



of
BRITISH COLUMBIA

Green-up Guidebook

Second edition

January 1999





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Preface

This guidebook has been prepared to help forest resource managers plan, prescribe and implement sound forest practices that comply with the Forest Practices Code.

Guidebooks are one of the four components of the Forest Practices Code. The others are the *Forest Practices Code of British Columbia Act*, the regulations and the standards. The *Forest Practices Code of British Columbia Act* is the legislative umbrella authorizing the Code's other components. It enables the Code, establishes mandatory requirements for planning and forest practices, sets enforcement and penalty provisions, and specifies administrative arrangements. The **regulations** lay out the forest practices that apply province-wide. **Standards** may be established by the chief forester, where required, to expand on a regulation. Both regulations and standards, where required and established under the Code, must be followed.

Forest Practices Code guidebooks have been developed to support the regulations, but are not part of the legislation. The recommendations in the guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable. Guidebooks are not intended to provide a legal interpretation of the *Act* or regulations. In general, they describe procedures, practices and results that are consistent with the legislated requirements of the Code.

The information provided in each guidebook is to help users exercise their professional judgment in developing site-specific management strategies and prescriptions to accommodate resource management objectives. Some guidebook recommendations provide a range of options or outcomes considered acceptable under varying circumstances.

Where ranges are not specified, flexibility in the application of guidebook recommendations may be required to adequately achieve land use and resource management objectives specified in higher-level plans. A recommended practice may also be modified when an alternative could provide better results for forest resource stewardship. The examples provided in many guidebooks are not intended to be definitive and should not be interpreted as the only acceptable options.

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Introduction

This guidebook provides information that clarifies the intent of Forest Practices Code legislation related to green-up and explains how to meet the requirements associated with green-up. However, this guidebook is not referenced in the legislation.

The Forest Practices Code sets out requirements for ensuring that previously harvested cutblocks adjacent to proposed cutblocks are greened-up before the proposed cutblocks are harvested.

Generally, for green-up to be achieved, a stand must have the required height, stocking and block coverage requirements set out in the *Operational Planning Regulation*. When a stand has met these requirements it will provide a level of hydrological, visual and wildlife habitat recovery.

Other specifications for green-up may be established in a higher level plan or may be approved by the district manager, or the district manager and designated environment official, to achieve landscape- and stand-level management objectives. Biodiversity objectives, wildlife habitat needs, visual quality, hydrologic concerns and situations requiring salvage of damaged timber may affect the green-up requirement. When basic green-up requirements are varied, the applicable regulations should be consulted to ensure the variation is in line with the legislation.

Requirements to meet hydrologic and visual green-up are specifically covered in the *Community Watershed Guidebook*, the *Coastal Watershed Assessment Procedure Guidebook* and the *Interior Watershed Assessment Procedure Guidebook*, the *Visual Landscape Management Guidebook*, and the *Visual Impact Assessment Guidebook*. Requirements for setting objectives to meet green-up to retain a range of cutblock sizes is contained in the *Landscape Unit Planning Guide*.

This guidebook describes green-up requirements, when and how to apply them, and when variation from these requirements is permitted. A recommended green-up survey procedure is summarized in Appendix 1.

Situations where green-up does not apply

The first step in assessing green-up requirements is to determine whether or not the requirements apply. Situations to which green-up requirements do not apply are listed in the *Timber Harvesting Practices Regulation* (THPR). It should be noted that green-up requirements do not have to be considered on or adjacent to private forest land that is not in a tree farm licence or woodlot licence because the Forest Practices Code currently does not apply to these lands. Also, green-up requirements do not apply if the proposed block is adjacent to an area that has been subject to a wildfire or other natural disturbance where harvesting has not taken place.

- THPR s9(2)(a)

Green-up requirements do not need to be considered when authorizing a licence to cut (i.e., hydro right-of-ways, mining activities and other Crown tenures where clearing was allowed) or a Christmas tree permit, or when proposing a cutblock adjacent to a licence to cut or a Christmas tree permit.

- THPR s9(2)(b)

Section 9(2)(b) exempts cutblocks to be harvested by a partial cut silvicultural system when 40% or more of the pre-harvest basal area is to be retained because the post-harvest stand structure will satisfy green-up objectives. The requirement for “uniform distribution” is included to prevent achieving the required 40% basal area by balancing very heavy cutting in one part of the cutblock with light or no cutting concentrated in another part.

- THPR s9(2)(c)

Section 9(2)(c) is primarily intended to allow for the exemption of cutblocks to be harvested by a seed or preparatory cut of a shelterwood system, commercial thinning, and other partial cuts or intermediate cuts if basal area retention is less than 40%, the residual trees are uniformly distributed, and the residual stand structure satisfies green-up objectives. The onus is on the proponent to provide sufficient detail to enable the district manager to determine whether the residual stand structure will satisfy green-up objectives.

Subsection (ii) also provides for green-up requirements being met if the residual stocking will have a green-up height of at least three metres. For the cutblock to be considered “stocked with trees” the residual stocking (species, density) must be acceptable to the district manager.

Examples of where this might apply include:

1. Partial cut systems with low basal area retention in which case the understory stocking would have to be present in sufficient density and have a green-up height of at least three metres to satisfy green-up objectives.
 2. A shelterwood scheduled for harvest a few years after the seedcut. The residual stocking left following shelterwood removal must be suitable to satisfy green-up objectives.
- THPR s9(2)(d)

Green-up requirements do not apply as long as the total combined cutblock area remains less than the specified or varied maximum block size.

- THPR s9(2)(e)

This section is primarily intended to enable harvesting along boundaries of previously harvested cutblocks that are not yet greened-up in order to mitigate visual impact as set out in a visual rehabilitation plan.

- THPR s9(2)(f)

Green-up requirements may be waived by the district manager to achieve a range of cutblock sizes to better match the temporal and spatial distribution of natural openings. Larger cutblocks are to be designed to retain the structural elements of natural openings, as guided by the stand management recommendations to maintain biodiversity in the *Landscape Unit Planning Guide* (under development as of January, 1999).

The term “resultant opening” includes the block to be harvested as well as any previously harvested cutblocks that will become amalgamated into a single opening. This subsection can be used to authorize harvesting of leave strips that will amalgamate previously harvested areas that do not meet green-up, where the objective is to create larger openings to mimic natural disturbance regimes. This clause enables landscape-level decisions to be implemented in advance of the establishment of landscape unit objectives.

In conjunction with approval of larger cutblocks or openings, the district manager may increase green-up requirements for these cutblocks to provide for complete recovery of stand attributes – before areas adjacent to these cutblocks can be harvested in the future. Larger patches require longer green-up at the landscape level.

- THPR s9(2)(g)

Green-up requirements do not apply where the harvesting is carried out for the purposes of sanitation treatments, minor salvage operations, expedited major salvage operations or emergency harvesting. The proposed cutblock should incorporate structural characteristics of natural disturbances wherever possible. Natural openings generally have some or all of the following characteristics:

- wildlife trees individually and/or in patches
- coarse woody debris
- irregular edges
- regeneration by a mixture of tree species (natural or planted)
- naturally occurring understorey species
- mature and immature deciduous species
- minor tree species such as yew, birch, alder, aspen and cottonwood
- individual trees or patches of trees .

Basic green-up requirements

Generally, green-up standards are applied when a proposed cutblock with an even-aged silvicultural system such as clearcut or seed tree, is located adjacent to a previously harvested cutblock or cutblocks that are also under an even-aged management system, and the total harvested area will exceed the maximum cutblock size that applies to the area.

Determination of the applicable green-up requirements for a particular cutblock should follow a systematic decision-making process based on the criteria set out in the *Operational Planning Regulation* (OPR). The first consideration is whether green-up requirements have been specified in an applicable higher level plan (HLP).

Higher level plans (OPR s68(4))

A cutblock is greened-up if it has attained the green-up requirements specified in a HLP for the area. However, if the HLP does not specify all three green-up requirements (height, stocking and block coverage), the OPR standards apply for the requirements not addressed in the HLP.

If there are no, or only partial, green-up requirements established in a HLP, the next step in determining green-up requirements is to classify the block on the basis of stocking as either “adequately stocked” or “not adequately stocked.”

Stocking

Adequately stocked (OPR s67)

The term “adequately stocked” has been defined for the purposes of green-up requirements to establish a threshold number of trees (800 trees per hectare on the coast, 1000 in the interior) used to identify stands with sufficient stocking that can compensate for a lower green-up height and still meet green-up objectives. “Adequately stocked” is assessed on the basis of total trees of commercially valuable species rather than well-spaced trees. However, the green-up survey (see Appendix 1) incorporates the concept of an “M” value (maximum number of trees that can be tallied in a plot) to ensure a reasonable degree of stocking uniformity. **The trees counted to determine whether a cutblock is “adequately stocked” must be at least 1.3 metres tall.**

“Commercially valuable species” is not defined in the legislation. It would generally include the species listed in applicable *Establishment to Free Growing* guidebooks, regional mixed wood and hardwood stocking standards, and

species included in the timber supply review as contributing to allowable annual cut (AAC).

Not adequately stocked (OPR s68(5)(b)(ii))

For cutblocks that are not “adequately stocked,” the legislation establishes a default minimum stocking of 500 trees per hectare on the coast and 700 in the interior based on total trees of commercially valuable species greater than 1.3 metres in height. However, the district manager has the flexibility to approve lower stocking levels or different species if satisfied that these stocking levels will adequately manage and conserve hydrological, wildlife, recreational and scenic values. For the purposes of green-up, the specified minimum number of trees should be based on total trees.

Height requirements

Green-up height is determined on the basis of the average height of those trees that are the tallest trees of a commercially valuable species or other species acceptable to the district manager, in each 0.01 (1/100th) hectare plot included in a representative sample.

Implicit in the use of green-up height is the assumption that there is a “normal” distribution of tree heights for each species in the stand. In particular, it is assumed that the average height of the trees of a species in the stand is somewhat below the green-up height of that species (i.e., 70–90% of the green-up height). However, there are stands in which this assumption is incorrect (e.g., a naturally regenerated stand where ingress occurred sporadically over a prolonged period). These stand types may require a variance to green-up specifications to ensure green-up objectives are met (see page 8, OPR s68(6)).

Green-up height requirements vary based on whether or not the stand is adequately stocked.

Height requirements for adequately stocked stands (OPR s68(5)(a))

For adequately stocked stands, a green-up height of at least three metres is required.

Height requirements for stands that are not adequately stocked (OPR s68(5)(b)(i))

For stands that are not adequately stocked, a green-up height of at least 3.5 metres is required. The increased height requirement ensures the stand is comprised of larger trees at the time green-up is achieved in order to compensate for the lower stocking.

Block coverage requirements (OPR s68(3))

To satisfy green-up objectives, the requirements for height, stocking and species must generally have been met on at least 75% of the net area. The 25% not required to meet green-up provides a net down allowance for portions of the net area not meeting the height, stocking and species requirements for green-up. The 25% may be scattered in patches throughout the net area or concentrated in a single portion.

The district manager may specify either a higher or lower coverage requirement than the 75% as may be appropriate to adequately manage and conserve hydrological, wildlife, recreational and scenic values. Alternatively, the district manager may specify that only a specific portion of the cutblock need meet green-up requirements. However, this portion must be immediately adjacent to the proposed cutblock and of sufficient size to adequately manage and conserve forest resources.

For example, on large cutblocks, if a specified proportion of the previously harvested area immediately adjacent to the proposed cutblock meets green-up requirements, green-up objectives may be satisfied even if the total percentage of the net area not meeting green-up exceeds 25%.

Varying basic green-up requirements

- OPR s68(1) and (2)

Requirements to satisfy green-up objectives may vary on a site-specific or district basis. Legislative provisions that authorize statutory decision makers to vary green-up requirements are described below. Variances are established through written notices given to any agreement holder that may be affected by the variance. If a decision is made to increase a green-up requirement, it is important that this information be communicated as soon as possible so forest development plans and harvesting practices can be adjusted accordingly. In the absence of written notices, proponents will plan and schedule harvest activities in accordance with the default standards established in the legislation.

- OPR s68(6)

This subsection is intended for specific circumstances where a stand may meet the basic green-up requirements but does not have an adequate stand structure to achieve other green-up objectives. This could occur when the green-up height requirement is, for example, six metres to ensure scenic values are adequately managed. In this case, the minimum countable tree height of 1.3 metres may not ensure a sufficient stand structure to meet green-up objectives. Although the basic green-up height, stocking and block coverage requirements have been met, the stand structure may not satisfy scenic green-up objectives for the area because the majority of trees may be too small. In this instance, the district manager may specify a required number of trees per hectare of three metres height for the area to be considered greened-up.

- OPR s68(7)(a)

This subsection addresses instances where the stand structure created by deciduous species, in areas where the deciduous species is considered a commercially valuable species, may not satisfy green-up objectives for hydrological, wildlife or scenic values. This clause enables the district manager to specify that deciduous species be excluded from the determination of green-up height.

- OPR s68(7)(b)

This subsection addresses the scenario where deciduous or other species satisfy green-up requirements but are scheduled for brushing or knock-down treatment, and the post-treatment stand structure will not satisfy green-up objectives. This may also apply to stands with serious forest health problems that are scheduled for rehabilitation.

- OPR s68(8)(a)

The district manager may approve a green-up height less than three metres if both the district manager and designated environment official are satisfied that the lowered height will adequately manage and conserve hydrological, wildlife, recreational and scenic values. This decision may be made on a block-by-block basis or for all or part of the forest district. It is intended to enable landscape-level decisions such as concentrating harvesting in one area in order to protect resource values in another area.

- OPR s68(8)(b)

Additional information on varying green-up requirements to a height that is greater than three metres, to address visual quality objectives, wildlife habitat needs and hydrological considerations is provided below.

Visual quality objectives

Visual quality objectives (VQOs) are established in higher level plans or by the district manager. To ensure that scenic values are adequately managed for known scenic areas, the district manager may increase green-up height requirements.

Requirements for green-up in a scenic area are commonly referred to as visually effective green-up (VEG). Visually effective green-up is the stage at which regeneration on a cutblock is perceived, by the public, as being a newly established forest. The district manager may specify a VEG default and/or a site-specific prescription based on reference to the *Visual Landscape Management (VLM) Guidebook*. The forest cover on the cutblock should generally be of sufficient height to block stumps, logging debris and bare ground from view and address concerns about visual impacts of cutblock/forest edges. The tree height to achieve VEG will vary based on the biophysical variables and site conditions that are present in a given area. Table 1 provides a guide to recommended green-up heights to meet VEG for adequately stocked stands by slope class **for areas identified as “scenic areas”** and made known by the district manager or through a higher level plan.

Table 1. Height to meet VEG by percent slope for adequately stocked stands*

	Slope class (%)											
	0–5	6–10	11–15	16–20	21–25	26–30	31–35	36–45	46–50	51–55	56–60	60+
Height (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5

* From: *Procedures for Factoring Visual Resources into Timber Supply Analyses*, Ministry of Forests, March 1998.

Wildlife habitat needs

The Ministry of Environment, Lands and Parks (MELP) may request that the district manager consider varying green-up requirements to address wildlife habitat needs. Increased green-up requirements may provide improved hiding cover, security cover and thermal cover. For example, in areas important for Roosevelt Elk on Vancouver Island or moose winter habitat in some areas of the interior with deeper snow packs, an increased height may be required. Increased green-up requirements may also be used to manage forage production adjacent to important wildlife winter range. It may also apply to areas being managed for spring forage production. If the cutblock supports a deciduous stand, increased green-up requirements may be needed to provide adequate wildlife recovery.

Hydrologic considerations

The *Operational Planning Regulation* specifies that the following watershed types must undergo a watershed assessment (to assess hydrologic cumulative effect impacts) before a FDP is approved:

- all community watersheds (see the *Community Watershed Guidebook* for a list of all community watersheds in British Columbia)
- watersheds with high value fish streams or with high domestic water values that have been designated, by both the district manager and the designated environment official, as requiring a watershed assessment due to the potentially high hydrologic impact
- watersheds designated by the district manager.

Where a watershed assessment shows that basic green-up requirements cannot address hydrologic concerns, the recommendations from a watershed assessment must be incorporated into the FDP or a rationale must be provided in the FDP as to why the recommendations have not been incorporated.

The *Interior Watershed Assessment Procedure Guidebook* and the *Coastal Watershed Assessment Procedure Guidebook* describe, in detail, how to conduct a watershed assessment and how it is used to provide direction to the FDP.

Approval process

Forest development plan approval process (OPR s18(s))

At the forest development plan (FDP) stage, the only legislative requirement related to green-up is a mapping requirement. For FDPs submitted for approval the FDP map must show the location of cutblocks that have been harvested but are not yet greened-up and that are adjacent to approved category A cutblocks, or cutblocks proposed to achieve category A status if the proposed FDP is approved. This requirement highlights adjacent cutblocks that will need to be assessed for green-up prior to commencement of harvest. If the proponent is unsure of the green-up status of an adjacent cutblock, it should be indicated as not greened-up on the FDP until an assessment proves otherwise.

Green-up as a practice requirement

Section 9(1) of the *Timber Harvesting Practices Regulation* places responsibility on the proponent to ensure where applicable, that harvesting does not commence until adjacent previously harvested cutblocks are greened-up. When green-up coincides or follows soon after free growing, additional data collected during the free growing survey may suffice to verify green-up requirements have or will be met.

When several years elapse between free growing and green-up, an assessment will be required prior to commencement of harvest. Reconnaissance assessments will be sufficient where it is obvious that green-up requirements have been met. For situations where it is not obvious that green-up requirements have been met, a more detailed assessment following the survey procedures described in Appendix 1 may be required.

Field notes and or survey cards verifying that green-up requirements have been met should be kept on file.

References

Coastal Watershed Assessment Procedure Guidebook

Community Watershed Guidebook

Interior Watershed Assessment Procedure Guidebook

Procedures for Factoring Visual Resources into Timber Supply Analyses

Visual Landscape Management Guidebook

Visual Landscape Training Manual

Landscape Unit Planning Guide (under development as of January, 1999)
(The biological rationale for this guide is outlined in the *Biodiversity
Guidebook*.)

Glossary

Adequately stocked: means a total stand density of commercially valuable species of not less than 800 trees/ha on the coast and 1000 trees/ha in the interior that are at least 1.3 metres in height.

Adjacent: means an area contiguous to, or in close proximity to,

- a. a road or proposed road
- b. a cutblock
- c. an area under a stand management prescription

that, due to its location, could directly impact on, or be impacted by a forest practice carried out within the area of the road, cutblock or prescription.

Biological diversity: the diversity of plants, animals and other living organisms in all their forms and levels of organization and includes the diversity of genes, species, ecosystems and the evolutionary and functional processes that link them.

Clearcut: a silvicultural system that

- removes the entire stand of trees in a single harvesting operation from an area that is
 - one hectare or greater, and
 - at least two tree heights in width and
- is designed to manage the area as an even-aged stand.

Clearcut with reserves: a variation of clearcutting in which trees are retained, either uniformly or in small groups, for purposes other than regeneration.

Community watershed: a community watershed as defined in section 41 (8) of the *Act*.

Cutblock: a cutblock as defined in the *Act*, except that for the purposes of green-up, the forest development plan or permit referred to in that definition means the most recently approved plan, licence or permit for the area, whether or not it has expired.

Even-aged stand: a stand of trees consisting of one or two age classes.

Free growing stand: a stand of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs or other trees.

Green-up height: a height of three or 3.5 metres or as varied by the district manager and is based on the average height of the tallest tree (of a commercially valuable species or other species acceptable to the district manager) in each of a representative sample of 0.01 (1/100th) hectare plots.

Green-up survey: a survey used to determine if the species, stocking, height, and block coverage requirements for green-up as set out in OPR have been met in a previously harvested cutblock.

Group selection: a silvicultural system that

- removes trees to create openings in a stand less than twice the height of mature trees in the stand
- is designed to manage the area as an uneven-aged stand.

Higher level plan: means an objective for a

- resource management zone
- landscape unit or sensitive area
- recreation site, recreation trail or interpretive forest site
- (not yet in force).

Hydrologic green-up: the height and crown closure at which a second growth stand will hydrologically resemble old growth in terms of timing and quantity of water yield.

Net area: the net area to be reforested as identified in the most recent silviculture prescription for the cutblock, whether or not the silviculture prescription has expired or, if no silviculture prescription identifies a net area to be reforested, it is the area of the cutblock excluding all of the following: any area occupied by permanent access structures; any area of rock, wetland or other area that in its natural state is incapable of growing commercially valuable trees; any contiguous area within the cutblock of more than four hectares that is composed of non-commercial forest cover; or any area reserved from harvesting because of wildlife trees or riparian reserve zones.

Partial cutting: a silvicultural system in which only selected trees are harvested and includes seed tree, shelterwood, single-tree and group selection, and clearcutting with reserves.

Patch cutting: a silvicultural system that creates openings of less than one hectare and is designed to manage each opening as a distinct even-aged opening.

Private tenure: a timber licence, old temporary tenure, or private land in a tree farm licence area.

Sanitation treatment: tree removal or modification operations designed to reduce damage caused by forest pests and to prevent their spread.

Scenic area: any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by the district manager.

Seed tree: a silvicultural system in which selected trees are left standing after the initial harvest to provide a seed source for natural regeneration.

Shelterwood: a silvicultural system in which trees are removed in a series of cuts designed to achieve a new even-aged stand under the shelter of remaining trees.

Single tree selection: a silvicultural system in which age classes are created or maintained by the removal, uniformly throughout the stand, of individual trees of all size classes.

Uneven-aged stand: a stand of trees consisting of three or more age classes.

Visually effective green-up: the stage at which regeneration on a cutblock is perceived by the public as being newly established forest. The forest cover on the cutblock must generally be of sufficient height to block stumps, logging debris and bare ground from view.

Visual quality objective: a resource objective established by the district manager or contained in a higher level plan that reflects the desired level of visual quality based on the physical characteristics and social concern for the area.

Watershed assessment: an assessment of the cumulative impact that proposed activities and developments would have on stream flows, suspended sediment, landslide and stream channel stability within the watershed.

Appendix 1. Green-up survey procedures

Objective

The objective of the green-up survey is to determine whether or not a cut block is greened-up as specified or varied in the *Operational Planning Regulation*. In general, to make this assessment the surveyor must:

1. Estimate the total density of commercially valuable species that are at least 1.3 m in height
2. Estimate the green-up height
3. Determine what proportion of the net area meets density, species and green-up height requirements.

Prior to commencing a survey, a surveyor must be aware of any variances to green-up requirements that may be set out for the opening in higher level plans or through district manager written notices.

Definitions

For the purpose of establishing green-up status, as defined in OPR, the measurement criteria for green-up height shall be the tallest tree of any commercially valuable species (unless the species has been excluded by the district manager), or other species acceptable to the district manager, in a 0.01 hectare (5.64 metre radius) plot. Commercially valuable species are defined by the district manager (see note on commercially valuable species on page 5).

Survey area

Green-up requirements apply only to the net area (e.g., net area to be reforested for areas under a silviculture prescription). Net area excludes: permanent access structures; rock, wetland or other area incapable in its natural state of growing commercially valuable trees; contiguous areas of non-commercial cover greater than four hectares; and any area reserved from harvesting because of wildlife trees or riparian reserve zones. Areas in which 40% or more of the pre-harvest basal area has been retained will contribute to the greened-up area, but will not form part of the sample area.

To fulfill green-up requirements, at least 75% of the net area must meet the green-up criteria unless otherwise specified by the district manager (see “Block coverage requirements”). Surveyors must, therefore, identify all mappable areas (as defined by district policy on minimum strata size) that fail to meet the green-up criteria. This could include areas that do not meet the required green-up height, stocking or species.

Survey methods

Three sources of information can be used to determine green-up status:

- free growing survey summaries
- information gathered during a walk-through
- green-up survey results.

Free growing survey

If a free growing survey (or equivalent) has recently been conducted on a cutblock, results can be used to assist in determining green-up status. If the total free growing trees on all strata is more than 1000 trees per hectare in the interior and 800 trees per hectare on the coast, and the height of the well-spaced trees exceeds three metres (unless otherwise varied), the block is greened-up. If the total free growing trees on all strata is between 700–1000 trees per hectare in the interior and 500–800 trees per hectare on the coast, and the height of the well-spaced trees is at least 3.5 metres (unless otherwise varied), the block is greened-up.

If free growing trees alone are insufficient to meet the requirement of “adequately stocked,” the area may still be adequately stocked because:

- an additional component of the total stocking, which is greater than or equal to 1.3 metres in height, may contribute to adequate stocking
- for the purpose of green-up, trees are not required to be well spaced
- green-up forest health standards are less restrictive than free growing standards.

The average height of the well-spaced trees is not the same as the green-up height because green-up height refers only to the average height of the tallest tree in each 0.01 hectare plot. Therefore, if the free growing survey results indicate that the stand is “adequately stocked” but the mean height of the well-spaced trees is less than the required green-up height, the block may still be greened-up. If the average height of the well-spaced trees is greater than two metres, and the block is near target stocking, there is a good chance a green-up height of three metres has been achieved. However, in such circumstances, an on-site assessment should be conducted to verify green-up height.

The need for a separate green-up survey can usually be eliminated by collecting the following additional stocking and height data at a free growing survey plot:

- total trees of a commercially valuable species greater than 1.3 metres tall
- height of the tallest tree of any commercially valuable species, or other species acceptable to the district manager, in a 5.64 metre radius plot.

Also, sufficient plots must be established to meet the required minimum of 10 green-up survey plots.

Finally, by collecting leader lengths during a free growing survey, it will be possible to project height increment and estimate when green-up will be achieved. A subsequent walk-through is recommended to confirm achievement of green-up height prior to harvesting.

Walk-through

Where there are no reliable free growing survey data, or it is not obvious from the survey data that the block is greened-up, an on-site inspection will be required. If, during the site inspection, it becomes obvious that the block is greened-up, or not greened-up, a walk-through assessment can be conducted. Field notes describing the stocking, species composition, green-up height and what proportion of the NAR meets top height requirements and/or the minimum stocking requirement should be recorded and filed.

Green-up survey

When it is not clear whether the block, or a portion of the block, is greened-up, a more detailed survey (as described below) is recommended. A minimum of 10 well-distributed plots should be established in each stratum. More plots (up to a maximum of 1.5 per hectare) may be required to meet the required precision. When using less than 1.5 plots per hectare, statistical requirements must be met (see Appendix 1-A).

Stratification and sampling design

Strata identified for green-up purposes will not necessarily be the same as those used during a free growing survey. Stratification during a green-up survey is based on changes in:

- stocking; adequately or not adequately stocked
- green-up height; greater than or less than three metres or 3.5 metres or as otherwise specified.

In the following example (Table A-1), only stratum 1 would be sampled during a green-up survey. The greened-up area exceeds 75% of the net area (stratum 1 + stratum 3 = 82.9%).

Table A-1. Identifying the sample area

Description of net area	Area (ha)	Percent of net area
Stratum 1 – greened-up	23.4	52.0
Stratum 2 – not greened-up	7.7	17.1
Stratum 3 – >40% basal area retained	13.9	30.9
Total area	45.0	100.0

If in the example above, the greened-up area in stratum 1 contained two or more distinct strata based on total density relative to the *adequately stocked* level, and/or green-up height, the area can be further stratified accordingly (Table A-2).

Table A-2. Stratification of the sample area

Description of net area	Area (ha)	Percent of net area
Stratum 1 – Pl ₇ Fd ₂ Lw ₁ – 3.3 m – 1200 CVS ^a /ha	14.4	32.0
Stratum 2 – Fd ₅ Pl ₃ Lw ₂ – 3.9 m – 850 CVS/ha ^b	9.0	20.0
Stratum 3 – Not greened-up	7.7	17.1
Stratum 4 – >40% basal area retained	13.9	30.9
Total area	45.0	100.0

^a Commercially valuable species.

^b Stratum is not adequately stocked, but exceeds the minimum stocking level. Therefore, 3.5 metres top height is required.

Once potential strata have been refined in the field, a detailed green-up survey can be conducted. Plots must be established throughout the stratum in a manner that will ensure complete and uniform coverage. This can be achieved using either a systematic grid or a random pattern.

Plot sizes

To estimate both density and green-up height during the same survey, a nested plot design is recommended. At each sample point, establish **a 0.005 hectare (3.99 m radius) plot to obtain stocking information and a 0.01 hectare (5.64 m radius) plot to obtain green-up height information.**

Plot data

In the 0.005 hectare (3.99 m radius) plot, tally the total number of commercially valuable species greater than 1.3 metres tall up to a maximum plot tally. **The maximum plot tally used in the statistical analysis (M value) is six on the coast and seven in the interior.** This maximum plot tally should not be confused with the M value used to determine stocking or free growing status. There is no inter-tree spacing requirement.

However, a tree can only be tallied and be a “countable tree” for the purposes of green-up if it is:

- a commercially valuable species or another species acceptable to the district manager
- at least 1.3 metres in height
- free of damage, insects or pathogens that make mortality imminent (e.g., root disease, comandra or stalactiform stem cankers, white pine blister rust).

Multiple stems on a single stump are to be tallied as one tree.

From the same plot centre, a 0.01 hectare (5.64 m) plot is used to identify the green-up height tree. Identify the largest acceptable tree and accurately determine its total height. An ocular estimate of height is inadequate; height must be measured. To be acceptable, a tree must be at least 1.3 metres in height, of an acceptable species, free from insects or pathogens that make mortality imminent (defects such as weeviled or broken tops are acceptable) and must not include trees that are not representative of the population being sampled for green-up. For example, scattered residuals or seed trees should not be measured in a stand where the stand structure that will satisfy green-up objectives is dependent on the understorey. Including the seed trees in the sample would inappropriately bias the estimate of top height upwards. However, if these trees meet the criteria of a “countable tree” they can be tallied for the estimate of stocking.

If protection of advance regeneration during harvesting was used to regenerate the area, and where this advance regeneration creates a stand structure that will satisfy green-up objectives, green-up height sample trees may include acceptable residuals.

Compilation

Total stand density of countable trees is estimated by summing 0.005 hectare (3.99 m) plot totals (using the M value) multiplying by 200 and dividing by the number of plots. Statistical tolerances must be met on each stratum, if less than the maximum number of plots is established.

Green-up height is determined by summing the sample tree heights collected from 0.01 hectare (5.64 m) plots and dividing by the number of plots that have at least one countable tree. Statistical tolerances must be met if less than the maximum number of plots are established.

When the district manager specifies a minimum number of trees required to reach three metres, stocking for the purposes of green-up is estimated by only tallying trees greater than three metres in the countable trees column. Totals in the countable trees column are then multiplied by 200 and divided by the number of plots.

Appendix 1-A. Decision rules for determining the number of plots required for a green-up survey

Unless the maximum number of plots has been established, a separate statistical analysis must be carried out for each stratum for both the number of commercially valuable trees per hectare and green-up height.

A. Statistical tolerances for adequate stocking

A minimum of 10 well-distributed plots should be established per stratum. More plots (up to a maximum of 1.5 per hectare) may be required to meet the 90% confidence interval (CI). Use the following decision rules:

1. If the estimate of total countable trees per hectare and its 90% lower confidence limit (LCL) are greater than 800 total trees/ha on the coast and 1000 total trees/ha in the interior, the area is considered adequately stocked for the purposes of a green-up survey (Figure A-1a). No further stocking plots are required. The area must meet a three metre green-up height before it is considered greened-up.
2. If the estimate of total countable trees per hectare is greater than 800 total trees/ha on the coast and 1000/ha in the interior, but its LCL is less (Figure A-1b), then:
 - sufficient plots must be established and measured to ensure that the desired sampling precision has been achieved. The area must meet a three metre green-up height before it is considered greened-up, or
 - no further plots are required. The area must meet a 3.5 metre green-up height before it is considered greened-up.
3. If the estimate of total countable trees per hectare and its LCL are less than 800 total trees/ha but greater than 500 total trees/ha on the coast, and less than 1000 trees/ha but greater than 700 trees/ha in the interior (Figure A-1c), the area meets the default stocking levels set in the legislation. No further stocking plots are required. The area must meet a 3.5 metre green-up height before it is considered greened-up.
4. If the estimate of total countable trees per hectare is greater than 500 total trees/ha on the coast and 700 trees/ha in the interior, but its LCL is less (Figure A-1d), then:
 - sufficient plots must be established and measured to ensure that the desired sampling precision has been achieved; and the area must meet a 3.5 metre green-up height before it is considered greened-up, or

- no further plots are required. The area must meet a 3.5 metre green-up height and requirements that satisfy the district manager before it is considered greened-up.
5. If the estimate of total countable trees per hectare is less than 500 total trees/ha on the coast and 700 trees/ha in the interior, no further plots are required. The area must meet green-up requirements specified by the district manager before it is considered greened-up (Figure A-1e).
 6. Sampling precision (e) is acceptable when the confidence interval (CI) is less than or equal to e where:
 - $e = \pm 100$ stems/ha, if the estimate of total countable trees per hectare is less than or equal to 1000 stems/ha,
 - $e = \pm 10\%$ stems/ha, if the estimate of total countable trees per hectare is greater than 1000 stems/ha,
 - $CI = t_{(n-1)} \times S_{\bar{x}} \times 200$, ($S_{\bar{x}}$ = standard error of mean)

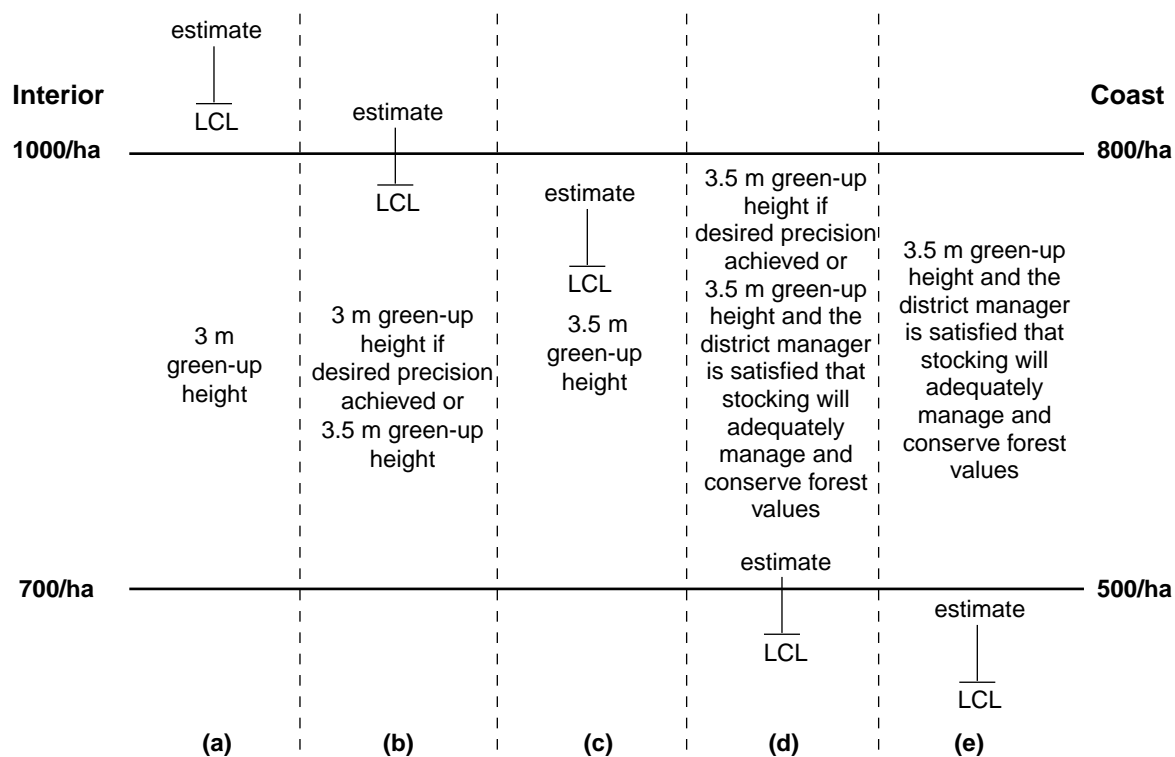


Figure A-1. Relationship between adequate stocking levels, minimum stocking levels and green-up height requirements.

Note: These scenarios would differ accordingly if the district manager specifies an increased green-up height requirement or the district manager/designated environmental official has specified a reduced green-up height.

7. Compare confidence interval (CI) to e:
 - (i) if CI is less than or equal to e, the area is considered to be adequately stocked or above the minimum stocking level as the case may be; no further plots are required,
 - (ii) if CI is greater than e, more plots are required to meet statistical precision and to be considered adequately stocked or above the minimum stocking level as the case may be.

8. Where more plots are required, use the following formula:

$$n = t^2 \times s^2 \div e^2$$

where: n = the estimated number of sampling plots required to meet sampling precision

t² = the student “t” value (refer to FS 1138B)

s² = the standard deviation squared

e² = the square of the desired sampling precision

This estimates the total number of plots required to achieve the required statistical precision. However, the maximum number of plots for an area is limited to 1.5 plots per hectare (minimum of 10 per stratum).

Additional plots (up to a maximum of 1.5 plots per hectare) should be established systematically along a pre-defined line or randomly.

Once additional plot information has been collected, recalculate statistics and make the decision based on a direct comparison between your estimate of total countable trees of per hectare and 800 trees/ha or 500 trees/ha on the coast and 1000 trees/ha or 700 trees/ha in the interior, as the case may be. **DO THIS ONLY ONCE** – do not establish any more plots or do any further calculations.

B. Statistical tolerances for green-up height

A minimum of 10 well-distributed plots should be established per stratum. More plots (up to a maximum of 1.5 per hectare) may be required to meet the 90% confidence interval (CI). Use the following decision rules:

1. If the estimate of green-up height and its 90% lower confidence limit (LCL) are greater than three metres, 3.5 metres or the green-up height specified by the district manager or by the DM and DEO, as the case may be, the area has achieved green-up height. No further height plots are required.

2. If the estimate of green-up height is less than three metres, 3.5 metres or the green-up height specified by the district manager or by the DM and DEO, as the case may be, the area has not achieved green-up height. No further plots are required.
3. If the estimate of green-up height is greater than three metres, 3.5 metres or the green-up height specified by the district manager or by the DM and DEO, as the case may be, but its lower confidence limit is less, sufficient plots must be established and measured to ensure that the desired sampling precision has been achieved.

Sampling precision (e) is acceptable when the confidence interval (CI) is less than or equal to e where:

- $e = \pm 40$ cm if the estimate of green-up height is less than or equal to four metres.
- $e = \pm 10\%$ of the green-up height, if the estimate is greater than four metres.
- $CI = t_{(n-1)} \times S_{\bar{x}}$

4. Compare confidence interval (CI) to e:
 - (i) if CI is less than or equal to e, the decision is made that the area has achieved green-up height; no further plots are required,
 - (ii) if CI is greater than e, more plots are required to meet statistical precision for green-up height

Where more plots are required, use the following formula:

$$n = t^2 \times s^2 \div e^2$$

This states the total number of plots required to achieve the required statistical precision. However, the maximum number of plots for an area is limited to 1.5 plots per hectare (minimum of 10 per stratum).

In a systematic manner, additional plots (up to a maximum of 1.5 plots per hectare) should be established evenly spaced along a pre-defined line.

Once additional plot information has been collected, recalculate statistics and make the decision based on a direct comparison between your estimate of green-up height to three or 3.5 metres or the green-up height specified by the district manager. **DO THIS ONLY ONCE** – do not establish any more plots or do any further calculations.

Note: Where a statistical analysis indicates that sufficient plots have been established to meet the statistical precision for density, but there are insufficient plots established to meet the statistical precision for green-up height, additional 5.64 m radius plots ONLY (green-up height plots) need to be established. Where a statistical analysis indicates that sufficient plots are established to meet the statistical precision for green-up height, but insufficient plots are established to meet the statistical precision for density, additional 3.99 metre radius plots ONLY (density plots) need to be established.

Example #1

A 20 hectare coastal block. Walk-through indicates area is a single stratum and is likely greened-up. Minimum of 10 plots is established.

GREEN UP SURVEY DATA							PAGE	OF	
							1	1	
MAPSHEET/OPENING NO.: 92L 064-001				SURVEYOR: Joe Tracker			DATE: July 3, 1999		
BLOCK:								BEC UNIT: CWH ms1	
PLOT	UNIT	SPECIES COMPOSITION	COUNTABLE TREES		TALLEST TREE (m)	SPP	LEADER LENGTH (cm)	COMMENTS	
			> 1.3 m	> 3 m					
1		Fd ₈ Pw ₂	4		3.5				
2		Cw ₆ Hw ₄	M		3.3				
3		Cw ₆ Hw ₃ Fd ₁	4		3.3				
4		Cw ₉ Hw ₁	M		3.0			3 alder	
5		Cw ₈ Hw ₂	M		2.9				
6		Cw ₆ Hw ₄	M		3.4			12 alder	
7		Cw ₉ Hw ₁	5		3.2				
8		Cw ₃ Hw ₂	4		2.8				
9		Cw ₇ Hw ₃	M		3.0				
10		Cw ₁₀	M		2.7			12 alder	
COMMENTS: Salal dominates the understorey, less than 10% of the stratum appears to be marginally greened-up. Species composition Cw ₇ Hw ₂ Fd ₁									

Statistical calculations

Stocking M = 6

Estimate = 1060 trees/ha

n = 10

s = 0.949

t = 1.833

$S_{\bar{x}} = 0.300$

CI = 110 trees/ha

LCL = 950 trees/ha, therefore the block is adequately stocked

Green-up height

Estimate = 3.1 m

n = 10

s = 0.269

t = 1.833

$S_{\bar{x}} = 0.085$

CI = 0.2 m

LCL = 2.9 m

LCL is not greater than 3 m, however, sampling precision is acceptable, CI ≤ 40 cm. Therefore, decision is that green-up height of 3.0 m is achieved

Green-up status: Greened-up

Example # 2

An interior pine stand. The stand is not adequately stocked but density exceeds the minimum density level of 700 countable trees/ha and therefore requires a green-up height of 3.5metres to be considered greened-up.

GREEN UP SURVEY DATA							PAGE	OF
							1	1
MAPSHEET/OPENING NO.: 92L 064-001				SURVEYOR: Joe Tracker			DATE: July 3, 1999	
BLOCK:							BEC UNIT: ICH mk1	
PLOT	UNIT	SPECIES COMPOSITION	COUNTABLE TREES		TALLEST TREE (m)	SPP	LEADER LENGTH (cm)	COMMENTS
			> 1.3 m	> 3 m				
1		At ₆ PI ₃ Ep ₁	5		3.7	PI		
2		PI ₃ Ep ₃ At ₂ Fd ₂	3		4.2	PI		
3		PI ₆ Ep ₂ Fd ₂	5		3.8	PI		
4		PI ₃ Fd ₂	3		3.9	PI		
5		At ₁ PI ₂ Ep ₂ Fd ₁	5		4.0	PI		
6		Sx ₆ PI ₃ Fd ₁	M		3.5	Sx		
7		PI ₃ Ep ₃ Fd ₃ At ₁	4		3.9	PI		
8		PI ₉ At ₁	2		4.3	PI		
9		PI ₇ Fd ₂ Ep ₁	M		3.5	PI		
10		PI ₄ Ep ₄ Fd ₂	M		3.7	Fd		
COMMENTS: Spaced stand, dominant pine overstorey, block will not be adequately stocked with 1000 tpha.								

Statistical calculations

Stocking $M = 7$

Estimate = 960 trees/ha

$n = 10$

$s = 1.816$

$t = 1.833$

$S_{\bar{x}} = 0.573$

CI = 210 trees/ha

LCL = 750 trees/ha, therefore

the block is not adequately stocked,

but meets the minimum stocking level

Green-up height

Estimate = 3.8 m

$n = 10$

$s = 0.268$

$t = 1.833$

$S_{\bar{x}} = 0.085$

CI = 0.2 m

LCL = 3.7 m

LCL is > 3.5 m. The block has achieved

a green-up height of 3.5 m

Green-up status: The area exceeds minimum stocking levels and has a green-up height greater than 3.5 m, therefore, it is greened-up.

Example # 3

A stocked 4–5 m tall Douglas-fir, larch, pine stand. The minor amount of 2 m tall spruce and western white pine contributes to stocking, but does not meet the green-up objective to provide critical winter wildlife habitat. The district manager has issued a written variance increasing the green-up height requirement of adequately stocked stands to 5 m.

GREEN UP SURVEY DATA							PAGE	OF
							1	1
MAPSHEET/OPENING NO.: 82F 053–22				SURVEYOR: Joe Tracker			DATE: Nov. 23, 1999	
BLOCK:								BEC UNIT: ICH mw
PLOT	UNIT	SPECIES COMPOSITION	COUNTABLE TREES		TALLEST TREE (m)	SPP	LEADER LENGTH (cm)	COMMENTS
			> 1.3 m	> 3 m				
1		Lw ₃ Fd ₃ Pw ₃ Sx ₁	M		5.1	Lw	60	
2		Sx ₅ Fd ₅	5		2.9	Fd	30	
3		Pl ₃ Fd ₃ Lw ₃ Sx ₁	M		4.8	Lw	65	
4		Fd ₃ Pl ₃ Sx ₂ Lw ₂	M		5.0	Lw	65	
5		Lw ₅ Fd ₅	M		4.5	Lw	50	
6		Lw ₃ Pl ₂ Fd ₂ Sx ₂ Pw ₁	M		5.5	Lw	50	
7		Fd ₄ Lw ₃ Pl ₃	M		5.2	Pl	55	
8		Ep ₈ Sx ₂	4		3.5	Sx	35	8 Ep
9		Ep ₅ Fd ₂ Lw ₂ Sx ₁	6		4.2	Pl	45	10 Ep
10		Fd ₆ Pl ₂ Lw ₁ Sx ₁	M		5.6	Lw	60	
COMMENTS: This block will be greened-up next year, re-assess heights only using walk-through.								

Statistical calculations**Stocking M = 7**

Estimate = 1280 trees/ha

n = 10

s = 1.075

t = 1.833

 $S_{\bar{x}} = 0.340$

CI = 125 trees/ha

LCL = 1155 trees/ha

this block is adequately stocked

Green-up height

Estimate = 4.6 m

n = 10

s = 0.874

t = 1.833

 $S_{\bar{x}} = 0.277$

CI = 0.5 m

LCL is > 4.1 m

green-up height requirement is not achieved

Green-up status: This block is not greened-up. The 51.5 cm average leader length data indicates that block may be greened-up next year, and will definitely be greened-up in 2 years. A follow-up walk-through is required to confirm achievement of height requirement.

