HOW MUCH BIG-TREED OLD GROWTH REMAINS IN BC?

- VERY LITTLE -

In a report released in 2020[1], and published in a peer-reviewed journal in 2021[2], Price et al. describe the widely different levels of risk experienced by BC's diverse old forest ecosystems:

> "*Our analyses confirm provincial government claims that about a quarter of BC's forests are old growth but find that most of this area has low realized productivity, including subalpine and bog forests, and that less than 1% is highly productive old growth, growing large trees. Within biogeoclimatic variant, nearly half of high-productivity forest landscapes have less than 1% of the expected area of old forest. Low-productivity ecosystems are over-represented in protected forest*."

These analyses found that very little big-treed old growth remains in BC and that very little is protected.

However, a 2021 report commissioned by the forest industry lobby group the Council of Forest Industries (COFI) and authored by Cam Brown disputed this claim:

> *"When old forests are characterised using PSPL[3] data, the percentage of old forest is relatively consistent across site productivity classes and approximately 3.34 million ha of old forest is growing on sites where the expected site index is greater than 20m (29.3% of all old forest in the province)."*

And

> *"Approximately 75% of BC's old forest is considered protected or not within the Timber Harvesting Land Base, with this proportion being significantly higher on the coast versus the interior".*

These statements imply there are no concerns with the state of BC's old forest. This conclusion contradicts the findings of the Old Growth Strategic Review ("OGSR"; Gorley and Merkel 2020). It concerns us as ecologists because it relies on three fallacies that have dogged the implementation of sound forest management over recent decades:

1. The Brown report equates all forest types, suggesting that there is no subset of ecologically different old forest at high risk, and hence no need to consider different forest types for analysis and management.
2. Ignores that current policy **directs protection away** from these most at-risk forests.
3. And, equates "protection" with "area outside the Timber Harvesting Landbase", ignoring the very different management status of these two designations, and the differing distribution of forested ecosystems typically found inside and outside the THLB.

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[1] Price et al. 2020: https://veridianecological.files.wordpress.com/2020/05/bcs-old-growth-forest-report-web.pdf
[2] Price et al. 2021: https://cdnsciencepub.com/doi/abs/10.1139/cjfr-2020-0453
[3] PSPL = Provincial Site Productivity Layer

This paper summarises how the two reports reached different conclusions.

- Section 1 summarises key analysis issues.
- Section 2 provides general background and analysis on site index metrics.
- Section 3 provides technical background to support points.

Our analysis supports our original conclusion that BC's biggest-treed old forest is at high risk because a small fraction of its original extent remains, and because protection specifically avoids big-treed forest.

This analysis matters because BC has committed to a paradigm shift in forest management, based on OGSR recommendations. However, if some in industry and elsewhere deny the problem, it may doom the paradigm shift to failure. And – like climate change denial – failure to shift the paradigm towards maintaining forest resilience should be of significant concern to forest professionals, to all governments, and to the public. We depend on resilient forests as the pressures of the global climate crisis increase.

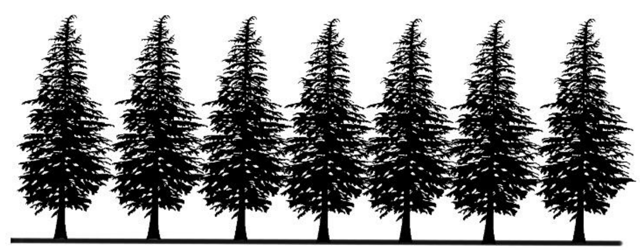
SECTION 1: A SUMMARY OF KEY POINTS COMPARING ANALYSIS BETWEEN PRICE ET AL. (BC LAST STAND REPORT) AND BROWN (THE COFI REPORT).

The crux of the difference between the two reports lies in the definition of what constitutes a "big" tree. The reports vary in their choice of indicator. Price et al. 2020, 2021 used Vegetation Resources Inventory (VRI) site index. Brown 2021 used the Provincial Site Productivity Layer (PSPL).

#1: INDICATORS ARE DESIGNED FOR DIFFERENT FUNCTIONS

- PSPL **does not claim** to measure **current** stand height or volume of natural stands. It is therefore inappropriate to use PSPL data to reflect current condition.
- Reflecting this challenge, the Province uses VRI[4] site index to describe current natural stands, and uses PSPL to describe future managed stands.

VRI Represents today's natural stands



PSPL Represents future managed stands

Brown report: Page 18: [PSPL data]…
"this may be a less direct reflection of the trees currently on a given site… "

#2: VRI REFLECTS TREE SIZE PRESENT ON THE GROUND BETTER THAN PSPL

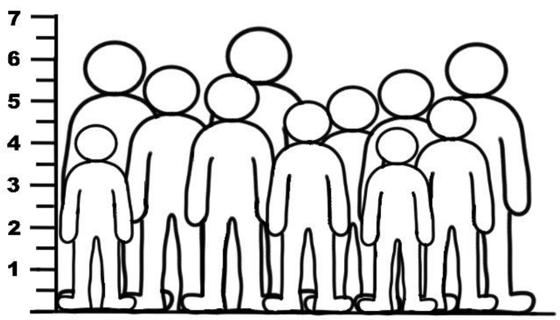
- PSPL performs more poorly than VRI in representing tree size in both ground plots and inventory databases.
    - Within 1,945 ground plots of forests over 140 years old, VRI site index data reflect actual tree height and diameter better than PSPL in every ecosystem type (Section 3.1).
    - Within the provincial inventory database, for forests over 100 years old, VRI site index is related to inventory tree height better than PSPL in every ecosystem type (Section 3.2).
- VRI site index data are correlated to stand volume, as designed. Conversely, PSPL data are not correlated to stand volume (Section 2).

[4] Vegetation Resources Inventory Site Index

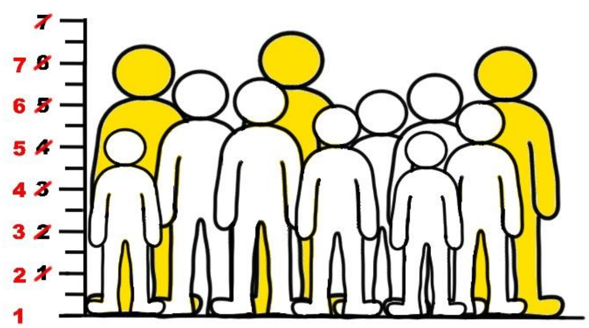
Comparing the two results as per the Brown report is a case of Apples versus Oranges

It is important to compare results appropriately.

- PSPL site index estimates are on average 6 points higher than VRI site index (Sections 2 and 3.1). It is therefore meaningless to use the same threshold to identify how much big-treed old growth exists.



Imagine a population of people (above left). Someone does an analysis and says everyone over 6 feet is tall (above right). A few tall people are tall.



Someone else comes along with a new ruler – the points on the ruler are higher than those on the original ruler (left).

This analyst decides to use the same threshold – 6 feet – to judge whether people are tall. Suddenly, a lot more people are tall (right).

This example is a direct analogy of why the COFI report found more tall trees – **they used a different ruler, but the same threshold.** Essentially, they redefined what the Price et al. 2020, 2021 report classed as “medium-sized” trees as “big” trees, and – unsurprising – they found more “big-treed” old growth.

USING EQUIVALENT THRESHOLDS FOR PSPL FINDS THE SAME LOW AMOUNT OF BIG-TREED OLD GROWTH AS VRI: 3 – 4%

PSPL shifts site index by 6.5 units across BC (inventory data; median shift based on 10.8 million hectares of old growth across BC; patterns are similar within each BEC zone). This means that to capture the same size of trees with PSPL as with VRI, the measurement threshold must be 6.5 units higher. If “big” is defined as VRI site index >20m, then the equivalent “big” as defined by PSPL is >26.5m. (see Section 3.3 for more details and additional comparisons).

Using this definition, there are about 416,000 hectares of “big-treed” old growth in BC. This represents 4% of BC’s old growth (in the inventory database). This amount is very close to the 3% described in Price et al. 2020, 2021 and very far from the 30% described in Brown 2021.

Section 2: General background on site index

Note that the **OG TAP DID NOT USE SITE INDEX** to identify areas of old forest for deferral.

However, understanding the extent of the old growth problem is a prerequisite to a solution that feeds into a paradigm shift.

INTRODUCTION

Stratifying old forest appropriately to capture variability in tree size is challenging, particularly in risk assessment where it is important to assess how much remains compared to historic amounts (see Section 3.1). While we can use height and diameter to select big-treed old growth for deferral candidates, we cannot use height and diameter to compare current amounts of big-treed old growth to expected amounts, because size varies with age. Hence, we need to describe ecosystem type using indicators that remain constant over time.

BEC variant remains constant and provides an excellent filter, but is too coarse a unit to capture the variation in risk amongst forest types. For example, within coastal BEC variants, forest ecosystems can vary from highly productive valley-bottom forests with massive Sitka spruce to bog forests dominated by bonsai shore pine. We suggest that site index—a measure of productive capacity—within BEC variant provides the best available information to capture this finer-scale, and highly important, variability.

Two estimates of site index are available within the provincial forest database: original inventory estimates of site index (sometimes termed VRI site index or "realized" site index) and the newer PSPL[5] models of site index. Price et al. 2021 used VRI Site Index to demonstrate that very little area of larger treed old forest (those typically found on sites with higher site index) remains and that these higher productivity forests are at a considerably higher risk than old forest found on sites with lower site index. Note that in Price et al., the question of interest was not "how fast will trees grow on the site", (i.e., "what is the productivity of the site"), but instead "what is the size of the trees that have grown on the site and remain there today?"

Because few people understand these datasets, what they are, what they mean, and their relative pros and cons, we compare the two indices here.

WHAT IS SITE INDEX?

Site index (SI) estimates the growth potential of a site. For example, SI 15 means that an average tree will reach 15m tall by 50 years old. Higher site indices represent more productive sites that can grow bigger trees faster.

- VRI Site Index reflects, at least to some degree, **what is on the site today** (i.e., how big the existing trees are) and as a result is often termed "realized" site index.
    - Developed and modified over several decades, it assigns site index based on air photo interpretation supplemented by ground sampling.

[5] PSPL = Provincial Site Productivity Layer

  - The provincial government uses VRI site index to estimate the growth of natural stands in TSR analysis.
- PSPL Site Index assigns a **growth potential** to the site, based on averaged growth estimates for individual species. PSPL is not intended to reflect what is on the site today.
  - It estimates potential average growth rate for a site based on ground plot data in the portion of the province with TEM or PEM mapping, and based on a biophysical model where mapping does not exist.
  - The provincial government uses PSPL site index to measure the growth potential in future stands.

DISTRIBUTIONS OF VRI AND PSPL SITE INDICES DIFFER

Across the province, PSPL assigns a higher site index to stands than VRI site index for both crown forest and old forest (i.e., the distribution is shifted to the right; Figure 1).

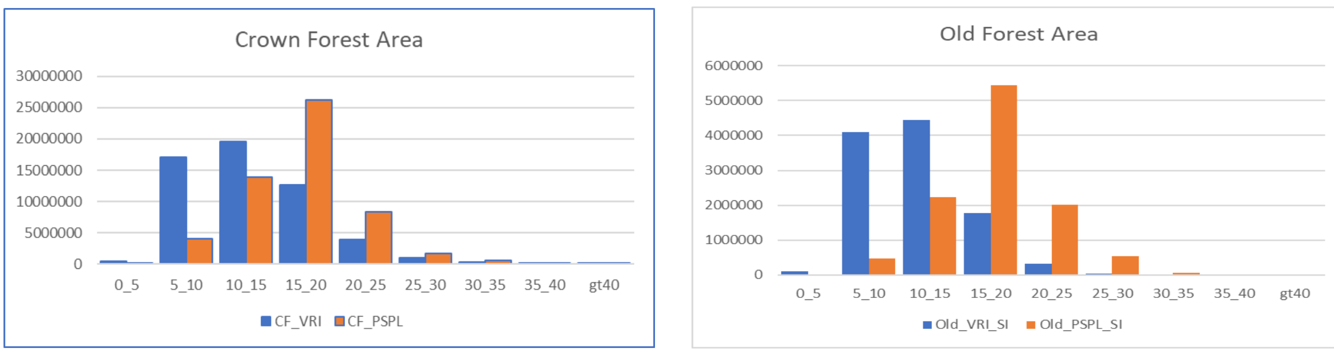
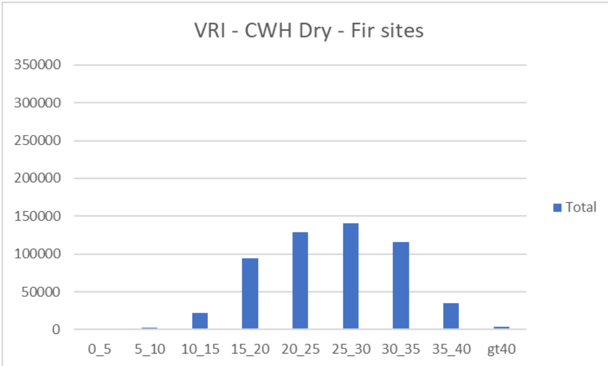


Figure 1. Distribution of site index classes in VRI and PSPL across the crown forest landbase and for old forest.

The mean site index is 12 for VRI and 18 for PSPL within old forest (6m higher for PSPL). Median site index is 6.5m higher for PSPL. Modal site index class is 10 – 15 for VRI and 15 – 20 for PSPL. The distribution of PSPL site index is normal, while the VRI distribution is skewed to lower site index (i.e., more trees from SI 5 – 15 than SI 15 – 25). The analysis of ground plot data (Section 3.1) found that PSPL on average classified site index for a given measured stand as 6.2m higher than VRI.

Given that PSPL identifies a higher site index for the **same** forest stand, it is inappropriate to use the same site index threshold as VRI to categorise “big-treed” old growth. **The PSPL dataset defines “big-treed” to include stands that are described as “medium-treed” in VRI, and thus increases the apparent big-treed area, without changing what is present on the ground** (illustration in Section 1)**.**

This pattern of higher average site index with PSPL is consistent within BEC units. In addition, VRI data show a wider range of site index estimates within a BEC unit than PSPL. For example, in fir-leading sites in the CWH dry, VRI site index has a flatter distribution centered around SI 20 -25, whereas PSPL site index has a strong tendency to a central point, around SI 30-35 (Figure 2). As well as increasing projected productivity, PSPL captures less of the natural variability found on the ground, and narrows the overall range.



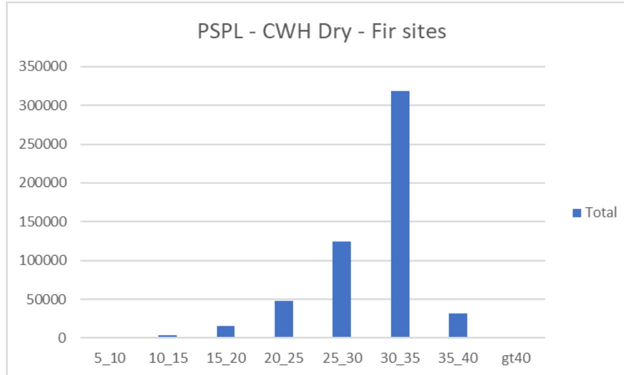


Figure 2. Distribution of site index classes within CWH dry fir sites

WHY ARE SITE INDEX NUMBERS HIGHER IN PSPL?

PSPL data reflect the growth of the fastest growing trees on any particular site. Field sampling selects the **very best** site-potential trees—those showing no suppression or damage and growing in perfect conditions—and measures their height and age. The size of these very rare, tallest site trees is then applied to all similar polygons. As a result, the measure of site index is higher than VRI site index, which is based on the average height of co-dominant trees rather than the tallest trees. VRI potentially under-estimates the potential site productivity in old growth, because old trees can be damaged, and many will not reach their theoretical potential. However, does not change its ability to assess **relative** size of current old forest.

WHY IS THE RANGE NARROWER IN PSPL?

PSPL site index is based on site data for similar ecosystems where available. The height of trees that meet the criteria for the best on a site is averaged across plots within a BEC unit and applied to all other sites within that BEC unit. This approach reduces the range of estimates for a BEC unit, by assuming that all sites will grow similarly. Natural variability in current realized growth is not reflected in PSPL data.

Where BEC unit plots are unavailable—a significant proportion of the province—the PSPL site index is estimated based on a biophysical model. This model is ecologically coarse, applying climate data to the biogeoclimatic zone (a very broad unit) rather than finer units. Assigning site index at such a coarse scale makes it impossible to assess potential differences between ecologically different areas (e.g., high productive riparian areas compared to adjacent steep slopes).

Where TEM data are used to generate the base input information, accuracy will be higher, though the effect of applying a 'maximum' site tree average value to all sites remains a significant issue. Where the biophysical model is used to generate the input data, the application is considerably weaker.

VRI REFLECTS WHAT IS ON THE GROUND TODAY BETTER

Because we are interested in knowing which sites have the largest trees, and not in determining the actual potential growth in a site, we asked "how well do measured tree height and diameter relate to estimates of site index from VRI inventory and from PSPL?"

Appendix 5 of the OG TAP Appendices (repeated below in Section 3.1) summarises our analysis of ground plots, comparing VRI and PSPL site index estimates to tree height and diameter. Those data reflect detailed stand data collected by the province of BC to reflect forest stand conditions. That analysis concludes VRI site index performs better than PSPL at estimating actual tree height and diameter in old growth stands. Across tree species/BEC zone groups with sufficient data, VRI site index was related to measured old growth tree attributes equally or more strongly than PSPL site index in every case. PSPL did not perform better within any group. Based on this analysis, we concluded that it inappropriate to use PSPL data to reflect the current condition of old forest today.

In the inventory data, VRI is related more strongly to height than PSPL (Section 3.2 for graphs).

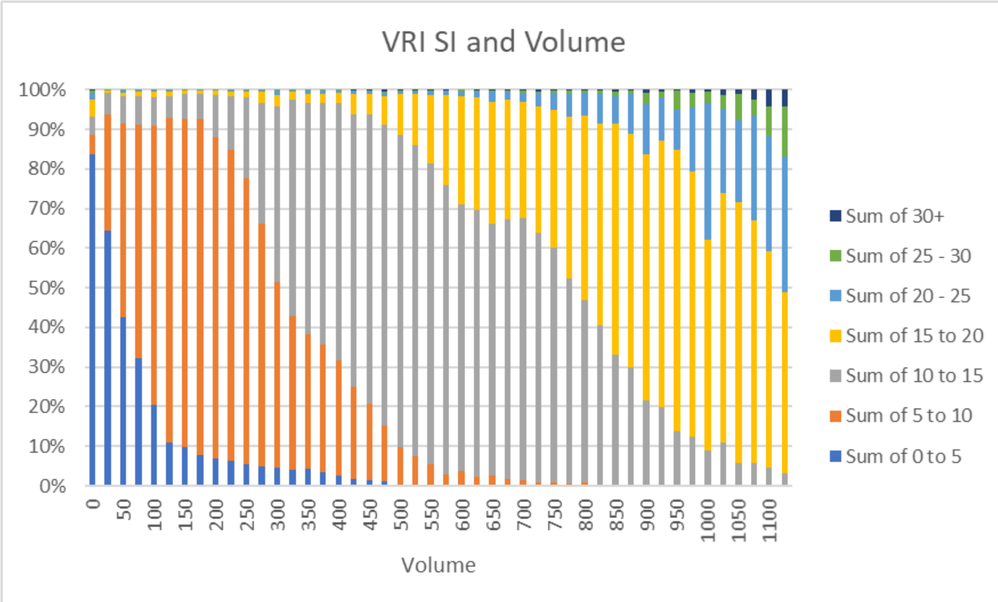
Measurement	VRI	PSPL	Comment
Slope	0.45	0.27	VRI is significantly steeper ($p<0.001$; generalized least squares fit). The shallow slope for PSPL means that tall and short trees have a more similar site index.
Intercept	-1	15	While VRI slope meets the Y-axis at the intercept, the PSPL slope crosses at 15. That means that trees that are 0m tall have a PSPL site index of 15.
Model fit (R-squared)	0.53	0.20	The R-squared value is much higher for VRI. This means that there is much less variation within each class for VRI (a given tree height will be assigned a similar site index), while PSPL site index varies considerably within each height class. The graph (Section 3.2) shows larger whiskers for each height class in PSPL.

Implications: This analysis did not ask which site index measure best reflects potential productivity of a site because we are interested in what is present on the site today, not in what might be present tomorrow. Although neither site index measure is perfectly suited to this analysis, our analysis confirms that, at the provincial scale in both ground plots and inventory data, VRI site index performs better than PSPL at estimating actual tree height and diameter in old growth stands. Thus, we used inventory site in our analyses[6] and recommend that others do the same.

VOLUME ANALYSIS

Another approach to understanding this issue is to look at how well the two site indices reflect the volume of wood as described in provincial data. We assessed the relationship between site index group and volume within a set of coastal stands older than 140 years. In the VRI comparison, stands with high volume are classified as having high productivity, while those with low volume are defined as low productivity (Figure 3 - top). The pattern is far less clear using PSPL site index (Figure 3 - bottom).

[6] Reminder that OG TAP did not use site index to identify forests for deferral. We only used site index to reduce the target percentages for the lowest risk forests when identifying big-treed forest for deferral.



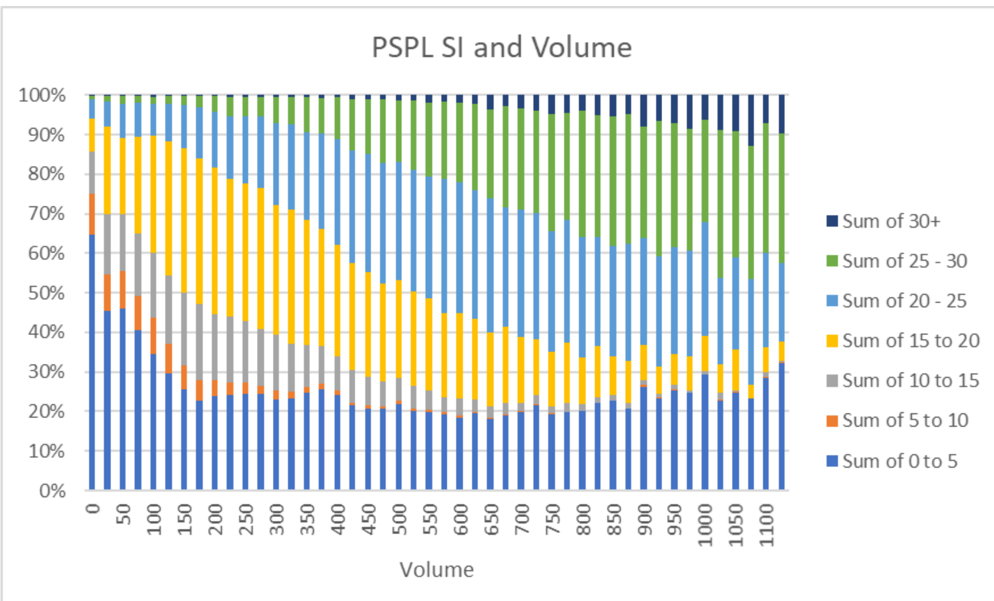


Figure 3. Relationship between stand volume and site index.

This analysis supports our conclusion that VRI site index is a reasonable measure of relative stand volume and that PSPL site index does not correlate well with the volume of the trees on the ground today.

BIG TREE ANALYSIS

We did not analyse single big trees to investigate this question (contrary to the COFI report). Big trees can be found on many sites as a result of local conditions and very long time periods. They do not represent an appropriate scale at which to verify a strategic level dataset. By definition, single big trees—the "perfect" trees used to define PSPL, will be better related to PSPL. However, these trees will not necessarily be related to the average size of the stand. Our analysis of ground plots is a superior test of stand condition relative to site index.

SUMMARY AND CONCLUSIONS

1. Both PSPL and VRI site indices pose interpretational challenges. Different pros and cons mean that each is useful for a different function.
2. PSPL site index is about 6 – 6.5m higher than VRI site index
    a. Using the same site index threshold for defining "big-treed" old growth will always result in a higher area assigned in PSPL versus VRI but will not change what is on the ground.
3. VRI better reflects the "realized" productivity of a stand and thus better at identifying existing big-treed old growth
    a. It is better related to stand volume than PSPL in the inventory data (Figure 3)
    b. It is better related to stand height and diameter in ground plots (Section 3.1)
    c. It is based on site-specific interpretation and not averaged across sites
    d. It reflects **relative** site index in natural stands better than PSPL because natural variability is not averaged.
4. PSPL better reflects the growth potential on a site, where good plot data exist
    a. However, averaging across sites and then applying the average universally reduces the capacity of PSPL to detect real differences in forest size (or productivity) on the ground
    b. The paucity of plots for some ecosystems mean that estimates are based on very broad models
    c. PSPL likely reflects **absolute** site index better than VRI
5. Before determining what dataset is appropriate to address a question, it is vital to define the question appropriately. While PSPL is likely better for predicting maximum growth rate in young stands, VRI is better for assessing the relative size of old growth.
    a. Answering the question 'what is the conservation status of existing old growth in the province' is best answered with VRI site index. Price et al. 2021 used the site index data in the same way as the province – using VRI site index to reflect realized site potential in natural stands.
    b. Answering the question 'what is the potential productivity of the site, or what kind of forest could it grow tomorrow' is best answered with PSPL site index.
    c. VRI site index likely under-estimates the site productivity in old growth, but that poses no difficultly for assessments of relative site index or relative tree size.

Section 3: Technical Background

3.1: Using Ground Plots to Compare PSPL and VRI Estimates of Site Index[7]

Identifying the most at-risk old growth requires comparing the current area of old growth to the area expected to be old under natural disturbance regimes. If the current amount of old forest is similar to the naturally expected amount, risk to biodiversity and ecological function is low; if current amount is low relative to expected, risk is high. At the provincial scale, this analysis, by necessity, relies on existing databases. Available inventory data are uncertain because they rely on remote assessment or extrapolated models and because it is difficult to capture the immense variability amongst forested ecosystems without walking through them.

While we can use height and diameter to select big-treed old growth for deferral candidates, we cannot use height and diameter to compare current amounts of big-treed old growth to expected amounts, because size varies with age. Hence, we need to describe ecosystem type using indicators that are in defined categories.

BEC subzone/variant remains constant and provides an excellent filter but is too coarse a unit to capture the variation amongst forest types. For example, within coastal BEC variants, forest ecosystems can vary from highly productive valley-bottom forests with massive Sitka spruce to bog forests dominated by bonsai shore pine. Ideally, we would use site series mapping, but this is not available at the provincial scale. Instead, we suggest that site index—a measure of productive capacity—within BEC subzone/variant provides the best *available* surrogate to capture this finer-scale, and highly important, variability.

Two estimates of site index are available within the provincial forest database: inventory estimates of site index and PSPL[8] models of site index. Our previous analyses of risk to old growth forest types used inventory estimates.[9] Others suggest that PSPL might provide a better estimate for old forest. We used available ground plot data to test the relationship between each measure of site index and old forest height and diameter—the factors selected to indicate large-treed old growth.

Because we are interested in knowing which sites have the largest trees, and not in determining the actual potential growth in a site, we asked "how well do measured tree height and diameter relate to estimates of site index from inventory and from PSPL?"

Methods

Government analysts collated and provided available ground plots (n = 6,978) and spatially linked inventory data. Because this project focusses on old growth, we limited our exploration to relationships between site index and ground measurements in old forests. We used the dataset previously created to

[7] Section 3.1 is a copy of Appendix 5 from the Old Growth Technical Advisory Panel supplementary material found here: insert weblink.
[8] PSPL = Provincial Site Productivity Layer
[9] Price et al. 2021: https://cdnsciencepub.com/doi/abs/10.1139/cjfr-2020-0453

examine the relationship between ground plot attributes and older forests, including 1,945 plots of forest > 140 years old (See Appendix 1 for exclusions and inclusions). We focused analyses on tree height and diameter as tree size attributes.

Because ecosystems vary and because tree species vary in their growth patterns, we examined the data stratified by tree species within BEC zone. This stratification reduces sample size within groups considerably. To avoid misleading results from small samples, we only used leading species/BEC zone combinations with at least 30 ground plots.[10] For each leading species/BEC zone group, we ran general linear models of site index against height and diameter.[11]

Results

Across the full sample of old growth plots, inventory site index and PSPL site index are significantly positively correlated with each other (Figure 1; r = 0.52; n = 1,652 plots with PSPL data). PSPL site index is generally higher than inventory site index (difference = 6.2 ± 0.1; mean ± SE; n = 1,652)

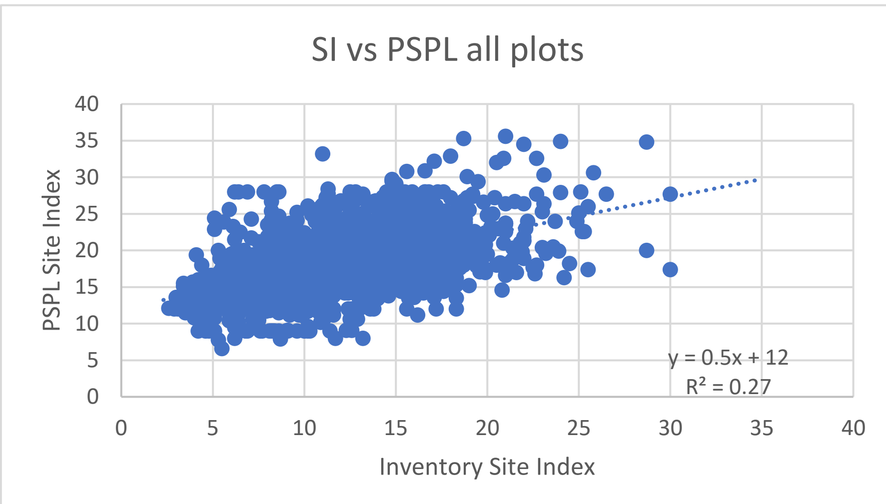


Figure 1. VRI inventory site index and PSPL site index on sites measured in old growth plots.

Across tree species/BEC zone groups with sufficient data (i.e., > 30 plots[12]), inventory site index was related to measured old growth tree attributes equally or more strongly than PSPL site index in every case (Table 1). PSPL did not perform better at reflecting attributes on the ground, within any group. Relationship strength varied across groups. Both inventory and PSPL site index were related to tree height and diameter in western hemlock within the CWH, subalpine fir and interior spruce in the ESSF and interior spruce in the SBS. Neither were related to tree size in subalpine fir in the SBS.

Site index (both VRI inventory and PSPL) in the ICH performs strangely. For both western redcedar and western hemlock in the ICH, the relationship between measured attributes and site index were negatively related (i.e., stands classed as more productive had smaller trees). There are no obvious causes on quick inspection (e.g., the breadth of the variables is as wide as other groups); this pattern requires further investigation.

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[10] Arbitrary selection of sample size as time precluded power analyses.

[11] R Core Team 2021. R: a language and environment for statistical computing. R Foundation for Statistical Computing. Vienna Austria. https://www.R-project.org/.

[12] Note that not all plots have PSPL estimates; MH plots do not achieve n=30 for PSPL.

Table 1. Linear relationships between site index and attributes measured on the ground, stratified by leading species/BEC zone. Green cells have significantly positive relationships (dark green P<0.01, light green P< 0.05). Pink cells have significantly negative relationships (i.e., plots with higher site index have smaller trees).

BEC	Species	Variable	VRI Inventory SI			PSPL SI		
			F	df	P	F	df	P
CWH	BA	Diameter	10	47	<0.01	3	35	0.1
		Height	10	44	<0.01	2	32	0.14
CWH	CW	Diameter	32	132	<0.01	0	119	0.6
		Height	39	116	<0.01	21	106	<0.01
CWH	HW	Diameter	20	147	<0.01	11	123	<0.01
		Height	36	138	<0.01	15	115	<0.01
CWH	YC	Diameter	44	76	<0.01	0	48	0.6
		Height	4	70	0.04	2	44	0.14
ESSF	BL	Diameter	127	410	<0.01	10	390	<0.01
		Height	42	404	<0.01	24	385	<0.01
ESSF	SE	Diameter	8	69	<0.01	3	66	0.09
		Height	5	67	0.02	1	64	0.3
ESSF	SX	Diameter	13	42	<0.01	8	40	<0.01
		Height	12	41	<0.01	12	39	<0.01
ICH	CW	Diameter	4	86	0.05	19	82	<0.01
		Height	1	76	0.4	1	73	0.3
ICH	HW	Diameter	7	75	<0.01	2	74	0.2
		Height	2	71	0.16	2	71	0.2
IDF	FD	Diameter	11	91	<0.01	0	88	0.5
		Height	25	88	<0.01	8	85	<0.01
MH	HM	Diameter	26	40	<0.01	0	8	0.8
		Height	1	40	0.2	0	8	0.6
SBS	BL	Diameter	2	71	0.16	1	62	0.2
		Height	1	69	0.3	0	60	0.8
SBS	SX	Diameter	52	108	<0.01	18	91	<0.01
		Height	24	106	<0.01	9	89	<0.01

IMPLICATIONS

This analysis did not ask which site index measure best reflects potential productivity of a site because we are interested in what is present on the site today, not in what might be present tomorrow. Although neither site index measure is perfectly suited to this analysis, our analysis confirms that, at the provincial scale, VRI site index performs better than PSPL at estimating actual tree height and diameter in old growth stands. Thus, we used inventory site in our analyses[13] and recommend that others do the same.

[13] Reminder that OG TAP did not use site index to identify forests for deferral. We only used site index to reduce the target percentages for the lowest risk forests when identifying big-treed forest for deferral.

Section 3.2: How well does site index (PSPL and VRI) match tree height in inventory data?

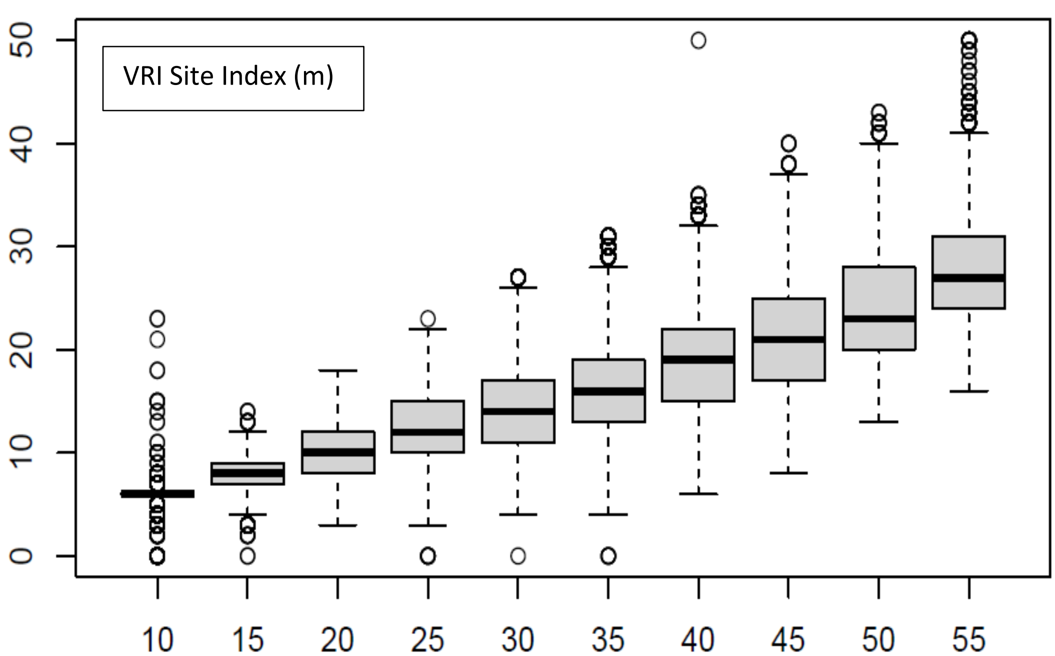
We compared the relationship between inventory tree height and two measures of site index (PSPL and VRI) using inventory data for the province. We assessed patterns for stands over 100 years old; most of these are unmanaged stands. This analysis is a companion to the assessment of ground plot data that shows that for old growth stands, 1) inventory tree height correlates well with measured tree height (better than any other size indicators) and 2) VRI site index correlates better with measured tree height than does PSPL.

If site index is closely related to tree height, we'd expect that site index would increase as height increases.

VRI site index is much more strongly related to height class than PSPL index (Figure 1), with a significantly steeper slope (VRI: slope = 0.45; PSPL: slope = 0.27; t = 338, df = 929,604, $p < 0.001$; generalized least squares fit comparing the slopes). The shallow slope for PSPL means that tall and short trees have a more similar site index; that is, PSPL does not discriminate as well among tree size classes.

While the VRI slope meets the Y-axis at the intercept, the PSPL slope does not. That means that trees that are 0m tall have a PSPL site index of about 15m.

The model fit is much higher for VRI than PSPL (VRI: $R^2 = 0.53$; PSPL $R^2 = 0.20$). This means that there is much less variation within each height class for VRI (a given tree height will be assigned a similar site index), while PSPL site index varies considerably within each height class. The whiskers are larger for each height class in the PSPL graph (Figure 1).



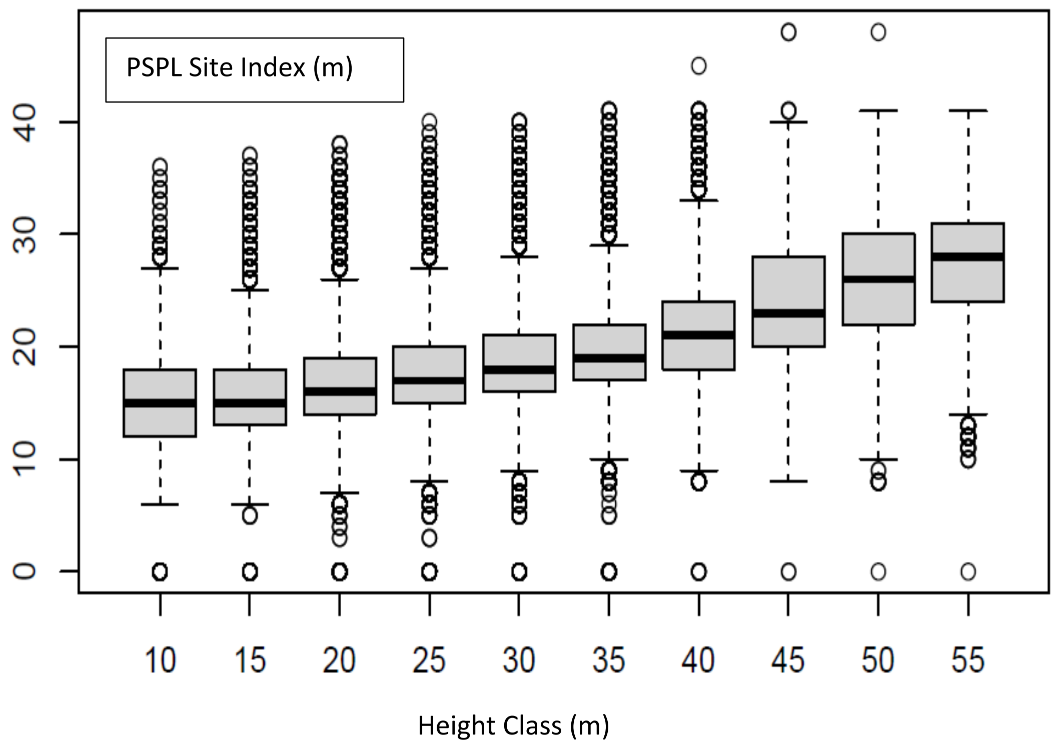


Figure 1. Box plots show the distribution of site index estimates for each tree height class based on inventory data for stands over 100 years old across BC.

These patterns are consistent across all BEC zones (Table 1). In every BEC zone, VRI is closely related to tree height while PSPL site index is not. While VRI R-squared values range from 0.33 to 0.74, PSPL R-squared values range from 0 to 0.15.

Table 1. Slope and R-squared value (model fit) for the relationship between site index (PSPL and VRI) and tree height class from inventory data across BC.

BEC Zone	PSPL Slope	VRI Slope	PSPL R^2	VRI R^2
BG	0.05	0.45	0.01	0.74
BWBS	0.13	0.51	0.05	0.55
CDF	0.11	0.58	0.05	0.72
CWH	0.23	0.49	0.14	0.61
ESSF	0.14	0.33	0.09	0.36
ICH	0.09	0.42	0.04	0.33
IDF	0.19	0.47	0.15	0.63
MH	0.10	0.37	0.03	0.56
MS	0.13	0.39	0.11	0.44
PP	0.03	0.44	0.00	0.55
SBPS	0.12	0.41	0.05	0.46
SBS	0.17	0.53	0.15	0.55
SWB	0.11	0.34	0.02	0.35

SECTION 3.3: HOW MUCH BIG-TREED OLD GROWTH REMAINS IN BC: COMPARING THREE INDICATORS

Assessing how much big-treed old-growth remains requires a definition of what constitutes a “big” tree. This definition has two parts: choosing a measurement indicator of size and determining an appropriate “big” threshold for the indicator. Several indicators for measuring tree size are available in provincial datasets including the following:

1. Vegetation Resource Inventory (VRI) site index
2. Provincial Site Productivity Layer (PSPL) site index
3. Estimates of tree height in VRI.[i]

VRI and PSPL site index both estimate elements of site productivity.[ii] We expect bigger trees on more productive sites—such as valley-bottom floodplains—and smaller trees at high elevations and sites with limited nutrient availability such as bogs. Both site index indicators estimate tree height in metres at age 50 and capture trends in productivity, but because of different assumptions and methodologies, they result in different values for a given old-growth forest stand.

This note estimates the area of big-treed old growth as measured by each indicator using an equivalent threshold for each. Previous work identified a VRI site index threshold of >20m for big-treed old growth[iii] and determined that about 3% of BC’s remaining old growth met this threshold. For the other two indicators, we need to ensure we’re "comparing apples to apples” and use thresholds that capture trees of the same height as VRI site index >20m.

For a given old-growth tree height, PSPL site index is consistently 6m higher than VRI site index. This difference holds in ground plots where tree height is measured[iv] and in inventory datasets where height is estimated.[v] The pattern is similar across ecosystems. Hence, the comparable thresholds for “big” (VRI site index >20m) using PSPL site index is 6m more than for VRI site index (i.e., PSPL site index >26m).

Similarly, to compare the area of “big-treed” old growth based on inventoried tree height, we need to establish an equivalent threshold. Stands with trees >45m tall have an average VRI site index of 19 and PSPL site index of 25, slightly lower than the site index thresholds, but close enough for comparison.[vi]

This table compares the area of “big-treed” old growth in B.C. using the three indicators. The areas are similar (height gives a larger area, but the threshold is slightly lower so this is expected). Using equivalent thresholds, **all indicators estimate that big-treed old growth makes up between 3.3 and 4.7% of BC’s total old growth, confirming previous estimates as described in Price et al. 2021.**

Indicator	“Big” threshold	Area of “big” old growth (ha)	% of total old growth**
VRI site index	SI>20	353,283*	3.3%
PSPL site index	SI>26	415,977	3.9%
Height	>45m	507,224	4.7%

* Using VRI site index > 20m as a threshold, Price et al. 2021 found 415,000 ha of big-treed old growth. Updated data decreases both the area of old growth with SI > 20m and the total area of old growth.
** Based on 10.8 million ha of old growth with height data.[vii]

Using a PSPL threshold of SI >20m would capture a much larger area of old growth because a lower threshold would encompass relatively smaller "medium-sized" as well as "big" trees. Such an analysis would be inconsistent with identifying "at-risk old growth".

Summary:

This note demonstrates that the amount of old growth remaining **on equivalent high productivity sites** is very similar. Using an equivalent height measurement also results in a similar percentage of big-treed old forest remaining. In all cases, the amount remaining is very small.

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[i] The Old Growth Technical Advisory Panel used tree height and diameter to identify stands of big trees for harvest deferral. This note takes a simpler approach and selects height over diameter as data show it is more accurate.

[ii] See Section 2 for a description of why these datasets measure different types of productivity.

[iii] The authors chose the threshold based on personal field experience in stands with VRI site index >20m, on reviews of timber supply analyses that used similar VRI thresholds for highly productive sites, and on the distribution of area in different VRI site index classes.

[iv] Old Growth Technical Advisory Panel Technical Appendix 5. OG TAP Background and technical appendices

[v] Xxx Need to write this up formally.

[vi] Based on inventory data. Using ground plot data results in a higher estimate (50m or more), but there are few plots with trees this tall and hence

[vii] Out of a total of about 11.1 million hectares of old growth in BC (Old Growth Technical Advisory Panel)