A New Basis for Understory Stocking Standards for Partially Harvested Stands in the British Columbia Interior

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ABSTRACT: *For partially harvested stands in the British Columbia interior, we present a new method for specifying regeneration stocking standards and a procedure for comparing achieved regeneration to the standard. Understory stocking is assessed in terms of the deviation from potential yield that the observed understory tree density represents. For a harvested area, the minimum stocking standard is stated as the maximum allowable mean deviation from potential. Deviation from potential is expressed on a relative (0–1) scale and predicted from overstory basal area and understory tree density. Because of a scarcity of calibration data, we undertook a crude, preliminary calibration of this relationship. As overstory basal area increases, the understory density required to achieve a given degree of understory stocking decreases. Issues pertaining to the stand management context and other approaches to regulating regeneration also are discussed. West. J. Appl. For. 20(1):5–12.*

Key Words: Regeneration, stocking standards, British Columbia, growth and yield, partial harvest, regulation, policy.

Setting regeneration standards and assessing whether the regeneration on harvested areas meets these standards are two processes that are critical to forest management. In British Columbia, in areas harvested by either single-tree selection or clearcutting, government policy prescribes a system for setting regeneration standards and assessing postharvest compliance (BC Ministry of Forests 2002). However, there is no corresponding provincial system suitable for the heterogeneous (mixed, multicohort, spatially variable) stands that result from some forms of partial harvest.

Heterogeneous stands in the BC interior are created by partial cutting to salvage mountain pine beetle (*Dendroctonus ponderosae*)-infested trees, maintain visual quality, promote certain types of habitat, and sustain ecosystem function by retaining live trees at harvest (Franklin et al. 1997). During harvest, trees of a wide range of sizes, species, and conditions are retained in a variety of spatial patterns throughout the harvested area. In the central interior of British Columbia, common tree species in these stands include lodgepole pine (*Pinus contorta*), Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), interior spruce (*Picea engelmannii x glauca*), and trembling aspen (*Populus tremuloides*).

For use on a wide variety of sites with a wide range of postharvest stand structures and species compositions, a method is urgently required for setting standards for the minimum allowable postharvest understory (US) stocking. In this article, we describe a new method for assessing US stocking that we propose for setting regeneration standards, and evaluating regeneration accomplishment, in heterogeneous, partially cut stands in the central interior of British Columbia. Elements of our approach may be applicable in other locations.

Conceptual Model

A new measure of US stocking provides the basis for a new type of US stocking standard. On most harvested sites in the BC interior, sustained timber production is a key

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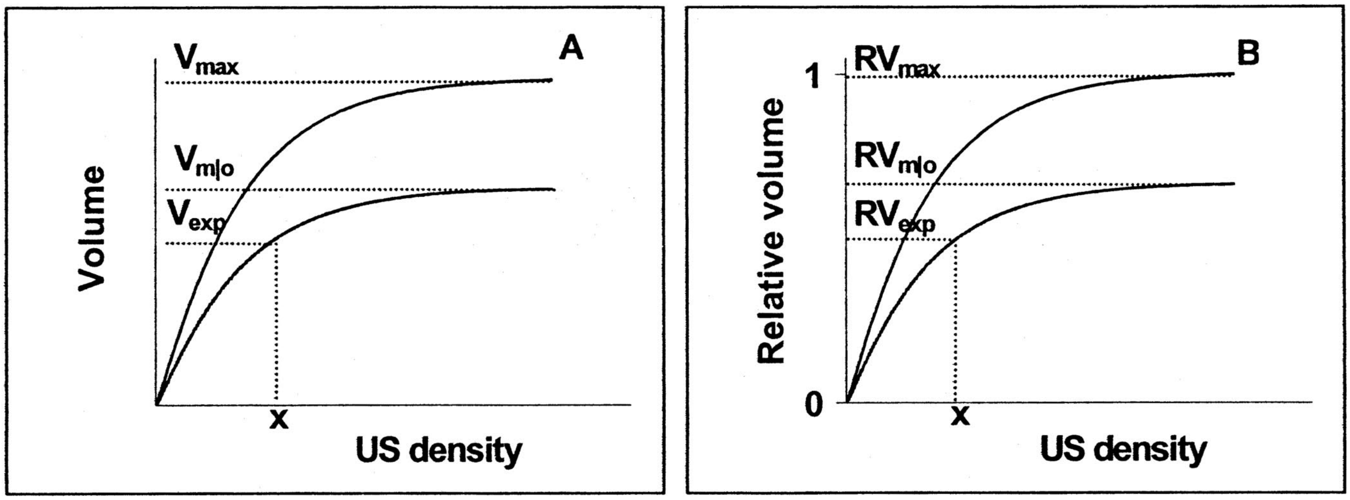

Figure 1. The concept of deviation from potential. A, The relationship of initial US tree density to future volume in the absence of OS (upper curve) and with a given amount of OS (lower curve) at a particular location in a particular stand. V_{max} is the future US volume achieved with the US density that maximizes yield, no OS, and all other variables fixed. $V_{m|o}$ is the future US volume achieved with the US density that maximizes yield with the observed OS. V_{exp} is the future US volume achieved with the observed US density of x and the observed OS. B, All volumes are divided by V_{max} to re-express them on a relative scale. At a location in a stand with an US density of x and a given OS, the deviation from potential is $RV_{m|o}$–RV_{exp}.

management objective. Thus, it seems appropriate to measure stocking in terms of impact on future volume per hectare yield. Consider a plantation of a given species on a given site. Some establishment density will maximize volume per hectare at a specified future date. If a is the maximum volume possible at this date from optimal establishment density and b is the volume expected given the actual establishment density, then $a - b$ is an indicator of stocking, the degree to which the achieved seedling density will capture the potential yield.

In partially harvested stands, the residual overstory (OS) affects the future volume that can be expected from the US. How could the concept of stocking as the deviation from potential yield be applied to the US of stands with large retained trees? Understory stocking could be defined as the difference between expected US volume production and the maximum possible, given the observed amount of OS. However, this difference is a poor stocking measure because it is too sensitive to site quality, species composition, and other factors. A more stable quantity that provides an equivalent indicator of stocking can be constructed by dividing each volume by the maximum possible volume without OS, creating a measure of stocking that is based on the difference in relative volumes. Thus, we adopt the following as our measure of US stocking: the deviation of expected relative US volume from the maximum relative US volume possible, given the observed amount of OS. For brevity, we call this stocking indicator "deviation from potential" (Figure 1).

The concept can be represented as follows:

V = Future US volume produced by a given US tree density growing in the presence of a given OS, with all other determinants of volume fixed.

V_{max} = Maximum future US volume: V with no OS and the US tree density that maximizes future volume.

$V_{m|o}$ = Maximum future US volume given the observed OS: V with the observed OS and the US tree density that maximizes future volume.

V_{exp} = Expected future US volume: V with the observed OS and the observed US tree density.

RV = Relative future US volume:

$$RV = \frac{V}{V_{max}}$$

$RV_{m|o}$ = Maximum relative future US volume given the observed OS:

$$RV_{m|o} = \frac{V_{m|o}}{V_{max}}$$

RV_{exp} = Expected relative future US volume:

$$RV_{exp} = \frac{V_{exp}}{V_{max}}$$

$RV_{m|o} - RV_{exp}$ = Deviation from potential. The discrepancy between the expected relative future US volume and the maximum possible, given the observed OS.

The quantity $RV_{m|o} - RV_{exp}$ is our measure of US stocking. It is the metric in which we specify US stocking standards. Observed US density is translated into $RV_{m|o} - RV_{exp}$ to assess whether US stocking meets the standard.

For operational application, RV should be predicted from variables that are inexpensive to measure and familiar to local foresters. The desired degree of generality, and accuracy sufficient for our purpose, can be achieved by predicting *RV* from simple measures of OS amount and US density. We chose basal area per hectare at the sample point as the OS measure and well-spaced (Stein 1978), acceptable trees per plot as the US measure.

Stocking is assessed location-by-location throughout a harvested area. US density and OS basal area at a sample point are translated into an estimate of stocking at that sample point. When an estimate of the mean stocking on a harvested area is desired, it is calculated from the collection of individual, point-by-point stocking estimates.

$RV_{m|o} - RV_{exp}$ is algebraically equivalent to $(V_{m|o} - V_{exp})/V_{max}$, suggesting the alternative interpretation of this stocking indicator as the difference between potential and expected yield at a given level of OS, expressed as a proportion of the yield potential without OS.

Calibration of the Model

Empirical data linking future yield to various combinations of OS basal area and US density do not exist for our stand types. Well-calibrated stand growth models are available for even-aged stands in the BC interior, but not for our heterogeneous stand types. So, to calibrate our conceptual model and provide first approximation predictions of *RV*, we: (1) related *RV* to US density in the absence of OS; (2) related US height growth to OS basal area; and (3) invoked the crude assumption that where OS was present, *RV* would be reduced to the same degree that US height growth was reduced:

$$RV = PMV \cdot OSA. \tag{1}$$

PMV is the proportion of maximum future volume per hectare predicted from observed US density without OS. *OSA* is the OS adjustment factor predicted from observed OS basal area. When better calibration data become available, this crude preliminary calibration can be updated by directly fitting *RV* (or $RV_{m|o} - RV_{exp}$) as a function of OS basal area and US density.

PMV

To relate US density to future yield without OS, simulations were conducted with the stand growth model TIPSY (Di Lucca 1999) for pure lodgepole pine stands on site index 17 m, pure Douglas-fir stands on site index 19 m, and pure interior spruce stands on site index 21 m. For each species-site group, plantation density was varied from 278 to 2,000 trees/ha. An establishment density of approximately 2,000 trees per hectare maximized merchantable volume per hectare 80 years postharvest. In each species-site group, for each establishment density, merchantable volume 80 years postharvest was expressed as a proportion of the maximum yield (the yield from planting 2,000 trees/ha). Plantation density was converted to mean density per 0.005 ha regeneration sample plot. A model conditioned to pass through 0,0 and 10,1 was fit to the data resulting in the following equation:

$$PMV = 1.0066 \cdot (1 - e^{-0.5171 \cdot X})^{1.1479} \tag{2}$$

where *X* is the number of seedlings per 0.005 ha sample plot and *e* is the base of the natural logarithm (Figure 2). Because seedlings in the spatially explicit growth simulation are planted on a uniform grid, well-spaced trees per plot was considered equal to seedlings per plot. Equation 2 was taken as universally applicable to all sites, species, and densities relevant to our application.

OSA

We searched the literature for published relationships between OS basal area and US light levels (Figure 3). We generated the relationship attributed in Figure 3 to Comeau (1998) by estimating data points off a figure in Comeau's publication and then fitting a model to the data. As it was roughly the median relationship, exhibited desired behavior, and was calibrated in B.C., the Comeau (1998) curve was selected for use:

$$USL = e^{-0.0865 \cdot BA} \tag{3}$$

where *USL* is US light as a proportion of full (open-sky) light and *BA* is OS basal area (m^2/ha).

Published relationships between US light and sapling height growth were obtained for species relevant to our application. Each relationship was scaled between zero and one by dividing predicted height growth by the maximum growth predicted under full light (Figure 4). A model conditioned to pass through 0,0 and 1,1 was fit to this data resulting in the following equation:

$$PMHG = USL^{(0.9786 - 0.5663 \cdot USL)} \tag{4}$$

where *PMHG* is proportion of maximum US tree height growth. To relate OS basal area to US growth, Equation 3

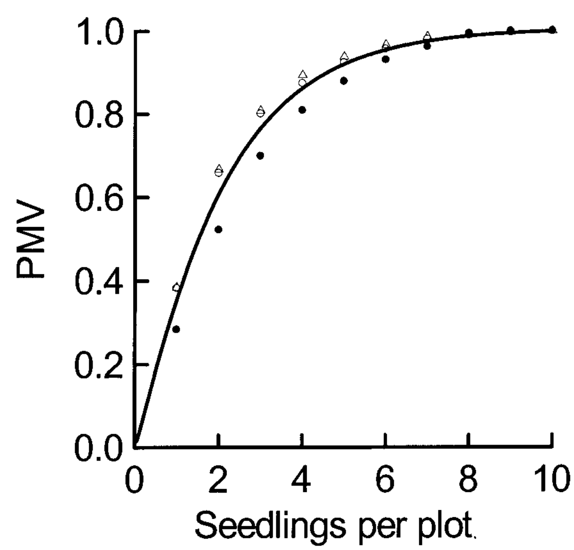

Figure 2. Seedling density and volume production relationships for plantation Douglas-fir on site index 19 m (open circle), lodgepole pine on site index 17 m (solid circle), and interior spruce on site index 21 m (triangle) predicted by the stand growth model TIPSY. PMV is proportion of maximum volume. Seedling plot size is 0.005 ha. Solid line is the fitted relationship (Equation 2).

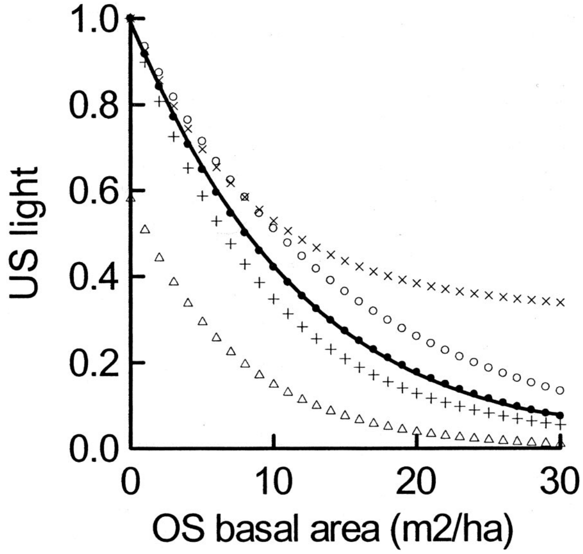

Figure 3. Overstory basal area and understory light relationships for pine ("×", Puettmann and Duvall 1998), aspen (open circle, Comeau 2001), alder/birch (solid circle with line, Comeau 1998), maple/birch (cross, Puettmann and Duvall 1998), and maple (triangle, Thomas and Comeau 1998). US light is expressed as the proportion of full (open-sky) light.

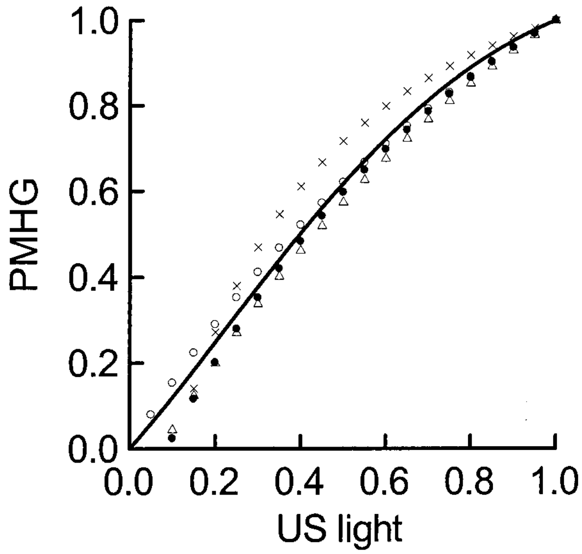

Figure 4. Understory light and seedling height growth relationships for Douglas-fir (open circle, Drever and Lertzman 2001), lodgepole pine (solid circle, Coates and Burton 1999), interior spruce (triangle, Coates and Burton 1999) and subalpine fir ("×", Coates and Burton 1999). Solid line is the fitted relationship (Equation 4). PMHG is the proportion of maximum height growth. US light is expressed as the proportion of full (open-sky) light.

was substituted into Equation 4. Finally, we assumed that *PMHG* was a suitable proxy for *OSA*. That is, the impact of OS on US volume production was assumed equal to the impact of OS on US tree height growth. The resulting relationship between OS basal area and the adjustment to US yield (*OSA*) is illustrated in Figure 5.

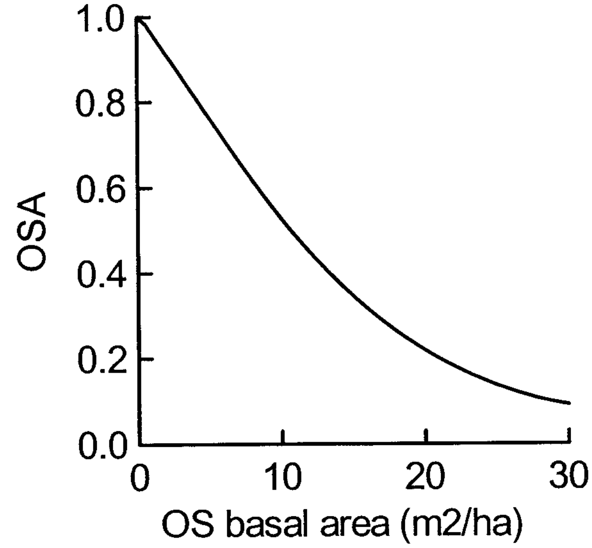

Figure 5. The relationship of overstory basal area to OSA, the yield multiplier that reduces understory increment.

RV

With *PMV* and *OSA* specified, Equation 1 was calibrated (Figure 6). Last, deviation from potential was calculated. $RV_{m|o} - RV_{exp}$ was computed with Equation 1 for combinations of OS basal area (from 0 to 30 m^2/ha in 5 m^2/ha increments) and US tree density (from 0 to 10 trees per 0.005-ha sample plot in 1 tree increments; Table 1). Because future volume maximized at 10 trees per plot (and due to the structure of Equation 1), $RV_{m|o}$ was computed with 10 trees per plot. In those infrequent instances when a plot contains more than 10 well-spaced trees, a tree count of 10 must be input to Table 1.

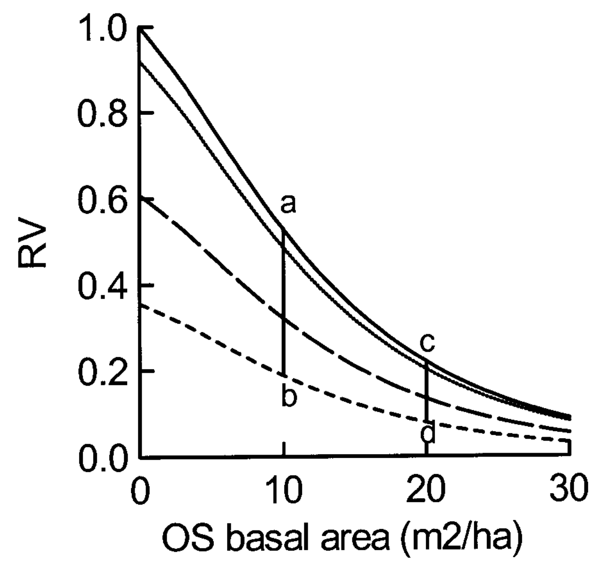

Figure 6. Relative future understory volume (RV) as a function of overstory basal area and understory tree density with 1 (short dash), 2 (long dash), 5 (dotted), and 10 (line) well-spaced, acceptable trees per 0.005 ha plot, respectively. When a plot contains only one understory tree, the deviation from potential is *ab* with 10 m^2/ha of overstory and *cd* with 20 m^2/ha of overstory.

Table 1. Deviation from potential ($RV_{m|o} - RV_{exp}$) by understory tree density and overstory basal area.

US tree density (no. per plot)[a]	Overstory basal area (m^2/ha)						
	0	5	10	15	20	25	30
0	1.00	0.77	0.53	0.34	0.22	0.14	0.09
1	0.64	0.49	0.34	0.22	0.14	0.09	0.06
2	0.39	0.30	0.21	0.13	0.09	0.05	0.03
3	0.23	0.18	0.12	0.08	0.05	0.03	0.02
4	0.14	0.11	0.07	0.05	0.03	0.02	0.01
5	0.08	0.06	0.04	0.03	0.02	0.01	0.01
6	0.05	0.03	0.02	0.02	0.01	0.01	0.00
7	0.02	0.02	0.01	0.01	0.01	0.00	0.00
8	0.01	0.01	0.01	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥10	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[a] Acceptable, well-spaced understory trees in a 0.005 ha plot.

Behavior of the Model

In the absence of OS, as US density increases US future volume increases and then saturates (Figure 6). Across all US densities, as OS basal area increases US future volume declines (Figure 6). For any given tally of US trees in a plot, the deviation from potential declines as OS basal area increases (Figure 6, Table 1). For example, with one US tree in a plot, the deviation from potential is 0.34 with 10 m^2/ha OS and 0.14 with 20 m^2/ha OS (Table 1), indicated by the line segments ab and cd in Figure 6. Under a heavy OS, there is less growing space available to the US and thus less US yield is forgone with low US density.

Application of the Approach

Presurvey

Stratify the harvest unit to separate large contiguous areas in which there is no reforestation requirement (uncut areas), areas in which the traditional even-aged standards can be applied (large, clearcut patches), and the remaining heterogeneous, partially harvested areas. In the heterogeneous area, our new approach can be used.

To guide reforestation, the minimum stocking standard should be established before (or immediately after) harvest. Stocking standards for mesic sites in central British Columbia that are under even-aged management typically require a minimum of 700 well-spaced acceptable trees per hectare (BC Ministry of Forests 2002). To mirror the current procedure, the new standard should be stated as the maximum allowable mean deviation from potential. A rough translation of the current standard (700 trees/ha) to deviation from potential suggests that the minimum stocking standard under our new approach should be set at 0.2. That is, the mean deviation from potential should not exceed 0.2 (e.g., 20% of potential US production). This value should be refined as local foresters gain experience with our approach under their typical conditions.

To use the new procedure, a sample size rule is required. In operational regeneration surveys, sample size depends on desired precision subject to limits on survey cost. Based on a consideration of these factors, we recommend a minimum of 10 sample points in a stand. After 10 points are established, no additional samples are required if the sample size exceeds 1 point/ha or the standard error of the mean is ≤0.05.

Also, before surveying to determine whether standards are met, the decision rule should be defined. For our system, we recommend a mean decision rule (Bergerud 2002). The harvested area is deemed adequately restocked when the sample mean deviation from potential is less than the minimum stocking standard, as long as the sample size rule has been followed.

Before surveying, one must clearly define the characteristics that US trees must have before they can be tallied (Brand and Weetman 1986). To apply our method, we recommend:

1. listing the acceptable tree species (commercially valuable and ecologically appropriate for the site with due regard for their growth potential under partial shade);
2. specifying a minimum height for counting US trees;
3. for the common forest health agents, specifying the degree of damage that will be accepted;
4. specifying tree form requirements, e.g., so that advanced regeneration can only contribute to stocking when it has maintained a single, straight stem and epinastic control (Oliver and Larson 1996); and
5. describing the degree of brush encroachment that will be allowed.

Survey

We recommend a nested plot design that samples large trees with a variable radius plot and small trees with a fixed radius plot around a common plot center (Stage and Rennie 1994). When initiating the survey, select the lowest basal area factor (BAF) prism that meets two tests. The chosen prism should select 12 or fewer trees at each sample point and should not select trees more than 12 m from any sample point. In central British Columbia, metric 2–5 BAF prisms appear reasonable for the target stand types.

Establish a minimum of 10 sample locations at random (or on a grid) throughout the heterogeneous stratum. At each sample point, using a minimum intertree distance of 2 m, tally the number of well-spaced US trees in a 3.99-m radius plot with dbh (diameter outside bark at 1.3 m) <12.5 cm that meet the acceptability criteria. With a prism sweep around the sample point, count the number of "in" trees with dbh ≥12.5 cm. Exclude from the OS tally both dead and moribund trees. Record OS basal area (m^2/ha) and US tree count (acceptable, well-spaced trees per plot) at each sample point.

Postsurvey

After the survey, input the OS basal area and US tree count from each sample point into Table 1 to obtain the deviation from potential at each sample point. Compute the mean deviation from potential and the standard error of the mean. As long as the sample size rule has been followed, the area can be declared adequately stocked if the sample mean is less than the minimum stocking standard.

Discussion

Prediction of US Future Volume

It is abundantly clear that our method, and particularly the crude preliminary calibration, will not provide precise estimates of relative future US volume (*RV*). Stand types differ in the degree to which they attenuate US light at a given OS basal area (Figure 3). A 360° prism sweep fails to account for the spatial location of OS crowns—an important factor that determines light transmission (Canham et al. 1999). In addition, the preliminary calibration does not account for the fact that the US light level may decline over time if OS trees are vigorous and expand their crowns—or it may increase if OS trees blow down or die and the US grows up into an improved light environment (Comeau 2001).

For all of our tree species, we portray the US growth response to reduced light with a single relationship. Although the absolute growth of different species at a given light level can vary widely (Coates and Burton 1999, Drever and Lertzman 2001), the relative response across the light gradient is similar (Figure 4). Also, although the relationship between absolute future yield and establishment density varies greatly with site index and species, it is much less variable when expressed on a relative scale (Figure 2). We contend that when using an attribute of future yield (such as volume per hectare) for the purpose of stocking assessment, it is sufficient to consider only relative response and appropriate to use a relative scale. For example, future volume will be greater on good sites than on poor sites: but for assessing stocking one cares only about the extent to which the site's potential will be captured, not the actual volume that can be expected. Similarly, whether different species could achieve greater absolute growth is immaterial for the purpose of stocking assessment, as long as the established species are deemed appropriate for the site. Western redcedar (*Thuja plicata*), for example, has high economic, cultural, and habitat values, but grows more slowly than Douglas-fir on some sites where both are considered acceptable species. If a regeneration plot contains only cedar seedlings, the sole concern is the degree to which the observed density of cedar seedlings will capture the site's cedar growth potential. The fact that Douglas-fir might produce more volume on the same site is an important forest management issue, but not relevant at the time of regeneration stocking assessment once cedar has been deemed an equally acceptable species for the site. For these reasons, our method uses relative scales. We assess stocking with predictions of *RV* that express expected growth relative to the maximum that can be achieved by the given species with optimal density on the given site.

Although the impact of OS on US is complex, our yield relationship recognizes only the dampening of US growth by the OS. However, an OS may benefit an US by reducing the risk of frost damage (Groot 1999). In addition, OS trees may contribute to increased natural regeneration. We do not account for the lag in response to OS removal common among shade-intolerant species that have been suppressed for a long time (Wright et al. 2000). Furthermore, although the model dampens growth, it does not reflect the increased mortality that occurs at very low light levels. Thus, at high OS basal area, the preliminary calibration of our model likely overestimates deviation from potential.

Additional research is needed to identify the optimum BAF for characterizing US growing conditions (Puettmann and D'Amato 2002). Our recommendation for selecting a BAF is based on a consideration of the correlations between US growth and the OS when sampled at various plot sizes (Puettmann and D'Amato 2002, Woodall et al. 2003), the sensitivity of competition indices to distance (Ledermann and Stage 2001), and the desire to control sampling cost.

In stands with clumpy distributions of US trees, our method likely overestimates RV_{exp} at low US densities thereby underestimating the deviation from potential at these densities (Bergerud 2002). This distortion arises from the assumption that TIPSY's plantation density is equivalent to well-spaced density, an assumption that breaks down as the spatial arrangement of US trees deviates from uniform.

The assumption that sapling height growth reduction is an adequate proxy for the overall impact of OS on US yield is certainly crude. However, this assumption results in a relationship between US growth and residual OS that is similar in shape to those found in several retrospective (Rose and Muir 1997, Acker et al. 1998) and simulation (Birch and Johnson 1992, Long and Roberts 1992) studies. Although we made some critical assumptions to calibrate our conceptual model, the resulting fitted model (Figure 6) exhibits behavior consistent with widely accepted principles of tree and stand growth: (1) as seedling density increases from zero, future volume increases and eventually levels-off; and (2) as OS basal area increases, US growth declines. As the amount of OS increases, the growing space available to US trees decreases, and with it the magnitude of US yield loss associated with low US density.

Clearly, the US growth response on any individual site may vary considerably from the response predicted by our method. Nevertheless, from the preceding discussion, we conclude that the general shape of our yield relationship is correct and that it provides a robust, generally applicable framework for setting US stocking standards and assessing US stocking.

Stand and Forest Management Context

A mountain pine beetle epidemic is raging in central British Columbia. In the emergency salvage harvests that create heterogeneous residual stands, there is little opportunity to design optimal postharvest stand structures. Because this is the management context in which our system must function, our approach focuses exclusively on US stocking levels and implicitly accepts the residual OS that has been retained. Although our method can be applied to a wide range of stand conditions, it is critical to recognize that some conditions will not produce healthy, productive, valuable stands. Whenever possible, silviculturists should avoid creating unfavorable conditions such as susceptible regeneration under a dwarf mistletoe (*Arceuthobium* spp.)-infected OS, retention of an OS of unstable, deformed, low-value, nonvigorous trees (O'Hara and Kollenberg 2003), and susceptible regeneration intimately mixed with stumps on sites infected with root disease (Morrison et al. 2001).

Where a subsequent harvest entry is anticipated in the near future, more US trees may be required to allow for losses at the next harvest. Our survey procedure must be enhanced to meet the broader objectives of a comprehensive reforestation evaluation which may include describing forest cover, locating areas of low stocking, assessing treatment alternatives, and detecting excessive density (Stein 1978). US stocking standards set with our method provide no assurance that other management goals will be met if these goals are for resource values not correlated with US volume production.

Approaches to Regulating US Stocking

British Columbia's existing even-aged and uneven-aged stocking standards (BC Ministry of Forests 2002) are inappropriate in spatially heterogeneous, partial-cut stands as they involve averaging plot tree tallies over the fine-scale mix of gaps, uncut areas, and thinned patches that comprise these stands. The resulting average tree density typically provides a poor indication of the adequacy of stocking over the harvested area. An indicator that remains meaningful when plots are averaged across a variety of stand structures is required in this stand type. The stocking indicator $RV_{\mathrm{m|o}} - RV_{\mathrm{exp}}$ (deviation from potential) has this desirable property.

In many other jurisdictions around the world, reforestation standards for heterogeneous stand types are specified in terms of combinations of mean OS basal area and mean US seedling density (Oregon Department of Forestry 1994, Westland Resource Group 1995). These dual variable systems also perform poorly when plot data are averaged over highly variable conditions. In contrast, California's stocking sampling procedures (the basal area, point count, and combination procedures) reliably evaluate stocking in spatially heterogeneous stands (see the California Forest Practice Rules, sections 1070–1075 at *ceres.ca.gov/topic/env_law/fpa/reg/7art5.html*). Like the approach presented in this paper, stocking is assessed at each sample point within a harvested area, and overall stocking is computed from the point-by-point stocking values.

Although regeneration standards specified in terms of tree density and basal area are easy to relate to, they tend to obscure the consequences of alternative stocking levels on fundamental forest management goals. These traditional types of reforestation standards have been criticized for failing to highlight the relationship between regeneration stocking and future yield (Alberta Reforestation Standards Science Council 2001). On most sites in central British Columbia, after harvest, a generally applicable, widely accepted objective is to re-establish enough regeneration to capture most of the timber-growing potential of the site. As our method expresses the regeneration density in terms of deviation from potential yield, it helps clarify the relationships among the stocking standard, the achieved stocking, and the timber production goal.

The approach that we have described is philosophically aligned with approaches described by Newton (1998) and Martin et al. (2002, 2004) for the regulation of regeneration in an even-aged context. These approaches belong to a new class of systems for establishing regeneration standards and assessing achievement that are organized around explicit yield predictions. The simple yield relationships embedded within these new systems are tailored to their specific purpose of providing the basis for regeneration standards and evaluating regeneration accomplishment.

Conclusion

Foresters in British Columbia lack an appropriate framework for establishing regeneration standards for the heterogeneous stands that result from some forms of partial cutting. The high degree of within-stand variation and the fact that the growing space available to the US is inversely related to the amount of OS pose particular problems. The system described in this article, we believe, provides a first approximation solution. By measuring US stocking in a new way, the system allows foresters to set regeneration stocking standards and assess outcomes in a manner that is consistent with the management objective of capturing potential yield and the biological principles that govern the growth of regeneration in the presence of retained OS trees.

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