Noble Fir	*A. procera*	Bp
Subalpine Fir	*A. lasiocarpa*	Bl
Mountain Hemlock	*Tsuga mertensiana*	Hm
Western Hemlock	*T. heterophylla*	Hw
Mountain and Western Hybrid	*T. mertensiana* x *heterophylla*	Hxm
Rocky Mountain Juniper	*Juniperus scopulorum*	Jr
Alpine Larch	*Larix lyalli*	La
Tamarack	*L. laricina*	Lt
Western Larch	*L. occidentalis*	Lw
Jack Pine	*Pinus banksiana*	Pj
Limber Pine	*P. flexilis*	Pf
Lodgepole Pine	*P. contorta*	Pl
Lodgepole Pine	*P. contorta* var. *latifolia*	Pli
Lodgepole x Jack Pine Hybrid	*P. murrayxbanksiana*	Pxj
Ponderosa Pine	*P. ponderosa*	Py
Shore Pine	*P. contorta* var. *contorta*	Plc
Western White Pine	*P. monticola*	Pw
Whitebark Pine	*P. albicaulis*	Pa
Black Spruce	*Picea mariana*	Sb
Engelmann Spruce	*P. engelmannii*	Se
Sitka Spruce	*P. sitchensis*	Ss
White Spruce	*P. glauca*	Sw
Spruce Hybrid	*P. cross*	Sx
Engelmann x White	*P. engelmannii x glauca*	Sxw
Sitka x White	*P. x lutzii*	Sxl
Engelmann x Sitka	*P. engelmannii x sitchensis*	Sxe
White x Black	*P. glauca x mariana*	Sxb
White x Engelmann x Sitka	*P. glauca x engelmannii x sitchensis*	Sxx
Sitka x unknown hybrid	*P. sitchensis x ?*	Sxs
Western Yew	*Taxus brevifolia*	Tw
Mountain Alder	*Alnus tenuifolia*	Dm
Red Alder	*A. rubra*	Dr
Poplar	*Populus balsamifera*	Ac

Balsam Poplar	*P. balsamifera ssp. balsamifera*	Acb
Black Cottonwood	*P. balsamifera ssp. trichocarpa*	Act
Hybrid Poplars	*P. spp.*	Ax
Trembling Aspen	*P. tremuloides*	At
Arbutus	*Arbutus menziesii*	Ra
Alaska Paper Birch	*Betula neoalaskana*	Ea
Alaska x Paper Birch Hybrid	*B. x winteri*	Exp
Paper Birch	*B. papyrifera*	Ep
Water Birch	*B. occidentalis*	Ew
Water x Paper Birch Hybrid	*B. x piperi*	Exw
Cascara	*Rhamnus purshiana*	Kc
Bitter Cherry	*Prunus emarginata*	Vb
Choke Cherry	*P. virginiana*	Vv
Pin Cherry	*P. pennsylvanica*	Vp
Pacific Dogwood	*Cornus nuttallii*	Gp
Bigleaf Maple	*Acer macrophyllum*	Mb
Vine Maple	*A. circinatum*	Mv
Garry Oak	*Quercus garryana*	Qg
Bebb's Willow	*Salix bebbiana*	Wb
Pacific Willow	*S. lucida*	Wp
Peachleaf Willow	*S. amygdaloides*	Wa
Pussy Willow	*S. discolor*	Wd
Scouler's Willow	*S. scouleriana*	Ws
Sitka Willow	*S. sitchensis*	Wt
Unknown Conifer		Xc
Unknown Broadleaf		Xh

APPENDIX 5: Comparison charts for visual estimation of foliage cover



Developed by Richard D. Terry and George V. Chilingar. Published by the Society of Economic Paleontology and Mineralogy in Journal of Sedimentary Petrology 25(3): 229–234, September 1955.

APPENDIX 6: Special situations encountered when measuring diameters

Forked Trees: Where a tree forks below 1.3 meters, measure as two trees. Where a fork occurs at or above 1.3 meters, measure as one tree and record the diameter at 1.3 meters or lower if this diameter is smaller. Where two trees are growing together, "caliper" the diameter of each tree. To "caliper" a tree, hold the distance side of a diameter tape up against the tree and determine the distance across from one side of the tree to the other.

Debris at the Base: Where there is an accumulation of forest litter or stones at the base of the tree, this should be moved aside to the level where the litter becomes partially decomposed on the highest side of the tree. This is the "high side" location, irrespective of any forest litter, rock, bolder or downed tree which may rest against the tree. If a DBH stick is used, it should be placed at the same level. The stick should not be driven down to mineral soil.

Flared Roots: Trees growing on windfall, chunks or rocks, will have long, sloping roots. In order to calculate an accurate volume, these trees should have "high side" located so that DBH is the same as for a normal tree. The root collar is often a good position for "high side" in this situation. "High side" can not be lower than the point of germination.

Abnormalities at 1.3 meters: For abnormal butt swells, limbs, catfaces, etc., measure above and below 1.3 meters, or measure the taper on a nearby tree of the same species of similar diameter/height and taper and apply this to a diameter which is not at dbh.

Trees without bark or with a catface: No allowance for missing bark will be made.

Cruising in the snow will only be permitted when dbh can be located at 1.3 meters and the diameter accurately measured.

When measuring diameter, care must be taken that the diameter tape does not end up above nor sag below 1.3 meters on the side away from the observer. This problem is more prevalent on big trees on uneven terrain.

APPENDIX 7: Coarse woody debris field form

Coarse Woody Debris Inventory Data Card

Plot No.	Transect Slope	Horiz. Dist.	Slope Dist.	Transect Azimuth

Piece No.	Species	Decay Code	Dia. Class*	Volume (m3/ha)	Number Factor (no./ha)**

Diameter Class*	Diameter Range (cm)	Length Class	Length Range (m)
10	7.5 - 12.5	1	0.5 - 1.5
15	12.6 - 17.5	2	1.6 - 2.5
20	17.6 - 22.5	3	2.6 - 3.5
25	22.6 - 27.5	4	3.6 - 4.5
30	27.6 - 32.5	5	4.6 - 5.5
35	32.6 - 37.5	6	5.8 - 7.0
40	37.6 - 42.5	8	7.1 - 9.0
45	42.6 - 47.5	10	9.1 - 12.5
50	47.6 - 52.5	15	12.6 - 17.5
55	52.6 - 57.5	20	17.6 - 22.5
60	57.6 - 62.5	25	22.6 - 27.5
65	62.6 - 67.5	30	27.6 - 32.5
70	67.6 - 72.5	35	32.6 - 37.5
75	72.6 - 77.5	40	37.6 - 42.5
80	77.6 - 82.5	45	42.6 - 47.5
85	82.6 - 87.5	50	47.6 - 52.5
90	87.6 - 92.5	55	52.6 - 57.5
95	92.6 - 97.5	60	57.6 - 62.5
100	97.6 - 102.5	65	62.6 - 67.5
		70	67.6 - 72.5

APPENDIX 8: Coarse woody debris volume table

Coarse Woody Debris Volume Table

	Diameter Class (cm)								
	10	15	20	25	30	35	40	45	50
No. of Pieces per 30m	7.5 | 12.5	12.6 | 17.5	17.6 | 22.5	22.6 | 27.5	27.6 | 32.5	32.6 | 37.5	37.6 | 42.5	42.6 | 47.5	47.6 | 52.5
	CWD Volume (m^3/ha)								
1	4	9	16	26	37	50	66	83	103
2	8	19	33	51	74	101	132	167	206
3	12	28	49	77	111	151	197	250	308
4	16	37	66	103	148	202	263	333	411
5	21	46	82	129	185	252	329	416	514
6	25	56	99	154	222	302	395	500	617
7	29	65	115	180	259	353	461	583	720
8	33	74	132	206	296	403	526	666	822
9	37	83	148	231	333	453	592	749	925
10	41	93	164	257	370	504	658	833	1028

	Diameter Class (cm)								
	55	60	65	70	75	80	85	90	95
No. of Pieces per 30m	52.6 | 57.5	57.6 | 62.5	62.6 | 67.5	67.6 | 72.5	72.6 | 77.5	77.6 | 82.5	82.6 | 87.5	87.6 | 92.5	92.6 | 97.5
	CWD Volume (m^3/ha)								
1	124	148	174	202	231	263	297	333	371

(Developed by S. Taylor, Canadian Forest Service)

APPENDIX 9: Coarse woody debris piece number table

Coarse Woody Debris Piece Number Table

	Length Class (m)									
	1	2	3	4	5	6	8	10	15	20
No. of Pieces per 30m	0.5 | 1.5	1.6 | 2.5	2.6 | 3.5	3.6 | 4.5	4.6 | 5.5	5.8 | 7.0	7.1 | 9.0	9.1 | 12.5	12.6 | 17.5	17.6 | 22.5
	Number Factor (no./ha)									
1	524	262	175	131	105	87	65	52	35	26
2	1047	524	349	262	209	175	131	105	70	52
3	1571	785	524	393	314	262	196	157	105	79
4	2094	1047	698	524	419	349	262	209	140	105
5	2618	1309	873	655	524	436	327	262	175	131
6	3142	1571	1047	785	628	524	393	314	209	157
7	3665	1833	1222	916	733	611	458	367	244	183
8	4189	2094	1396	1047	838	698	524	419	279	209
9	4712	2356	1571	1178	942	785	589	471	314	236
10	5236	2618	1745	1309	1047	873	655	524	349	262

	Length Class (m)									
	25	30	35	40	45	50	55	60	65	70
No. of Pieces per 30m	22.6 | 27.5	27.6 | 32.5	32.6 | 37.5	37.6 | 42.5	42.6 | 47.5	47.8 | 52.5	52.6 | 57.5	57.6 | 62.5	62.6 | 67.5	67.6 | 72.5
	Number Factor (no./ha)									
1	21	17	15	13	12	10	10	9	8	7

(Developed by S. Taylor, Canadian Forest Service)

APPENDIX 10: Photo guides for estimating the abundance of arboreal lichens

Classifying Lichen Abundance

The objective is to classify each tree into one of six lichen abundance classes. These classes are based on the actual weight of the lichens (all *Alectoria* and *Bryoria* combined) on the trees.

Only lichens below 4.5 m high on the trees are included in the rating. In the photos, the 4.5 m point is indicated by the top of the height pole positioned against the trunk. Lichens up to this height are available to caribou when they are standing on a deep, settled snowpack.

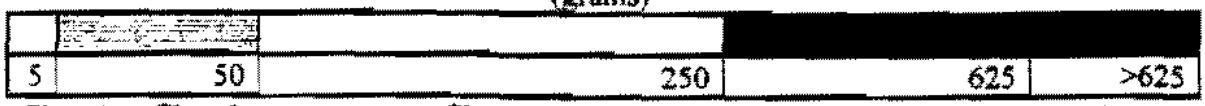
The general impression of lichen abundance in a tree varies with the growth form and the vigor of the tree. Three photo series are provided:

Series A: mostly living branches
Series B: mixed living and dead branches
Series C: mostly dead branches

Photos are provided for all the class boundaries except between Class 0 and Class 1. Class 0 is reserved for trees with no noticeable lichen at all. Trees having even a single wisp of lichen belong in Class 1.

For simplicity, the photos show only *Alectoria*. In practice, however, *Bryoria* must also be included in the estimate of overall abundance.

Amount of Lichen
(grams)



How To Classify A Tree

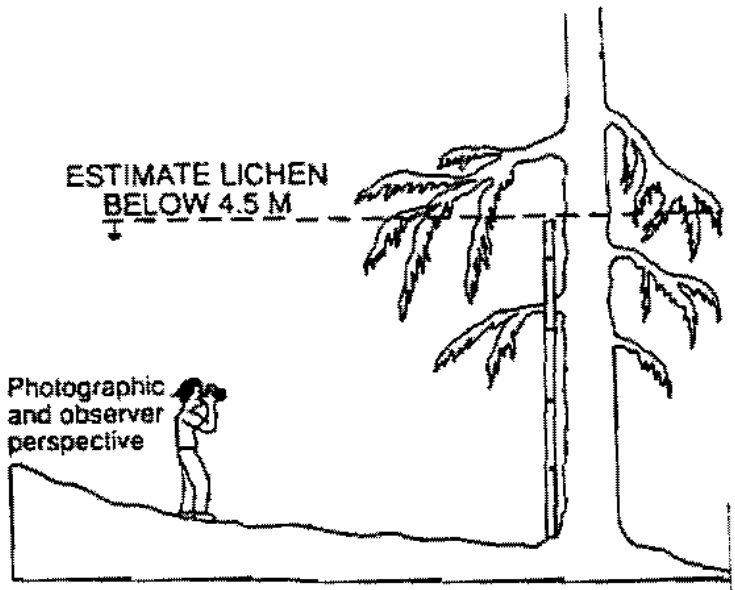
Step 1 Decide which photo series (A, B, or C) best matches the tree, and use it to determine roughly into which class the tree fits.

Step 2 Turn to the photos that distinguish the classes closest to your estimate and confirm your classification.

Remember: All photos show boundaries between classes. Only lichen below 4.5 m should

be included in your estimate (see diagram).

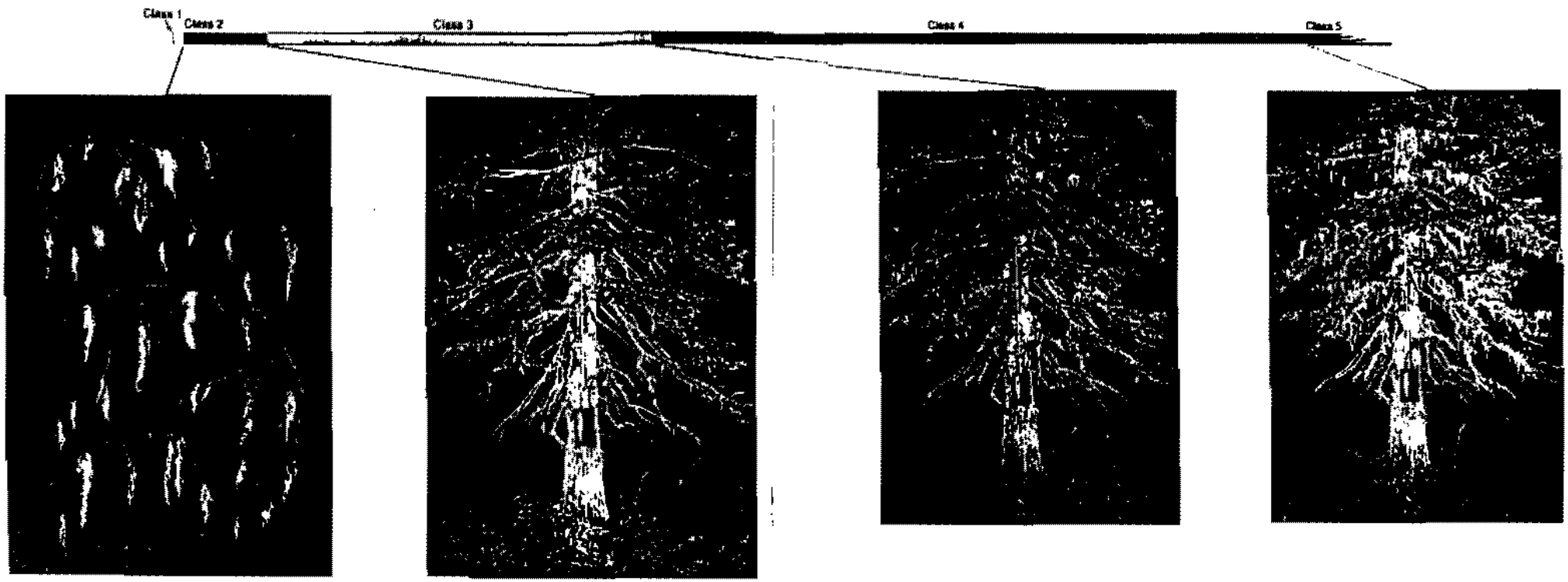
Zone of Lichen Estimation



Be careful only to include lichen below 4.5 m. The photographic and observer perspective is deceiving. Branches in front of the height pole may appear to be above the estimation zone, but are actually below 4.5 m; while branches behind the pole may appear to be within the estimation zone but are actually above 4.5 m.

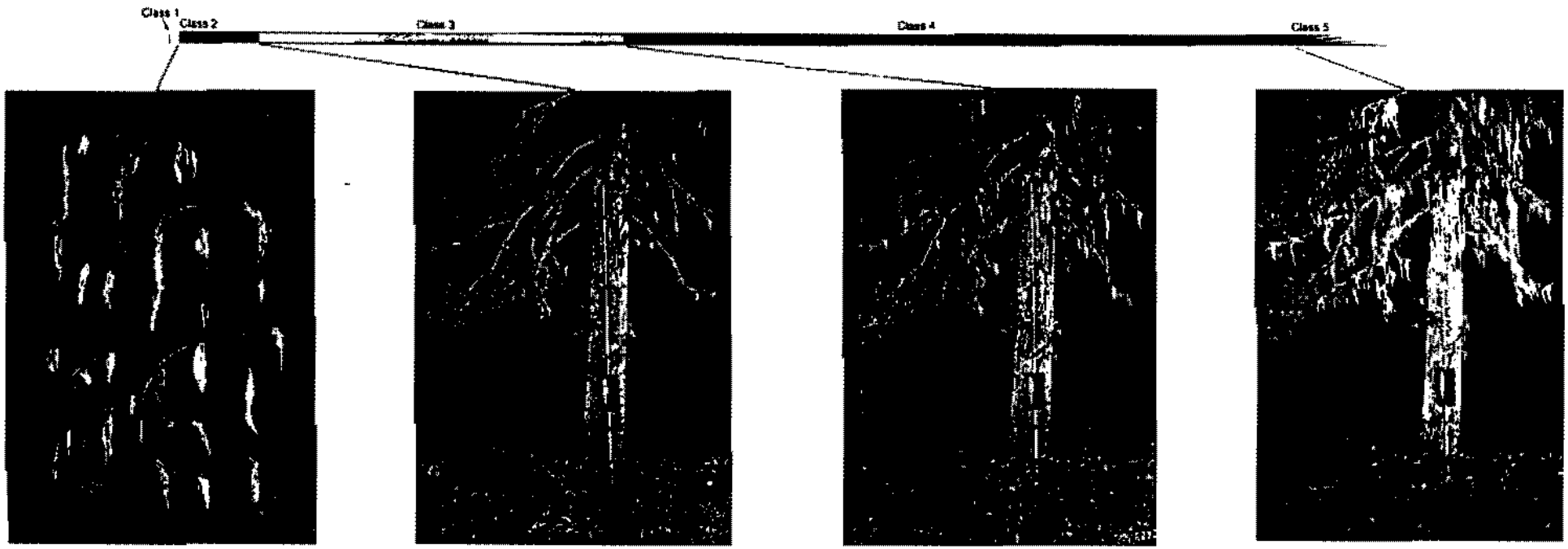
SERIES A: MOSTLY LIVING BRANCHES

Photos illustrate boundaries between classes



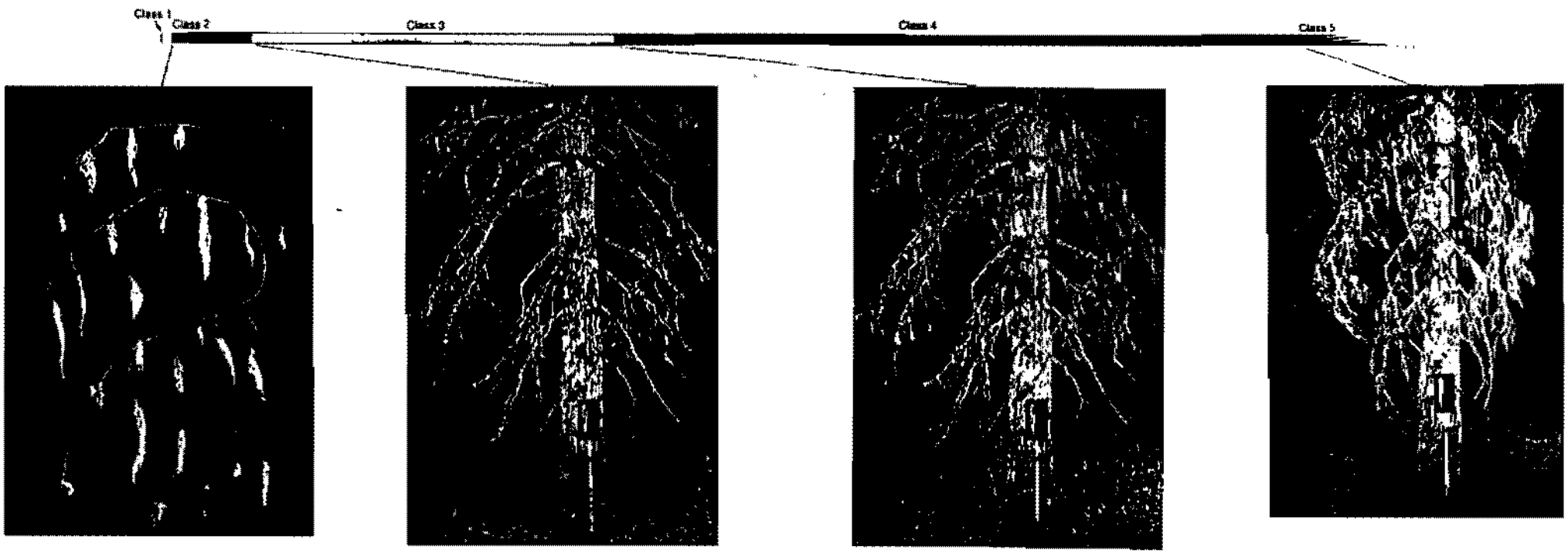
SERIES B: MIXED LIVING AND DEAD BRANCHES

Photos illustrate boundaries between classes



SERIES C: MOSTLY DEAD BRANCHES

Photos illustrate boundaries between classes



APPENDIX 11: Indicator species – common and scientific names

Common name	Scientific name
alpine azalea	*Loiseleuria procumbens*
alpine wintergreen	*Gaultheria humifusa*
small-flowered alumroot	*Heuchera micrantha*
kneeling angelica	*Angelica genuflexa*
Pacific crab apple	*Malus fusca*
heart-leaved arnica	*Arnica cordifolia*
mountain arnica	*Arnica latifolia*
Sitka mountain ash	*Sorbus sitchensis*
western mountain ash	*Sorbus scopulina*
sticky false asphodel	*Tofieldia glutinosa*
fringed aster	*Aster ciliolatus*
snowy aster	*Aster conspicuous*
large-leaved avens	*Geum macrophyllum*
false azalea	*Menziesia ferruginea*
baneberry	*Actaea rubra*
beak-sedge	*Rhynchospora alba*
sweet-scented bedstraw	*Galium triflorum*
northern bentgrass	*Agrostis aequivalvis*
Brewer's bitter-cress	*Cardamine breweri*
Nuttal's bitter-cress	*Cardamine pulcherrima*
evergreen blackberry	*Rubus laciniatus*
trailing blackberry	*Rubus ursinus*
bleeding heart	*Dicentra formosa*
small-flowered blue-eyed mary	*Collinsia parviflora*
Alaskan blueberry	*Vaccinium alaskaense*
bog blueberry	*Vaccinium uliginosum*
dwarf blueberry	*Vaccinium caespitosum*
oval-leaved blueberry	*Vaccinium ovalifolium*
velvet-leaved blueberry	*Vaccinium myrtilloides*
bluejoint	*Calamagrostis canadensis*
bog-laurel	*Kalmia microphylla* ssp. *occidentalis*
white bog-orchid	*Platanthera dilatata*
bog-rosemary	*Andromeda polifolia*
coast boykinia	*Boykinia elata*
five-leaved bramble	*Rubus pedatus*
California brome	*Bromus carinatus*
Columbia brome	*Bromus vulgaris*
American brooklime	*Veronica americana*

Scotch broom	*Cytisus scoparius*
buckbean	*Menyanthes trifoliata*
false bugbane	*Trautvetteria caroliniensis*
small-flowered bulrush	*Scirpus microcarpus*
bunchberry	*Cornus canadensis*
Cordilleran bunchberry	*Cornus unalaschkensis*
great burnet	*Sanguisorba officinalis*
Sitka burnet	*Sanguisorba canadensis*
American bush-cranberry	*Viburnum trilobum*
creeping buttercup	*Ranunculus repens*
little buttercup	*Ranunculus uncinatus*
subalpine buttercup	*Ranunculus eschscholtzii*
western buttercup	*Ranunculus occidentalis*
common camas	*Camassia quamash*
great camas	*Camassia leichtlinnii*
candystick	*Allotropa virgata*
cascara	*Rhamnus purshiana*
redstem ceonothus	*Ceonothus sanguineus*
choke cherry	*Prunus virginiana*
sticky cinquefoil	*Potentilla glandulosa*
cleavers	*Galium aparine*
Alaska club-moss	*Lycopodium sitchense*
alpine club-moss	*Lycopodium alpinum*
fir club-moss	*Huperzia haleakalae*
running club-moss	*Lycopodium clavatum*
stiff club-moss	*Lycopodium annotinum*
tufted clubrush	*Trichophorum caespitosum*
palmate coltsfoot	*Petasites frigidis* var. *palmatus*
sweet coltsfoot	*Petasites frigidis*
red columbine	*Aquilegia formosa*
copperbush	*Cladothamnus pyroliflorus*
spotted coralroot	*Corallorhiza maculata*
western coralroot	*Corallorhiza mertensiana*
narrow-leaved cotton-grass	*Eriophorum angustifolium*
Rocky Mountain cow-lily	*Nuphar polysepalum*
cow-parsnip	*Heracleum lanatum*
bog cranberry	*Vaccinium oxycoccos*
crowberry	*Empetrum nigrum*
red-flowering currant	*Ribes sanguinium*
stink currant	*Ribes bracteosum*
trailing black currant	*Ribes laxiflorum*

subalpine daisy	*Erigeron peregrinus*
meadow death-camas	*Zygadenus venenosus*
deer-cabbage	*Fauria crista-galli*
single delight	*Moneses uniflora*
fern-leaved desert-parsley	*Lomatium dissectum*
devil's club	*Oplopanax horridus*
spreading dogbane	*Apocynum androsaemifolium*
red-osier dogwood	*Cornus stolonifera*
western flowering dogwood	*Cornus nuttallii*
red elderberry	*Sambucus racemosa*
woolly eriophyllum	*Eriophyllum lanatum*
fairy-slipper	*Calypso bulbosa*
hooker's fairybells	*Disporum hookeri*
rough-fruited fairybells	*Disporum trachycarpum*
Smith's fairybells	*Disporum smithii*
weak false-manna	*Torreyochloa pauciflora*
false polytrichum	*Timmia austriaca*
falsebox	*Paxistima myrsinites*
red-stemmed feathermoss	*Pleurozium schreberi*
beech fern	*Phegopteris connectilis*
Braun's holly fern	*Polystichum braunii*
deer fern	*Blechnum spicant*
fragile fern	*Cystopteris arostichoides*
lady fern	*Athyrium felix-femina*
maidenhair fern	*Adiantum pedatum*
male fern	*Dryopteris filix-mas*
mountain holly fern	*Polystichum lonchitis*
oak fern	*Gymnocarpium dryopteris*
parsley fern	*Cryptogramma crispa*
spiny wood fern	*Dryopteris expansa*
sword fern	*Polystichum munitum*
bearded fescue	*Festuca subulata*
crinkle-awned fescue	*Festuca subuliflora*
western fescue	*Festuca occidentalis*
fireweed	*Epilobium angustifolium*
cut-leaved foamflower	*Tiarella laciniata*
one-leaved foamflower	*Tiarella unifoliata*
three-leaved foamflower	*Tiarella trifoliata*
tall fringecup	*Tellima grandiflora*
sweet gale	*Myrica gale*
king gentian	*Gentiana sceptrum*

swamp gentian	*Gentiana douglasiana*
dovefoot geranium	*Geranium molle*
wild ginger	*Asarum caudatum*
gnome-plant	*Hemitomes congestum*
goatsbeard	*Aruncus dioicus*
fern-leaved goldthread	*Coptis asplenifolia*
three-leaved goldthread	*Coptis trifolia*
black gooseberry	*Ribes lacustre*
gummy gooseberry	*Ribes lobbii*
wild gooseberry	*Ribes divaricatum*
fringed grass-of-Parnassus	*Parnassia fimbriata*
ground-cedar	*Lycopodium complanatum*
ground-pine	*Lycopodium obscurum*
groundcone	*Boschniakia hookeri*
arrow-leaved groundsel	*Senecio triangularis*
common groundsel	*Senecio vulgaris*
wood groundsel	*Senecio sylvaticus*
grouseberry	*Vaccinium scoparium*
early hairgrass	*Aira praecox*
mountain hairgrass	*Vahlodea atropurpurea*
silver hairgrass	*Aira caryophyllea*
tufted hairgrass	*Deschampsia cespitosa*
hardhack	*Spiraea douglasii*
Scouler's hairbell	*Campanula scouleri*
white-flowered hawkweed	*Hieracium albiflorum*
black hawthorn	*Crataegus douglasii*
beaked hazelnut	*Corylus cornuta*
Cooley's hedge-nettle	*Stachys cooleyae*
Mexican hedge-nettle	*Stachys mexicana*
Indian hellebore	*Veratrum viride*
highbush-cranberry	*Viburnum edule*
hairy honeysuckle	*Lonicera hispidula*
Utah honeysuckle	*Lonicera utahensis*
western trumpet honeysuckle	*Lonicera ciliosa*
common horsetail	*Equisetum arvense*
giant horsetail	*Equisetum telmateia*
wood horsetail	*Equisetum sylvaticum*
black huckleberry	*Vaccinium membranaceum*
blue-leaved huckleberry	*Vaccinium deliciosum*
evergreen huckleberry	*Vaccinium ovatum*
red huckleberry	*Vaccinium parvifolium*

Indian-pipe	*Monotropa uniflora*
Indian-plum	*Oemleria cerasiformis*
common juniper	*Juniperus communis*
Rocky Mountain juniper	*Juniperus scopulorum*
kinnikinnick	*Arctostaphylos uva-ursi*
Labrador tea	*Ledum groenlandicum*
dog lichen	*Peltigera canina*
freckled lichen	*Peltigera aphthosa*
green reindeer lichen	*Cladina mitis*
reindeer lichen	*Cladina rangiferina*
chocolate lily	*Fritillaria affinis*
pink fawn lily	*Erythronium revolutum*
tiger lily	*Lilium columbianum*
white fawn lily	*Erythronium oregonum*
false lily-of-the -valley	*Maianthemum dilatatum*
alligator-skin liverwort	*Conocephalum conicum*
cedar-shake liverwort	*Plagiochila porelloides*
common leafy liverwort	*Barbilophozia lycopodioides*
green-tongue liverwort	*Marchantia polymorpha*
mountain leafy liverwort	*Barbilophozia floerkei*
shiny liverwort	*Pellia neesiana*
bracted lousewort	*Pedicularus bracteosa*
sickletop lousewort	*Pedicularus racemosa*
arctic lupine	*Lupinus arcticus*
Nootka lupine	*Lupinus nootkatensis*
hairy manzanita	*Arctostaphylos columbiana*
mountain mare's-tail	*Hippurus montana*
marsh-marigold	*Caltha biflora*
marsh-marigold	*Caltha leptosepala*
western meadowrue	*Thalictrum occidentale*
Siberian miner's-lettuce	*Claytonia sibirica*
Brewer's mitrewort	*Mitella breweri*
common mitrewort	*Mitella nuda*
five-stamened mitrewort	*Mitella pentandra*
oval-leaved mitrewort	*Mitella ovalis*
mock-orange	*Philadelphus lewisii*
small-leaved montia	*Montia parvifolia*
awned haircap moss	*Polytrichum piliferum*
broken-leaf moss	*Dicranum tauricum*
coastal leafy moss	*Plagiomnium insigne*
curly heron's-bill moss	*Dicranum fuscescens*

electrified cat's-tail moss	*Rhytidiadelphus triquetrus*
elegant moss	*Isopterygnum elegans*
flat moss	*Plagiothecium undulatum*
glow moss	*Aulacomnium palustre*
grey frayed-cap rock moss	*Rhacomitrium canescens*
knight's plume moss	*Ptilium crista-castrensis*
lanky moss	*Rhytidiadelphus loreus*
lawn moss	*Brachythecium albicans*
Oregon beaked moss	*Kindbergia oregana*
palm tree moss	*Leucolepis menziesii*
pipecleaner moss	*Rhytidiopsis robusta*
poor-fen moss	*Sphagnum fallax*
red-mouthed leafy moss	*Mnium spinulosum*
step moss	*Hylocomium splendens*
yellow-green rock moss	*Rhacomitrium heterostichum*
Alaskan mountain-heather	*Cassiope stelleriana*
four-angled mountain-heather	*Cassiope tetragona*
pink mountain-heather	*Phyllodoce empetriformis*
white mountain-heather	*Cassiope mertensiana*
yellow mountain-heather	*Phyllodoce glanduliflora*
mountainbells	*Stenanthium occidentale*
stinging nettle	*Urtica dioica* ssp. *gracilis*
alpine enchanter's nightshade	*Circaea alpina*
Pacific enchanter's nightshade	*Circaea pacifica*
Pacific ninebark	*Physocarpus capitatus*
poverty oatgrass	*Danthonia spicata*
timber oatgrass	*Danthonia intermedia*
ocean-spray	*Holodiscus discolor*
Hooker's onion	*Allium acuminatum*
nodding onion	*Allium cernuum*
Alaska oniongrass	*Melica subulata*
dull Oregon-grape	*Mahonia nervosa*
tall Oregon-grape	*Mahonia aquifolium*
partridgefoot	*Luetkea pectinata*
pathfinder	*Adenocaulon bicolor*
creamy peavine	*Lathyrus ochroleucus*
purple peavine	*Lathyrus nevadensis*
piggy-back plant	*Tolmiea menziesii*
pinedrops	*Pterospora andromeda*
pinegrass	*Calamagrostis rubescens*
pinesap	*Hypopitys monotropa*

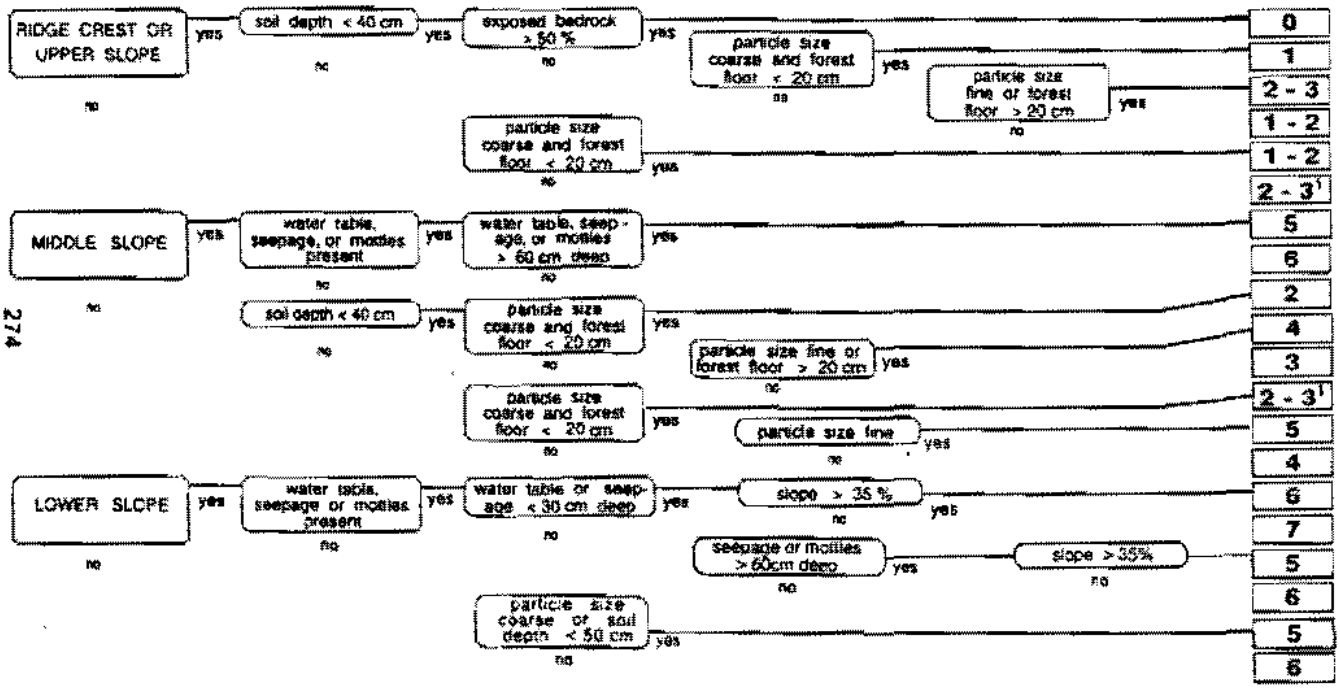
Menzies' pipsissewa	*Chimaphila menziesii*
princes' pine	*Chimaphila umbellata*
field pussytoes	*Antennaria neglecta*
queen's cup	*Clintonia uniflora*
black raspberry	*Rubus leucodermis*
red raspberry	*Rubus idaeus*
trailing raspberry	*Rubus pubescens*
rattlesnake-plantain	*Goodyera oblongifolia*
western rattlesnake-root	*Prenanthes alata*
Pacific reedgrass	*Calamagrostis nutkaensis*
round-leaved rein-orchid	*Platanthera orbiculata*
white-flowered rhododendron	*Rhododendron albiflorum*
baldhip rose	*Rosa gymnocarpa*
Nootka rose	*Rosa nutkana*
prickly rose	*Rosa acicularis*
common rush	*Juncus effusus*
dagger-leaved rush	*Juncus ensifolius*
salal	*Gaultheria shallon*
salmonberry	*Rubus spectabilis*
big-leaved sandwort	*Moehringia macrophylla*
Pacific sanicle	*Sanicula crassicaulis*
Sierra sanicle	*Sanicula graveolens*
wild sarsaparilla	*Aralia nudicaulis*
saskatoon	*Amelanchier alnifolia*
satin-flower	*Olsynium douglasii*
leatherleaf saxifrage	*Leptarrhena pyrolifolia*
Tolmie's saxifrage	*Saxifraga tolmiei*
scapania	*Scapania bolanderi*
scouring-rush	*Equisetum hyemale*
Dewey's sedge	*Carex deweyana*
Henderson's sedge	*Carex hendersonii*
long-stoloned sedge	*Carex inops*
Merten's sedge	*Carex mertensii*
pale sedge	*Carex livida*
Ross' sedge	*Carex rossii*
Sitka sedge	*Carex sitchensis*
slough sedge	*Carex obnupta*
smooth-stemmed sedge	*Carex laeviculmis*
sweet sedge	*Carex anthoxanthea*
Wallaces' selaginella	*Selaginella wallacei*
broad-leaved shootingstar	*Dodecatheon hendersonii*

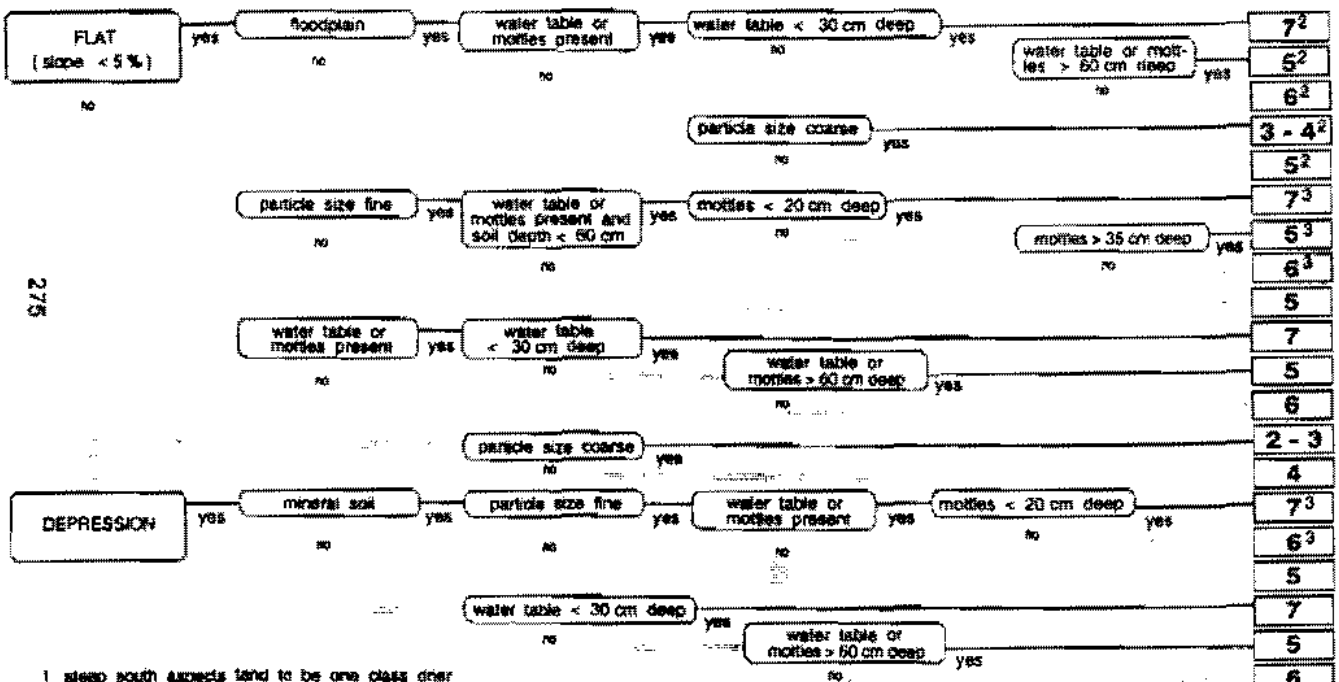
few-flowered shootingstar	*Dodecatheon pulchellum*
sibbaldia	*Sibbaldia procumbens*
skunk cabbage	*Lysichitum americanum*
common snowberry	*Symphoricarpus albus*
trailing snowberry	*Symphoricarpus mollis* var. *hesperius*
snowbrush	*Ceanothus velutinus*
star-flowered Solomon's-seal	*Smilacina stellata*
false Solomon's-seal	*Smilacina racemosa*
soopolallie	*Sheperdia canadensis*
common brown sphagnum	*Sphagnum fuscum*
common green sphagnum	*Sphagnum girgensohnii*
common red sphagnum	*Sphagnum capillifolium*
birch-leaved spirea	*Spirea betulifolia*
pink spirea	*Spirea menziesii*
subalpine spirea	*Spirea densiflora*
western St. John's-wort	*Hypericum formosum*
broad-leaved starflower	*Trientalis latifolia*
northern starflower	*Trientalis arctica*
crisp starwort	*Stellaria crispa*
northern starwort	*Stellaria calycantha*
broad-leaved stonecrop	*Sedum spathulifolium*
wild strawberry	*Fragaria virginiana*
wood strawberry	*Fragaria vesca*
round-leaved sundew	*Drosera rotundifolia*
mountain sweet-cicely	*Osmorhiza chilensis*
woodland tarweed	*Madia madioides*
western tea-berry	*Gaultheria ovatifolia*
thimbleberry	*Rubus parvifolius*
bastard toadflax	*Geocaulon lividum*
western trillium	*Trillium ovatum*
nodding trisetum	*Trisetum cernuum*
broad-leaved twayblade	*Listera convallarioides*
heart-leaved twayblade	*Listera cordata*
northwestern twayblade	*Listera caurina*
black twinberry	*Lonicera involucrata*
twinflower	*Linnaea borealis*
clasping twistedstalk	*Streptopus amplexifolius*
rosy twistedstalk	*Streptopus roseus*
small twistedstalk	*Streptopus streptopoides*
Scouler's valerian	*Valeriana scouleri*
Sitka valerian	*Valeriana sitchensis*

vanilla-leaf	*Achlys triphylla*
American vetch	*Vicia americana*
early blue violet	*Viola adunca*
marsh violet	*Viola palustris*
round-leaved violet	*Viola orbiculata*
stream violet	*Viola glabella*
trailing yellow violet	*Viola sempervirens*
wall-lettuce	*Lactuca muralis*
water-parsley	*Oenanthe sarmentosa*
bluebunch wheatgrass	*Elymus spicatum*
blue wildrye	*Elymus glaucus*
hairy wildrye	*Elymus hirsutus*
Bebb's willow	*Salix bebbiana*
Hooker's willow	*Salix hookeriana*
Scouler's willow	*Salix scouleriana*
Sitka willow	*Salix sitchensis*
broad-leaved willowherb	*Epilobium latifolium*
green wintergreen	*Pyrola chlorantha*
one-sided wintergreen	*Orthilia secunda*
pink wintergreen	*Pyrola asarifolia*
white-veined wintergreen	*Pyrola picta*
nodding wood-reed	*Cinna latifolia*
many-flowered woodrush	*Luzula multiflora*
small-flowered woodrush	*Luzula parviflora*
yampah	*Perideridia gairdneri*
western yarrow	*Achillea millifolium* var. *lanulosa*
yerba buena	*Satureja douglasii*
Yorkshire fog	*Holcus lanatus*

APPENDIX 12: Key to relative soil moisture regime

KEY TO RELATIVE SOIL MOISTURE REGIME





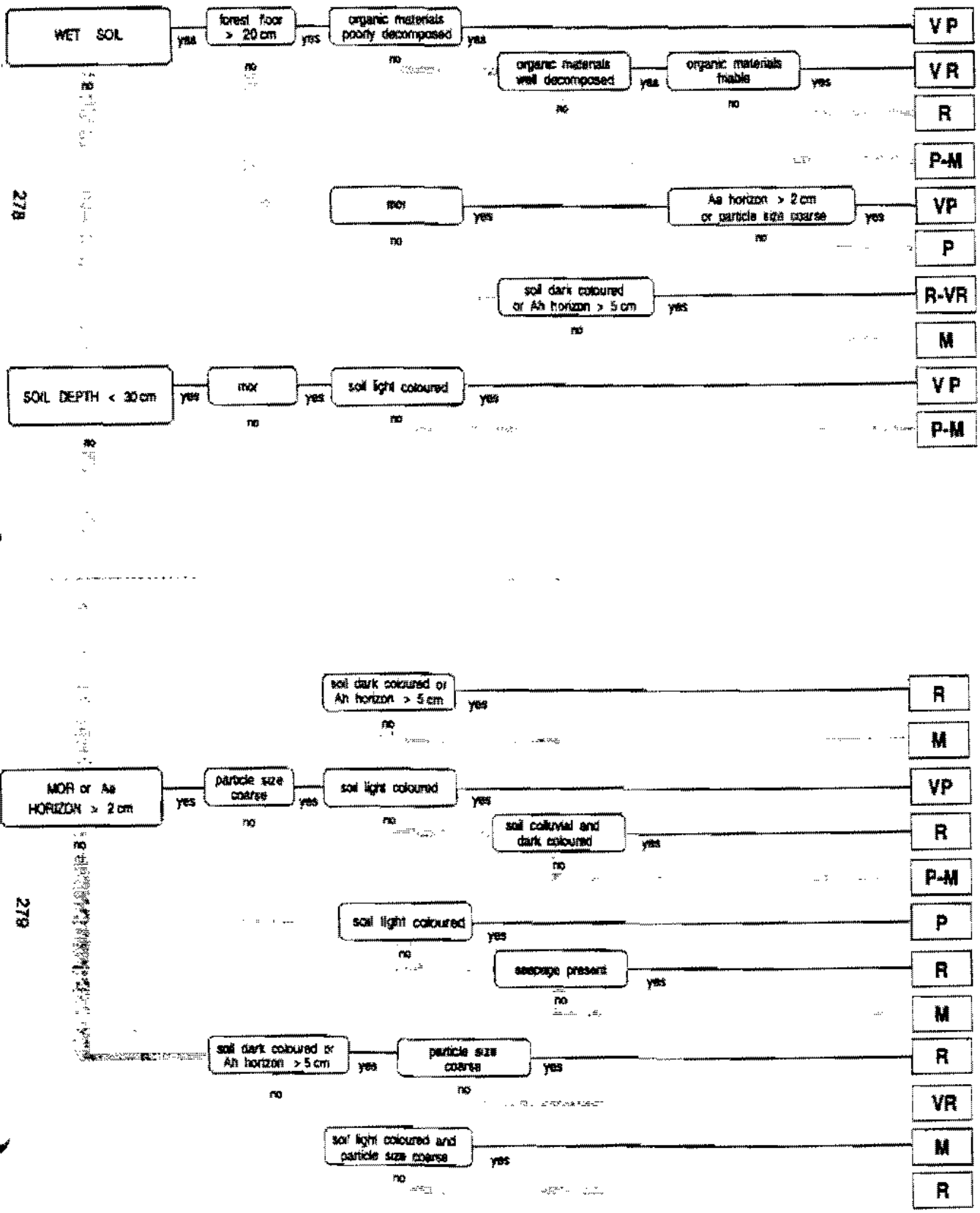
1 steep south aspects tend to be one class drier

2 note floodplain bench height with suffixes : l (low bench), m (middle bench), and h (high bench) after SMR ; e.g., 6m

3 sites with strongly fluctuating water table ; use suffix "f" after SMR ; e.g., 5f

APPENDIX 13: Key to soil nutrient regime

KEY TO SOIL NUTRIENT REGIME



APPENDIX 14: Forest health indicator codes

Field Codes			Description	
O	No detectable abiotic or biotic damage			
A	ABIOTIC INJURIES			
	AB		fire	
	AD		drought	
	AF		frost	
		AFC	frost crack	
		AFH	frost heaved	
		AFK	shoot/bud frost kill	
	AH		hail	
	AK		fumekill	
	AL		lightning	
	AN		road salt	
	AO		flooding	
	AR		redbelt	
	AS		slide	
	AW		windthrow	
		AWS	soil failure	
		AWT	treatment or harvesting related	
	AX		scarring/rubbing	
	AY		snow or ice (includes snow press)	
	AZ		sunscald	
D	DISEASES			
	DB		Broom Rusts	
		DBF	fir broom rust	*Melampsorella caryophyllacearum*
		DBS	spruce broom rust	*Chrysomyxa arctostaphyli*
	DD		Stem Decays	
		DDA	artists conk	*Ganoderma applanatum*
		DDB	birch trunk rot	*Fomes fomentarius*
		DDC	cedar brown pocket rot	*Poria sericeomollis*
		DDE	rust-red stringy rot	*Echinodontium tinctorium*
		DDF	brown crumbly rot	*Fomitopsis pinicola*
		DDI	hardwood trunk rot	*Phellinus ignarius*
		DDL	lacquer conk	*Ganoderma tsugae*
		DDP	pini (red ring) rot	*Phellinus pini*
		DDQ	quinine conk	*Fomitopsis officinalis*
		DDS	sulfur fungus	*Laetiporus sulphureus*
		DDT	aspen trunk rot	*Phellinus tremulae*
	DF		Foliage Disease	
		DFA	western pine aster rust	*Coleosporium asterum*
		DFC	large-spored spruce-labrador tea	*Chrysomyxa ledicola*

			rust	
		DFD	spruce needle cast	*Lirula macrospora*
		DFE	elytroderma disease	*Elytroderma deformans*
		DFH	larch needle blight	*Hypodermella laricis*
		DFL	pine needle cast	*Lophodermella concolor*
		DFM	larch needle cast	*Meria laricis*
		DFP	fir-fireweed rust	*Pucciniastrum epilobii*
		DFR	Douglas-fir needle cast	*Rhabdocline pseudotsugae*
		DFS	red band needle blight	*Scirrhia pini*
		DFT	sirococcus tip blight	*Sirococcus strobilinus*
		DFU	cedar leaf blight	*Didymascella thujina*
	DL		Leader or branch dieback	
		DLD	dermea canker	*Dermea pseudotsugae*
		DLF	red flag disease	*Potebniamyces balsamicola*
		DLP	phomopsis canker	*Phomopsis lokoyae*
		DLS	sydowia (sclerophoma) tip dieback	*Sclerophoma pithyophila*
		DLV	aspen-poplar twig blight	*Venturia* spp.
	DM		Dwarf Mistletoe	
		DMF	Douglas-fir dwarf mistletoe	*Arceuthobium douglasii*
		DMH	hemlock dwarf mistletoe	*Arceuthobium tsugense*
		DML	larch dwarf mistletoe	*Arceuthobium laricis*
		DMP	lodgepole pine dwarf mistletoe	*Arceuthobium americanum*
	DR		Root Disease	
		DRA	armillaria root disease	*Armillaria ostoyae*
		DRB	black stain root disease	*Leptographium wageneri*
		DRC	laminated root rot, cedar strain	*Phellinus weirii*
		DRL	laminated root rot	*Phellinus weirii*
		DRN	annosus root disease	*Heterobasidiom annosum*
		DRR	rhizina root disease	*Rhizina undulata*
		DRS	schweinitzii butt rot	*Phaeolus schweinitzii*
		DRT	tomentosus root rot	*Inonotus tomentosus*
	DS		Stem Disease (Bark Cankers and Rusts)	
		DSA	atropellis canker	*Atropellis piniphila*
		DSB	white pine blister rust	*Cronartium ribicola*
		DSC	comandra blister rust	*Cronartium comandrae*
		DSG	western gall rust	*Endocronartium harknessii*
		DSN	aspen cankers	*Hypoxylon mammatum* *Cryptosphaeria populina* *Nectria galligena* *Ceratocystis fimbriata* *Encoelia pruinosa* *Cytospora Chrysosperma*
		DSS	stalactiform blister rust	*Cronartium coleosporioides*

		DSX	exploding canker of douglas-fir and interior spruces	
I	INSECTS			
	IA		Aphids	
		IAB	balsam woolly adelgid	*Adelges piceae*
		IAC	giant conifer aphid	*Cinara* spp.
		IAG	cooley spruce gall adelgid	*Adelges cooleyi*
		IAS	green spruce aphid	*Elatobium abietinum*
	IB		Bark Beetles	
		IBB	western balsam bark beetle	*Dryocetes confusus*
		IBD	douglas-fir beetle	*Dendroctonus pseudotsugae*
		IBI	engraver beetle	*Ips* spp.
		IBM	mountain pine beetle	*Dendroctonus ponderosae*
		IBP	twig beetle and others	*Pityogenes pityophthorus spp.*
		IBS	spruce beetle	*Dendroctonus rufipennis*
		IBT	red turpentine beetle	*Dendroctonus vales*
		IBW	western pine beetle	*Dendroctonus brevicomis*
	ID		Defoliators	
		IDA	black army cutworm	*Actebia fennica*
		IDB	2-year cycle budworm	*Choristoneura biennis*
		IDC	larch casebearer	*Coleophora laricella*
		IDD	looper (deciduous)	*Erannis vancouverensis*
		IDE	eastern spruce budworm	*Choristoneura fumiferana*
		IDF	forest tent caterpillar	*Malacosoma disstria*
		IDG	greenstriped forest looper	*Melanolophia imitata*
		IDH	western blackheaded budworm	*Acleris gloverana*
		IDI	pine needle sheath miner	*Zellaria haimbachi*
		IDL	western hemlock looper	*Lambdina fiscellaria lugubrosa*
		IDM	gypsy moth	*Lymantria dispar*
		IDN	birch leaf miner	*Fenusa pusilla*
		IDP	larch sawfly	*Pristiphora erichsoni*
		IDR	red alder sawfly	*Eriocampa ovata*
		IDS	conifer sawflies	*Neodiprion spp.*
		IDT	Douglas-fir tussock moth	*Orgyia pseudotsugata*
		IDU	satin moth	*Leucoma salicis*
		IDW	western spruce budworm	*Choristoneura occidentalis*
		IDX	large aspen tortrix	*Choristoneura conflictana*
		IDZ	western false hemlock looper	*Nepytia freemani*
	IS		Shoot Borers	
		ISB	western cedar borer	*Trachykele blondeli*
		ISE	european pine shoot moth	*Rhyacionia buoliana*
		ISG	gouty pitch midge	*Cecidomyia pinitopis*
		ISP	pitch nodule moths	*Petrova* spp.

		ISQ	sequoia pitch moth	*Synanthedon sequoiae*
		ISS	western pine shoot borer	*Eucosma sonomana*
	IW		root and terminal weevils	
		IWC	conifer seedling weevil	*Steremnius carinatus*
		IWM		*Magdalis* spp.
		IWP	lodgepole pine terminal weevil	*Pissodes terminalis*
		IWS	white pine (spruce) weevil	*Pissodes strobi*
		IWW	Warren's root collar weevil	*Hylobius warreni*
		IWY		*Cylindrocopturus* spp. weevils
		IWZ	Yosemite bark weevil	*Pissodes schwarzi*
M			Mites	*Trisetacus* spp.
T	TREATMENT INJURIES			
	TC		chemical	
	TH		harvested	
	TL		logging	
	TM		mechanical	
	TP		planting	
		TPM	poor microsite	
V	VEGETATION PROBLEMS			
	VH		herbaceous competition	
	VP		vegetation press	
	VS		shrub competition	
	VT		tree competition	
W	WILDLIFE			
	WB		bear	
	WC		cattle	
	WD		deer	
	WE		elk	
	WH		hare or rabbit	
	WM		moose	
	WP		porcupine	
	WS		squirrel	
	WV		vole	
	WX		birds	
	WZ		beaver	

Literature Cited

Armleder, H.M., S.K. Stevenson, and S.D. Walker. 1992. Estimating the abundance of arboreal forage lichens. Land Mgmt Hand. Field Guide Insert 7. B.C. Min. For. Victoria, B.C.

B.C. Ministry of Forests. 1995. Riparian management area guidebook. Victoria, B.C.

_____. 1995. Silviculture prescription guidebook. Victoria, B.C.

_____. 1995. Forest health surveys guidebook. Victoria, B.C.

_____. 1997. Vegetation resource inventory: ground sampling procedures. Victoria, B.C.

_____. 1997. Forest Service cruising procedures and cruise compilation. Victoria, B.C.

Brown, J.K. 1974. Handbook for inventorying downed woody material. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. INT-16. Ogden, Utah.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1993. Characteristics of spotted owl nest trees in the Wenatchee National Forest. *Rap. Res.* 27:1-7.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by spotted owls in the eastern Washington Cascades. *J. Wildl. Manage.* 59(2):301-310.

Bull, E.L., C.G. Parks, and T.R. Torgersen. 1997. Trees and logs important to wildlife in the Interior Columbia River Basin. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. PNW-GTR-391. Portland, Oreg.

Carey, A.B. 1991. The biology of arboreal rodents in Douglas-fir forests. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. PNW-GTR-276. Portland, Oreg.

Carey, A. B., S.P. Horton, and B.L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. *Ecol. Mono.* 62(2):223-250.

Carey, A.B., and M.L. Johnson. 1995. Small mammals in managed, naturally young, and old-growth forests. *Ecol. Appl.* 5(2):336-352.

Dunbar, D., and I. Blackburn. 1994. Management options for the northern spotted owl in British Columbia. B.C. Environment. Surrey, B.C.

Everett, R., D. Schellhaas, D. Spurbeck, P. Ohlson, D. Keenum, and T. Anderson. 1997. Structure of northern spotted owl nest stands and their historical conditions on the eastern slope of the Pacific Northwest Cascades, USA. *For. Ecol. Manage.* 94:1-14.

Expert Committee on Soil Survey (ECSS) 1987. The Canadian system of soil classification. 2nd ed. Publ. 1647. Agric. Can. Res. Br., Ottawa, Ont.

FEMAT. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Assessment Team. Washington, D.C.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. *Wildl. Mono.* 87:1-64.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For. Victoria, B.C.

Gutierrez, R.J. 1984. An overview of recent research on the spotted owl. *In*: R.J. Gutierrez and A.B. Carey (tech. eds.), Ecology and management of the spotted owl in the Pacific Northwest. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. PNW-185. Portland, Oreg.

Hamer, T.E., S.G. Seim, and K.R. Dixon. 1989. Preliminary report: northern spotted owl and northern barred owl habitat use and home range size in Washington. Wash. Dept. Wildlife. Olympia, Wash.

Hanson, E., D. W. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted owl habitat in Washington. Washington Forest Practices Board. Olympia, Wash.

Hayward, G., and R. Rosentreter. 1994. Lichens as nesting material for northern flying squirrels in the northern Rocky Mountains. *J. Mammal* 75(3):663-673.

Hitchcock, C.L., and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. Wash. Press. Seattle, Wash.

King, G.M., K.R. Bevis, E.E. Hanson, and J.R. Vitello. 1997. Northern spotted owl management: mixing landscape and site-based approaches. *J. For.* 95(8):21-27.

Klinka, K., V.J. Krajina, A Ceska, and A.M. Scagel. 1989. Indicator plants of coastal British Columbia. Univ B.C. Press, Vancouver, B.C.

Little, E.L. 1980. The Audubon Society Field Guide to North American Trees. Alfred A. Knopf, Inc. New York, NY.

Luttmerding, H.A., D.A. Demerchi, E.C. Lea, D.V. Meidinger, and T. Vold. 1990. Describing ecosystems in the field. B.C. Min. Env., Victoria, B.C.

Lujan, M. 1992. Recovery plan for the northern spotted owl - draft. U.S. Dep. Int. Fish and Wildl. Serv. Washington, D.C.

Maser, Z., C. Maser, and J.M. Trappe. 1985. Food habits of the northern flying squirrel (*Glaucomys sabrinus*) in Oregon. *Can. J. Zool.* 63:1085-1088.

Maser, C., Z. Maser, J.W. Witt, and G. Hunt. 1986. The northern flying squirrel: a mycophagist in southwestern Oregon. *Can. J. Zool.* 64:2086-2089.

Mills, L.S., R.J. Fredrickson, and B.B. Moorhead. 1993. Characteristics of old-growth forests associated with northern spotted owls in Olympic National Park. *J. Wildl. Manage.* 57(2):315-321.

Oliver, C.D. and B.C. Larson. 1996. Forest stand dynamics. John Wiley and Sons, Inc. New York, NY.

Parish, R. 1994. Tree book: learning to recognize trees of British Columbia. Min. For., Victoria, B.C.

Parish, R., R. Coupe, and D. Lloyd. 1996. Plants of southern interior British Columbia. B.C. Ministry of Forests and Lone Pine Publishing. Vancouver, BC.

Parks, C.G., E.L. Bull, and T.R. Torgersen. 1997. Field guide for the identification of snags and logs in the Interior Columbia River Basin. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. PNW-GTR-390. Portland, Oreg.

Petrides, G.A., and O. Petrides. 1992. The Peterson Field Guide Series: Field Guide to Western Trees. Houghton Mifflin Company. New York, NY.

Pojar, J., and A. MacKinnon. 1994. Plants of coastal British Columbia. B.C. Min. For. and Lone Pine Publishing. Vancouver, BC.

Ripple, W.J., D.H. Johnson, K.T. Hershey, and E.C. Meslow. 1991. Old-growth and mature forests near spotted owl nests in western Oregon. *J. Wildl. Manage.* 55:316-318.

Spies, T.A., J.F. Franklin, and T.B. Thomas. 1988. Coarse woody debris in Douglas-fir forests of western Oregon and Washington. *Ecol.* 69(6):1689-1702.

Spotted Owl Management Inter-Agency Team. 1997. Managing spotted owl habitat: operational guidelines component of the spotted owl management plan. B.C. Min. For., B.C. Min. Env., Lands, Parks. Victoria, B.C.

Taylor, S.W. 1997. A field estimation procedure for downed coarse woody debris. Can. For. Serv. Tech. Trans. Notes No. 2. Victoria, B.C.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A Conservation Strategy for the Northern Spotted Owl. Report of the Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl. Portland, Oreg.

Vitt, D.H., J.E. Marsh, and R.B. Bovey. 1988. Mosses, lichens and ferns of northwest North America. Lone Pine Publishing. Edmonton, AB.

Zabel, C.J., K. McKelvey, and J.P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (*Strix occidentalis caurina*). *Can. J. Zool.* 73:433-439.

Zabel, C.J., and J.R. Waters. 1997. Food preferences of captive northern flying squirrels from the Lassen National Forest in northeastern California. *NorthWest Sci.* 71(2):103-107.

Appendix B: Retaining Large Trees in the MFHA

To assist in operational planning, examples from 2 forest licensees are provided to identify how the 40 of the largest 80 trees in the drier ecosystems (or 15 of the largest 30 in the wetter maritime ecosystem) are determined.

Example 1: **Taking the 40 of the largest 80 trees**

In the cruise compilation for cutting authority, there is a Stand and Stock Table with stems per hectare by species and by 5 cm diameter classes, and similarly for all species. The 80 largest is determined working downward from the highest diameter class. The required 40 retention stems would fall within the diameter class range where the 80 largest occur, with the appropriate species distribution.

The Block Stand Table (stems/ha) in the cutting authority cruise compilation is used to determine the 80 largest stems per hectare. This table (as shown below) provides the average number of stems per hectare, by species and by diameter class.

The 80 largest stems per hectare (sph) are determined by summing the total sph column, starting with the largest diameter class and in this case 275 cm. In this example the 80th tree would lie within the 60 cm dbh class. Proration of the 60 cm dbh class was required to determine the exact 80 largest by species (e.g. the largest 80 sph would include all trees that are 65cm dbh or larger and from the 60cm dbh class, 3.2 sph of cedar and 4.1 sph of balsam).

The species breakdown for the 80 largest trees in this example would be 11% fir, 58 % cedar, 26 % hemlock and 5 % balsam, based on the sph by species that are within the 80 largest sph.

Accordingly, the retention target of 40 of the largest 80 sph would be an average of 5 fir, 23 cedar, 10 hemlock, and 2 balsam, each 60 cm or greater in diameter. These trees are identified in the field and flagged for retention.

Example of a Stand Table for a Cutblock in a Managed Future Habitat Area

Diameter Class	Fir	Cedar	Hemlock	Balsam	Total	Total Stems/ha of the largest trees
5						
10						
15						
20						
25						
30			87.5		87.5	376.9
35			52.0	59.8	111.8	289.4
40						177.6
45		5.0	45.9		50.9	177.6
50		4.0	17.4		21.4	126.7
55			21.1		21.1	105.3
60		**5.1**		**6.4**	**11.5**	**84.2**
65		13.5	10.5		24.0	**72.7**
70		3.7	3.0		6.7	48.7
75		3.1			3.1	42.0
80			2.3		2.3	38.9
85						36.6
90						36.6
95		2.4	3.3		5.7	36.6
100		5.1			5.1	30.9
105		1.5			1.5	25.8
110		1.5			1.5	24.3
115		1.7			1.7	22.8
120	2.0				2.0	21.1
125	1.8	1.4			3.2	19.1
130	1.6	2.1			3.7	15.9
135		3.1			3.1	12.2
140			1.5		1.5	9.1
145		1.9			1.9	7.6
150	3.7	0.9			4.6	5.7
175		0.8			0.8	1.1
200						0.3
225						0.3
250						0.3
275		0.3			0.3	0.3
Total	**9.1**	**57.1**	**244.5**	**66.2**	**376.9**	

Example 2: Taking the 40 of the largest 80 trees

Managed Future Habitat Area Retention Summary for sample block:

- Total retention required is 27.0 ha x 40 of the largest 80 stems/ha: **1080** trees
- Wildlife tree retention contributes 5.6 ha x 80 of the largest 80 stems/ha which equals 448 trees, but only 40% of the retained 40 of the largest 80 can be attributed to the WTRA so only **432** [1080 trees X 0.40] of the 40 of the largest 80 in the WTRA can be counted.
- Therefore, **648** trees [1080-432] are to be retained on the 20.2 ha NAR which results in an average of **32** stems/ha to be retained on the 20.2 ha NAR.

Determining the diameter range for 40 of the largest 80 stems/ha:

The Block Stand Table (stems/ha) in the cutting authority cruise compilation is used to determine the 80 largest stems per hectare. This table (as shown below) provides the average number of stems per hectare, by species and by diameter class. Note that the dead potential stems have been removed from the table as they are difficult to retain based on safety issues.

The 80 largest stems per hectare (sph) are determined by summing the total sph column, starting with the largest diameter class [in this case 140 cm]. The determination of the size range of the largest 80 stems/ha is an exercise which requires calculations and some estimation as well as some judgment, and subjectivity, to address all of the variables involved.

a. Based on the cruise data for the block, the largest 85 stems/ha are >57.5cm dbh.

b. The BMPs state that it is desirable to maintain a relatively even distribution of stems throughout the opening, yet recognize that the trees are not necessarily evenly and regularly distributed through the pre-harvest stand. The BMPs also recognize that the distribution of retained trees will also be subject to other variables such as windthrow risk, topography, harvesting system requirements, and forest health factors. Additionally variables such as safety, efficiency, economics, ground disturbance and other retention objectives can also effect the final distribution of retained trees.

c. In this block the larger trees tend to be located in the lower third of the block and there are some areas with lots of large trees and some areas with very few trees greater than 55cm dbh.

d. It is not unreasonable to assume that there is at least 25% variability within the stand as compared to the cruise average for the stand. Therefore it is unreasonable to assume that the largest 80 stems/ha are >57.5cm dbh on every hectare in the block, so a reasonable range in dbh [below the 57.5cm dbh] must be determined for the purpose of defining the minimum diameter acceptable for the retention of 40 of the largest 80 stems/ha. Based on the cruise data for the block, the largest 110 stems/ha are >50cm dbh. This suggests that a minimum 50cm dbh should account for any variation or irregularity in the distribution of trees within the stand.

e. Based on previous blocks and having spent 2 days walking around in this block, it is apparent that the irregular distribution of trees in the pre-harvest stand necessitates that the tree size and distribution criteria for selecting retention trees be flexible enough to address all of the issues, while still achieves the objective of retaining 40 of the largest 80 stems/ha on site.

f. In consideration of all of the above information and the intent of the BMPs for MFHAs, the criteria for selecting retention trees in this block are presented in the Retention Tree Selection Criteria below:

Criteria for the Selection of Retention Trees

a. Recognize the variability in the stand and the operational constraints [safety, topography, yarding system, windthrow, etc.] and select the retention trees from the **largest trees available** in the general area [approximately 0.2 ha].

b. Retain an approximate average of **32 stems/ha** with the overall retention exceeding **648** trees within the harvested part of the block.

c. Where available the trees selected for retention should **exceed 60cm dbh**.

d. In areas where there are not many large trees, the trees selected for retention **can be as small as 50cm dbh**.

e. Select retention trees from all available species on site.

f. Select retention trees with **wildlife tree attributes** such as large limbs, broken tops, mistletoe, cavities, forks or other deformities.

g. **At least 20%** of the selected retention trees are to **exceed 70cm dbh.**

h. Some smaller incidental trees can be retained for operational reasons, but they do not contribute to the target of **648** retained trees.

i. If there are areas of the block which do not have enough trees >50cm dbh to meet the criteria, smaller trees can be accepted, but these areas must be accurately mapped and carefully documented.

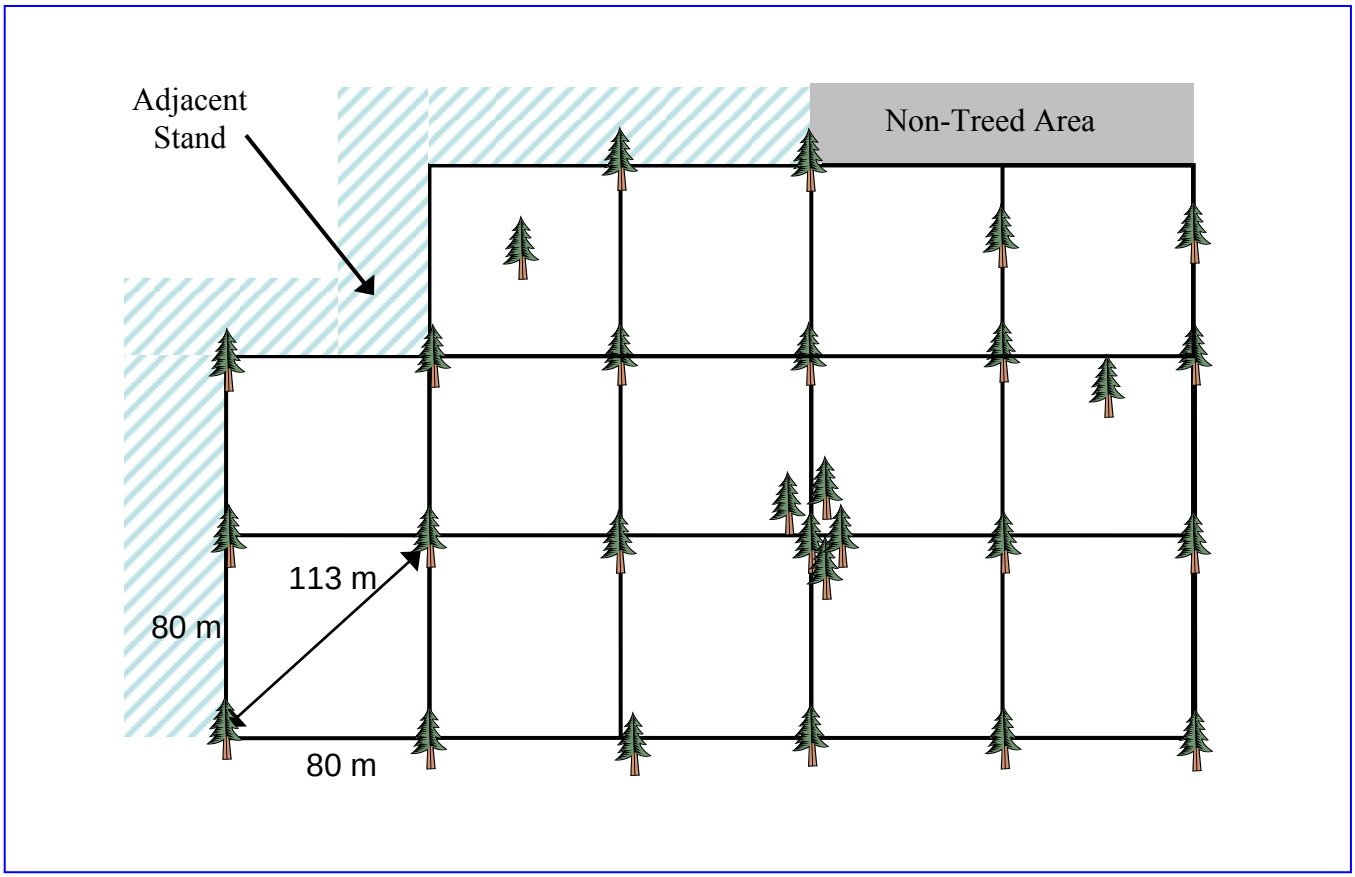
j. These retention criteria can be adjusted if necessary to address unforeseen operational issues.

Example of a Stand Table for a Cutblock in a Forest Management Area

Diameter Class	Fir	Cedar	Hemlock	Balsam	Total stems/ha	Total Stems/ha of the largest trees
20				18.5	18.5	
25		27.6	44.6		72.2	
30			11.1		11.1	
35		21.3	22.5	13.9	57.7	
40	11.5	5.2	27.1	5.9	49.7	
45	11.8		21.9		33.7	
50	6.8	11.3	19.6	13.6	51.3	156.4
55	**8.1**	**2.9**	**8.7**		**19.7**	**105.1**
60	**4.8**		**16.8**	**6.8**	**28.4**	**85.4**
65	4.1	3.3	11.7	2.0	21.1	57.0
70	1.9		13.1		15.0	35.9
75	4.3	4.1	2.9		11.3	20.9
80	1.3	1.7	1.4		4.4	9.6
85	3.3				3.3	5.2
90					0	1.9
95					0.0	1.9
100		1.5			1.5	1.9
105					0.0	0.4
110					0.0	0.4
115					0.0	0.4
120					0.0	0.4
125					0.0	0.4
130					0.0	0.4
135					0.0	0.4
140	0.4				0.4	0.4
145					0.0	
150					0.0	
175					0.0	
Total	**58.3**	**78.9**	**201.4**	**60.7**	**399.3**	

Appendix C: Illustration of Distribution of Retained Trees

Large trees can be retained as individual dispersed or in small or large groups, as shown below. No locational point in the block should be further than 40 m away from a retained tree; therefore, within a block, it is possible to have a maximum of 80 m between two retained trees. Assuming the edge of the block is adjacent to a treed stand, then the maximum 80 m rule may apply; otherwise, in non-treed areas (e.g. rock outcrop or wetlands), then the retained tree should be 40 m or less from the block edge.



Appendix D: Variable Density Planting

Reforestation options in Habitat Enhancement Practices and Harvest with Retention Practices could consider **variable density planting** and stocking.

Lower and Variable Planting Densities:

Planting for timber-focused management objectives focuses on planting densities for prompt site occupancy and regular spacing providing for development of similarly sized trees. As management objectives shift to Spotted Owl habitat development, research suggests lower planting densities could help meet Spotted Owl objectives sooner. Tree and Stand Simulator (TASS[1]) simulations suggest reducing planting densities from 900 to 500 improve development of larger trees and improve likelihood that tree diameter objective requirements for TYPE B habitat (> 30 cm dbh) would develop over the simulation period (D'Anjou et al 2006). Brodie et al (2007) modeled a range of silvicultural treatments and found high quality Spotted Owl habitat objectives after clearcutting were most quickly achieved by planting 625-900 seedlings per hectare. Retention of dispersed trees and wildlife trees prescribed in these best management practices is expected to contribute to natural regeneration to complement planted seedlings, justifying lower planting densities.

Varying planting spacing within a block including designating small portions of unplanted areas and areas of higher densities can initiate development of stand heterogeneity. Surviving advanced regeneration can develop additional structure and complement planting. Consider leaving small areas (< 100 m^2) of desired deciduous and shrub species (e.g. vine maple, huckleberry, bitter cherry, or seed bearing shrubs) unplanted because both are beneficial for prey habitat.

1. As the objective in MFHA is to produce potential Spotted Owl habitat if needed in the long-term, some consideration should be given to prescribing reforestation at lower densities such as 400-600 sph that should hasten the development of large diameter, limby trees desired for Spotted Owl habitat. **Note that the stocking standard (i.e. minimum, maximum and target stocking) still have to be met but the stocking may vary across the block**. If low density planting is prescribed for more than one continuous hectare, then this area should be delineated out as a separate Standard Unit with its own stocking standard. Lower density plantings are usually conducted over 0.25 to 0.5 ha.

2. It is not necessary to prescribe low density reforestation throughout a block, but it should be considered as an option in some portion of some blocks. In particular, low density reforestation might be a mitigation factor in areas where the retained trees are significantly grouped and there are larger gaps in the distribution of retained trees.

[1] http://www.for.gov.bc.ca/hre/gymodels/tass/